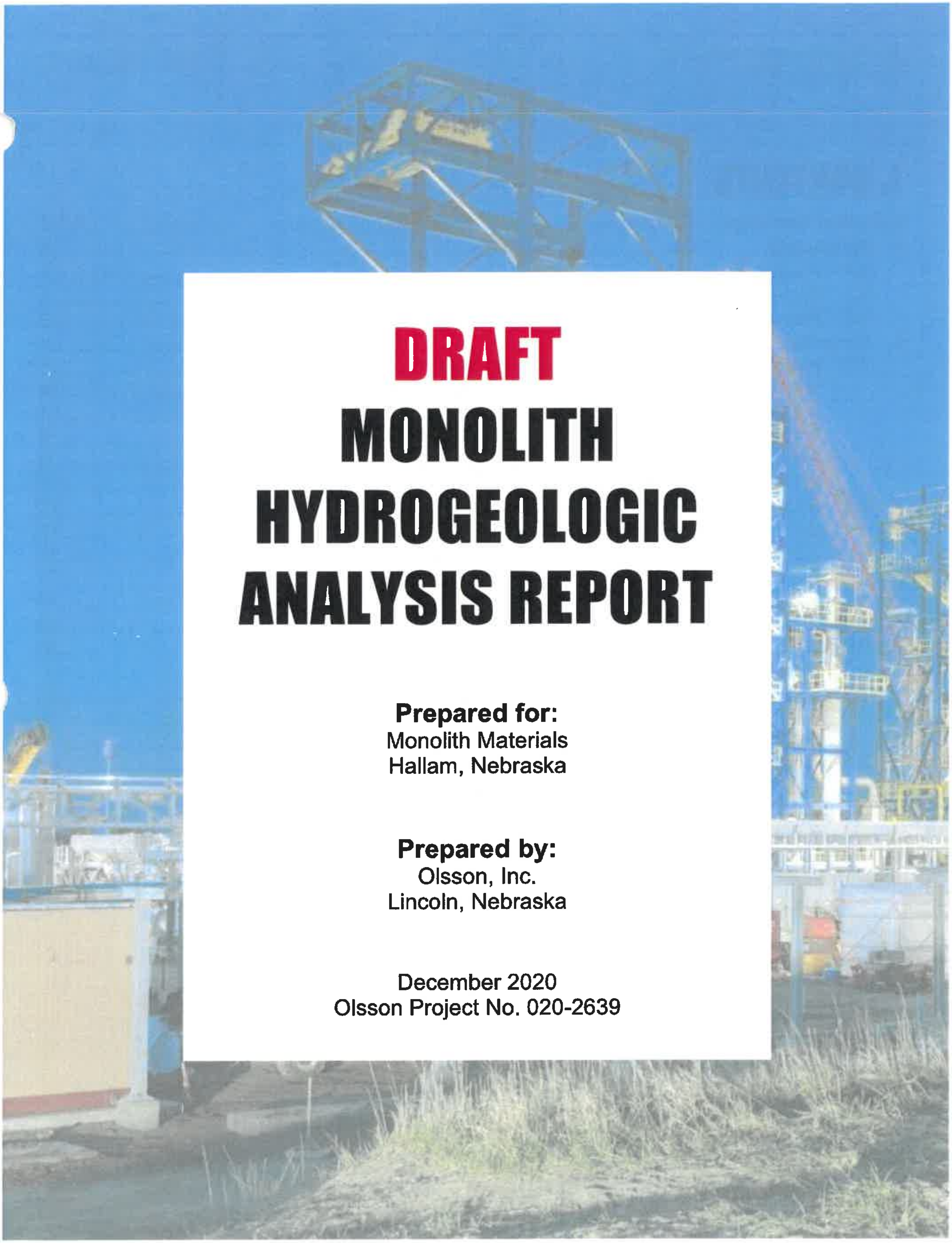

DRAFT

MONOLITH HYDROGEOLOGIC ANALYSIS REPORT

Prepared for:
Monolith Materials
Hallam, Nebraska

Prepared by:
Olsson, Inc.
Lincoln, Nebraska

December 2020
Olsson Project No. 020-2639

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1. CONTENTS

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ACRONYMS AND ABBREVIATIONS

AF ..... acre feet
BAS Package ..... Basic Package
cfs ..... cubic feet per second
CLN ..... Connected Linear Network
CPA ..... Crete-Princeton-Adams
CSD ..... Conservation and Survey Division
DISU File ..... Discretization File
ENWRA ..... Eastern Nebraska Water Resources Assessment
EVT ..... Evapotranspiration Package
GET ..... Groundwater Evaluation Toolbox
GHB Package ..... General Head Boundary Package
HEM ..... Helicopter Electromagnetic Mapping
HPRCC ..... High Plains Regional Climate Center
LPF Package ..... Layer Property Flow Package
LPMT ..... Lower Platte Missouri Tributaries
LPSNRD ..... Lower Platte South Natural Resources District
MGY ..... million gallons per year
NDEE ..... Nebraska Department of Environment and Energy
NDNR ..... Nebraska Department of Natural Resources
NPPD ..... Nebraska Public Power District
OC File ..... Output Control File
PEST ..... Parameter Estimation
RCH Package ..... Recharge Package
RIV Package ..... River Package
SMS ..... Sparse Matrix Solver
SNR ..... School of Natural Resources
STR Package ..... Stream Package
UBBNRD ..... Upper Big Blue Natural Resources District
UNL ..... University of Nebraska Lincoln
USDA ..... United State Department of Agriculture
USG ..... Unstructured Grid
USGS ..... United States Geological Survey
WEL Package ..... Well Package

EXECUTIVE SUMMARY

Monolith Materials, Inc. (Monolith), currently operates a manufacturing facility in southern Lancaster County just north of the Village of Hallam, Nebraska. Monolith is currently planning a roughly ten-fold expansion of this facility, with a corresponding expansion of their water needs. As such, Monolith will need to install several additional water wells, and collectively the annual withdrawal from these wells will exceed the threshold set in the Lower Platte South Natural Resources Districts (LPSNRD) Rules and Regulations, thus requiring additional testing and evaluation. Monolith has completed the required pumping test and has previously submitted the results of the evaluation of the data collected during that test. An additional requirement is for a hydrogeologic analysis report, which is required to evaluate the impact of the proposed withdrawal on current users and on the aquifer for potential future users. This report provides that evaluation.

The aquifer that Monolith will be withdrawing water from is referred to in the LPSNRDs Rules and Regulations as the Crete-Princeton-Adams (CPA) aquifer. The hydrogeologic structure of this aquifer has been thoroughly mapped by previous researchers and generally consists of upper and lower aquifer materials that are directly connected in some locations and separated by some thickness of non-aquifer materials in other locations. The upper aquifer is overlain by some thickness of non-aquifer materials in some locations, elsewhere it is at or very near to the land surface. While this aquifer is more limited in lateral extent relative to aquifers in other parts of Nebraska (such as the High Plains Aquifer which underlies much of the state), it is none-the-less an important source of water in the area and has supported domestic, irrigation, and manufacturing water uses for many decades while experiencing very little change in water levels over the long term (See Figure ES.1).

This evaluation began with the examination and use of a regional groundwater flow model of eastern Nebraska referred to as the Lower Platte Missouri Tributaries (LPMT) groundwater model. Development of the LPMT model involved an extremely rigorous estimation of the water budget for the aquifers in this area. This involved estimation of land use (crop type and whether that crop was irrigated) by year for over a fifty-year period. This information was combined with data on soils and climate (precipitation and temperature) to provide detailed estimates of groundwater recharge and groundwater withdrawals. When combined with the estimated aquifer parameters, the LPMT model replicates observed water levels and stream baseflows to a high degree of accuracy, indicating that the estimated water budget provides a good spatial and temporal representation of groundwater recharge and withdrawals.

An initial estimate of the likely impacts of the newly proposed groundwater withdrawals by Monolith was obtained using the LPMT groundwater model. First, the levels of water supply and water use were compared for the area of the LPMT model that coincides with the CPA aquifer as defined in the LPSNRD Rules and Regulations. Long-term average groundwater supplies (composed of precipitation derived recharge and inflows from other parts of the aquifer) are approximately 6.5 billion gallons per year. Groundwater use has varied over time as a result of groundwater irrigation development and varying climatic conditions. Generally, the more recent groundwater use has tracked at about one billion gallons per year, though exceeding two billion gallons per year in the most recent dry years. The unused supply, or roughly four to five billion gallons per year, is largely discharged from the aquifer to streams in the area. This represents the balance between the inflows of water to the aquifer and the outflows of water from the aquifer.

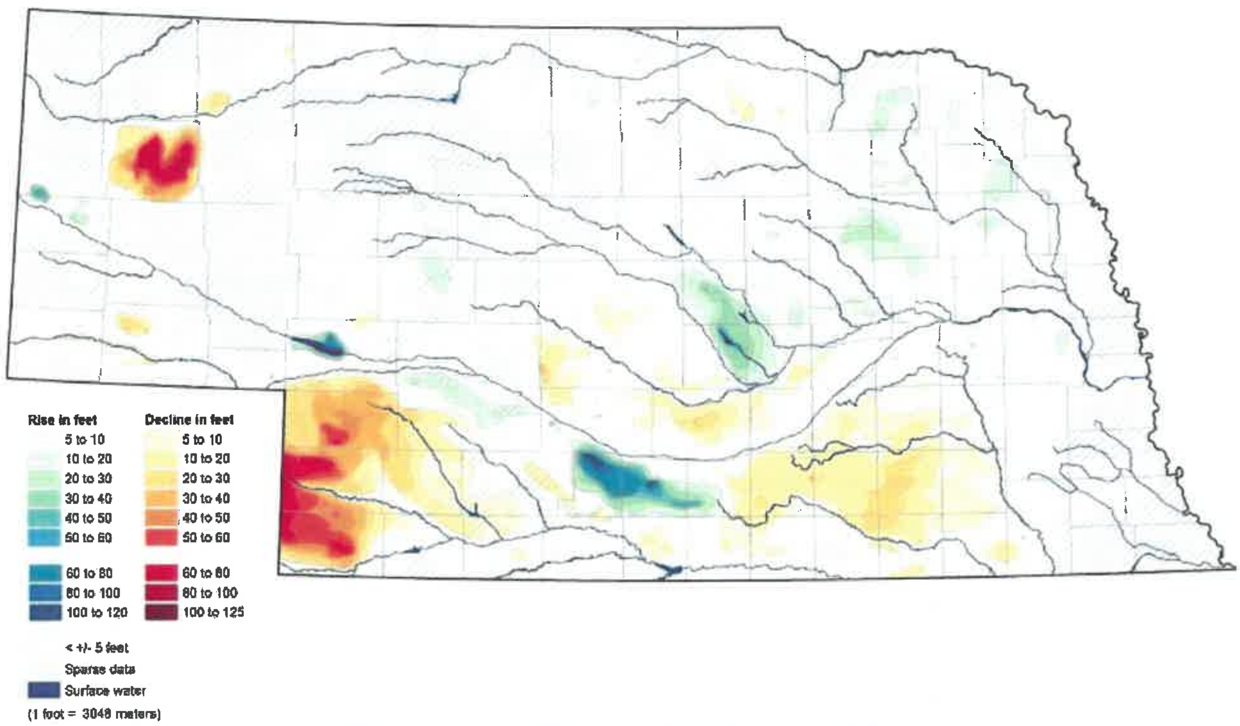


Figure ES.1 Change in water levels in aquifers in Nebraska, predevelopment to 2019.

Monolith has estimated that its water usage will average 320 million gallons per year. Therefore, there is clearly room within the available water supply, given existing uses, for this additional water use, while leaving more than half of the water supply available for future users. The LPMT model was further leveraged to gain insight on the potential impact of this new water use on existing users. The model was run for 50 years with an additional 320 million gallons per year being withdrawn at the location of the Monolith plant[1]. Predicted drawdowns ranged from less than one foot to as much as 7.5 feet in the immediate vicinity of the Monolith plant. Drawdown patterns notably indicate that drawdowns are likely limited by the interception of water that would otherwise be discharge as stream baseflows. Indeed, subsequent modeling efforts (discussed below) verify that the primary impact of the new water use will be a reduction to stream baseflows.

While the results from the LPMT groundwater model provide a good initial estimate of the likely impact of Monolith's water use, these results needed to be corroborated through the development of a subregional groundwater model that is significantly more refined that the regional LPMT groundwater model. The development of a subregional groundwater model allowed for the incorporation of the more detailed hydrogeology described above. The refined Monolith model encompasses the entire CPA aquifer in southern Lancaster County and extends beyond that area some distance to the south and west. Much of the information incorporated in the LPMT modeling effort was directly used for the Monolith model. The two primary differences between the regional and subregional model are the refined geology and a refined representation of the streams in the model. The refined geology was used to simulate up to four

[1] It is important to note that the LPSNRD Rules and Regulations only require evaluating 20 years into the future. This report provides a 50-year evaluation in order to go above and beyond that base requirement.

geological model layers at any given location, as compared to one layer simulated in the regional model. The base model grid size of 160 acres (2640 feet by 2640 feet) used in the LPMT model was refined in the Monolith model to model cells 330 feet on each side to represent area stream segments and to 165 feet on each side in the area surrounding the Monolith site. The aquifer properties (horizontal and vertical hydraulic conductivity) were estimated using a calibration process that matched simulated water levels to observed water levels to a degree generally considered to be sufficient to provide a model capable of providing estimates of future impacts of this type of new use.

In order to evaluate the potential impacts of the proposed water use by Monolith, a baseline future scenario was developed to provide for a representation of future water use within the model domain without the addition of the Monolith water usage. Climate conditions from 1995-2019 were repeated to create a 50-year future scenario beginning at the end of 2019. Recharge values from these historic years were used with no modification. Pumping values were revised upward to ensure that the most recent irrigated acres dataset (2013) was represented for all future years. Cumulative future withdrawals are estimated to be approximately 12,000 acre-feet per year on average across the model domain before adding in the Monolith pumping. This value would increase to approximately 13,000 acre-feet per year on average with the addition of the Monolith pumping. The approximately 1,000 acre-feet per year of new pumping reduces aquifer storage at a rate of about 300 acre-feet per year on average, with the remainder of that new use resulting in reductions to stream discharges and other boundary conditions (e.g., the lateral boundary of the model).

Maximum aquifer drawdowns in the Monolith groundwater model are somewhat greater than those simulated with the LPMT model. This is likely due to the refined nature of the model cell that withdrawal was assigned to. However, within about one mile (the distance to the nearest irrigation wells), maximum drawdown was only about three feet. The saturated thickness of the aquifer in the vicinity of the Monolith site is approximately 150 feet, so the likely impact to existing users in the area is a reduction of saturated thickness of approximately two percent. The LPSNRD has a phased management approach to maintaining the quantity of groundwater available for use in its aquifers. This approach utilizes triggers that indicate when an area should be triggered into a higher phase of groundwater management. The CPA aquifer has never hit the first of these triggers and, based on our analysis of the trigger monitoring wells, it does not appear that the addition of the Monolith water use to the existing group of water users will cause that trigger to be reached in the future.

1. INTRODUCTION

The hydrogeologic analysis described in this report was completed by Olsson under contract with Monolith Materials, Inc. (Monolith). This document was prepared solely for Monolith in accordance with professional standards at the time the services were performed and in accordance with the contract between Monolith and Olsson dated September 4, 2020. The document is governed by the specific scope of work authorized by Monolith and it is not intended to be relied upon by any other party except for the regulatory authorities that will use this analysis for consideration during water supply permitting and oversight including but not limited to the Lower Platte South Natural Resources District (LPSNRD). All data, drawings, documents, or information contained in this report have been prepared exclusively for Monolith and may not be relied upon by any other person or entity without the prior written consent by Monolith.

1.1 Project Introduction

Monolith is developing a carbon black production facility near Hallam, Nebraska (Figure 1.1). At the new facility, Monolith will use renewable electricity to transform natural gas into materials including carbon black and hydrogen. Carbon black is a common material found in everyday products like tires, automotive and industrial hoses and belts, plastics, inks and food packaging. Conventional carbon black is produced by burning a specific type of oil or coal tar that releases large amounts of greenhouse gases into the atmosphere. When the production facility is complete, using Monolith's proprietary methane pyrolysis process combined with 100 percent renewable electricity, the facility near Hallam will create carbon black and as a secondary product it will produce carbon-free anhydrous ammonia. The facility is projected to eliminate nearly 1 million tons of carbon dioxide per year from entering the atmosphere and the locally produced ammonia will reduce dependency on the 1.75 million tons of ammonia imported each year to grow crops in Nebraska and across the United States (Monolith 2020a).

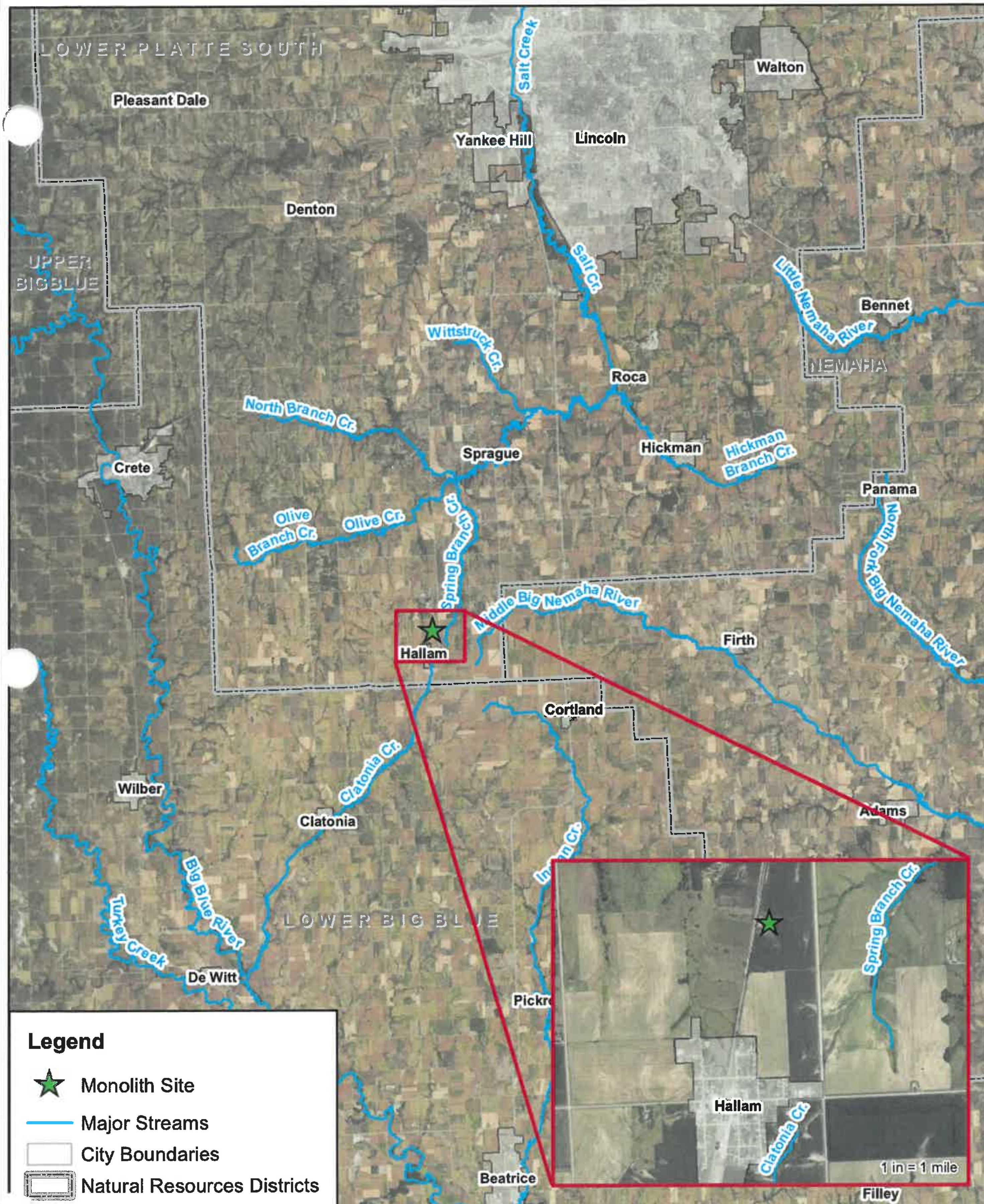
Operation of the plant will require non-contact cooling water to be pumped into the plant, piped through the cooling tower, and discharged to a nearby stream. Preliminary feasibility and conceptual design estimates of non-contact cooling water needed to operate the plant have been refined to arrive at a detailed design estimate for annual water use. The current annual water use estimate needed to operate the plant is up to 320 million gallons per year (MGY) (Monolith 2020b). This volume of industrial water use is along the same order of magnitude as the amount of water used each year at Sheldon Station power plant when it was operating and producing electricity for the Nebraska Public Power District (NPPD).

1.2 Project Scope and Objectives

This project was initiated to support the application for a permit to construct a Class 2 water well in the LPSNRD (LPSNRD 2020). As required for Class 2 water wells, "[a] hydrogeologic analysis report considering the impact of the proposed withdrawal on current groundwater users and a minimum twenty (20) year impact on the aquifer for potential future users shall be submitted by the Applicant" (LPSNRD 2020). Therefore, the primary objective of this hydrogeologic analysis was to evaluate the potential impact of the proposed water supply well(s) on existing groundwater users and on the local water supply. There are no specific guidelines within the groundwater management rules and regulations for the LPSNRD, however this evaluation follows standard scientific methods and uses the best available science to meet this need. Specifically, this hydrogeologic analysis includes information about the geology, hydrogeology, existing water use, proposed water use, sufficiency of the groundwater supply, anticipated impacts to the groundwater supply, and pumping capacity of wells within three miles of the proposed new water well(s).

1.3 Report Organization

The report is organized as a standard scientific paper with an introduction, methods, results, and discussion. This organization provides clarity on the specific datasets and scientific methods used to complete the analysis. Additionally, the results of the analysis are separated from the discussion to provide transparency between the groundwater modeling results and the interpretation of results. References to datasets, research, and publications are provided at the end of the report with hyperlinks provided when available. The report was prepared under the control of a professional engineer licensed in the State of Nebraska, as required by the LPSNRD.



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Location Map
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE
1.1

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2. METHODS

The methods used to complete the hydrogeologic analysis are subdivided into two parts. The first part included collecting, evaluating, and summarizing the existing hydrologic and geologic data to develop a conceptual model (or conceptual understanding) of the hydrogeology in and around Hallam. The second part of the analysis included developing a groundwater model to simulate the hydrogeologic conditions so that the impact of the new wells on the aquifer and existing wells could be evaluated. This section provides information on how the conceptual and groundwater models were developed.

2.1 Hydrogeologic Data Assessment and Mapping

There are numerous published and unpublished reports that provide data on the hydrogeology of the Hallam area. The three primary sources of information used for this project include the extensive evaluation of the hydrogeology and hydrology of eastern Nebraska conducted as part of the development of the Lower Platte Missouri Tributaries (LPMT) groundwater model. Additionally, the LPSNRD has partnered with five other NRDs and several agencies (Nebraska Department of Natural Resources [NDNR], Conservation and Survey Division [CSD], School of Natural Resources [SNR], University of Nebraska-Lincoln [UNL]; and U.S. Geological Survey [USGS]) in support of the Eastern Nebraska Water Resources Assessment (ENWRA), a project initiated in 2006 to develop a geologic framework and water budget for the previously glaciated portion of eastern Nebraska including the Hallam area. The ENWRA project has completed extensive geologic mapping, completed groundwater monitoring and published numerous reports on the hydrogeology of the area (www.enwra.org). And finally, UNL-CSD published the Groundwater Atlas of Lancaster County (Divine 2014) with detailed cross sections and information on the local groundwater aquifers. The information from these primary resources and others, as noted below, were used to develop an understanding of the hydrogeologic setting for the area as presented in the following discussion.

2.1.1 Geographic Setting and Land Use

The geographic setting of Hallam is described as rolling hills dissected by stream valleys (Korus et al, 2013). The topography of Lancaster County was surveyed using LiDAR in 2016 and 2017 and the topographic relief ranges from 1190 to 1524 feet above mean sea level (USGS 2016). The primary land use is agricultural with irrigated row crops covering approximately 68 percent of the land followed by grass or pasture and deciduous forest. More information on land use as it relates to irrigation water demand in the study area is presented in Section 2.2.5.

2.1.2 Hydrology

Although no large streams flow through the Monolith property, there are several water features within the study area that direct surface water flow in several directions (Figure 2.1). Spring Branch Creek flows north from the east side of Hallam and joins Olive Branch of Salt Creek just west of Sprague. From Sprague the creek flows east to Roca where it joins another branch and flows north into Lincoln. According to the Lancaster Groundwater Atlas, Salt Creek is the main surface drainage in Lancaster County. A USGS stream gauge on Salt Creek at Roca indicates that the stream flow averaged approximately 35 cubic feet per second (cfs) over the past decade (Divine 2012). Along the western margin of the study area, the Big Blue River flows from northwest of Crete south to the east side of Wilber. On the eastern side of the study area, the Little Nemaha River and the North Fork of the Big Nemaha River flow east and southeast, respectively. Additionally, there are three man-made reservoirs within the study area:

Stagecoach (120-acre feet [AF], Bluestem (315 AF), and Wagon Train (325 AF). The three small lakes are primarily used for flood control and recreation.

The hydrologic connection between surface and groundwater in Lancaster County is not well understood (Divine 2014). The reason is that the connection between surface and groundwater is complicated. The hydrologic connection is based on several different factors including the sediment type of the streambed and the material between the streambed and the aquifer. Additionally, the connection is dependent on the elevation of the groundwater table in relation to the elevation of the surface water feature. This relationship affects whether a stream is described as a losing stream, or a stream that is losing water to the groundwater; or as a gaining stream, a stream that is gaining water from the groundwater (Winter et al 1999).

However, the stream gaging record for Salt Creek and its tributaries clearly document a perennial stream with consistent baseflow contributions from the aquifer. Figure 2.1 is a figure from the report on the LPMT groundwater model (this model is described in more detail in Section 2.1.6 below). This figure shows the measured (based on a baseflow separation from the total measured flow) and computed baseflow in the Salt Creek at the stream gage on the Salt Creek at Roca. The stream clearly serves as a source of aquifer discharge for the area.

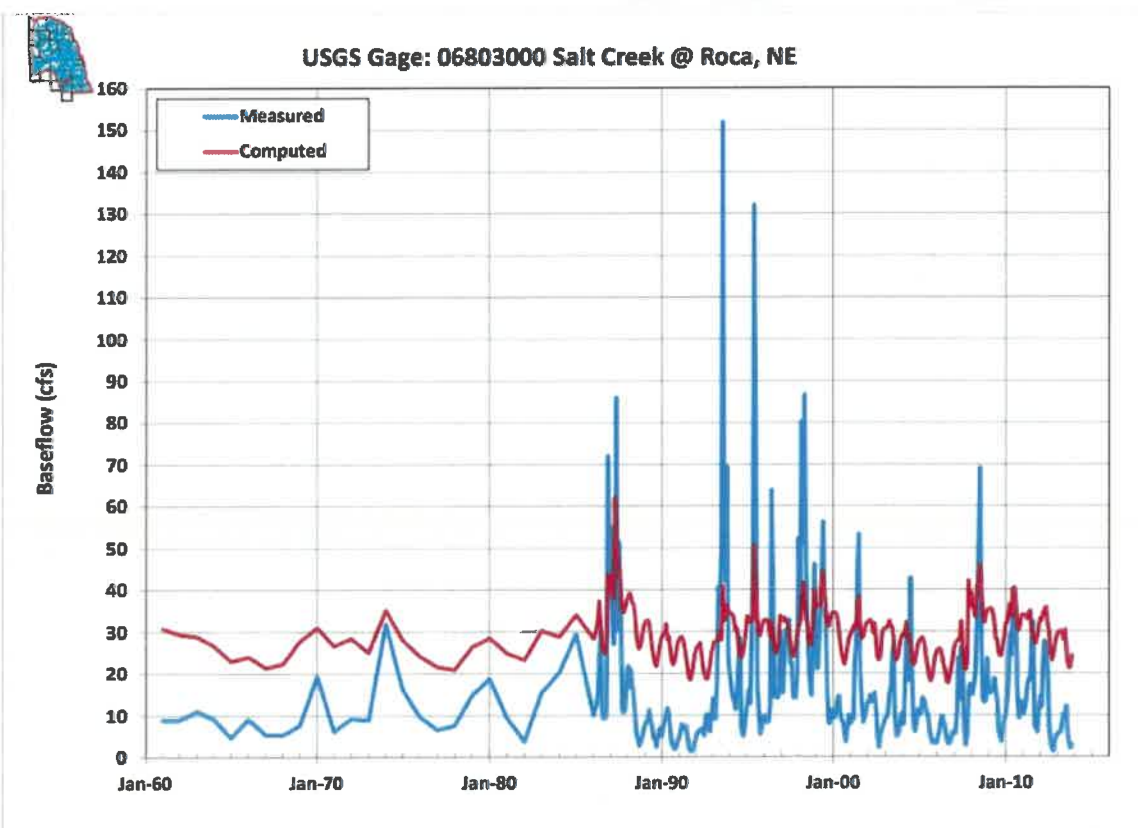


Figure 2.1 The measured and computed baseflow for the Salt Creek at Roca stream gage in the LPMT model (NDNR 2018).

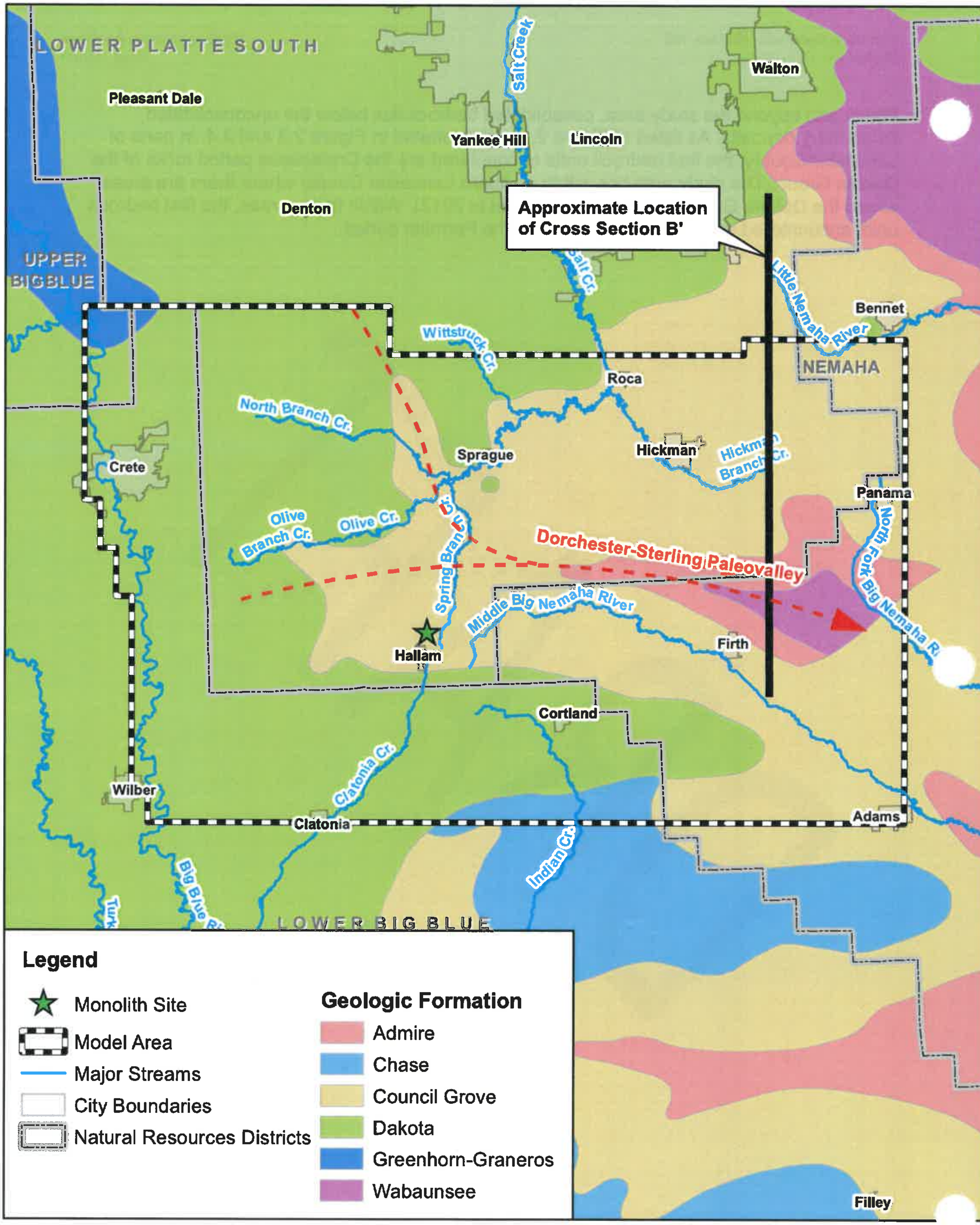
2.1.3 Soils and Geology

Soil and geologic maps for Lancaster County are available through the U.S. Department of Agriculture (USDA 2014) and the USGS STATEMAP program (UNL-CSD 2020a). The soil and geologic maps show material at the land surface and subsurface above bedrock consists mostly of loess, till, and alluvium that ranges from 0 to over 400 feet in thickness. The silt likely originated in the Sand Hills region of central Nebraska and accumulated on grass-covered hills of weathered glacial till (Reed and Dreeszen 1965). Glacial till is a poorly sorted mixture of silt, clay, sand, gravel, and boulders deposited by melting glaciers (Reed et al 1966). Glaciers repeatedly advanced and retreated across in eastern Nebraska over an approximately 2-million-year period that is informally referred to as the Ice Age or more formally as the Quaternary (Figure 2.2).

Era	Period	Epoch	Group	Formation	Thickness (ft)	Lithology	Age (Ma)†
Cenozoic	Quaternary	Holocene			0 to 400+	Alluvium (silt, sand, gravel)	0.0117
		Pleistocene				Loess and glacial till (clay, silt, sand, gravel)	2.58
	Neogene				Absent		
	Paleogene						66.0
Mesozoic	Cretaceous	Late	Colorado	Greenhorn	20 to 30	Chalky limestone	
				Graneros	20 to 30	Gray shale	100.5
		Early	Dakota	Woodbury	0 to 400+	Sandstone and shale	
				Nishnabotna		Sandstone and shale	145.0
	Jurassic				Absent		201.3
	Triassic				Absent		252.2
Paleozoic	Permian	Big Blue	Chase		Absent		
			Council Grove		0 to 300+	Limestone and shale	
			Admire			Shale and thin limestone	299.0
	Pennsylvanian	Virgil	Wabaunsee		< 100 to 550	Shale, limestone, sandstone, coal	
			Shawnee			Limestone and shale	
			Douglas			Shale and limestone	
		Missouri	Lansing		200 to 250+	Limestone and shale	
			Kansas City			Limestone and shale	
		Des Moines	Marmaton		< 100 to 200+	Shale, limestone, coal	
			Cherokee			Shale, sandstone, coal	323.0

Figure 2.2 Geologic time scale and shallow bedrock stratigraphy within Lancaster County. *From Divine 2014.*

Within and beyond the study area, consolidated bedrock lies below the unconsolidated Quaternary deposits. As listed in Figure 2.2 and illustrated in Figure 2.3 and 2.4, in parts of Lancaster County, the first bedrock units encountered are the Cretaceous period rocks of the Dakota Group. The study area lies within southern Lancaster County where there are areas where the Dakota Group was eroded (Korus et al 2012). Within these areas, the first bedrock units encountered are the deeper units from the Permian period.



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N
0 1 2 4 Miles
1 in = 4 miles
NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Bedrock Map
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE
2.3

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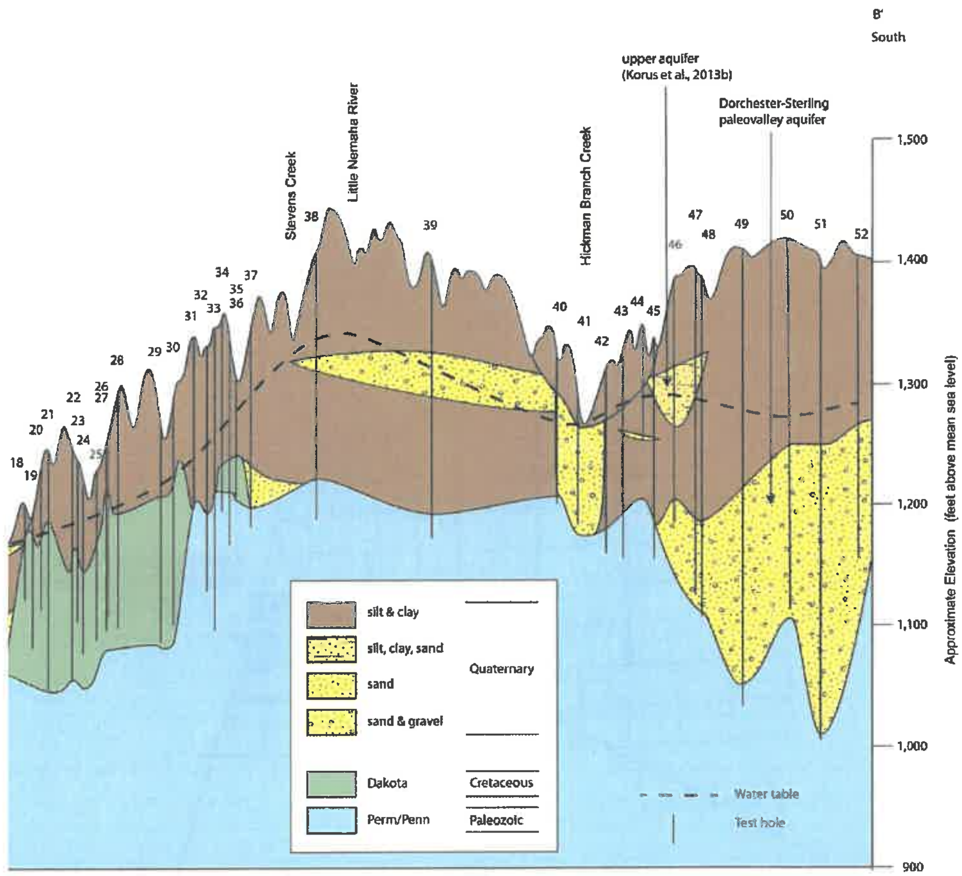

Figure 2.4 Geologic Cross Section through Southern Lancaster County adapted from Divine 2014.

2.1.4 Aquifers

Since this report is focused on understanding the impact of the proposed new water wells on the aquifer, one of the first steps to this evaluation is to understand the vertical and lateral extent of the local aquifers. The two main types of aquifers in the LPSNRD include aquifers in the unconsolidated units that overlie the bedrock (alluvial aquifers) and bedrock aquifers. Alluvial aquifers consist of paleovalley aquifers occurring in ancient, buried stream valleys; alluvial aquifers created by modern streams; and aquifers of other origins. Bedrock aquifers are water-bearing, consolidated to semi-consolidated, rock formations (Divine et al 2009).

It is important to note that the hydrogeology of eastern Nebraska is markedly different from the hydrogeologic framework of western Nebraska (Divine 2014). Specifically, the High Plains Regional Aquifer System with a water saturation thickness ranging from a few feet to more than 1,000 feet, often referred to as the Ogallala aquifer, is not present in eastern Nebraska. Instead, as stated above, the primary aquifers of eastern Nebraska are isolated in vertical and lateral extent as illustrated in cross section by permeable sand and gravel deposits surrounded by relatively impermeable silt and clay deposits (Figure 2.5). A secondary aquifer in Lancaster County is the Dakota sandstone aquifer. As with the bedrock units in the study area, this secondary aquifer is not discussed further in this report because the proposed new wells will be completed in the primary or Quaternary aquifer and therefore understanding the impact of the new wells on the primary aquifer is the focus here.

The LPSNRD is subdivided into Groundwater Management Areas that are based on the distribution of the primary aquifers within the district. The aquifer in the Hallam area is the Crete-Princeton-Adams (CPA) aquifer, also referred to as the Dorchester-Sterling paleovalley by the CSD. The saturated thickness of the Dorchester-Sterling paleovalley fill ranges from approximately 70 to 220 feet thick (Divine 2014).

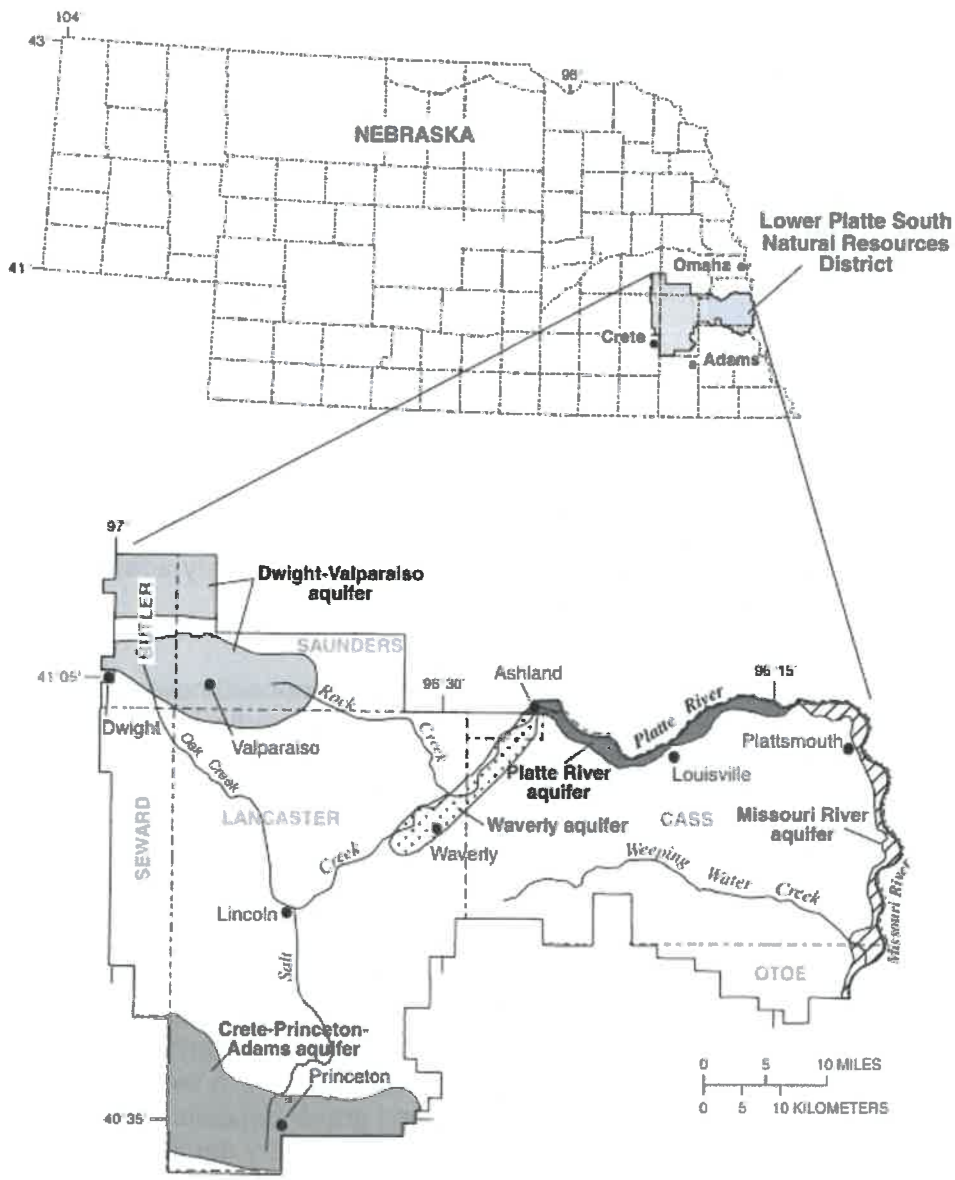

Figure 2.5 Location of the principal aquifers within the LPSNRD from Druliner, 2001.

2.1.5 Previous Modeling Efforts

The NDNR has previously contracted with engineering consultants to develop the LPMT regional groundwater model. Covering the eastern portion of the state along the Missouri River, the model was developed as a tool to "evaluate the effect of well pumping on stream baseflow in the central and northern parts of the LPMT basins" (NDNR 2018). To meet this objective, the groundwater model was calibrated to be able to reproduce transient baseflow conditions in the major streams of the model domain and the transient groundwater level changes at monitoring well locations. The model domain includes areas covered by the Lewis and Clark Natural Resources District (NRD), the Lower Elkhorn NRD, the Lower Platte North NRD, the Lower Platte South NRD, and the Papio-Missouri River NRD (Figure 2.6). The large model area makes it an appropriate tool to evaluate regional-scale management scenarios but does not reproduce every detail of the hydrogeologic system at a local scale.

Several hydrogeologic studies and databases were carefully incorporated into the LPMT model, including UNL-CSD test hole data, USGS geologic maps, and the Nebraska Statewide Groundwater Level Program database. Pumping and recharge estimates were calculated with a watershed model, which combines a climate model, a soil water balance model called CROPSIM, and a regionalized soil water balance (RSWB) model (NDNR 2018). The climate model uses weather data from 50 weather stations to produce precipitation, temperature, and reference evapotranspiration data. CROPSIM computes inflows and outflows of the soil water balance based on characteristics such as crop type, soil class, management, and irrigation on a daily basis (Martin 1984). The daily calculations are aggregated into monthly summaries of runoff, evapotranspiration, and deep percolation. The final component of the watershed model, the RSWB, is used to develop estimates of pumping and recharge for incorporation into the groundwater model as MODFLOW WEL and RCH files. Pumping estimates are based on Net Irrigation Requirements (NIR) by crop type, irrigation system information, assumptions about irrigation management, and application efficiency. In the LPMT model, the average pumping is estimated to be approximately 8.25 inches. Municipal and industrial pumping is also included in the model. Recharge represents the portion of the water budget that percolates past the root zone and into the aquifer below. Recharge averages 3.8 inches per year in the LPMT model.

The model was constructed to simulate the historical conditions from 1960-2013. Annual stress periods make up the timespan from 1960-1985. From 1985-2013, monthly stress periods are used. The model is discretized into 0.5-mile by 0.5-mile grid cells (or 160 acres) and two vertical layers to represent the principal aquifer and bedrock below. The model was calibrated to produce a volumetric water budget error of less than 1 percent. In addition, simulated and observed water levels and baseflows are reasonably matched.

The high degree of calibration and regional nature of the LPMT model make it a reasonable tool to evaluate management scenarios and their impacts to the hydrologic system as a whole. Figure 2.7 shows an example of how the simulated water level from the LPMT model compares to observed water level in a well near Hallam, Nebraska. This is a strong indication that the simulated water budget in the Hallam area in the LPMT model is consistent with the actual water budget for the CPA aquifer.

N

0 5 10 20 Miles

1 in = 20 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

LPMT Model Domain Map

Monolith OC2

Groundwater Modeling Report

Lancaster County, NE

FIGURE

2.6

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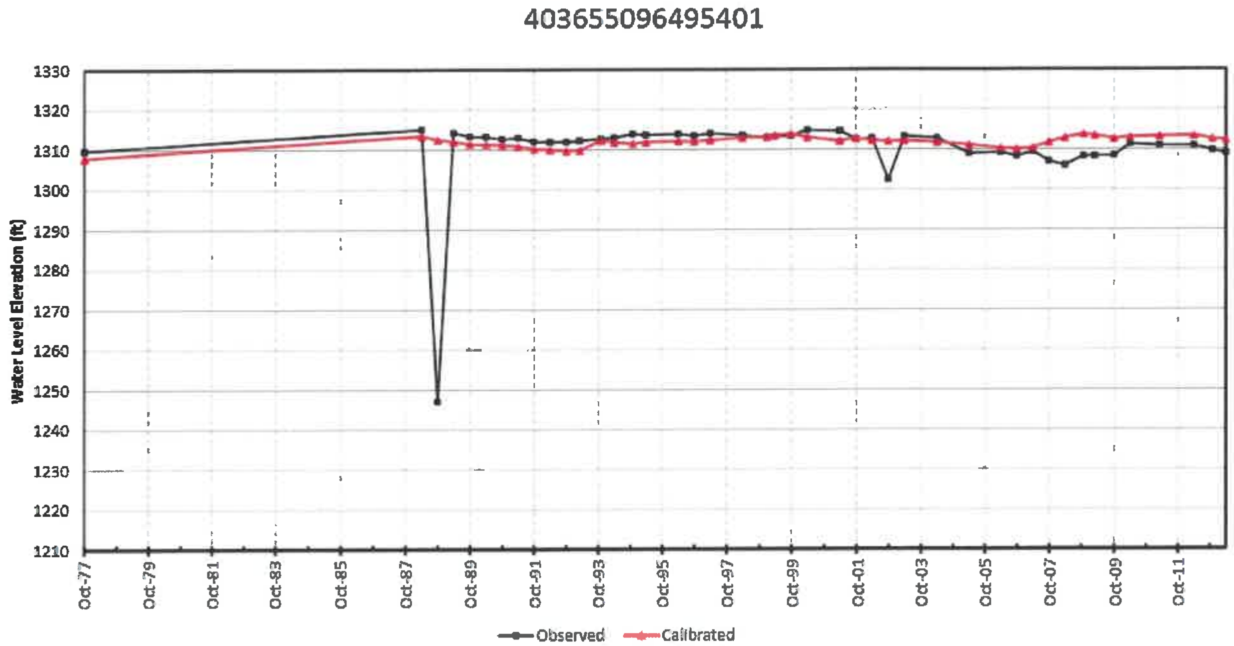


Figure 2.7 Example calibration dataset from the LPMT model for a well near Hallam. (Note: the strong departure in long-term average water levels during 1988 is likely a data transcription error or some similar issue with data quality.) (NDNR 2018)

Further information on the water budget for the CPA aquifer is shown in Figure 2.8, which compares the average annual groundwater supply and the actual annual groundwater use in Lancaster County. Groundwater use has increased from approximately 0.5 billion gallons per year in 1960 to approximately 1.5 billion gallons per year by 2010 (it should be noted that 2012 and 2013 reflect extremely dry years, with 2012 being the hottest and driest year in the climate record for Nebraska [NOAA 2012]). The groundwater supply represents recharge to the aquifer from local precipitation as well as the inflow to this portion of the aquifer from other areas. The excess groundwater supply is primarily discharged from the aquifer to streams in the same area.

With Olsson's proprietary groundwater modeling software, called the Groundwater Evaluation Toolbox (GET), two separate pumping scenarios were simulated with the LPMT model to provide an initial assessment of potential impacts of Monolith's water use. Monolith's estimated groundwater needs can be met with a well that pumps on average 320 million gallons per year. More information on how Monolith arrived at this estimate is included in Appendix A. To "bookend" the possible water use scenarios, a well pumping 320 million gallons per year for 50 years was placed at the proposed plant site and run with GET. A similar model run was done with a well pumping 400 million gallons per year to represent maximum operating capacity. The change in water levels at the end of the 50-year model runs are shown in Figures 2.9 and 2.10.

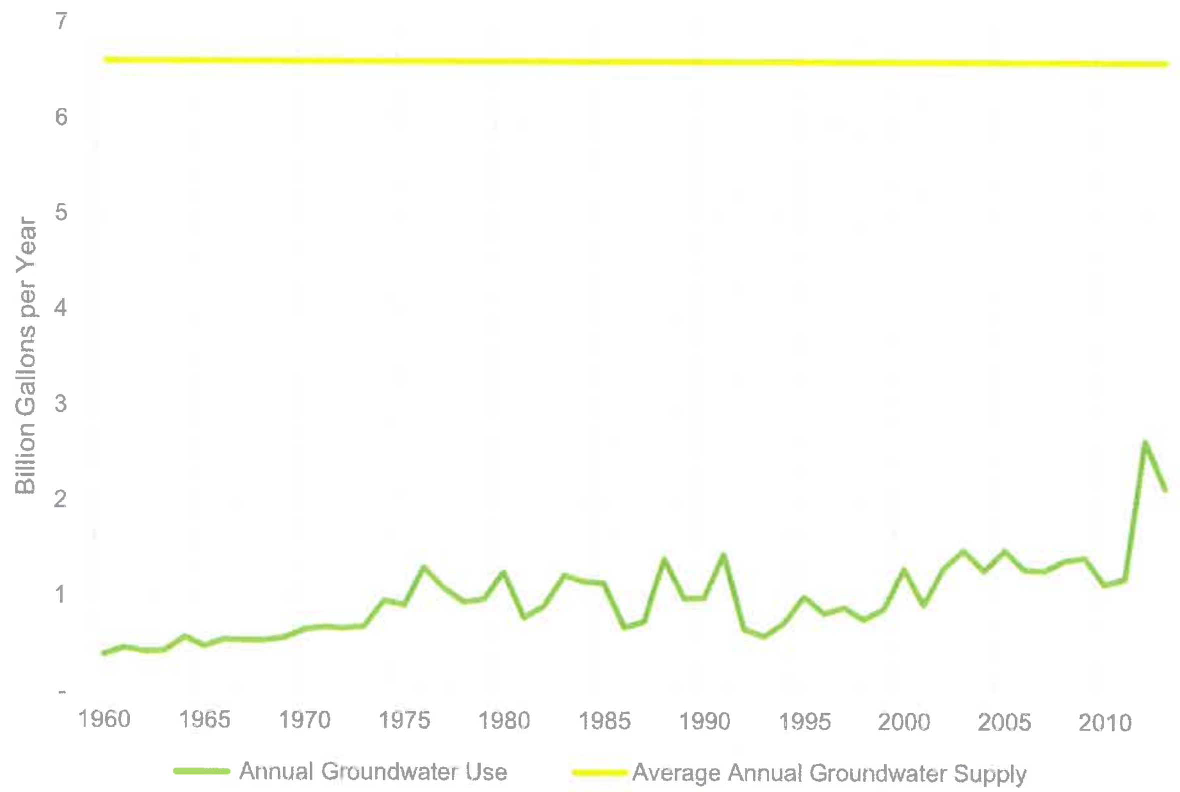


Figure 2.8 Comparison of average annual groundwater supply and annual groundwater use for the CPA aquifer area of Lancaster County in the LPMT model.

The results show a maximum decline of 7.5 feet and 9.4 feet in the 320 and 400 million gallons per year scenario, respectively, in the groundwater model cell containing the new well. Water level declines quickly drop to less than five feet within approximately one mile from the model cell containing the new well. While water level declines appear to be widespread, these declines are generally one foot or less. Furthermore, the aquifer declines do not extend to the north of portions of Olive Branch as well as Salt Creek and Hickman Branch. In these areas the model predicts a reduction in aquifer discharge to these streams as opposed to a reduction in water levels. In fact, by the end of the 50 year simulation, additional reductions in aquifer storage due to the new water withdrawal are nearly zero, with the majority of the additional impact of the new water well manifesting as reductions in stream baseflow.

While these simulations provide an initial indication of the potential impact of Monolith's proposed new water use, a more refined model that is capable of representing the local scale features of the CPA aquifer is needed to verify these results. A sub-regional model can offer a clearer look at spatial impacts of certain management actions and the stream-aquifer interaction. The LPMT model offers an excellent starting point for building more complexity into a highly refined model that represents the Monolith plant site and surrounding areas. The construction of this highly refined model is discussed in the following report sections.

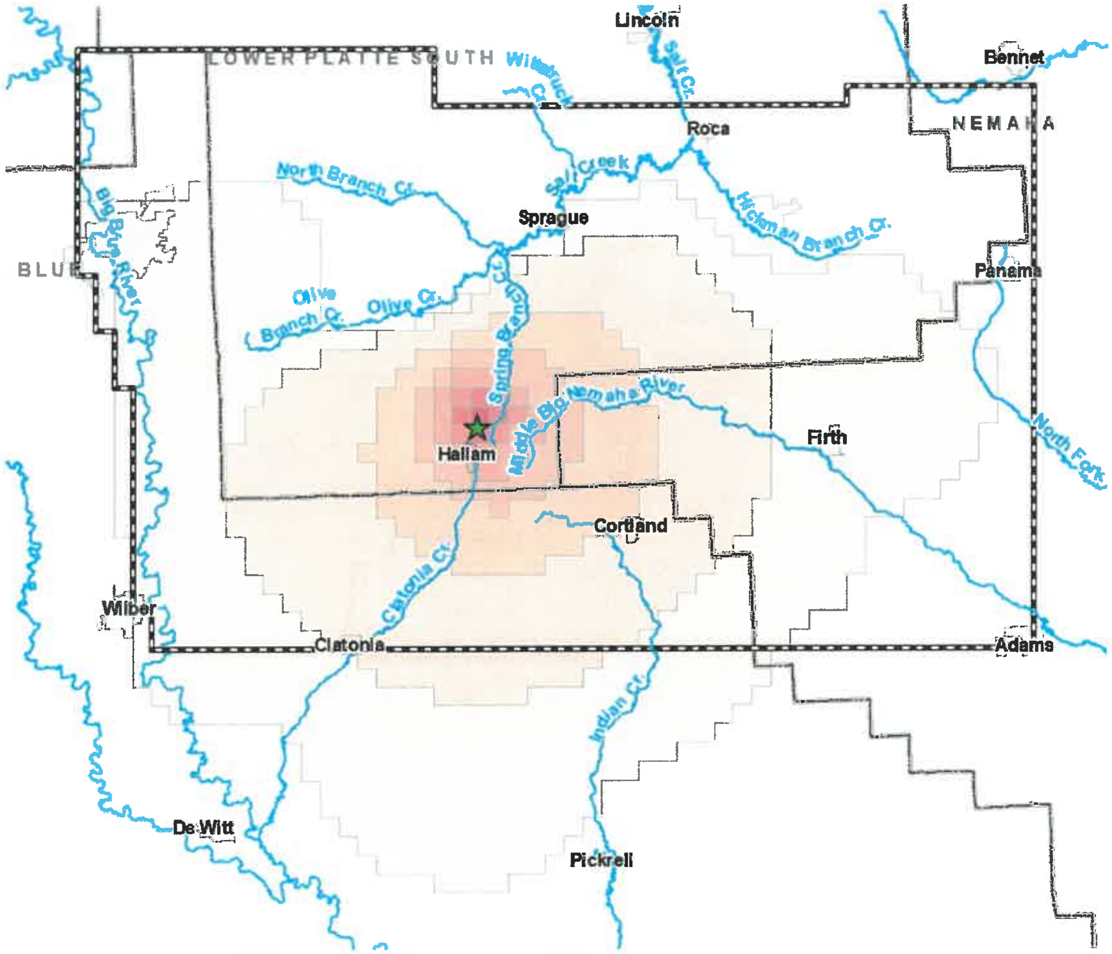


Figure 2.9 Water level change resulting from a well pumping 320 million gallons per year after 50 years. Changes range from -0.1 feet in the palest peach area to -7.5 feet in the immediate vicinity of the well. (GET 2020)

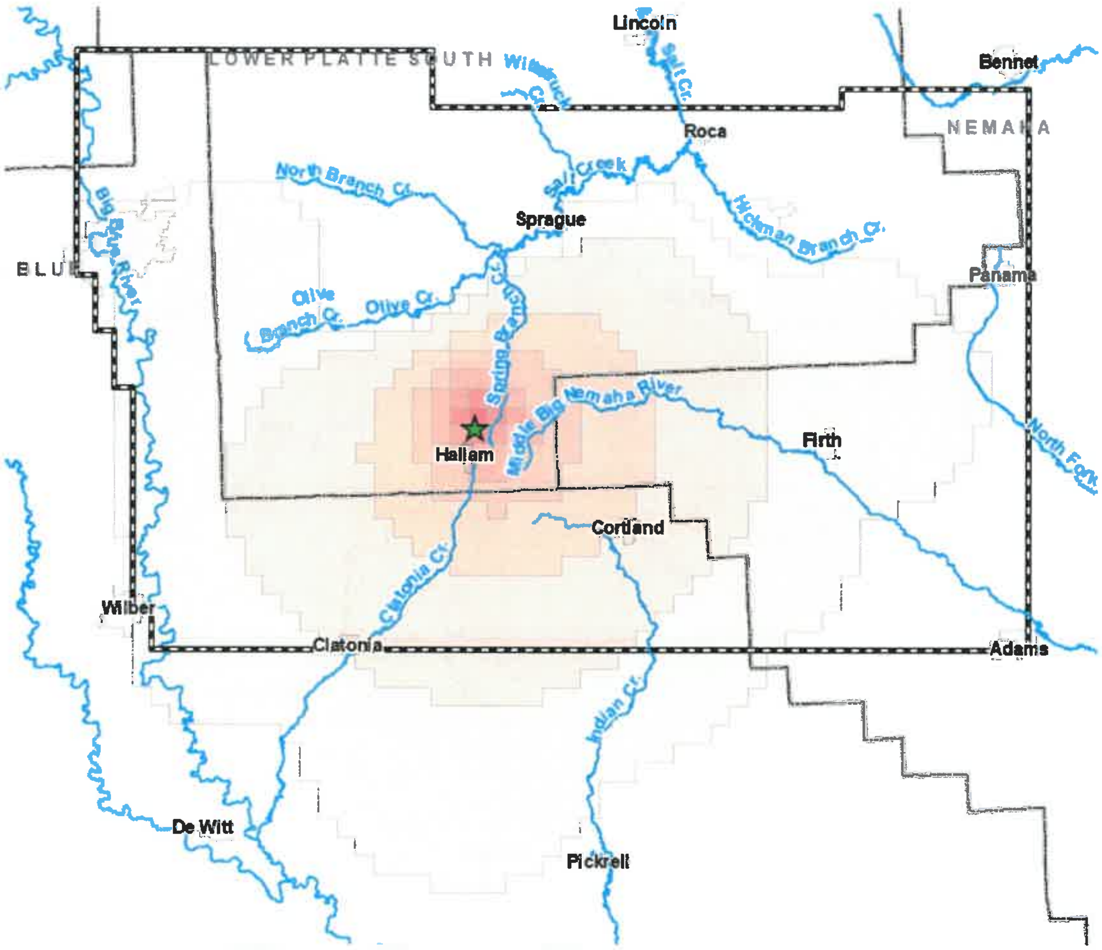


Figure 2.10 Water level change resulting from a well pumping 400 million gallons per year after 50 years. Changes range from -0.1 feet in the palest peach area to -9.4 feet in the immediate vicinity of the well. (GET 2020)

2.2 Refined Groundwater Model Development

A refined groundwater model was constructed to encompass the Monolith plant site and surrounding areas. There is a wealth of data regarding the aquifer in the Hallam area that was not used in the construction of the regional LPMT model but was considered when building the local-scale model. Specifically, the information collected by the LPSNRD as part of the 2009 ENWRA lends a high degree of detail on the CPA aquifer. The results of this investigation were published by the CSD in a report titled "Three-dimensional hydrostratigraphy of the Sprague, Nebraska Area: Results from Helicopter Electromagnetic (HEM) mapping in the ENWRA 2009." This report documents an upper and a lower aquifer in the area overlain and interspersed with non-aquifer materials, mostly clay. The complexity of the aquifer geometry and its flow properties can be more accurately represented by a refined model.

2.2.1 Model Code and Applications

The refined groundwater model uses the MODFLOW-Unstructured Grid (USG) program. This version of the industry standard USGS modeling software called MODFLOW provides for substantial flexibility in model discretization by removing the traditional layer-row-column approach for implicitly defining cell connectivity and replacing this with explicit details of the way in which each cell interacts with any other cells.. In the area of the refined model, MODFLOW-USG was used to include complex geologic layering, such as discontinuous aquifer and semi-confining layers. MODFLOW-USG was also used for lateral spatial refinement in areas of special interest, such as in the immediate vicinity of the plant site and along streams.

Much of the LPMT model was used as the starting point for construction of the refined model MODFLOW files. One by one, each LPMT file was carefully deconstructed, additional data was incorporated, and the MODFLOW files were reassembled to adhere to MODFLOW-USG format. The MODFLOW files used in the refined model are explained in Table 2.1.

Table 2.1 The MODFLOW-USG files that compose the refined groundwater model.

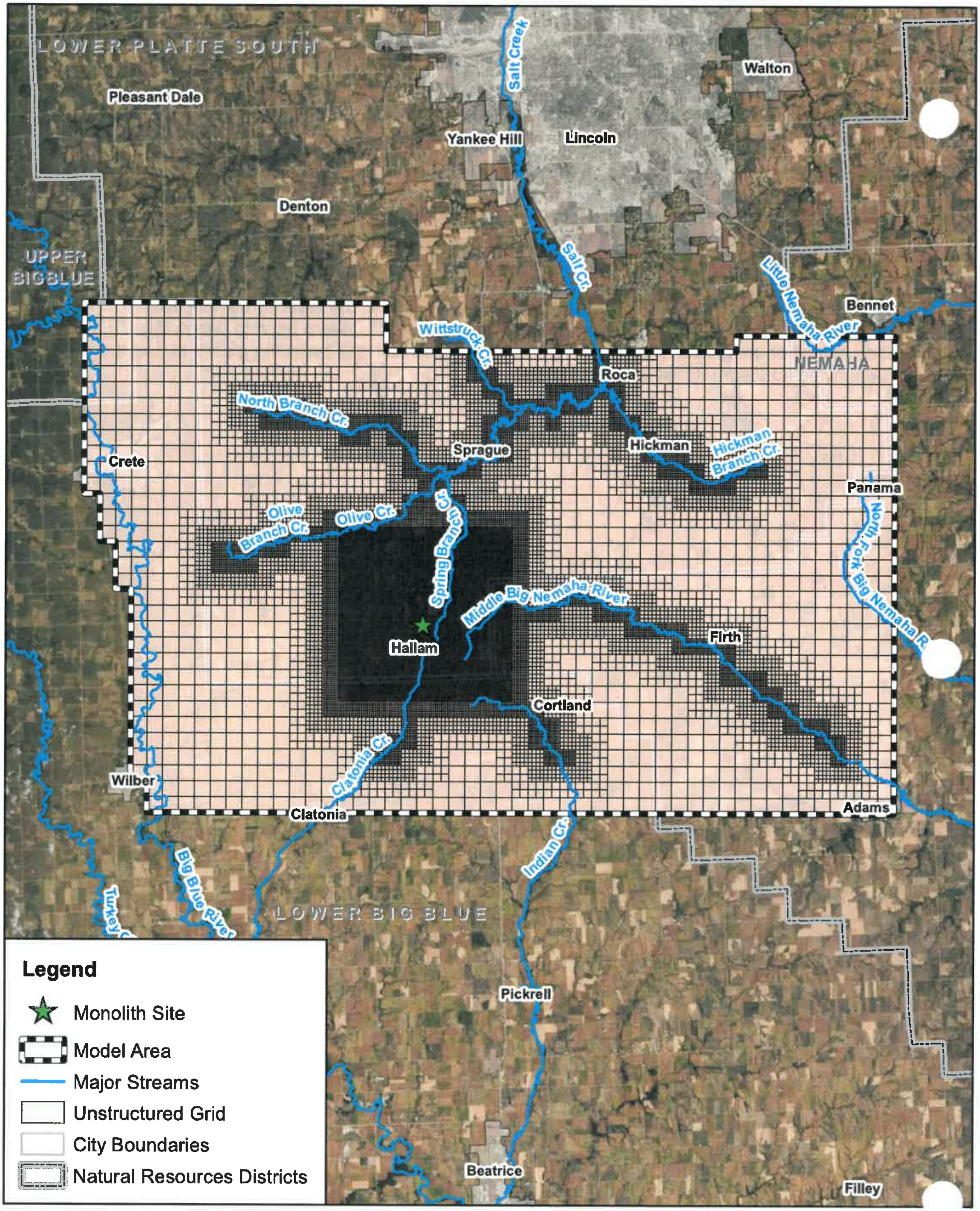
MODFLOW File	Description
BAS	Basic Package: this file is used to specify the locations of active, inactive, and specified head cells as well as the initial heads in all cells.
CLN	Connected Linear Network Process: this file specifies the location of one-dimensional connected features and how they should interact with the three-dimensional grid. The wells in the LPSNRD and their screen intervals are defined in the CLN file.
DISU	Discretization File: this file is used to specify the model grid geometry, such as elevations of the vertical layers. Each grid cell is given a node number, which can be found in this file. This file also specifies the time discretization of the model.
EVT	Evapotranspiration Package: this package specifies how the model should simulate the head-dependent flux of evapotranspiration. The evapotranspiration (ET) surface, extinction depth, and monthly ET rate are defined in this file.
GHB	General Head Boundary Package: the head-dependent flux boundaries are simulated with this package. A transient elevation is defined for each boundary node.
LPF	Layer Property Flow Package: this file is used to specify properties controlling flow between cells, such as hydraulic conductivity and specific yield.
OC	Output Control Option: this file specifies which head, drawdown, or budget data should be printed or saved.
RCH	Recharge Package: this file specifies the transient recharge flux in each cell.
RIV	River Package: in this file, the transient river stage is specified, along with the riverbed hydraulic conductance, and elevation of the bottom of the riverbed.
SMS	Sparse Matrix Solver: this file provides several nonlinear methods, as well as several linear solution schemes to solve the matrix equations.
STR	Stream Package: the streams in the model are defined in this file. The stream routing, inflows, stream stage, streambed hydraulic conductance, and top and bottom elevation of the streambed are included in this file.
WEL	Well Package: this file is used to simulate a specified flux to individual cells that contain wells.

2.2.2 Model Discretization

The model extent was developed to be large enough that the full extent of possible impacts in the CPA aquifer within southern Lancaster County could be simulated without any significant interference due to boundary conditions. The model area encompasses about 370 square miles in portions of Gage, Lancaster, and Saline County. The Monolith site is located in the south-central portion of the model domain.

The model grid utilizes varying cell sizes to accomplish a higher degree of spatial accuracy around features of interest. The largest cells in the model area measure 0.5-mile by 0.5-mile, like in the LPMT regional model. Cells are refined around streams down to a cell size of 330-ft by 330-ft. In the immediate vicinity of the Monolith site, cells measure 165-ft by 165-ft. As a result of this refinement, physical features such as streams and wells can be modeled very close to their real-world location rather than at the center of a large 0.5-mile by 0.5-mile cell. The refined model grid is shown in Figures 2.11 and 2.12.

The model was further discretized to contain up to four model layers at any specific location (Figures 2.13-2.16). Two sources of information were used to specify the existence and relative elevation of each of these model layers. Where the more refined aquifer geometry data were available from Divine and Korus (2012), that information was used to define the occurrence and elevation of up to four model layers, as appropriate. These layers, where present, represent the overlying glacial till, the upper aquifer material, the non-aquifer material separating the upper and lower aquifer, and the lower aquifer. Outside of this area, the recently developed unpublished data on the Dorchester Sterling Aquifer from CSD were used to define the occurrence of the glacial till layer and the boundary between the overlying glacial till and the underlying aquifer material (Divine and Howard 2020).



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Refined Model Grid
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.11

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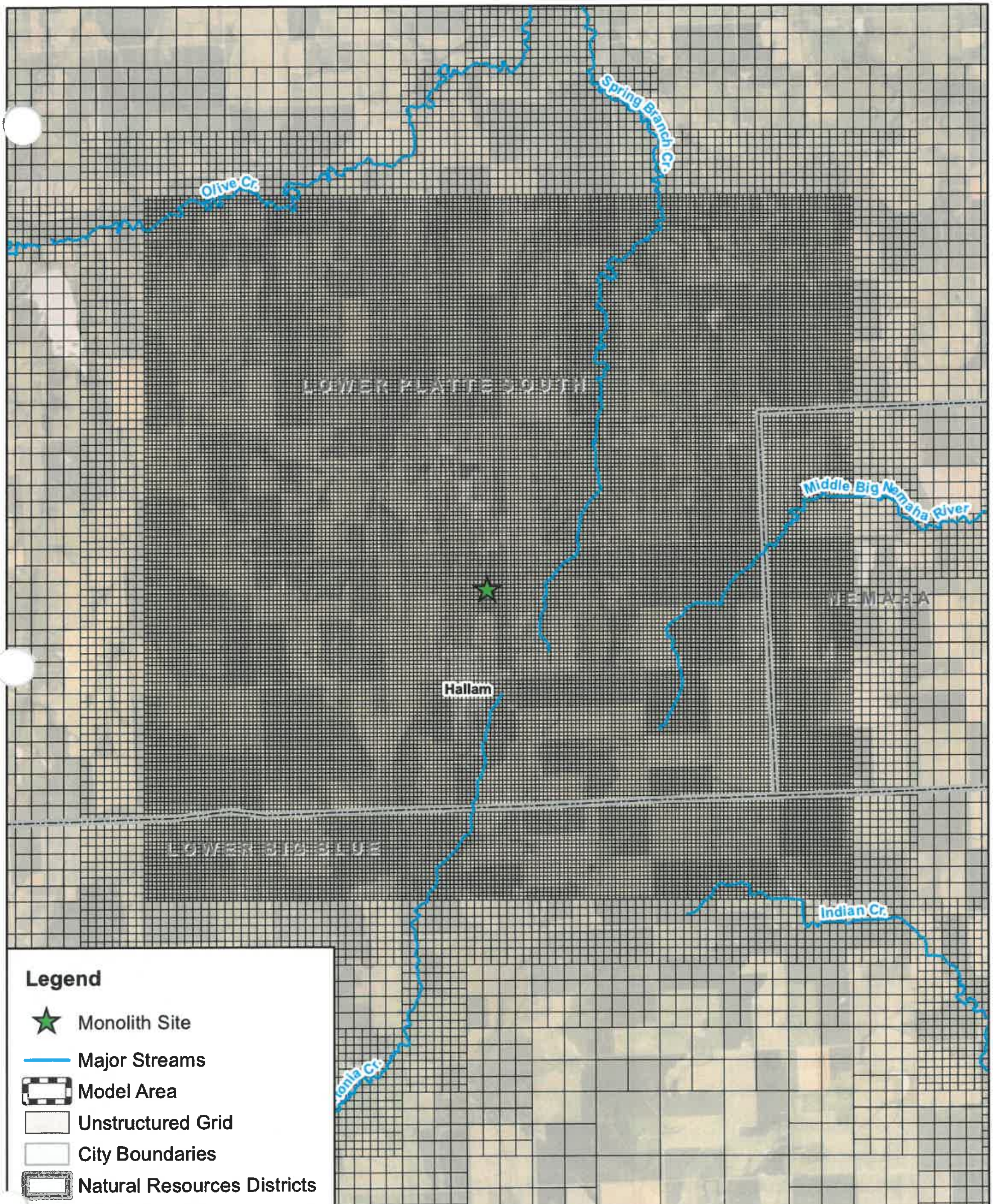

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N

0 0.25 0.5 1 Miles

1 in = 1 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Refined Model Grid - Project Site

Monolith OC2

Groundwater Modeling Report

Lancaster County, NE

FIGURE

2.12

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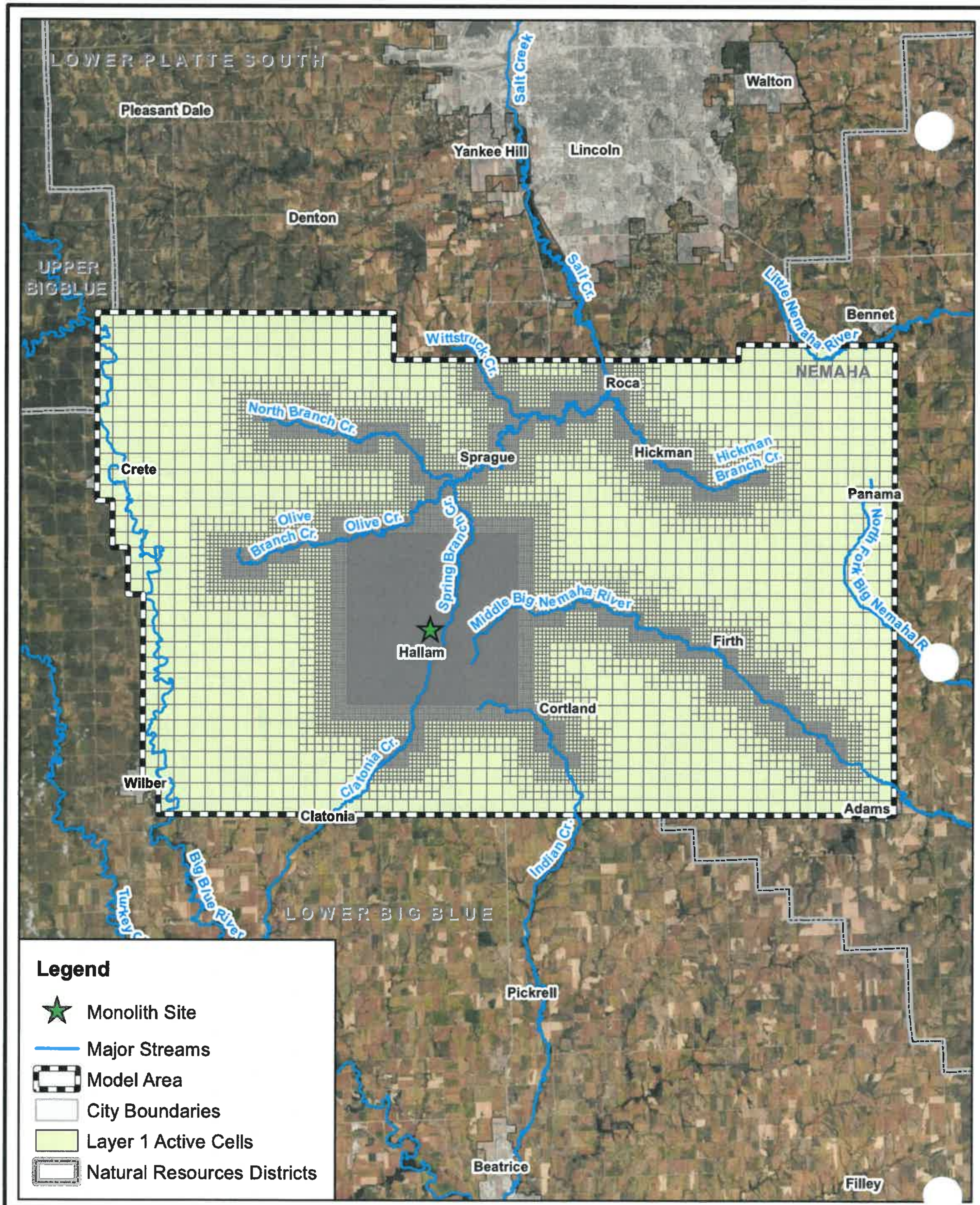

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Layer 1 Active Cells
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.13

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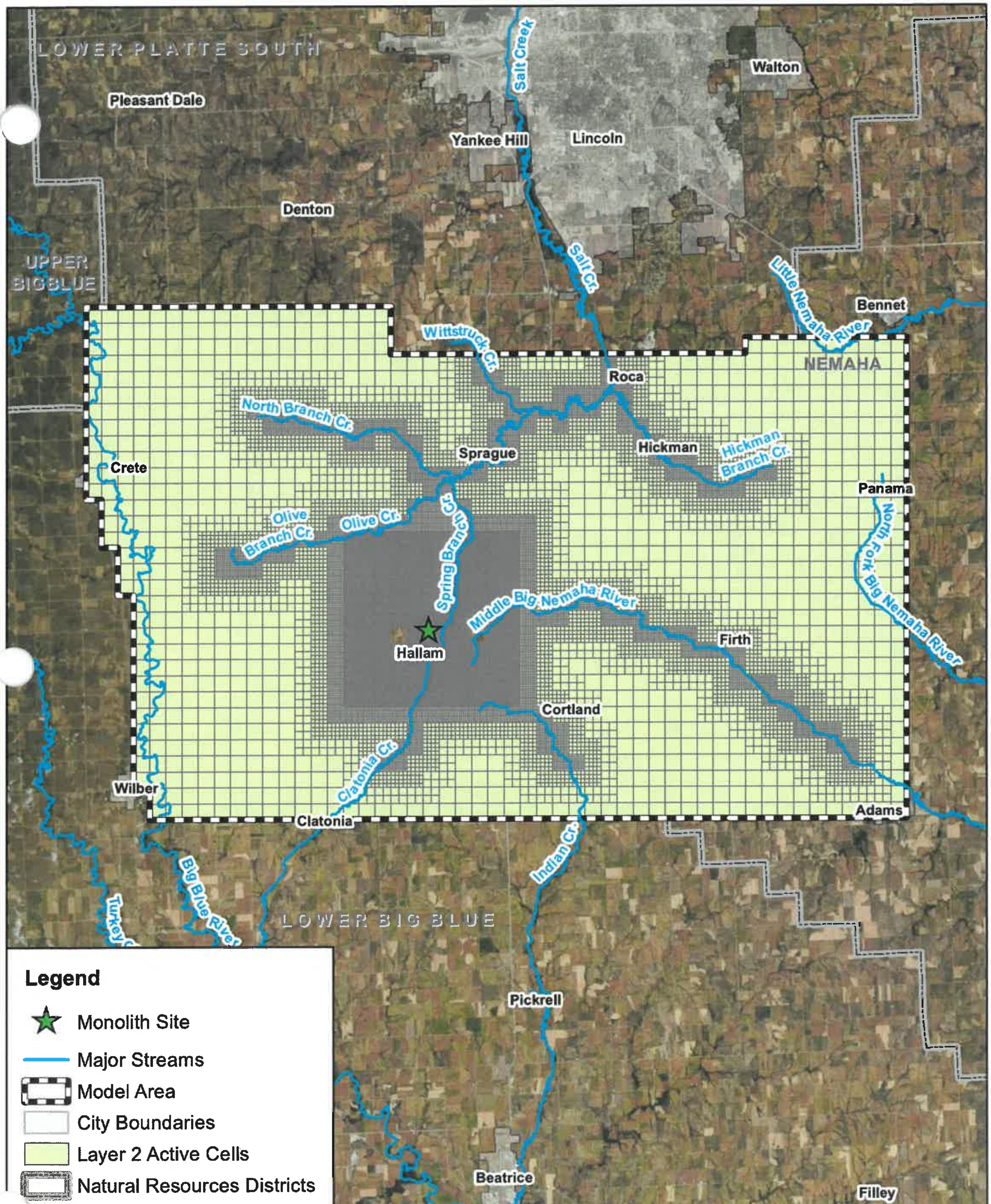

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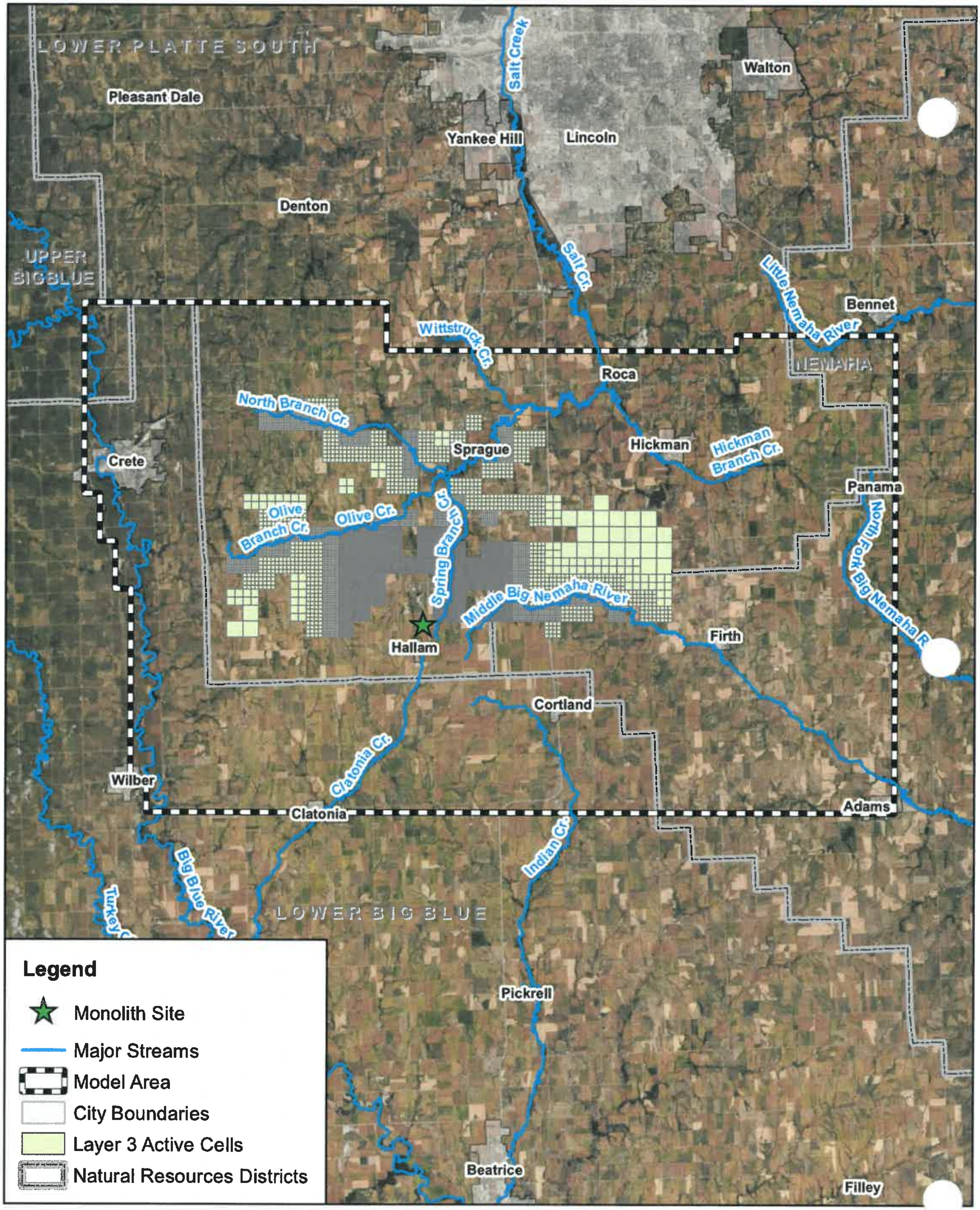
Layer 2 Active Cells
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE
2.14



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N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Layer 3 Active Cells
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.15

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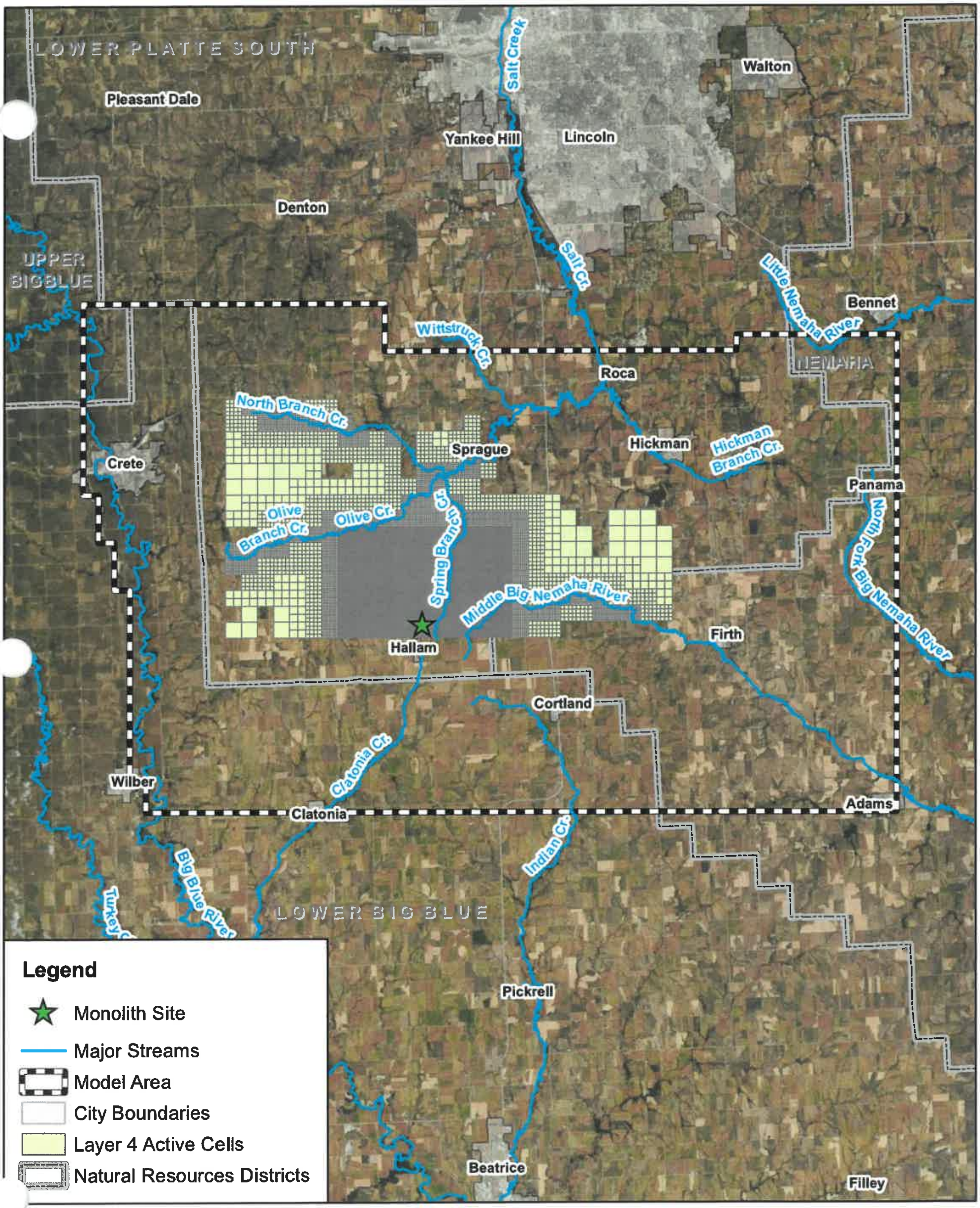

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N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Layer 4 Active Cells
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.16

The historic simulation is initiated using a single steady state stress period, which provides a basis for starting water levels in the transient simulation. The transient simulation consists of 434 stress periods, with the first 26 representing each year from 1960-1985. Then the model is temporally discretized into monthly stress periods from 1986-2019. Many of the transient refined model files (e.g., the well and recharge files) were based upon the corresponding LPMT model files, however, the LPMT model only runs through 2013. To fill in the data for the 2014-2019 time period, historical years with similar climate conditions were selected to represent hydrologic conditions (Table 2.2). The historical year was selected based on similar precipitation total, as long as the total was less than the year it was being assigned to. For example, in 2014, a weather station in Crete, Nebraska recorded 31.8" of precipitation. In 2011, the same weather station recorded 31.3" of precipitation. The precipitation total in 2011 is the closest to the total in 2014 without exceeding it from 1986-2019, and was therefore used to help complete the timeseries (Figure 2.17).

Table 2.2 Historical data used to fill in the 2014-2019 time period.

Refined Model Year	Historical Year Used
2014	2011
2015	1993
2016	2010
2017	2010
2018	1987
2019	1993

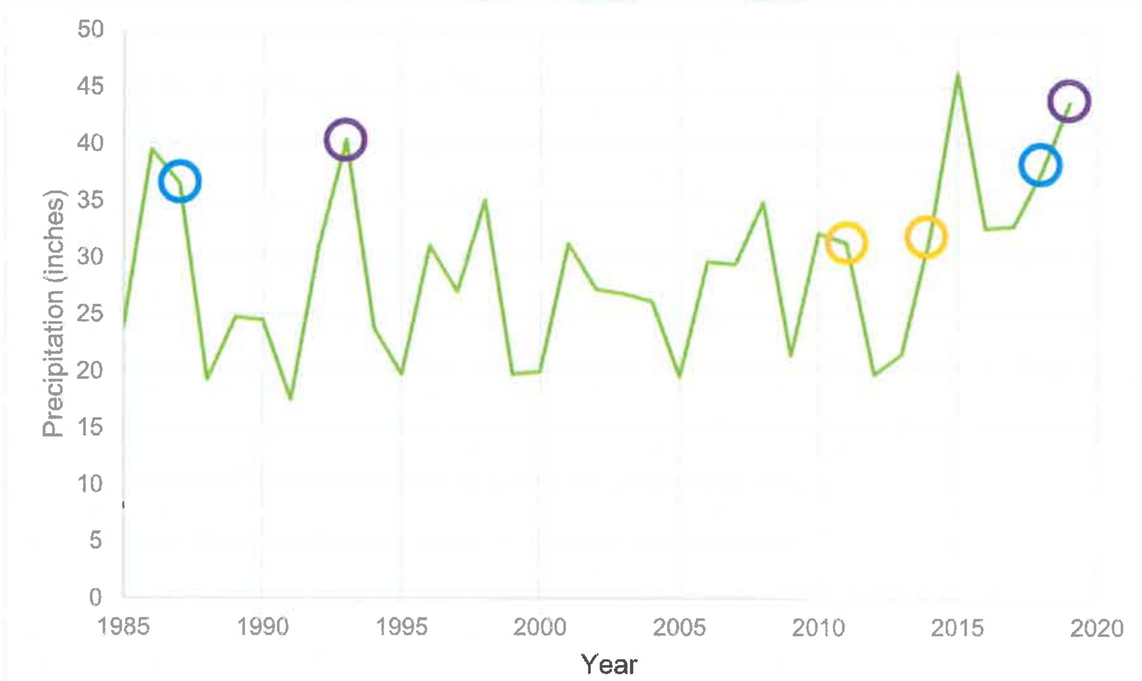


Figure 2.17 Precipitation used in the model from 1985-2019. From 2014-2019, historical years with similar precipitation totals were chosen. Examples are marked by the colored circles.

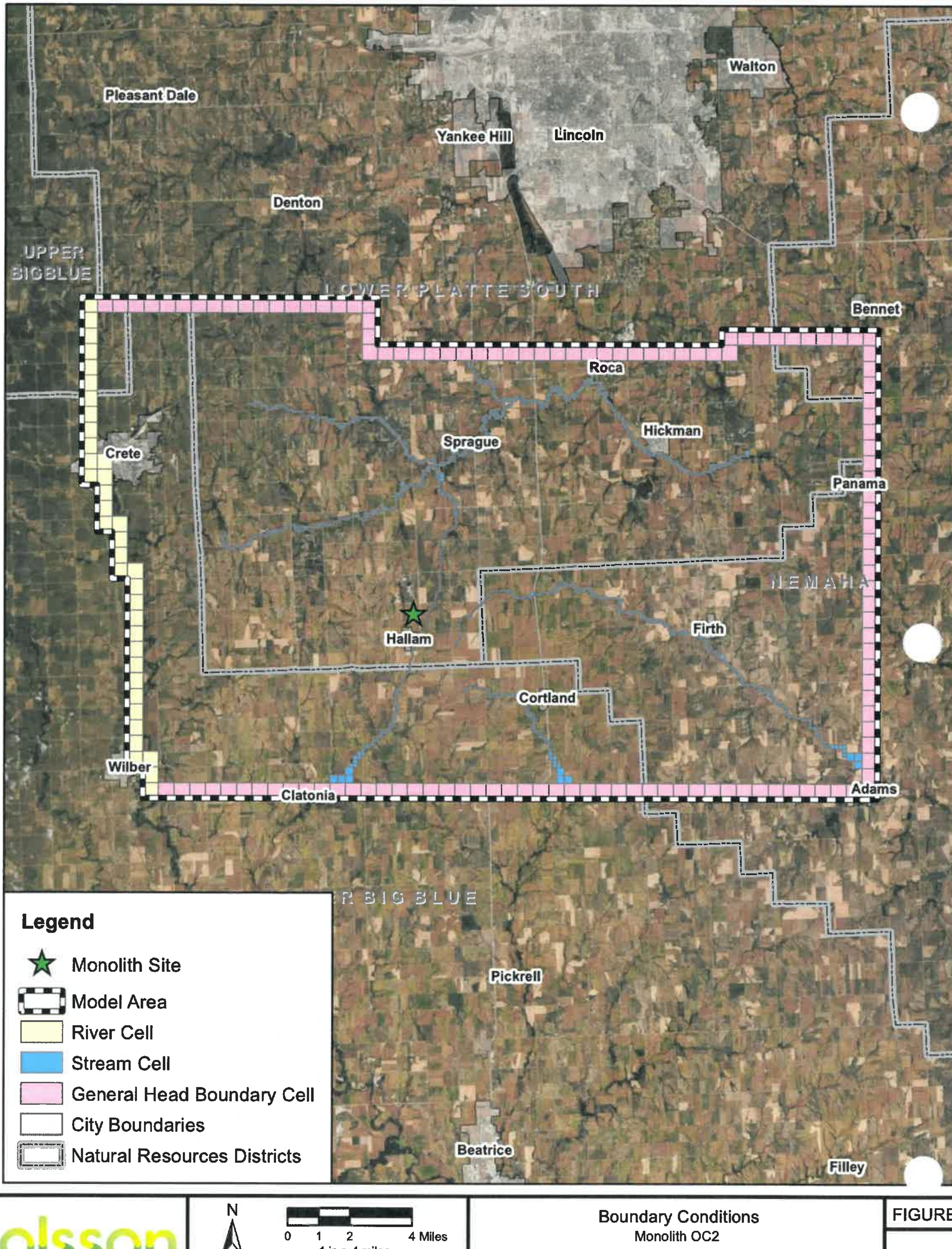
2.2.3 Boundary Conditions

The exterior cells in the model are represented using the General Head Boundary (GHB) package and the River (RIV) package (Figure 2.18). The Big Blue River forms much of the western model boundary and is simulated using the RIV package. The remaining exterior cells are all contained in the GHB package.

The RIV package requires the specification of a riverbed top and bottom and the conductance of the riverbed materials. The elevations of the top of the riverbed were determined using the 2016 Eastern Nebraska LiDAR dataset. The minimum elevation was calculated using the Zonal Statistics tool in ArcGIS and used to specify the riverbed top elevation. The riverbed bottom elevation was then specified by assuming a nominal five-foot riverbed thickness. Finally, the initial riverbed conductance was specified as 10,000 ft^2/day. The river cells were assigned to layer two.

The GHB package requires the specification of a general head elevation and a conductance term. The general head elevation was specified as the computed elevation for the corresponding cells in the LPMT model for each stress period. The initial general head conductance was specified as 10,000 ft^2/day. GHB cells were assigned to the exterior cells in layer one and two.

The Stream (STR) package was used to represent the major streams that are internal to the model boundaries. The streams represented in the model include Salt Creek and its major tributaries, the Middle Big Nemaha River, Indian Creek, and Claytonia Creek. The STR package collects and routes streamflows through the network of stream segments with each stream segment having one reach per cell. The STR package for this model included 13 stream segments broken into a total of 1,941 stream reaches. For each stream reach the STR package requires the specification of the stream top and bottom, and the conductance of the streambed. The top of the streambed was determined in a manner identical the way that the top of the riverbed was determined as described above. The streambed bottom elevation was then specified by assuming a nominal two-foot streambed thickness. The initial streambed conductance of each stream reach was computed by multiplying 250 ft/day (which accounts for the streambed hydraulic conductivity and thickness and the stream width) by the length of the stream in each cell. For each stream segment the STR package requires the specification of width, slope, and Manning's coefficient for the purpose of computing the flow routing. The width was specified as 50 feet, the slope was computed based on the elevation of the beginning and the end of each stream segment, and the Manning's coefficient was set at 0.03.



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Boundary Conditions
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.18

2.2.4 Evapotranspiration, Recharge, and Pumping Inputs

The LPMT model provided for potential evapotranspiration from the water table using the evapotranspiration (EVT) package for much of the area covered by this model. Therefore, the parameters from the EVT package (evapotranspiration surface, extinction depth, and maximum evapotranspiration) from the LPMT model for were assigned to the EVT package for this model. The EVT package was set up to allow evapotranspiration to occur in the highest active layer.

Recharge estimates were adapted from the LPMT model for inclusion in the refined model. These estimates were determined by the LPMT model developers using a watershed model described in section 2.1.6 of this report. The watershed model is also documented extensively and available on the NDNR website (NDNR 2018). Average recharge in the refined model area is approximately 3.14 inches per year. The monthly recharge is shown in Figure 2.19. The recharge package was set up to allow recharge to be assigned to the highest active layer.

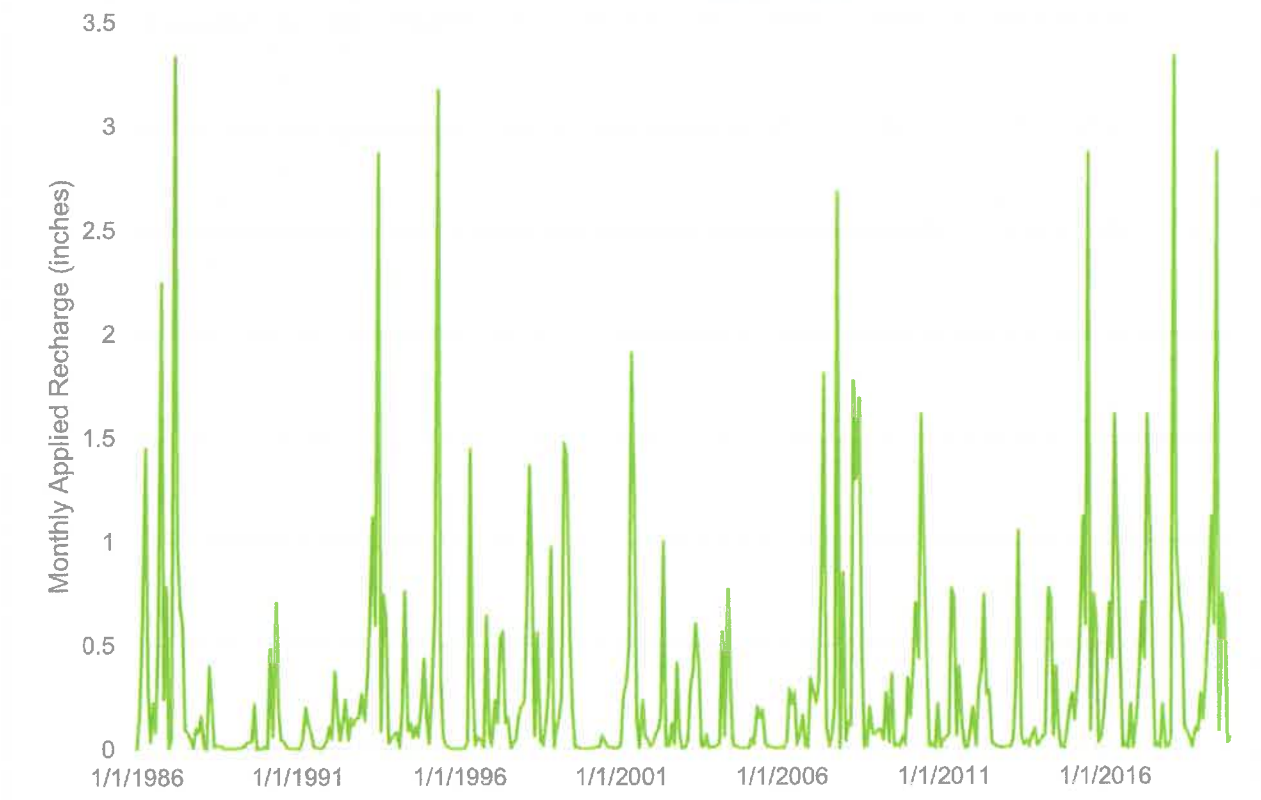


Figure 2.19 Recharge applied to the model from 1986-2019

Pumping in the model was defined using a combination of LPMT data and shapefiles supplied by the LPSNRD. Certified acres and active irrigation well locations within the LPSNRD were used to distribute pumping with a much higher degree of detail than in the LPMT model. In the shapefiles received from the LPSNRD, 77 active irrigation wells within the model area were successfully matched to certified acres. The pumping volume from the LPMT model files was summarized and redistributed to the 77 well locations based on the number of associated acres. For example, a well irrigating 140 acres would be assigned a higher total volume of water use than a well irrigating only 20 acres. This process was repeated for each stress period to assemble the full 1986-2019 model timespan. This step was necessary to translate the LPMT pumping data from large 0.5-mile by 0.5-mile cells to the point locations of the wells (Figure 2.20

and 2.21). A time series of the number of groundwater irrigated acres used in the model simulation is shown in Figure 2.22.

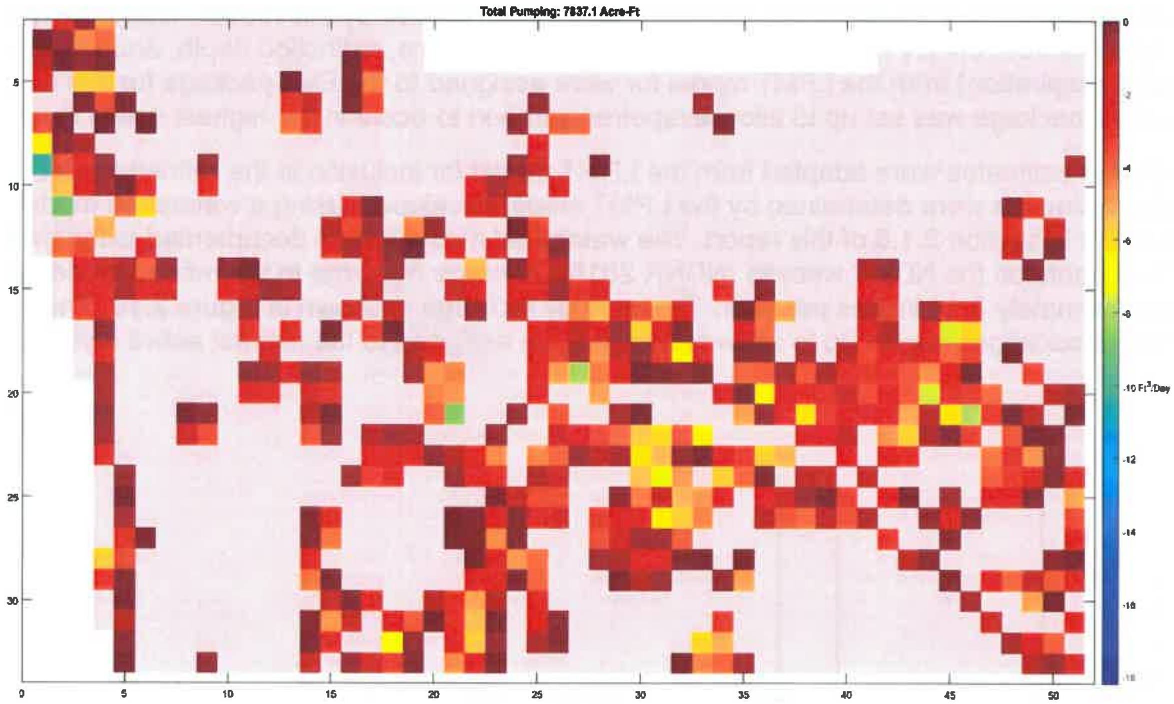


Figure 2.20 Spatial distribution and magnitude of pumping simulated in the LPMT model in July 2013.

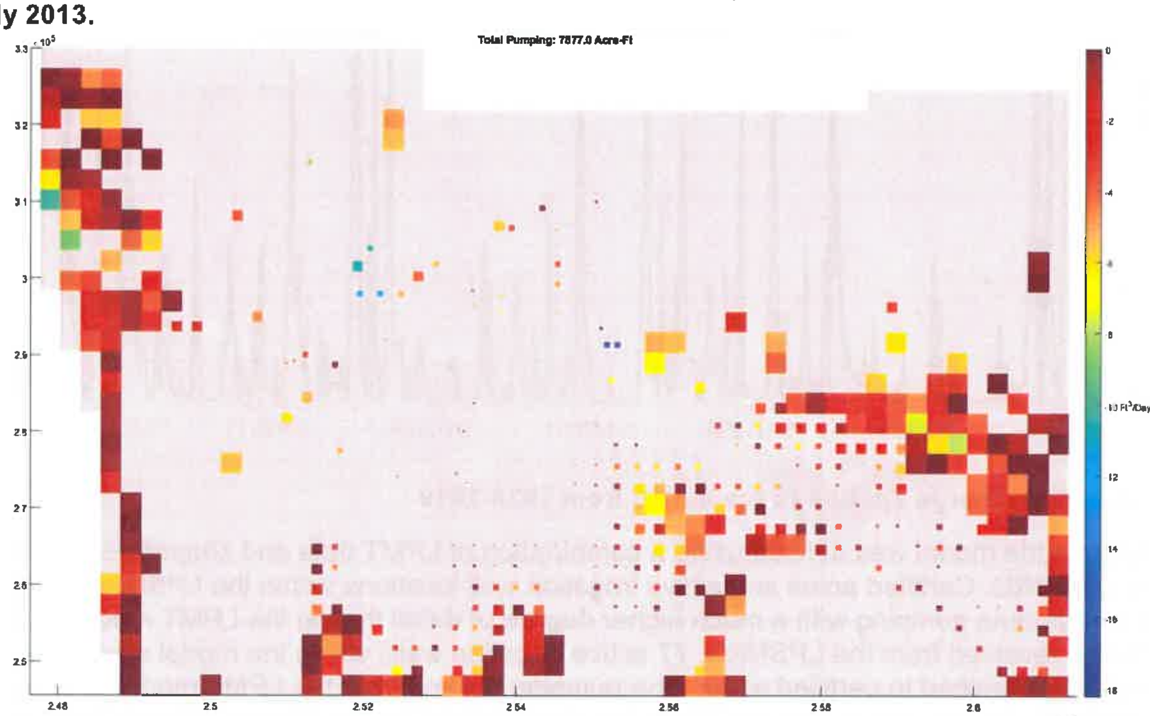


Figure 2.21 Spatial distribution and magnitude of pumping simulated in the refined model in July 2013.

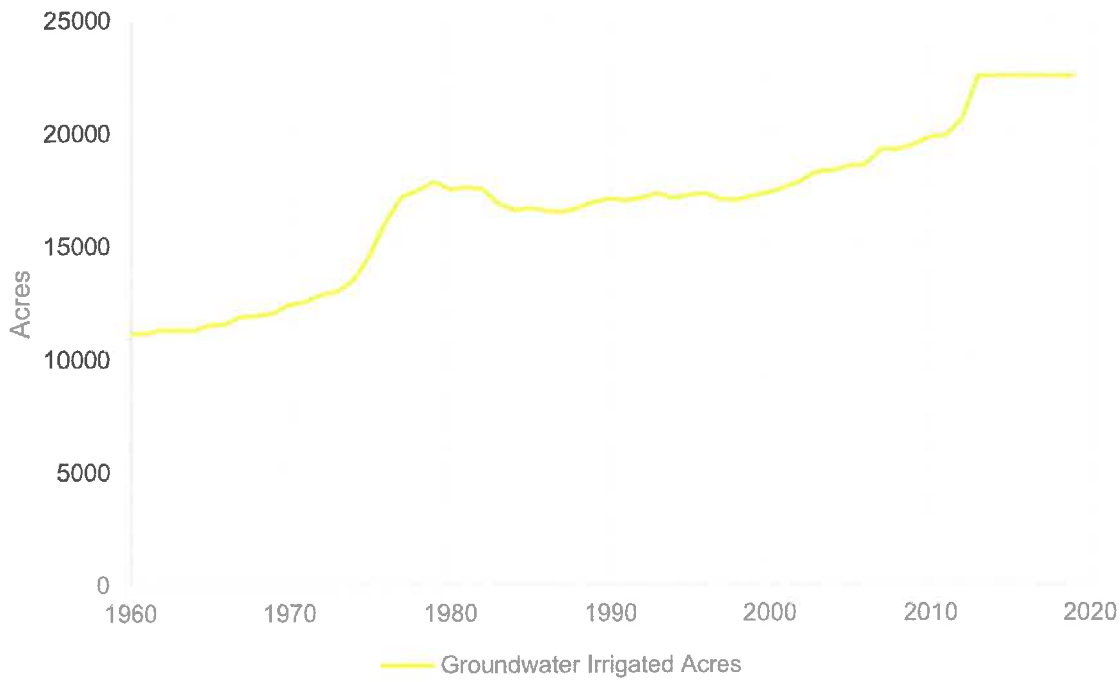


Figure 2.22 A time series of the number of groundwater irrigated acres simulated within the model from 1960-2019. The last dataset available is from 2013 so those years were repeated for 2014-2019.

The LPSNRD also provided meter data for a selection of irrigation wells in the model domain. Discussions were held over data quality concerns, and it was decided by the modeling team to use the meter data solely as a validation dataset, rather than incorporate it into the simulation. Overall, the average annual pumping compares reasonably, with the modeled pumping totaling 34.6 inches over the 2011-2019 time period, and the metered pumping totaling 37.1 inches (Figure 2.23). Comparison charts of modeled pumping and metered pumping on a well-by-well basis are included in Appendix B.

This process was only utilized for the irrigated acres within the LPSNRD. Outside of this area, a simple intersection was performed between the LPMT regional model grid and refined model grid to find which cells should be assigned pumping. This method is not as sophisticated as the one used to distribute pumping within the LPSNRD, but maintains the accuracy of the LPMT model.

Municipal and industrial pumping from the LPMT model was adapted and used in the refined model. Municipal pumping in Hallam was equally distributed to two well locations based on information provided by the LPSNRD. The main industrial water user in the area is NPPD, which operates eight active wells registered as a commercial or industrial use. The industrial pumping corresponding to these well locations in the LPMT model was equally distributed among these eight wells in the refined model.

Given the geologic complexity of the refined model, particularly in southern Lancaster County where an upper and lower aquifer has been defined and mapped, it became necessary to

Figure 2.23 Average pumping depth comparison between metered and modeled pumping in the LPSNRD.

develop an approach for the vertical location to assign pumping. As such, a Connected Linear Network (CLN) package was developed with each CLN feature representing the vertical well screen of each well. The CLN package describes the spatial relationship between each node on each CLN (a CLN has more than one node if it exists in more than one layer) and the cell that the CLN feature is in. Pumping is assigned to the bottom-most node within each CLN, and the rate of flow from each layer to each CLN feature is computed based on the water level difference between the CLN and each model cell to which that CLN is connect with.

When considered on a per acre basis across the model (as opposed to per irrigated acre), average groundwater withdrawals are significantly less than average recharge, at about 0.4 inches per year (as compared to 3.14 inches per year of recharge). Of course, this is the average from 1960-2019, and irrigation is considerably more today than it was 60 years ago (See Figure 2.24). The average groundwater withdrawals from a more recent period are somewhat higher, nearly 0.5 inches per year on average from 2001-2020.

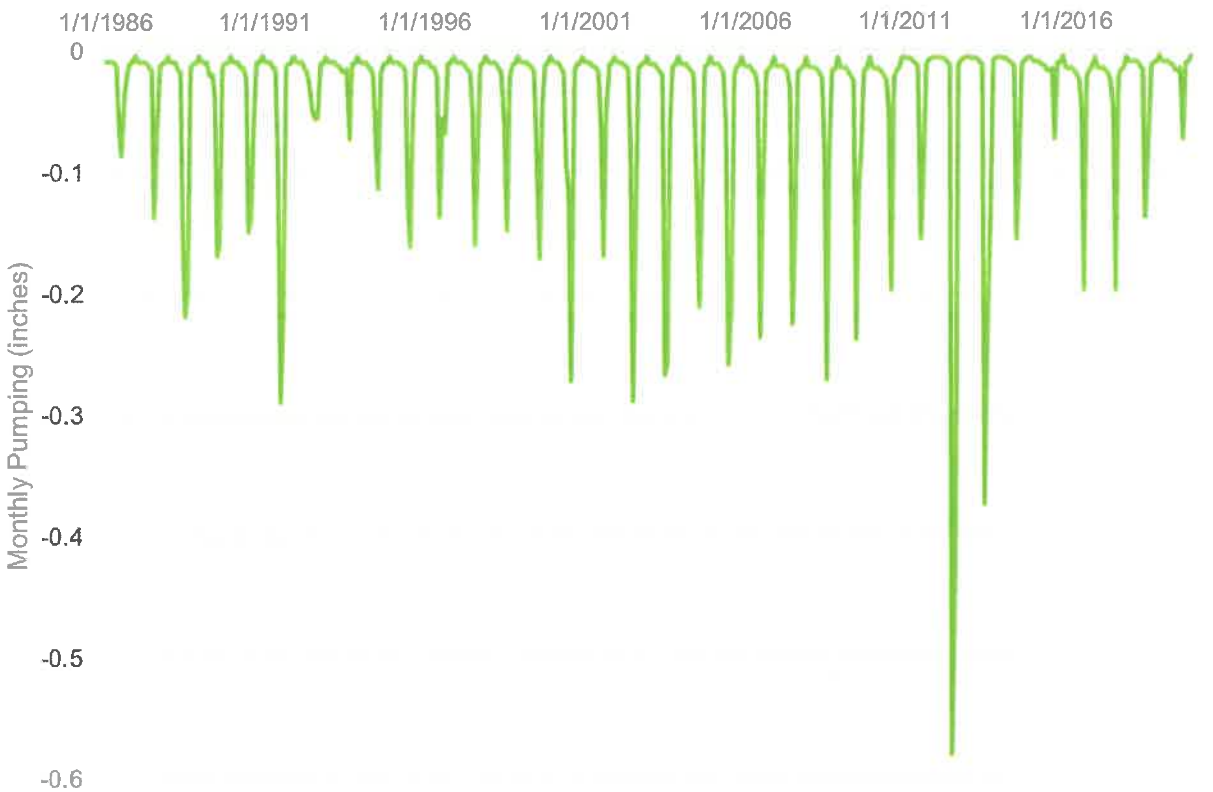


Figure 2.24 Monthly pumping simulated in the refined model on a per acre basis.

2.2.5 Aquifer Parameters

Several sources of information on aquifer parameters were considered in setting the initial aquifer parameters. In July 2020, the two researchers at the CSD completed an evaluation of the paleovalley aquifers south of Lincoln (Divine and Howard 2020). Their work included maps and descriptions of the Quaternary aquifers, bedrock surface, aquifer saturated thickness and transmissivity.

In August of 2020, Monolith completed a pump test at the site of the planned future facility. A step- and a constant-rate pump test were performed on the test well and observation well (OB) shown in Figure 2.25. The results of the pump test and the analysis of the data collected during the pump test were provided to the LPSNRD by memo in September 2020, with an addendum to that memo submitted in early October 2020 (EA 2020). The memo and addendum are included in Appendix C.

As reported in the memo submitted to the LPSNRD, the step-rate tests were used to determine pumping water levels at various discharge rates, which can in turn be used to evaluate overall well efficiency and permanent pumping equipment requirements. The constant-rate test was used to estimate aquifer parameters and measure and project aquifer drawdown around the pumping well. The results of the pump test indicated that the aquifer was likely unconfined in the general area of the Monolith facility. Analysis using the Theis and Neuman methods generally indicated that hydraulic conductivity values for the aquifer in this area are likely to fall in the range of 100 to 200 feet per day. The Storage Coefficient was estimated at between 0.001-0.01, and Specific Yield was estimated at between 0.17-0.20.

Aquifer parameters were specified in the model using the Layer Property Flow (LPF) package. Layers 1 and 2 were simulated as convertible (layer type 1) and layers three and four were simulated as confined (layer type 0). The storage coefficient was set as 0.001 and the specific yield was set to 0.2. The hydraulic conductivity of layers one and three was specified as 10 feet per day. The vertical hydraulic conductivity was set to be one tenth of the horizontal hydraulic conductivity in all layers. The horizontal hydraulic conductivity in layers two and four was the focus of model calibration.

Figure 2.25 Aquifer pumping test and observation (OB) well locations (EA 2020).

3. RESULTS

3.1 Model Calibration

The model was calibrated using the parameter estimation tool called PEST (Doherty and Hunt 2010). The goal of the calibration process was to produce simulated water levels that compare favorably to the observed water levels and produce a good representation of the hydrologic system. This goal was quantified as being met when the weighted absolute residual mean was less than 5% of the range of observations.

3.1.1 Calibration Targets

The primary model calibration targets used in the calibration process consisted of water level observations. A secondary calibration target was the simulated stream baseflow in the Salt Creek above the location of the Salt Creek at Roca streamgage. Water level observations were obtained from the USGS and associated with the correct location within the model domain (USGS 2020). There are 87 observation locations and a total of 1,798 water level observations. The number of water level observations for each location ranged from as little as one to as many as 298. In fact, 60 of the water level observation locations contained less than ten observations.

Due to the significant variation in the number of water level observations at each location, a weighting scheme was developed that sought to reduce the influence of the few wells with a large number of observations as well as those with a very small number of observations. Table 3.1 describes the weighting scheme that was used.

Table 3.1 Weighting scheme used for water level calibration targets.

Category	Equation	Number of Wells in this Category
If the number of observations was greater than 52	Weight = (1 - number of observations - 52) / 52	12
If the number of observations was less than 52	Weight = Number of observations / 52	75

The value of 52 represents the approximate median number of observations for the subset of wells that had a minimum of 20 observations. The purpose of this process will be discussed further in the next section. Plots comparing observed and (weighted) simulated water level at targets with more than 52 observations are included in Appendix D.

3.1.2 Calibration Approach

The calibration approach that was adopted was to utilize the software platform PEST (Doherty and Hunt 2010) to estimate the aquifer parameters that resulted in a best fit between observed and simulated water levels. Pilot points were used as a means to either apply a multiplier against previously estimated hydraulic conductivity or to represent the actual aquifer parameter at the location of the pilot point (Figure 3.1). The overall goal was to achieve a residual error between observed and simulated water levels as close to zero as possible, and an absolute residual error of between 5-10% of the range in observed water levels.

PEST computed a weighted objective function at the beginning of each pest simulation and then sought to minimize that weighted objective function. This highlights the purpose of computing weights for each observation point so as not to bias the parameters estimation process toward wells with a large number of observation or a large group of wells with relatively few observation points.

Two approaches for estimating the final horizontal hydraulic conductivity values were attempted. The first approach started with hydraulic conductivity values derived from the unpublished CSD data that documents values for aquifer transmissivity and saturated thickness (Divine and Howard 2020). By dividing the transmissivity by the saturated thickness, the hydraulic conductivity was computed and inserted into the model. Then, a set of pilot points were established that could act as multipliers on this baseline hydraulic conductivity. While this approach yielded a fairly good level of calibration, another approach was also attempted to see if it would yield considerably better results.

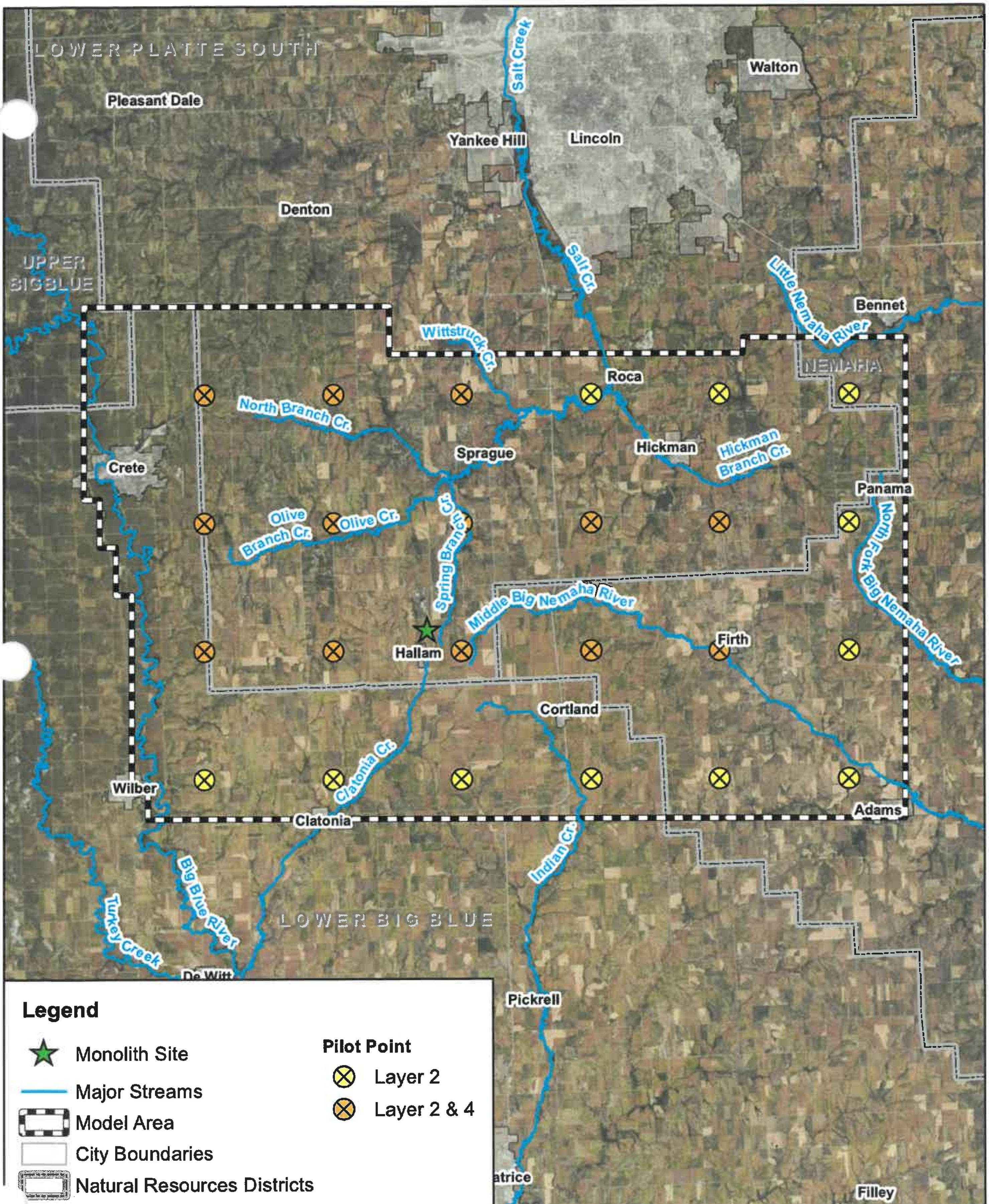
The second approach started with a series of pilot points that were meant to represent the actual value for hydraulic conductivity. These pilot points were given an initial value of 100 feet per day and allowed to vary anywhere between 20 and 200 feet per day. After several PEST iterations it became clear that this approach was yielding significantly better calibration results. The secondary calibration target of stream baseflows in the Salt Creek and its tributaries above the stream gage on Salt Creek at Roca was not used directly in any PEST simulations, but rather it was used as an additional check on how well the model was matching observed information.

3.1.3 Calibration Results

The estimated final model parameters, obtained through the model calibration process described above, produce a well calibrated model with an excellent representation of the hydrologic system. The final model simulation was conducted using the calibrated model parameters. Final calibration statistics, which compare modeled water levels to actual observed water levels, can be found in Table 3.2.

Table 3.2 Final calibration statistics.

Calibration Parameter	Result (ft)
Residual Mean	0.69
Absolute Residual Mean	7.25
Residual Standard Deviation	12.0
Sum of Squares	261,520
Root Mean Square (RMS) Error	12.1
Minimum Residual	-48.9
Maximum Residual	53.8
Range in Observations	205.4
Scaled Residual Standard Deviation	0.06
Scaled Absolute Residual Mean	0.04
Scaled RMS Error	0.06



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Pilot Points
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.1

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While the minimum and maximum residuals are large, these values are attributed to outliers in the data set. Figure 3.2 shows the distribution of the absolute residuals. As can be seen, the vast majority (approximately 92%) of the absolute residuals are less than 15 feet. The absolute residual mean for this slightly smaller subset of the observation data is approximately 5 feet.

Figures 3.3 and 3.4 show the final distribution of the estimated hydraulic conductivities for model layers 2 and 4, respectively. One notable result of the final model simulation is that the vast majority of cells in model layer 1 become dry during the model simulation (Figure 3.5). A cell becomes dry in a model simulation when the computed water level falls below the bottom of the cell. Most of those cell conversions from wet to dry happen in the initial steady state stress period (see Section 2.2.2 above). While cell rewetting, an optional setting in MODFLOW, was not turned on in the model simulation, it is unlikely that the resulting simulation would have been significantly different.

Part of the reason that so many cells become dry during the initial steady state stress period is that the GHB elevations specified in model layer 1 (from the LPMT model simulation) are below the bottom of model layer 1. This is also consistent with the aquifer response during the pump test as an unconfined aquifer. If the water levels in layer two are below the top of layer two (and the bottom of layer one), the aquifer will behave as an unconfined, or water table, aquifer. There are also some cells in model layer 2 that become dry (Figure 3.6). These cells are mostly associated with areas where model layer 2 is very thin because the aquifer is predominantly represented by model layer 4, and areas in the northeastern portion of the model where the aquifer becomes very thin.

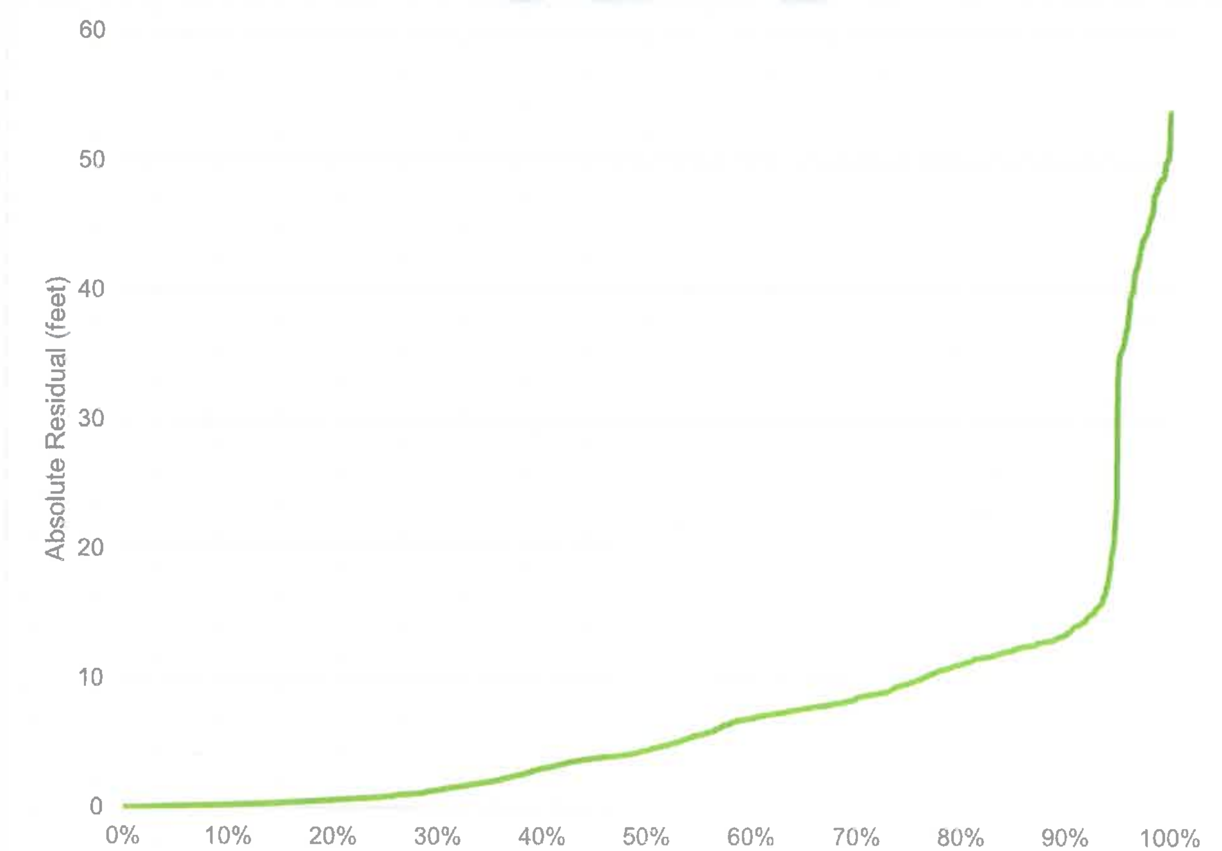
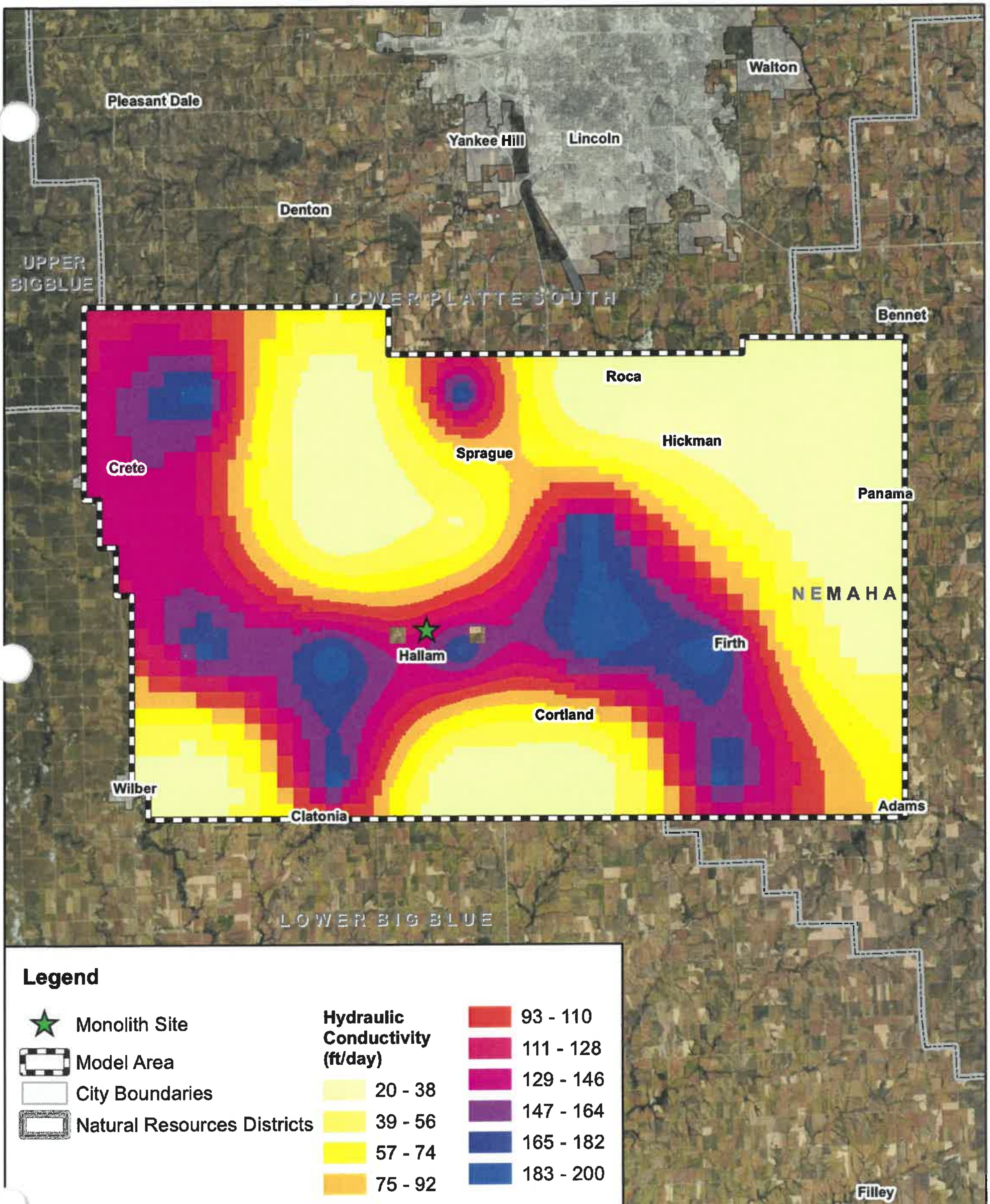


Figure 3.2 Distribution of the absolute residuals.



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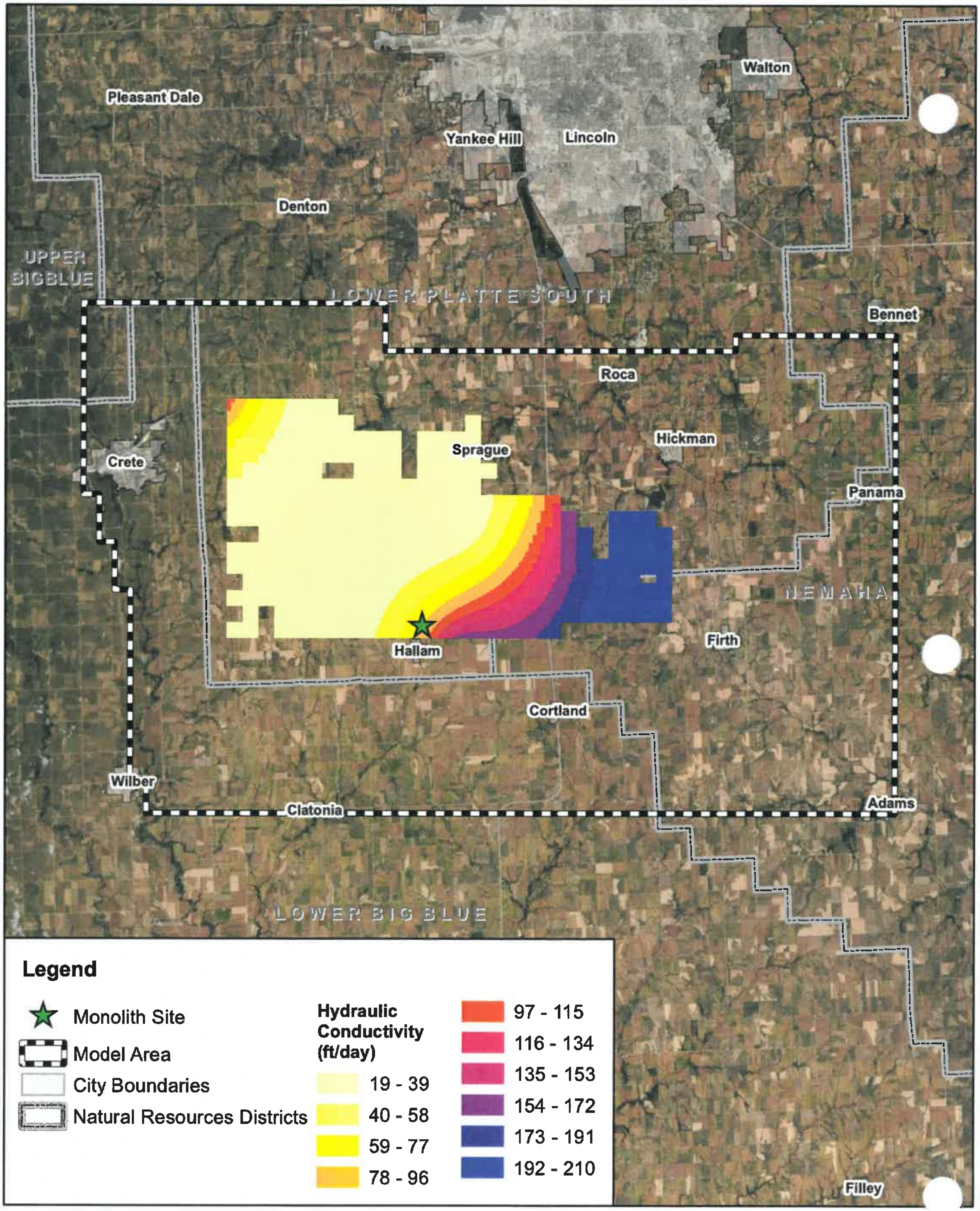
Layer 2 Hydraulic Conductivity
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.3



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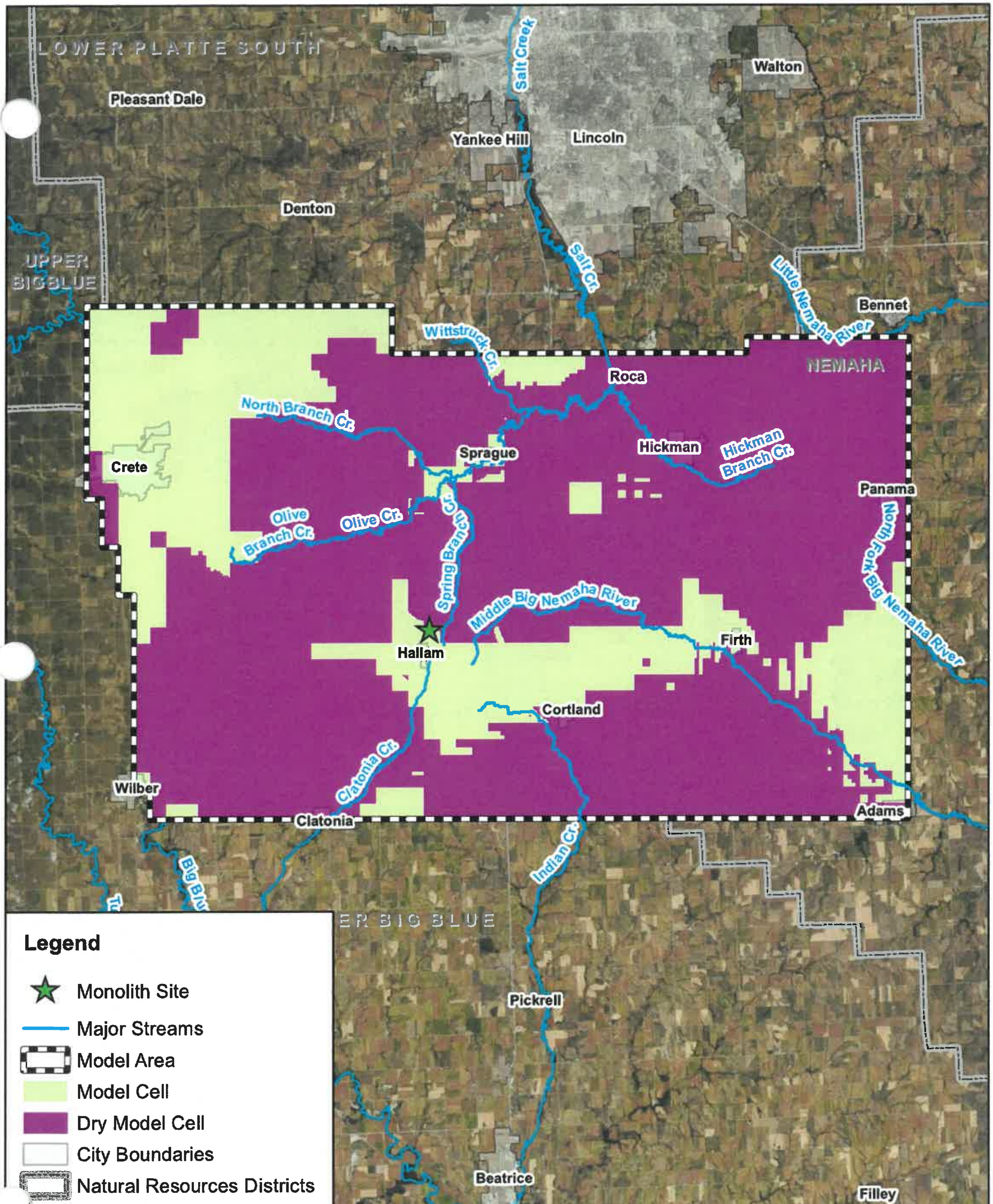
Layer 4 Hydraulic Conductivity
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.4



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Dry Cells in Layer 1
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.5

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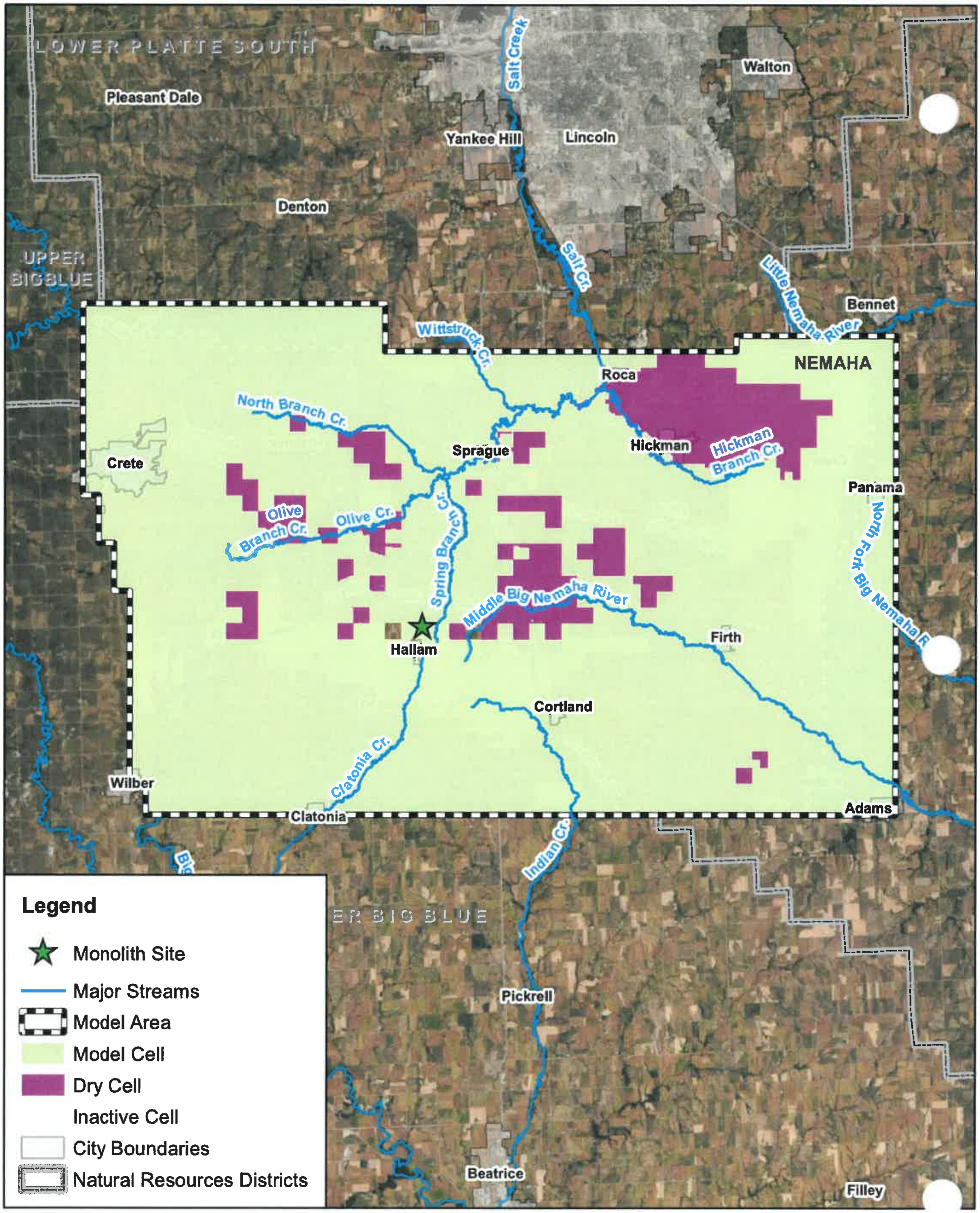

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N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Dry Cells in Layer 2

Monolith OC2

Groundwater Modeling Report

Lancaster County, NE

FIGURE

3.6

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The cumulative water budget for the 60-year simulation period (1960-2019) is presented in Table 3.3. Model budget terms along with average annual values and the percent of net recharge (recharge minus pumping) are shown.

Table 3.3 The cumulative water budget for the final model simulation in acre-feet per year.

Model Budget Term	Value (acre-feet per year)	Percent of Net Recharge
Storage	-6,722	12%
Wells	-8,058	N/A
River	-5,138	9%
Evapotranspiration	-757	1%
General Head Boundary	-2,305	4%
Recharge	62,414	N/A
Stream Leakage	-39,515	73%
Total	-2	0%

The cumulative water budget is also presented in Figure 3.7. As can be seen, total recharge over the 60-year period is approximately 3.75 million acre-feet, or approximately 62,500 acre-feet per year. Most of this water discharges to the aquifer as stream baseflow (Stream Leakage). Minor percentages of the net recharge manifest as discharge to the Big Blue River (River), Evapotranspiration, and the model boundary (General Head Boundary). The remaining portion of the net recharge manifests as a net increase in aquifer storage, though the aquifer experiences periods of storage reduction along with periods of storage replenishment.

The water levels in the aquifer at the end of the simulation period (1960-2019) are shown in Figure 3.8. The aquifer in the area of Salt Creek and some of its tributaries is clearly interacting with these surface water features in the northern portion of the model, and with the Middle Big Nemaha River in the southeastern portion of the model. This is due to the fact that the water level elevations in the aquifer decline with the decline of the stream elevation. In contrast, this is not seen on Claytonia Creek or Indian Creek, where streambed elevations appear to be above computed water levels. Figure 3.9 is a bubble map showing the average magnitude of the difference between the simulated and the observed water levels. Figure 3.10 shows the simulated stream baseflows into Salt Creek above the Salt Creek and Roca streamgage. These results compare well with the simulated baseflows from the LPMT model as documented in Figure 2.1 above. While the baseflows computed by the LPMT model and the Monolith model tend to be greater than the observed baseflows, it's important to note that the riparian evapotranspiration budget term is very small relative to the computed baseflow. It is likely that the computed baseflows can be readily matched much more closely by refining the EVT package inputs around the streams. However, as computing impacts to stream baseflows is outside of the purview of this evaluation, this extra step was not taken.

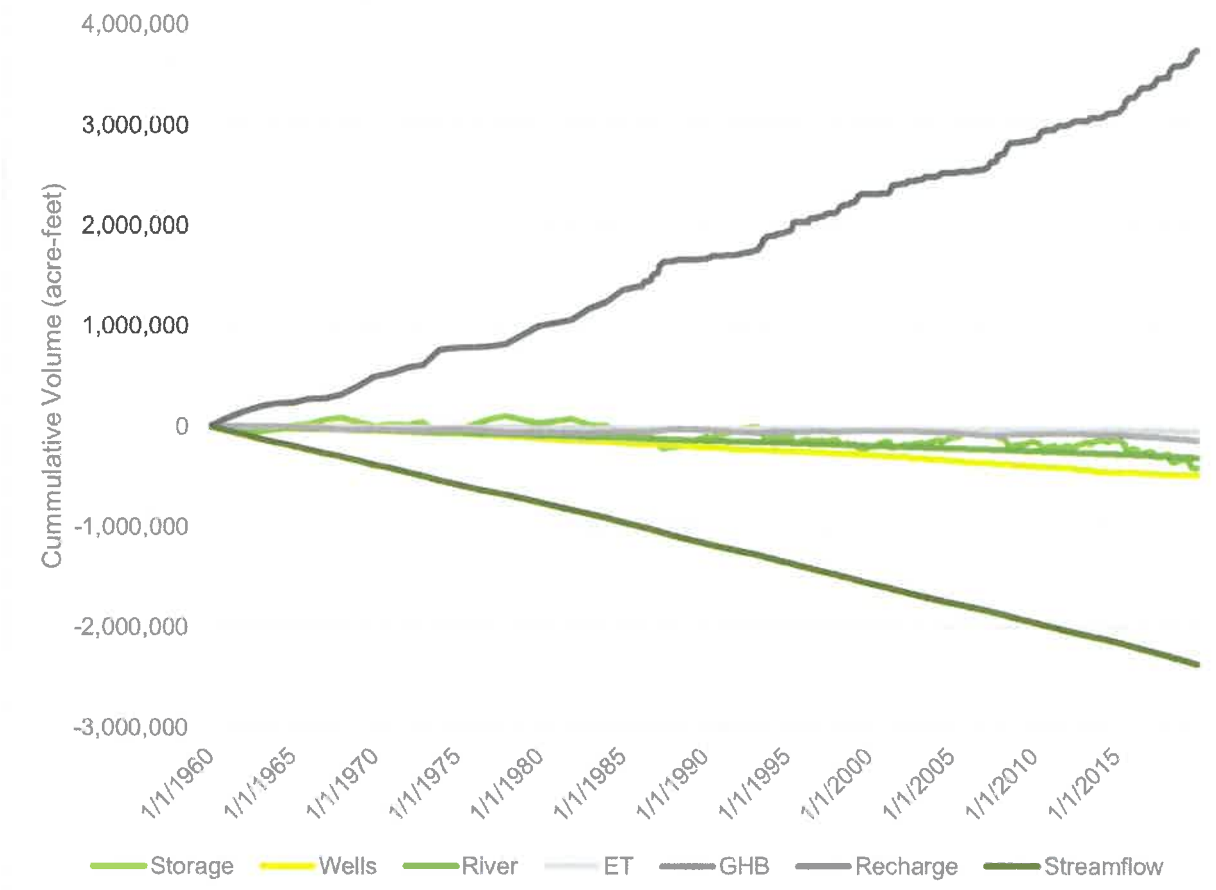
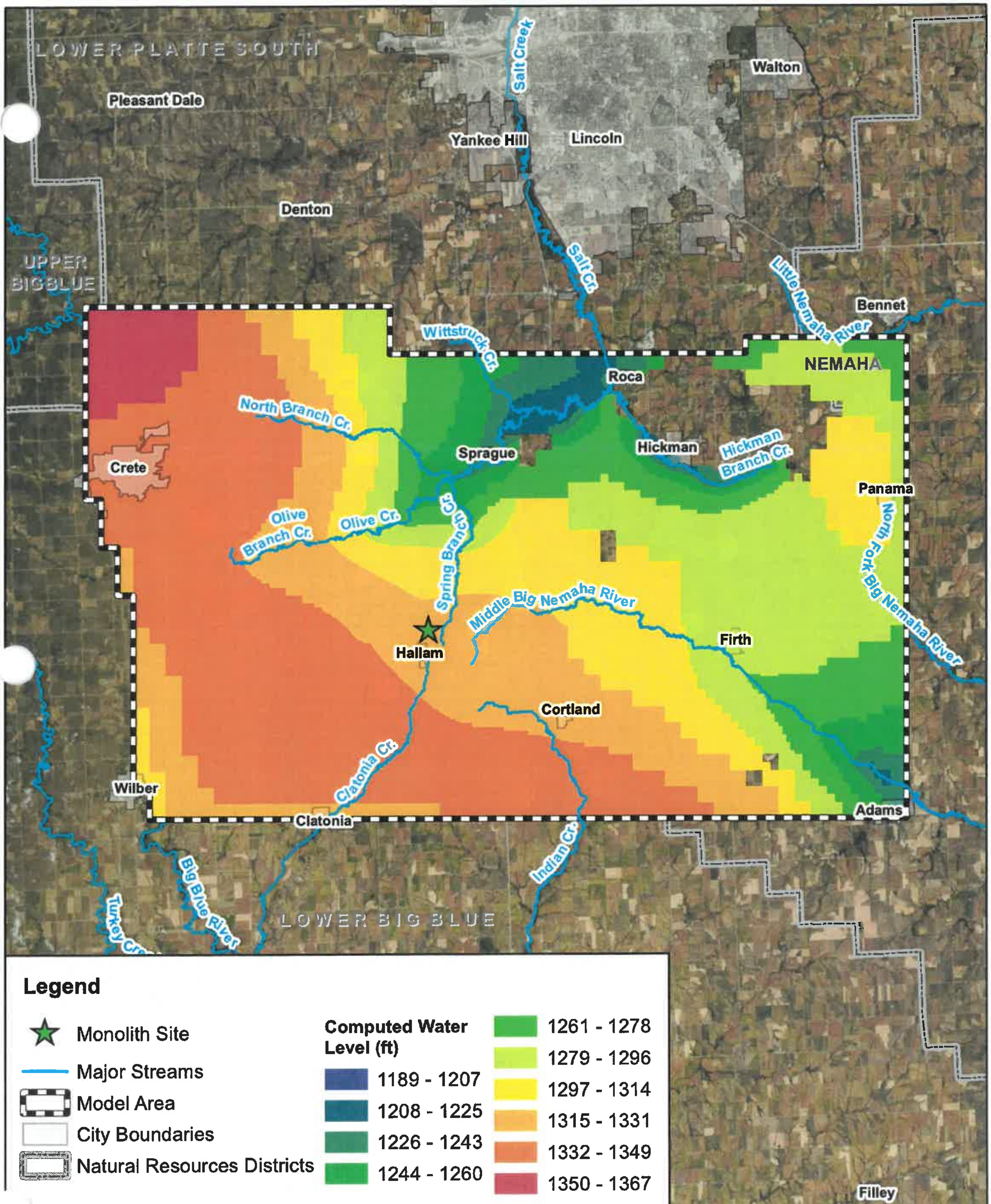


Figure 3.7 The cumulative water budget for the calibrated model simulation.



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N

0 1 2 4 Miles
1 in = 4 miles
NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Computed Water Levels
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.8

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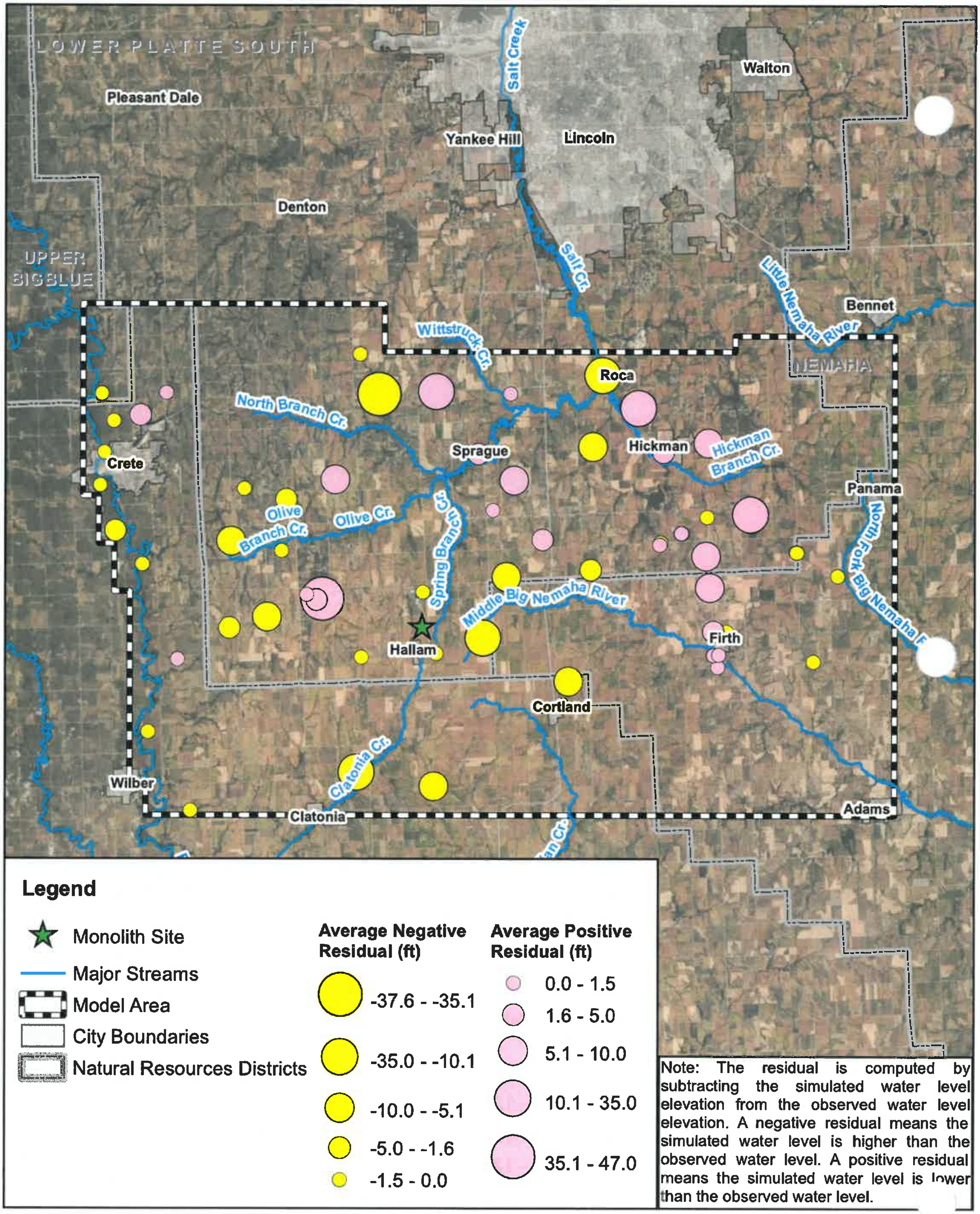

Note: The residual is computed by subtracting the simulated water level elevation from the observed water level elevation. A negative residual means the simulated water level is higher than the observed water level. A positive residual means the simulated water level is lower than the observed water level.

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N
0 1 2 4 Miles
1 in = 4 miles
NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Water Level Targets
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.9

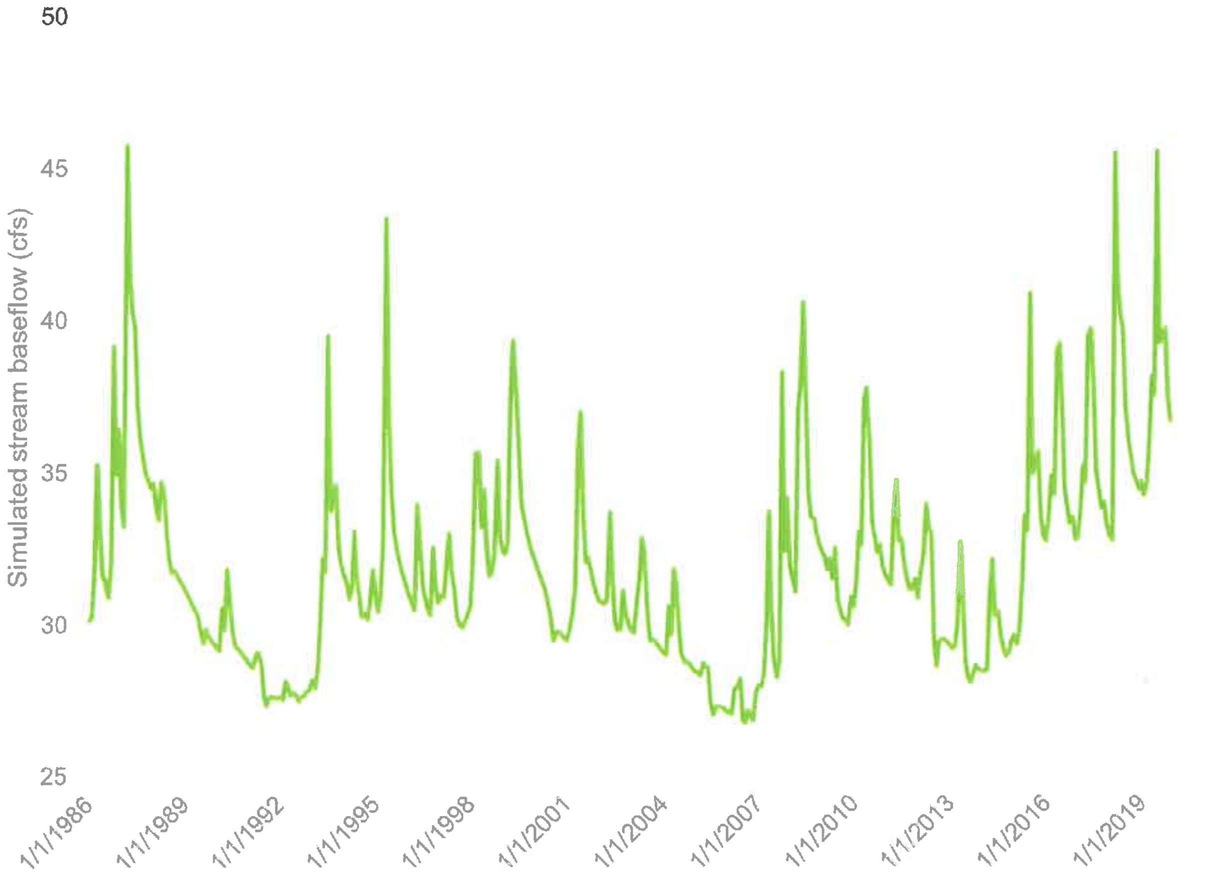


Figure 3.10 Simulated stream baseflow in Salt Creek.

3.2 Modeling Results

The calibration period model (1985-2019) was adapted to create a future scenario model (2020-2069) to simulate the impacts of the proposed Monolith well. Climate conditions from 1995-2019 were repeated for the 50-year future model run. To simulate future irrigation pumping, the 2013 groundwater irrigated acres from the LPMT model were held constant and a pumping demand per acre was applied to the model cells (as noted above for Figure 2.22, 2013 is the last year with this data currently available). In the LPSNRD area, pumping was assigned at all irrigation wells with a matching certified acre parcel using the demand per acre. The demand per acre was calculated by dividing the pumped monthly volume by the number of actively irrigated acres in a given model stress period. Municipal and industrial pumping from the 1995-2019 time was repeated for inclusion in the future scenario model. Total pumping simulated in the future scenario model with and without the proposed Monolith well is shown in Figure 3.11.

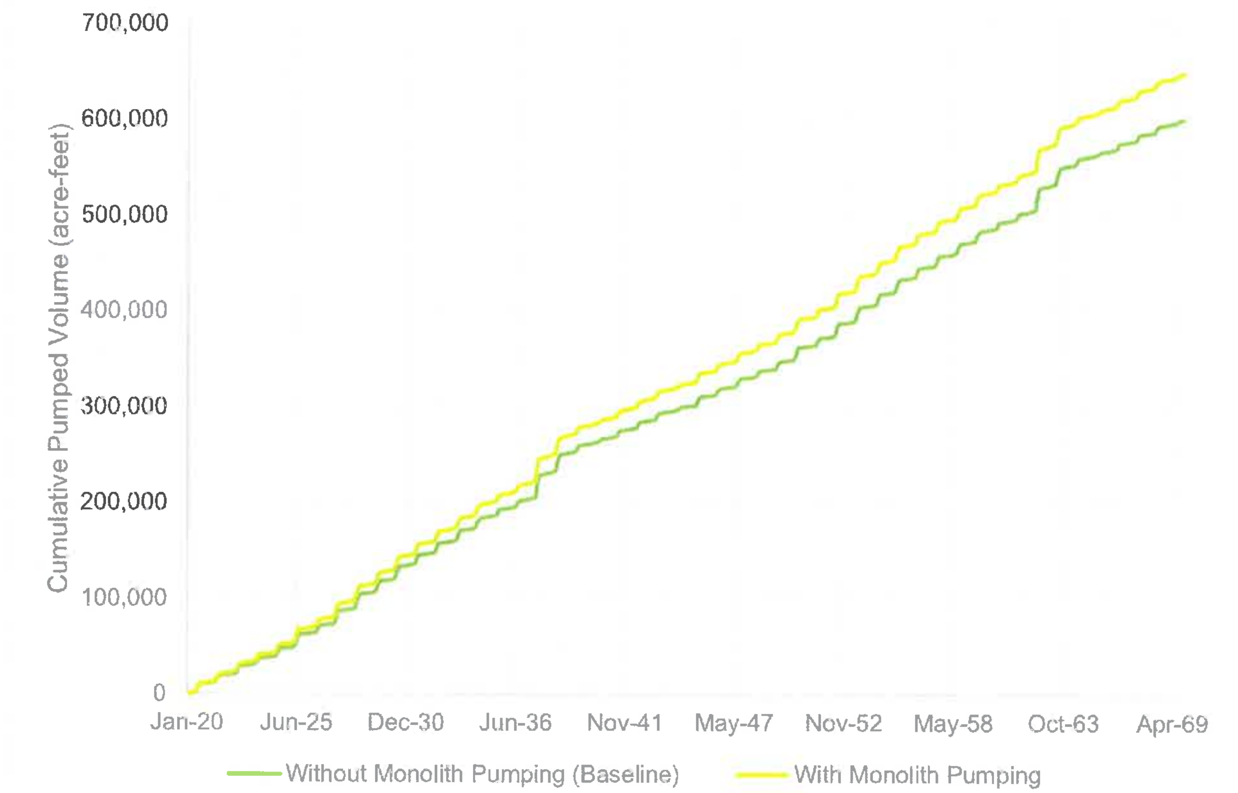


Figure 3.11 Simulated cumulative pumping in the future scenario model.

At the end of the 50-year simulation, the additional volume pumped by the Monolith well is about 48,000 acre-feet.

3.2.1 Operational Scenarios Evaluated

A detailed annual pumping schedule for the proposed well was provided by Monolith and simulated with the future scenario model. Pumping varies by month, climate condition, and operational capacity. The annual pumping schedule was transformed into a 25-year record of pumping using the historical temperature data from 1995-2019 (Figure 3.12). The data was repeated for the 50-year future scenario. In practice, Monolith intends to withdraw water from between one and three wells at any given time. However, due to the close spatial proximity of the wells, the projected water use was simulated with a single well in the model.

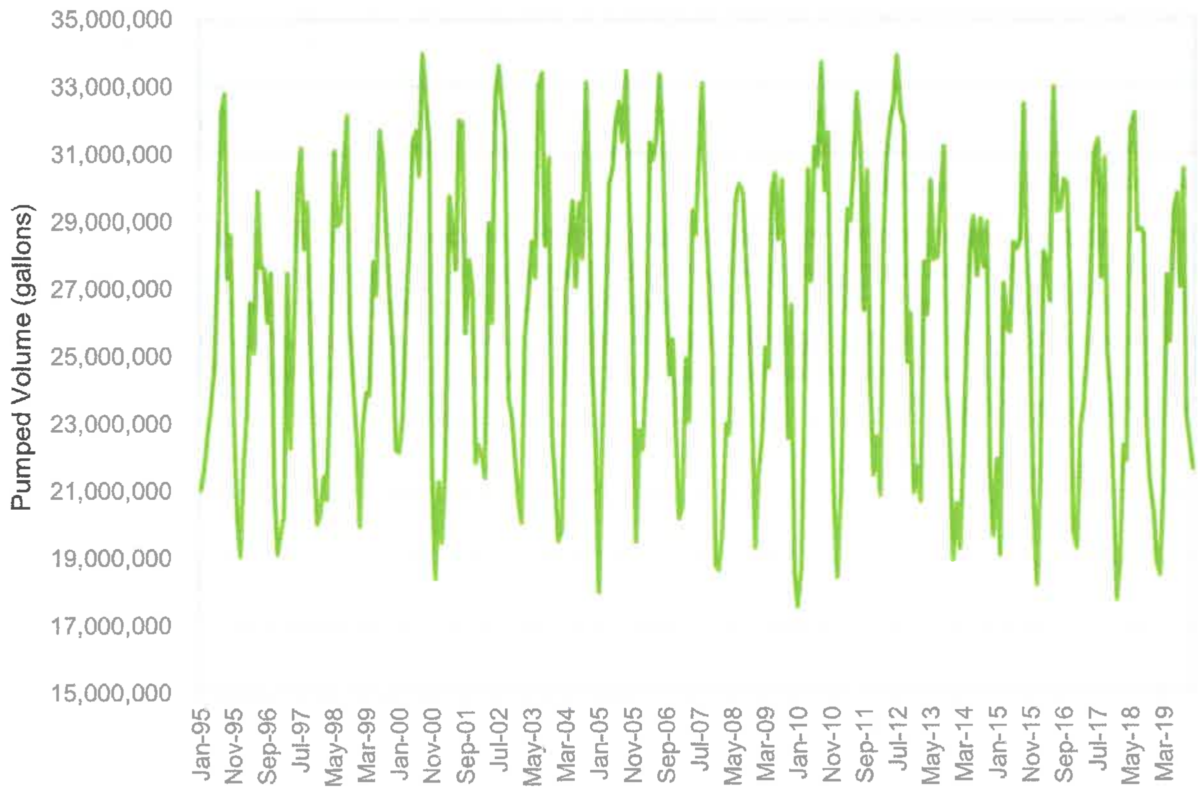


Figure 3.12 Proposed Monolith well pumping used in the future scenario model.

3.2.2 Water Budget

The cumulative water budget for the 50-year simulation period (2020-2069) is presented in Table 3.4. Model budget terms along with average annual values are shown for both the baseline and additional pumping scenarios.

Table 3.4 The cumulative water budget for the future model simulation scenarios in acre-feet per year.

Model Budget Term	Baseline Scenario Value (acre-feet per year)	Monolith Pumping Scenario Value (acre-feet per year)	Difference (acre-feet per year)
Storage	-1,889	-1,588	-301
Wells	-12,016	-12,975	959
River	-7,452	-7,407	-45
Evapotranspiration	-1,130	-1,126	-4
General Head Boundary	-6,839	-6,682	-157
Recharge	72,309	72,309	0
Stream Leakage	-42,983	-42,530	-453
Total (In-Out)	-1	-1	0

Note the difference in average annual pumping in the baseline scenario (~12,000 acre-feet) as compared to the average annual pumping during the period from 1960-2019 (~8,000 acre-feet, see Table 3.3). This difference of approximately 4,000 acre-feet represents the result of the process described above whereby irrigation is represented for all currently irrigated acres every year in the future regardless of whether those acres were irrigated during the historic proxy year used in the future scenario.

The cumulative water budget for the scenario with the proposed Monolith well is also presented in Figure 3.13. While covering a slightly shorter time period, this graph can be compared to Figure 3.7 above. Note that the line representing change in cumulative storage drifts below zero (indicating net addition to storage) during the historic scenario whereas it hovers around zero (indicating minimal net change in storage) during the future scenario, even with the addition of the water use at Monolith.

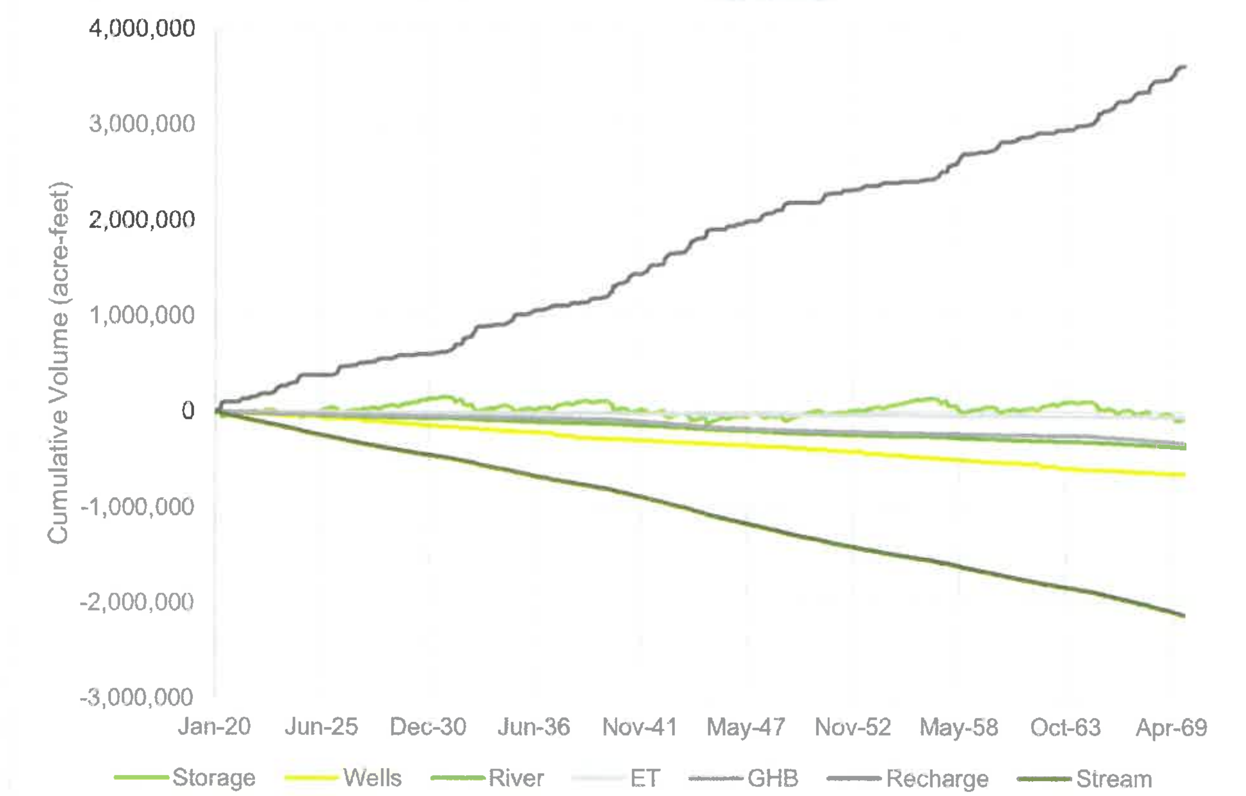
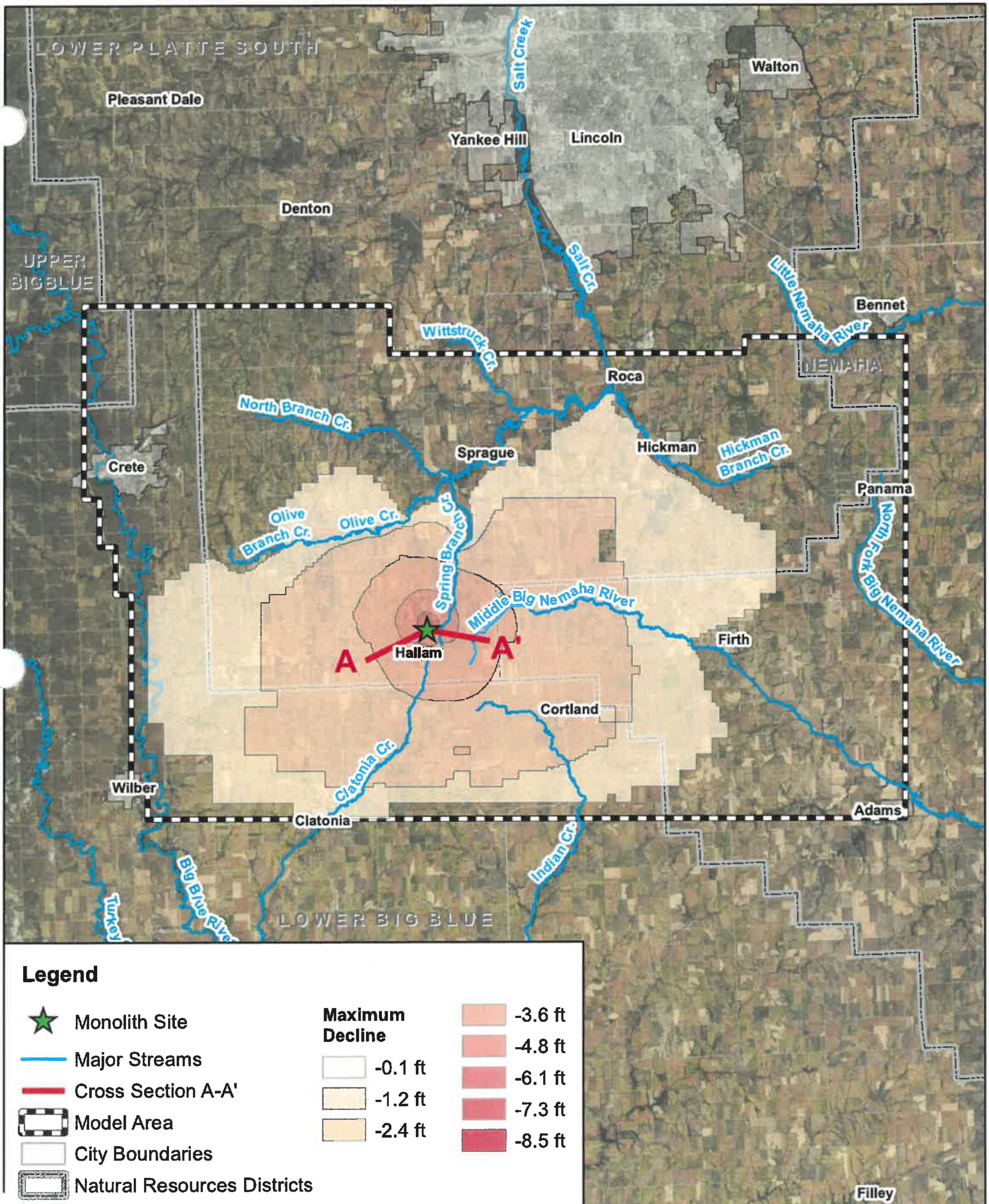


Figure 3.13 Cumulative water budget for the future scenario with Monolith pumping.

3.2.3 Aquifer Impacts

The proposed Monolith well was simulated in GET to produce water level change figures. At the end of the 50-year future scenario simulation with the variable Monolith pumping schedule, the results show a maximum decline of 8.5-feet in the model cell containing the well (Figure 3.14). Water level declines decrease substantially with distance from the well, and amount to less than 4 feet about a mile away. Declines extend to the edges of the southern model area and range from 0.1-1.2 feet. Aquifer declines do not continue to the north of Olive Branch and Salt Creek. Instead, the model predicts a reduction in aquifer discharge to these streams as opposed to a decline in aquifer levels.



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Future Scenario Declines With Monolith Pumping
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3.14

While the spatial extent of the impacts may seem significant, this needs to be taken in the context of the current saturated thickness of the aquifer. Figure 3.15 depicts a cross section along the red line included on Figure 3.14. The grey area is the bedrock below the aquifer, the blue area is the remaining saturated thickness of the aquifer after 50 years of pumping at Monolith, and the pink area is the portion of the current saturated thickness that will be dewatered after 50 years of pumping at Monolith.

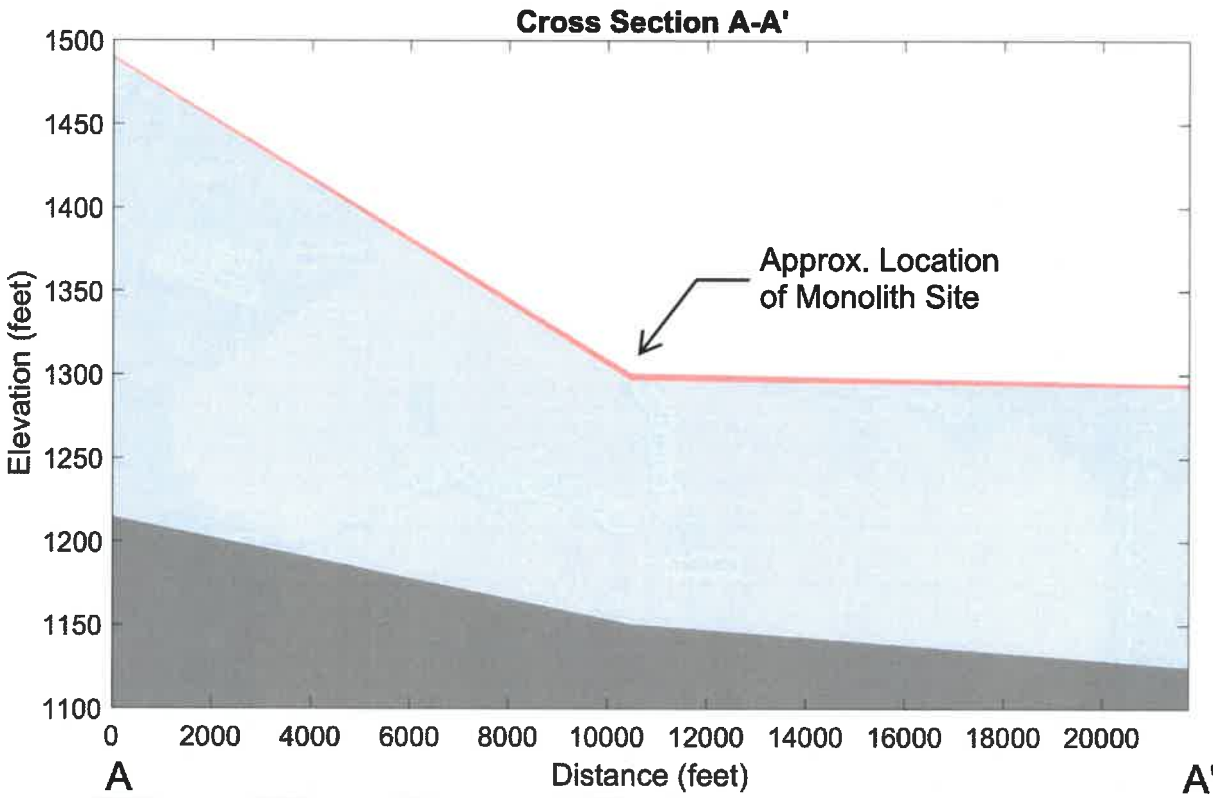


Figure 3.15. Cross section showing the saturated thickness remaining (blue) above the bedrock (grey) after 50 years of pumping at Monolith and the portion of the current saturated thickness that will be dewatered (pink) after 50 years of pumping at Monolith.

Finally, in order to assess the sensitivity of these results to the estimated aquifer parameters (e.g., hydraulic conductivity), several simulations were conducted. These simulations applied a uniform percentage adjustment to the aquifer parameters and the subsequent changes in the water level declines were examined. In general, the relationship between a unit percentage change in an aquifer parameter and the percentage change in aquifer drawdowns was 1:1. For example, a 20% decrease in the hydraulic conductivity results in an approximate 20% increase in aquifer drawdown. Therefore, even if there is a relatively considerable difference between the estimated aquifer parameters and the actual aquifer parameters, the resulting actual drawdown will be similar to the currently estimated impact (i.e., a small impact to the aquifer on the order of a few feet).

4. DISCUSSION

The LPSNRD has adopted Rules and Regulations pertaining to the permitting of groundwater wells within the District. These Rules and Regulations define four classes of well permits based on whether the proposed well would be drilled within a currently recognized Ground Water Reservoir and the quantity of water the well would be designed to pump. Based on the location and quantity of water that Monolith is proposing to withdraw, the well permit that they have applied for is considered a Class 2 Permit, because it will be

> *...located in a Ground Water Reservoir [and] designed and constructed to pump 1000 gallons per minute or more, or pump 250 acre-feet or more water per year ...*

Monolith is proposing to install a set of three groundwater wells in order to meet their water use needs. While none of these wells will be designed and constructed to pump 1000 gallons per minute or more, collectively they will pump greater that 250 acre-feet of water per year, and Section C, Rule 1, part (a)(iv) states:

> *Any wells commingled, combined, clustered, or joined with any other water well or wells [...] shall be considered one water well and the combined capacity shall be used as the rated capacity.*

This hydrogeologic analysis report has been prepared as required for a Class 2 Permit under Section C, Rule 2, part (c)(i)(A)(5) of the LPSNRDs Rules and Regulations, in order to consider

> *... the impact of the proposed withdrawal on current ground water users and a minimum twenty (20) year impact on the aquifer for potential future users ...*

Rule 3, part (a) of Section C of the LPSNRDs Rules and Regulations further states that

> *[a]n application for a permit or late permit for any water well in a Ground Water Reservoir shall be granted unless the District finds ... (vii) [that f]or a Class 2 Permit: (A) The hydrogeologic analysis indicates potential short or long-term detrimental effect to the aquifer and/or if the drawdown as determined by an aquifer test would adversely affect a nearby well with a higher preference of use ...*

While the specific impacts to be considered are not further defined in these Rules and Regulations, it is generally understood that significant aquifer drawdowns resulting from a newly proposed water use could be detrimental to the aquifer as this could impact:

1. The useful life of the Ground Water Reservoir,
2. The relative saturated thickness in nearby wells associated with a higher preference use, or
3. The total dissolved solids (TDS) within the Groundwater Reservoir due to upwelling of underlying water with higher TDS.

Historically, the CPA aquifer in southern Lancaster County has not seen the significant water level declines that have been experienced in other areas of Nebraska (see Figure ES.1). Generally speaking, this is unsurprising due to the relatively sparse nature of irrigation development and the generally high levels of aquifer recharge experienced in this part of the state.

However, as required by the Groundwater Management and Protection Act, the LPSNRD adopted a Ground Water Management Plan (GWMP) in 1995. The GWMP contains the following goal:

> *Maintain the Quantity and Quality of Ground Water for any Beneficial Use in Conformance with State Standards.*

In order to achieve this goal in terms of Ground Water Quantity, the LPSNRDs GWMP and subsequently adopted Rules and Regulations contain Designated Areas of Management, a commitment to monitor water levels within each management area, and successive Phase Determination Criteria for water level management Phases. Initially, the entire LPSNRD was placed into Phase I upon establishment of the Ground Water Management Area. Subsequent triggers for potential Phase II and Phase III designation are included for each designated management area. For the CPA Aquifer, a Phase II designation would occur when more than:

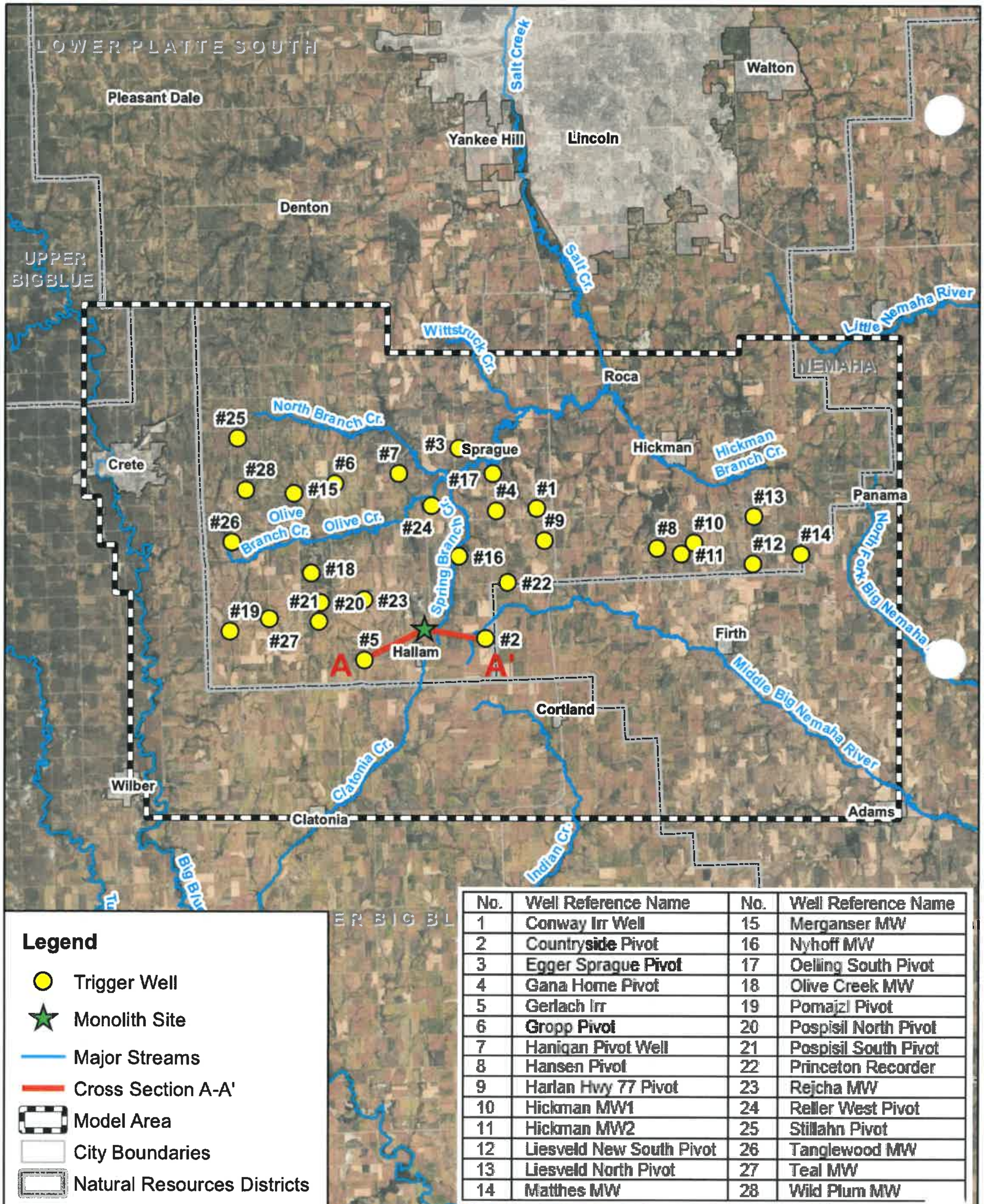
> *… 30% of the monitoring network wells have declined from the established upper elevation of the saturated thickness to an elevation that represents greater than or equal to a[n 8%] reduction in the saturated thickness and has remained below that elevation for more than two [2] consecutive years.*

To date, there has been no determination that this has occurred. A review of the data collected from the monitoring network makes it clear why that has not occurred (D. Ehrman, personal communication).

On average, the monitoring wells in the CPA Aquifer contain approximately 170 feet of saturated thickness. This is very consistent with the conditions encountered at the Monolith site, with test drilling in 2020 encountering about 155 feet of saturated aquifer materials. A review of the average depth to water encountered within the LPSNRDs monitoring network in the CPA aquifer indicates that this average saturated thickness has either increased or at the very least remained stable since 1995 (Figure 4.1).

Average depth to water has varied between approximately 105 feet and 90 feet during this 25-year period, with the shallowest water levels being encountered in recent years. There is likely some bias introduced into these average values due to the change in the total number of wells being measured and the actual number of wells that have been measured. Generally, this number has increased, however some wells that were monitored during early years have not been monitored in recent years. The monitoring well network is shown in Figure 4.2.

Figure 4.1 The average depth to groundwater and number of measurements taken in the LPSNRD's monitoring well program.



No.	Well Reference Name	No.	Well Reference Name
1	Conway Irr Well	15	Merganser MW
2	Countryside Pivot	16	Nyhoff MW
3	Egger Sprague Pivot	17	Oelling South Pivot
4	Gana Home Pivot	18	Olive Creek MW
5	Gerlach Irr	19	Pomajzl Pivot
6	Gropp Pivot	20	Pospisil North Pivot
7	Hanigan Pivot Well	21	Pospisil South Pivot
8	Hansen Pivot	22	Princeton Recorder
9	Harlan Hwy 77 Pivot	23	Rejcha MW
10	Hickman MW1	24	Reller West Pivot
11	Hickman MW2	25	Stillahn Pivot
12	Liesveld New South Pivot	26	Tanglewood MW
13	Liesveld North Pivot	27	Teal MW
14	Matthes MW	28	Wild Plum MW

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N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

LPSNRD Trigger Well Locations

Monolith OC2

Groundwater Modeling Report

Lancaster County, NE

FIGURE

4.2

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Further review of the data indicates that only one of the 28 monitoring wells could potentially meet the criteria of eight percent reduction for more than two years. However, this well (G-107746/Teal Monitoring Well) is apparently a dedicated monitoring well with less than 12 feet of saturated thickness, meaning that small changes in water levels can have large effects on the percent of saturated thickness. There are several other wells that were close to, or even exceeded, an eight percent change in the past, but only for a single year. There is only one other well (G-048702/Gana Home Pivot) that is likely to meet or exceed the eight percent threshold (with or without the Monolith well) in the future. However, two wells is only seven percent of the total number of monitoring wells, significantly short of the required 30 percent that would trigger the area into Phase II management. None of the wells in close vicinity to the Monolith well, where water level declines are predicted to be up to a few feet, are anywhere close to an eight percent reduction in saturated thickness. Therefore, there is little chance of a Phase II trigger being hit, with or without the Monolith well, and therefore there is no threat to the life of the CPA aquifer should this well permit be granted.

Moreover, given the relative small degree of water level declines, even in the vicinity of the closest wells of greater preference than Monolith's water use, it is apparent that any impacts that arise from the granting of the permit to Monolith will not cause a long-term detrimental effect on the quantity of groundwater in the CPA aquifer or to the existing users with a higher preference of use (Figures 4.3-4.5).

The final issue for consideration is any effects of upwelling of underlying water with higher TDS. The mechanism for the upwelling of underlying water would be broad-scale significant declines of water levels. While declines of up to 8.5 feet can be anticipated in the immediate vicinity of the Monolith well, impacts of this extent will be localized and are generally less than 1-2 feet over most of the aquifer. This is because the primary source of water for the Monolith well will come from a decrease in discharge to streams in the area.

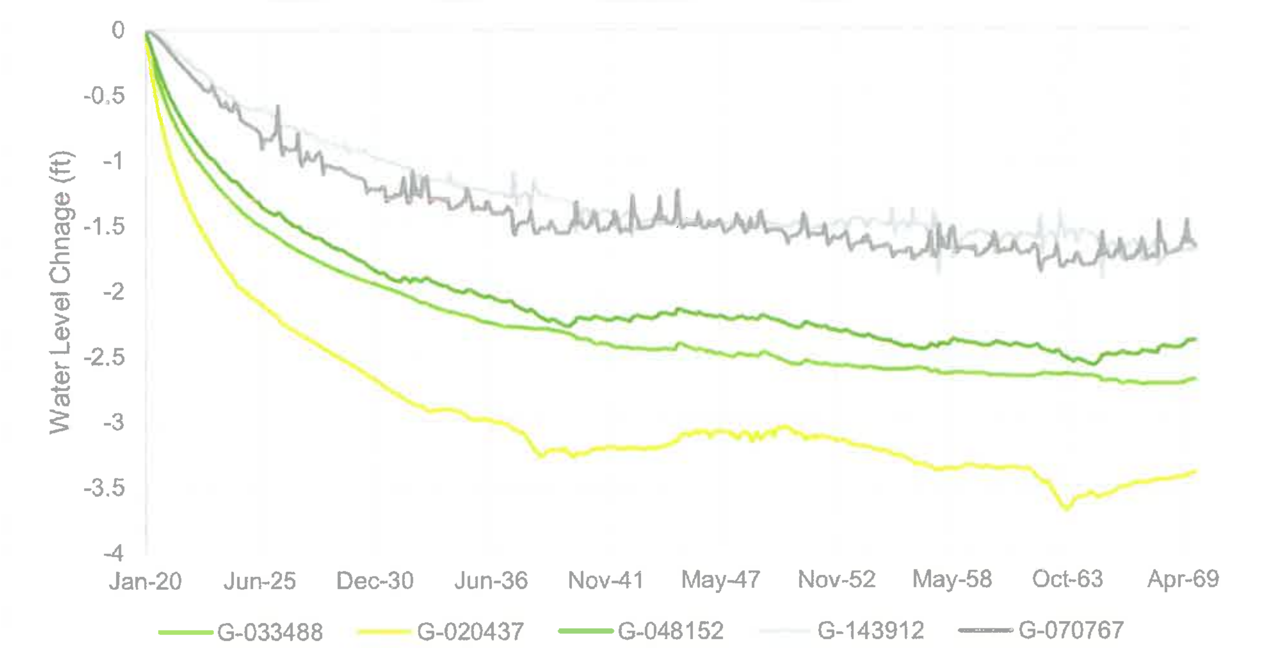

Figure 4.3 Water level changes during the future scenario in irrigation wells within a 3-mile radius of the Monolith plant site.

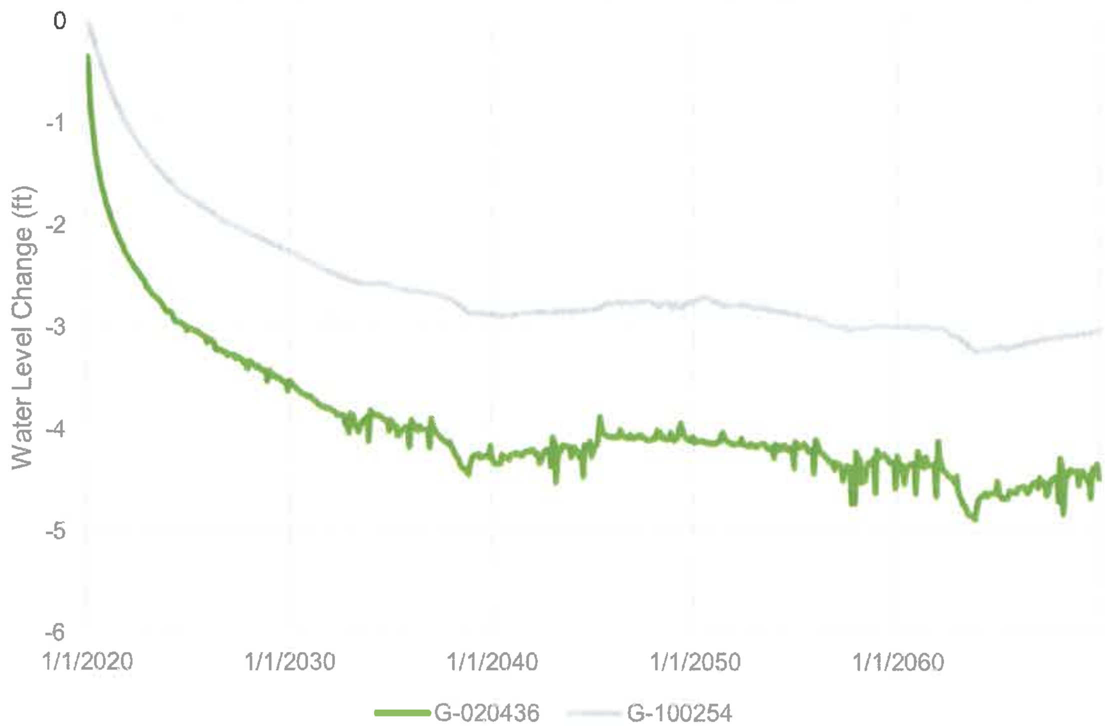

Figure 4.4 Water level changes during the future scenario for the closest (green) and furthest (grey) NPPD wells from the Monolith site.

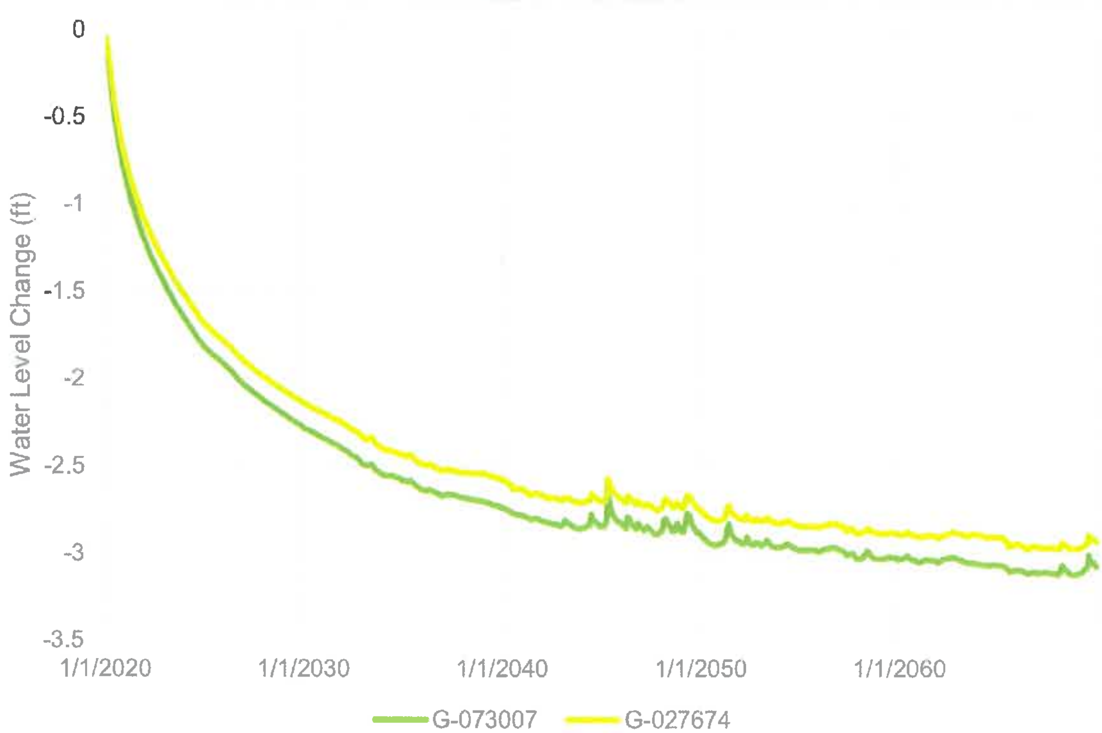

Figure 4.5 Water level changes during the future scenario for the two municipal wells in Hallam.

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(SIGNED AND DATED SEAL)

MONOLITH HYDROGEOLOGIC ANALYSIS REPORT

Monolith Materials, Hallam, Nebraska

December 2020

Olsson Project No. 020-2639

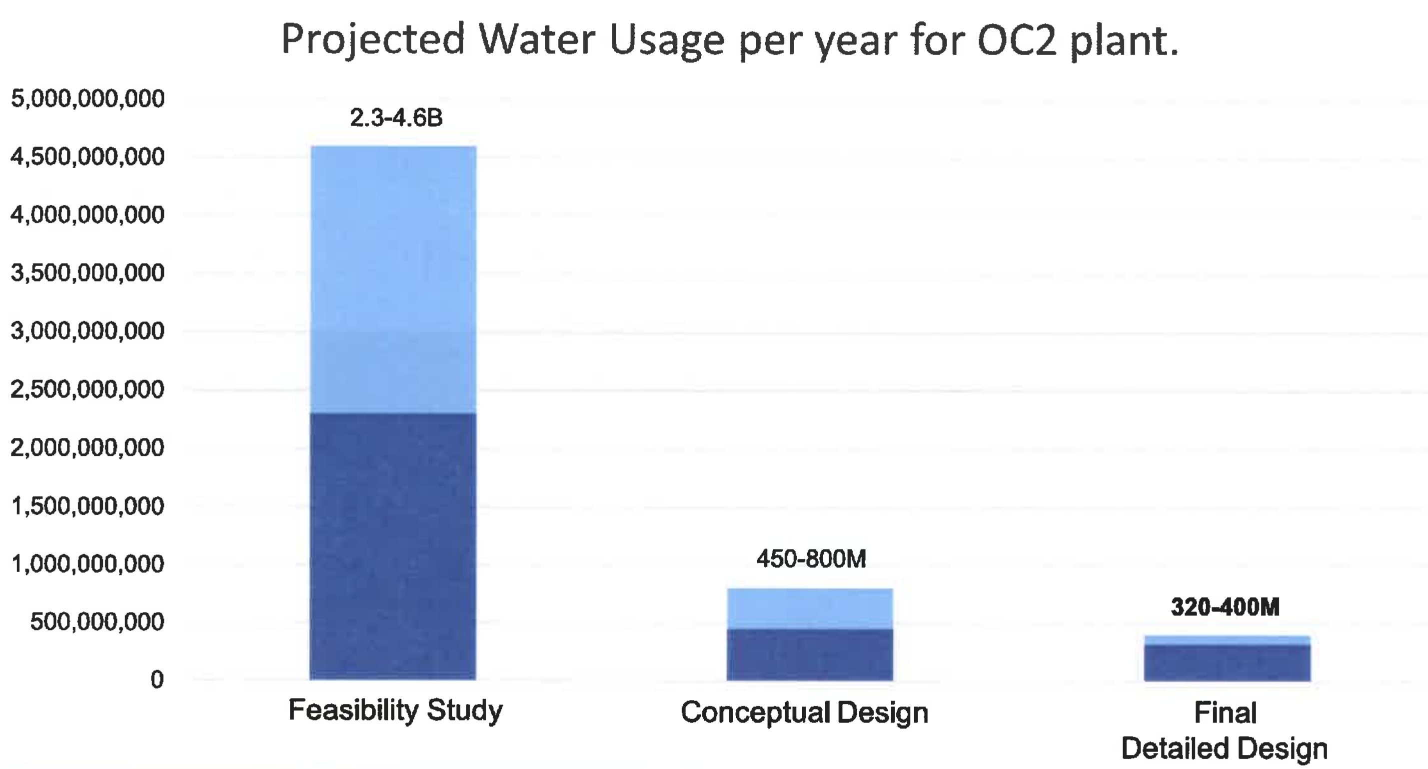
APPENDIX A

OC2 Water Use Estimation from Monolith Presentation

OC? Water Usage Design Development

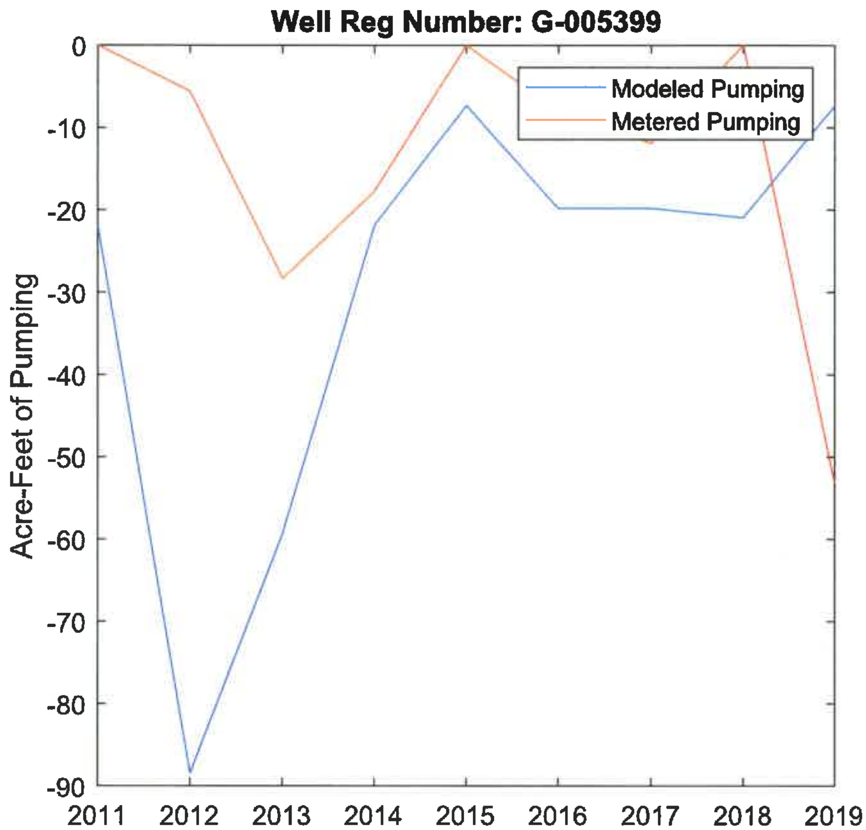
- Preliminary feasibility study completed (2.3-4.6B gal/year)
  - Primary use of water is to remove heat from process
  - Incorrect design assumptions used
    - Volume of heat needed to remove
    - Methods to use to remove the heat
  - Resulted in errant water estimate inappropriately communicated
- Conceptual design stage (450-800M gal/year)
  - Prioritized cooling water system
    - Identifying specific technology to use
  - 450-800 mil gallons/year
- **TODAY:** Detailed design – Cooling water system: (320-400M gal/year)
  - Cooling water system design finalized at maximum operating capacity
  - Hydrogen decision finalized

OC2 Water Usage Design Development



APPENDIX B

Comparisons of Modeled and Metered Pumping in the LPSNRD


Well Reg Number: G-005399
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
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-90
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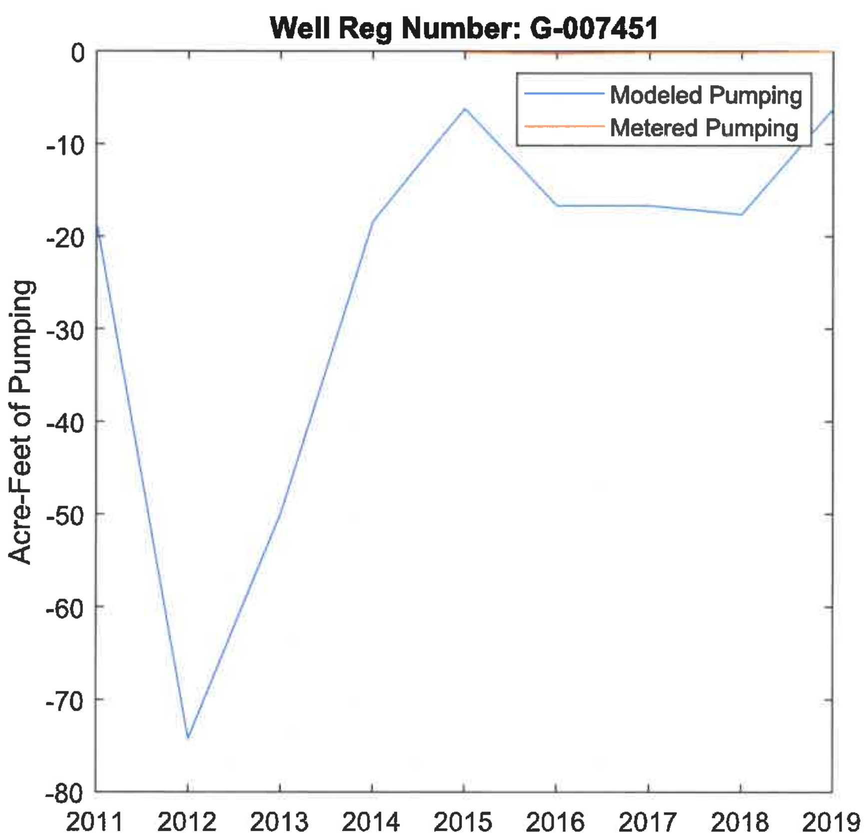
2015
2016
2017
2018
2019


Well Reg Number: G-007451
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-10
-20
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-40
-50
-60
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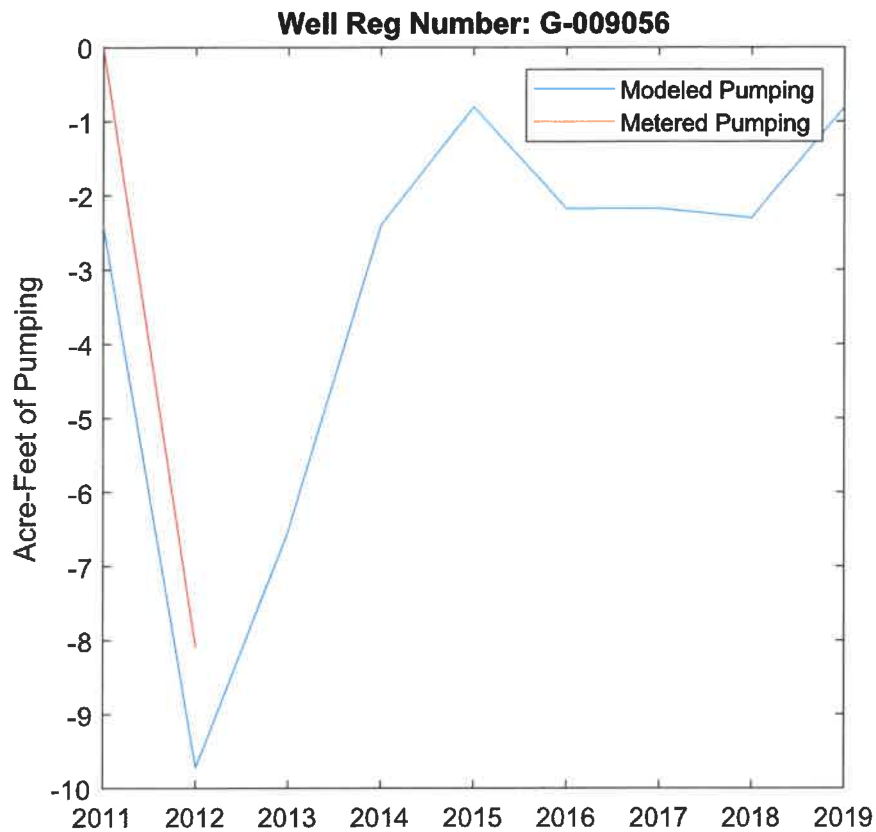
2015
2016
2017
2018
2019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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-1
-2
-3
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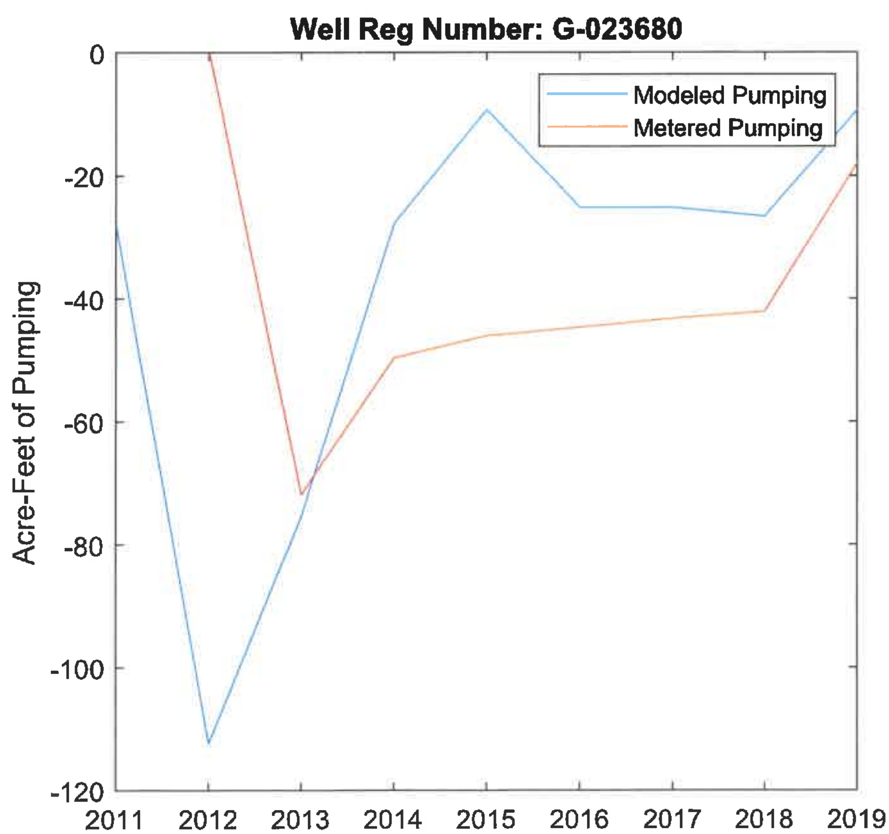
2015
2016
2017
2018
2019


Well Reg Number: G-023680
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Metered Pumping
Acre-Feet of Pumping
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-40
-60
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-100
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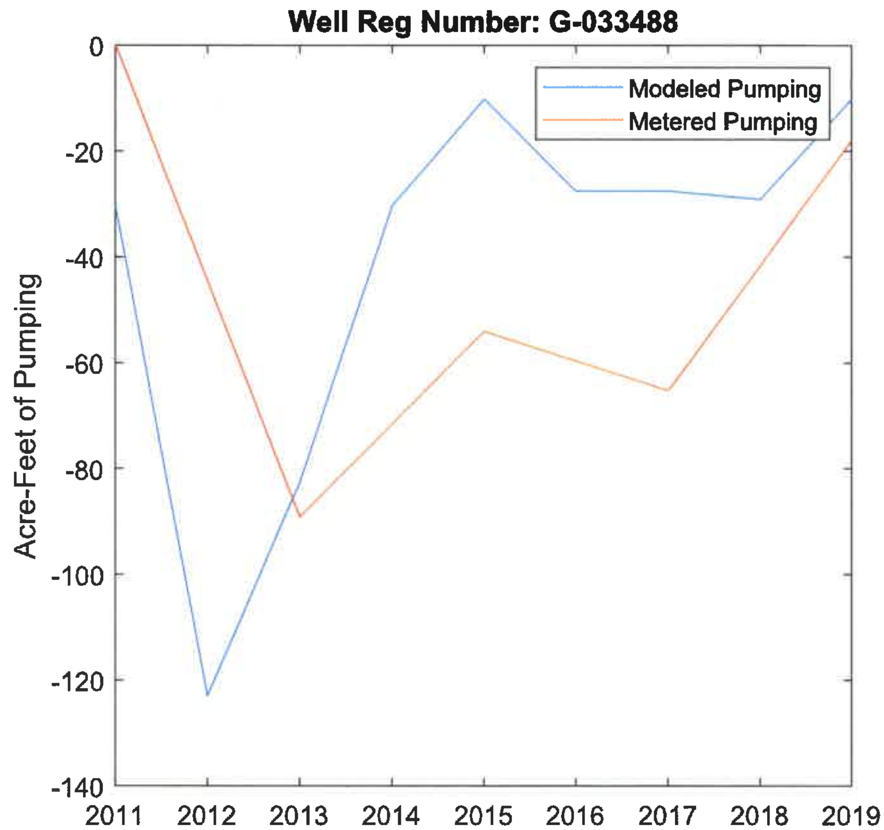
2017
2018
2019


Well Reg Number: G-033488
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-20
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-60
-80
-100
-120
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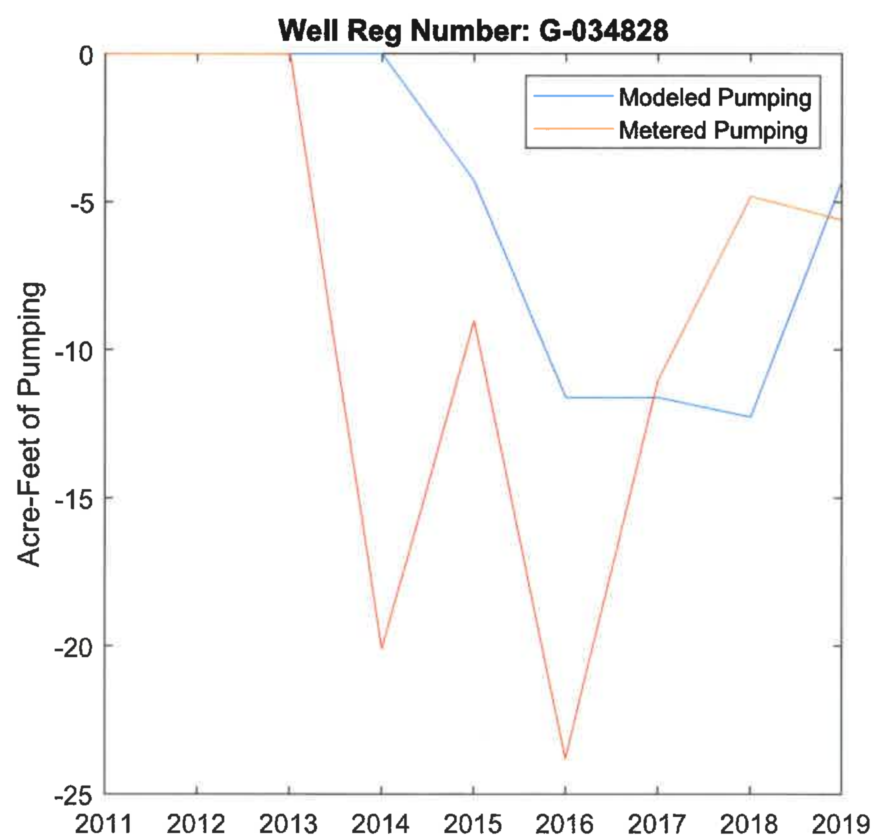
2015
2016
2017
2018
2019


Well Reg Number: G-034828
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-5
-10
-15
-20
-25
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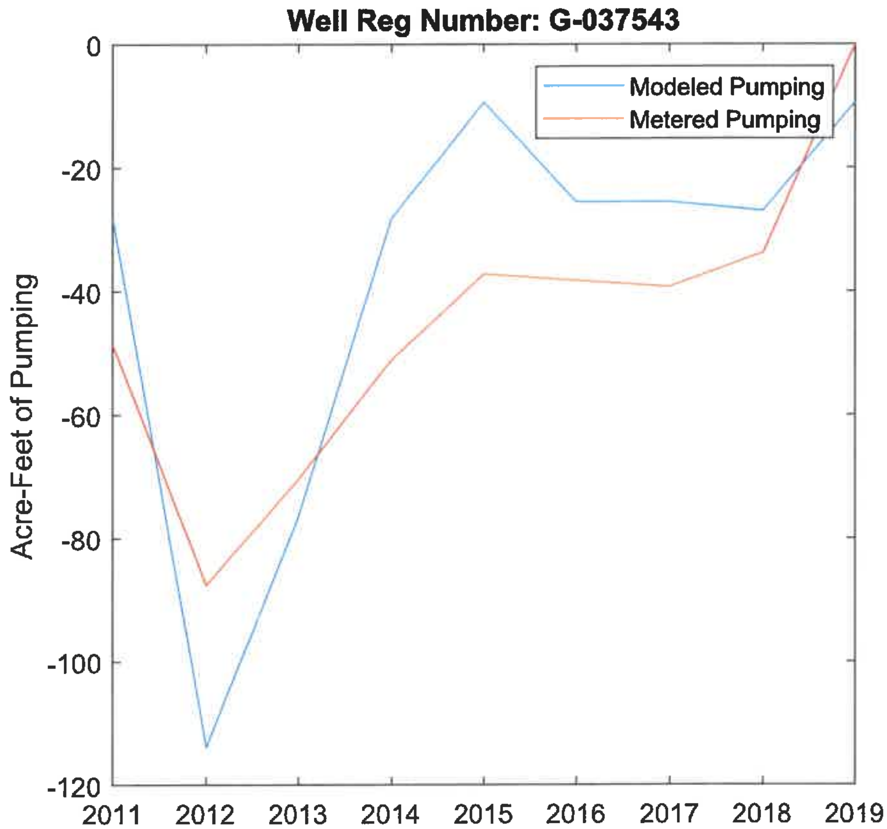
2015
2016
2017
2018
2019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Metered Pumping
Acre-Feet of Pumping
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-40
-60
-80
-100
-120
2011
2012
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2016
2017
2018
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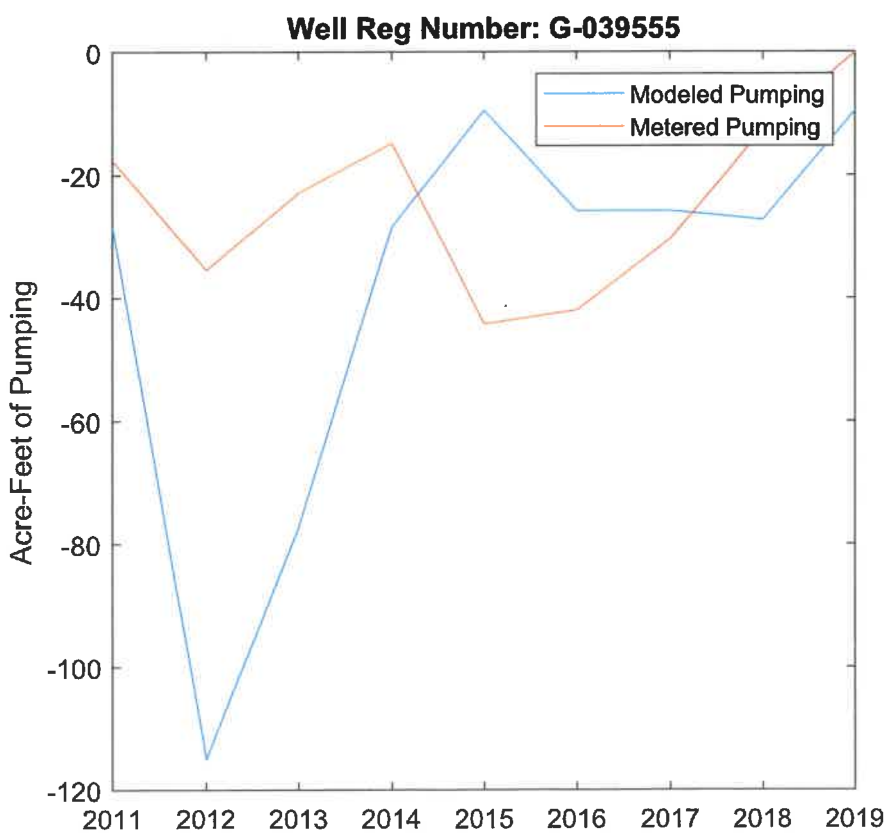
Well Reg Number: G-039555
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-20
-40
-60
-80
-100
-120
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2012
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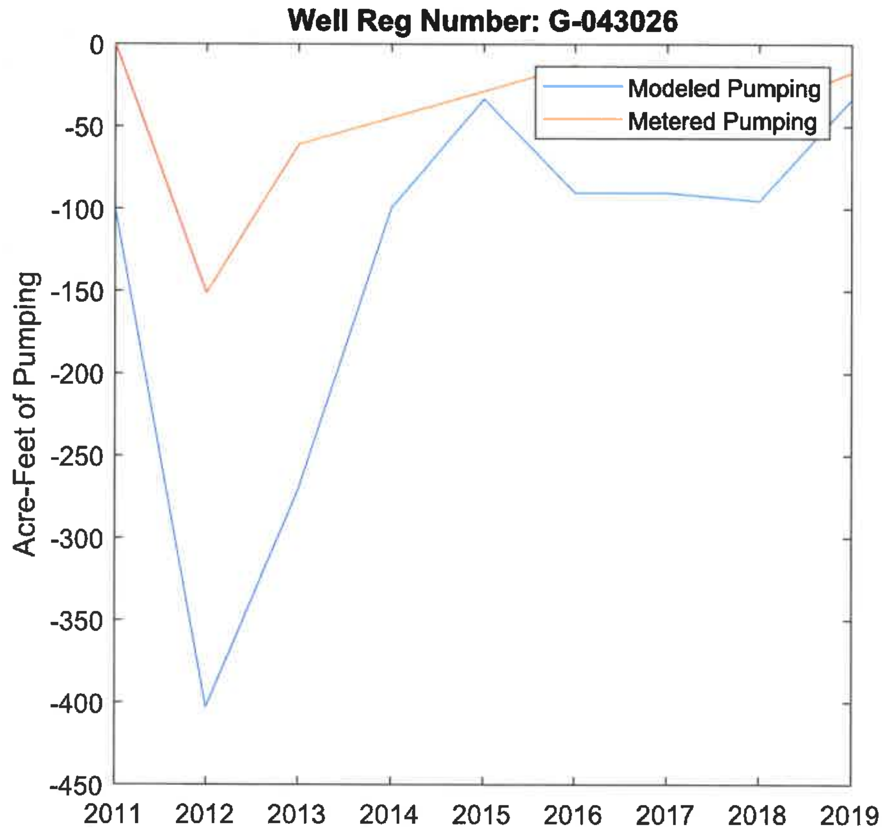
2016
2017
2018
2019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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-50
-100
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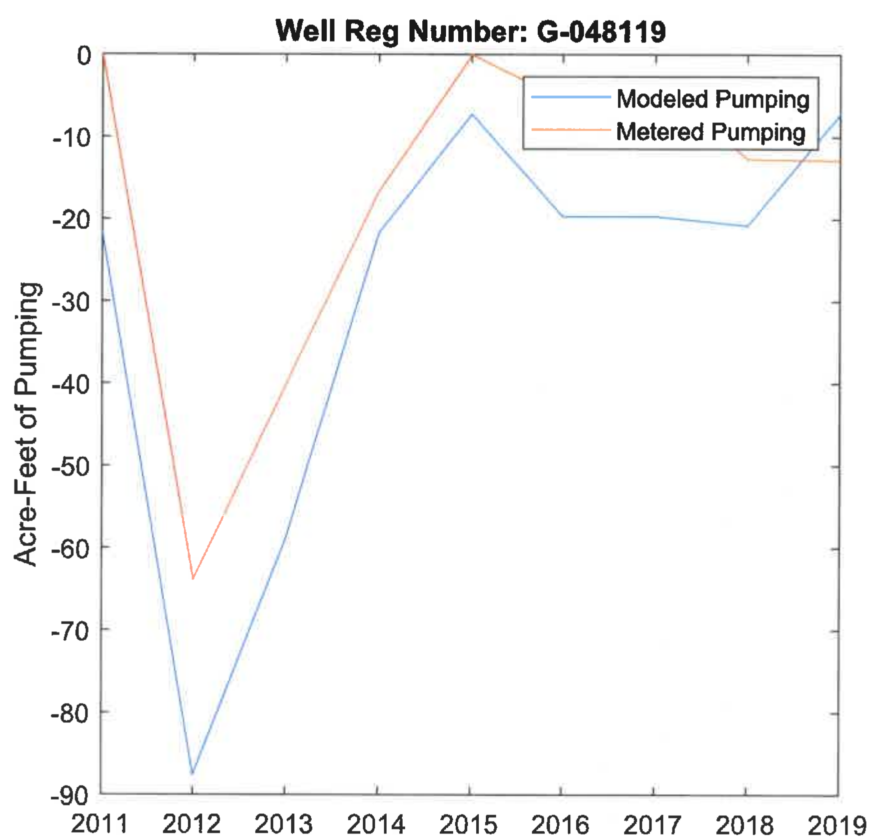
2015
2016
2017
2018
2019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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-50
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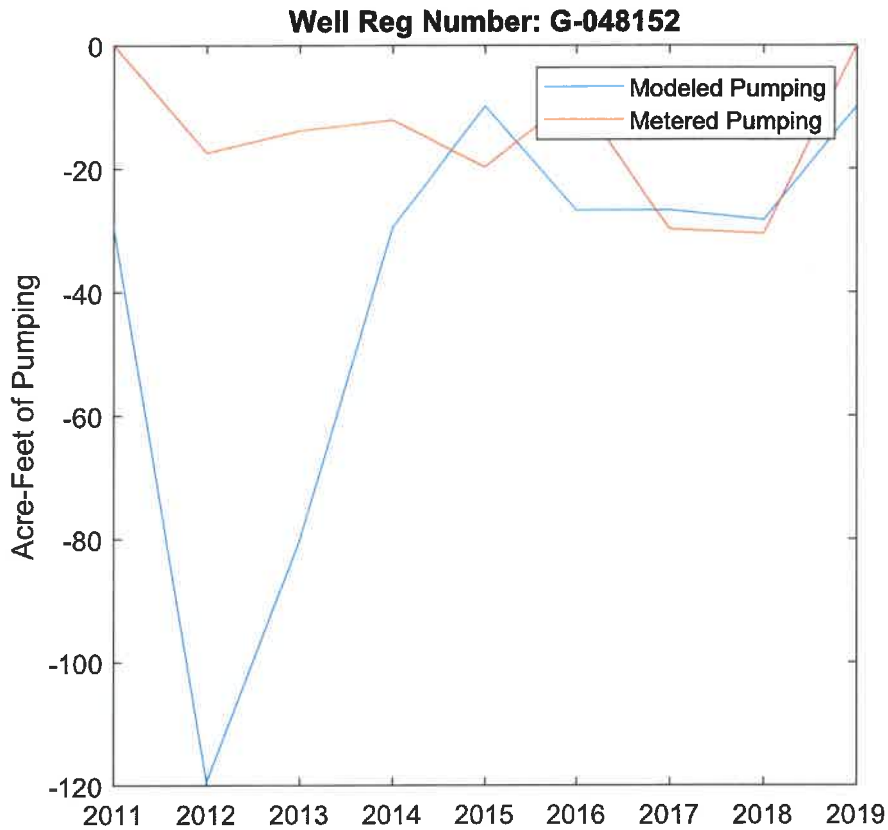
2015
2016
2017
2018
2019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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-40
-60
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-100
-120
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2017
2018
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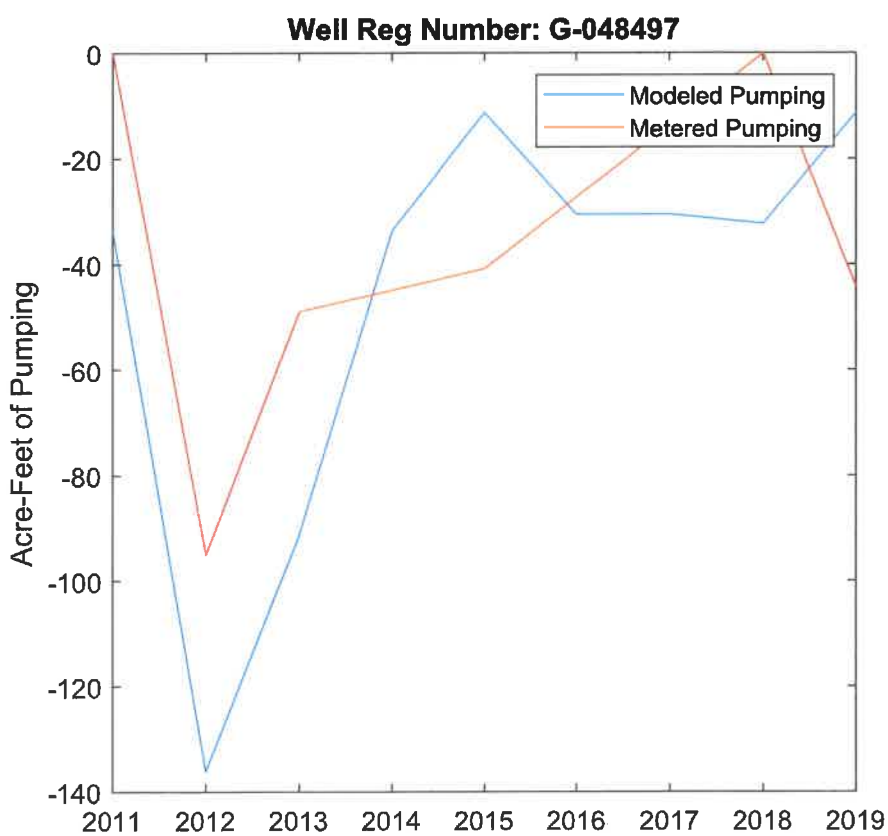
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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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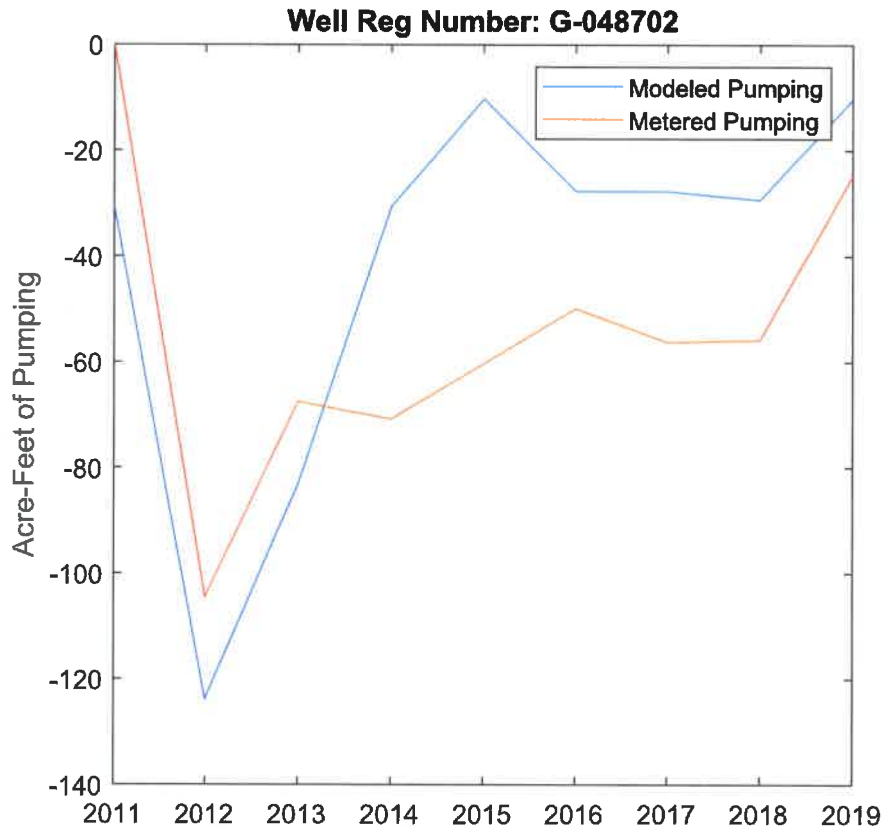
2015
2016
2017
2018
2019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Metered Pumping
Acre-Feet of Pumping
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-60
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-100
-120
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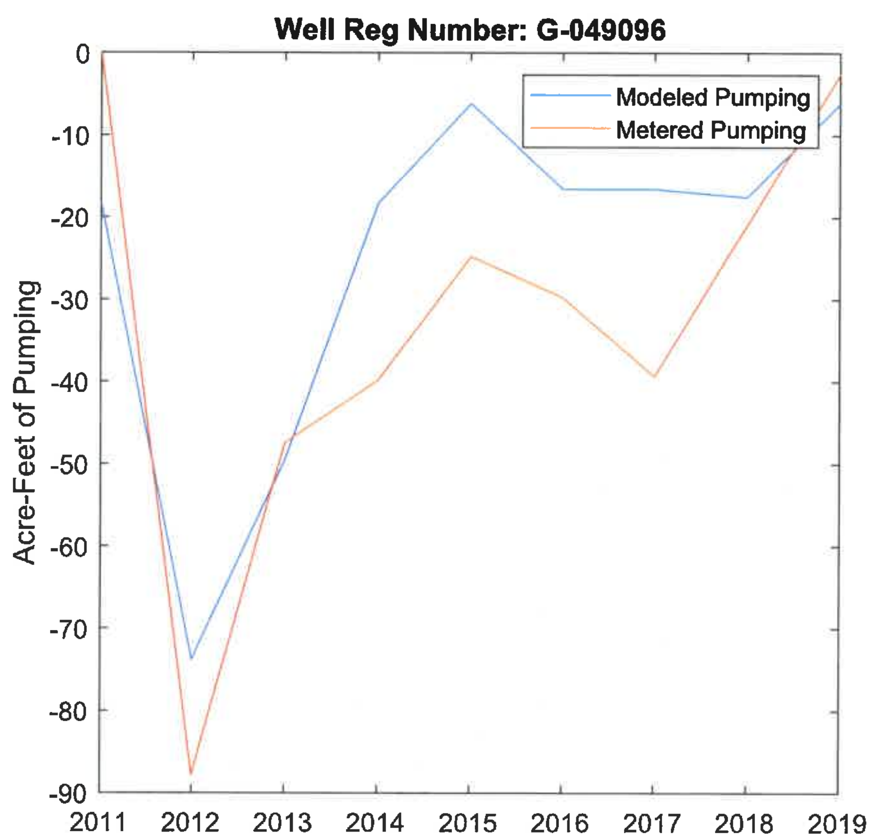
2015
2016
2017
2018
2019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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-10
-20
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-40
-50
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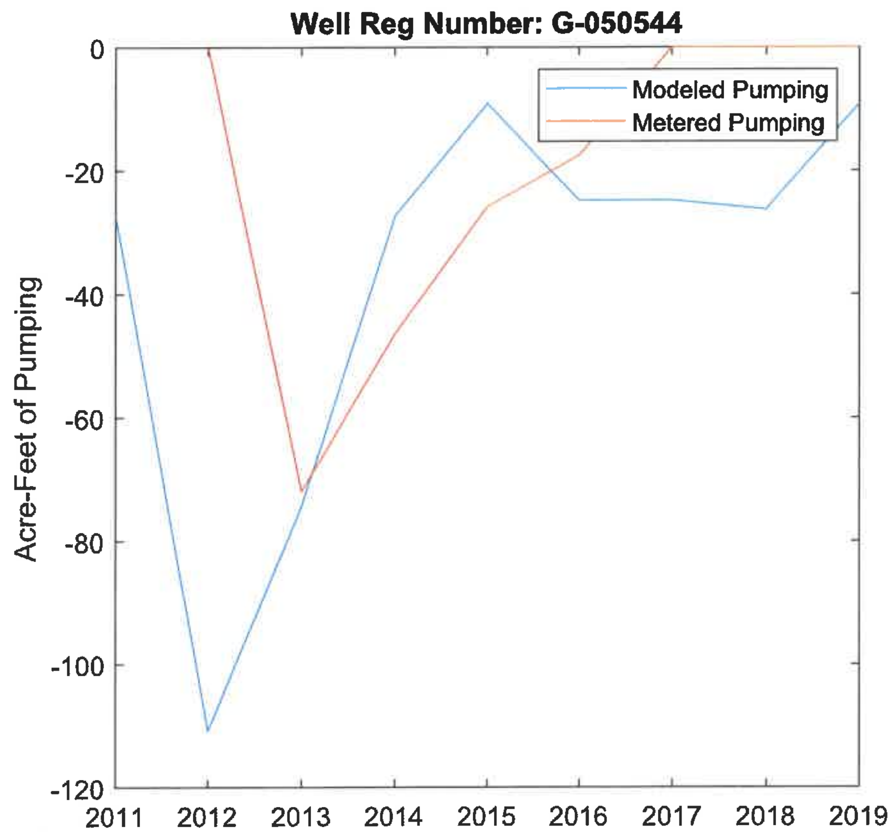
2015
2016
2017
2018
2019


Well Reg Number: G-050544
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-40
-60
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-100
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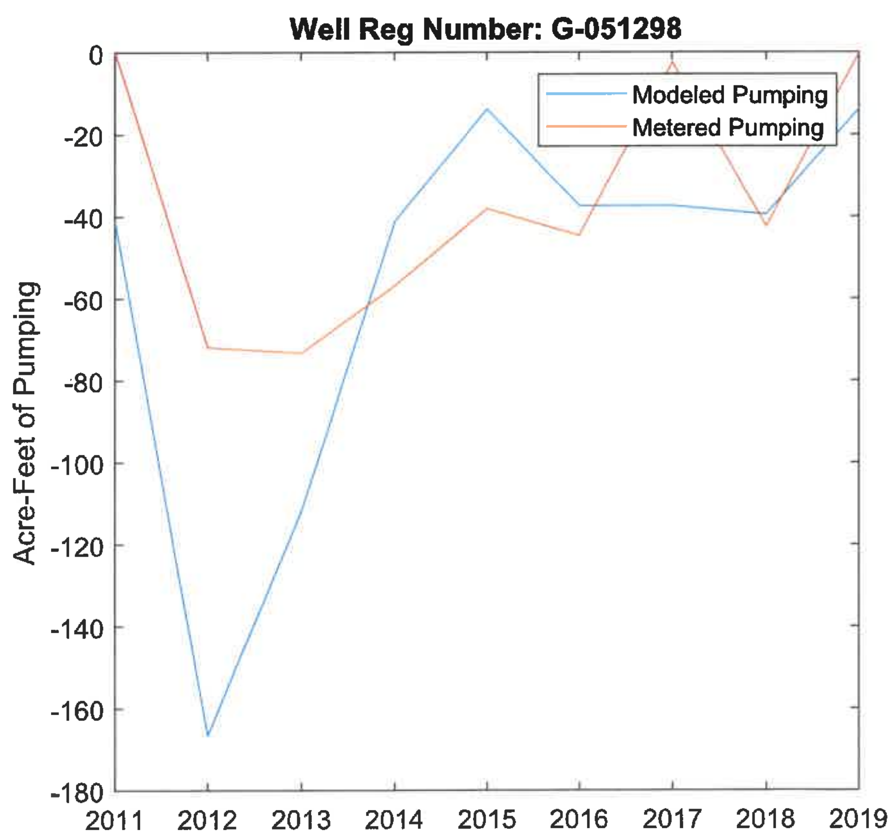
2017
2018
2019


Well Reg Number: G-051298
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
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-100
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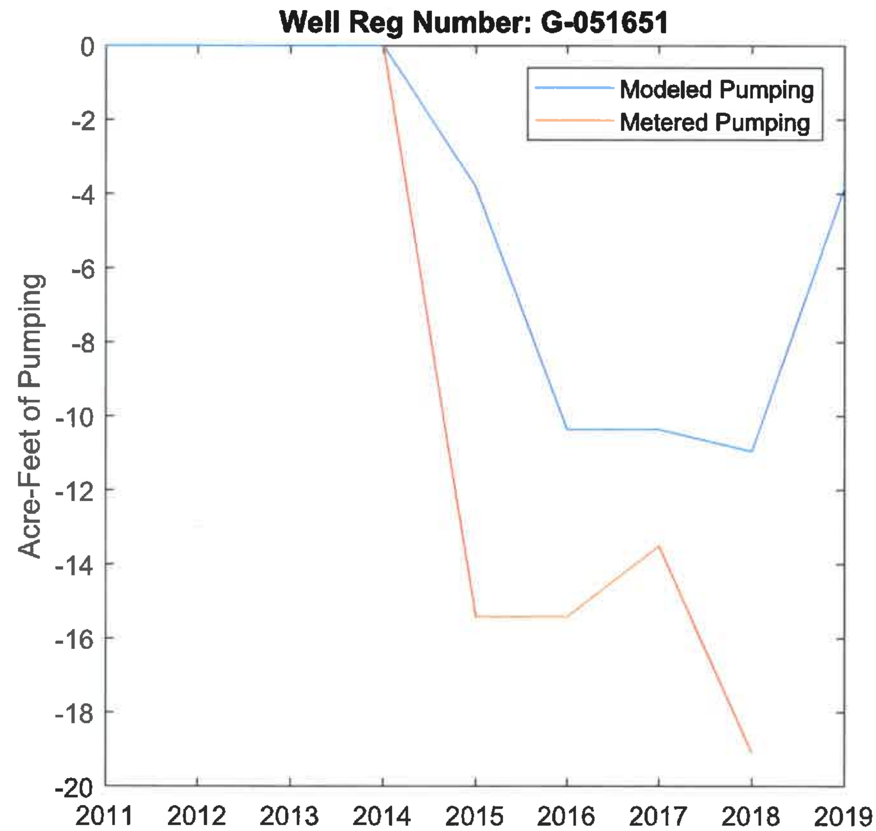
2015
2016
2017
2018
2019



Well Reg Number: G-051651
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-2
-4
-6
-8
-10
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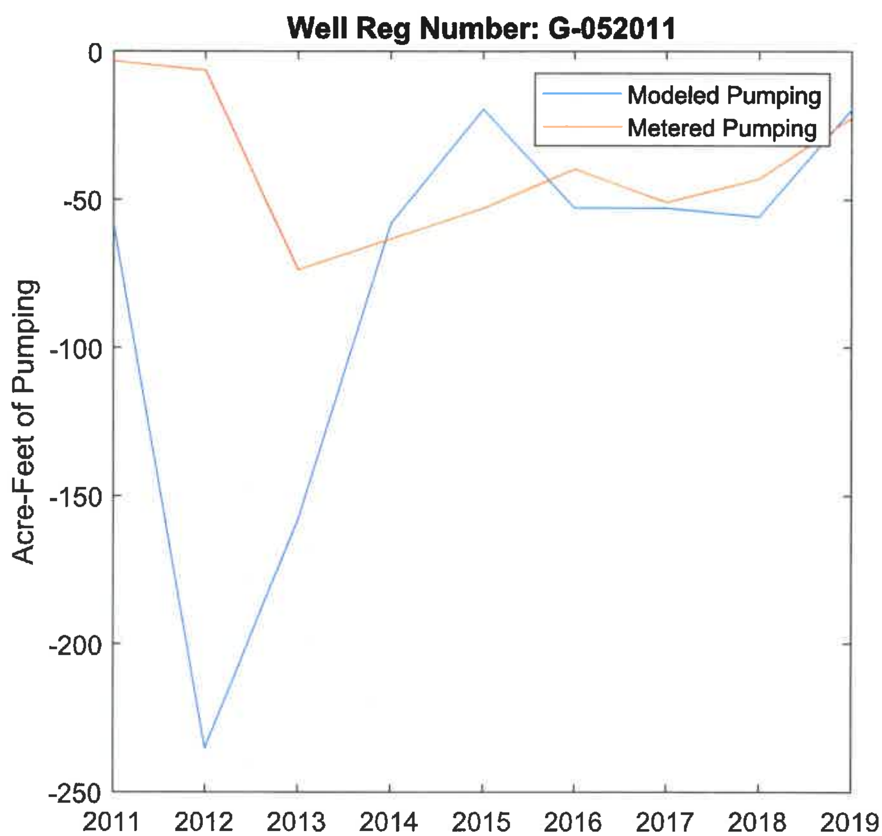
2015
2016
2017
2018
2019



Well Reg Number: G-052011
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-50
-100
-150
-200
-250
2011
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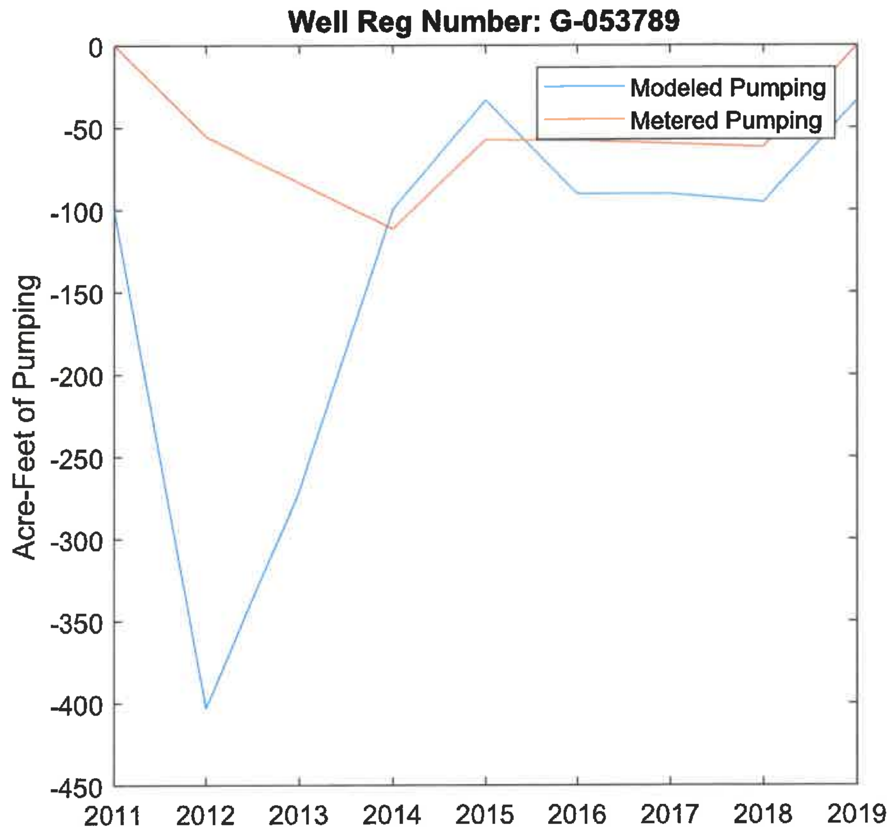
2017
2018
2019


Well Reg Number: G-053789
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-50
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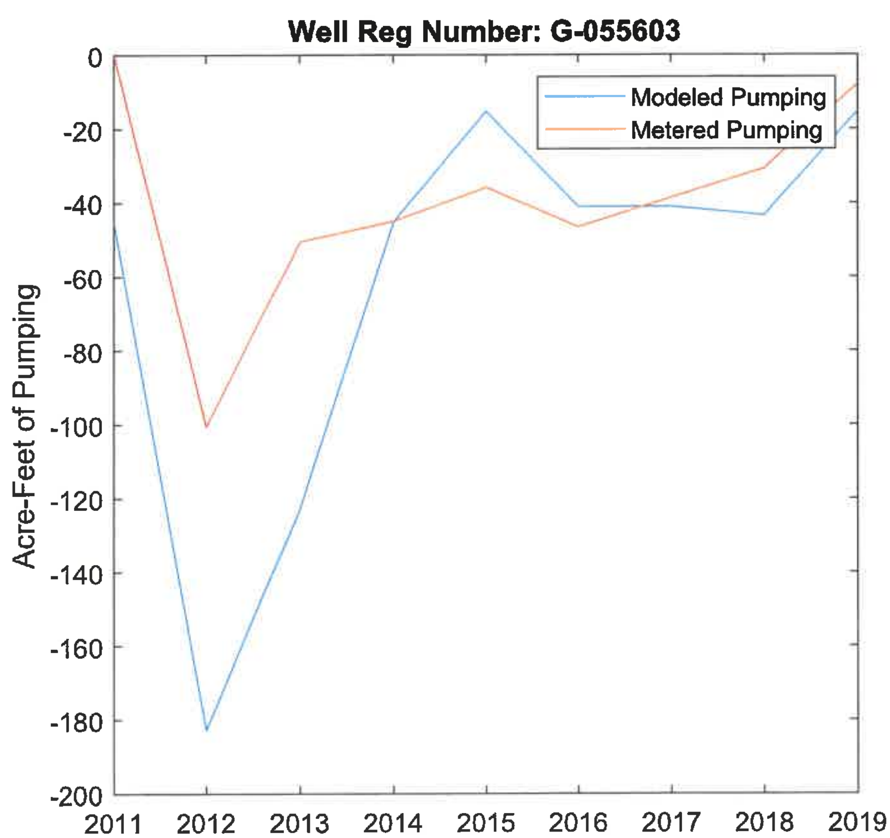
2018
2019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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-20
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2016
2017
2018
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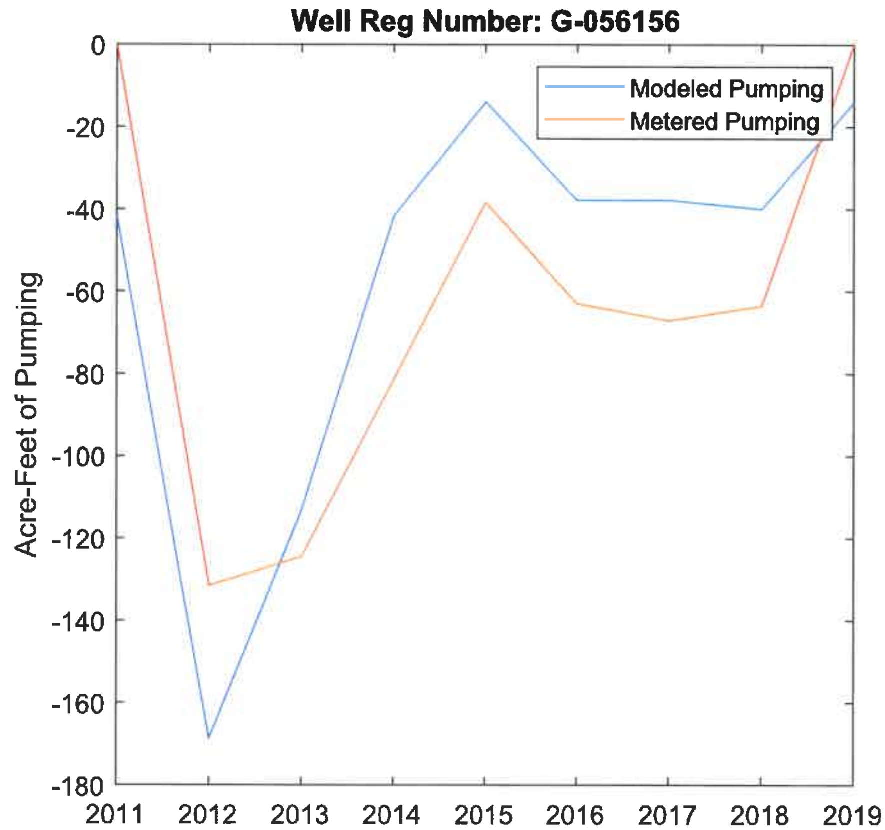
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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-60
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-100
-120
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2015
2016
2017
2018
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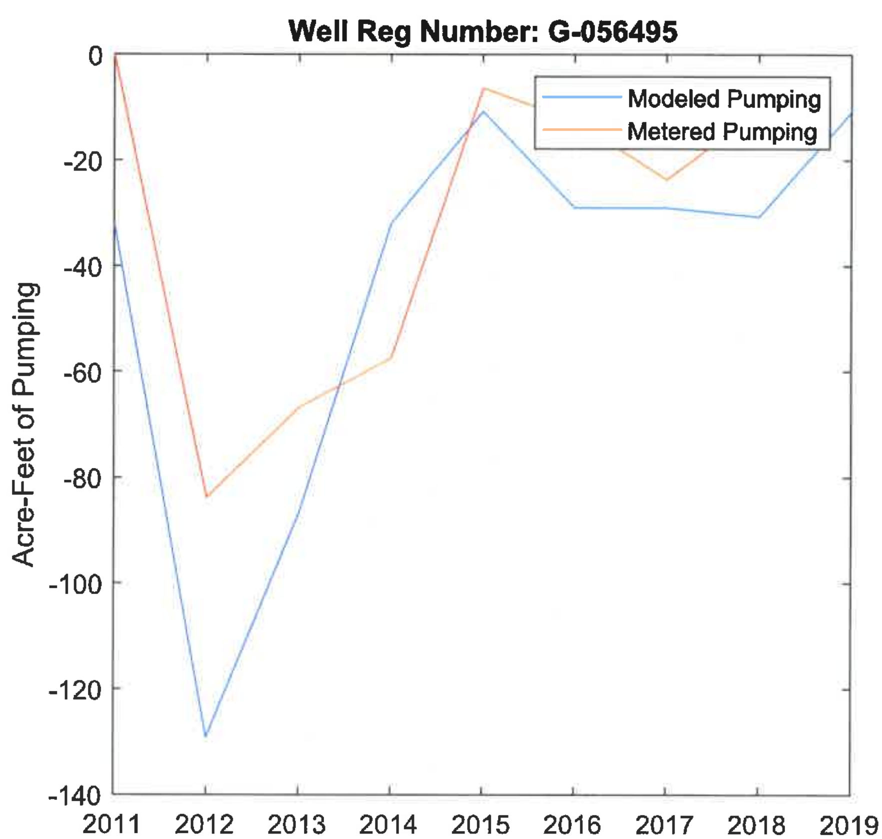
Well Reg Number: G-056495
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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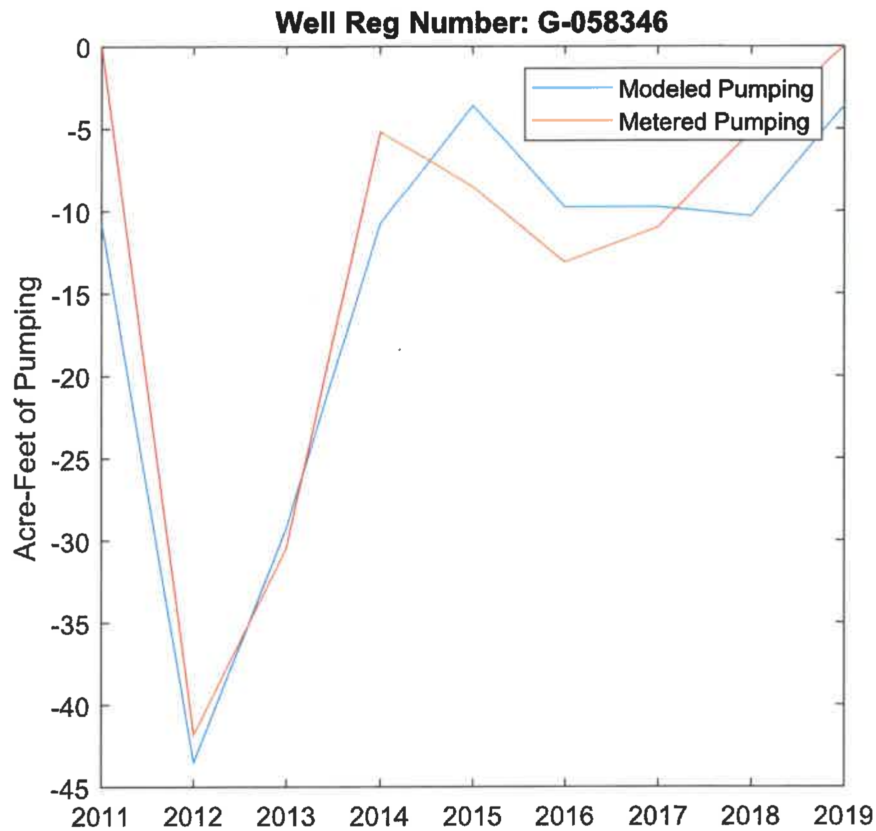
-60
-80
-100
-120
-140
2011
2012
2013
2014
2015
2016
2017
2018
2019


Well Reg Number: G-058346
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-5
-10
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-25
-30
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-45
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2015
2016
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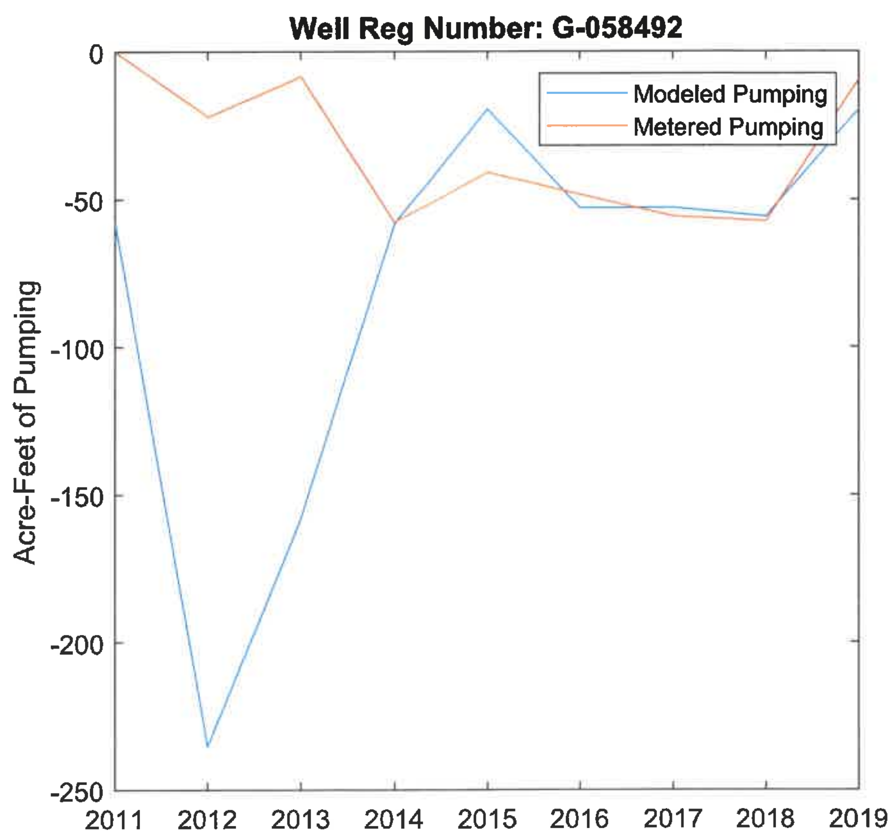
2018
2019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Metered Pumping
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2018
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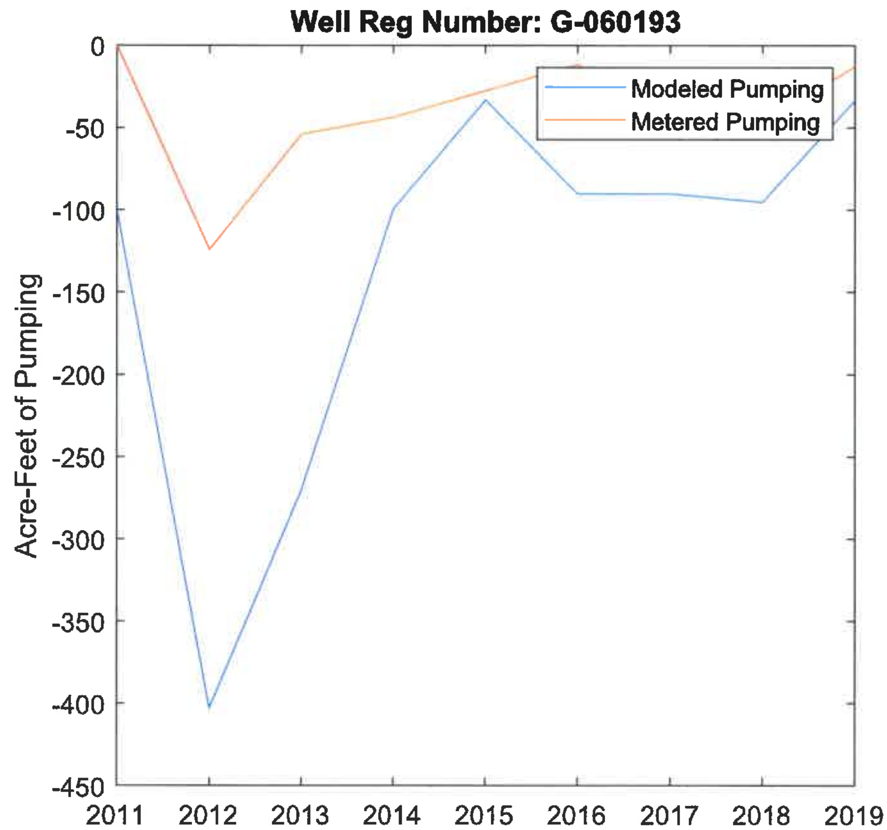
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Acre-Feet of Pumping
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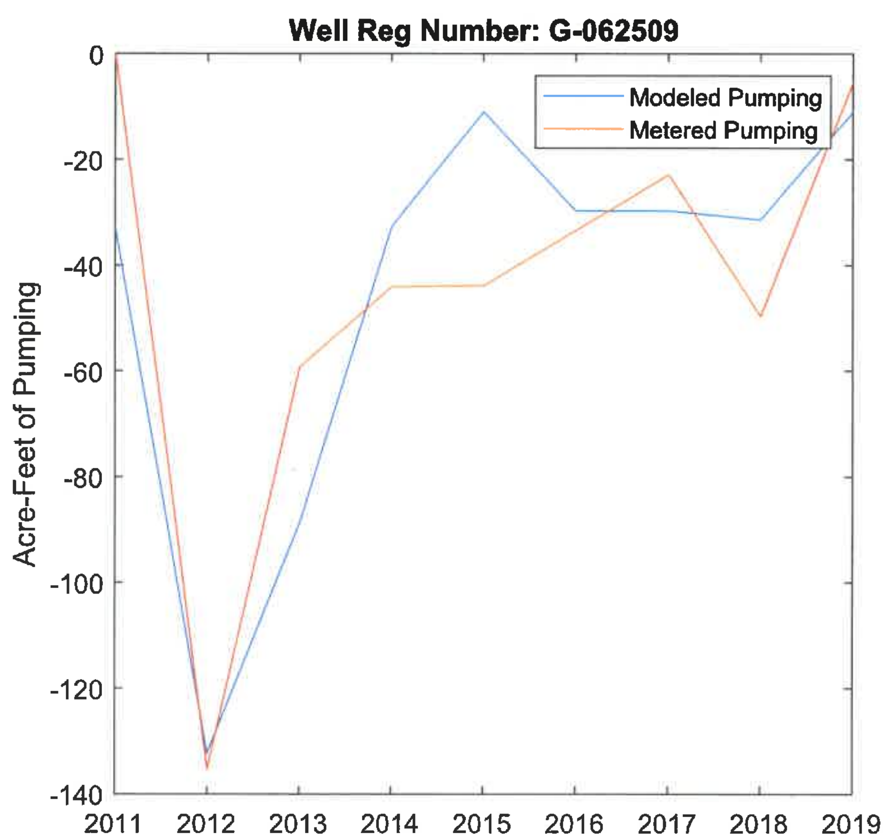
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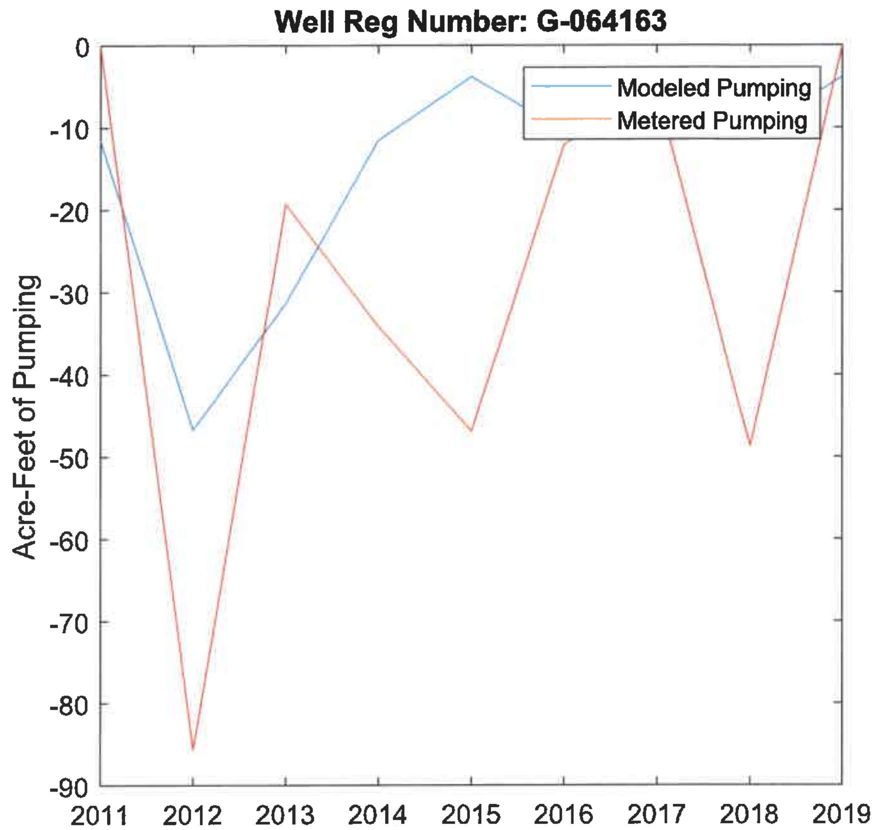

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Metered Pumping
Acre-Feet of Pumping
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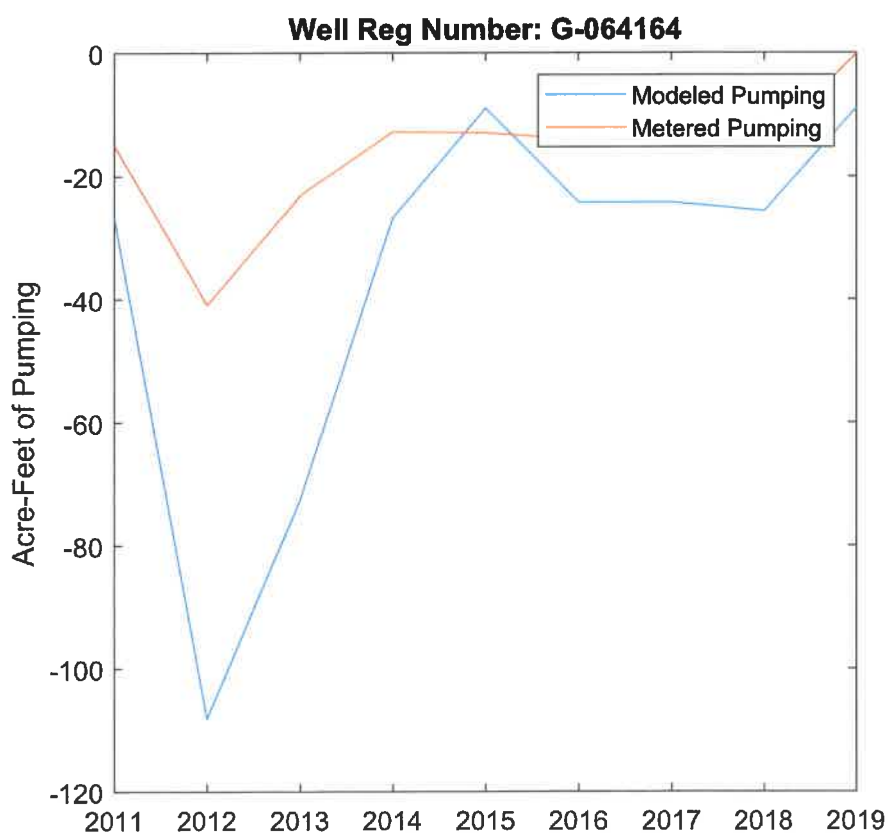

Well Reg Number: G-064164
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-120
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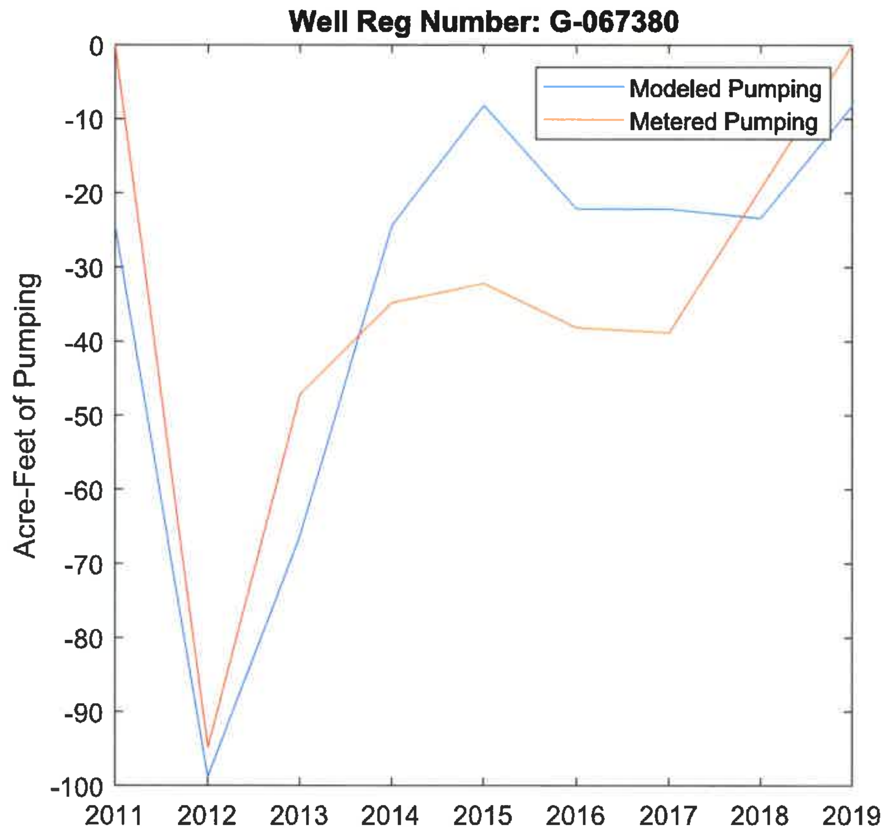
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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-10
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-60
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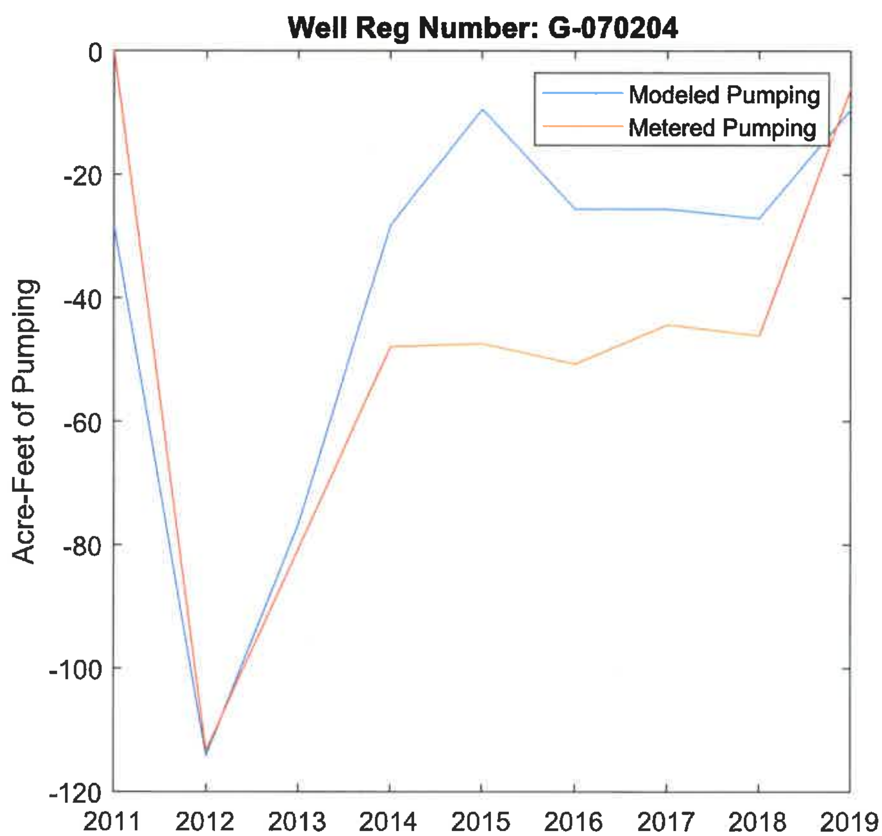
2019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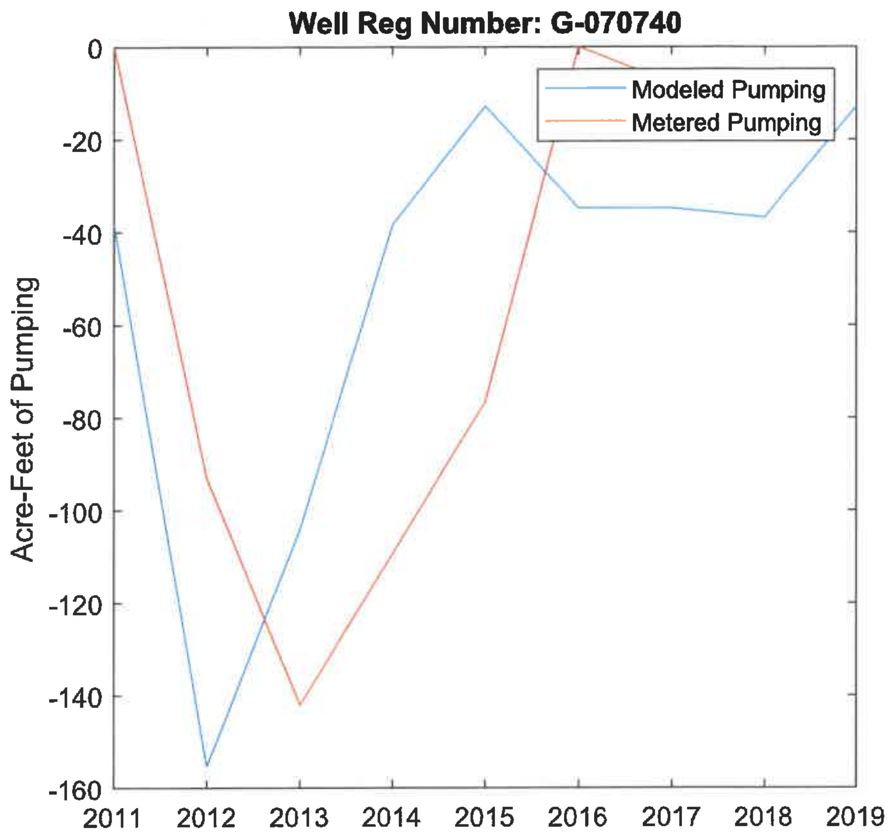
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Acre-Feet of Pumping
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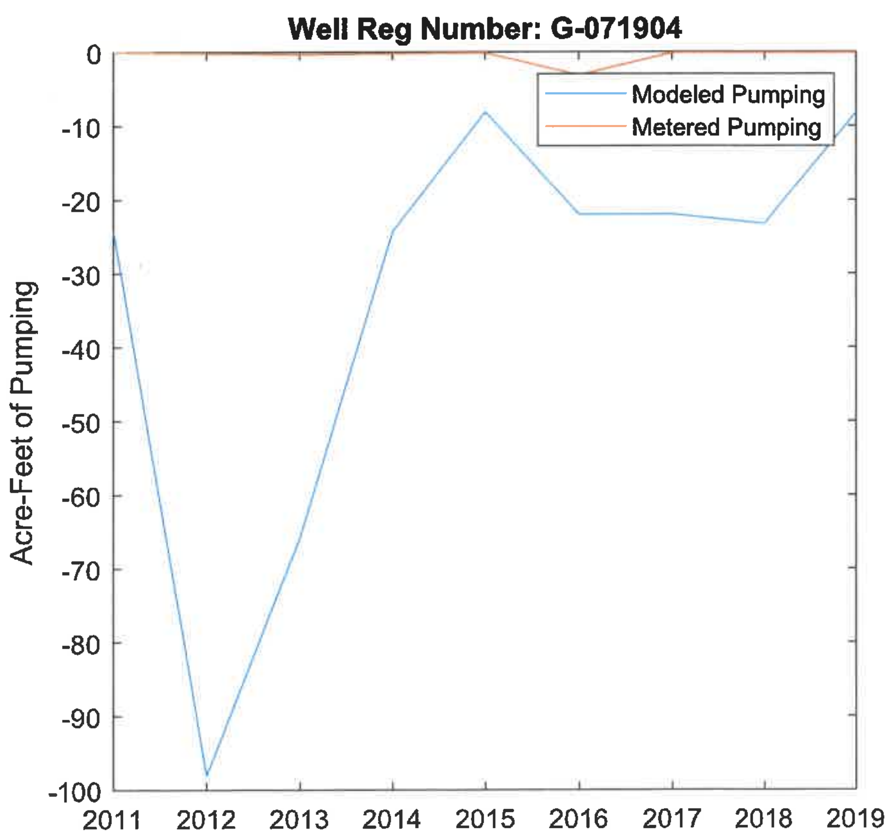
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Acre-Feet of Pumping
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-10
-20
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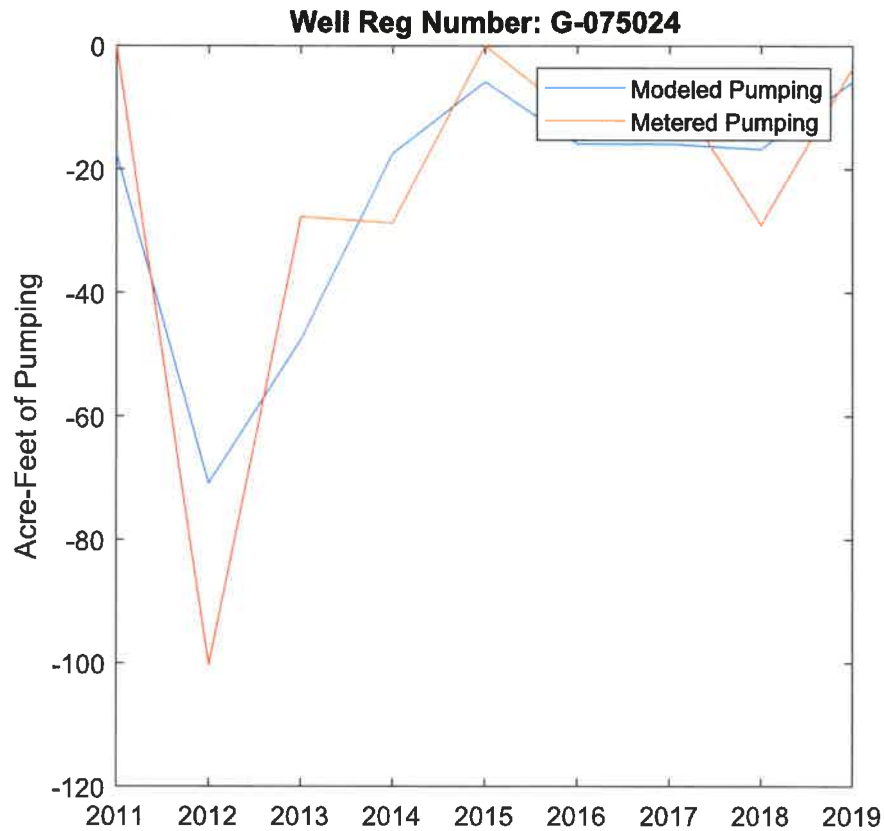
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Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-40
-60
-80
-100
-120
2011
2012
2013
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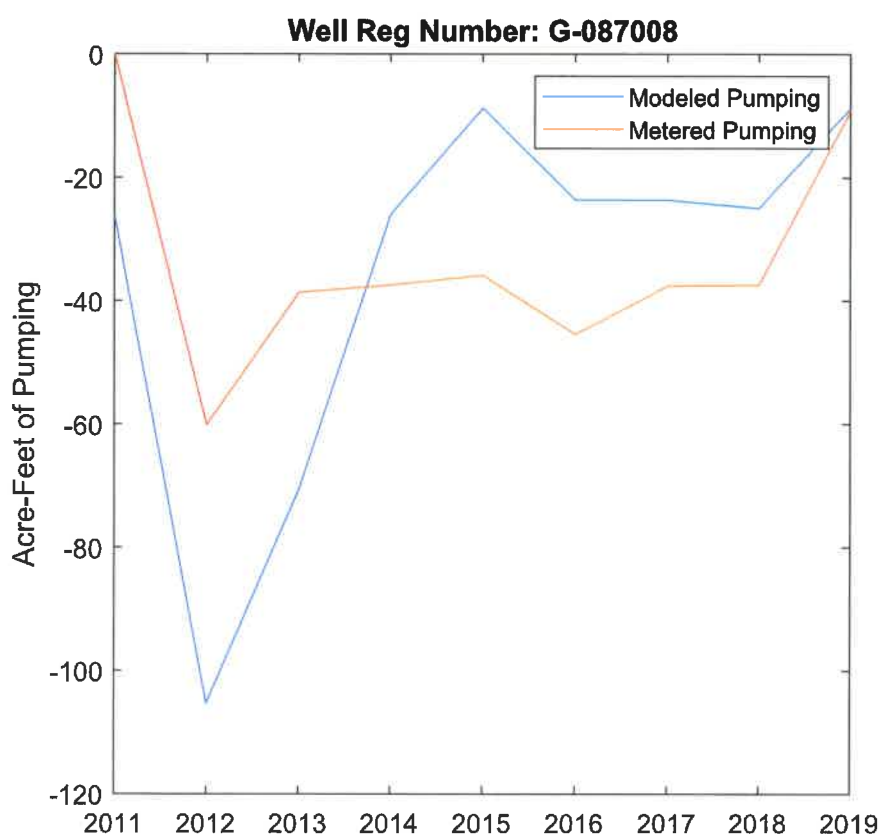
2016
2017
2018
2019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Metered Pumping
Acre-Feet of Pumping
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-60
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-100
-120
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2018
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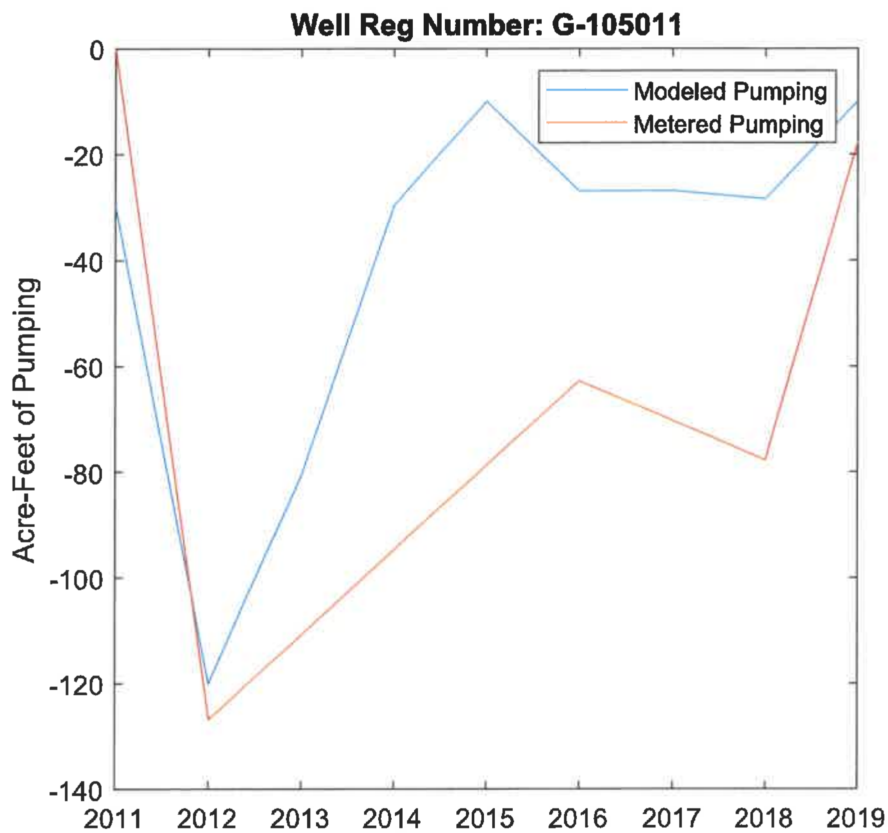
Well Reg Number: G-105011
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-60
-80
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-120
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2018
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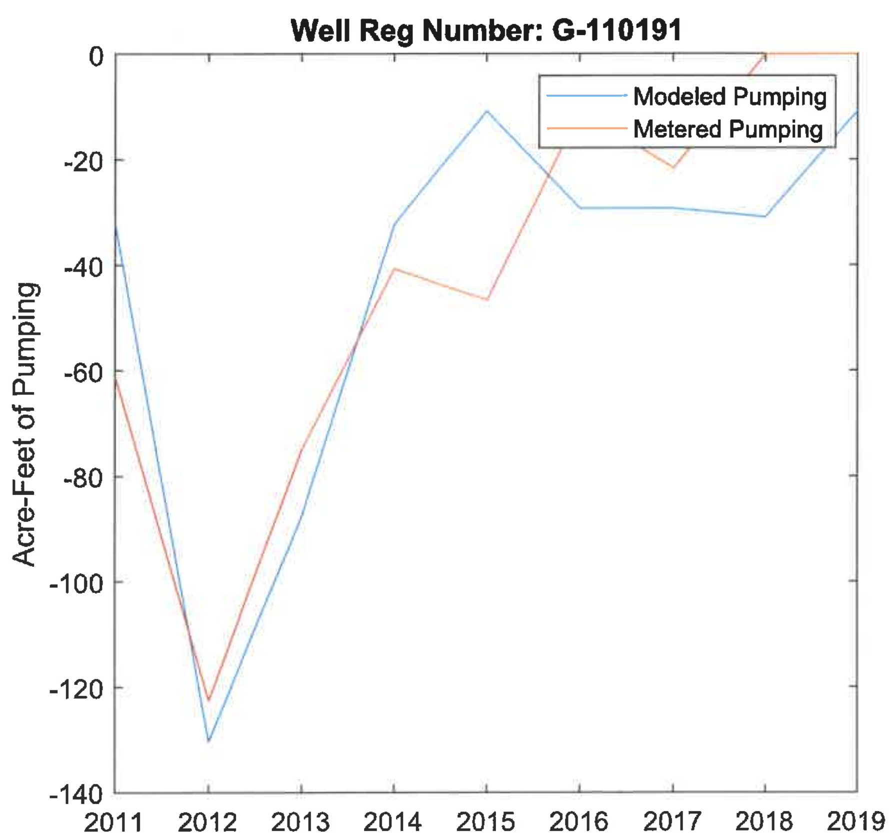
Well Reg Number: G-110191
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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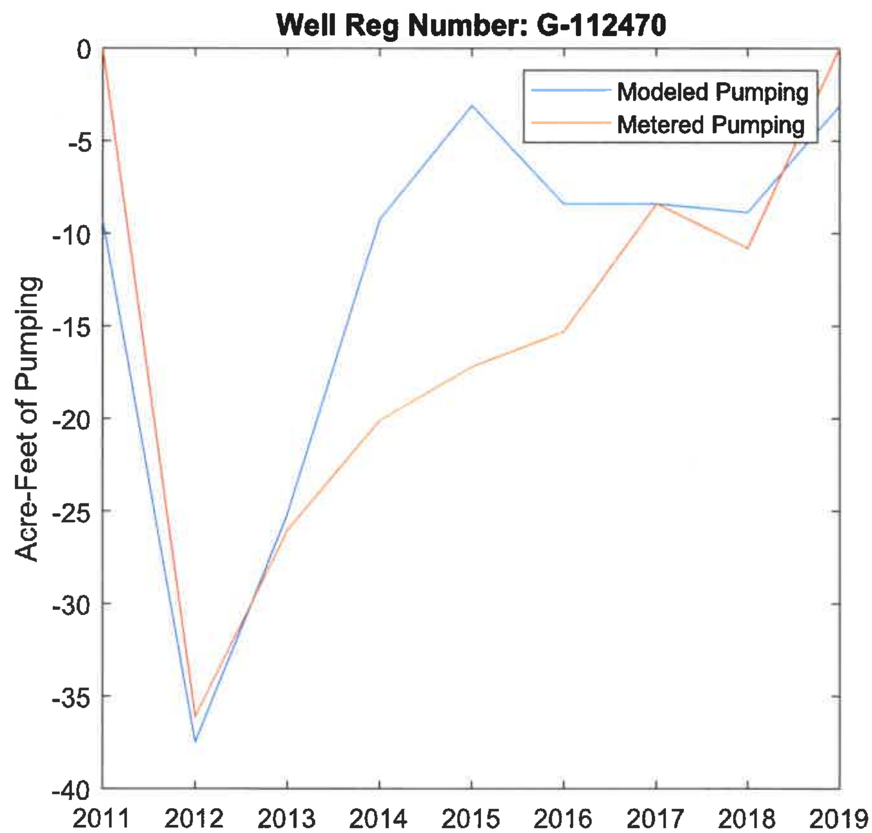
-40
-60
-80
-100
-120
-140
2011
2012
2013
2014
2015
2016
2017
2018
2019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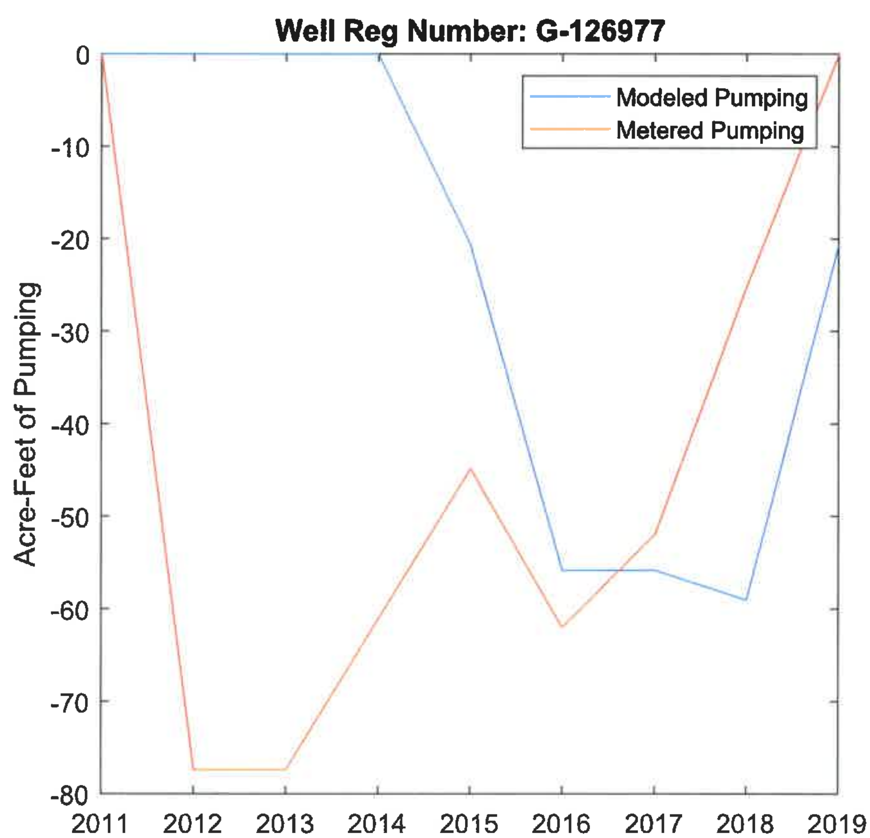
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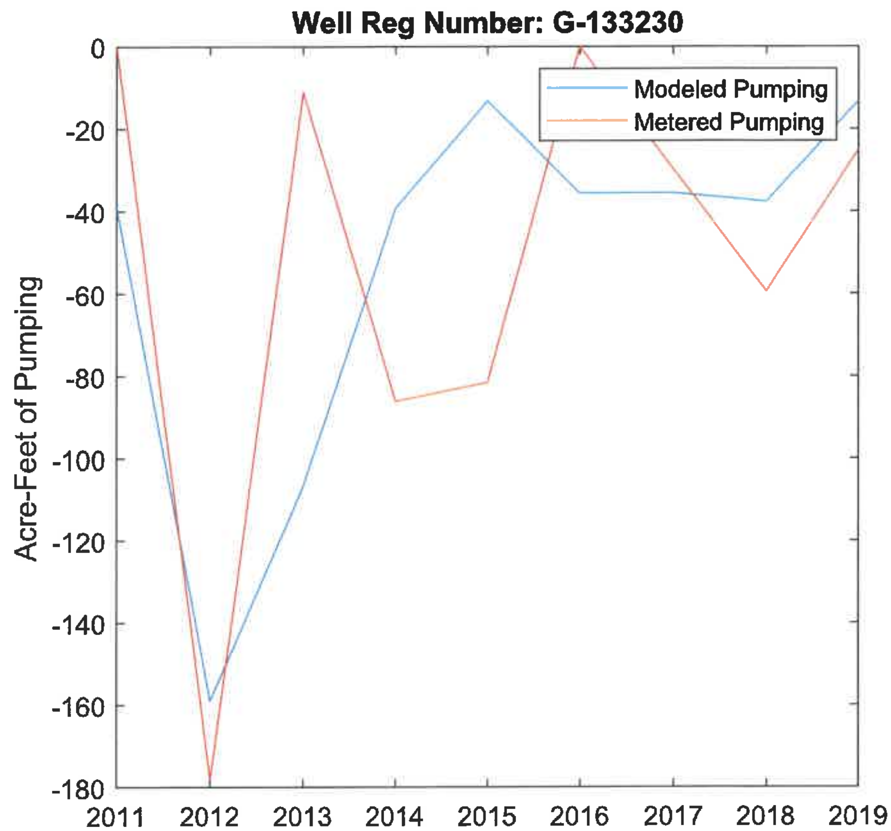

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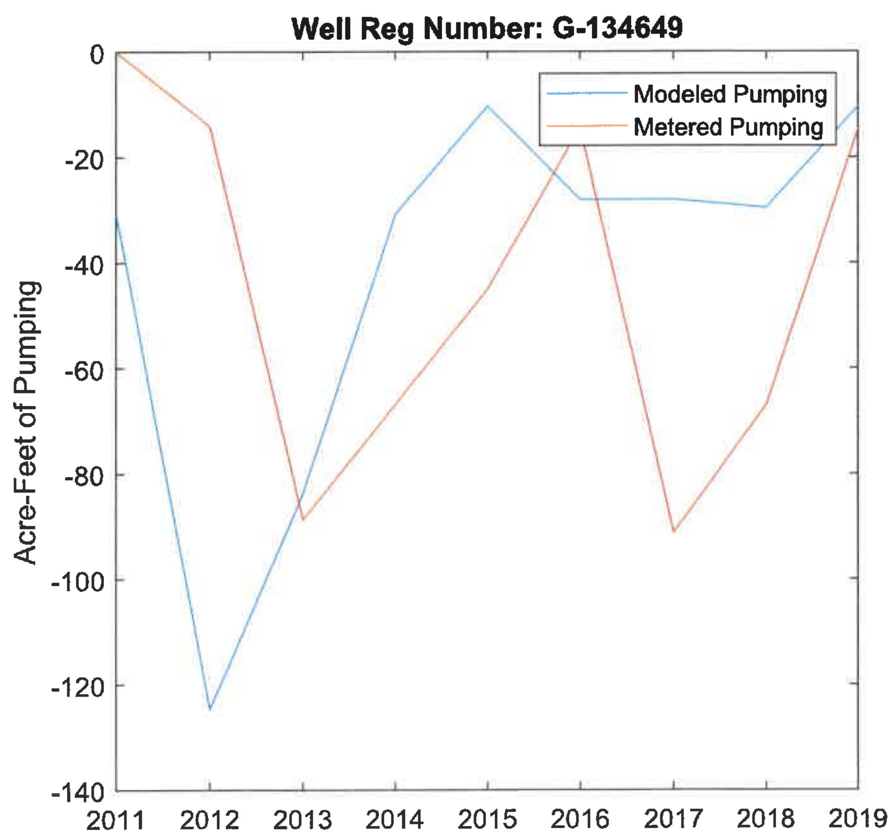

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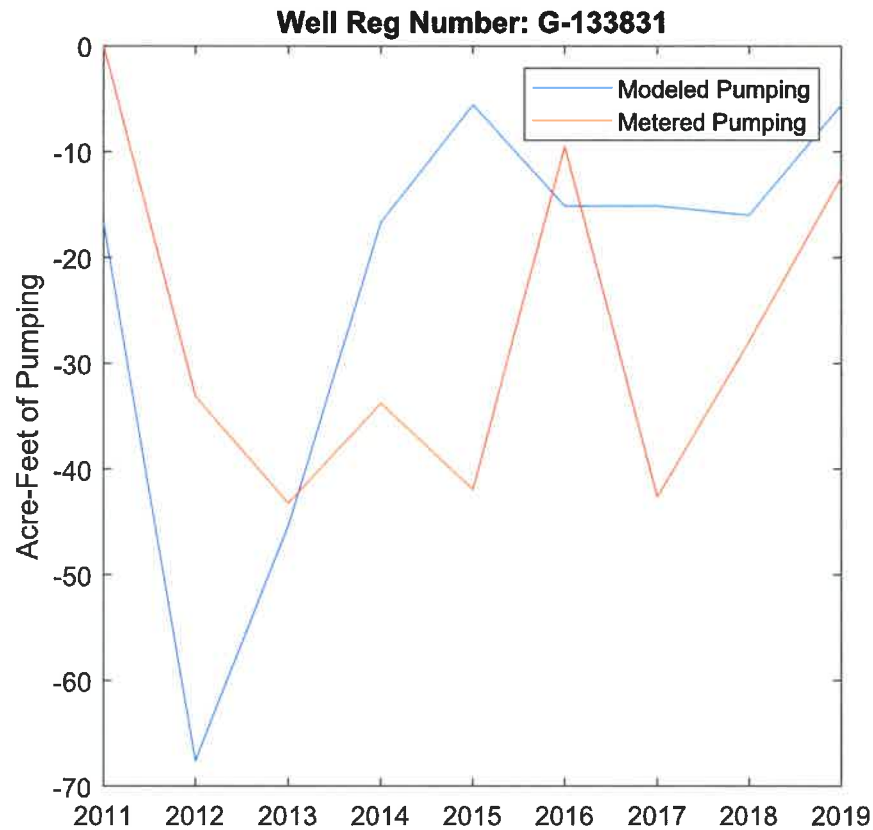
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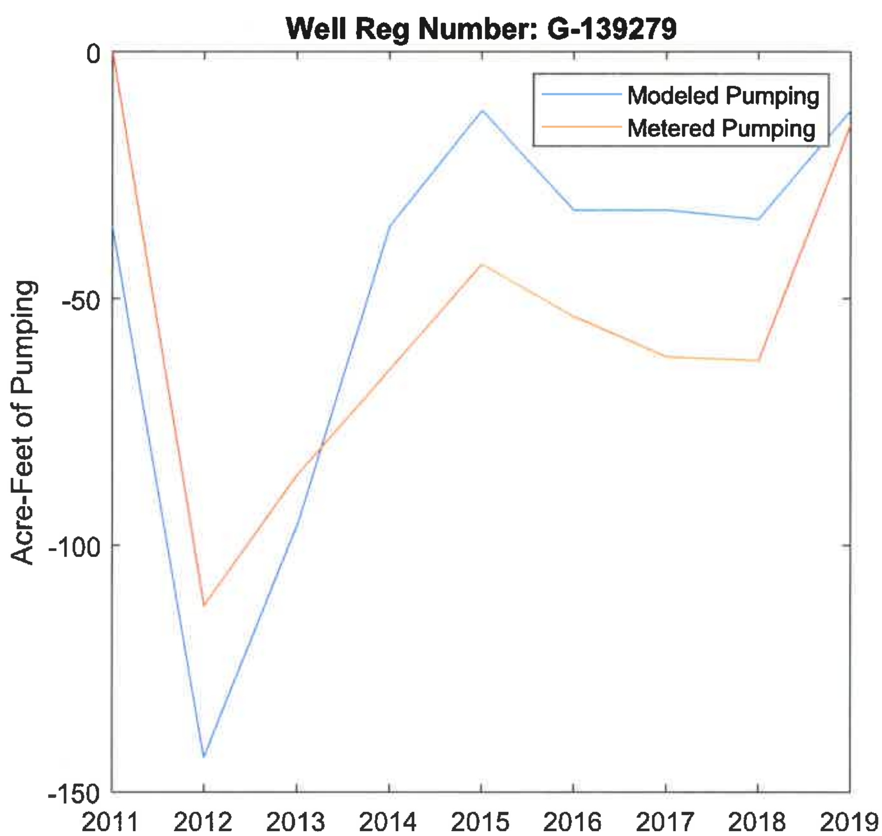
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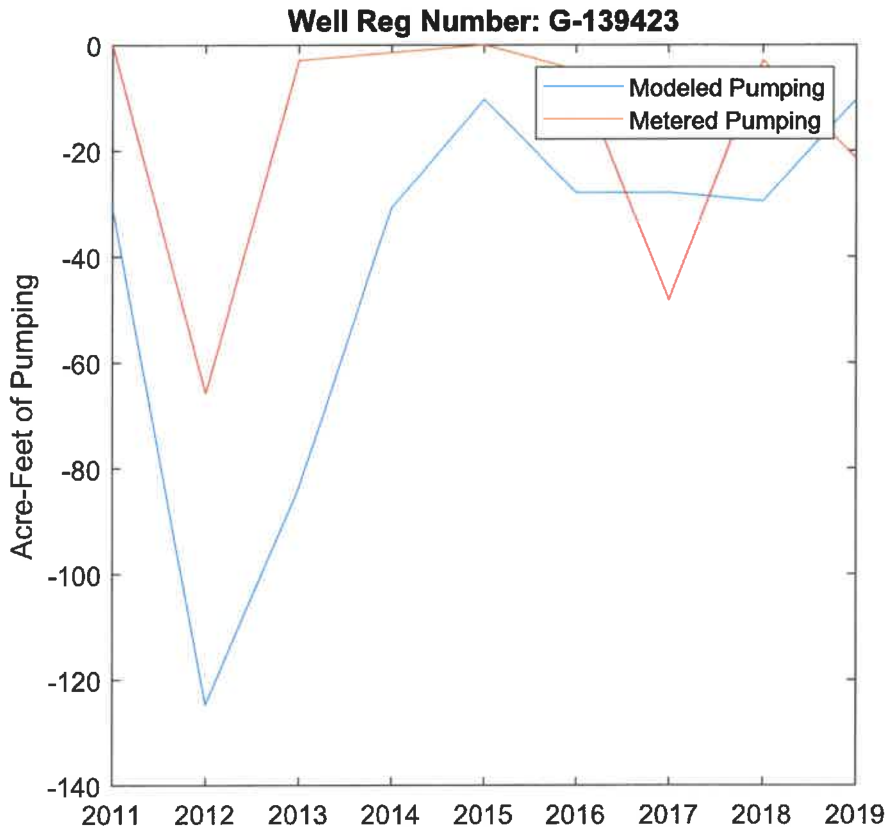
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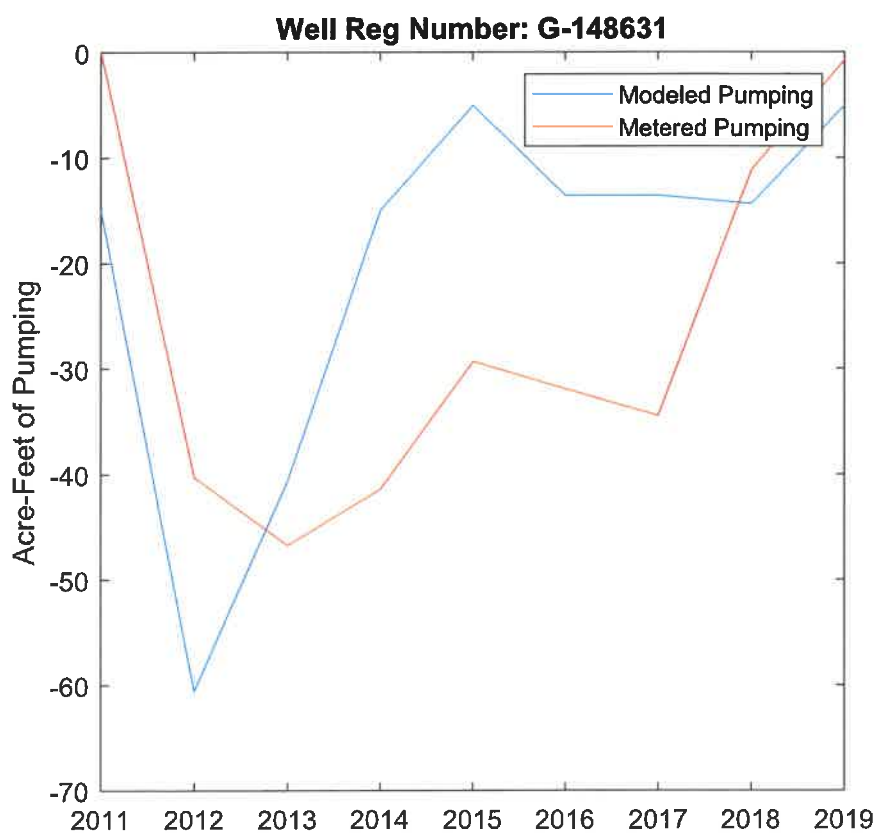
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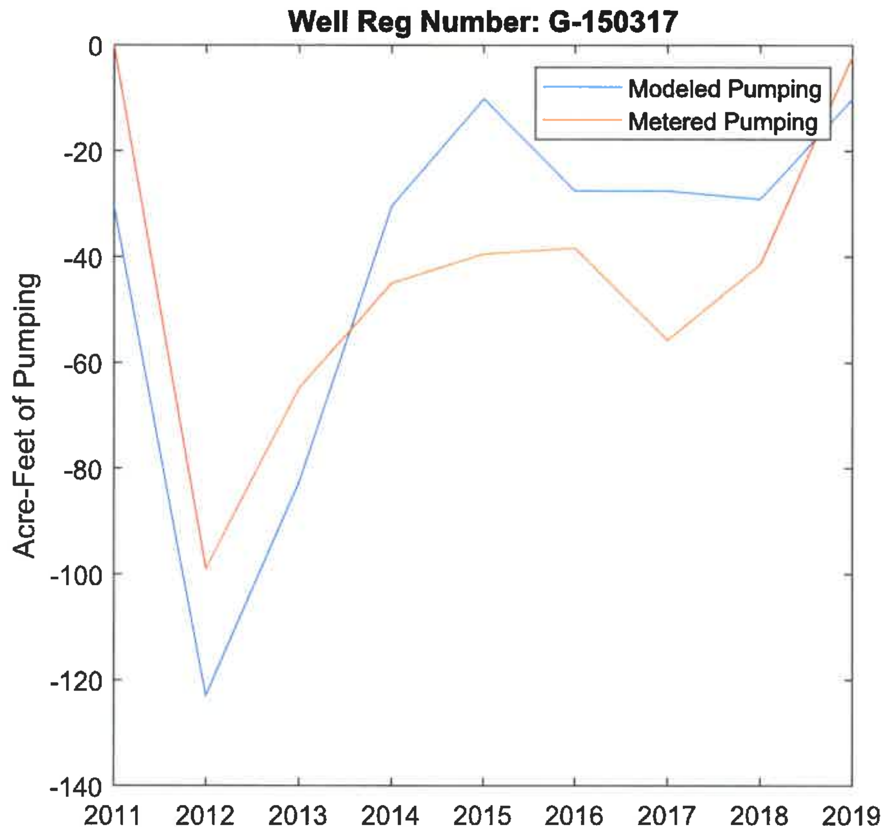
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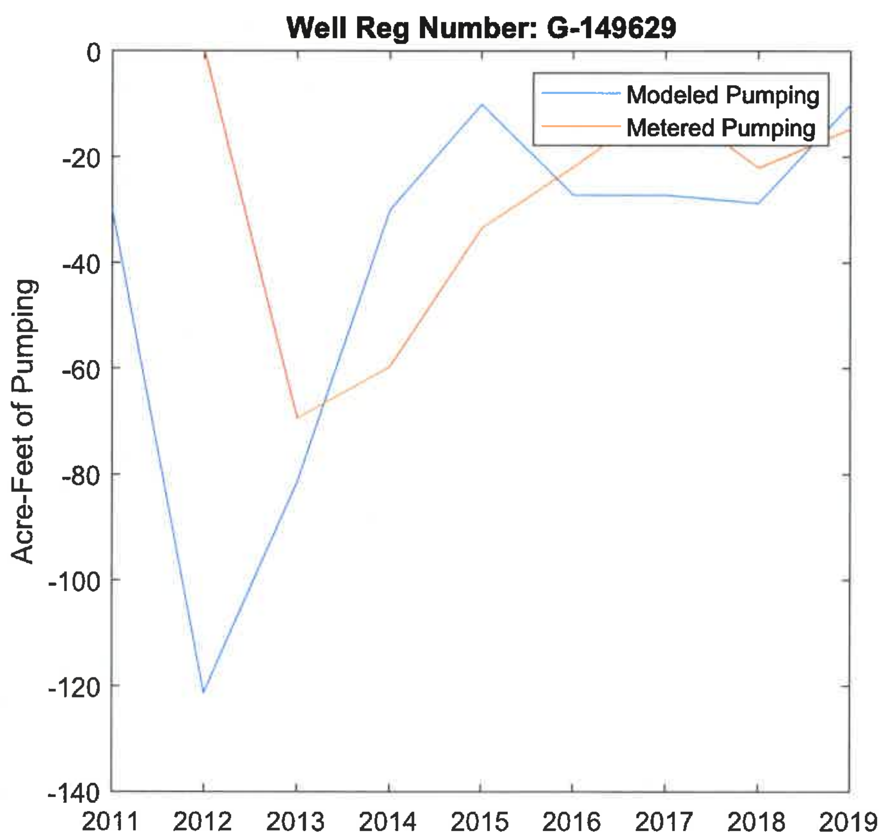
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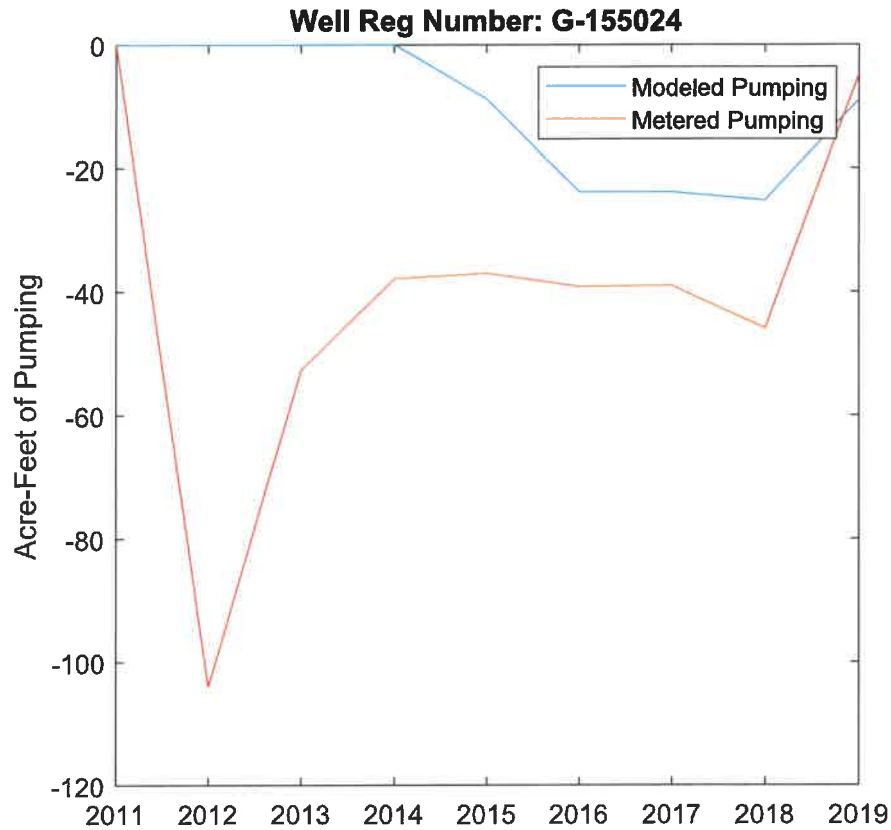

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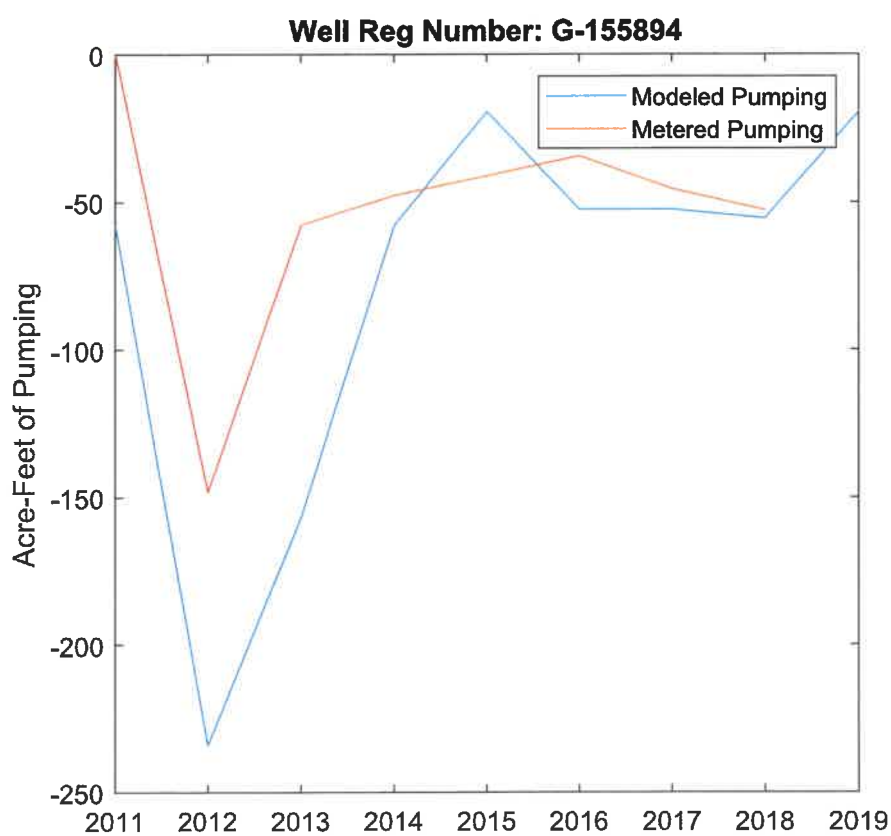

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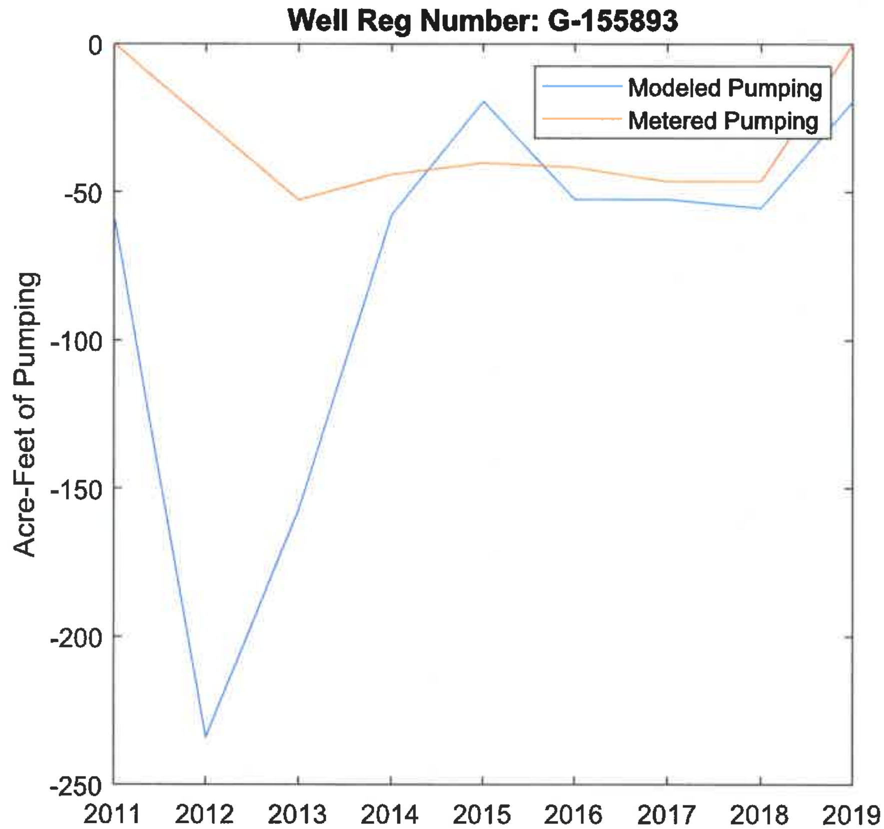
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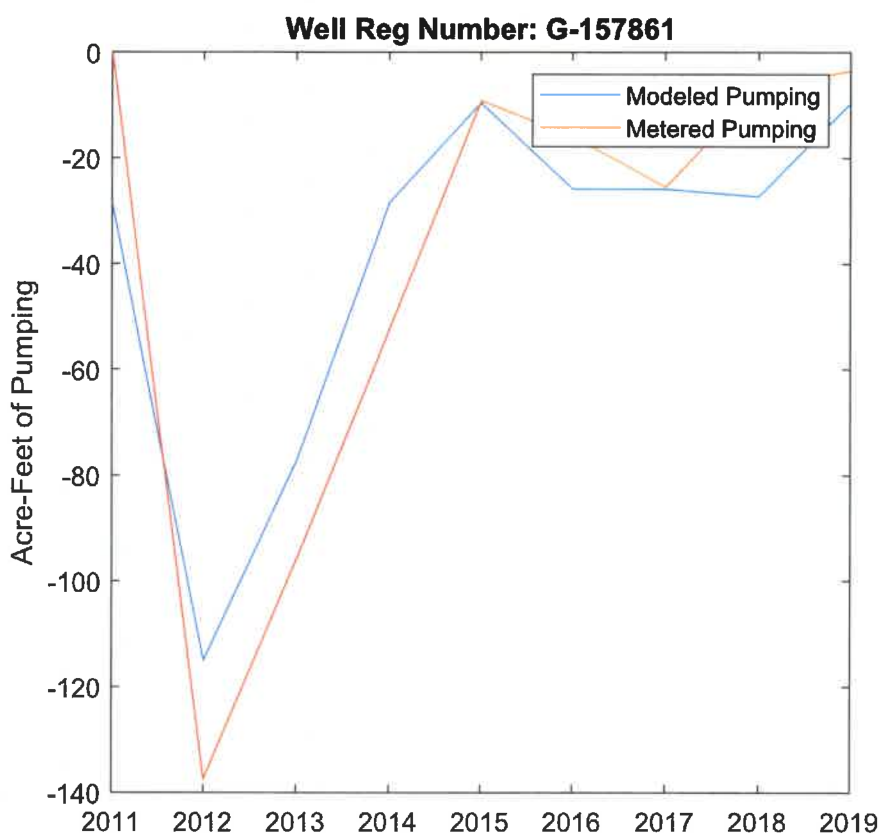
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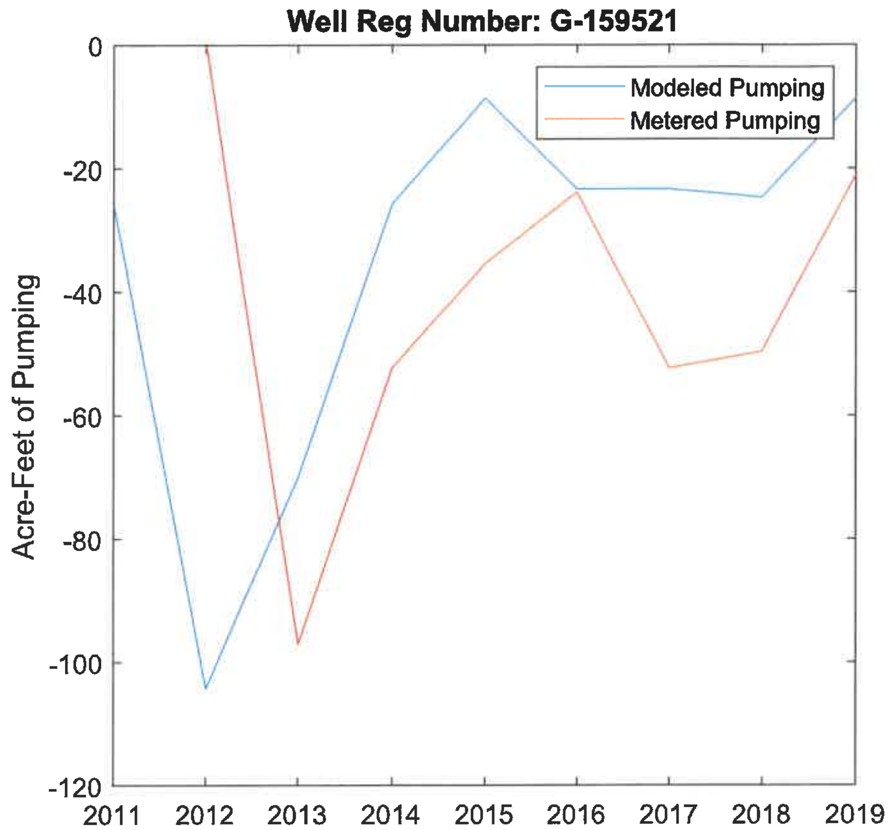
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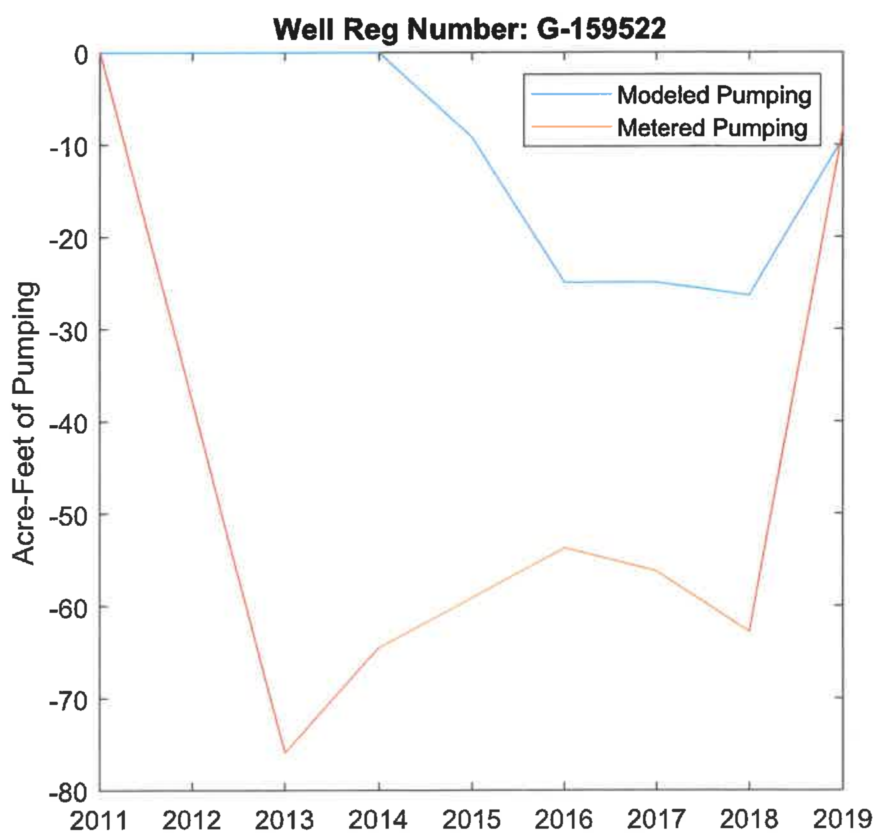
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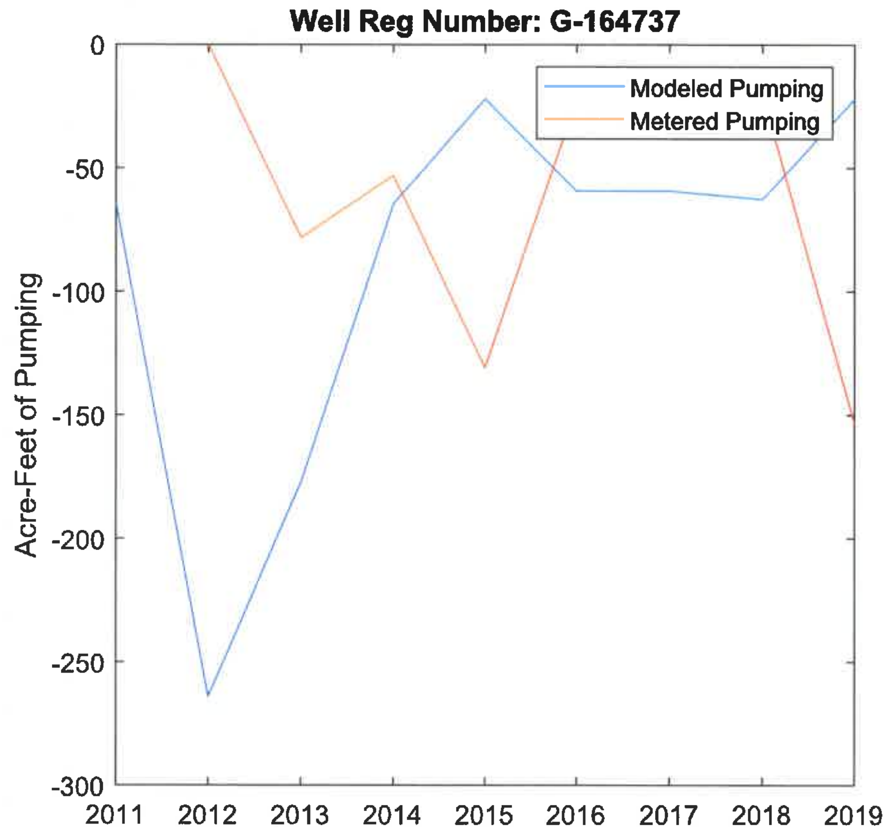
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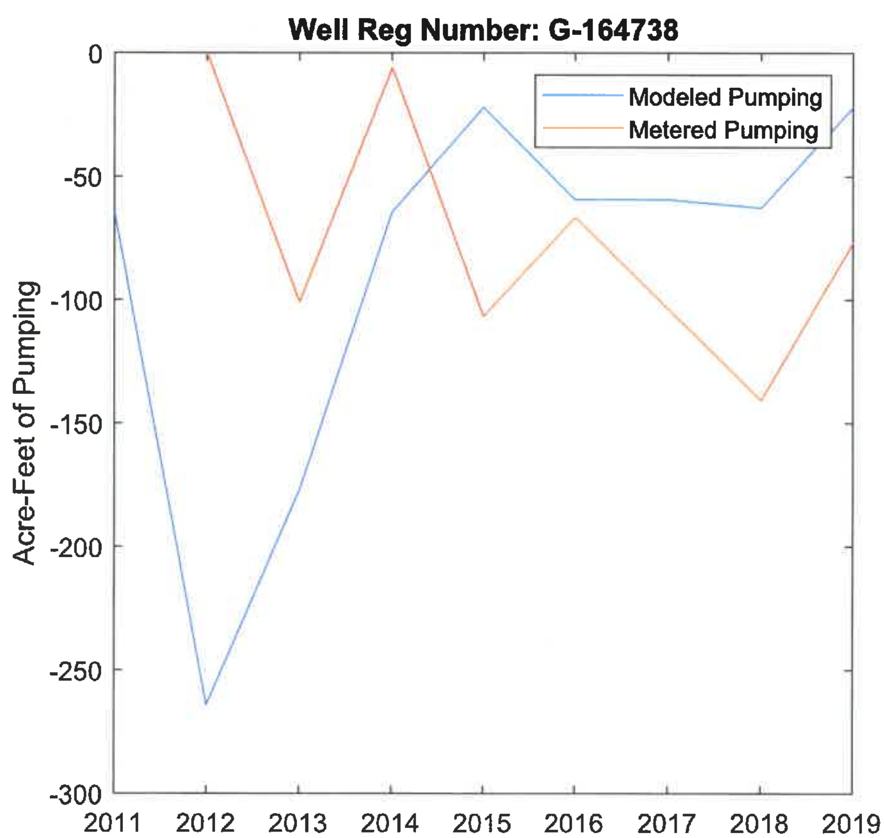
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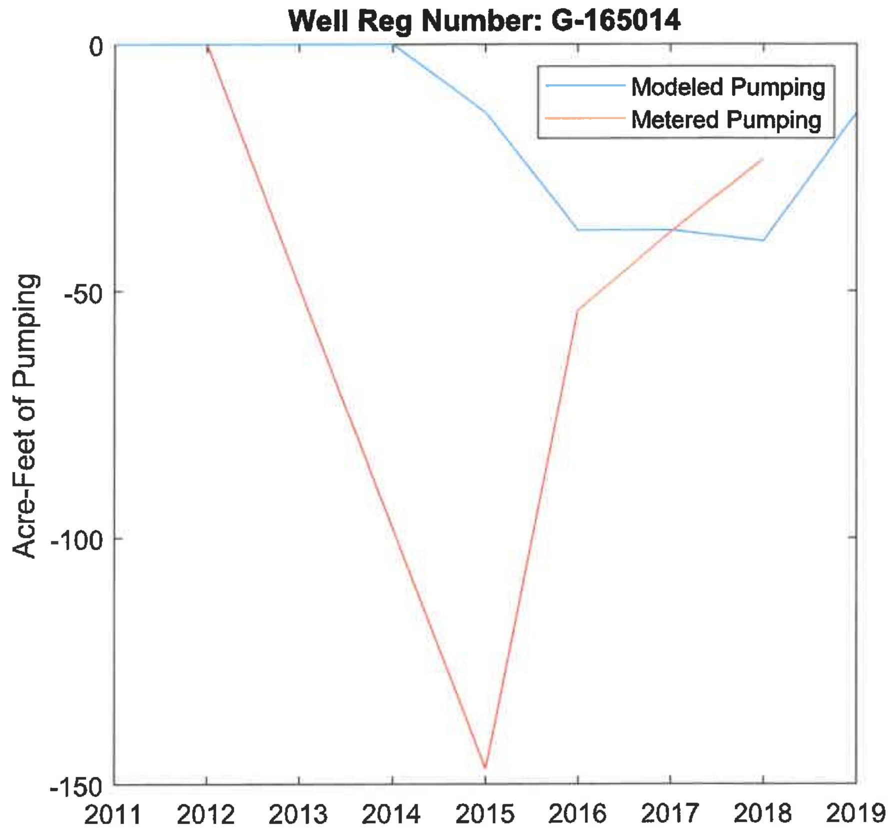
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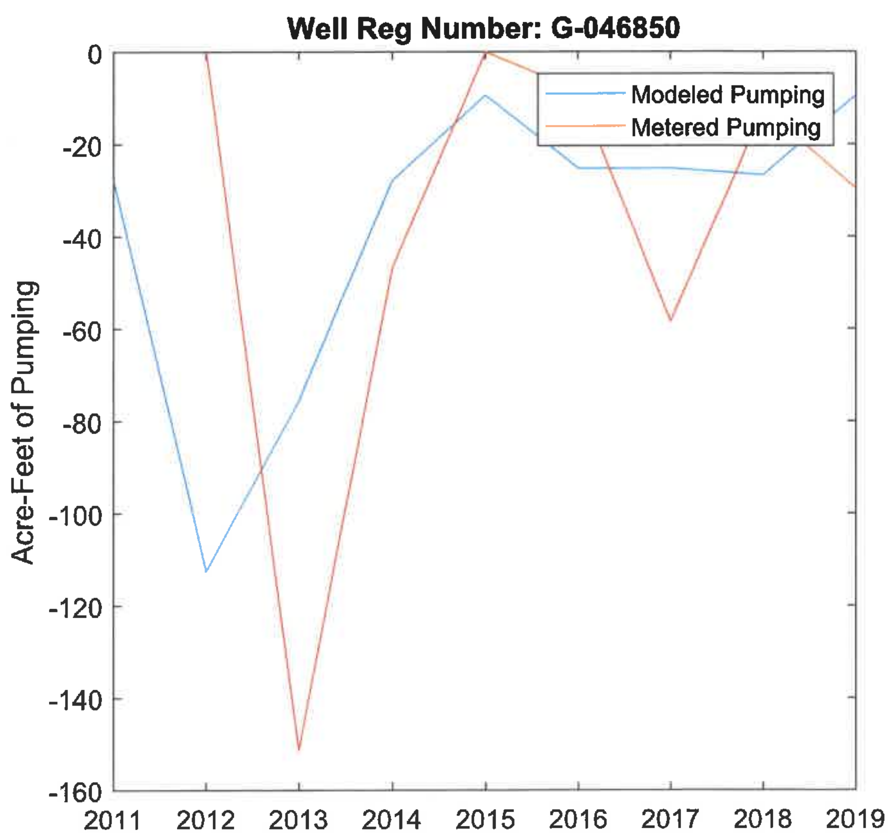
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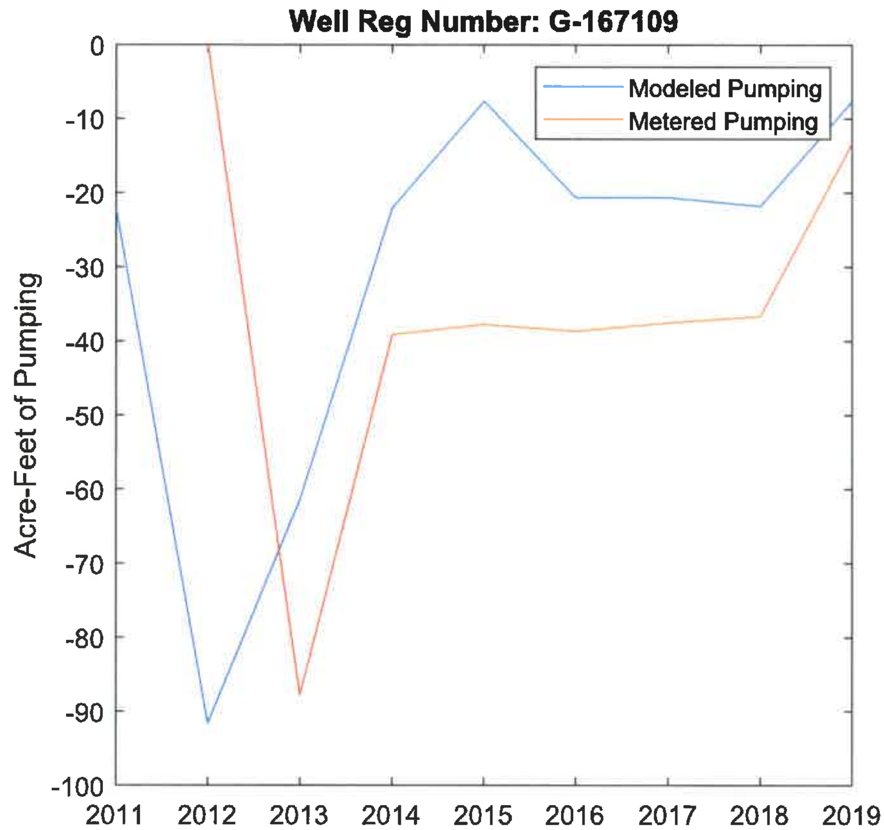

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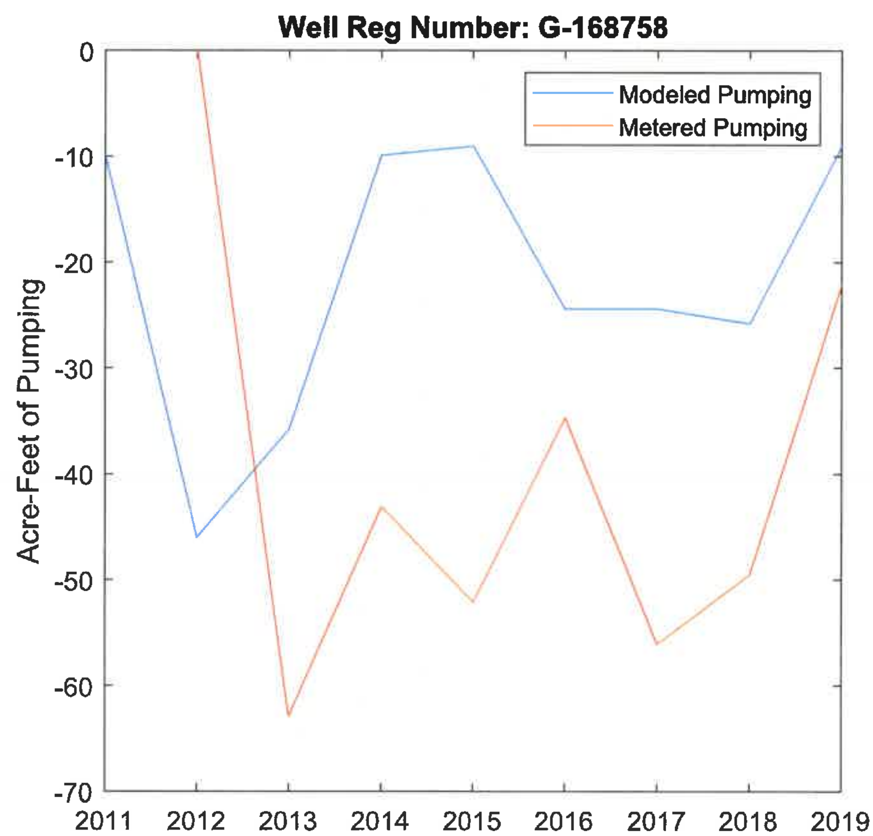

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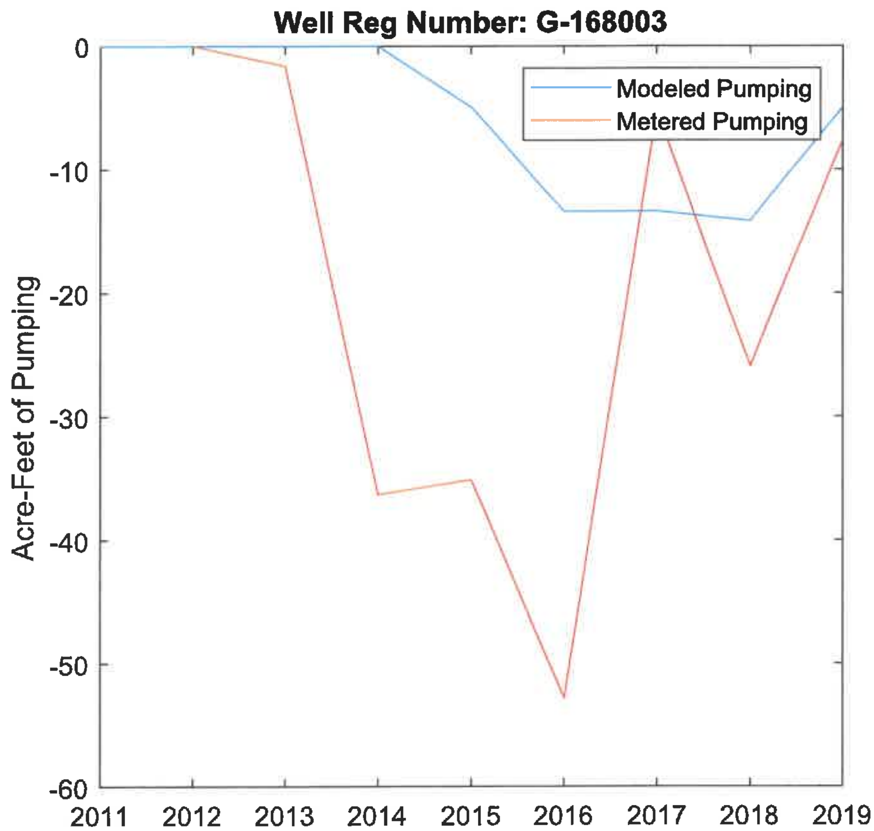
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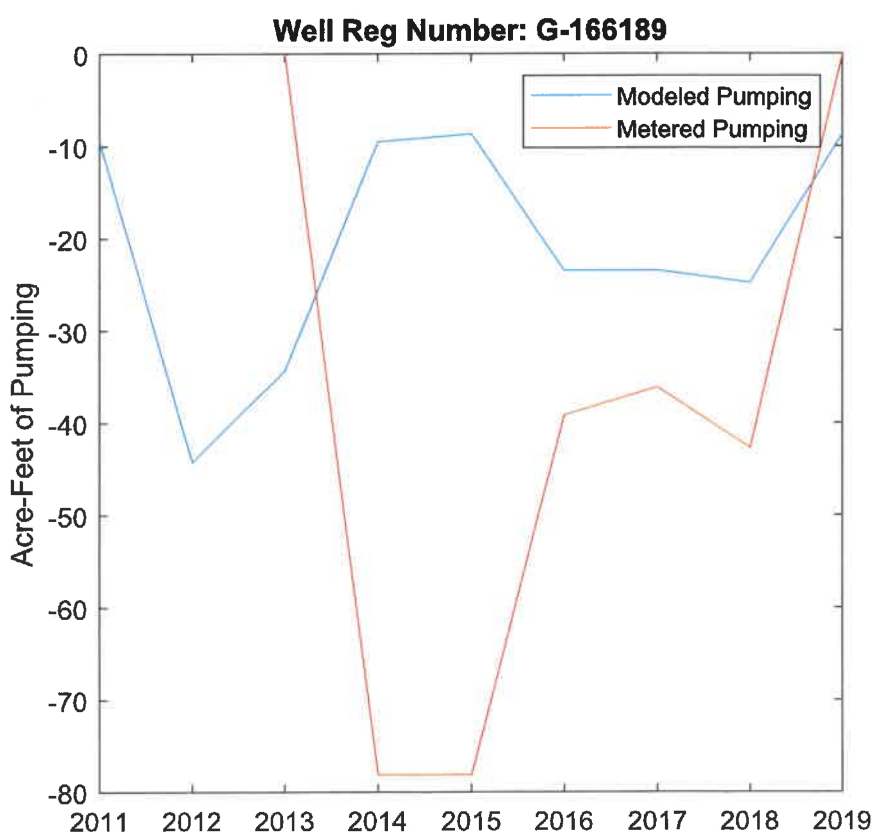
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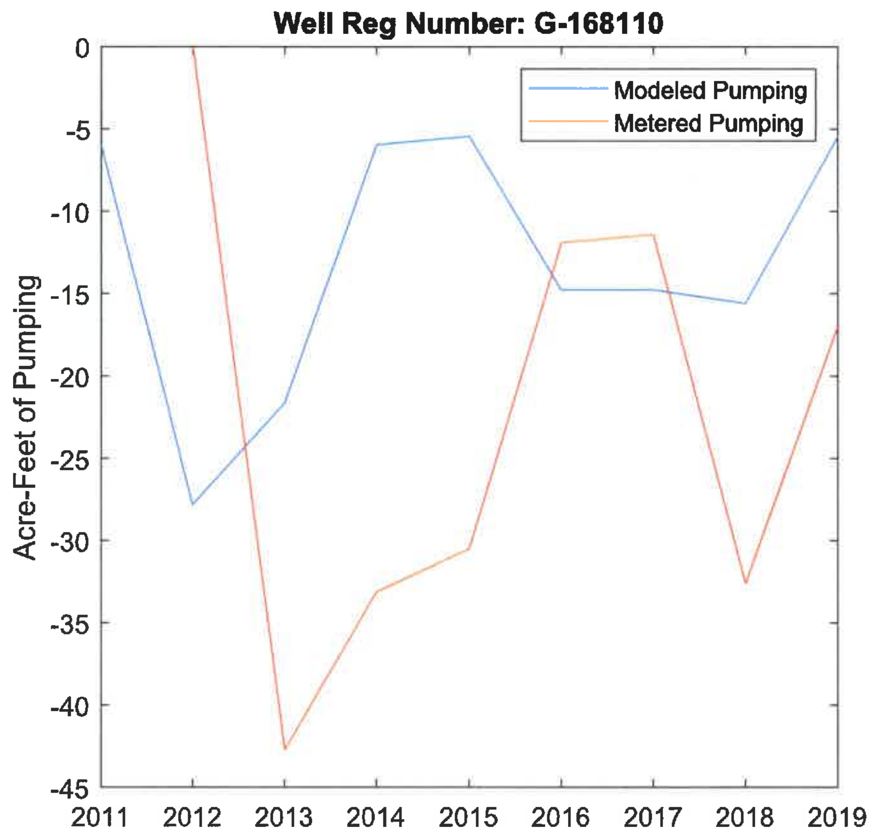
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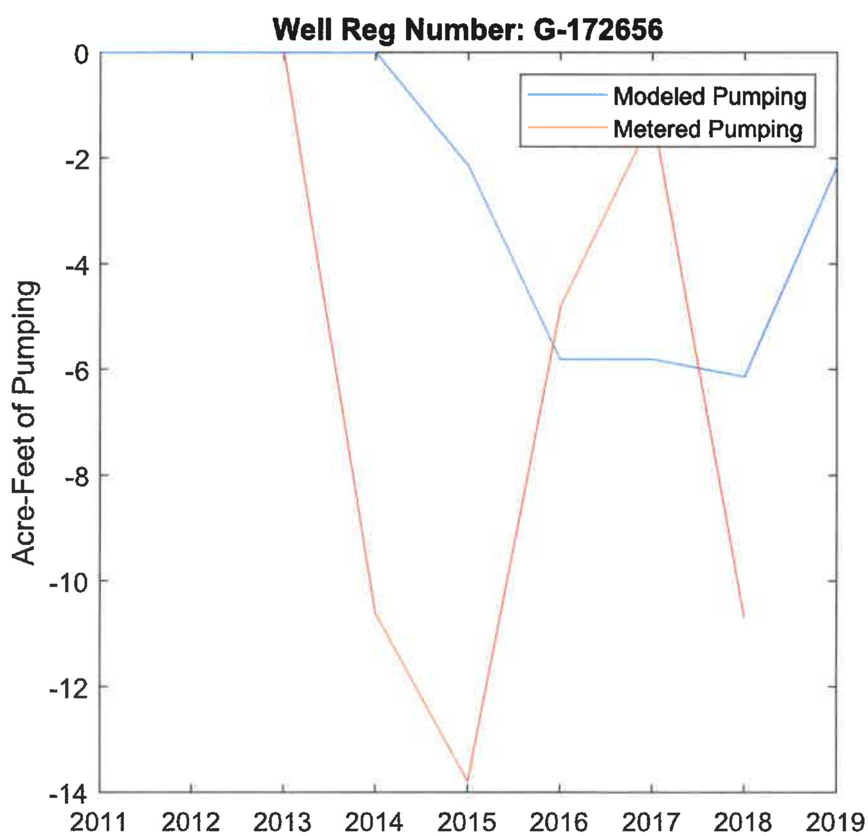
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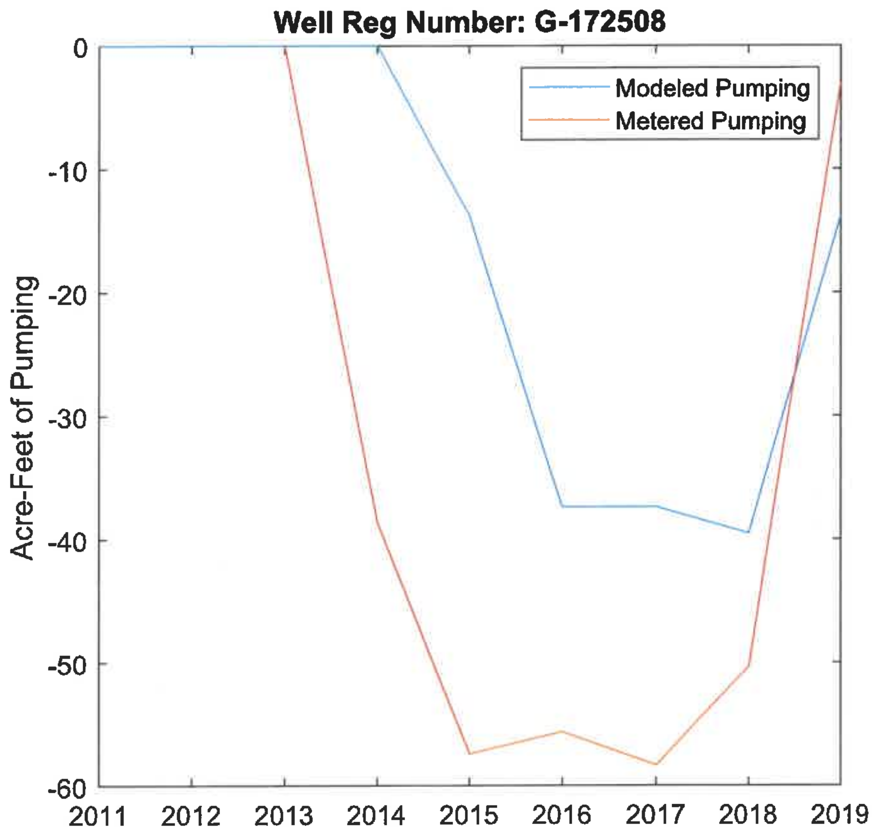
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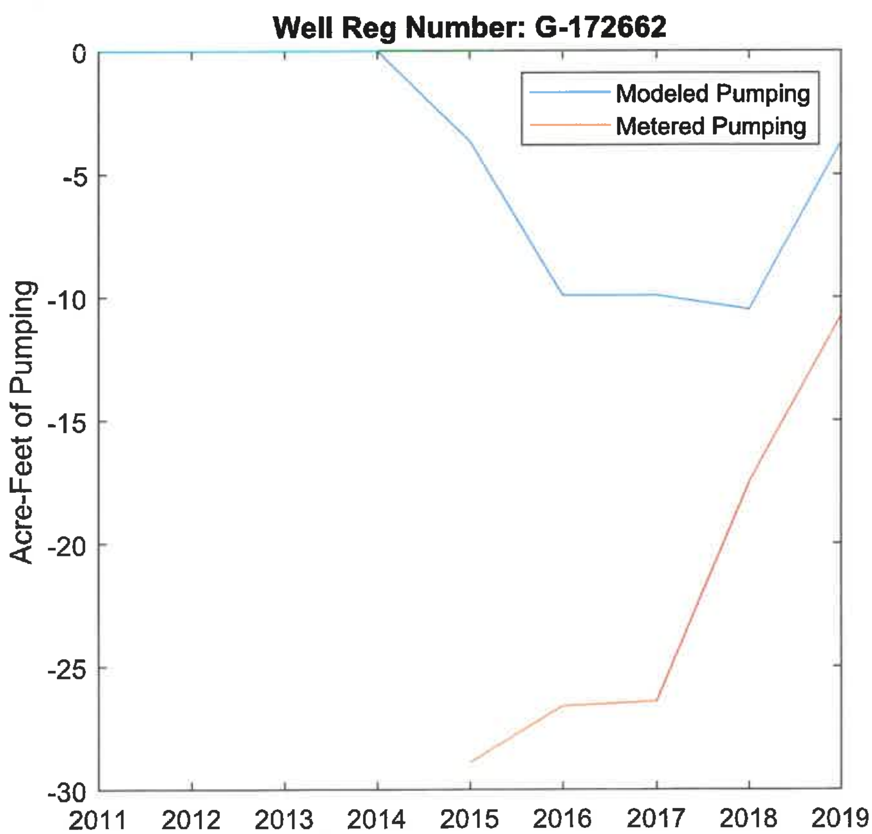
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2011
2012
2013
2014
2015
2016
2017
2018
2019

APPENDIX C
Technical Memorandum on Aquifer Pumping Test

Technical Memorandum
Aquifer Pumping Test Procedures, Analysis, and Results

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Hallam, Nebraska

Prepared for
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Prepared by
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September 2020
Revision: 01
EA Project No. 1602602.0002

CONTENTS

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TABLES

FIGURE

ATTACHMENTS

1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has prepared this technical memorandum to document the procedures, analysis, and results of aquifer pumping tests conducted at the Monolith Nebraska LLC (Monolith) property located near Hallam, Nebraska (Figure 1). The Monolith property is known as the Olive Creek 1 Carbon Black Manufacturing Facility (OC1).

On July 10, 2020, the Lower Platte South Natural Resources District (LPSNRD) issued Preliminary Well Construction Permit LPSP-200412 for onsite test well construction and aquifer testing. The Class II permit is for wells completed in a Ground Water Reservoir for industrial use. The test well site is in the northeast part of the property within the Northeast 1/4 of the Northeast 1/4 of Section 30, Township 7 North, Range 6 East of Lancaster County.

Between June 30 and September 8, 2020, the test well and a nearby observation well were installed and aquifer testing was completed. Table 1 provides a summary of well completion details. Well installation records are provided in Attachment 1. Field work was performed in accordance with NRD permit conditions which included an approved aquifer testing plan (EA 2020).

1.1 PURPOSE

LPSNRD Ground Water Rules and Regulations require estimates of aquifer parameters to determine the effect a permitted well has on existing wells, and to demonstrate that an adequate groundwater supply is present for the well to be permitted for use. To satisfy this requirement, step- and constant-rate pumping tests were performed on the test well. Step-rate tests are used to determine pumping water levels at various discharge rates which can in turn be used to evaluate overall well efficiency and permanent pumping equipment requirements. The constant-rate test is used to estimate aquifer parameters (i.e., transmissivity, storativity) and measure and project aquifer drawdown around the pumping well.

1.2 CHRONOLOGY OF FIELD ACTIVITIES

The following field activities were completed between June 30, 2020 and September 8, 2020:

Day	Date	Activities
Tuesday - Wednesday	June 30 – July 1, 2020	The observation well was installed. Geophysical logging occurred on July 1, 2020.
Tuesday-Thursday	July 14 – 16, 2020	The observation well was developed.
Tuesday - Saturday	July 14 – 18, 2020	Test well 1 was installed.

Day	Date	Activities
Thursday	July 24, 2020	Test well 1 casing failure occurred following cementing the borehole annular space. Failure (casing collapse) was noted during downhole video of the well.
Tuesday - Monday	August 11– 17, 2020	Replacement well 1R was installed.
Wednesday - Friday	August 21 – 28, 2020	Test well 1 replacement (1R) was developed.
Wednesday	August 26, 2020	Transducers were installed in the test well and the observation well.
Monday	August 31, 2020	Data from pressure transducers in the test and observation wells were downloaded, and data logging was stopped. Data logging restarted in both wells for the step-rate test. A four-step pumping test was conducted at pumping rates of 410, 695, 960, and 1,200 gallons per minute (gpm), respectively. Each pumping period was two hours. The step-rate test began at 14:01 local time.
Tuesday	September 1, 2020	Well head discharge piping was reconfigured due to variable flow meter measurements resulting from turbulent flow in piping. This was verified by discrepancy between flow meter readings with contractor provided orifice weir flow rates.
Wednesday	September 2, 2020	The 72-hour constant-rate pumping test began at 07:54. Data collected included manual water levels at both wells, discharge rate, total gallons pumped, and field water quality parameters.
Thursday	September 3, 2020	The pumping test continued with manual well gauging and transducer data logging.
Friday	September 4, 2020	Continued the pumping test with manual well gauging and transducer data logging. Collected a water sample at 14:15 for laboratory analysis of sodium, chloride, and total dissolved solids (TDS). Shipped groundwater samples to Eurofins Laboratory in Lancaster, Pennsylvania.
Saturday	September 5, 2020	Downloaded data from both transducers, stopped the automated data logging, and restarted each transducer for recovery data collection. Stopped the 72-hour constant-rate pumping test at 08:00 and manually gauged water levels in the test well and observation well for approximately 3 hours. Left transducers to record data every two minutes until at least 95% recovery was achieved in the test well.

Day	Date	Activities
Sunday	September 6, 2020	Manually gauged the test well and observation well; downloaded transducer data.
Tuesday	September 8, 2020	Manually gauged the test well and observation well; downloaded transducer data.

2. FIELD METHODS

Two types of aquifer pumping tests were conducted: (1) a step-rate test at four separate pumping rates, and (2) a 72-hour constant-rate pumping test at a set pumping rate. Groundwater levels in the test well and observation well were measured using automated data logging pressure transducers and manual well gauging prior to, during, and after periods of pumping.

The test well was equipped with a 100-horsepower, 3-stage American Marsh submersible pump (Model 9LC) with the pump intake set at approximately 220 ft bgs. A diesel generator powered the electrical submersible pump. Discharge was measured with a newly purchased (for this application) McCrometer M0300 - Bolt-on Saddle Clamp propeller type flow meter capable of providing instantaneous flow rate and total gallons pumped (e.g., total discharge) throughout the duration of testing. The calibrated flow meter is accurate within ±2% of readings throughout the full range of operation (0 to 2,000 gpm).

A photographic log of the well site conditions including the configuration of surface piping, valves, gauges, and the flow meter are provided in Attachment 2.

Field methods used to complete each test are provided below.

2.1 STEP-RATE PUMPING TEST

Prior to the step-rate pumping test, static water levels were measured and data-logging pressure transducers (Insitu Level Troll 700®) were placed in both wells for automated data collection. The test well was pumped at stepped rates of 410-, 695-, 960-, and 1,200-gpm for 2 hours each step. Each pumping rate was based on a correlation between the contractor's circular orifice weir setup and the calibrated McCrometer flow meter. The test was initiated on Monday, August 31, 2020 at 14:01, and the pump was turned off at 22:00 the same day. Water level recovery was monitored following the completion of pumping via transducers placed in both the test well and the observation well. Water level drawdown plots for the step test are provided in Attachment 3. Step-rate pumping test manual gauging data is summarized in Table 2. Water quality data collected during the step-rate test is in Table 3.

2.2 CONSTANT-RATE PUMPING TEST

A 72-hour constant-rate pumping and recovery test was performed on the test well, using one observation well screened in the same interval. After the pump, discharge piping, and flow meter were installed, the transducer was calibrated against the water level as measured from the top of casing with the water level indicator, and the data logger was set to record water level measurements at intervals appropriate for analysis. Before starting the tests, pressure transducer readings were monitored to confirm water level equilibration following setting of the pump in the well.

Pumping rates were measured and recorded at frequent time intervals. Adjustments to the flow rate were not required, as pumping rates were found to be consistent throughout the testing interval. Pumping rates were verified using the calibrated flow meter's instantaneous flow rate displayed on the meter, which was compared to the total discharge divided by pumping time to yield the overall average pumping rate. The constant pumping rate was chosen based on the observed drawdown during the step tests. The visually observed flow rate was steady at approximately 805 gpm. The overall average pumping rate was 797 gpm, determined by dividing total gallons pumped (3,449,000 gallons) by time of pumping (4,327 minutes), or a one percent variation between methods of flow measurement.

Data recorded during the tests included clock time, elapsed time since pumping started, depth to water, the pumping rate, and total gallons discharged. The pump was turned off at the end of the drawdown phase and recovery subsequently manually monitored until the water level was at least 95 percent of the static (pre-test) water level. Data was downloaded from the transducer at the end of both the pumping and recovery periods. The manual water level gauging data is summarized in Table 4. Field water quality data collected during the 72-hour test is summarized in Table 5, and pumping rate data is in Table 6.

2.3 PUMPED WATER DISCHARGE

During the step- and constant-rate pumping tests discharge was routed into a field located to the north of the test well location. A total of 3.86 million gallons were discharged during both tests, and no ponding was noted in the immediate vicinity of the discharge during the duration of testing (photograph No. 7, Attachment 2).

2.4 SAMPLING AND ANALYSIS OF GROUNDWATER

During the constant-rate pumping test, groundwater samples were collected as required under the Preliminary Well Construction Permit (LPSP-200412) issued by the LPSNRD. This permit designated the test well as a Class II well and groundwater samples were required for analysis of sodium, chloride, and total dissolved solids. Results from the September 4, 2020 sample collected 54.2 hours after pumping started are shown below. The full laboratory report is included as Attachment 4.

Sample Well	Sodium (mg/L)	Chloride (mg/L)	TDS (mg/L)
Test Well 1R	98	61 (E, F1)	650
Notes: E = Result exceeded calibration range. F1 = Matrix spike and/or matrix spike duplicate recovery exceeds control limits. mg/L = milligrams per liter TDS = total dissolved solids			

3. METHODS OF DATA ANALYSIS

This section discusses the methods of data analysis for the aquifer pumping tests.

3.1 STEP-RATE TEST

The test well pumping rate and drawdown data collected during the step test were used to estimate specific capacity and identify a suitable pumping rate for the 72-hour constant-rate test. Specific capacity was determined by dividing the discharge rate in gpm by the total drawdown from static water level conditions at the end of step. The following table displays results of the step test. Well efficiency was determined to be 97.14% at 800 gpm. Results are summarized in Attachment 3.

Step	Pumping Rate (gpm)	Start Time	End Time	Drawdown (feet)	Specific Capacity (gpm/ft)
1	410	14:02	16:02	3.92	104.6
2	695	16:02	18:02	6.52	106.6
3	960	18:02	20:02	9.13	105.1
4	1,200	20:02	22:03	11.80	101.7

3.2 CONSTANT-RATE TEST

A testing rate of 800 gpm was selected for the 72-hour constant-rate test. The constant rate pumping test data were analyzed with analytical solutions commonly used for confined aquifers. Analysis methods and the simplifying assumptions are described in detail within Driscoll (1986) and Kruseman and deRidder (1991). Cooper and Jacob straight-line methods were applied to the analysis of the recovery data. The straight-line method can be used to evaluate transmissivity of the aquifer if a critical time is exceeded during the constant rate pumping test to ensure the effects of casing storage are negligible. The critical time is a function of the well radius and the aquifer transmissivity; its physical significance is the time of pumping necessary to overcome the effects well bore storage, which were easily overcome during the 72-hour test. Results obtained by the analytical methods used to determine aquifer transmissivity are summarized in Section 4.

Data collected during the 72-hour test were analyzed by using the software program AQTESOLV, and by using Cooper and Jacob (1946) straight-line method. AQTESOLV outputs using Theis (1935) recovery data and data plots of the Cooper and Jacob method analysis from the 72-hour well pumping-recovery test are provided in Attachment 5. Electronic versions of all data files from both the step test and 72-hour test are included in Attachment 6.

4. AQUIFER PUMPING TEST RESULTS

Water level drawdown and recovery plots for the step test are provided in Attachment 3, and Step test results are included in Section 3.1.

Constant-rate pumping test data was analyzed using a combination of Microsoft Excel graphing techniques and the modeling software AQTESOLV. Test well 1R and the observation well were analyzed separately using these techniques, and the wells were analyzed together using AQTESOLV. Results are summarized in the table below.

Well	Method	Software	Data	T (gallons /ft/day)	T (ft^2/day)	Hydraulic Conductivity (ft/day)	S
Test Well 1R	Theis (1935)	Aqtesolv	Drawdown-Recovery	234,058	31,291	522	-
			Recovery	87,634	11,716	195	-
	Cooper-Jacob (1946)	Excel	Drawdown	89,535	11,970	199	-
Observation Well	Theis (1935)	Aqtesolv	Drawdown-Recovery	166,954	22,320	372	-
			Recovery	87,634	11,716	195	-
	Cooper-Jacob (1946)	Excel	Drawdown	155,585	20,800	347	-
Both Wells	Theis (1935)	Aqtesolv	All data	175,140	23,414	390	0.004

Notes:

S = Storativity (unitless)
T = Transmissivity
Hydraulic conductivity is estimated by dividing T in ft^2/day by the 60 ft screen length.

5. SUMMARY

This technical memorandum describes the events and results of aquifer pumping tests conducted at the Monolith site located near Hallam Nebraska between June 30, 2020 and September 8, 2020. A step- and constant-rate pumping test were performed in Test Well 1R to meet applicable requirements of the LPSNRD Ground Water Rules and Regulations regarding new production wells. Salient points from the pumping test are as follows:

1. A pumping rate of 800 gpm was selected for the pumping rate after conducting a step test at pumping rates of 410-, 695-, 960-, and 1,200-gpm.

2. Well efficiency is high, ranging from 99 to 96 percent for flow rates ranging from 200 to 1,000 gpm.

3. The maximum observed drawdown in the test well at the average pumping rate of 797 gpm over the 72-hours period was 9.01 ft.

4. The maximum drawdown in the observation well located at a radial distance of 72.5 ft from the pumping well was 2.32 ft at the end of the 72-hour period of pumping at 797 gpm.

5. AQTESOLV drawdown and recovery data analysis of observation well data along with testing well data resulted in a hydraulic conductivity value of 390 ft/day (assuming a saturated thickness of 60 ft). The estimated transmissivity value was 23,414 ft^2/day. Storativity was estimated at 0.004 (dimensionless).

6. AQTESOLV drawdown and recovery data for the test well resulted in a hydraulic conductivity of 522 ft/day. The estimated transmissivity was 31,291 ft^2/day. Analysis of recovery data alone resulted in a transmissivity of 11,716 ft^2/day and a hydraulic conductivity of 195 ft/day. Excel software (Cooper and Jacob method) analysis of drawdown data resulted in a transmissivity of 11,970 ft^2/day and a hydraulic conductivity of 199 ft/day.

7. AQTESOLV drawdown and recovery data for the observation well resulted in a hydraulic conductivity of 372 ft/day. The estimated transmissivity was 22,320 ft^2/day. Analysis of recovery data alone resulted in a transmissivity of 11,716 ft^2/day and a hydraulic conductivity of 195 ft/day. Excel software (Cooper and Jacob method) analysis of drawdown data resulted in a transmissivity of 20,800 ft^2/day and a hydraulic conductivity of 347 ft/day.

6. REFERENCES

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Theis, C.V., 1935. The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well using Groundwater Storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

TABLES

Table 1. Test Well Completion Information

Well I.D.	Distance from Pumping Well (ft)	Bottom of Screen (ft bgs)	Top of Screen (ft bgs)	Diameter of Borehole (inches)	Diameter of Well (inches)	Depth to Water[1] (ft bgs)	Water Column[2] (ft)
Test Well	NA	300.9	240.9	18.50	12	164.75	136.15
Observation Well	72.5	300	240	12.25	6	161.80	138.20

Notes:

[1] - Observation well depth to water adjusted to ft bgs; data collected during the field event was recorded from the top of casing measuring point. Depths are static water levels prior to the start of the 72-hour test.

[2] - Depth to bottom of screen minus depth to water.

bgs = below ground surface

ft = feet

I.D. = Identification

Table 2. Step-Rate Test - Drawdown and Recovery Data – Manual Gauging

Date	Pumping Rate	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)
Pump Started at 14:02				
8/31/2020	410	14:05:00	3.0	168.56
8/31/2020	410	14:13:00	8.0	168.63
8/31/2020	410	14:18:00	16.0	168.58
8/31/2020	410	14:22:00	20.0	168.62
8/31/2020	410	14:27:00	25.0	168.64
8/31/2020	410	14:32:00	30.0	168.63
8/31/2020	410	14:37:00	35.0	168.63
8/31/2020	410	14:42:00	40.0	168.63
8/31/2020	410	14:47:00	45.0	168.63
8/31/2020	410	14:52:00	50.0	168.62
8/31/2020	410	14:57:00	55.0	168.63
8/31/2020	410	15:02:00	60.0	168.66
8/31/2020	410	15:07:00	65.0	168.67
8/31/2020	410	15:12:00	70.0	168.65
8/31/2020	410	15:17:00	75.0	168.67
8/31/2020	410	15:22:00	80.0	168.68
8/31/2020	410	15:27:00	85.0	168.69
8/31/2020	410	15:32:00	90.0	168.65
8/31/2020	410	15:37:00	95.0	168.73
8/31/2020	410	15:42:00	100.0	168.70
8/31/2020	410	15:47:00	105.0	168.65
8/31/2020	410	15:52:00	110.0	168.70
8/31/2020	410	15:57:00	115.0	168.67
8/31/2020	695	16:02:00	120.0	168.65
8/31/2020	695	16:12:00	130.0	171.18
8/31/2020	695	16:22:00	140.0	171.19
8/31/2020	695	16:32:00	150.0	171.25
8/31/2020	695	16:42:00	160.0	171.21
8/31/2020	695	16:52:00	170.0	171.22
8/31/2020	695	17:02:00	180.0	171.23
8/31/2020	695	17:12:00	190.0	171.24
8/31/2020	695	17:22:00	200.0	171.24
8/31/2020	695	17:32:00	210.0	171.26
8/31/2020	695	17:42:00	220.0	171.26
8/31/2020	695	17:52:00	230.0	171.27
8/31/2020	960	18:02:00	240.0	171.27
8/31/2020	960	18:12:00	250.0	173.74

Table 2. Step-Rate Test - Drawdown and Recovery Data – Manual Gauging

Date	Pumping Rate	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)
8/31/2020	960	18:22:00	260.0	173.70
8/31/2020	960	18:32:00	270.0	173.75
8/31/2020	960	18:42:00	280.0	173.77
8/31/2020	960	18:52:00	290.0	173.85
8/31/2020	960	19:02:00	300.0	173.79
8/31/2020	960	19:12:00	310.0	173.81
8/31/2020	960	19:22:00	320.0	173.83
8/31/2020	960	19:32:00	330.0	173.82
8/31/2020	960	19:42:00	340.0	173.84
8/31/2020	960	19:52:00	350.0	173.88
8/31/2020	1200	20:02:00	360.0	173.86
8/31/2020	1200	20:12:00	370.0	176.36
8/31/2020	1200	20:22:00	380.0	176.46
8/31/2020	1200	20:32:00	390.0	176.42
8/31/2020	1200	20:42:00	400.0	176.45
8/31/2020	1200	20:52:00	410.0	176.46
8/31/2020	1200	21:02:00	420.0	176.46
8/31/2020	1200	21:12:00	430.0	176.51
8/31/2020	1200	21:22:00	440.0	176.47
8/31/2020	1200	21:32:00	450.0	176.57
8/31/2020	1200	21:42:00	460.0	176.52
8/31/2020	1200	21:52:00	470.0	176.57
8/31/2020	1200	22:02:00	480.0	176.55
Pump Off at 22:03				

Notes:

[1] - Central Standard Time.

bgs = below ground surface

bTOC = below top of casing

ft = feet

Table 3. Step Test - Water Quality Data

Date	Time[1]	Temp (^0C)	Specific Conductance (µs/cm)	pH	Tubidity (NTU)	Discharge Rate (gpm)[2]
8/31/2020	14:41	16.90	873	7.66	1.38	410
8/31/2020	15:08	15.81	835	7.00	1.93	410
8/31/2020	15:41	15.79	835	7.07	1.67	410
8/31/2020	16:01	14.95	837	7.11	3.26	410
8/31/2020	16:21	15.22	834	7.37	2.19	695
8/31/2020	16:43	15.47	836	7.21	2.74	695
8/31/2020	17:07	15.52	842	7.31	2.44	695
8/31/2020	17:29	14.91	840	7.33	1.99	695
8/31/2020	17:55	14.83	847	7.25	2.00	695
8/31/2020	18:13	14.90	845	7.20	4.18	960
8/31/2020	18:32	14.88	848	7.16	1.80	960
8/31/2020	18:52	14.89	849	7.17	2.25	960
8/31/2020	19:12	14.50	853	7.19	2.87	960
8/31/2020	19:32	14.57	853	7.19	1.75	960
8/31/2020	19:52	14.50	855	7.17	1.49	960
8/31/2020	20:12	14.20	857	7.27	4.06	1200
8/31/2020	20:35	14.05	860	7.19	2.58	1200
8/31/2020	20:55	14.21	866	7.22	2.94	1200
8/31/2020	21:15	13.99	868	7.21	2.29	1200
8/31/2020	21:35	13.90	871	7.24	3.38	1200
8/31/2020	21:55	13.86	870	7.24	2.35	1200

Notes:

[1] - Central Standard Time.

[2] - Note that after piping realignment, piezometer levels used to set the pumping rate during the step test were calibrated against the newly aligned flow meter.

^0C = degrees Celsius

µs/cm = microsiemens per centimeter

gpm = gallons per minute

in = inches

NTU = nephelometric turbidity units

Table 4. Constant Rate Test - Drawdown and Recovery Data – Manual Gauging

Test Well				Observation Well			
Date	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)	Date	Clock Time	Elapsed Time	Depth to Water (ft bTOC)
9/2/2020	7:00:00	N/A	165.10	9/2/2020	7:15:00	N/A	165.00
9/2/2020	7:54:00	0.0	165.10	9/2/2020	7:54:00	0	165.01
9/2/2020	7:55:00	1.0	172.20	9/2/2020	7:54:30	0.5	165.90
9/2/2020	7:55:30	1.5	172.23	9/2/2020	7:55:00	1	166.01
9/2/2020	7:56:00	2.0	172.31	9/2/2020	7:55:30	1.5	166.06
9/2/2020	7:57:00	3.0	172.36	9/2/2020	7:56:00	2	166.09
9/2/2020	7:59:00	5.0	172.39	9/2/2020	7:56:30	2.5	166.11
9/2/2020	8:01:00	7.0	172.42	9/2/2020	7:57:00	3	166.13
9/2/2020	8:03:00	9.0	172.40	9/2/2020	7:57:30	3.5	166.14
9/2/2020	8:08:00	14.0	Data Error	9/2/2020	7:58:00	4	166.15
9/2/2020	8:12:00	18.0	172.49	9/2/2020	7:58:30	4.5	166.16
9/2/2020	8:14:00	20.0	172.51	9/2/2020	7:59:00	5	166.17
9/2/2020	8:17:00	23.0	172.52	9/2/2020	7:59:30	5.5	166.18
9/2/2020	8:24:00	30.0	172.55	9/2/2020	8:00:00	6	166.19
9/2/2020	8:29:00	35.0	172.55	9/2/2020	8:04:00	10	166.21
9/2/2020	8:34:00	40.0	172.57	9/2/2020	8:06:00	12	166.22
9/2/2020	8:45:00	51.0	172.58	9/2/2020	8:08:00	14	166.22
9/2/2020	8:50:00	56.0	172.61	9/2/2020	8:10:00	16	166.24
9/2/2020	8:52:00	58.0	172.63	9/2/2020	8:12:00	18	166.25
9/2/2020	9:00:00	66.0	172.64	9/2/2020	8:14:00	20	166.25
9/2/2020	9:11:00	77.0	172.66	9/2/2020	8:19:00	25	166.27
9/2/2020	9:21:00	87.0	172.67	9/2/2020	8:24:00	30	166.29
9/2/2020	9:31:00	98.0	172.66	9/2/2020	8:29:00	35	166.30
9/2/2020	9:41:00	107.0	172.69	9/2/2020	8:34:00	40	166.31
9/2/2020	10:00:00	126.0	172.71	9/2/2020	8:39:00	45	166.33
9/2/2020	10:26:00	152.0	172.72	9/2/2020	8:44:00	50	166.34
9/2/2020	10:41:00	167.0	172.74	9/2/2020	8:49:00	55	166.35
9/2/2020	10:56:00	182.0	172.75	9/2/2020	8:54:00	60	166.36
9/2/2020	11:13:00	199.0	172.74	9/2/2020	8:59:00	65	166.36
9/2/2020	11:28:00	214.0	172.76	9/2/2020	9:04:00	70	166.37
9/2/2020	11:43:00	229.0	172.75	9/2/2020	9:14:00	80	166.39
9/2/2020	11:57:00	243.0	172.76	9/2/2020	9:24:00	90	166.39
9/2/2020	12:12:00	258.0	172.75	9/2/2020	9:34:00	100	166.40
9/2/2020	12:27:00	273.0	172.77	9/2/2020	9:49:00	115	166.43
9/2/2020	12:42:00	288.0	172.78	9/2/2020	10:05:00	131	166.45
9/2/2020	12:57:00	303.0	172.78	9/2/2020	10:20:00	146	166.45

Table 4. Constant Rate Test - Drawdown and Recovery Data – Manual Gauging

Test Well				Observation Well			
Date	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)	Date	Clock Time	Elapsed Time	Depth to Water (ft bTOC)
9/2/2020	13:12:00	318.0	172.78	9/2/2020	10:35:00	161	166.47
9/2/2020	13:27:00	333.0	172.79	9/2/2020	10:50:00	176	166.48
9/2/2020	13:42:00	348.0	172.78	9/2/2020	11:05:00	191	166.59
9/2/2020	13:57:00	363.0	172.78	9/2/2020	11:20:00	206	166.51
9/2/2020	14:12:00	378.0	172.79	9/2/2020	11:35:00	221	166.52
9/2/2020	14:27:00	393.0	172.79	9/2/2020	11:50:00	236	166.54
9/2/2020	14:42:00	408.0	172.78	9/2/2020	12:05:00	251	166.54
9/2/2020	14:57:00	423.0	172.78	9/2/2020	12:35:00	281	166.55
9/2/2020	15:14:00	440.0	172.78	9/2/2020	13:05:00	311	166.56
9/2/2020	15:27:00	453.0	172.78	9/2/2020	13:35:00	341	166.56
9/2/2020	15:42:00	468.0	172.78	9/2/2020	14:05:00	371	166.57
9/2/2020	15:57:00	483.0	172.79	9/2/2020	14:35:00	401	166.58
9/2/2020	16:13:00	499.0	172.79	9/2/2020	15:05:00	431	166.58
9/2/2020	16:30:00	516.0	172.78	9/2/2020	15:35:00	461	166.58
9/2/2020	17:01:00	547.0	172.79	9/2/2020	16:05:00	491	166.57
9/2/2020	17:32:00	578.0	172.79	9/2/2020	16:35:00	521	166.58
9/2/2020	18:00:00	606.0	172.79	9/2/2020	17:05:00	551	166.58
9/2/2020	18:30:00	636.0	172.78	9/2/2020	17:35:00	581	166.58
9/2/2020	19:03:00	66.0	172.79	9/2/2020	18:05:00	611	166.58
9/2/2020	19:33:00	699.0	172.79	9/2/2020	18:35:00	641	166.58
9/2/2020	20:03:00	728.0	172.80	9/2/2020	19:05:00	671	166.66
9/2/2020	20:29:00	756.0	172.80	9/2/2020	19:39:00	705	166.68
9/2/2020	21:02:00	788.0	172.80	9/2/2020	20:10:00	736	166.69
9/2/2020	21:31:00	817.0	172.80	9/2/2020	20:36:00	762	166.69
9/2/2020	21:59:00	845.0	172.85	9/2/2020	21:05:00	791	166.70
9/2/2020	22:30:00	876.0	172.85	9/2/2020	21:36:00	822	166.69
9/2/2020	22:58:00	904.0	172.85	9/2/2020	22:06:00	852	166.69
9/2/2020	23:29:00	935.0	172.84	9/2/2020	22:36:00	882	166.69
9/2/2020	23:59:00	965.0	172.84	9/2/2020	23:05:00	911	166.69
9/3/2020	0:30:00	996.0	172.83	9/2/2020	23:35:00	941	166.68
9/3/2020	1:30:00	1056.0	172.78	9/3/2020	0:07:00	973	166.68
9/3/2020	2:29:00	1115.0	172.76	9/3/2020	0:36:00	1002	166.68
9/3/2020	3:28:00	1174.0	172.76	9/3/2020	1:36:00	1062	166.68
9/3/2020	4:29:00	1235.0	172.77	9/3/2020	2:36:00	1122	166.69
9/3/2020	5:30:00	1296.0	172.78	9/3/2020	3:35:00	1181	166.68
9/3/2020	6:30:00	1356.0	172.80	9/3/2020	4:35:00	1241	166.59

Table 4. Constant Rate Test - Drawdown and Recovery Data – Manual Gauging

Test Well				Observation Well			
Date	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)	Date	Clock Time	Elapsed Time	Depth to Water (ft bTOC)
9/3/2020	7:30:00	1416.0	172.86	9/3/2020	5:35:00	1301	166.58
9/3/2020	8:30:00	1476.0	172.90	9/3/2020	6:30:00	1356	166.56
9/3/2020	9:31:00	1537.0	172.91	9/3/2020	7:30:00	1416	166.60
9/3/2020	10:31:00	1597.0	172.96	9/3/2020	8:30:00	1476	166.63
9/3/2020	11:34:00	1660.0	173.06	9/3/2020	9:30:00	1536	166.66
9/3/2020	12:31:00	1717.0	173.01	9/3/2020	10:30:00	1596	166.70
9/3/2020	13:38:00	1774.0	173.02	9/3/2020	11:30:00	1656	166.81
9/3/2020	14:30:00	1836.0	173.04	9/3/2020	12:30:00	1716	166.75
9/3/2020	15:30:00	1896.0	173.05	9/3/2020	13:30:00	1776	166.76
9/3/2020	16:30:00	1956.0	173.05	9/3/2020	14:30:00	1836	166.79
9/3/2020	17:30:00	2016.0	173.06	9/3/2020	15:30:00	1896	166.80
9/3/2020	18:30:00	2076.0	173.10	9/3/2020	16:30:00	1956	166.81
9/3/2020	19:30:00	2136.0	173.14	9/3/2020	17:30:00	2016	166.82
9/3/2020	20:30:00	2196.0	173.16	9/3/2020	18:30:00	2076	166.85
9/3/2020	21:29:00	2255.0	173.17	9/3/2020	19:30:00	2136	166.88
9/3/2020	22:29:00	2315.0	173.20	9/3/2020	20:30:00	2196	166.89
9/3/2020	23:29:00	2375.0	173.23	9/3/2020	21:32:00	2258	166.89
9/4/2020	0:27:00	2433.0	173.24	9/3/2020	22:30:00	2316	166.89
9/4/2020	1:28:00	2492.0	173.24	9/3/2020	23:30:00	2376	166.89
9/4/2020	2:27:00	2553.0	173.22	9/4/2020	0:30:00	2436	166.89
9/4/2020	3:28:00	2614.0	173.24	9/4/2020	1:30:00	2496	166.89
9/4/2020	4:28:00	2674.0	173.24	9/4/2020	2:30:00	2556	166.89
9/4/2020	5:30:00	2736.0	173.24	9/4/2020	3:30:00	2616	166.88
9/4/2020	6:30:00	2796.0	173.24	9/4/2020	4:30:00	2676	166.88
9/4/2020	7:30:00	2856.0	173.26	9/4/2020	5:30:00	2736	166.93
9/4/2020	8:30:00	2916.0	173.27	9/4/2020	6:30:00	2796	166.97
9/4/2020	9:30:00	2976.0	173.31	9/4/2020	7:30:00	2856	166.98
9/4/2020	10:30:00	3036.0	173.32	9/4/2020	8:30:00	2916	167.01
9/4/2020	11:30:00	3096.0	173.35	9/4/2020	9:30:00	2976	167.03
9/4/2020	12:30:00	3156.0	173.34	9/4/2020	10:30:00	3036	167.07
9/4/2020	13:30:00	3216.0	173.33	9/4/2020	11:30:00	3096	167.08
9/4/2020	14:32:00	3278.0	173.31	9/4/2020	12:30:00	3156	167.09
9/4/2020	15:30:00	3336.0	173.31	9/4/2020	13:30:00	3216	167.08
9/4/2020	16:30:00	3396.0	173.32	9/4/2020	14:30:00	3276	167.07
9/4/2020	17:30:00	3458.0	173.33	9/4/2020	15:30:00	3336	167.08
9/4/2020	18:30:00	3516.0	173.36	9/4/2020	16:30:00	3396	167.10

Table 4. Constant Rate Test - Drawdown and Recovery Data – Manual Gauging

Test Well				Observation Well			
Date	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)	Date	Clock Time	Elapsed Time	Depth to Water (ft bTOC)
9/4/2020	19:30:00	3576.0	173.39	9/4/2020	17:30:00	3456	167.10
9/4/2020	20:30:00	3636.0	173.43	9/4/2020	18:30:00	3516	167.11
9/4/2020	21:30:00	3696.0	173.49	9/4/2020	19:30:00	3576	167.16
9/4/2020	22:30:00	3756.0	173.49	9/4/2020	20:30:00	3636	167.20
9/4/2020	23:30:00	3816.0	173.52	9/4/2020	21:30:00	3696	167.30
9/5/2020	0:27:00	3873.0	173.57	9/4/2020	22:30:00	3756	167.25
9/5/2020	1:26:00	3932.0	173.58	9/4/2020	23:30:00	3816	167.25
9/5/2020	2:28:00	3994.0	173.59	9/5/2020	0:30:00	3876	167.25
9/5/2020		No		9/5/2020	1:30:00	3936	167.25
9/5/2020		Data		9/5/2020	2:30:00	3996	167.28
9/5/2020	5:45:00	4191.0	173.59	9/5/2020		No	
9/5/2020	6:30:00	4236.0	173.59	9/5/2020		Data	
9/5/2020	7:31:00	4297.0	173.58	9/5/2020	5:45:00	4191	167.30
9/5/2020	8:00:00	4326.0	173.61	9/5/2020	6:30:00	4236	167.30
Pump off at 0801:35 9/5/2020				9/5/2020	7:30:00	4296	167.33
9/5/2020	8:03:07	--	166.42	Pump off at 0801:35 9/5/2020			
9/5/2020	8:03:52	--	166.37	9/5/2020	7:56:00	--	167.31
9/5/2020	8:05:09	--	166.32	9/5/2020	8:02:00	--	166.92
9/5/2020	8:06:55	--	166.27	9/5/2020	8:02:24	--	166.69
9/5/2020	8:10:00	--	166.22	9/5/2020	8:02:50	--	166.49
9/5/2020	8:16:41	--	166.17	9/5/2020	8:03:20	--	166.37
9/5/2020	8:32:50	--	166.12	9/5/2020	8:04:30	--	166.27
9/5/2020	8:57:20	--	166.07	9/5/2020	8:05:22	--	166.22
9/5/2020	9:10:24	--	166.04	9/5/2020	8:07:00	--	166.18
9/5/2020	9:23:31	--	166.02	9/5/2020	8:08:50	--	166.18
9/5/2020	9:39:46	--	166.00	9/5/2020	8:12:40	--	166.11
9/5/2020	10:31:40	--	165.97	9/5/2020	8:18:05	--	166.07
9/5/2020	11:04:10	--	165.95	9/5/2020	8:26:15	--	166.05
				9/5/2020	8:35:25	--	166.02
				9/5/2020	8:48:30	--	166.00
				9/5/2020	9:02:00	--	165.97
				9/5/2020	9:08:00	--	165.95
				9/5/2020	9:39:00	--	165.90
				9/5/2020	9:43:00	--	165.85

Table 4. Constant Rate Test - Drawdown and Recovery Data – Manual Gauging

Test Well				Observation Well			
Date	Clock Time[1]	Elapsed Time	Depth to Water (ft bgs)	Date	Clock Time	Elapsed Time	Depth to Water (ft bTOC)
				9/5/2020	9:50:00	--	165.80
				9/5/2020	9:55:00	--	165.75
				9/5/2020	10:00:00	--	165.70
				9/5/2020	10:11:00	--	165.65
				9/5/2020	10:17:00	--	165.60
				9/5/2020	10:21:00	--	165.55
				9/5/2020	10:27:00	--	165.50
				9/5/2020	10:31:00	--	165.45
				9/5/2020	10:38:00	--	165.35
				9/5/2020	10:42:00	--	165.25
				9/5/2020	10:45:00	--	165.15
				9/5/2020	10:48:00	--	165.05
				9/5/2020	11:16:00	--	165.76

Notes:

1 - Central Standard Time.

bgs = below ground surface

bTOC = below top of casing

ft = feet

Table 5. Constant Rate Test – Water Quality Data

Date	Time[1]	Temp (^{0}C)	Specific Conductance (µs/cm)	pH	Tubidity (NTU)	Discharge Rate (gpm)[2]
9/2/2020	8:22	16.19	937	7.09	2.34	810
9/2/2020	8:45	16.37	944	6.82	1.63	800
9/2/2020	9:14	16.16	929	6.26	1.31	800
9/2/2020	9:50	15.00	940	6.90	1.36	805
9/2/2020	10:25	15.60	940	6.96	1.32	800
9/2/2020	10:56	16.95	951	6.88	1.53	800
9/2/2020	11:30	16.10	956	7.04	2.35	800
9/2/2020	11:56	16.47	954	6.94	1.93	800
9/2/2020	12:25	16.59	959	7.00	1.72	800
9/2/2020	12:54	16.72	963	7.01	1.85	800
9/2/2020	13:30	16.93	966	7.06	2.17	800
9/2/2020	14:01	16.76	974	7.03	1.84	800
9/2/2020	14:34	17.36	977	7.05	1.88	800
9/2/2020	15:03	17.10	979	7.02	1.82	800
9/2/2020	15:36	17.05	984	7.04	1.92	805
9/2/2020	16:05	17.55	987	7.01	1.96	805
9/2/2020	16:35	1.00	1002	7.13	2.28	805
9/2/2020	17:05	16.6	994	6.93	2.04	805
9/2/2020	17:34	16.30	1002	7.00	1.89	805
9/2/2020	18:02	15.26	1000	6.96	1.88	805
9/2/2020	18:33	15.35	998	6.94	1.89	805
9/2/2020	19:12	15.68	995	6.86	2.73	805
9/2/2020	19:37	15.58	1001	7.01	2.27	805
9/2/2020	20:08	15.11	1002	6.95	1.93	805
9/2/2020	20:35	14.85	1001	6.93	1.75	805
9/2/2020	21:09	14.53	1009	6.90	1.89	805
9/2/2020	21:36	14.72	1004	6.83	1.70	805
9/2/2020	22:04	14.76	1006	6.91	1.30	805
9/2/2020	22:35	14.30	1021	7.09	1.81	805
9/2/2020	23:03	14.17	1010	6.91	1.61	805
9/2/2020	23:33	14.15	1028	7.04	1.51	805
9/3/2020	0:05	14.26	1023	6.92	1.56	805
9/3/2020	0:34	14.21	1027	6.89	1.80	805
9/3/2020	1:34	14.21	1070	7.09	1.61	805
9/3/2020	2:34	14.35	1050	7.09	1.74	805
9/3/2020	3:33	14.18	1047	7.10	1.41	805
9/3/2020	4:32	14.14	1053	7.10	1.61	805
9/3/2020	5:35	14.23	1039	7.11	1.50	805

Table 5. Constant Rate Test – Water Quality Data

Date	Time[1]	Temp (^0C)	Specific Conductance (µs/cm)	pH	Tubidity (NTU)	Discharge Rate (gpm)[2]
9/3/2020	6:33	14.13	1062	6.98	1.73	805
9/3/2020	7:35	14.37	1070	6.99	2.01	805
9/3/2020	8:36	14.70	1076	6.97	1.94	805
9/3/2020	9:34	14.85	944	6.98	1.98	805
9/3/2020	10:37	14.99	953	7.03	2.01	805
9/3/2020	11:38	15.38	951	7.07	2.84	805
9/3/2020	12:34	15.42	967	7.10	2.14	805
9/3/2020	13:33	15.64	980	7.12	2.25	805
9/3/2020	14:34	16.53	988	7.07	2.23	805
9/3/2020	15:35	15.51	985	7.07	2.28	805
9/3/2020	16:34	15.94	996	7.09	2.38	805
9/3/2020	17:33	15.74	996	7.08	2.40	805
9/3/2020	18:34	15.90	1005	7.11	2.23	805
9/3/2020	19:35	14.10	1003	7.06	2.11	805
9/3/2020	20:33	13.77	1004	6.97	1.69	805
9/3/2020	21:35	13.50	967	6.91	1.90	805
9/3/2020	22:30	13.50	999	7.00	1.83	805
9/3/2020	23:30	13.41	993	7.12	1.81	805
9/4/2020	0:33	13.38	1012	6.98	2.12	805
9/4/2020	1:29	13.46	1020	6.95	2.21	805
9/4/2020	2:31	13.34	1021	7.01	1.76	805
9/4/2020	3:31	13.50	1032	6.91	1.63	805
9/4/2020	4:30	13.47	1025	6.97	2.14	805
9/4/2020	5:30	13.36	1035	6.95	1.97	805
9/4/2020	6:31	13.33	1041	7.02	1.81	805
9/4/2020	7:39	13.44	1048	7.04	2.22	805
9/4/2020	8:34	14.47	1471	6.64	2.39	805
9/4/2020	9:34	15.01	1228	7.01	2.77	805
9/4/2020	10:35	15.96	1253	7.04	2.38	805
9/4/2020	11:35	15.77	1256	7.09	2.38	805
9/4/2020	12:35	15.72	1261	7.10	2.15	805
9/4/2020	13:36	15.00	1255	7.10	2.55	805
9/4/2020	14:35	15.02	1268	7.07	2.63	805
9/4/2020	15:33	14.66	1273	7.06	2.80	805
9/4/2020	16:28	15.15	1280	7.12	2.81	805
9/4/2020	17:28	15.27	1280	7.10	2.68	805
9/4/2020	18:30	15.38	1286	7.08	2.60	805
9/4/2020	19:31	14.59	1266	7.07	2.16	805

Table 5. Constant Rate Test – Water Quality Data

Date	Time[1]	Temp (^{0}C)	Specific Conductance (μs/cm)	pH	Tubidity (NTU)	Discharge Rate (gpm)[2]
9/4/2020	20:32	14.29	1273	7.08	2.51	805
9/4/2020	21:32	14.06	1183	7.02	2.14	805
9/4/2020	22:32	14.05	1291	7.02	2.05	805
9/4/2020	23:30	14.14	1183	7.04	2.22	805
9/5/2020	0:27	13.87	1282	7.13	2.20	805
9/5/2020	1:27	13.81	1290	7.02	2.60	805
9/5/2020	2:31	14.15	827	6.96	2.39	805
9/5/2020	3:31	Missing Data				
9/5/2020	4:31	Missing Data				
9/5/2020	5:58	13.81	1309	7.04	2.12	805
9/5/2020	6:30	13.76	1260	7.03	2.40	805
9/5/2020	7:29	13.58	1318	6.95	2.23	805

Notes:

[1] - Central Standard Time.

[2] - Flow rates were read from a calibrated flow meter during the 72-hour test.

^{0}C = degrees Celsius

μs/cm = microsiemens per centimeter

gpm = gallons per minute

in = inches

NTU = nephelometric turbidity units

Table 6. Constant Rate Test - Pumping Rate Data

Date	Time[1]	Elapsed Time (min)	Initial Totalizer Reading (gallons)	Running Totalizer Reading (gallons)	Flow Rate, Average (gpm)[2]	Instantaneous Flow Rate (gpm)
9/2/2020	7:54	0	408,500	408,500	--	--
9/2/2020	8:05	11	408,500	417,000	850	810
9/2/2020	8:15	21	408,500	425,000	786	810
9/2/2020	8:25	31	408,500	433,000	790	800
9/2/2020	8:40	46	408,500	446,000	815	800
9/2/2020	9:02	68	408,500	463,000	801	805
9/2/2020	9:23	89	408,500	479,000	792	805
9/2/2020	9:52	118	408,500	502,500	797	805
9/2/2020	10:22	148	408,500	526,000	794	800
9/2/2020	10:52	178	408,500	550,500	798	800
9/2/2020	11:26	212	408,500	577,500	797	800
9/2/2020	11:54	240	408,500	599,500	796	805
9/2/2020	12:22	268	408,500	622,000	797	800
9/2/2020	12:52	298	408,500	645,000	794	800
9/2/2020	13:25	331	408,500	672,000	796	800
9/2/2020	13:57	363	408,500	697,000	795	800
9/2/2020	14:31	397	408,500	724,000	795	800
9/2/2020	15:01	427	408,500	748,000	795	800
9/2/2020	15:32	458	408,500	772,000	794	805
9/2/2020	16:02	488	408,500	796,500	795	805
9/2/2020	16:32	518	408,500	820,500	795	805
9/2/2020	17:01	547	408,500	843,000	794	805
9/2/2020	17:31	577	408,500	867,000	795	805
9/2/2020	17:59	605	408,500	889,000	794	805
9/2/2020	18:30	636	408,500	913,500	794	805
9/2/2020	19:05	671	408,500	941,000	794	805
9/2/2020	19:31	697	408,500	962,000	794	805
9/2/2020	20:00	726	408,500	987,000	797	805
9/2/2020	20:24	755	408,500	1,007,000	793	805
9/2/2020	20:59	785	408,500	1,032,000	794	805
9/2/2020	21:29	815	408,500	1,056,000	794	805
9/2/2020	21:59	845	408,500	1,079,500	794	805
9/2/2020	22:30	876	408,500	1,105,000	795	805
9/2/2020	23:00	906	408,500	1,128,000	794	805
9/2/2020	23:30	936	408,500	1,152,500	795	805
9/3/2020	0:00	966	408,500	1,177,700	796	805
9/3/2020	0:30	996	408,500	1,201,000	796	805

Table 6. Constant Rate Test - Pumping Rate Data

Date	Time[1]	Elapsed Time (min)	Initial Totalizer Reading (gallons)	Running Totalizer Reading (gallons)	Flow Rate, Average (gpm)[2]	Instantaneous Flow Rate (gpm)
9/3/2020	1:30	1056	408,500	1,249,000	796	805
9/3/2020	2:30	1116	408,500	1,296,000	795	805
9/3/2020	3:30	1176	408,500	1,344,000	795	805
9/3/2020	4:30	1236	408,500	1,392,000	796	805
9/3/2020	5:32	1298	408,500	1,440,000	795	805
9/3/2020	6:30	1356	408,500	1,486,000	795	805
9/3/2020	7:32	1418	408,500	1,537,000	796	805
9/3/2020	8:32	1478	408,500	1,585,000	796	805
9/3/2020	9:31	1537	408,500	1,632,000	796	805
9/3/2020	10:32	1598	408,500	1,680,000	796	805
9/3/2020	11:35	1661	408,500	1,731,000	796	805
9/3/2020	12:32	1718	408,500	1,777,000	797	805
9/3/2020	13:30	1776	408,500	1,822,500	796	805
9/3/2020	14:31	1837	408,500	1,871,000	796	805
9/3/2020	15:31	1897	408,500	1,919,000	796	805
9/3/2020	16:31	1957	408,500	1,966,500	796	805
9/3/2020	17:30	2016	408,500	2,013,500	796	805
9/3/2020	18:31	2077	408,500	2,062,000	796	805
9/3/2020	19:32	2138	408,500	2,111,000	796	805
9/3/2020	20:31	2197	408,500	2,157,500	796	805
9/3/2020	21:30	2256	408,500	2,205,500	797	805
9/3/2020	22:27	2313	408,500	2,250,500	796	805
9/3/2020	23:28	2374	408,500	2,299,000	796	805
9/4/2020	0:29	2435	408,500	2,348,000	797	805
9/4/2020	1:26	2492	408,500	2,394,000	797	805
9/4/2020	2:29	2555	408,500	2,444,000	797	805
9/4/2020	3:29	2615	408,500	2,492,000	797	805
9/4/2020	4:30	2676	408,500	2,541,000	797	805
9/4/2020	5:29	2735	408,500	2,588,000	797	805
9/4/2020	6:31	2797	408,500	2,638,000	797	805
9/4/2020	7:33	2859	408,500	2,687,000	797	805
9/4/2020	8:30	2916	408,500	2,733,000	797	805
9/4/2020	9:32	2978	408,500	2,782,000	797	805
9/4/2020	10:32	3038	408,500	2,830,000	797	805
9/4/2020	11:32	3098	408,500	2,878,000	797	805
9/4/2020	12:31	3157	408,500	2,925,000	797	805
9/4/2020	13:34	3220	408,500	2,975,000	797	805

Table 6. Constant Rate Test - Pumping Rate Data

Date	Time[1]	Elapsed Time (min)	Initial Totalizer Reading (gallons)	Running Totalizer Reading (gallons)	Flow Rate, Average (gpm)[2]	Instantaneous Flow Rate (gpm)
9/4/2020	14:33	3279	408,500	3,022,000	797	805
9/4/2020	15:31	3337	408,500	3,068,000	797	805
9/4/2020	16:31	3397	408,500	3,116,000	797	805
9/4/2020	17:31	3457	408,500	3,163,000	797	805
9/4/2020	18:31	3517	408,500	3,212,000	797	805
9/4/2020	19:29	3575	408,500	3,257,000	797	805
9/4/2020	20:35	3641	408,500	3,309,500	797	805
9/4/2020	21:36	3702	408,500	3,358,000	797	805
9/4/2020	22:35	3761	408,500	3,405,000	797	805
9/4/2020	23:26	3812	408,500	3,446,000	797	805
9/5/2020	0:29	3875	408,500	3,495,500	797	805
9/5/2020	1:28	3934	408,500	3,543,000	797	805
9/5/2020	2:36	4002	408,500	3,597,000	797	805
9/5/2020	3:36	4062	408,500	No data	--	--
9/5/2020	4:36	4122	408,500	No data	--	--
9/5/2020	5:53	4199	408,500	3,755,000	797	805
9/5/2020	6:36	4241	408,500	3,789,500	797	805
9/5/2020	7:32	4298	408,500	3,834,000	797	805
9/5/2020	8:01	4327	408,500	3,857,500	797	805

Notes:

[1] - Central Standard Time.

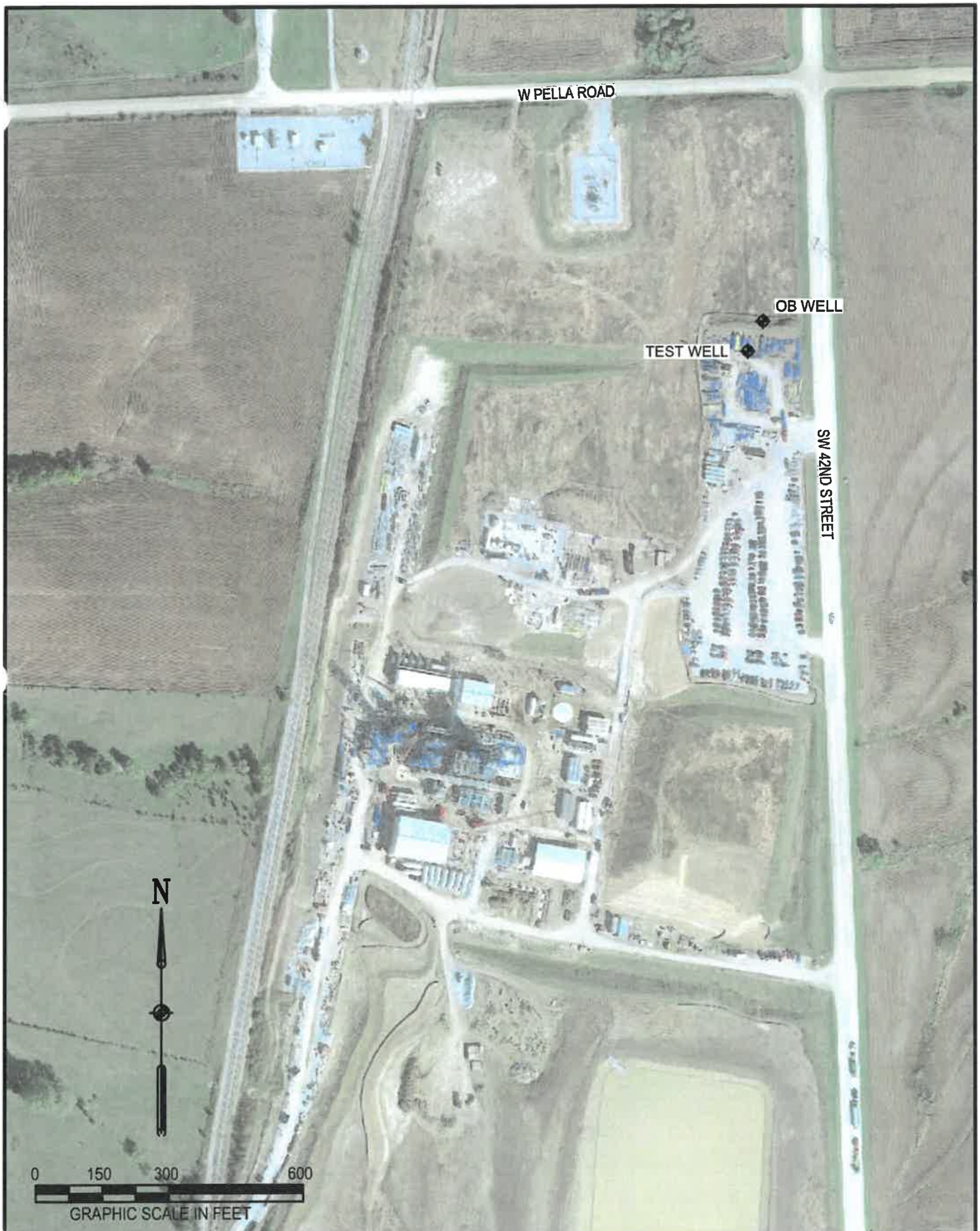
[2] - Running gallons minus initial gallons/elapsed time

gpm = gallons per minute

in = inches

min = minutes

FIGURE



EA Engineering, Science, and Technology, Inc., PBC

FIGURE 1
SITE MAP

FILE PATH: DR... DWG [8.5X11 VERTICAL REPORT] MATHER, JASON 9/15/2020 4:59 PM

ATTACHMENT 1

WELL INSTALLATION RECORDS

1a. Well Boring Logs and Construction Diagrams

1b. Well Development Forms

1c. Well Permit

ATTACHMENT 1a

Well Boring Logs and Construction Diagrams

EA Engineering, Science and, Technology, Inc., PBC

BORING LOG

PROJECT: Monolith	BORING DEPTH: 315 ft bgs	BORING NO.: Observation Well
EA PROJECT #: 1602602	SURFACE ELEV: TBD	DATE DRILLED: 6/30/2020 - 7/01/2020
DRILLING CO.: GeoSpec Drilling	NORTHING: TBD	BORING METHOD: Rotary
DRILLER: Bill Christopherson	EASTING: TBD	TYPE OF SURFACE: Pasture
GEOLOGIST: Dave Cookston	DEPTH TO WATER: 161.41 ft bTOC; 8/26/2020	

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
5			10YR5/2	CL	Silty clay, moist, firm, low plasticity, blocky, Fe stains, manganese	Grab				
10			10YR5/2	CL	Silty clay, moist, firm, med plasticity, blocky, Fe stains, manganese	Grab				
15			10YR5/2	CL	Silty clay, moist, firm, med plasticity, blocky, Fe stains, manganese	Grab				
			10YR5/1	CL	Silty clay, (Till), moist, hard, med plasticity, blocky, $CaCO_3$, nodules, Fe stains, manganese	Grab				
20			10YR5/2	CL	Silty clay, (Till), moist, hard, med plasticity, blocky, CaCO3, nodules, Fe stains, manganese, trace coarse gravel	Grab				
25										

EA Engineering, Science and, Technology, Inc., PBC

BORING LOG

PROJECT:	Monolith	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Observation Well
EA PROJECT #:	1602602	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	**NORTHING:**	TBD	**BORING METHOD:**	Rotary
DRILLER:	Bill Christopherson	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
30			10YR5/1	CL	Silty clay, (Till), moist, hard, med plasticity, blocky, Fe stains, manganese, trace fine sand	Grab				
35										
40			10YR6/2	CL	Silty clay, (Till), moist, hard, med plasticity, blocky, trace $CaCO_3$, Fe stains, manganese, fine to coarse sand 20%	Grab				
45										
50										

EA Engineering, Science and, Technology, Inc., PBC

BORING LOG

PROJECT: Monolith	**BORING DEPTH:** 315 ft bgs	**BORING NO.:** Observation Well	
EA PROJECT #: 1602602	**SURFACE ELEV:** TBD	**DATE DRILLED:** 6/30/2020 - 7/01/2020	
DRILLING CO.: GeoSpec Drilling	**NORTHING:** TBD	**BORING METHOD:** Rotary	
DRILLER: Bill Christopherson	**EASTING:** TBD	**TYPE OF SURFACE:** Pasture	
GEOLOGIST: Dave Cookston	**DEPTH TO WATER:** 161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
55			10YR6/2	CL	Silty clay, (till), moist, hard, med plasticity, blocky, Fe stains, fine to coarse sand, in matrix.	Grab				
60			10YR6/2	CL	Silty clay, (till), moist, hard, med plasticity, blocky, Fe stains, fine to coarse sand, in matrix.	Grab				
65										
70			10YR6/2	CL	Silty clay, (till), moist, hard, med to high plasticity, blocky, Fe stains, fine to coarse sand, in matrix, trace fine gravel	Grab				
75										

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BORING LOG

PROJECT:	Monolith	BORING DEPTH:	315 ft bgs	BORING NO.:	Observation Well
EA PROJECT #:	1602602	SURFACE ELEV:	TBD	DATE DRILLED:	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	NORTHING:	TBD	BORING METHOD:	Rotary
DRILLER:	Bill Christopherson	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
80										
			2.5YR4/1	CL	Silty clay, (till), moist, very hard, high plasticity, blocky, trace of fine sand	Grab				
85										
90					Hard drilling					
			10YR6/2	CL	Silty clay, (till), moist, very hard, high plasticity, blocky, Fe stains, manganese, fine to med sand in matrix.	Grab				
95										
					Hard drilling.					
100										

EA Engineering, Science and, Technology, Inc., PBC

BORING LOG

PROJECT: Monolith	BORING DEPTH: 315 ft bgs	BORING NO.: Observation Well	
EA PROJECT #: 1602602	SURFACE ELEV: TBD	DATE DRILLED: 6/30/2020 - 7/01/2020	
DRILLING CO.: GeoSpec Drilling	NORTHING: TBD	BORING METHOD: Rotary	
DRILLER: Bill Christopherson	EASTING: TBD	TYPE OF SURFACE: Pasture	
GEOLOGIST: Dave Cookston	DEPTH TO WATER: 161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			2.5Y4/1	CL	Silty clay, (till), moist, very hard, high plasticity, blocky, fine to coarse sand in matrix	Grab				
105										
110			2.5Y4/1	CL	Silty clay, (till), moist, hard, high plasticity, blocky, Fe stains, fine to med sand in matrix.	Grab				
115										
120			2.5Y5/1	CL	Silty clay, (till), moist, firm, high plasticity, blocky, fine to med sand in matrix.	Grab				
125										

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BORING LOG

PROJECT:	Monolith	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Observation Well
EA PROJECT #:	1602602	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	**NORTHING:**	TBD	**BORING METHOD:**	Rotary
DRILLER:	Bill Christopherson	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
130			2.5Y4/1	CL	Silty clay, (till), moist, firm, high plasticity, blocky, fine to med sand in matrix.	Grab				
135										
140			2.5Y4/1	CL	Silty clay, (till), moist, firm, high plasticity, blocky, fine to med sand, 40-60%	Grab				
145										
			2.5Y4/1	SC	Clayey sand, very moist, loose fine to med grained 60-80% sand, grains are angular, 40-60% silty clay	Grab				
150										

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BORING LOG

PROJECT:	Monolith	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Observation Well
EA PROJECT #:	1602602	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	**NORTHING:**	TBD	**BORING METHOD:**	Rotary
DRILLER:	Bill Christopherson	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			2.5Y5/1	SP	Sand, poorly graded, loose, slight wet, fine to med grained, grains are angular	Grab				
155			10YR6/2	SS/SM	Sandstone, loosely cemented, moist, fine grained, silty sand, trace fine gravel	Grab				
160										
			2.5Y4/1	CL/SC	Silty clay w/interbedded clayey sand, moist to wet, soft, blocky, fine to coarse sand, trace coarse gravel, grains are angular in shape.	Grab				
165										
170										
175										

EA Engineering, Science and, Technology, Inc., PBC

BORING LOG

PROJECT: Monolith	BORING DEPTH: 315 ft bgs	BORING NO.: Observation Well	
EA PROJECT #: 1602602	SURFACE ELEV: TBD	DATE DRILLED: 6/30/2020 - 7/01/2020	
DRILLING CO.: GeoSpec Drilling	NORTHING: TBD	BORING METHOD: Rotary	
DRILLER: Bill Christopherson	EASTING: TBD	TYPE OF SURFACE: Pasture	
GEOLOGIST: Dave Cookston	DEPTH TO WATER: 161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
180										
			2.5Y5/1	SP	Sand, wet, loose, fine to med grained, well rounded, manganese	Grab				
185										
			2.5Y4/1	SP/GP	Sand and gravel, wet, loose fine to coarse sand, fine to med gravel, manganese, trace of chert in gravel.	Grab				
190										
195										
200										

EA Engineering, Science and, Technology, Inc., PBC

BORING LOG

PROJECT:	Monolith	BORING DEPTH:	315 ft bgs	BORING NO.:	Observation Well
EA PROJECT #:	1602602	SURFACE ELEV:	TBD	DATE DRILLED:	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	NORTHING:	TBD	BORING METHOD:	Rotary
DRILLER:	Bill Christopherson	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			2.5Y4/1	SP	Sand, wet, loose, fine grained, well rounded, trace coarse sand with trace fine gravel, manganese	Grab				
205			2.5Y4/1	SP	Sand, wet, loose, poorly graded, fine grained, manganese	Grab				
210										
215			2.5Y4/1	SP	Sand, wet, loose, poorly graded, fine grained, well rounded, manganese, trace fine gravel	Grab				
220										
225										

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BORING LOG

PROJECT:	Monolith	BORING DEPTH:	315 ft bgs	BORING NO.:	Observation Well
EA PROJECT #:	1602602	SURFACE ELEV:	TBD	DATE DRILLED:	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	NORTHING:	TBD	BORING METHOD:	Rotary
DRILLER:	Bill Christopherson	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
230										
235			2.5Y4/1	SP	Sand, wet, loose, fine grained, well rounded, manganese	Grab				
240			2.5Y4/1	SW	Sand, wet, loose, fine to coarse grained, well rounded, manganese	Grab				
245										
250										

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BORING LOG

PROJECT:	Monolith	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Observation Well
EA PROJECT #:	1602602	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	**NORTHING:**	TBD	**BORING METHOD:**	Rotary
DRILLER:	Bill Christopherson	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			2.5Y5/1	SW	Sand, wet, loose, fine to coarse grained, well rounded, manganese	Grab				
255										
260			2.5Y5/1	SW	Sand, loose, wet, fine to coarse grained, well rounded, manganese	Grab				
265										
270			2.5Y5/1	SW/GP	Sand and gravel, wet, fine to coarse sand, fine gravel, well rounded, manganese	Grab				
275										

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BORING LOG

PROJECT:	Monolith	BORING DEPTH:	315 ft bgs	BORING NO.:	Observation Well
EA PROJECT #:	1602602	SURFACE ELEV:	TBD	DATE DRILLED:	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	NORTHING:	TBD	BORING METHOD:	Rotary
DRILLER:	Bill Christopherson	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
280			2.5Y5/1	SW	Sand, wet, loose, fine to coarse grained, well rounded, manganese	Grab				
285			2.5Y5/1	SW	Sand, wet, loose, fine to coarse grained, trace fine gravel, well rounded, small silty clay nodules in matrix, well rounded, manganese	Grab				
290										
295										
300										

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BORING LOG

PROJECT:	Monolith	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Observation Well
EA PROJECT #:	1602602	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	6/30/2020 - 7/01/2020
DRILLING CO.:	GeoSpec Drilling	**NORTHING:**	TBD	**BORING METHOD:**	Rotary
DRILLER:	Bill Christopherson	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	161.41 ft bTOC; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			2.5Y5/1	SP	Sand, wet, loose, fine grained, well rounded, manganese	Grab				
305										
310			2.5Y5/1	SW	DC sand, wet, loose, fine to coarse grained, trace fine gravel, well rounded, manganese	Grab				
315					BOH@315' Drilling mud weight at end = 8.4 Viscosity = 32.20 sec 28oz.					
320										
325										

Project Name/ Project Number: Monolith #1602602
Start Date: ~~6/30/2020~~ 7/6/2020
Completion Date:
Well ID: Observation
Drilling Method: ~~X-XX-XXXX~~ Rotary
Depth to Water (FT TOC):
Driller Name, Company and Registration #: Bill Christopherson/GeoSpec/ 39333
Geologist Name: Dave Cookston/Travis Herman

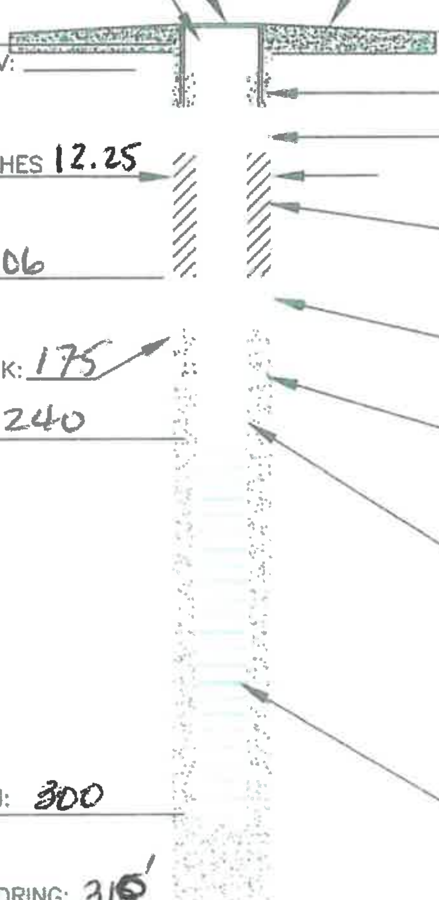
NOTES: 1. ALL MEASUREMENTS ARE IN FEET BELOW GROUND SURFACE UNLESS OTHERWISE INDICATED
2. ALL FEATURES NOT TO SCALE

TOP OF PROTECTIVE COVER ELEV:

TYPE OF CAP:
- ☐ J-PLUG
- ☒ PVC SLIP CAP
- ☐ WELL SEAL

SLOPED PAD AND TYPE OF MATERIAL:
- ☒ GRASS
- ☐ ASPHALT
- ☐ CONCRETE
- ☐ OTHER

GROUND SURFACE ELEV:
- ☒ GRASS
- ☐ ASPHALT
- ☐ CONCRETE
- ☐ OTHER



TOP OF CASING ELEV:

GRAVEL BLANKET

LENGTH OF SOLID RISER: ______ FT

DIAMETER OF BORE HOLE: INCHES 12.25

TOP OF SEAL: 106

TOP OF FILTER PACK: 175

TOP OF SCREEN: 240

LENGTH OF SCREEN: 60 FT

BOTTOM OF SCREEN: 300

TOTAL DEPTH OF BORING: 310'

BENTONITE SEAL INFORMATION:
TYPE:
DEPTH: ______ TO ______

GROUT INFORMATION:
TYPE: WYO-Ben Enviroplug Medium
RATIO:
DEPTH: 106 TO 3.5

BENTONITE SEAL INFORMATION:
TYPE: WYO-Ben Enviroplug Medium
DEPTH: 175 TO 106.

FILTERPACK MATERIAL:
TYPE: Filter Sil 0.75
DEPTH: 310 TO 175
BACKFILL METHOD: Freefall

RISER INFORMATION:
DIAMETER: 6"
SCHEDULE: SDR-21
MATERIAL: PVC
DEPTH: 0' TO 240'

SCREEN INFORMATION:
DIAMETER: 6"
SLOT SIZE: 0.025 1/8" Spacing.
SCHEDULE: SDR-21 Sch 40
MATERIAL: PVC
LENGTH: 60 ft. 240'-300'
TYPE OF PIPE JOINTS: Glued Joints

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR4/2	CL	Silty clay, soft, moist, low plasticity, non-cohesive, thickly bedded, blocky, MOU, trace uniform fine sand <5%, Eolian, Peorian, sharp					
5			10YR4/3	CL	Silty clay, medium, low plasticity, non-adhesive, thickly bedded, blocky, Fe stains, manganese, MOU2, few uniform, fine sand, resedimentation, subjugated, Kansan Till, sharp.					
10			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, med sands, resedimented subglacial, Kansan Till					
15			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, med sand, resedimented, subglacial, Kansan Till, Fe stains					
20			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, med sand (17%), resedimented, subglacial, Kansan Till, Fe stains					
25										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	BORING DEPTH:	315 ft bgs	BORING NO.:	Test Well 1R
EA PROJECT #:	1602602 / 0002	SURFACE ELEV:	TBD	DATE DRILLED:	8/11-17/2020
DRILLING CO.:	Cahoy	NORTHING:	TBD	BORING METHOD:	Reverse Rotary
DRILLER:	Austin / Kenny	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, coarse sand (4%), resedimented, subglacial, Kansan Till, Fe stains					
30			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, coarse sand (7%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
35			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, coarse sand (7%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
40			10YR5/3	CL	Silty clay, stiff, moist, med plasticity, massive, blocky, MOU2, few non-uniform, med to coarse sand (8%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
45			10YR5/3	CL	Silty clay, very stiff, med plasticity, massive, blocky, MOU2, few non-uniform, med sand (8%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
50										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR5/3	CL	Silty clay, very stiff, med plasticity, massive, blocky, MOU2, few non-uniform, med sand (7%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
55			10YR5/3	CL	Silty clay, very stiff, med plasticity, massive, blocky, MOU2, few non-uniform, med sand (7%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
60			10YR4/4	CL	Silty clay, hard, mottled, 1/4 inch nodules of varying colors, moist, low plasticity, non-uniform, MOU2, coarse sand (22%), resedimented, subglacial, Kansan Till, Fe stains, manganese					
65			10YR5/3	CL	Silty clay, hard, low plasticity, massive, blocky, JOU2, few non-uniform, fine sand (6%), resedimentation, Kansan Till, Fe stains, manganese					
70			10YR7/2	CL	Silty clay, hard, low plasticity, massive, blocky, JOU2, few non-uniform, fine sand (6%), resedimentation, subglacial, Fe stains, manganese					
75										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR5/3	CL	Silty clay, hard, low plasticity, moist, massive, blocky, JOU2, few non-uniform, fine sand (6%), resedimentation, subglacial, Fe stains, manganese, Kansan till					
80			10YR4/?	CL	Silty clay, hard, low plasticity, moist, massive, blocky, JOU2, few non-uniform, fine sand (6%), resedimentation, subglacial, Nebraskan till, sharp					
85			10YR3/1	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, few uniform, coarse sand (6%), resedimentation, subglacial, Nebraskan till					
90			10YR4/1	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform sand (3%), resedimentation, subglacial with fine root structures, Nebraskan till, gradational					
95			10YR3/1	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (4%), resedimentation, subglacial, Nebraskan till					
100										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (4%), resedimentation, subglacial, Nebraskan till					
105			10YR2/2	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (4%), resedimentation, subglacial, Nebraskan till					
110			10YR2/2	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, sand (3%), resedimentation, subglacial, Nebraskan till					
115			10YR2/2	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, sand (3%), resedimentation, subglacial, Nebraskan till					
120			10YR2/2	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, sand (3%), resedimentation, subglacial, Nebraskan till					
125										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	BORING DEPTH:	315 ft bgs	BORING NO.:	Test Well 1R
EA PROJECT #:	1602602 / 0002	SURFACE ELEV:	TBD	DATE DRILLED:	8/11-17/2020
DRILLING CO.:	Cahoy	NORTHING:	TBD	BORING METHOD:	Reverse Rotary
DRILLER:	Austin / Kenny	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	CL	Silty clay, hard, med plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (3%), resedimentation, subglacial, Nebraskan till					
130			10YR2/2	CH	Clay, hard, high plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (3%), resedimentation, subglacial, Nebraskan till					
135			10YR2/2	CH	Clay, hard, high plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (2%), resedimentation, subglacial, Nebraskan till					
140			10YR2/2	CH	Clay, hard, high plasticity, moist, massive, blocky, JOU2, trace uniform, fine sand (2%), resedimentation, subglacial, Nebraskan till					
145			10YR2/2	SP	Sand, very loose, med granular, moist, non-plastic, thinly bedded, granular, UU2, uniform sand (100%), fluvial, glacial fluvial, Nebraskan till					
			10YR2/2	SC	Clayey sand, med dense, fine to coarse sand, moist, non-plastic, thickly bedded, granular, UU2, some non-uniform coarse sand (60%), resedimentation, subglacial, Nebraskan till					
150										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	SW	Sand, loose, fine to coarse sand with trace coarse gravel, very moist, non-plastic, non-cohesive, thickly bedded, granular UU2, some non-uniform coarse sand (59%), fluvial, glacial fluvial, Nebraskan till					
155			10YR2/2	SW	Sand, loose, fine to coarse sand with trace coarse gravel, very moist, non-plastic, non-cohesive, thickly bedded, granular UU2, some non-uniform coarse sand (59%), fluvial, glacial fluvial, Nebraskan till					
160			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
165			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
170			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
175										

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BORING LOG

PROJECT: Monolith - Test Well 1R	**BORING DEPTH:** 315 ft bgs	**BORING NO.:** Test Well 1R	
EA PROJECT #: 1602602 / 0002	**SURFACE ELEV:** TBD	**DATE DRILLED:** 8/11-17/2020	
DRILLING CO.: Cahoy	**NORTHING:** TBD	**BORING METHOD:** Reverse Rotary	
DRILLER: Austin / Kenny	**EASTING:** TBD	**TYPE OF SURFACE:** Pasture	
GEOLOGIST: Dave Cookston	**DEPTH TO WATER:** 163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	SP	Sand, very loose, med granular, moist, non-plastic, thinly bedded, granular, UU2, uniform sand (100%), fluvial, glacial fluvial, Nebraskan till					
180			10YR2/2	SP	Sand, very loose, med granular, moist, non-plastic, thinly bedded, granular, UU2, uniform sand (100%), fluvial, glacial fluvial, Nebraskan till					
185			10YR2/2	SP	Sand, very loose, med granular, moist, non-plastic, thinly bedded, granular, UU2, uniform sand (100%), fluvial, glacial fluvial, Nebraskan till					
190			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
195			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
200										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
205			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
210			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
215			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
220			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
225										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	BORING DEPTH:	315 ft bgs	BORING NO.:	Test Well 1R
EA PROJECT #:	1602602 / 0002	SURFACE ELEV:	TBD	DATE DRILLED:	8/11-17/2020
DRILLING CO.:	Cahoy	NORTHING:	TBD	BORING METHOD:	Reverse Rotary
DRILLER:	Austin / Kenny	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
230			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
235			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
240			10YR2/2	SP	Sand, very loose, med granular, moist, non-plastic, thinly bedded, granular, UU2, uniform sand (100%), fluvial, glacial fluvial, Nebraskan till					
245			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
250										

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BORING LOG

PROJECT: Monolith - Test Well 1R		**BORING DEPTH:** 315 ft bgs		**BORING NO.:** Test Well 1R	
EA PROJECT #: 1602602 / 0002		**SURFACE ELEV:** TBD		**DATE DRILLED:** 8/11-17/2020	
DRILLING CO.: Cahoy		**NORTHING:** TBD		**BORING METHOD:** Reverse Rotary	
DRILLER: Austin / Kenny		**EASTING:** TBD		**TYPE OF SURFACE:** Pasture	
GEOLOGIST: Dave Cookston		**DEPTH TO WATER:** 163.30 ft bgs; 8/26/2020			

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
255			10YR2/2	CH	Clay, stiff, wet, cohesive, massive, blocky, UU2, trace fine sand (3%), resedimentation, subglacial, Nebraskan till					
260			10YR2/2	SW	Sand, loose, fine to coarse grained, wet, non-plastic, non-cohesive, bedded, granular, UU2, some non-uniform coarse sand, fluvial, resedimentation, resediment sediment flow, sharp.					
265			10YR2/2	SC	Clayey sand, fine to coarse grained, wet, low plasticity, non-cohesive, massive, granular, little non-uniform, coarse sand, fluvial, resedimented, sediment flow.					
270			10YR2/2	SC	Clayey sand, fine to coarse grained, wet, low plasticity, non-cohesive, massive, granular, little non-uniform, coarse sand, fluvial, resedimented, sediment flow.					
275										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	BORING DEPTH:	315 ft bgs	BORING NO.:	Test Well 1R
EA PROJECT #:	1602602 / 0002	SURFACE ELEV:	TBD	DATE DRILLED:	8/11-17/2020
DRILLING CO.:	Cahoy	NORTHING:	TBD	BORING METHOD:	Reverse Rotary
DRILLER:	Austin / Kenny	EASTING:	TBD	TYPE OF SURFACE:	Pasture
GEOLOGIST:	Dave Cookston	DEPTH TO WATER:	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	SC	Clayey sand, fine to coarse grained, wet, low plasticity, non-cohesive, massive, granular, little non-uniform, coarse sand, fluvial, resedimented, sediment flow.					
280			10YR2/2	SC	Clayey sand, fine to coarse grained, wet, low plasticity, non-cohesive, massive, granular, little non-uniform, coarse sand, fluvial, resedimented, sediment flow.					
285			10YR2/2	SW	Sand, med dense, fine to coarse sand with trace coarse gravel, wet, non-plastic, non-cohesive, thickly bedded, granular, UU2, some non-uniform fine gravel (29%), fluvial, resedimented sediment flow					
290			10YR2/2	SW	Sand, med dense, fine to coarse sand with trace coarse gravel, wet, non-plastic, non-cohesive, thickly bedded, granular, UU2, some non-uniform fine gravel (29%), fluvial, resedimented sediment flow					
295			10YR2/2	SW	Sand, med dense, fine to coarse sand with trace coarse gravel, wet, non-plastic, non-cohesive, thickly bedded, granular, UU2, some non-uniform fine gravel (29%), fluvial, resedimented sediment flow					
300										

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BORING LOG

PROJECT:	Monolith - Test Well 1R	**BORING DEPTH:**	315 ft bgs	**BORING NO.:**	Test Well 1R
EA PROJECT #:	1602602 / 0002	**SURFACE ELEV:**	TBD	**DATE DRILLED:**	8/11-17/2020
DRILLING CO.:	Cahoy	**NORTHING:**	TBD	**BORING METHOD:**	Reverse Rotary
DRILLER:	Austin / Kenny	**EASTING:**	TBD	**TYPE OF SURFACE:**	Pasture
GEOLOGIST:	Dave Cookston	**DEPTH TO WATER:**	163.30 ft bgs; 8/26/2020		

DEP. (FT)	ELEV (FT)	WELL CONST.	COLOR	USCS CODE	GEOLOGIC DESCRIPTION	SAMPLE METHOD	LENGTH (IN.)	% RE-COVERY	BLOW COUNT	LAB DATA
			10YR2/2	SW	Sand, med dense, fine to coarse sand with trace coarse gravel, wet, non-plastic, non-cohesive, thickly bedded, granular, UU2, some non-uniform fine gravel (29%), fluvial, resedimented sediment flow					
305			10YR2/2	SW	Sand, med dense, fine to coarse sand with trace coarse gravel, wet, non-plastic, non-cohesive, thickly bedded, granular, UU2, some non-uniform fine gravel (29%), fluvial, resedimented sediment flow					
310			10YR2/2	SW	Sand, med dense, fine to coarse sand with trace coarse gravel, wet, non-plastic, non-cohesive, thickly bedded, granular, UU2, some non-uniform fine gravel (29%), fluvial, resedimented sediment flow					
315					BOH @ 315					
320										
325										

Project Name/ Project Number: 1602602/0002
Monolith - Test Well 2nd Attempt

Start Date: 8/17/2020

Completion Date: 8/20/2020

Well ID: Test Well

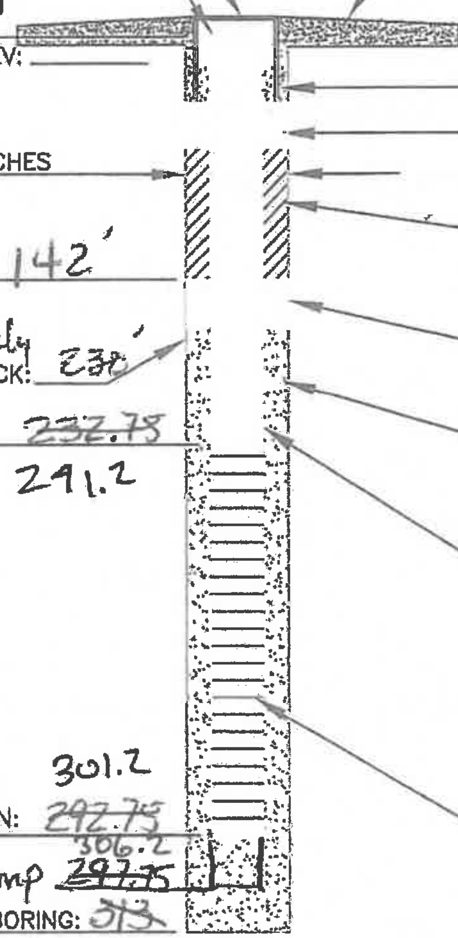
Drilling Method: Reverse Rotary

Depth to Water (FT TOC):

Driller Name, Company and Registration #: Austin / Kenny Cahoy

Geologist Name: David Cookston

NOTES:
1. ALL MEASUREMENTS ARE IN FEET BELOW GROUND SURFACE UNLESS OTHERWISE INDICATED
2. ALL FEATURES NOT TO SCALE



TOP OF PROTECTIVE COVER ELEV: ______

TYPE OF CAP: ______
- ☐ J-PLUG
- ☐ PVC SLIP CAP
- ✓ Welded cap

SLOPED PAD AND TYPE OF MATERIAL:
- ☑ GRASS
- ☐ ASPHALT
- ☐ CONCRETE
- ☐ OTHER

GROUND SURFACE ELEV: ______
- ☑ GRASS
- ☐ ASPHALT
- ☐ CONCRETE
- ☐ OTHER

TOP OF CASING ELEV: ______

GRAVEL BLANKET

LENGTH OF SOLID RISER

DIAMETER OF BORE HOLE: ______ INCHES

______ FT

~~TOP OF~~ SEAL: 142'

approximately
TOP OF FILTER PACK: 230'

TOP OF SCREEN: ~~232.75~~ 241.2

LENGTH OF SCREEN

60 FT

BOTTOM OF SCREEN: ~~292.75~~ 301.2

Bottom of Sump ~~297.75~~ 306.2

TOTAL DEPTH OF BORING: ~~313~~ 307.4

~~BENTONITE SEAL INFORMATION:~~
~~TYPE: ______~~
~~DEPTH: ______ TO ______~~

~~GROUT INFORMATION:~~
~~TYPE: ______~~
~~RATIO: ______~~
~~DEPTH: ______ TO ______~~

BENTONITE SEAL INFORMATION:
TYPE: Bentonite Chip
DEPTH: Surface TO 138 bgl

FILTERPACK MATERIAL:
TYPE: 6/9
DEPTH: 230 TO 297.75
BACKFILL METHOD: Airlift

RISER INFORMATION:
DIAMETER: 12 inch
SCHEDULE: Carbon Steel
MATERIAL: Carbon Steel
DEPTH: +1 ft. TO 232.75 ft below ground level

SCREEN INFORMATION:
DIAMETER: 12 inch
SLOT SIZE: 0.050
SCHEDULE: ______
MATERIAL: Stainless Steel
LENGTH: 60 feet
TYPE OF PIPE JOINTS: Welded

ATTACHMENT 1b

Well Development Forms

EA Engineering, Science, and Technology, Inc., PBC

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith	Project No: 1602602	Date: 7-14-2020
EA Personnel: Travis H.	Development Method: Purge	
Weather/Temperature/Barometric Pressure: Cloudy / 72°F / 29.77 in Hg		Time: 0750

Well No.:	Well Condition: New
Well Diameter: ~~[illegible]~~	Measurement Reference:

Well Volume Calculations	
A. Depth To Water (ft): 135.5	D. Well Volume/ft:
B. Total Well Depth (ft): TOC @ 301 ft.	E. Total Well Volume (gal)[C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0755	~~0800~~ 0805	~~0810~~ 0815	~~0815~~ 0820	0825	0830
Depth to Water (ft)	135.5					
Purge Rate (gpm)	~~20~~	~~20~~	20	20	20	20
Volume Purged (gal)	0		~~20~~ N/A	100	200	300
pH	7.05	7.99	7.35	7.36	7.27	7.25
Temperature (°F)	15.56	15.24	16.72	16.18	16.43	16.65
Conductivity (µmhos/cm)	3.658	5.780	1.047	0.960	0.933	0.905
Dissolved Oxygen (%)	32.0 %	21.4	17.6	15.0	17.9	16.8
Turbidity (NTU)	-114	-108	-100	-71	Over range	Over range
ORP (mV)	238.2	219.4	224.6	225.2	223.0	219.2

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	11 Volumes End
Time (min)	0835	0840	0845	0850	0855 *	~~0900~~ 1115
Depth to Water (ft)						
Purge Rate (gpm)	20	20	20	20	20	20
Volume Purged (gal)	400	500	600	700	800	~~900~~ ~~[illegible]~~ ~~[illegible]~~ 4,000 gal
pH	7.17	7.28	7.37	7.25	7.19	7.01
Temperature (°F)	17.08	17.47	17.51	17.04	17.52	17.00
Conductivity (µmhos/cm)	0.877	0.870	0.871	0.853	0.848	0.793
Dissolved Oxygen	24.2	27.4	24.8	21.5	16.1	32.4
Turbidity (NTU)	Over range	3744 AV	Over range	3900 AV	4003 AV	1733 AV
ORP (mV)	213.9	205.7	209.3	199.1	185.5	51.1

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

Well Volume Calculations: 2" = 0.163 gal/ft 4" = 0.653 gal/ft 6" = 1.1469 gal/ft

COMMENTS AND OBSERVATIONS: * Water flow is surging up + down to start 0755 to 0815. Flow adjusted to constant 20 gpm @ 0815.
* Pump stopped @ 0855 to surge pump inside casing + re-start. Continuing surging at pumping level of approx 225 ft. bgs. until improvement in flow/turbidity is seen.

EA Engineering, Science, and Technology, Inc., PBC

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith	Project No:	Date: 7-14-2020
EA Personnel: Dave C. / Travis H.	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:

Parameter	12 Vol ~~Beginning~~	13 Vol ~~1 Volume~~	14 Vol ~~2 Volumes~~	15 Vol ~~3 Volumes~~	16 Vol ~~4 Volumes~~	17 Vol ~~5 Volumes~~
Time (min)	1130	1200	1230	1300	1330	1400
Depth to Water (ft)						
Purge Rate (gpm)	20	20	20	20	20	20
Volume Purged (gal)	4300	4900	5500	6100	6700	7300
pH	7.15	7.62	7.33	7.56	7.48	7.51
Temperature (°F)	17.62	17.98	18.31	17.77	17.76	17.93
Conductivity (µmhos/cm)	0.794	0.794	0.790	0.789	0.782	0.786
Dissolved Oxygen	37.4	42.0	22.3	35.5	33.8	31.6
Turbidity (NTU)	1695 AU	1355 AU	1315AU	850 AU	662 AU	38 NTU
ORP (mV)	36.9	42.7	71.4	51.2	59.4	60.6

Parameter	18 Vol ~~6 Volumes~~	19 Vol ~~7 Volumes~~	20 Vol ~~8 Volumes~~	21 Vol ~~9 Volumes~~	22 Vol ~~10 Volumes~~	23 Vol ~~End~~
Time (min)	1430	1500	1530	1600	1630	1700
Depth to Water (ft)						
Purge Rate (gpm)	20	20	20	20	20	20
Volume Purged (gal)	7900	8500	9100	9700	10300	10900
pH	7.47	7.59	7.57	7.45	7.53	7.53
Temperature (°F)	18.19	17.85	17.91	17.31	17.77	17.69
Conductivity (µmhos/cm)	0.786	0.784	0.783	0.780	0.781	0.782
Dissolved Oxygen	35.3	34.8	32.6	25.0	24.4	24.8
Turbidity (NTU)	67.6 NTU	46.8 NTU	30.2 NTU	22.3 NTU	16.8 NTU	14.1 NTU
ORP (mV)	51.7	51.6	57.1	56.3	53.1	55.4

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FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith	Project No:	Date: 7-14-2020 + 7-16-2020
EA Personnel: Dave C. / Travis H.	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:

* Raise pump 5 feet.

Parameter	~~Beginning~~ 24 Vol	~~1 Volume~~ 25 Vol 7/16/20	2 Volumes 1320	3 Volumes	4 Volumes	* 5 Volumes
Time (min)	1730	1309	1320	1335	1350	1405
Depth to Water (ft)						
Purge Rate (gpm)	20	20	25			
Volume Purged (gal)	11500					
pH	7.51	7.16	7.74	7.88	7.95	8.02
Temperature (°F)	17.27	19.77	19.26	18.31	18.56	18.58
Conductivity (µmhos/cm)	0.780	0.917	0.862	0.836	0.836	0.818
Dissolved Oxygen	28.2	10.74	9.74	10.76	9.73	10.31
Turbidity (NTU)	11.78 NTU	1213 AU	49 NTU	67.7 NTU	68.5 NTU	63 NTU
ORP (mV)	55.2	193.3		120.2	96.3	79.3

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	* Raise 5 ft. ~~10 Volumes~~	~~End~~
Time (min)	1420 *	1435	1450	1505 *	1520	1535
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH	8.03	8.14	8.10	8.10	8.14	8.15
Temperature (°F)	18.52	19.43	18.31	18.72	19.06	18.82
Conductivity (µmhos/cm)	0.808	0.808	0.803	0.801	0.797	0.795
Dissolved Oxygen	10.20	10.06	10.44	9.97	10.27	10.65
Turbidity (NTU)	56.1 NTU	56.8	65.3	58.8	34.3 NTU	36.8
ORP (mV)	73.7	68.0	64.1	61.3	51.8	44.1

* record for 7/16/2020 continued on page 4.

Notes =>

* At 1400, pump was raised up 5 feet, Continue pumping/airlift development.

* At 1425, stop pump/airlift + allow well to rest/settle for 5-10 min. After, continue pumping/airlift procedures.

1435 - Restart pump/airlift procedure; collect sample.

* 1510, raise pump up another 5 feet + continue airlift/pumping development.

EA Engineering, Science, and Technology, Inc., PBC

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith OB Well	Project No: 1602602/6002		Date: 7-16-2020
EA Personnel: Travis H. / Dave C	Development Method: purge /airlift.		
Weather/Temperature/Barometric Pressure: Sunny, Breezy, 88°F, 30.03"			Time: 1610

Well No.:	Well Condition: New
Well Diameter: 6"	Measurement Reference:

~~1445~~, raised 5 feet (1643) * ; 1718 - raise 5 ft * ; raise 10 feet *

Parameter	~~Beginning~~	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	(1645) ~~1445~~	1700	1715	1730	1824	1839
Depth to Water (ft)						
Purge Rate (gpm)	20	20	20	20	20	20
Volume Purged (gal)						
pH	8.20	7.94	8.02	8.12	8.18	8.02
Temperature (°F)	18.74	19.01	18.67	18.74	18.69	19.45
Conductivity (µmhos/cm)	0.815	0.791	0.790	0.787	0.797	0.788
Dissolved Oxygen	11.09	10.32	10.35	10.26	10.06	10.03
Turbidity (NTU)	1058 AU	35.5 NTU	24.0 NTU	16.6 NTU	41.6 NTU	26.7 NTU
ORP (mV)	81.8	76.1	66.4	61.4	77.3	80.5

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)	1854	2025	2040			
Depth to Water (ft)						
Purge Rate (gpm)	20	20				
Volume Purged (gal)						
pH	8.04	8.22				
Temperature (°F)	18.96	18.46	18.64			
Conductivity (µmhos/cm)	0.784	0.781	0.782			
Dissolved Oxygen	9.78 ~~10.36~~	10.67				
Turbidity (NTU)	18.9	52.5	23.5 NTU			
ORP (mV)	78.2	102.1				

* ~~1445~~, 1643, pump /airlift is back up + running after raising 5 feet.
* 1718, raise pump 5 feet + continue airlift /development.
* 1735 Raise airlift apparatus 10 more feet to 271' bgs. Stop airlift to remove excess drop pipe + air line. ~~Stop airlift~~
* 1843 Raise airlift pipe 10 more feet to 261 bgl. ~~to remove drop pipe and air line~~ Stop airlift
* 1900 Raise airlift drop pipe 10 more feet to 251 bgl. Stop airlift to remove drop pipe 10 feet. ~~and~~ air line.
* Stop airlift @ 2047. Reinstall pump into well.

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith		Project No.:	Date: 8/21/2020
EA Personnel: David Muscigle		Development Method: Air Surging	
Weather/Temperature/Barometric Pressure: Sunny, 79°F, 29.83" ↓			Time: 1248

Well No:	Well Condition:
Well Diameter:	Measurement Reference:
Well Volume Calculations	
A. Depth to Water (ft):	D. Well Volume/foot:
B. Total Well Depth (ft):	E. Total Well Volume (gal) [C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):
Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)	

Bottom 10 Feet — raise 10 Feet

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes	6 Volumes
Time (min)	1248	1303	1318	1333	~~1318~~ 1348	~~1300~~ 1400	~~1301~~ 1401
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH	7.67	7.62	7.35	8.01	8.15	7.95	7.94
Temperature (°C)	~~15~~ 20.79	19.49	19.27	19.43	19.71	19.50	19.94
Conductivity ~~(µS)~~ mS/cm	0.689	0.663	0.666	0.671	0.677	0.578	0.665
Turbidity (NTU)	Overrange (-112)	-111	overrange	2816	1148	1392	1267

Parameter	7 Volumes	8 Volume	9 Volumes	10 Volumes	11 Volumes (raise 10 Feet)	12 Volumes	13 Volumes
Time (min)	~~1315~~ 1415	1430	1345	1400	1501	1515	1530
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH	8.01	8.06	8.17	8.16	8.03	8.23	8.27
Temperature (°C)	19.81	20.20	20.50	19.25	18.82	20.67	21.51
Conductivity (µS)	0.664	0.676	0.670	0.666	0.671	0.675	0.676
Turbidity (NTU)	2237	1430	~~26~~ 778	1006	1757	773	889

Comments and Observations:

	1248	1303	1318	1333	1348	1400	1401 (raise 10 Feet)	1415	1430
DO (%)	121.8	128.4	124.8	125.8	132.6	133.3	126	121.2	122.5
ORP (mV)	243.8	241.3	230.4	219.7	220.3	217.9	209.2	176.1	141.5
DO (mg/L)	10.4	11.67	11.38	11.43	11.75	11.90	11.40	10.99	10.84

	1345	1400	1501	1515	1530
DO (%)	121.1	130.5	129.0	122.4	122.5
ORP (mV)	122.0	128.4	126.0	113.1	131.7
DO (mg/L)	10.75	11.87	11.93	10.90	10.74

FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No.:	Date: 8/21/2020
EA Personnel: David Mesciale	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No:	Well Condition:
Well Diameter:	Measurement Reference:

Well Volume Calculations

A. Depth to Water (ft):	D. Well Volume/foot:
B. Total Well Depth (ft):	E. Total Well Volume (gal) [C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)

8/25/2020

Parameter	14 Volumes	15 Volumes	16 Volumes	17 Volumes	18 Volumes	19 Volumes	20 Volumes
Time (min)	1545	1600	0757	0813	0827	0843	0858
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH	8.24	8.17	7.96	7.99	8.04	8.16	8.13
Temperature (°C)	20.56	20.19	17.07	17.75	19.17	18.67	19.11
Conductivity (µS)	0.664	0.676	0.737	0.709	0.695	0.692	0.691
Turbidity (NTU)	705	612	2683AU	2675AU	2885AU	Over Range	Over Range

Parameter	21 Volumes	22 Volume	23 Volumes	24 Volumes	25 Volumes	26 Volumes	27 Volumes
Time (min)	0913	0944	1058	1113	1128		
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH	8.17	8.27	8.14	7.77	7.88		
Temperature (°C)	19.19	20.76	20.34	19.66	20.67		
Conductivity (µS)	0.689	0.691	0.702	0.688	0.692		
Turbidity (NTU)	Over Range	2646 AU	2406AU	2545AU	1961AU		

Comments and Observations:

	1545	1600	8/25/2020 0757	0813	0827	0843	0858	0913	0944
DO (%)	123.1	122.4	113.9	112.4	109.4	109.2	109.0	110.7	117.3
ORP (mV)	116.8	124.7	219.9	216.3	208.2	209.3	214.8	211.5	204.2
DO (mg/L)	10.88	10.90	10.92	10.67	10.00	10.14	10.13	10.13	10.44

Time	1058	1113	1128
DO(%)	125.3	123.1	123.3
ORP	217.6	236.5	227.4
DO(mg/L)	8.66	11.11	10.91

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith		Project No.: 1602602/0002	Date: 8/26/2020
EA Personnel: Dave Cookston		Development Method: Surge block, air lifting, pumping	
Weather/Temperature/Barometric Pressure: 91°F, Sunny, Hot, Press 29.88"			Time: 7 hrs 41 mins.

Well No: Test Well	Well Condition: New
Well Diameter: 12 inch	Measurement Reference: TOC
Well Volume Calculations	
A. Depth to Water (ft): 163.30	D. Well Volume/foot: 5.87
B. Total Well Depth (ft): 293.75	E. Total Well Volume (gal) [C*D]: 765.74
C. Water Column Height (ft): 130.45	F. Five Well Volumes (gal): 3,828.71
Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)	

Next 10' Screen

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes	6 Volumes
Time (min)	0707	0718	0728	0742	0826	0848	0854
Depth to Water (ft)	163.30	5					
Purge Rate (gpm)	>278	>278	>278	>278	>278	>278	>278
Volume Purged (gal)	0	3,058	5,838	6,950	21,962	28,078	29,746
pH				8.08	7.26	7.13	6.94
Temperature (°C)				16.54	16.75	16.96	16.67
Conductivity (µS)				1.523	1.517	1.484	1.520
Turbidity (NTU)		1120 AU	22.6	9.74	10.85	11.02	6.89

Parameter	7 Volumes	8 Volume	9 Volumes	10 Volumes	11 Volumes (Next Screen)	12 Volumes	13 Volumes (Next Screen)
Time (min)	0906	0919	0941	0956	1021	1048	1153
Depth to Water (ft)							
Purge Rate (gpm)	>278	>278	>278	>278	>278	>278	>278
Volume Purged (gal)	33,082	36,696	41,422	46,982	53,932	61,438	62,828
pH	7.04	6.85	7.01	7.09	7.07	7.01	7.07
Temperature (°C)	16.76	16.72	17.32	17.36	17.57	17.73	19.09
Conductivity (µS)	1.503	1.539	1.391	1.377	—	0.708	0.753
Turbidity (NTU)	8.95	9.39	5.15	4.61	7.60	~~7.07~~ 8.82	4.00

Comments and Observations:

Time	0742	0826	0848	0854	0906	0919	0941	0956	1021	1048	1153
%DO	25.9	102.9	37.0	50.6	154.9	225.1	136.9	—	—	21.5	24.
DO mg/L	1.62	11.17	4.00	6.69	13.28	21.13	13.42	—	—	1.99	2.1
ORP	244.8	280.6	287.5	294.7	294.6	302.5	296.2	217.1	185.0	171.7	193.

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith	Project No.: 1602602/0002	Date: 8/26/2020
EA Personnel: Dave Cookston	Development Method: Air lift, surge, pump	
Weather/Temperature/Barometric Pressure: 91°F, Sunny, Hot, Windy, Press 29.88"	Time: 7 hr 41min	

Well No: Test Well	Well Condition: New
Well Diameter: 12 inch	Measurement Reference: Top of Casing
Well Volume Calculations	
A. Depth to Water (ft): 163.30	D. Well Volume/foot: 5.87
B. Total Well Depth (ft): 297.75	E. Total Well Volume (gal) [C*D]: 765.74
C. Water Column Height (ft): 130.45	F. Five Well Volumes (gal): 3,828.71
Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)	

Parameter	14 Volumes	15 Volumes	16 Volumes	17 Volumes	18 Volumes	19 Volumes	20 Volumes
Time (min)	1240	1349	1449				
Depth to Water (ft)							
Purge Rate (gpm)	>278	>278	>278				
Volume Purged (gal)	92,574	111,478	128,158				
pH	7.07	7.04	6.96				
Temperature (°C)	19.73	17.91	18.33				
Conductivity (µS)	0.782	0.792	0.798				
Turbidity (NTU)	5.56	3.11	2.86				

Parameter	21 Volumes	22 Volume	23 Volumes	24 Volumes	25 Volumes	26 Volumes	27 Volumes
Time (min)							
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH							
Temperature (°C)							
Conductivity (µS)							
Turbidity (NTU)							

Comments and Observations:

Time	1240	1349	1449
% DO	23.8	37.1	44.4
mg/L DO	2.11	3.38	4.06
ORP	182.1	161.3	164.2

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith		Project No.: 1602602/0002	Date: 8/27/2018
EA Personnel: Daniel Cookston		Development Method:	
Weather/Temperature/Barometric Pressure:			Time:

Well No:	Well Condition:
Well Diameter:	Measurement Reference:
Well Volume Calculations	
A. Depth to Water (ft):	D. Well Volume/foot:
B. Total Well Depth (ft):	E. Total Well Volume (gal) [C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):
Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)	

Parameter	Beginning (305)	1 Volume	2 Volumes	3 Volumes (403)	4 Volumes	5 Volumes (506)	6 Volumes (603)
Time (min)	1514	1540	1551	1557	1609	1629	1659
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH		8.29	7.13	7.03	6.98	7.21	7.19
Temperature (°C)		18.49	17.34	17.20	17.26	17.83	17.86
Conductivity (µS)		0.820	0.787	0.780	0.783	0.790	0.797
Turbidity (NTU)		8.97	5.58	14.8	12.6	7.23	7.52

Parameter	7 Volumes (704)	8 Volume	9 Volumes	10 Volumes	11 Volumes	12 Volumes	13 Volumes
Time (min)	1729	1745	1803				
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH	7.13	7.06	6.95				
Temperature (°C)	17.90	17.84	16.53				
Conductivity (µS)	0.779	0.798	0.778				
Turbidity (NTU)	6.89	11.9	11.48				

Comments and Observations:

Time	1540	1551	1557	1609	1629	1659	1727	1745	1803
ODO	29.1	43.1	29.9	40.4	41.9	24.7	25.0	28.0	29.6
mg/L	2.63	4.02	2.74	3.80	3.86	2.31	2.31	2.65	2.80
ORP	166.4	167.4	156.7	158.1	162.0	168.8	170.6	169.5	168.7

FIELD RECORD OF WELL DEVELOPMENT

Project Name: David Mascitti	Project No.:	Date: 8/28/2020	
EA Personnel: David Mascitte	Development Method: Pump		
Weather/Temperature/Barometric Pressure: 77°F / Sunny / 29.75 in		Time: 0800	

Well No:	Well Condition:
Well Diameter:	Measurement Reference:

Well Volume Calculations

A. Depth to Water (ft): 163.88 ground	D. Well Volume/foot:
B. Total Well Depth (ft):	E. Total Well Volume (gal) [C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)

32 min @ 305 = 4760

30 min @ 506 = 5180

30 min @ 704 = 21120

Parameter	Beginning	1 Volume	2 Volumes (Increase to 500 gpm)	3 Volumes	4 Volumes	5 Volumes (700 gpm)	6 Volumes
Time (min)	0800	0825	0832	0902	0927	0932	0947
Depth to Water (ft)	168.45	168.40	170.58	170.70	170.78	173.09	173.02
Purge Rate (gpm)	305	305	506	506	506	704	704
Volume Purged (gal)	0	7025 ~~7,525~~	9790 ~~9,600~~	24,940	37,590	~~50,320~~	50680
pH	6.22	7.03	6.87	7.09	7.06	6.87	7.12
Temperature (°C)	17.02	17.08	16.05	16.58	16.55	16.48	17.15
Conductivity (µS)	0.817	0.815	0.807	0.815	0.818	0.813	0.816
Turbidity (NTU)	7.33	2.62	2.10	2.25	1.66	3.20	3.47

Parameter	7 Volumes	8 Volume	9 Volumes (800 gpm @ 1032)	10 Volumes	11 Volumes	12 Volumes	13 Volumes
Time (min)	1002	1017	1028	1043	1102	1117	1132
Depth to Water (ft)	173.02	173.05	173.05	174.55	174.60	174.55	174.65
Purge Rate (gpm)	704	704	704	802	802	802	802
Volume Purged (gal)	61240	71,800	79,544	94390	105,420 ~~1???~~	118,450	13,480
pH	7.02	7.29	7.13	6.94	7.11	7.11	7.09
Temperature (°C)	16.65	18.25	17.48	17.05	17.15	18.03	17.65
Conductivity (µS)	0.824	0.825	0.825	0.825	0.829	0.834	0.832
Turbidity (NTU)	3.41	4.25	4.87	7.96	5.99	4.87	5.03

Comments and Observations:

	0800	0825	0832	0902	0927	0932	0947
DO %	26.18	37.5%	34.6%	34.7%	31.8%	31.5%	38.4%
DO mg/L	2.53	3.55	3.33	3.33	3.03	3.02	3.57
ORP (mV)	261.0	210.8	226.0	223.2	143.2	94.2	189.0

	1002	1017	1028	1034	1102	1117	1132
DO %	27.8%	37.5%	42.0%	45.9	39.6	39.5	38.7
DO mg/L	2.61	3.43	3.89	4.33	3.70	3.24	3.5[illegible]
ORP	175.5	167.5	162.2	145.4	153.6	130.6	14[illegible]

FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No.:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No:	Well Condition:
Well Diameter:	Measurement Reference:
Well Volume Calculations	
A. Depth to Water (ft):	D. Well Volume/foot:
B. Total Well Depth (ft):	E. Total Well Volume (gal) [C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Well Volume/foot (gal/ft): (2" = 0.16) (4" = 0.65) (6" = 1.47) (8" = 2.61) (12" = 5.87)

@1232 increase to 915gpm

Parameter	14 Volumes	15 Volumes	16 Volumes	17 Volumes	18 Volumes	19 Volumes	20 Volumes
Time (min)	1147	1202	1217	1232	1247	1302	1332
Depth to Water (ft)	174.70	174.70	174.65	174.67	176.17	176.17	176.20
Purge Rate (gpm)	802	802	802	802	915	915	915
Volume Purged (gal)	142,510	154,540	166,570	178,600	192,325	206,050	219,775
pH	6.81	6.80	6.82	6.81	6.90	6.86	6.85
Temperature (°C)	16.01	16.19	16.46	16.32	16.57	16.14	16.88
Conductivity (µS)	0.828	0.826	0.832	0.829	0.830	0.825	0.828
Turbidity (NTU)	4.34	5.82	6.80	5.75	7.57	7.71	6.33

Parameter	21 Volumes	22 Volume	23 Volumes	24 Volumes	25 Volumes	26 Volumes	27 Volumes
Time (min)	1402	1432	1502	1532	1602		
Depth to Water (ft)	176.16	176.22	176.21	176.26	176.23		
Purge Rate (gpm)	915	906	906	906	906		
Volume Purged (gal)	233,500	247,090	260,680	282,270			
pH	6.75	6.87	6.75	6.70	6.70		
Temperature (°C)	17.27	16.16	16.87	16.90	15.87		
Conductivity (µS)	0.835	0.841	0.840	0.852	0.856		
Turbidity (NTU)	5.37	4.59	3.71	3.73	3.64		

Comments and Observations:

	1147	1202	1217	1232	1247	1302	1332	1402
DO %	24.5%	41.6	28.2%	27.3%	30.2%	27.7%	27.1%	30.8%
DO mg/L	2.33	3.99	2.71	2.64	2.87	2.63	2.55	2.92
ORP (mV)	102.3	88.7	67.0	70.3	41.6	28.0	31.2	66.0

	1432	1502	1532	1602
DO %	31.8	33.6	29.2	37.4%
DO mg/L	3.06	3.19	2.75	3.60
ORP (mV)	49.2	81.7	60.6	105.1

ATTACHMENT 1c

Well Permit

LOWER PLATTE SOUTH
natural resources district
3125 Portia Street | P.O. Box 83581 • Lincoln, Nebraska 68501-3581
P: 402.476.2729 • F: 402.476.6454 | www.lpsnrd.org

July 10, 2020

Monolith Nebraska LLC
134 S. 13th Street, Suite 700
Lincoln, NE 68508

Dear Matt:

The Lower Platte South NRD has approved your Preliminary Well Construction Permit for your Water Well Permit application (enclosed is a copy). The Preliminary Well Construction Permit (LPSP-200412) is located in the NE 1/4 of the NE 1/4 of Section 30, Township 7 North, Range 6 East, Lancaster County. The current location and GPS coordinates highlighted on the permit form meet current well spacing requirements. If this location is moved, you must contact the District before beginning drilling to make certain the new location meets well spacing requirements. This is a Class II permit for a well in a Ground Water Reservoir for industrial use. This gives you one year from the date of preliminary approval to complete and submit the information required for the class of permit you are applying for.

Class II Permit Requirements:

- A copy of the well log to determine the geologic formation(s) present.
- An accurate static water level.
- An aquifer test with at least one observation well, and all necessary drawdown and pumping data as required by the District. The aquifer test must be designed and supervised by a licensed professional geologist or engineer with experience in water resources evaluation. The aquifer test must be conducted according to the plan document submitted by EA Engineering, Science, and Technology via email on June 16, 2020.
- Water quality analysis of samples from a qualified laboratory. Samples are to be taken after 24 hour pump test at 100% of the designed pumping rate. Results to be attached include Sodium (Na), Chloride (Cl), and Total Dissolved Solids (TDS).
- A hydrogeologic analysis report considering the impact of the proposed withdrawal on the current groundwater users and the minimum twenty (20) year impact on the aquifer for potential users shall be prepared and submitted. The report must be prepared by a licensed professional geologist or engineer with experience in water resources evaluation.

Additional Information/Comments/Questions:

- We understand that there is the likelihood that additional wells will be needed to supply Monolith's needs, and that the water from these additional wells will be commingled.

Under current Nebraska law and LPSNRD regulations, such commingled wells will be considered as a single source and the total output of those wells will be treated as a single, aggregate amount. Given the large scale of this development, please be aware that, depending upon the results of the aquifer test and modeling as well as the number and capacity of any additional well(s) to be installed, additional analysis, including but not limited to additional aquifer testing, longer-term modeling, and additional data collection, may be required by the District.

- What is Monolith's ultimate, long-term plan for managing their total water use requirements as well as ensuring that nearby groundwater users (e.g. the Village of Hallam, domestic/other private well owners, irrigators, Nebraska Public Power District, etc.) are not adversely impacted by Monolith's groundwater withdrawals? LPSNRD understands that such planning will depend on the results of aquifer testing, groundwater modeling, and other factors, but initiating planning for the long term now will help avoid possible conflicts in the future.
- All groundwater users and NRDs are concerned about the effect additional large scale groundwater pumping may have on groundwater quality. LPSNRD has information indicating that groundwater in the vicinity of the Monolith facility may be elevated in certain constituents such as total dissolved solids (TDS). The source of TDS is generally thought to be deeper bedrock aquifers, and given the amount of groundwater Monolith may eventually be withdrawing, saltwater intrusion is a possible concern. The potential degradation of groundwater quality needs to be evaluated to insure the wellfields can be managed and operated properly without inducing the intrusion of groundwater of poorer quality.
- What is Monolith's plan for reaching out to and informing the public and other water users (e.g. the Nebraska Public Power District) in the general area? LPSNRD understands that Monolith has had contact with the Village of Hallam through the zoning/planning process, but it's clear very little information has been provided previously by Monolith to the NRD, community, or the area about your estimated groundwater needs to operate your facility.

Once you have gathered all the information necessary, please send it to the Lower Platter South NRD office along with the permit application form (enclosed). After all items have been received, your application will be considered for Final Approval. Please remember that all newly permitted wells must be equipped with a water meter. Cost share is available on the water meter. Also, the District requires that all irrigated acres be certified by the District prior to irrigating. Please contact myself or Maclane Scott at (402) 476-2729 if you have any questions.

Sincerely,

Paul D. Zillig
General Manager

Lower Platte South
Natural Resources District

Wellhead Willy

PRELIMINARY WELL CONSTRUCTION PERMIT
LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

1. Fill out #'s 1-10 on the attached Water Well Permit Application.
2. Sign below and submit to the District.

I, Matthew Rhodes (print name) acknowledge that I have received and read the guidance document, aquifer test procedures, and the water well permit classes flow chart. I also acknowledge this Preliminary Well Construction Permit is for constructing a well to gather the required information to complete a Water Well Permit application. I also acknowledge that approval of this Preliminary Well Construction Permit by the District does not assure me that I will receive a Water Well Permit, and I understand there is one year to complete the Water Well Permit application.

Signature ____________________ Date 6/12/2020

NRD – Preliminary Well Construction Permit site inspection by:

Inspector ____________________ Date 6-25-20

Preliminary Well Construction Permit Approval

Preliminary Permit Number LPSP-200412

Paul D. Zillig, General Manager ____________________ Date July 10, 2020

APPLICATION FOR A PERMIT TO CONSTRUCT A WATER WELL IN THE LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

GROUNDWATER RESERVOIR PERMIT FORM

DNR & NRD USE ONLY
Permit No. LPSP-200412
Reg. No. ________

1. **PERMIT CLASS (indicate one)**
Class I (50 gpm < X < 1000gpm and < 250 acre-feet/ year)
[Class II] (≥ 1000gpm and/ or ≥ 250 acre-feet/year)

Is this well intended to pump salt water for a beneficial use? ( ) Yes (✓) No
If Yes, then application will be considered for a Salt Water Well Permit

2. **IS THIS PERMIT FOR A SERIES OF WELLS?** ( ) Yes (✓) No
If Yes, how many wells? ________

3. **NAME AND ADDRESS OF APPLICANT:**

Monolith Nebraska, LLC
134 S 13th St Ste. 700
Lincoln, NE 68508
Phone (319) 541 — 1554

4. **NAME AND ADDRESS OF WELL DRILLER:**

Cahoy Pump Service, Inc.
24568 150th Street
Sumner, IA 50674
Phone (563) 578 — 1130

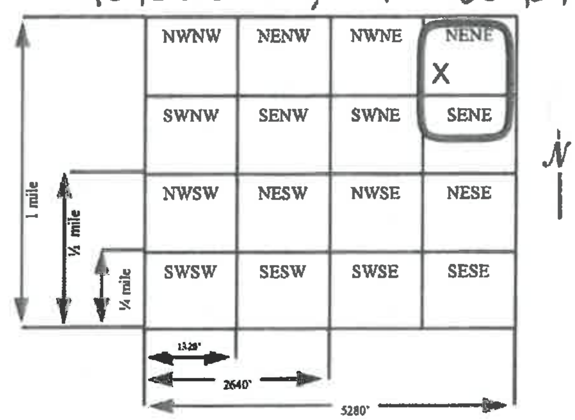
5. **PURPOSE OF WELL (indicate one)**
( ) Public Water Supply ( ) Irrigation ( ) Domestic ( ) Livestock
( ) Dewatering (over 90 days) ( ) Geothermal ( ) Monitoring ( ) Aquaculture (✓) Industrial
( ) Recovery ( ) Other ________

40.550568, -96.780457

6. **IDENTIFY THE LOCATION OF THE PROPOSED WELL:**
Lancaster ________ County,
Township 7 North, Range 6 East, Section 30

The box at the right represents one square mile, (section). Indicate with an "X", the proposed location of the well. Outline the proposed water use area, if water is to be used outside the above written legal description, give legal description of water use area,
Township ____ North, Range ____ East, Section ____

The well will be located _____ feet from the North/South section line, and will be _____ feet from the East/West section line.



If possible mark (with a flag) the well site in the field

7. **COMMINGLED, COMBINED, CLUSTERED, OR JOINED WELLS:**
Will the proposed well be connected to another well(s) or be used to supplement an existing water use from another well? ( ) Yes (✓) No
If yes, list registration numbers of other well(s) ________

8. **IRRIGATION WELLS:**
How many acres will be irrigated? 0
Type of irrigation system: ( ) Center Pivot ( ) Gravity ( ) Other (specify) ________.
Will Fertilizer, Chemicals or Animal Waste be applied through the system? ( ) Yes ( ) No

9. **REPLACEMENT AND ABANDONMENT WELL INFORMATION:**
Is this a replacement well? ( ) Yes (✓) No Registration number of well to be replaced: ________
Well to be replaced was last operated ________, 20____ Replacement well is ________ feet from the original well.
Will new well water the same tract of land or provide water for the same use as the decommissioned well? ( ) Yes ( ) No

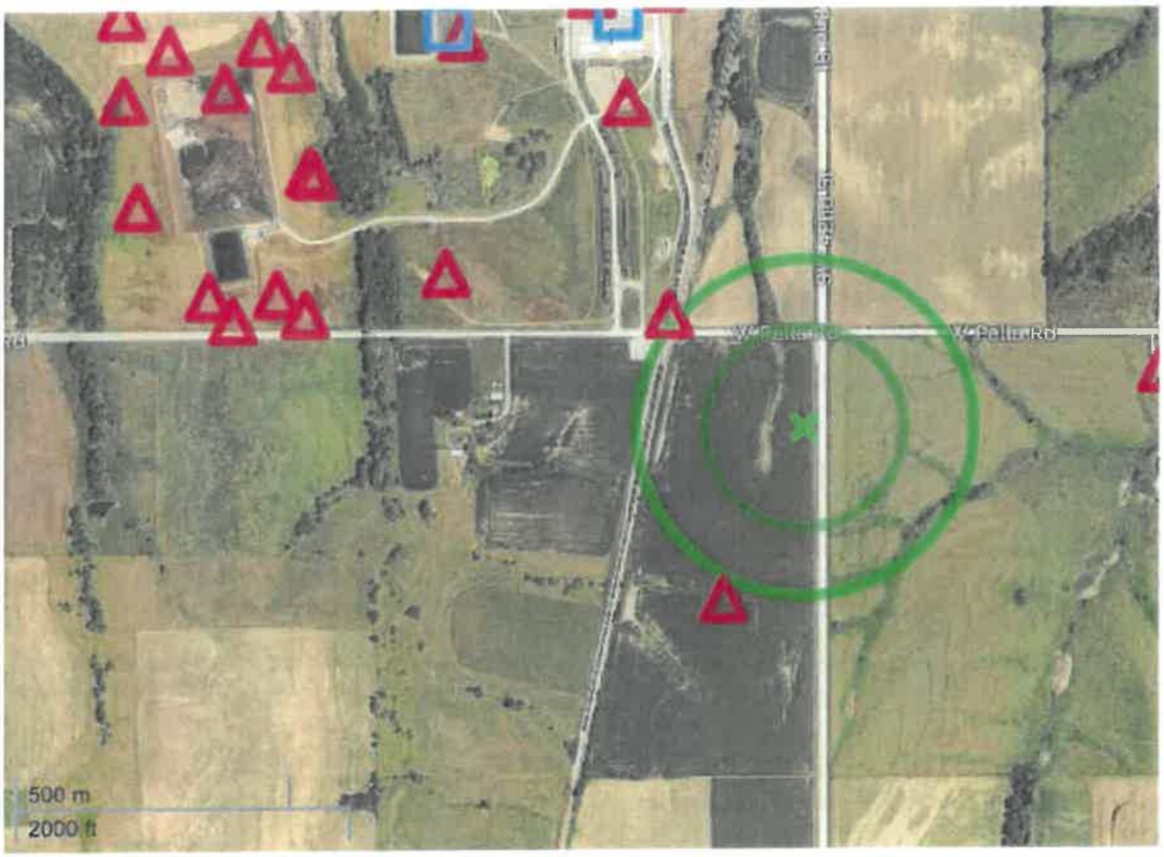
10. **SPECIFICATIONS OF INTENDED WELL AND PUMP:**
Approximate date when construction will begin: June 22, 20 2020
Estimated total well depth 310 feet. Estimated water well capacity: 800 gallons per minute
Pump column diameter: 6-8 inches. Well casing diameter: 12 inches.

DO NOT BEGIN CONSTRUCTION UNTIL AN APPROVED PRELIMINARY WELL CONSTRUCTION PERMIT FORM IS RETURNED TO THE LANDOWNER

See Other Side

LOWER PLATTE SOUTH
natural resources district

District Prelimin



Selected / Unselected Well from 600 and 1000 feet

Selected / Unselected Permit from 600 and 1000 feet

WELL INFORMATION

PERMIT INFORMATION

11. I certify that I am familiar with the information contained in this application, and its restrictions, rules and regulations and that to the best of my knowledge and belief such information is true, complete and accurate. The necessary supporting material, under the district's Groundwater Rules and Regulations (Section B), is attached for the well permit class to which I am applying. A copy of the Groundwater Rules and Regulations is available upon request.

This form must be completed in full and be accompanied by a non-refundable $50.00 filing fee (payable to the Lower Platte South Natural Resources District). Forward this application and filing fee to Lower Platte South Natural Resources District, P.O. Box #83581, 3125 Portia Street, Lincoln, Nebraska 68501-3581. Please take the time to fill out the information correctly. An incomplete or defective application will be returned by the District, with 60 days being allowed for resubmission. All permits shall be issued by the District with or without conditions attached, or denied no later than 30 days after receipt of a complete and properly prepared application pursuant to §46-736.

Date: 6/12/2020 Signature of Applicant: [signature]

Date Approved: ________ Date Denied: ________ Reason for Denial Attached _____ NRD Representative: ____________

PERMIT RESTRICTIONS & TERMS

1. ***Water well permits are required prior to completing construction and use of the water, if construction and use of the water well is commenced prior to obtaining a permit, a late permit must be obtained from the District along with a $250.00 application fee.***

2 Any person who, on or after August 13, 1996, commences or causes construction of such a water well for which the required permit has not been obtained, or who knowingly furnishes false information regarding such permit, shall be guilty of a Class IV misdemeanor pursuant to §46-602.02 and §46-613.02.

3. Prior to construction of a water well, a water well contractor shall take those steps necessary to satisfy himself or herself that the person for whom the well is to be constructed has obtained a permit pursuant to §46-602.

4. No irrigation or industrial water well or water well of any other public water supplier shall be drilled within 1,000 feet of any registered water well of any pubic water supplier; No water well of any such public water supplier shall be drilled within 1,000 feet of any registered irrigation or industrial water well; No irrigation water well shall be drilled within 1,000 feet of a registered industrial or within 600 feet of a registered irrigation water well; No industrial water well shall be drilled within 1,000 feet of a registered irrigation or industrial water well pursuant to §46-609 and §46-651. These spacing requirements shall not apply to water wells owned by the same person. Any person may apply to the Nebraska Department of Natural Resources for a special permit to drill a water well without regard to the spacing requirements pursuant to 653.

5. This permit does not register the water well with the Nebraska Department of Natural Resources. All water wells are required to be registered by the water well contractor constructing the well with the Nebraska Department of Natural Resources within 60 days after the water well is completed pursuant to §46-602.

6. A replacement water well is one which replaces an abandoned water well that has been operated within the last three years, and is constructed to water the same tract of land as the abandoned water well which is being replaced. As of August 13, 1996 replacement wells **DO** need a permit from the Lower Platte South Natural Resources District. If a water well is being replaced it must be properly abandoned according to state guidelines. A copy of these guidelines are available from the Lower Platte South Natural Resources District.

7. If the water well is not constructed and equipped within a one year period from the date of approval, a new water well permit is required.

8. Water wells may not be drilled within 50 feet of a stream bank without first getting a surface water right for that stream from the Nebraska Department of Natural Resources pursuant to §46-637.

9. Permits are not required for test holes, temporary dewatering wells with an intended use of less than 90 days, or a single water well designed and constructed to pump (yield) 50 gallons per minute or less pursuant to §46-656.29.

10. The issuance by the District of this permit or registration of a water well by the Director of the Nebraska Department of Natural Resources pursuant to §46-602 shall not vest in any person the right to violate any rule, regulation, or control in effect on the date of issuance of the permit or the registration of the water well or to violate any rule, regulation, or control properly adopted after such date.

11. All wells permitted after March 31, 2008 must be equipped with a NRD approved flow meter (See Section C, Rule 1 of the District's Ground Water Rules & Regulations)

12. All applicants for a water well permit shall, as a condition of the permit, agree to cooperate with the district, at its request, in ground water monitoring activities to include water level measurement and water quality sampling (See Section B, Rule 7 of the District's Ground Water Rules & Regulations)

COMMENTS / RESTRICTIONS / TERMS ____________

ATTACHMENT 2

PHOTOGRAPHIC LOG

Photograph No. 1: Observation well installation.
Date: 06-30-20 Direction: Northwest

Photograph No. 2: Drilling Test Well 1R.
Date: 08-07-20 Direction: Northwest

Photograph No. 3: Water level meter and transducer installed in the test well.
Date: 08-31-20 Direction: North

Photograph No. 4: Test well discharge piping and diesel generator.
Date: 09-02-20 Direction: West

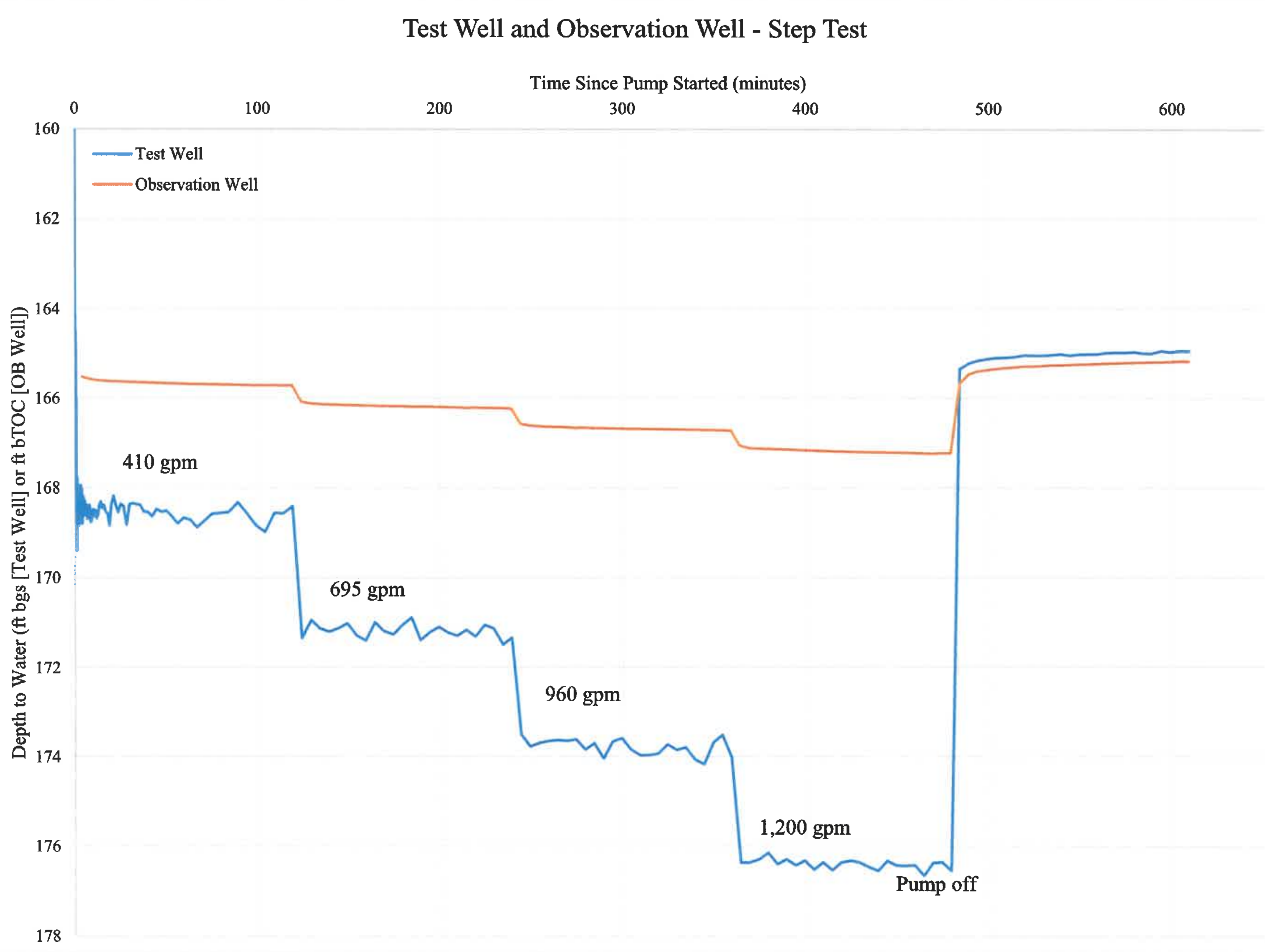
Photograph No. 5: Observation well with water level meter and transducer.
Date: 09-02-20 Direction: NA

Photograph No. 6: View of the observation well relative to test well.
Date: 09-03-20 Direction: Southwest

Photograph No. 7: Discharge area.
Date: 09-03-20 Direction: West

ATTACHMENT 3

STEP-RATE PUMPING TEST ANALYSIS



Test Well and Observation Well - Step Test
Time Since Pump Started (minutes)
0
100
200
300
400
500
600
Depth to Water (ft bgs [Test Well] or ft bTOC [OB Well])
160
162
164
166
168
170
172
174
176
178
Test Well
Observation Well
410 gpm
695 gpm
960 gpm
1,200 gpm
Pump off

Test Well 1R Step-Rate Test Analysis

Step	Duration (mins.)	Q (gpm)	s (ft)	s/Q	Q/s
1	120	410	3.92	0.010	104.59
2	120	695	6.52	0.009	106.60
3	120	960	9.13	0.010	105.15
4	121	1200	11.80	0.010	101.69

s/Q = CQ + B (Driscoll, eq. 16.9, p. 557)

slope (C) = 3.4238E-07 Well loss coefficient `
intercept (B) = 0.00929204 Formation loss coefficient

Drawdown & Specific Capacity Predictions:

SC = Q/s = 1/[CQ + B] (Driscoll, eq. 16.10, p. 557)

equivalent expression: $s = BQ + CQ^2$ (Roscoe Moss p. 303)

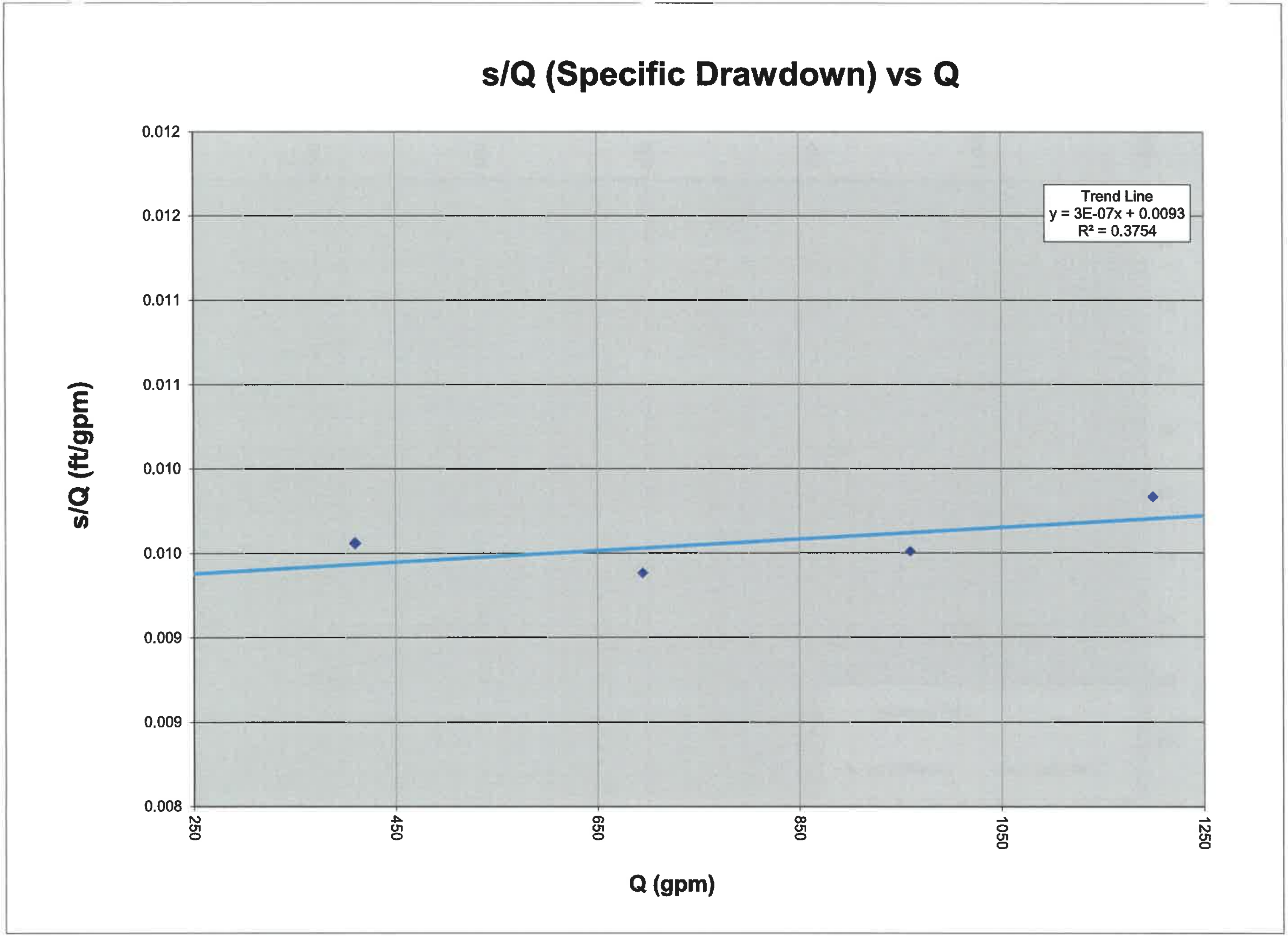
BQ = formation loss

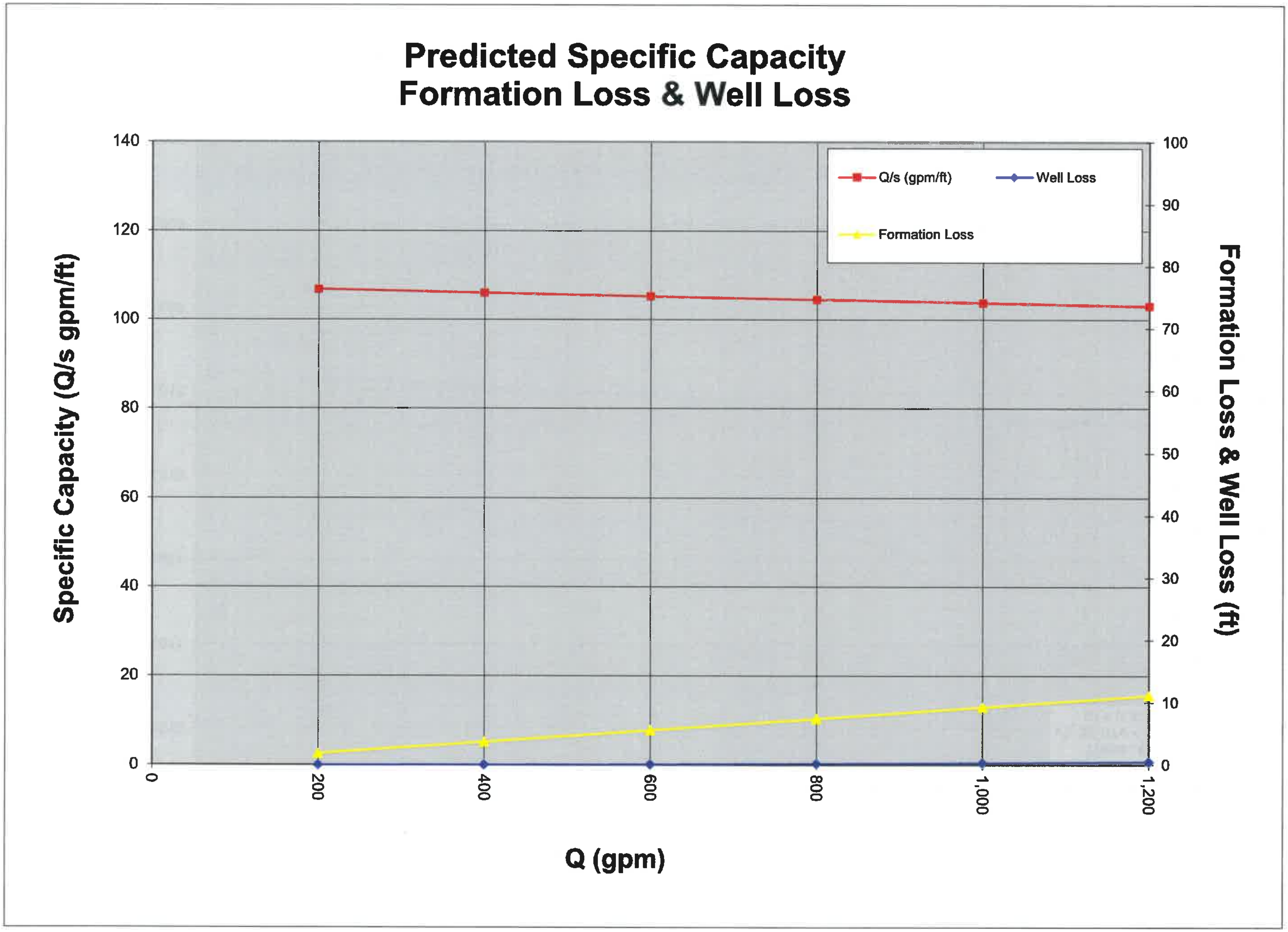
CQ^2 = well loss

Q (gpm)	Theoretical Drawdown s (ft)	Specific Capacity Q/s (gpm/ft)	Formation Loss BQ	Well Loss CQ^2
200	1.9	106.8	1.8584071	0.013695
400	3.8	106.1	3.72	0.05
600	5.7	105.3	5.58	0.12
800	7.7	104.5	7.43	0.22
1000	9.6	103.8	9.29	0.34
1200	11.6	103.1	11.15	0.49

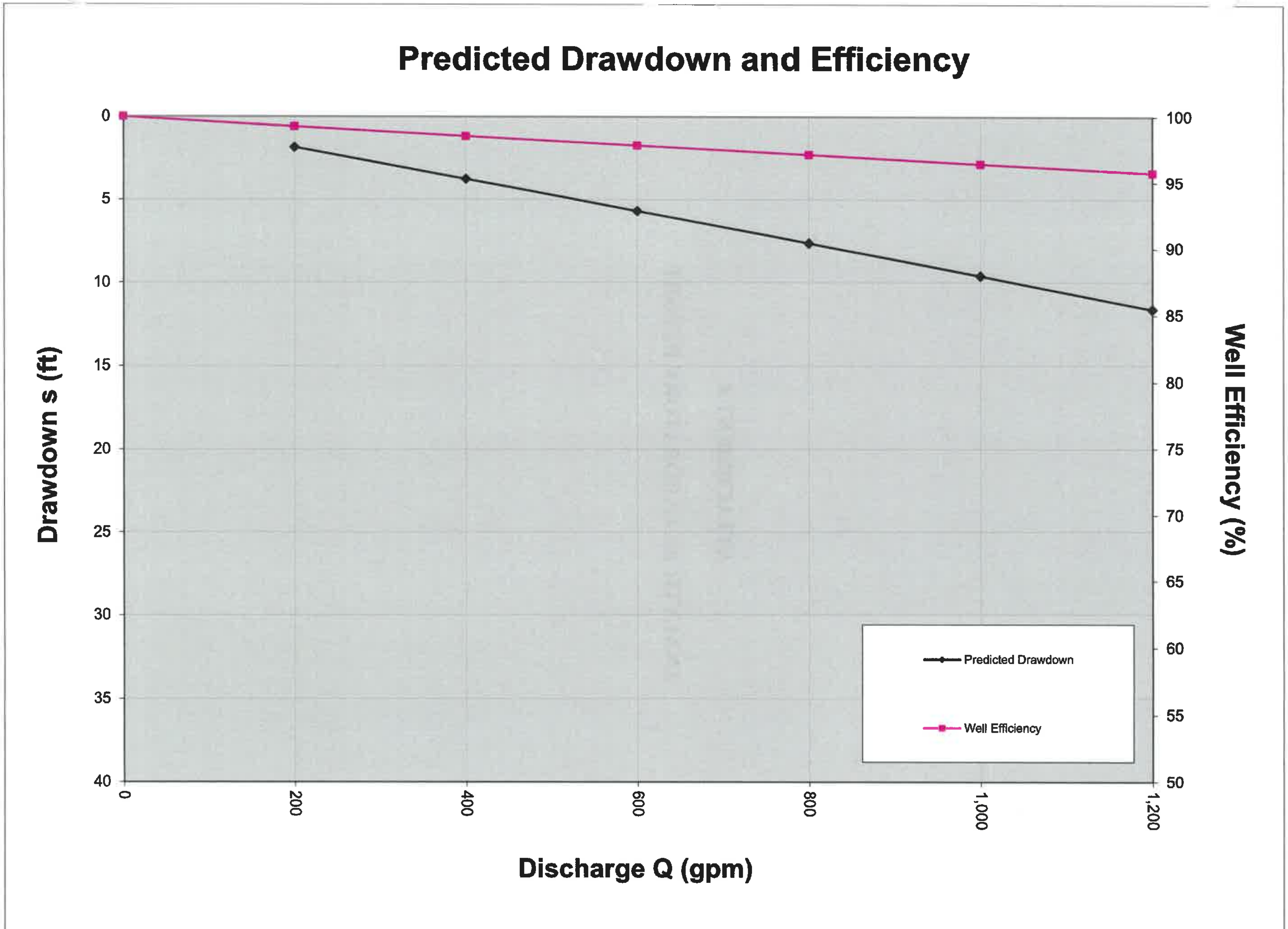
Well Efficiency (Roscoe Moss p. 305)

Q (gpm)	Efficiency
0	100
200	99.2684534
400	98.54753229
600	97.83700682
800	97.13665375
1000	96.44625619
1200	95.76560335


s/Q (Specific Drawdown) vs Q
Trend Line
y = 3E-07x + 0.0093
R² = 0.3754
s/Q (ft/gpm)
0.012
0.012
0.011
0.011
0.010
0.010
0.009
0.009
0.008
250
450
650
850
1050
1250
Q (gpm)



Predicted Specific Capacity
Formation Loss & Well Loss
Q/s (gpm/ft)
Well Loss
Formation Loss
Specific Capacity (Q/s gpm/ft)
Formation Loss & Well Loss (ft)
Q (gpm)
0
20
40
60
80
100
120
140
10
30
50
70
90
200
400
600
800
1,000
1,200



Predicted Drawdown and Efficiency
Drawdown s (ft)
0
5
10
15
20
25
30
35
40
Well Efficiency (%)
100
95
90
85
80
75
70
65
60
55
50
0
200
400
600
800
1,000
1,200
Discharge Q (gpm)
Predicted Drawdown
Well Efficiency

ATTACHMENT 4

ANALYTICAL LABORATORY REPORT

eurofins

Environment Testing America

ANALYTICAL REPORT

Eurofins Lancaster Laboratories Env, LLC
2425 New Holland Pike
Lancaster, PA 17601
Tel: (717)656-2300

Laboratory Job ID: 410-13225-1
Laboratory Sample Delivery Group: Monolith
Client Project/Site: Nebraska OC1 Groundwater Analysis

For:
EA Engineering, Science, and Technology
221 Sun Valley Boulevard
Suite D
Lincoln, Nebraska 68528

Attn: Jamie Suing

Authorized for release by:
9/28/2020 10:35:08 AM
Jennifer Pursel, Operations Support Specialist
(717)556-7262
jenniferpursel@eurofinsus.com

Designee for

Kay Hower, Principal Project Manager
(717)556-7364
kayhower@eurofinsus.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.eurofinsus.com/Env

The test results in this report meet all 2003 NELAC, 2009 TNI, and 2016 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Analytical test results meet all requirements of the associated regulatory program (e.g., NELAC (TNI), DoD, and ISO 17025) unless otherwise noted under the individual analysis. Data qualifiers are applied to note exceptions. Noncompliant quality control (QC) is further explained in narrative comments.

* QC recoveries that exceed the upper limits and are associated with non-detect samples are qualified but no further narration is needed since the bias is high and does not change a non-detect result.

* Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD is performed, unless otherwise specified in the method.

* Surrogate recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.

Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Measurement uncertainty values, as applicable, are available upon request.

Test results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. Times are local to the area of activity. Parameters listed in the 40 CFR Part 136 Table II as "analyze immediately" and tested in the laboratory are not performed within 15 minutes of collection.

This report shall not be reproduced except in full, without the written approval of the laboratory.

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Jennifer Pursel
Operations Support Specialist
9/28/2020 10:35:08 AM

Table of Contents

Qualifiers

HPLC/IC

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
E	Result exceeded calibration range.
F1	MS and/or MSD recovery exceeds control limits.
F3	Duplicate RPD exceeds the control limit
F5	Duplicate RPD exceeds limit, and one or both sample results are less than 5 times RL.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
1C	Result is from the primary column on a dual-column method.
2C	Result is from the confirmation column on a dual-column method.
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 410-13225-1

Laboratory: Eurofins Lancaster Laboratories Env, LLC

Narrative

Job Narrative
410-13225-1

Receipt
The sample was received on 9/5/2020 10:40 AM; the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 0.8° C.

HPLC/IC
Methods 300.0, 9056A: The continuing calibration verification (CCV) associated with batch 410-47905 recovered above the upper control limit for Chloride at 111% and sulfate at 113%. The associated sample is impacted: TW1 (410-13225-1).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Client Sample ID: TW1 — Lab Sample ID: 410-13225-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Fluoride	0.92	J F1 B	1.0	0.50	mg/L	10		EPA 300.0 R2.1	Total/NA
Sulfate	33		10	3.0	mg/L	10		EPA 300.0 R2.1	Total/NA
Chloride	61	E F1	4.0	2.0	mg/L	10		EPA 300.0 R2.1	Total/NA
Calcium	110		0.20	0.096	mg/L	1		200.7 Rev 4.4	Total Recoverable
Iron	1.2		0.20	0.040	mg/L	1		200.7 Rev 4.4	Total Recoverable
Magnesium	24		0.10	0.040	mg/L	1		200.7 Rev 4.4	Total Recoverable
Potassium	4.2		0.50	0.20	mg/L	1		200.7 Rev 4.4	Total Recoverable
Sodium	98		1.0	0.24	mg/L	1		200.7 Rev 4.4	Total Recoverable
Barium	0.13		0.0050	0.0010	mg/L	1		200.7 Rev 4.4	Total Recoverable
Copper	0.15		0.020	0.012	mg/L	1		200.7 Rev 4.4	Total Recoverable
Manganese	0.38		0.010	0.0030	mg/L	1		200.7 Rev 4.4	Total Recoverable
Zinc	0.098		0.020	0.0037	mg/L	1		200.7 Rev 4.4	Total Recoverable
Boron	0.16		0.030	0.012	mg/L	1		200.7 Rev 4.4	Total Recoverable
Strontium	0.54		0.0050	0.00073	mg/L	1		200.7 Rev 4.4	Total Recoverable
Total Dissolved Solids	650		120	40	mg/L	1		2540C-2011	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample Results

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Client Sample ID: TW1

Date Collected: 09/04/20 14:15
Date Received: 09/05/20 10:40

Lab Sample ID: 410-13225-1

Matrix: Water

Method: EPA 300.0 R2.1 - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.92	J F1 B	1.0	0.50	mg/L			09/25/20 15:55	10
Sulfate	33		10	3.0	mg/L			09/25/20 15:55	10
Chloride	61	E F1	4.0	2.0	mg/L			09/25/20 15:55	10

Method: 200.7 Rev 4.4 - Metals (ICP) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		0.20	0.15	mg/L		09/09/20 01:54	09/10/20 13:49	1
Calcium	110		0.20	0.096	mg/L		09/09/20 01:54	09/10/20 18:57	1
Iron	1.2		0.20	0.040	mg/L		09/09/20 01:54	09/10/20 18:57	1
Magnesium	24		0.10	0.040	mg/L		09/09/20 01:54	09/10/20 18:57	1
Potassium	4.2		0.50	0.20	mg/L		09/09/20 01:54	09/10/20 18:57	1
Sodium	98		1.0	0.24	mg/L		09/09/20 01:54	09/10/20 18:57	1
Thallium	ND		0.030	0.0081	mg/L		09/09/20 01:54	09/10/20 18:57	1
Arsenic	ND		0.030	0.016	mg/L		09/09/20 01:54	09/10/20 13:49	1
Selenium	ND		0.050	0.016	mg/L		09/09/20 01:54	09/10/20 13:49	1
Barium	0.13		0.0050	0.0010	mg/L		09/09/20 01:54	09/10/20 13:49	1
Beryllium	ND		0.0050	0.0010	mg/L		09/09/20 01:54	09/10/20 13:49	1
Cadmium	ND		0.0050	0.0010	mg/L		09/09/20 01:54	09/10/20 13:49	1
Chromium	ND		0.015	0.0016	mg/L		09/09/20 01:54	09/10/20 18:57	1
Copper	0.15		0.020	0.012	mg/L		09/09/20 01:54	09/10/20 13:49	1
Lead	ND		0.015	0.0071	mg/L		09/09/20 01:54	09/10/20 13:49	1
Manganese	0.38		0.010	0.0030	mg/L		09/09/20 01:54	09/10/20 13:49	1
Silver	ND		0.010	0.0050	mg/L		09/09/20 01:54	09/10/20 13:49	1
Zinc	0.098		0.020	0.0037	mg/L		09/09/20 01:54	09/10/20 13:49	1
Boron	0.16		0.030	0.012	mg/L		09/09/20 01:54	09/10/20 13:49	1
Strontium	0.54		0.0050	0.00073	mg/L		09/09/20 01:54	09/10/20 18:57	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	650		120	40	mg/L			09/08/20 07:14	1

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Method: EPA 300.0 R2.1 - Anions, Ion Chromatography

Lab Sample ID: MB 410-47905/4
Matrix: Water
Analysis Batch: 47905

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.0698	J	0.10	0.050	mg/L			09/25/20 15:37	1
Sulfate	ND		1.0	0.30	mg/L			09/25/20 15:37	1
Chloride	ND		0.40	0.20	mg/L			09/25/20 15:37	1

Lab Sample ID: LCS 410-47905/3
Matrix: Water
Analysis Batch: 47905

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	0.750	0.755		mg/L		101	90 - 110
Sulfate	7.50	8.00		mg/L		107	90 - 110
Chloride	3.00	3.20		mg/L		107	90 - 110

Lab Sample ID: 410-13225-1 MS
Matrix: Water
Analysis Batch: 47905

Client Sample ID: TW1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	0.92	J F1 B	5.00	1.89	F1	mg/L		19	90 - 110
Sulfate	33		50.0	86.2		mg/L		106	90 - 110
Chloride	61	E F1	20.0	146	E F1	mg/L		425	90 - 110

Lab Sample ID: 410-13225-1 DU
Matrix: Water
Analysis Batch: 47905

Client Sample ID: TW1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Fluoride	0.92	J F1 B	1.14	F5	mg/L		22	15
Sulfate	33		82.1	F3	mg/L		85	15
Chloride	61	E F1	148	E F3	mg/L		84	15

Method: 200.7 Rev 4.4 - Metals (ICP)

Lab Sample ID: MB 410-41886/1-A
Matrix: Water
Analysis Batch: 42610

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 41886

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		0.20	0.15	mg/L		09/09/20 01:54	09/10/20 13:06	1
Arsenic	ND		0.030	0.016	mg/L		09/09/20 01:54	09/10/20 13:06	1
Selenium	ND		0.050	0.016	mg/L		09/09/20 01:54	09/10/20 13:06	1
Barium	ND		0.0050	0.0010	mg/L		09/09/20 01:54	09/10/20 13:06	1
Beryllium	ND		0.0050	0.0010	mg/L		09/09/20 01:54	09/10/20 13:06	1
Cadmium	ND		0.0050	0.0010	mg/L		09/09/20 01:54	09/10/20 13:06	1
Copper	ND		0.020	0.012	mg/L		09/09/20 01:54	09/10/20 13:06	1
Lead	ND		0.015	0.0071	mg/L		09/09/20 01:54	09/10/20 13:06	1
Manganese	ND		0.010	0.0030	mg/L		09/09/20 01:54	09/10/20 13:06	1
Silver	ND		0.010	0.0050	mg/L		09/09/20 01:54	09/10/20 13:06	1
Zinc	ND		0.020	0.0037	mg/L		09/09/20 01:54	09/10/20 13:06	1
Boron	ND		0.030	0.012	mg/L		09/09/20 01:54	09/10/20 13:06	1

QC Sample Results

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Method: 200.7 Rev 4.4 - Metals (ICP)

Lab Sample ID: MB 410-41886/1-A
Matrix: Water
Analysis Batch: 42711

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 41886

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Calcium	ND		0.20	0.096	mg/L		09/09/20 01:54	09/10/20 18:04	1
Iron	ND		0.20	0.040	mg/L		09/09/20 01:54	09/10/20 18:04	1
Magnesium	ND		0.10	0.040	mg/L		09/09/20 01:54	09/10/20 18:04	1
Potassium	ND		0.50	0.20	mg/L		09/09/20 01:54	09/10/20 18:04	1
Sodium	ND		1.0	0.24	mg/L		09/09/20 01:54	09/10/20 18:04	1
Thallium	ND		0.030	0.0081	mg/L		09/09/20 01:54	09/10/20 18:04	1
Chromium	ND		0.015	0.0016	mg/L		09/09/20 01:54	09/10/20 18:04	1
Strontium	ND		0.0050	0.00073	mg/L		09/09/20 01:54	09/10/20 18:04	1

Lab Sample ID: LCS 410-41886/2-A
Matrix: Water
Analysis Batch: 42610

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 41886

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	0.401	0.371		mg/L		93	85 - 115
Arsenic	0.0600	0.0622		mg/L		104	85 - 115
Selenium	0.101	0.109		mg/L		108	85 - 115
Barium	0.0100	0.0107		mg/L		107	85 - 115
Beryllium	0.00992	0.00950		mg/L		96	85 - 115
Cadmium	0.00996	0.0104		mg/L		104	85 - 115
Copper	0.0398	0.0427		mg/L		107	85 - 115
Lead	0.0300	0.0327		mg/L		109	85 - 115
Manganese	0.0200	0.0214		mg/L		107	85 - 115
Silver	0.0200	0.0215		mg/L		108	85 - 115
Zinc	0.440	0.493		mg/L		112	85 - 115
Boron	0.0605	0.0576		mg/L		95	85 - 115

Lab Sample ID: LCS 410-41886/2-A
Matrix: Water
Analysis Batch: 42711

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 41886

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Calcium	0.400	0.412		mg/L		103	85 - 115
Iron	0.402	0.421		mg/L		105	85 - 115
Magnesium	0.200	0.209		mg/L		105	85 - 115
Potassium	5.60	5.84		mg/L		104	85 - 115
Sodium	2.00	2.09		mg/L		104	85 - 115
Thallium	0.0610	0.0639		mg/L		105	85 - 115
Chromium	0.0300	0.0295		mg/L		98	85 - 115
Strontium	0.00996	0.0104		mg/L		105	85 - 115

Method: 2540C-2011 - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 410-41515/1
Matrix: Water
Analysis Batch: 41515

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		30	10	mg/L			09/08/20 07:13	1

Method: 2540C-2011 - Solids, Total Dissolved (TDS) (Continued)

Lab Sample ID: LCS 410-41515/2
Matrix: Water
Analysis Batch: 41515

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	200	196		mg/L		98	72 - 127

HPLC/IC

Analysis Batch: 47905

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-13225-1	TW1	Total/NA	Water	EPA 300.0 R2.1	
MB 410-47905/4	Method Blank	Total/NA	Water	EPA 300.0 R2.1	
LCS 410-47905/3	Lab Control Sample	Total/NA	Water	EPA 300.0 R2.1	
410-13225-1 MS	TW1	Total/NA	Water	EPA 300.0 R2.1	
410-13225-1 DU	TW1	Total/NA	Water	EPA 300.0 R2.1	

Metals

Prep Batch: 41886

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-13225-1	TW1	Total Recoverable	Water	200.7 Rev 4.4	
MB 410-41886/1-A	Method Blank	Total Recoverable	Water	200.7 Rev 4.4	
LCS 410-41886/2-A	Lab Control Sample	Total Recoverable	Water	200.7 Rev 4.4	

Analysis Batch: 42610

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-13225-1	TW1	Total Recoverable	Water	200.7 Rev 4.4	41886
MB 410-41886/1-A	Method Blank	Total Recoverable	Water	200.7 Rev 4.4	41886
LCS 410-41886/2-A	Lab Control Sample	Total Recoverable	Water	200.7 Rev 4.4	41886

Analysis Batch: 42711

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-13225-1	TW1	Total Recoverable	Water	200.7 Rev 4.4	41886
MB 410-41886/1-A	Method Blank	Total Recoverable	Water	200.7 Rev 4.4	41886
LCS 410-41886/2-A	Lab Control Sample	Total Recoverable	Water	200.7 Rev 4.4	41886

General Chemistry

Analysis Batch: 41515

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-13225-1	TW1	Total/NA	Water	2540C-2011	
MB 410-41515/1	Method Blank	Total/NA	Water	2540C-2011	
LCS 410-41515/2	Lab Control Sample	Total/NA	Water	2540C-2011	

Lab Chronicle

Client: EA Engineering, Science, and Technology — Job ID: 410-13225-1
Project/Site: Nebraska OC1 Groundwater Analysis — SDG: Monolith

Client Sample ID: TW1 — Lab Sample ID: 410-13225-1

Date Collected: 09/04/20 14:15 — **Matrix: [illegible]er**
Date Received: 09/05/20 10:40

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA 300.0 R2.1		10	47905	09/25/20 15:55	IMZ	ELLE
Total Recoverable	Prep	200.7 Rev 4.4			41886	09/09/20 01:54	UJL8	ELLE
Total Recoverable	Analysis	200.7 Rev 4.4		1	42610	09/10/20 13:49	UPJE	ELLE
Total Recoverable	Prep	200.7 Rev 4.4			41886	09/09/20 01:54	UJL8	ELLE
Total Recoverable	Analysis	200.7 Rev 4.4		1	42711	09/10/20 18:57	UCIG	ELLE
Total/NA	Analysis	2540C-2011		1	41515	09/08/20 07:14	M98K	ELLE

Laboratory References:

ELLE = Eurofins Lancaster Laboratories Env, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Laboratory: Eurofins Lancaster Laboratories Env, LLC

U[illegible] otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Nebraska	State	NE-OS-32-17	01-31-20 *

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
200.7 Rev 4.4	200.7 Rev 4.4	Water	Aluminum
200.7 Rev 4.4	200.7 Rev 4.4	Water	Arsenic
200.7 Rev 4.4	200.7 Rev 4.4	Water	Barium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Beryllium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Boron
200.7 Rev 4.4	200.7 Rev 4.4	Water	Cadmium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Calcium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Chromium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Copper
200.7 Rev 4.4	200.7 Rev 4.4	Water	Iron
200.7 Rev 4.4	200.7 Rev 4.4	Water	Lead
200.7 Rev 4.4	200.7 Rev 4.4	Water	Magnesium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Manganese
200.7 Rev 4.4	200.7 Rev 4.4	Water	Potassium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Selenium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Silver
200.7 Rev 4.4	200.7 Rev 4.4	Water	Sodium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Strontium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Thallium
200.7 Rev 4.4	200.7 Rev 4.4	Water	Zinc
2540C-2011		Water	Total Dissolved Solids
EPA 300.0 R2.1		Water	Chloride
EPA 300.0 R2.1		Water	Fluoride
EPA 300.0 R2.1		Water	Sulfate

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Method	Method Description	Protocol	Laborator.
EPA 300.0 R2.1	Anions, Ion Chromatography	EPA	ELLE
200.7 Rev 4.4	Metals (ICP)	EPA	ELLE
2540C-2011	Solids, Total Dissolved (TDS)	SM	ELLE
200.7 Rev 4.4	Preparation, Total Recoverable Metals	EPA	ELLE

Protocol References:

EPA = US Environmental Protection Agency

SM = "Standard Methods For The Examination Of Water And Wastewater"

Laboratory References:

ELLE = Eurofins Lancaster Laboratories Env, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Sample Summary

Client: EA Engineering, Science, and Technology
Project/Site: Nebraska OC1 Groundwater Analysis

Job ID: 410-13225-1
SDG: Monolith

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
410-13225-1	TW1	Water	09/04/20 14:15	09/05/20 10:40	

410-13225 Chain of Custody

Chain of Custody Record

eurofins

Sampler: David M Masciale	Lab PM: Hower, Kay G	Carrier Tracking No(s):	COC No: 410-9444-2719 1
Client Contact: Jamie Suing	Phone:	E-Mail: kayhower@eurofinsus.com	Page: Page 1 of 1
Company: EA Engineering, Science, and Technology			Job #:
Address: 221 Sun Valley Boulevard Suite D	Due Date Requested:		
City: Lincoln	TAT Requested (days):		
State, Zip: NE, 68528			
Phone: 402-476-3766(Tel)	PO #: 20930		
Email: jsuing@eaest.com	WO #:		
Project Name: Nebraska OC1 Groundwater Analysis	Project #: 41002538		
Site: Monolith	SSOW#:		

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	2540C_SingleDry, 300_ORGFM_28D	200.7 - 20 ICP Metals	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	D		
TW1	9/4/2020	1415	G	Water			X	X		

Preservation Codes:
A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)
Other:

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by: | Date: | Time: | Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Edwin Hernandez	9/3/20 1330		David Masciale	9/4/2020 1300	EA
David Masciale	9/4/2020 1530	EA			
			[signature]	9/5/20 1040	ETE

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks: 0.8

Ver: 01/16/2019

TMR

9/28/2020

Login Sample Receipt Checklist

Client: EA Engineering, Science, and Technology

Job Number: 410-13225-1
SDG Number: Monolith

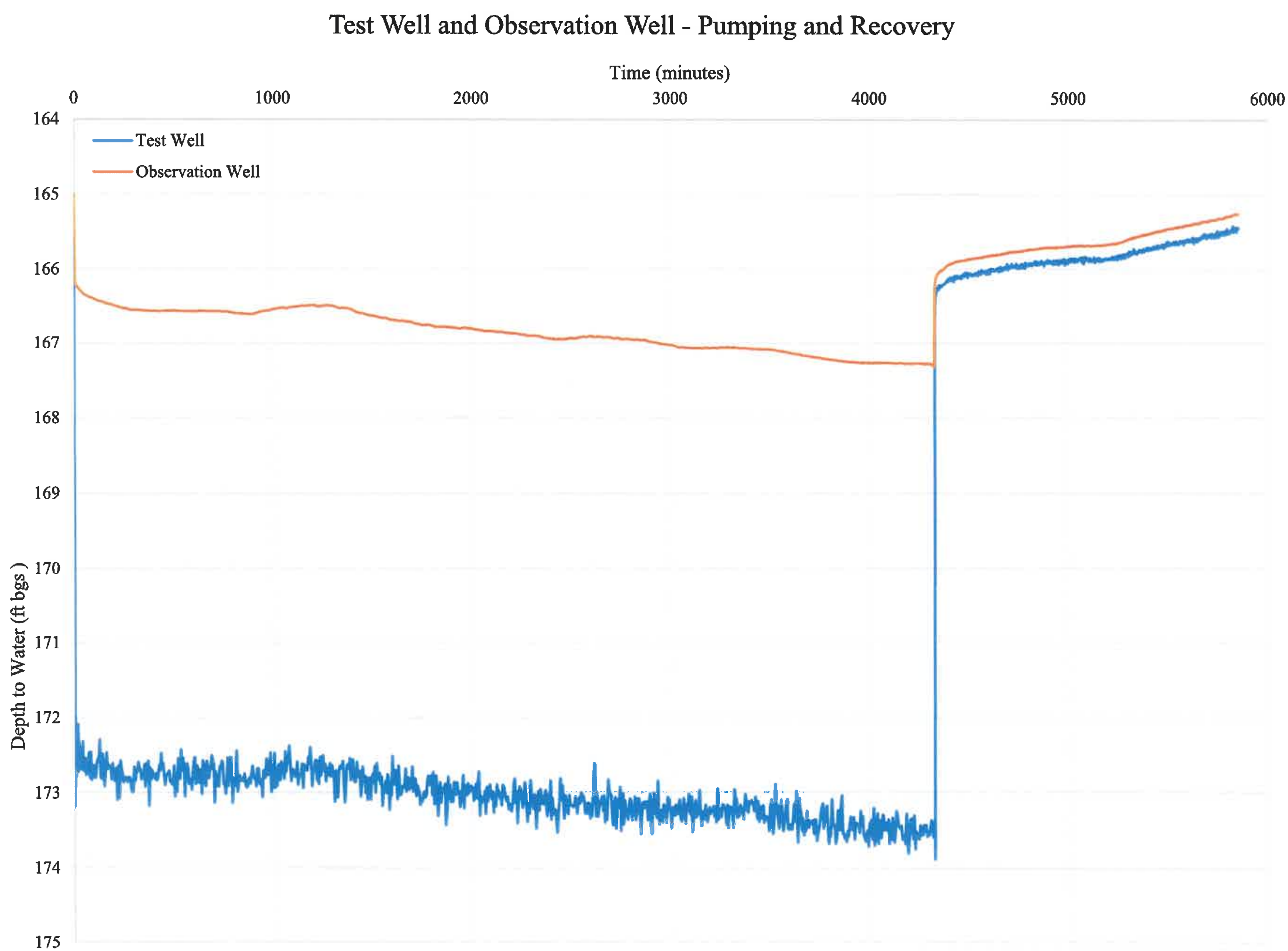
Login Number: 13225
List Number: 1
Creator: Rivera, Tatiana

List Source: Eurofins Lancaster Laboratories Env

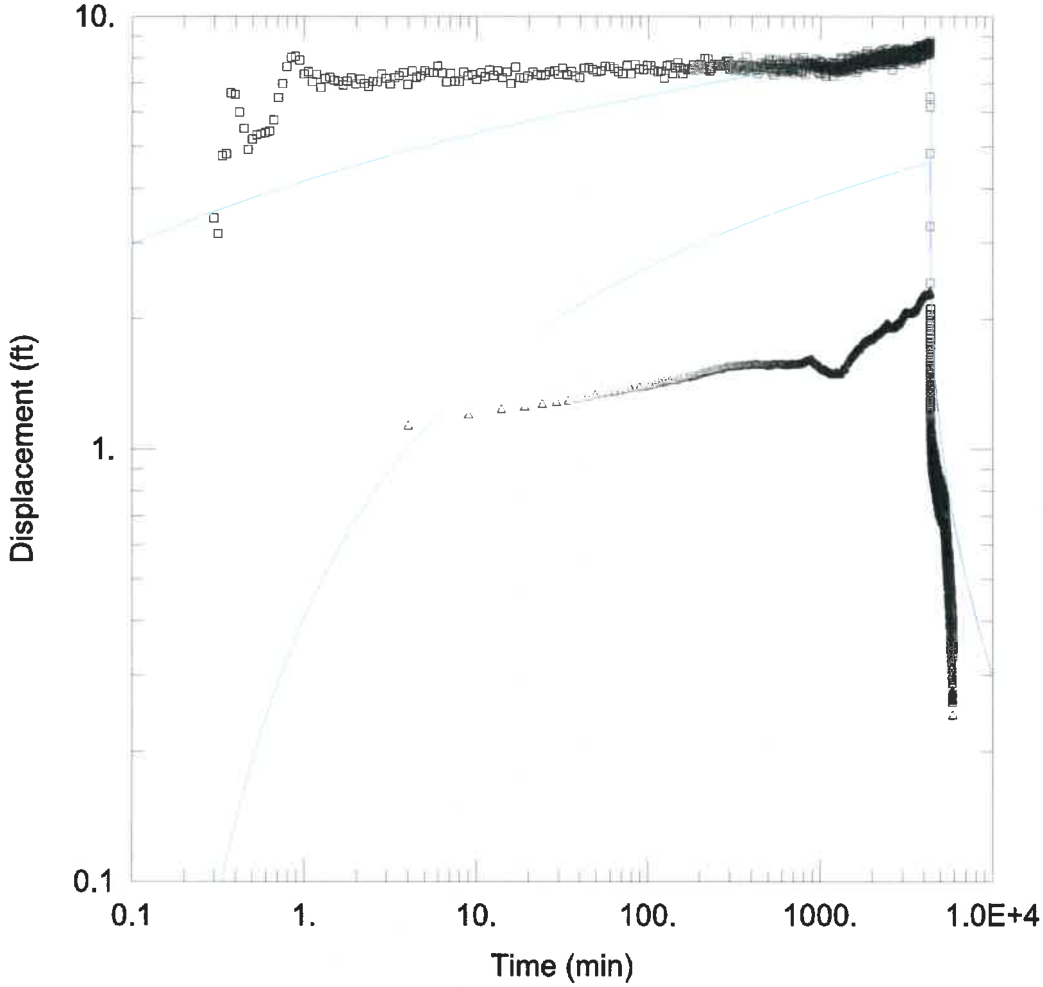
Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable (</=6C, not frozen).	True	
Cooler Temperature is recorded.	True	
WV: Container Temperature is acceptable (</=6C, not frozen).	N/A	
WV: Container Temperature is recorded.	N/A	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses.	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	N/A	
Is the Field Sampler's name present on COC?	True	
Sample Preservation Verified.	N/A	
Residual Chlorine Checked.	N/A	
Sample custody seals are intact.	N/A	

ATTACHMENT 5

CONSTANT RATE PUMPING TEST ANALYSES



Test Well and Observation Well - Pumping and Recovery
Time (minutes)
0
1000
2000
3000
4000
5000
6000
Depth to Water (ft bgs)
164
165
166
167
168
169
170
171
172
173
174
175
Test Well
Observation Well



All Data from Constant-Rate Test

Data Set: C:\...\Theis Analysis_all data.aqt
Date: 09/25/20 Time: 11:20:42

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well
Test Date: 9/2/2020

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ Test Well	0	0
△ OB Well	72.5	0

SOLUTION

Aquifer Model: Confined

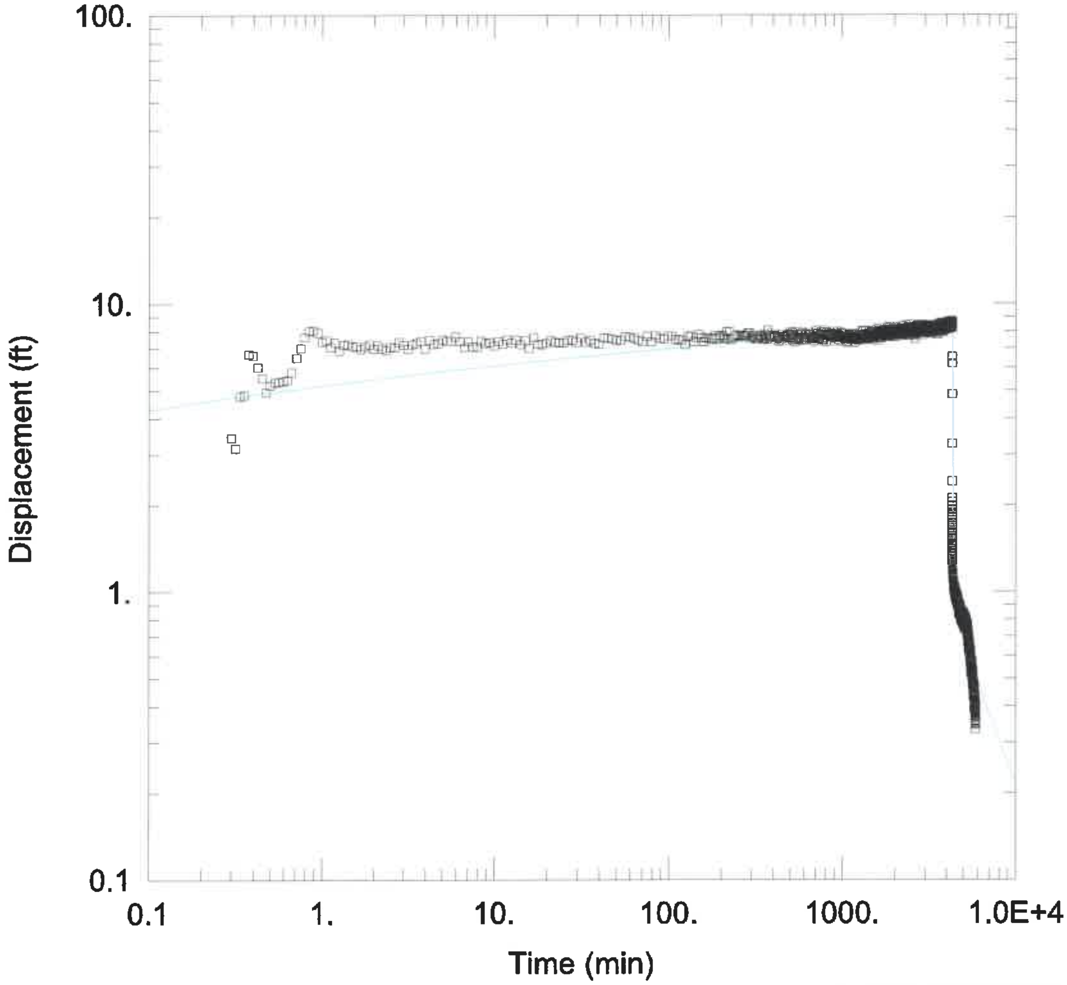
Solution Method: Theis

T = 16.26 ft^2/min

S = 0.004398

Kz/Kr = 1.

b = 60. ft



Test Well 1R - Constant Rate Test Data

Data Set: C:\...\Theis Analysis_Test Well Only.aqt

Date: 09/24/20 Time: 15:02:2

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well
Test Date: 9/2/2020

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ Test Well	0	0

SOLUTION

Aquifer Model: Confined

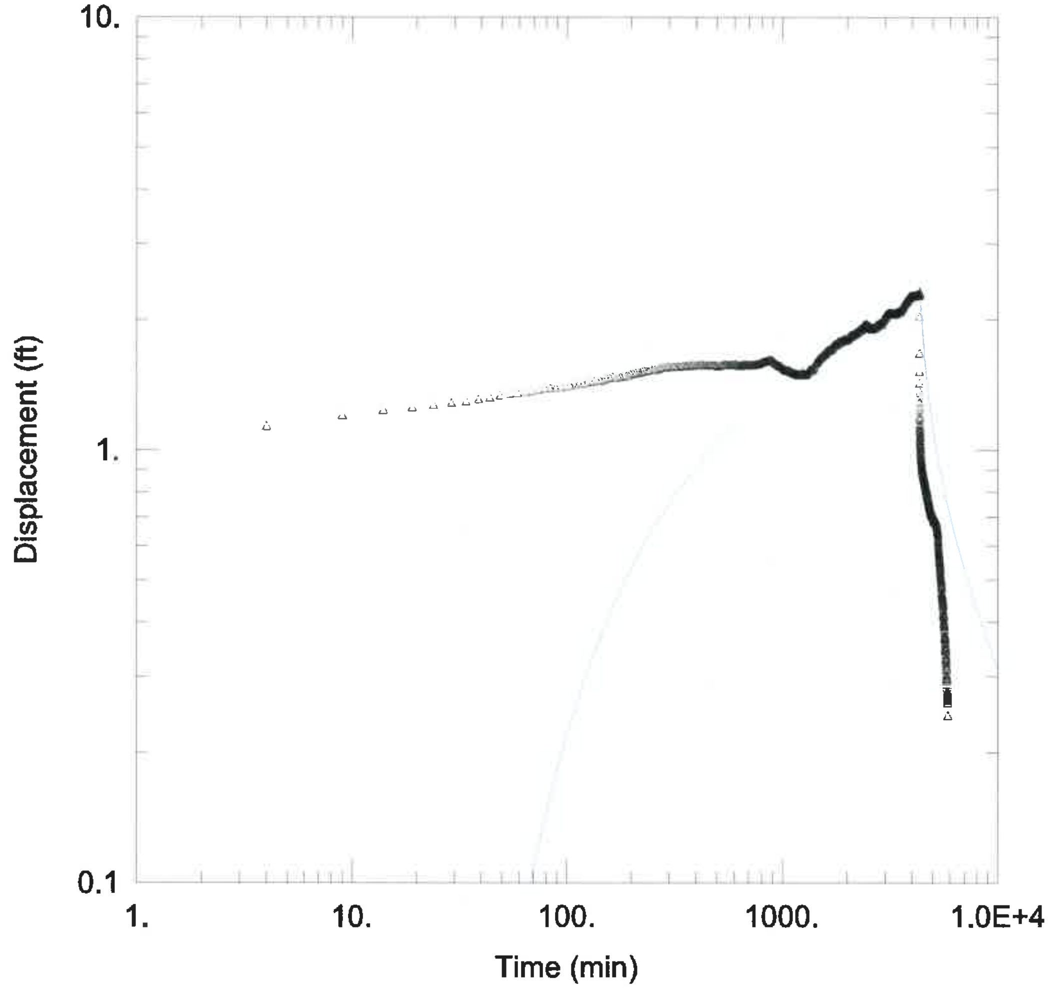
Solution Method: Theis

T = 21.73 ft^2/min

S = 7.198E-8

Kz/Kr = 1.

b = 60. ft



Observation Well - Constant Rate Test

Data Set: C:\...\Ob Well Aqtesolve Plot.aqt
Date: 09/24/20 Time: 15:24:21

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well
Test Date: 9/2/2020

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
OB Well	72.5	0

Observation Wells

Well Name	X (ft)	Y (ft)
OB Well	72.5	0

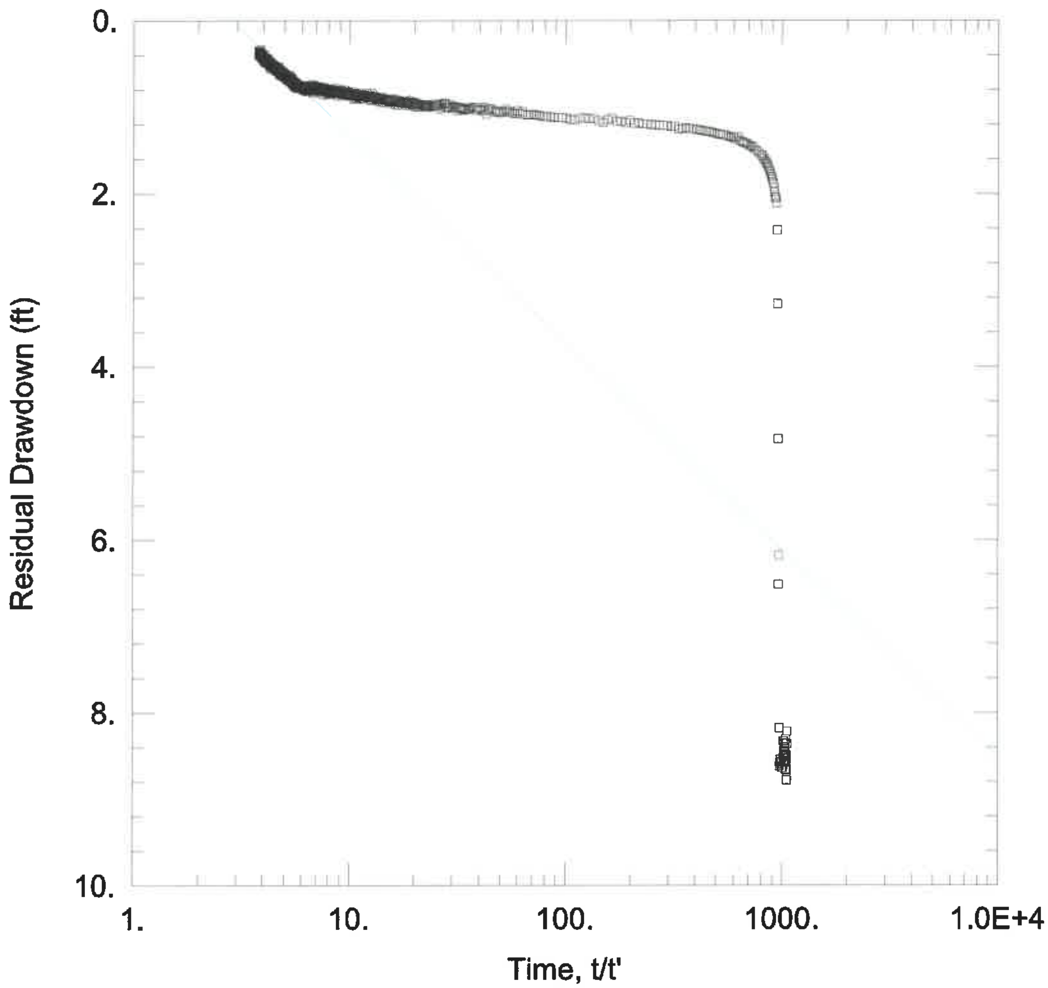
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 15.5 ft^2/min
Kz/Kr = 1.

S = 2.33
b = 60. ft



Test Well 1R Recovery, Constant Rate Test

Data Set: C:\...\Theis Test Well Recovery.aqt

Date: 09/25/20

Time: 11:55:18

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well
Test Date: 9/2/2020

AQUIFER DATA

Saturated Thickness: 60. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ Test Well	0	0

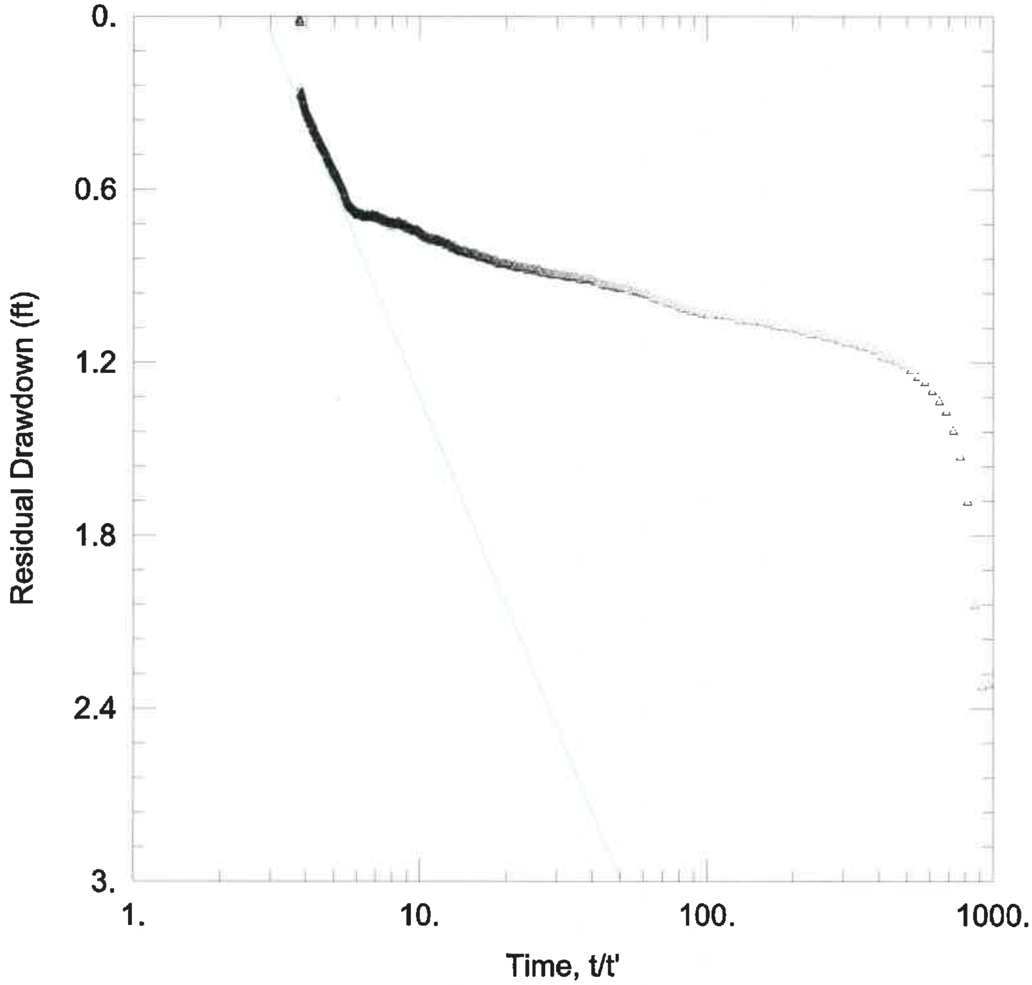
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 8.136 ft^2/min

S/S' = 2.827



OBSERVATION WELL RECOVERY, CONSTANT-RATE

TEST TEST Data Set: C:\...\Theis Ob Well Recovery.aqt

Date: 09/25/20 Time: 11:43:35

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well
Test Date: 9/2/2020

AQUIFER DATA

Saturated Thickness: 60. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
OB Well	72.5	0

Observation Wells

Well Name	X (ft)	Y (ft)
OB Well	72.5	0

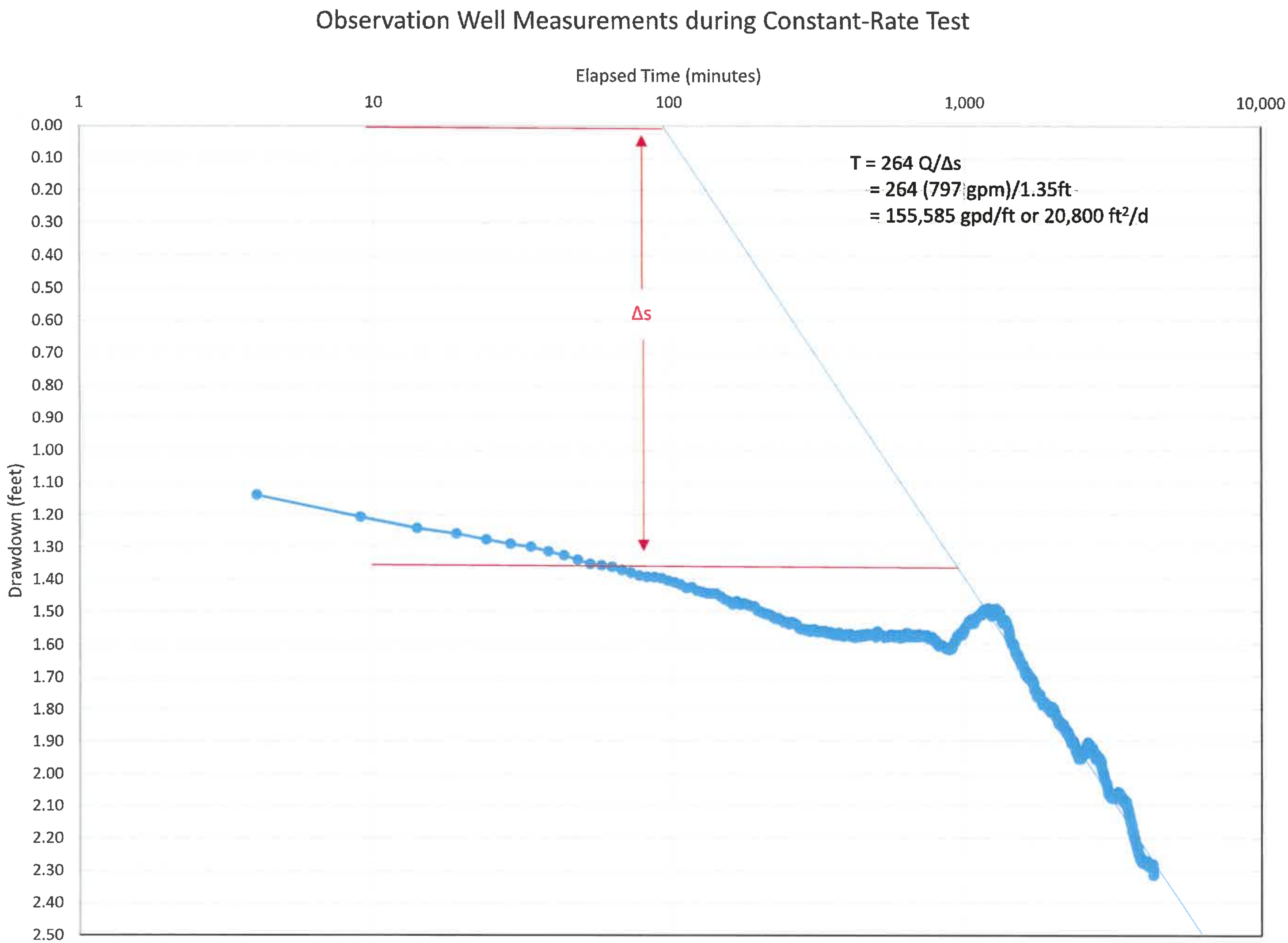
SOLUTION

Aquifer Model: Confined

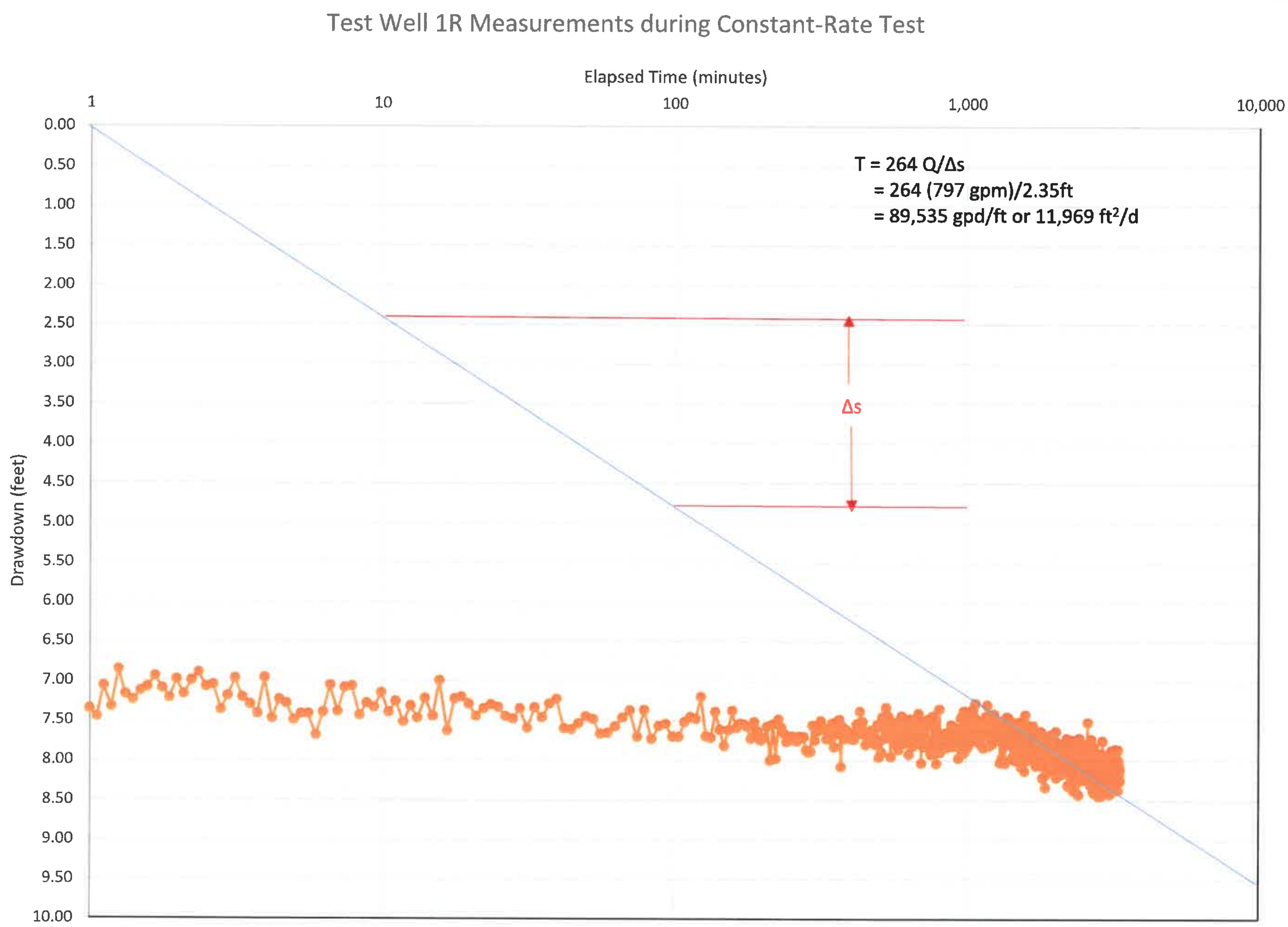
Solution Method: Theis (Recovery)

T = 8.136 ft^2/min

S/S' = 2.827



Observation Well Measurements during Constant-Rate Test
Elapsed Time (minutes)
1
10
100
1,000
10,000
Drawdown (feet)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
1.60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
2.50
Δs
T = 264 Q/Δs
= 264 (797 gpm)/1.35ft
= 155,585 gpd/ft or 20,800 ft²/d


Test Well 1R Measurements during Constant-Rate Test
Elapsed Time (minutes)
1
10
100
1,000
10,000
Drawdown (feet)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
10.00
T = 264 Q/Δs
= 264 (797 gpm)/2.35ft
= 89,535 gpd/ft or 11,969 ft²/d
Δs

ATTACHMENT 6

STEP- AND CONSTANT-RATE PUMPING TEST DATA FILES FOR TRANSDUCER MEASUREMENTS (ELECTRONICALLY PROVIDED)

EA Engineering, Science, and Technology, Inc., PBC

221 Sun Valley Blvd, Suite D
Lincoln, NE 68528
Telephone: 402-476-3766
www.eaest.com

05 October 2020

Mr. Matthew Rhodes
Monolith Nebraska LLC
a Delaware Limited Liability Company
134 South 13th Street, Suite 700
Lincoln, NE 68508

Re: Addendum to Technical Memorandum
Aquifer Pumping Test Procedures, Analysis, and Results
Olive Creek 1 Carbon Black Manufacturing Facility, Hallam Nebraska

Dear Mr. Rhodes:

EA Engineering, Science, and Technology, Inc., PBC (EA) is providing an addendum to the above-reference document submitted to Monolith Nebraska LLC on September 28, 2020. The addendum provides a more in depth analysis of the aquifer response to the imposed pumping stresses and refinement of hydraulic parameter estimates from the testing completed at Test Well 1R (TW-1R) located in the northeast portion of the Olive Creek 1 (OC1) site. A discussion of the provided materials is provided below and supported with the enclosed attachments.

Observation Well Hydrograph

Attachment A provides a graphical representation of the automated depth to water measurements collected between August 28 and September 24, 2020 within the observation well located a radial distance of 72.5 feet from the well TW-1R. Groundwater levels ranged within a 3.5-foot band during this period with the lowest levels occurring at the end of the step- and constant-rate testing period, and the highest levels occurring near the end of the automated data collection period. Groundwater levels ranged from approximately 163.75 to 167.25 feet below the top of casing. The graph includes pre-testing, step-rate test, constant-rate test, and post-testing measurements.

Since completion of the constant-rate pumping and recovery period, groundwater levels have increased by approximately 1.2 feet. The overall rising groundwater level trend is marked by short periods of decline likely associated with cyclic pumping by existing groundwater users. With the change in season, a decline in irrigation water demand is likely responsible for the general rise in groundwater levels.

Additional Constant-Rate Pumping Test Analysis

Lithologic logs were developed from cuttings provided by the well drilling contractor. The observation and test well samples consisted of silty clays from approximately 160 to 180 feet below ground surface (ft bgs). The unconsolidated sediments consisted primarily of sands from 180 to 300 ft bgs at the observation well location, while samples provided for the test well location contain significant intervals of clay. Both wells were screened from approximately 240 to 300 ft bgs.

Using aerial geophysical methods, Devine and Korus (2012) were able to map hydrostratigraphic units regionally. Beneath the OC1 site, the estimated aquifer thickness is 175 ft based on their work. The fine-grained unit present above the interval of well completion were not extensive enough to delineate a true confining unit in the area. However, the aquifer response to pumping and observed background trend suggest that that semi-confined condition are locally present.

The Theis (1935) and Jacob-Cooper (1946) analytical solutions are typically used to estimate aquifer parameters; however, when the underlying assumptions regarding aquifer type and partial penetration well details are considered the confined solution does not fully characterize the aquifer response to pumping (Attachment B). These solutions can be applied to other aquifers types (semi-confined and unconfined) with storage coefficient values being representative of aquifer conditions. In unconfined settings, this approach is also reasonable when the amount of drawdown is significantly less than the overall saturated thickness.

The Hantush and Jacob (1955) solution can account for partially penetrating wells and is useful for determining aquifer properties within semi-confined aquifers. Additional analysis was completed using this solution (Attachment B) as the effect of partial penetration and vertical leakance is likely significant. The test and observation well screens are exposed to only 34-percent of the entire aquifer thickness mapped by Divine and Korus (2012).

According to Neuman (1974), early-time response is controlled by the transmissivity and elastic storage coefficient (S) and is analogous to the response of a confined aquifer. While the late-time response is a function of transmissivity and drainable porosity, more commonly referred to as specific yield (Sy). At intermediate time, the response is controlled by the aquifer's vertical hydraulic conductivity. Additional analysis was completed using the Neuman solution for unconfined aquifer (Attachment B) to address observed deviation from classic Theis solution behavior during the drawdown period of the constant-rate test.

Aquifer Parameter Estimates

Attachment C provides refined estimates for the aquifer storage parameters S and Sy based on the analysis described above. Representative S and Sy values are estimated at 0.001 and 0.20, respectively.

The unconfined aquifer analysis appears to over-estimate aquifer transmissivity (T) values as the observed specific capacity and well efficiency is more in line with values in the range of 150,000 to 200,000 gallons per day/foot (gpd/ft).

Hydraulic conductivity estimates have been revised by dividing T by the estimated saturated thickness of 175 ft mapped by Diving and Korus (2012).

Closing

We have appreciated the opportunity to support Monolith. Please feel free to contact us by email or phone with any questions that you may have related the submitted addendum materials.

Sincerely,

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC

Jamie Suing, P.E.
Project Manager

Bob Marley, P.G
Senior Hydrogeologist

cc: Dale Schlautman

References

Divine, D.P. and Korus, J.T., 2012. Three-dimensional hydrostratigraphy of the Sprague, Nebraska Area: Results from Helicopter Electromagnetic (HEM) mapping for the Eastern Nebraska Water Resources Assessment (ENWRA). Conservation and Survey Division, School of Natural Resources, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln. Conservation Bulletin 4 (New Series), 32 p.

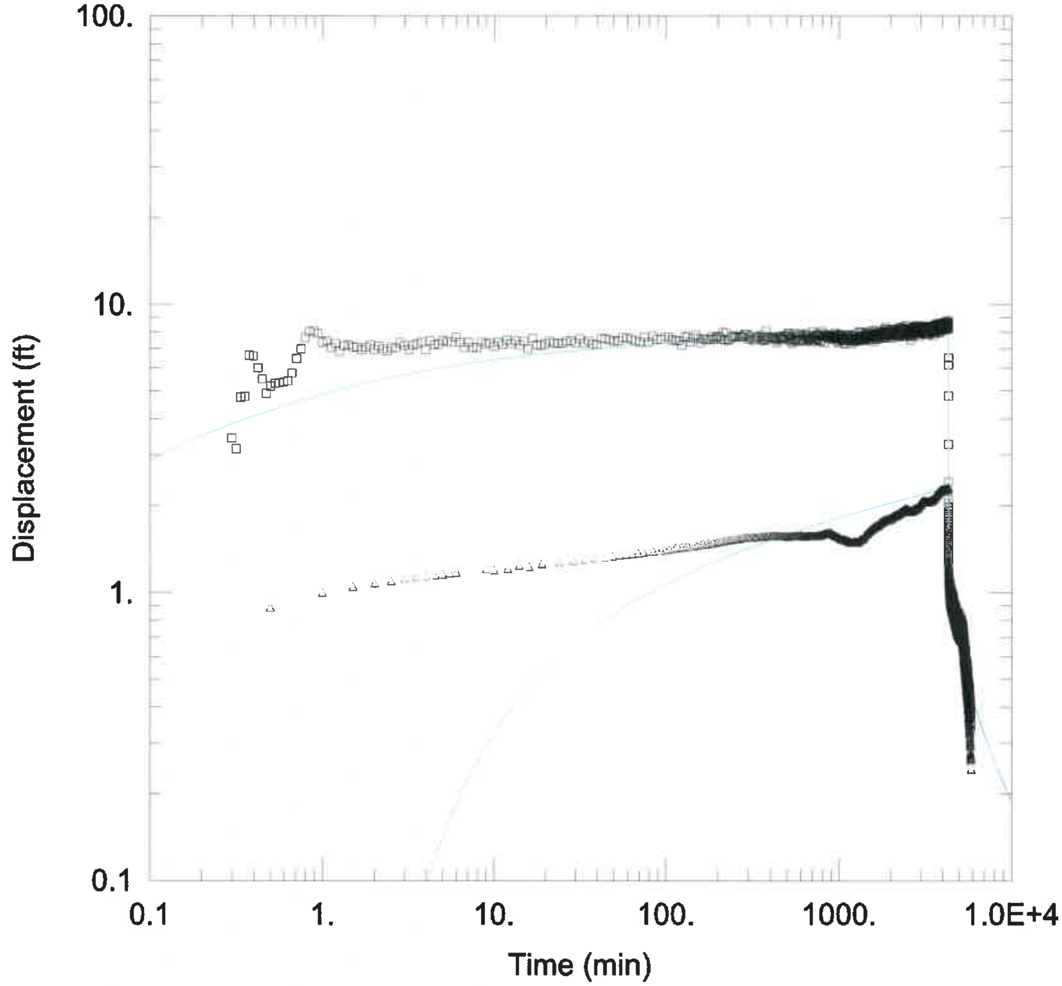
Hantush, M.S. and C.E. Jacob, 1955. Non-steady radial flow in an infinite leaky aquifer, Am. Geophys. Union Trans., vol. 36, no. 1, pp. 95-100.

Neuman, S.P., 1974. Effect of partial penetration on flow in unconfined aquifers considering delayed gravity response, Water Resources Research, vol. 10, no. 2, pp. 303-312.

Attachment A
Observation Well Hydrograph

Observation Well Hydrograph

Attachment B
Additional Constant-Rate Pumping Test Analysis



CONSTANT-RATE PUMPING TEST

Data Set: C:\...\Theis Well Analysis Update.aqt
Date: 10/05/20 Time: 11:23:57

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well TW-1R
Test Date: 9/2/2020

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0
OB Well	72.5	0

SOLUTION

Aquifer Model: Confined

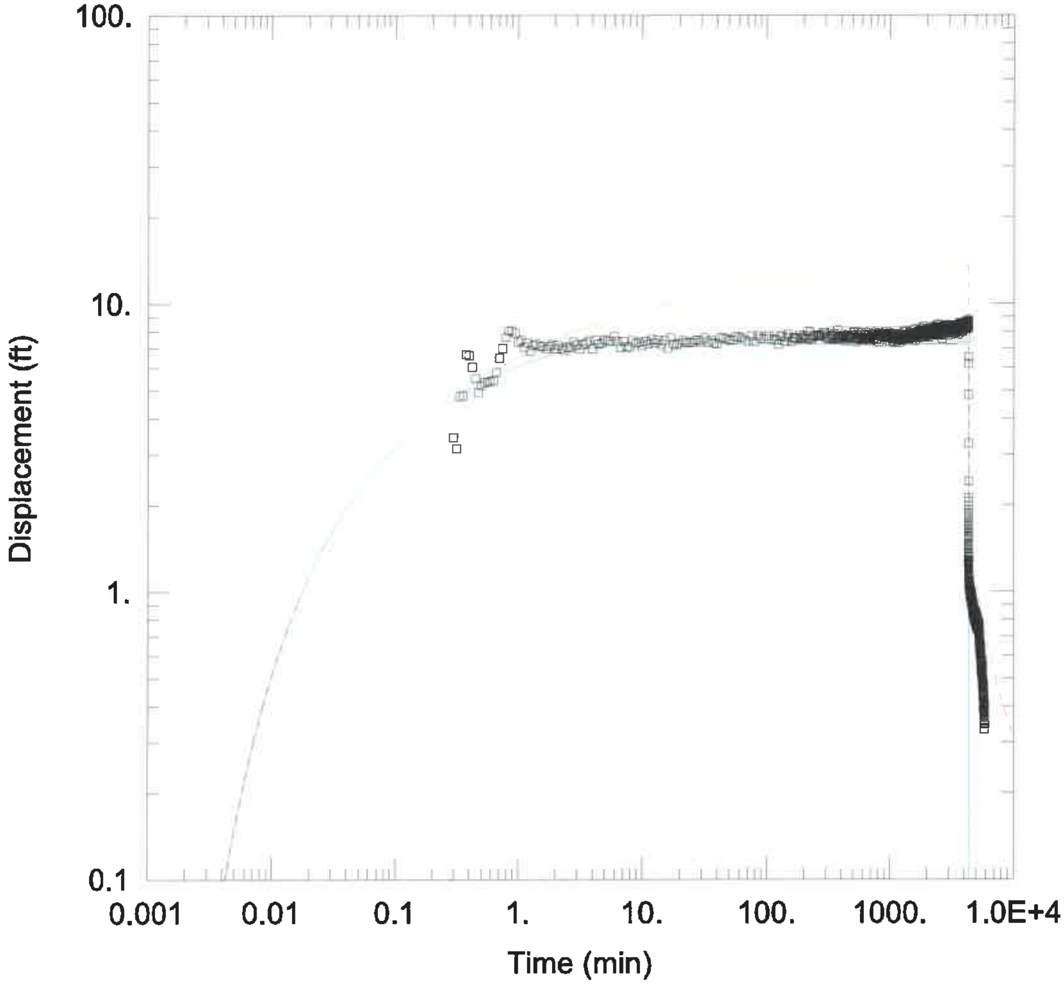
Solution Method: Theis

T = 25.52 ft^2/min

Kz/Kr = 0.3022

S = 0.1

b = 175. ft



CONSTANT-RATE PUMPING TEST

Data Set: C:\...\Leaky Confined.aqt
Date: 10/02/20 Time: 07:50:48

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well TW-1R
Test Date: 9/2/2020

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ Test Well	0	0

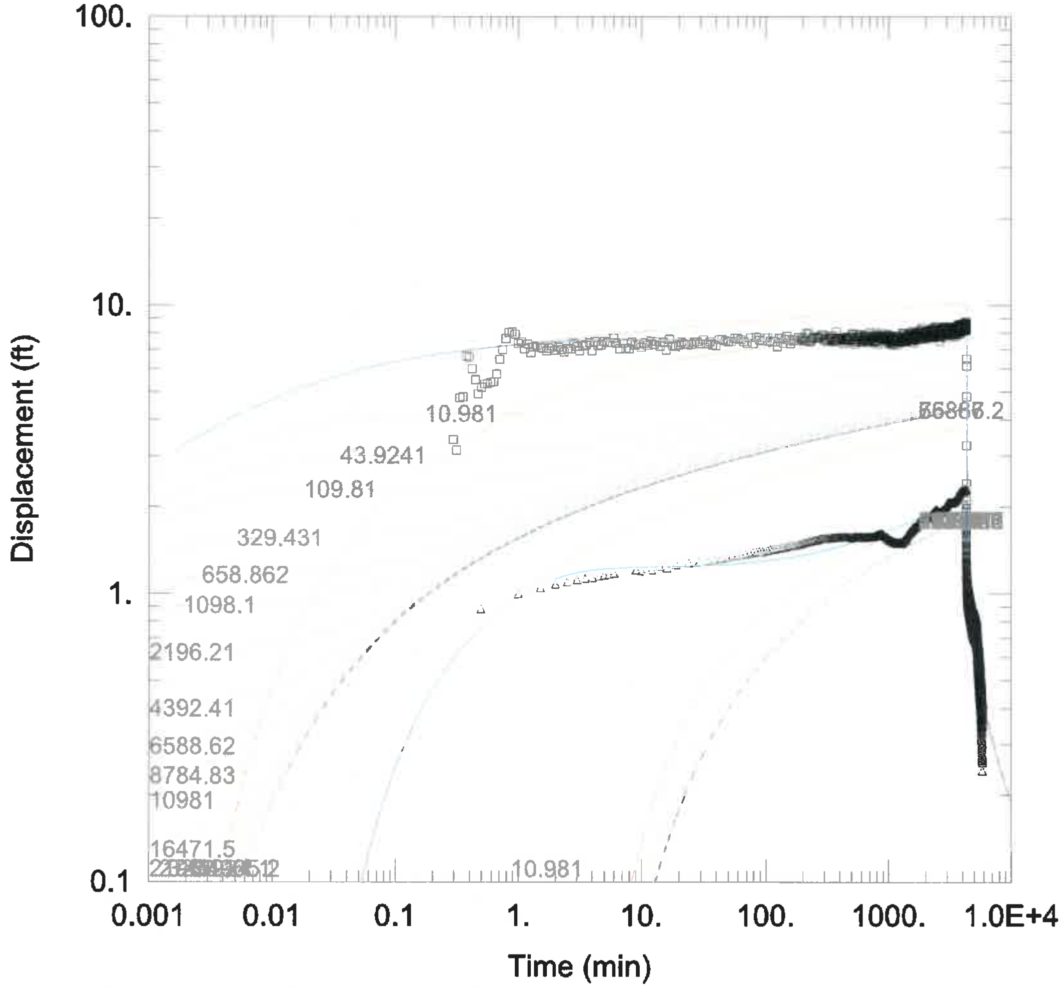
SOLUTION

Aquifer Model: Leaky

T = 15.64 ft^2/min
r/B = 0.1
b = 175. ft

Solution Method: Hantush-Jacob

S = 0.1717
Kz/Kr = 0.3



CONSTANT-RATE PUMPING TEST

Data Set: C:\...\Neuman AnalysisR1.aqt
Date: 10/01/20 Time: 17:59:13

PROJECT INFORMATION

Company: EA Engineering
Client: Monolith
Project: 1602602
Location: Hallam, NE
Test Well: Test Well TW-1R
Test Date: 9/2/2020

AQUIFER DATA

Saturated Thickness: 175. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Test Well	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ Test Well	0	0
△ OB Well	72.5	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman

T = 25.19 ft^2/min S = 0.001288

Attachment C
Aquifer Parameter Estimates

Section 4. Aquifer Parameter Estimates

Well	Method	Software	Data	T		K	S	Sy
				(gpd/ft)	(ft^2/day)	ft/day		
Test Well 1R	Theis (1935)	Aqtesolv	Drawdown-Recovery	234,058	31,291	179	-	-
			Recovery	87,634	11,716	67	-	-
	Cooper-Jacob (1946)	Excel	Drawdown	89,535	11,970	68	-	-
	Hantush-Jacob (1955)	Aqtesolv	Drawdown-Recovery	168,457	22,521	129	0.17	-
	Neuman (1974)	Aqtesolv	Drawdown-Recovery	269,280	36,000	206	0.004	0.17
Observation Well	Theis (1935)	Aqtesolv	Recovery	87,634	11,716	67	-	-
	Cooper-Jacob (1946)	Excel	Drawdown	155,585	20,800	119	-	-
Both Wells	Theis (1935)	Aqtesolv	Drawdown-Recovery	274,883	36,749	210	0.10	-
	Neuman (1974)	Aqtesolv	Drawdown-Recovery	271,327	36,274	207	0.001	0.20

Notes:

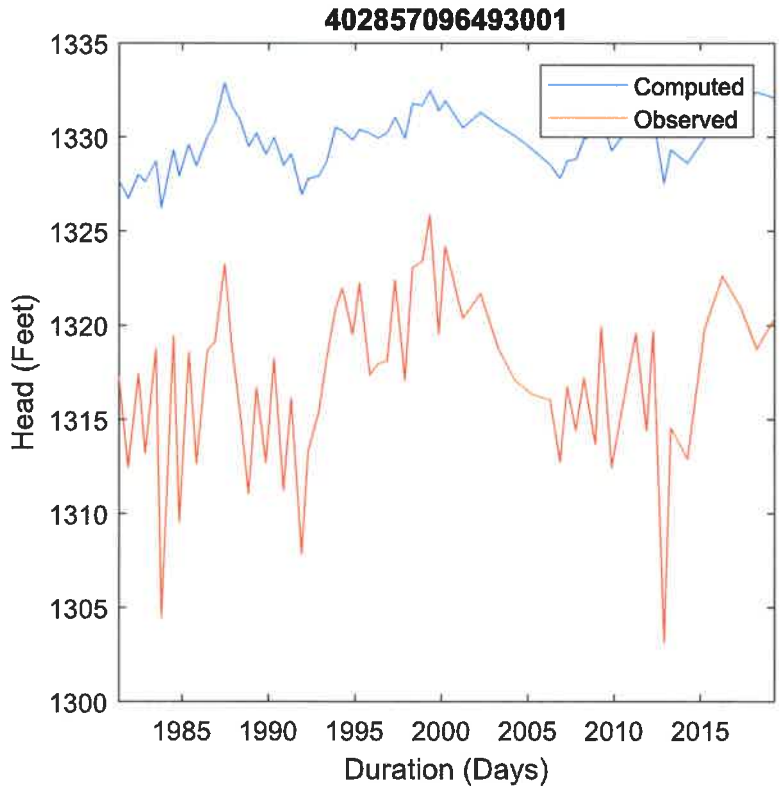
New analysis provided with addendum shaded in table.
Sy = Specific Yield (unitless)
S = Storativity (unitless)
T = Transmissivity
K = Hydraulic Conductivity

gpd/ft = gallons per day/foot

K values estimated by dividing T by estimated saturated thickness of 175 ft screen (Divine and Korus 2012).

APPENDIX D

Modeled and Observed Water Levels at Target Locations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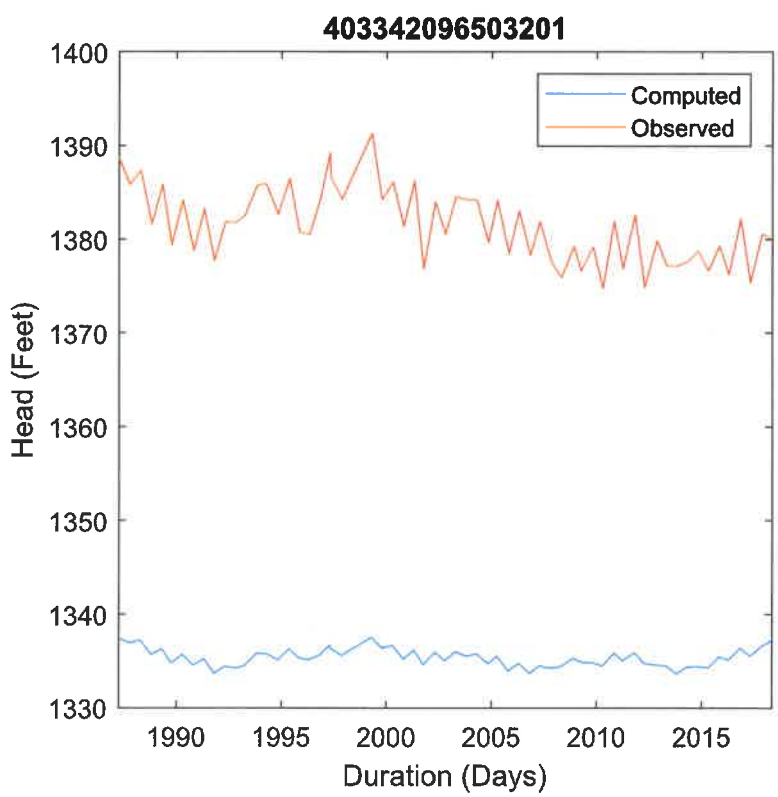
Computed
Observed
Head (Feet)
1335
1330
1325
1320
1315
1310
1305
1300
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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Head (Feet)
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1370
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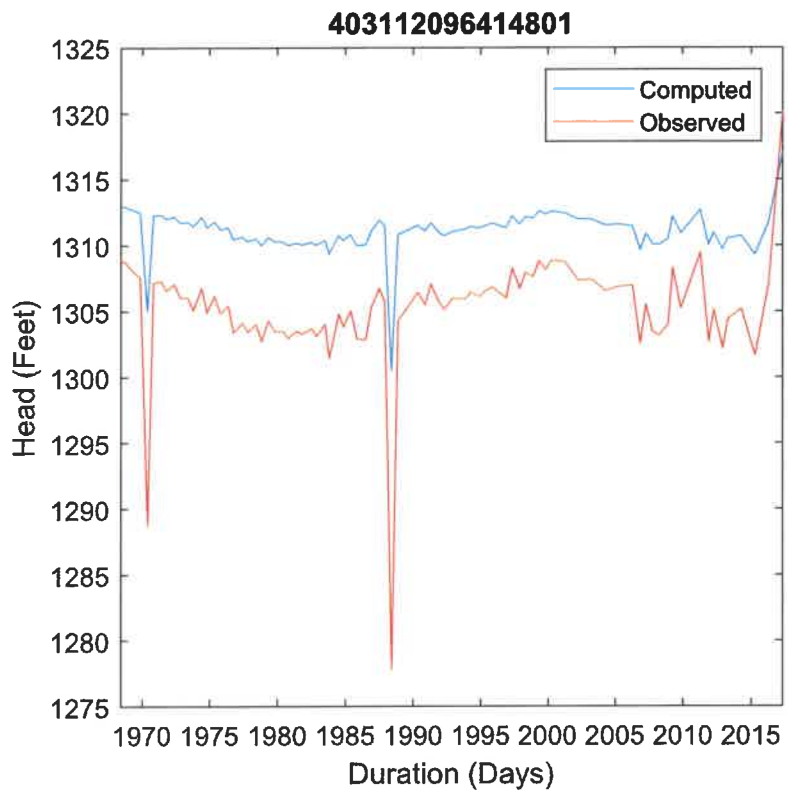
1990
1995
2000
2005
2010
2015
Duration (Days)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Observed
1325
1320
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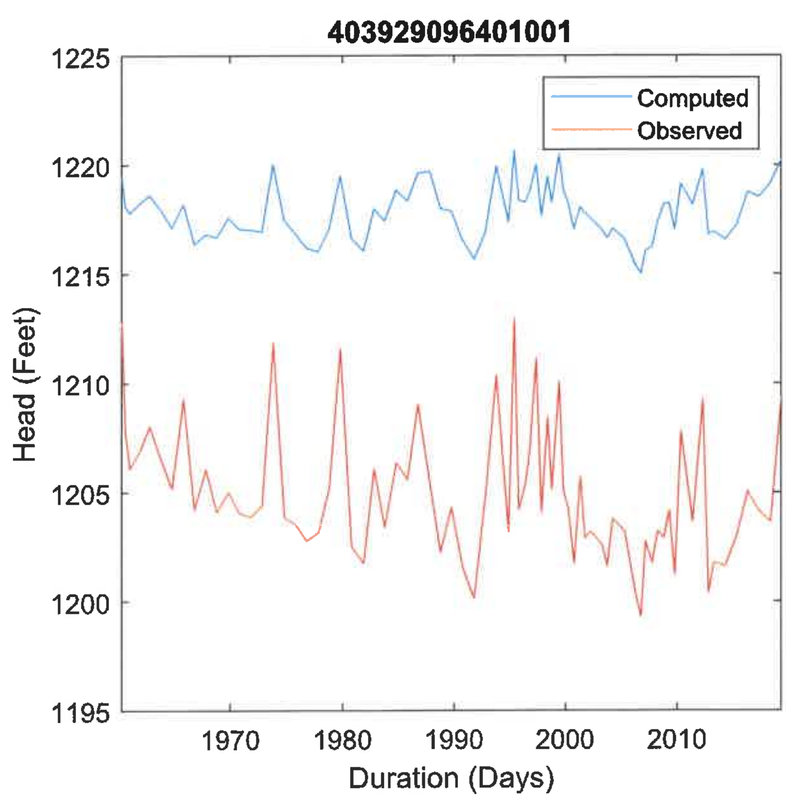
1305
1300
1295
1290
1285
1280
1275
Head (Feet)
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Duration (Days)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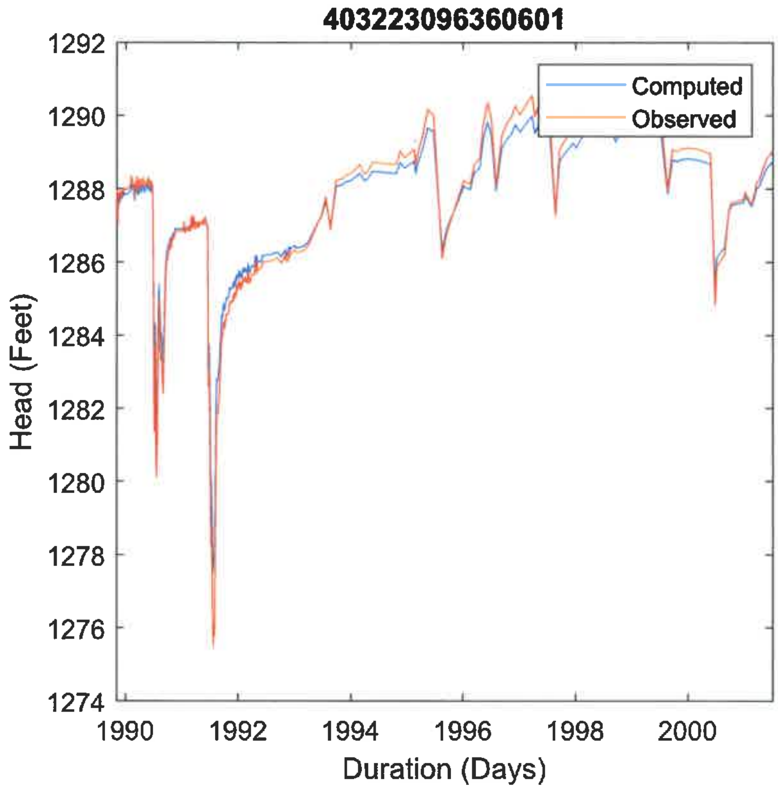
1205
1200
1195
Head (Feet)
1970 1980 1990 2000 2010
Duration (Days)



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Observed
Head (Feet)
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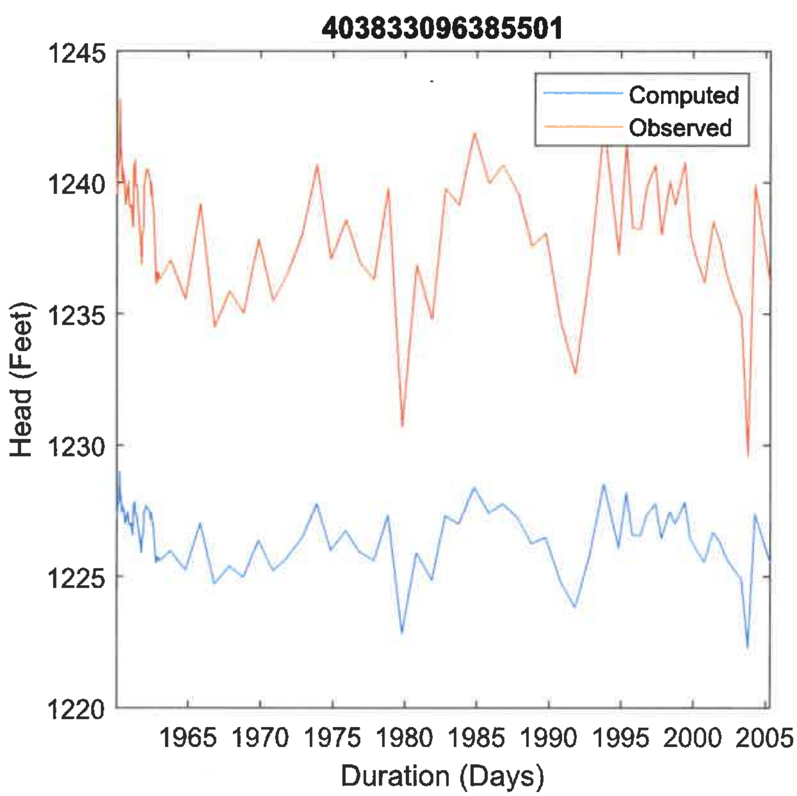
1290
1288
1286
1284
1282
1280
1278
1276
1274
1990
1992
1994
1996
1998
2000
Duration (Days)



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Computed
Observed
Head (Feet)
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1240
1235
1230
1225
1220
1965
1970
1975
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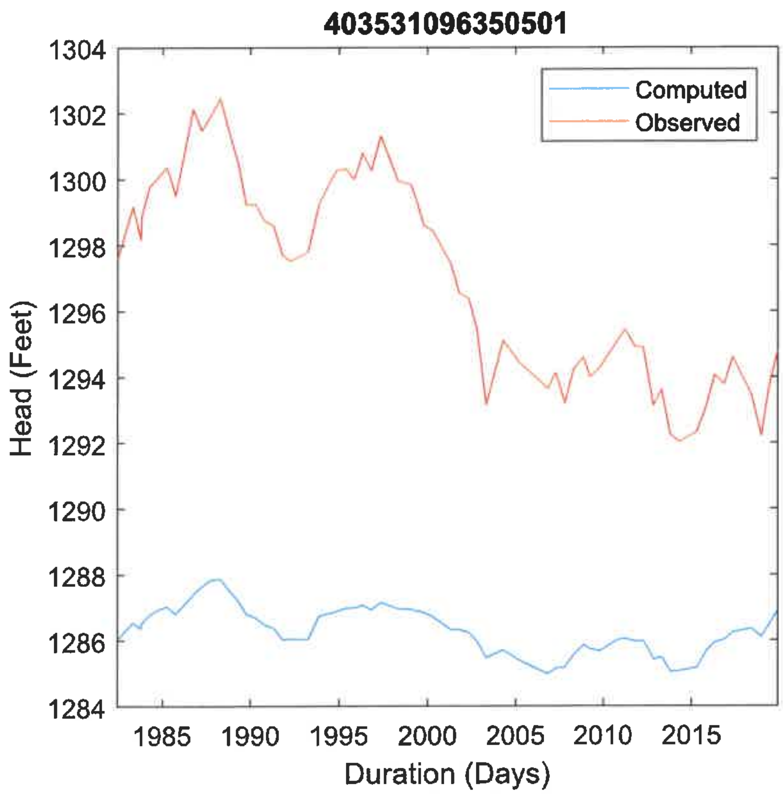
1990
1995
2000
2005
Duration (Days)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Head (Feet)
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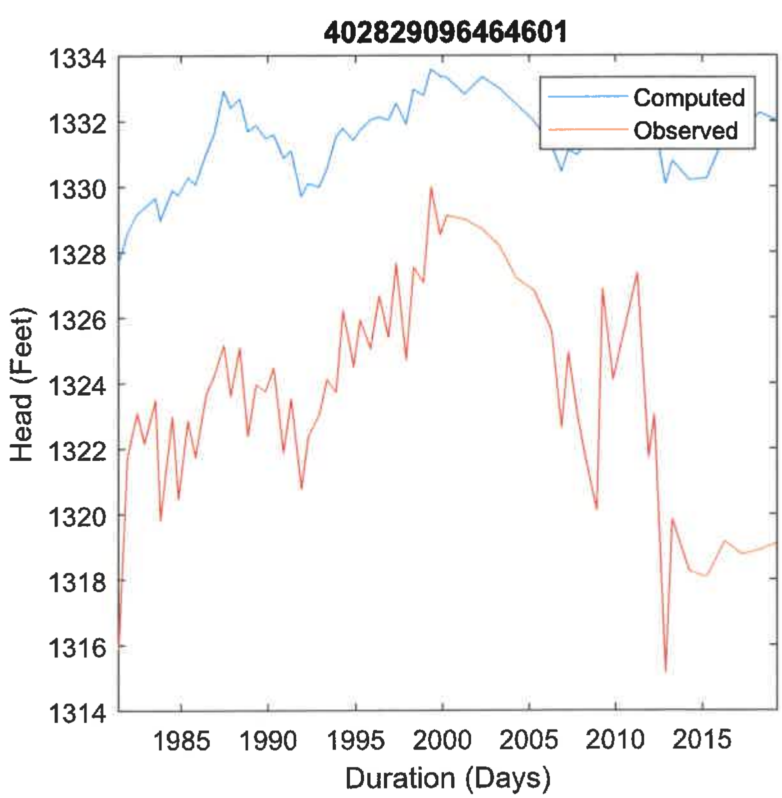
1302
1300
1298
1296
1294
1292
1290
1288
1286
1284
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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Observed
Head (Feet)
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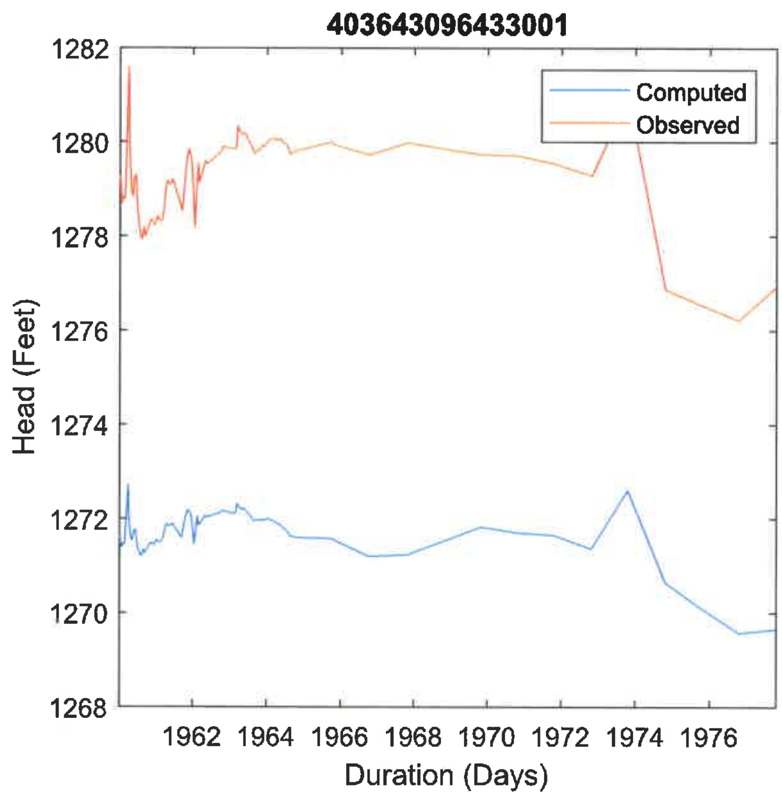
1332
1330
1328
1326
1324
1322
1320
1318
1316
1314
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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Observed
Head (Feet)
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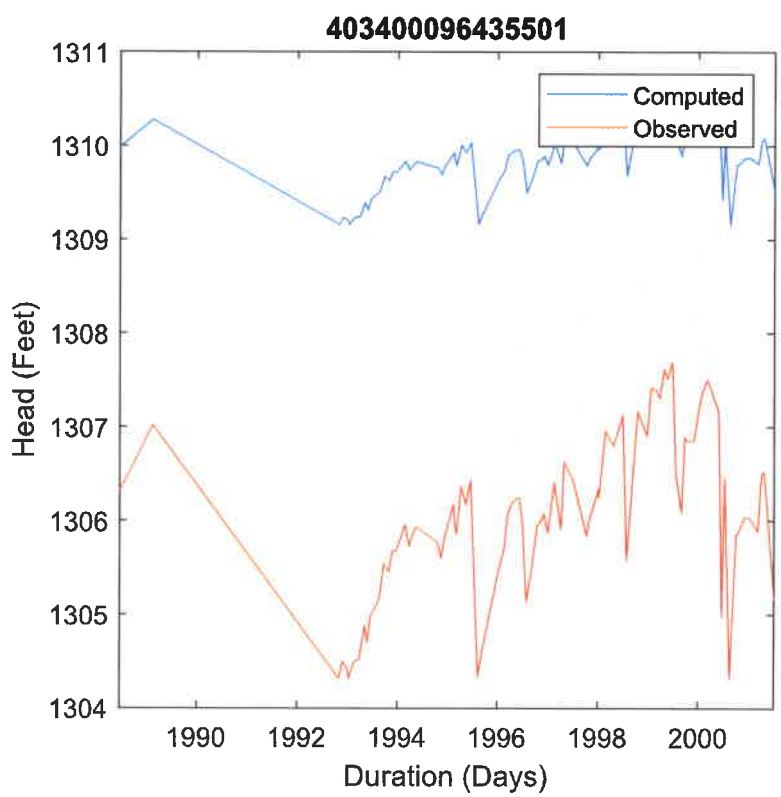
1280
1278
1276
1274
1272
1270
1268
1962
1964
1966
1968
1970
1972
1974
1976
Duration (Days)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Computed
Observed
Head (Feet)
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1310
1309
1308
1307
1306
1305
1304
1990
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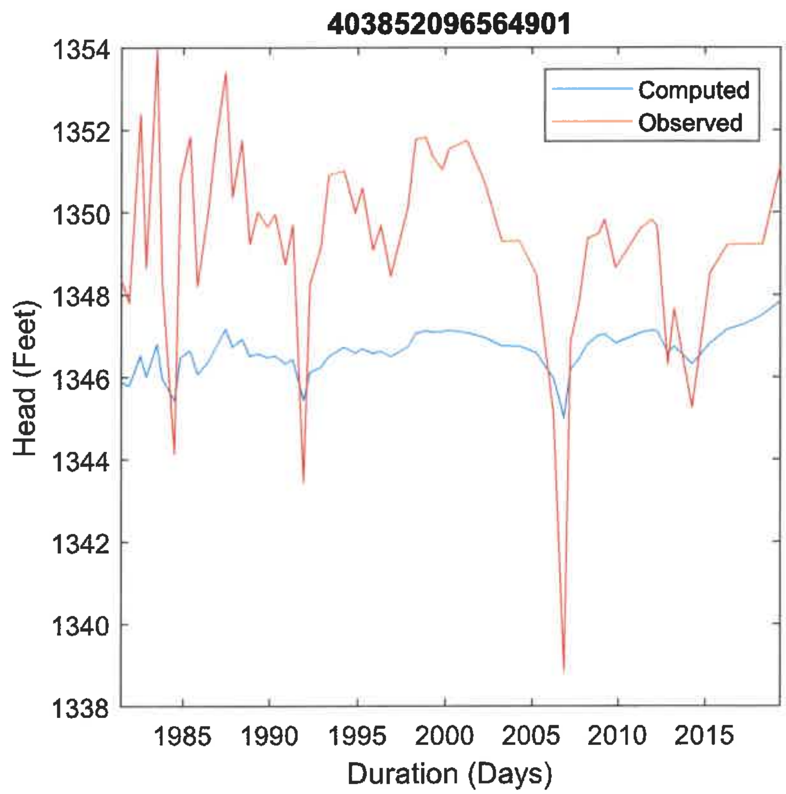
1994
1996
1998
2000
Duration (Days)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Observed
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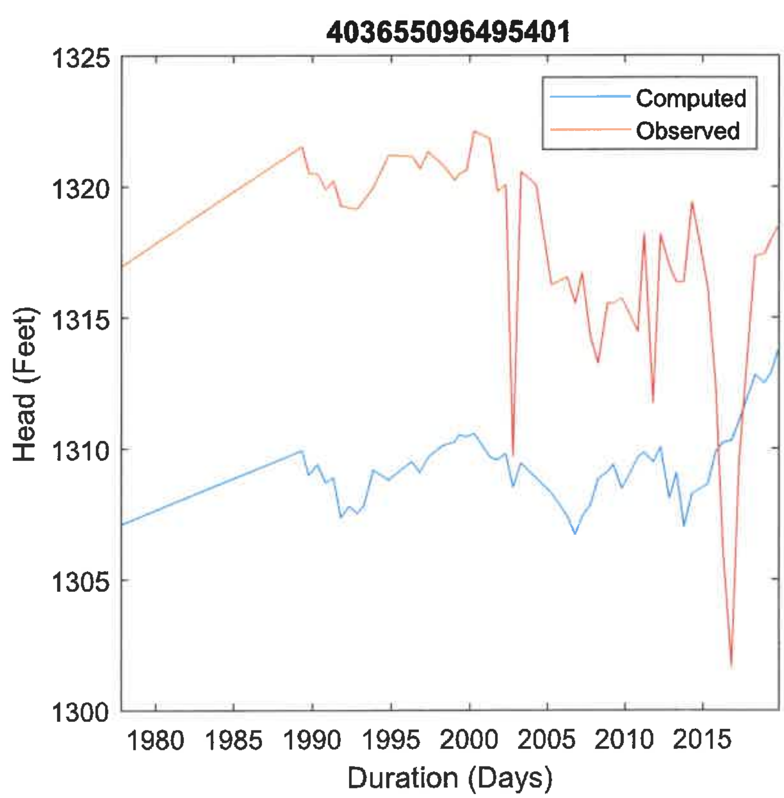
1352
1350
1348
1346
1344
1342
1340
1338
Head (Feet)
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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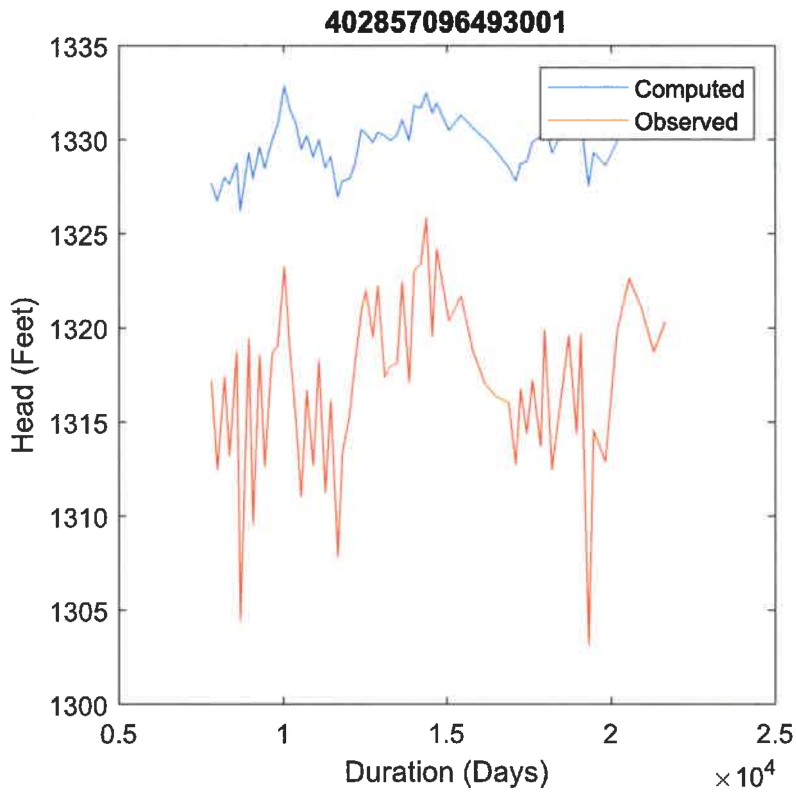
1300
Head (Feet)
1980
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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Observed
Head (Feet)
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1330
1325
1320
1315
1310
1305
1300
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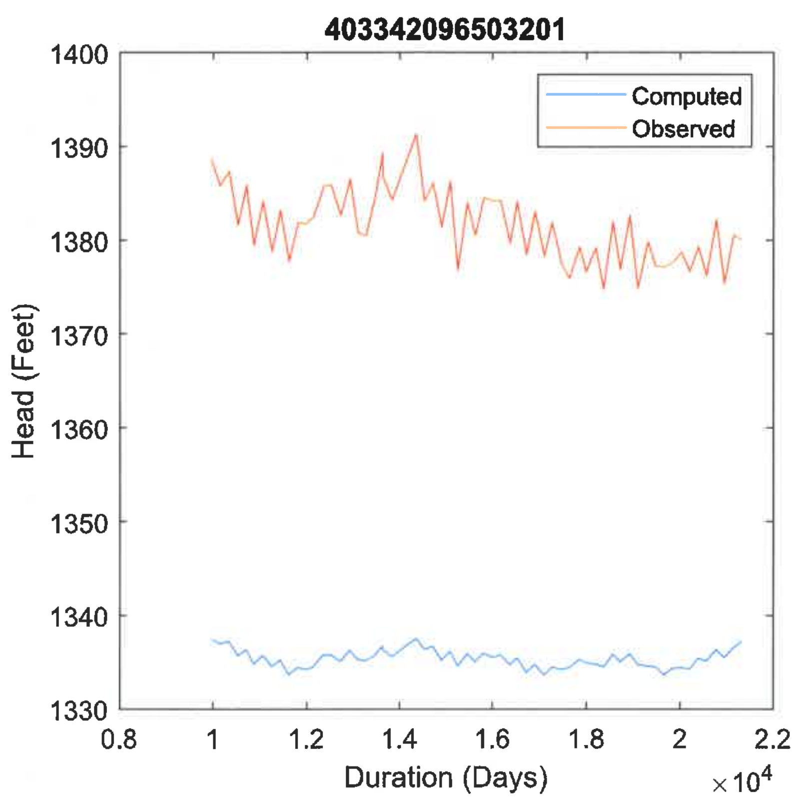
1.5
2
2.5
Duration (Days)
×10^4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Computed
Observed
Head (Feet)
1400
1390
1380
1370
1360
1350
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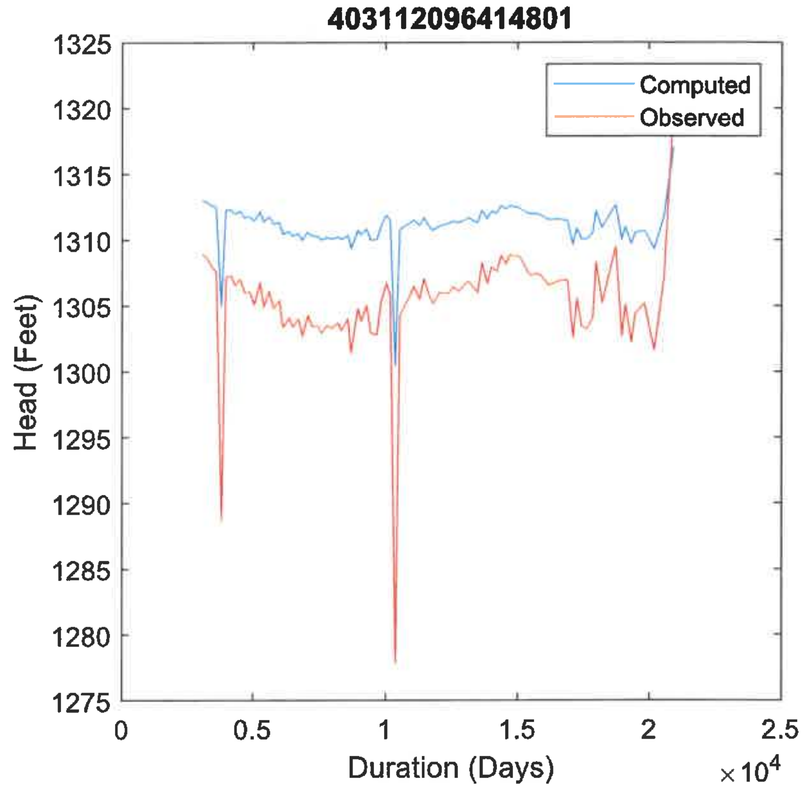
1.4
1.6
1.8
2
2.2
Duration (Days)
×10^4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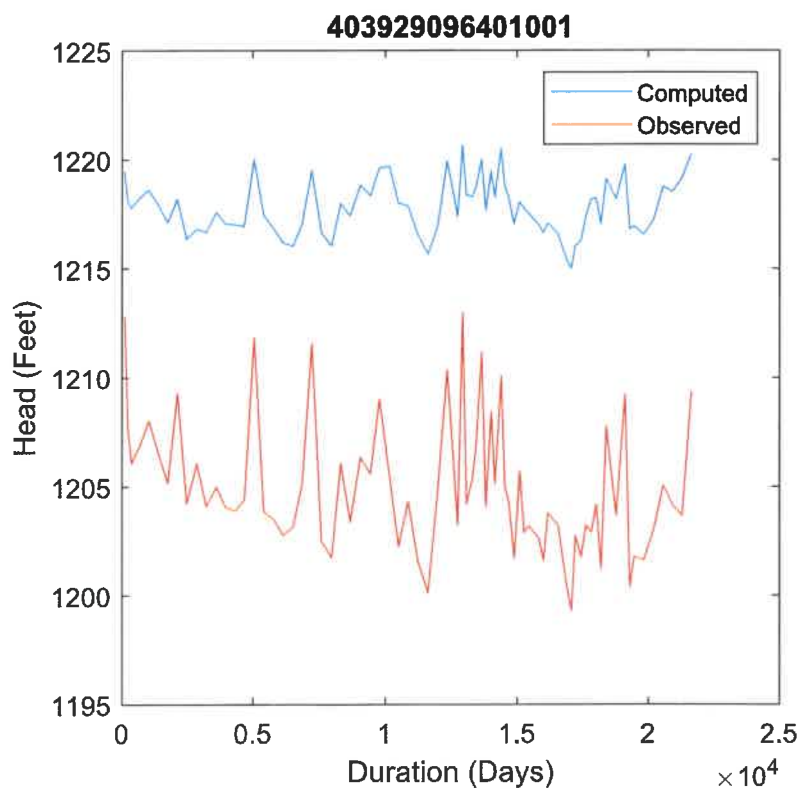
Observed
Head (Feet)
1325
1320
1315
1310
1305
1300
1295
1290
1285
1280
1275
0
0.5
1
1.5
2
2.5
Duration (Days)
$\times 10^4$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Head (Feet)
1225
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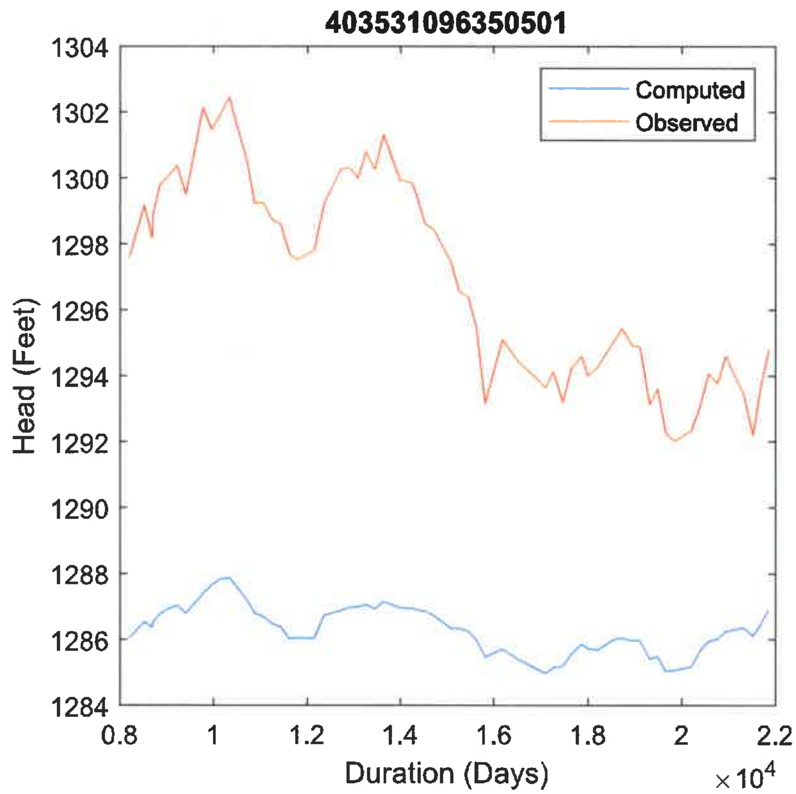
1205
1200
1195
0
0.5
1
1.5
2
2.5
Duration (Days)
$\times 10^4$



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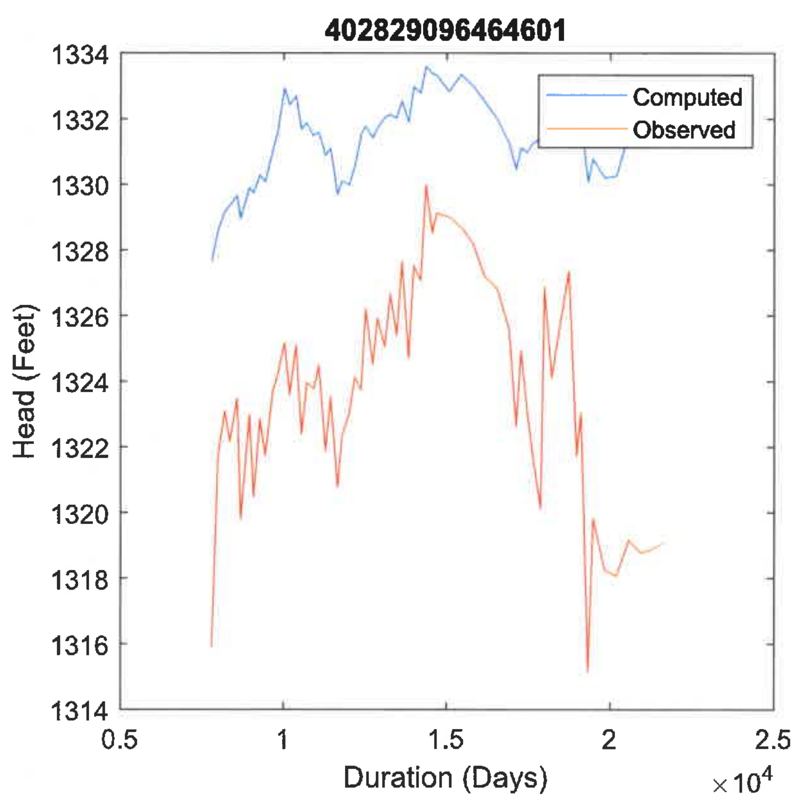
Computed
Observed
Head (Feet)
1304
1302
1300
1298
1296
1294
1292
1290
1288
1286
1284
0.8
1
1.2
1.4
1.6
1.8
2
2.2
Duration (Days)
$\times 10^4$



402829096464601
Computed
Observed
Head (Feet)
1334
1332
1330
1328
1326
1324
1322
1320
1318
1316
1314
0.5
1
1.5
2
2.5
Duration (Days)
$\times 10^4$