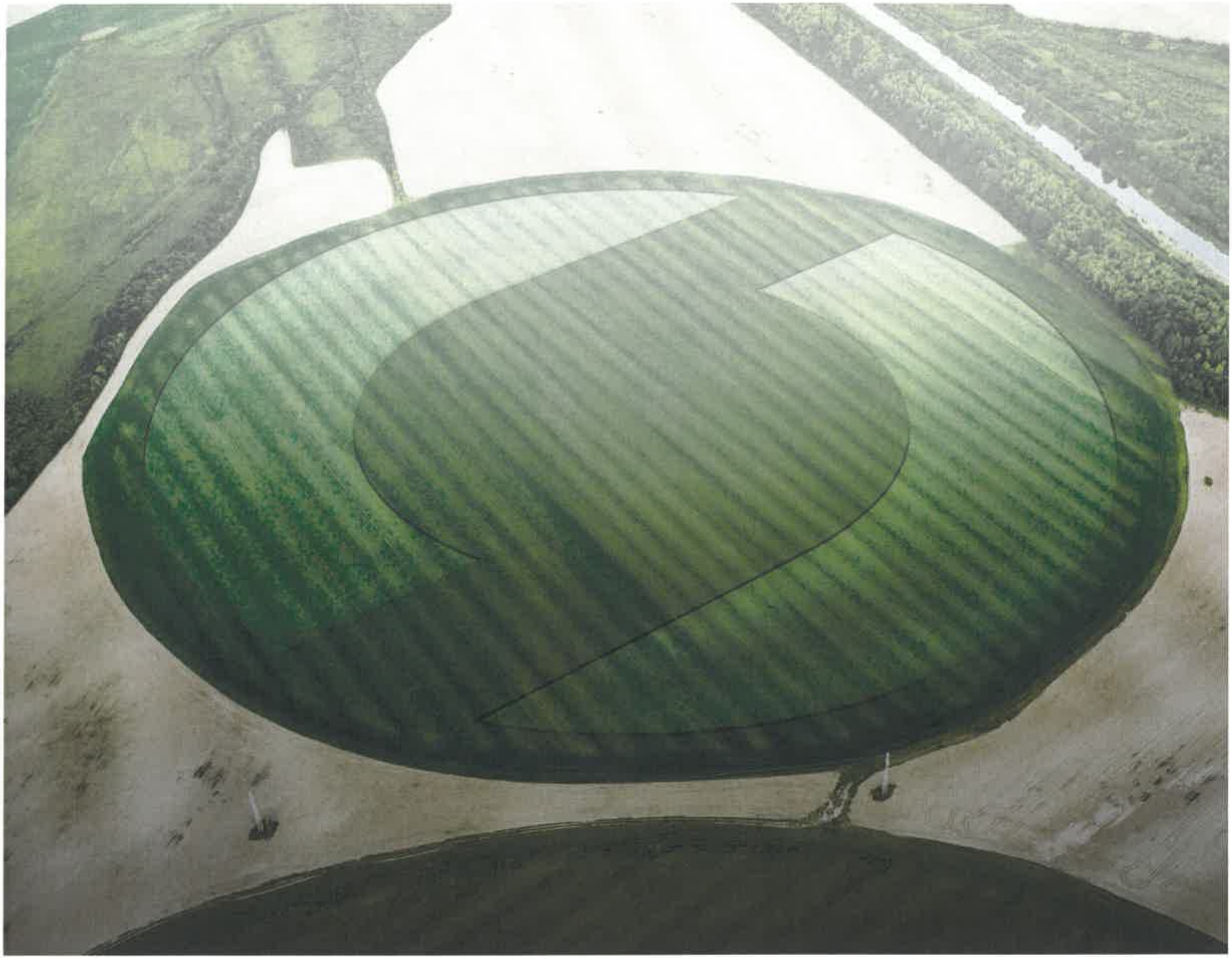


Monolith Well Permit Application

Submitted to the Lower Platte South Natural Resources District

June 4, 2021

MONOLITH

Lincoln Office
134 S. 13th Street, Suite 700
Lincoln, NE 68508
monolithmaterials.com

June 4, 2021

Paul Zillig
General Manager
Lower Platte South Natural Resources District
3125 Portia Street
PO Box 83581
Lincoln, NE 68508

Dear Paul,

Enclosed are Monolith's three previously approved Preliminary Well Construction Permits for wells OC #1, OC #2, and OC #3 (LPSP-200412, LPSP-210423, LPSP-210422, respectively), and Variance Request #014 and Variance Request #015. Please note that I have corrected LPSP-200412 to indicate that OC #1 will now be part of a series of three wells and will have a revised capacity of 600 gallons per minute.

In addition to the approved preliminary permit and variance applications, you will find a complete set of information required for these Class 2 permits, including copies of the Monolith Hydrogeologic Analysis Report prepared by Olsson and addendum information requested by the Lower Platte South Natural Resources District Board of Directors. As discussed, we understand that once drilled, the static water level and total dissolved solids data for OC #2 and OC #3 will be required.

You will also find copies of our various public presentations, etc. Please refer to the table of contents for details.

We understand this is not a typical well permit application. We appreciate the time and engagement that you, staff and members of the Water Resources Subcommittee and Board of Directors committed to Monolith and to the proper development of this application.

We look forward to working with you throughout the remainder of the approval process and developing a well monitoring program that provides insight to help us manage future water usage together. As we acknowledged in prior presentations to the Board, Monolith understands that it, like all other water users, may be subject to new District rules and regulations if hydrologic or legal conditions change in the future.

Please don't hesitate to let me know if you have any questions about this well permit application.

Sincerely,

Amy Ostermeyer

Amy Ostermeyer
Executive Vice President of Development
amy.ostermeyer@monolithmaterials.com
(402) 413-5763

MONOLITH

Table of Contents

Application – All well permit applications appear behind this tab.

OC2 Well 1 App – Original well permit application for OC2 (LPSP-200412)

OC2 Well 2 App – Application for OC2 well #2 (LPSP-210423)

OC2 Well 3 App – Application for OC2 well #3 (LPSP-210422)

Variance Request – Request for Variance along with supporting documentation for OC2 well #2 (LPSP-210423) and OC2 well #3 (LPSP-210422)

Hydrogeologic Analysis Report – Prepared by Olsson on behalf of Monolith and per permit application regulations

Appendix A – OC2 Water Use Estimation (part of Hydrogeologic Analysis)

Appendix B – Comparisons of Modeled and Metered Pumping in the LPSNRD (part of Hydrogeologic Analysis)

Appendix C – Technical Memorandum on Aquifer Pumping Test (part of Hydrogeologic Analysis)

Appendix D – Modeled and Observed Water Levels at Target Locations (part of Hydrogeologic Analysis)

Motions – Motions made by the LPSNRD Board specifying the contents for an Addendum to the Hydrogeological Analysis Report

Addendum – Addendum requested by the LPSNRD Board to accompany the Hydrogeologic Analysis Report along with LRE Response to the Addendum

LRE Final – The final findings from LRE Water after reviewing the Olsson/Monolith Hydrogeologic Analysis Report

Communications Summary – Letters of support and samples of key presentations that comprised Monolith's community outreach around the well permit application and findings from the Hydrogeologic Analysis Report

Application

C ell Application

LOWER PLATTE SOUTH

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.

 Protecting our natural resources for future generations

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] 6/12/2020
Signature Date

NRD – Preliminary Well Construction Permit site inspection by:

Mark Scott 6-25-20
Inspector Date

Preliminary Well Construction Permit Approval LPSP-200412
Preliminary Permit Number

[signature] July 10, 2020
Paul D. Zillig, General Manager Date

Amended Application - OC2 Well #1

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)

Corrected

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?** (X) Yes ~~( )~~ No AO
If Yes, how many wells? 3

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

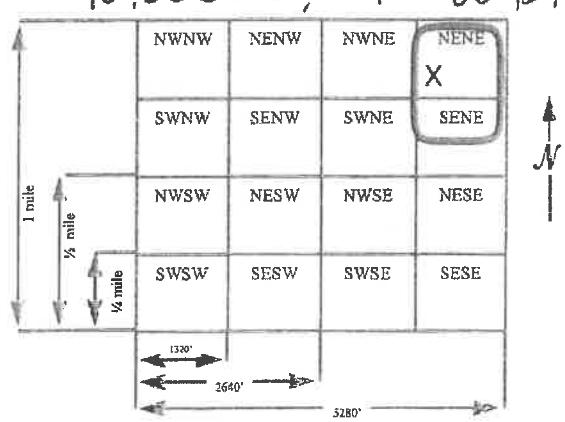
5. **PURPOSE OF WELL (indicate one)** ( ) Public Water Supply ( ) Irrigation ( ) Domestic ( ) Livestock
( ) Dewatering (over 90 days) ( ) Geothermal ( ) Monitoring ( ) Aquaculture (✓) Industrial
( ) Recovery ( ) Other ______

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

Corrected

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~~ 600 AO 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

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 public 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 §46-653.

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 <u>DO</u> 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)

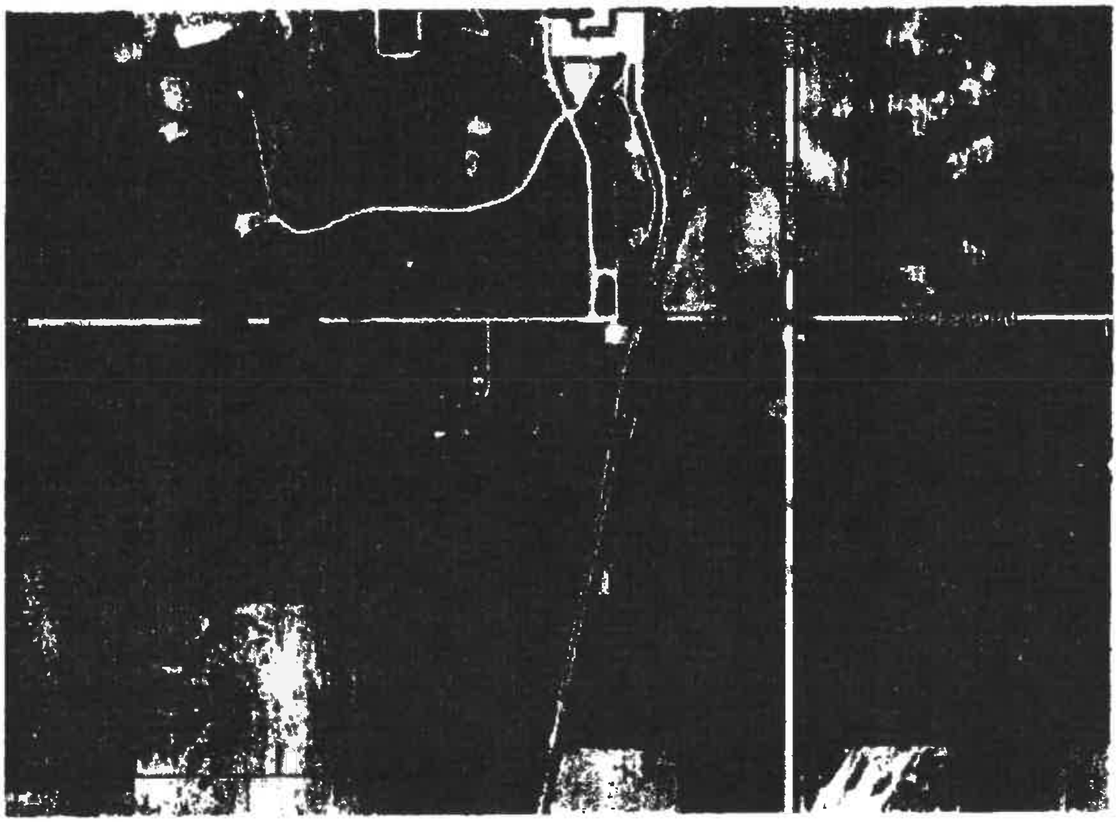
12. All applicants for a water well permit shall, as a condition of the permit, agree to cooperate with the district, at its request, in ground water monitoring activities to include water level measurement and water quality sampling (See Section B, Rule 7 of the District's Ground Water Rules & Regulations)

COMMENTS / RESTRICTIONS / TERMS ________

LOWER PLATTE SOUTH NRD PO BOX #83581 3125 PORTIA STREET
LINCOLN, NE 68501-3581 PHONE (402) 476-2729 www.lpsnrd.org

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

C ell Application

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

April 27, 2021

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

Dear Amy:

The Lower Platte South NRD has approved preliminary Well Construction Permits for Monolith's two additional Water Well Permit Applications (enclosed is a copy). The Preliminary Well Permits (LPSP-210422 for OC2 Well #3 and LPSP-210423 for OC2 Well #2) are located in the NE ¼ of the NE ¼ of Section 30, Township 7 North, Range 6 East, Lancaster County. The current locations and GPS coordinates highlighted on the permit form meet current well spacing requirements. If these locations are 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.

The NRD also received and considered the two Variance Requests for each of these wells.

- Variance Request # 014 (OC2 Well #2, LPSP-210423) and
- Variance Request #015 (OC2 Well #3, LPSP-210422).

The NRD approved, for both wells, the variance request concerning the aquifer test and hydrogeologic analysis report and "tabled" until next month's Board Meeting the variance request for the static water level measurement and water quality samples for both wells. Copies of the partially approved Variance Requests for both wells are enclosed. We will need to determine a recommended solution to the tabled variance requests, and present that recommendation to the NRD's Water Resources Subcommittee in May.

Please feel free to give me a call if you have any questions.

Sincerely

Paul D. Zillig
General Manager

PDZ/pz

Encl. 4

Monolith Nebraska LLC
Preliminary Well Construction Permit
LPSP-210422

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, Amy Ostermeyer (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.

Amy Ostermeyer
Signature

4.12.2021
Date

NRD – Preliminary Well Construction Permit site inspection by:

MS
Inspector

4-16-21
Date

Preliminary Well Construction Permit Approval

LPSP-210422
Preliminary Permit Number

[signature]
Paul D. Zillig, General Manager

4/27/2021
Date

S - 40° 32' 52'' N
96° 46' 50''

N - 40° 32' 59'' N
96° 46' 49'' W

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

GROUNDWATER RESERVOIR PERMIT FORM 062 Well #3

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

DNR & NRD USE ONLY
Permit No. LPSP-210422
Reg. No. ________

2. **IS THIS PERMIT FOR A SERIES OF WELLS?** (✓) Yes ( ) No
   If Yes, how many wells? 3

3. **NAME AND ADDRESS OF APPLICANT:**
   Monolith NE LLC
   134 S 13th St. Suite 700
   Lincoln NE 68508
   Phone (402) 413 – 5763

4. **NAME AND ADDRESS OF WELL DRILLER:**
   Sargent
   PO Box 367
   Geneva NE 68361
   Phone (402) 759 – 3902

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

40° 32' 51.9 – 96° 46' 49.9"
40.54775
-96.780527

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 1617 feet from the North/South section line, and will be 138 feet from the East/West section line.

NWNW	NENW	NWNE	NENE
SWNW	SENW	SWNE	SENE X
NWSW	NESW	NWSE	NESE
SWSW	SESW	SWSE	SESE

1 mile; ½ mile; ¼ mile; 1320'; 2640'; 5280'; N

   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? NA
   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: July 1, 2021
    Estimated total well depth 310 feet. Estimated water well capacity: 600 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

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: 4·12·2021 Signature of Applicant: Amy Ostermeyer

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 §46-653.

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 <u>**DO**</u> 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 ________

LOWER PLATTE SOUTH NRD PO BOX #83581 3125 PORTIA STREET
LINCOLN, NE 68501-3581 PHONE (402) 476-2729 www.lpsnrd.org

Supporting Documentation For LPSNRD Groundwater Reservoir Water Well Permits

Class I Permit

☐ 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).

Class II Permit

☒ A copy of the well log to determine the geologic formation.

☐ An accurate static water level.

☐ An aquifer test with at least observation well, and all necessary drawdown and pumping data, as required by the District. Aquifer test must be designed by and supervised a licensed professional geologist or engineer.

☐ 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.

Name, Address and License Number of the Licensed Professional Geologist or Engineer

Brian P Dunnigan, PE

601 P Street Suite 200

Lincoln NE 68508

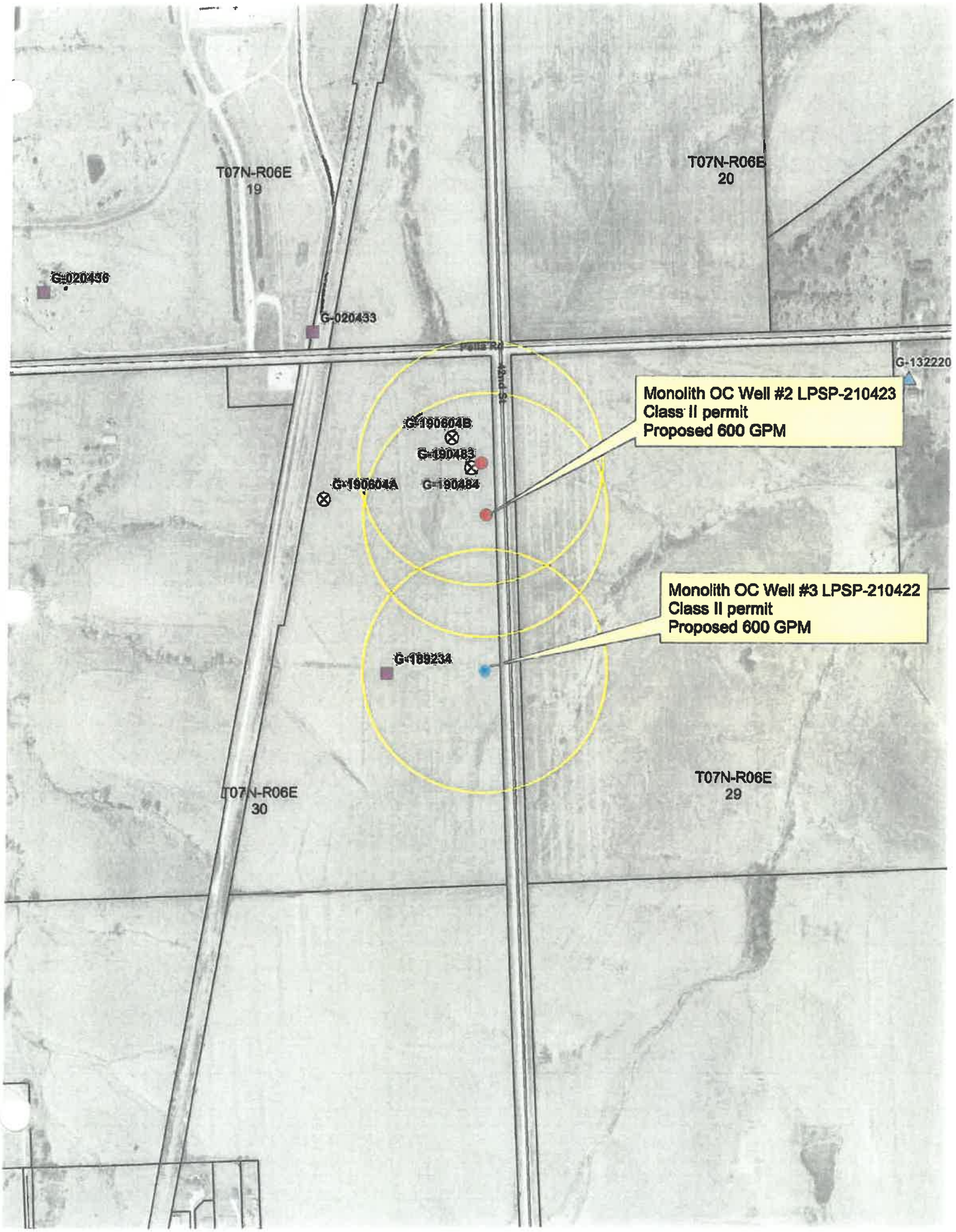
License Number E-6179

Salt Water Well Permit

☐ Water quality analysis of samples from a qualified laboratory. Samples are to be taken during pumping at various pumping rates. One sample each shall be taken at a pumping rate of 5 gallon per minute or less, at 50% of designed pumping rate, and at 100% of the designed pumping rate. Results to be attached include Sodium (Na), Chloride (Cl), and Total Dissolved Solids (TDS).

☐ Water quality analysis of samples from a qualified laboratory. Samples are to be taken during a 24 hour pump test at 100% of the designed pumping rate. One sample each shall be taken within the first 15 minutes of the beginning of the test, within 15 minutes of the halfway point of the test, and within 15 minutes of the end of pumping. Results to be attached include Sodium (Na), Chloride (Cl), and Total Dissolved Solids (TDS).


OC 2 new wells
Write a description for your map.
Legend
OC2 Well #2
OC2 Well #3
Google Earth
© 2021 Google
500 ft
N



T07N-R06E
19
T07N-R06E
20
G-020436
G-020433
Fells Rd
42nd St
G-132220
Monolith OC Well #2 LPSP-210423
Class II permit
Proposed 600 GPM
G-190604B
G-190483
G-190604A
G-190484
Monolith OC Well #3 LPSP-210422
Class II permit
Proposed 600 GPM
G-189234
T07N-R06E
30
T07N-R06E
29

Monolith Nebraska LLC
Preliminary Well Construction Permit
LPSP-210423

C ell Application

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, Amy Ostermeyer (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.

Amy Ostermeyer
Signature

4-12-2021
Date

NRD – Preliminary Well Construction Permit site inspection by:

MS
Inspector

4-16-21
Date

Preliminary Well Construction Permit Approval

Paul D. Zillig, General Manager

LPSP-210423
Preliminary Permit Number

4/27/2021
Date

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

GROUNDWATER RESERVOIR PERMIT FORM - OC2 Well #2

DNR & NRD USE ONLY
Permit No. LPSP-210423
Reg. No. ____________

1. **PERMIT CLASS (indicate one)**
   Class I (50 gpm < X < 1000gpm and < 250 acre-feet/ year)
   (Class II circled) (≥ 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?** (X) Yes ( ) No
   If Yes, how many wells? 3

3. **NAME AND ADDRESS OF APPLICANT:**
   Monolith Nebraska LLC
   134 S 13 St. Suite 700
   Lincoln NE 68508
   Phone (402) 415 - 5763

4. **NAME AND ADDRESS OF WELL DRILLER:**
   Sargent
   PO Box 367
   Geneva NE 68361
   Phone (402) 759 - 3902

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

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 879 feet from the North/South section line, and will be 69 feet from the East/West section line.

   <u>**If possible mark (with a flag) the well site in the field**</u>

40"32'59.5" - 96"46'49.4"

NWNW	NENW	NWNE	NENE X
SWNW	SENW	SWNE	SENE
NWSW	NESW	NWSE	NESE
SWSW	SESW	SWSE	SESE

1 mile; ½ mile; ¼ mile; 1320'; 2640'; 5280'

~~40.5044715~~ ~~-96.785~~
N
40.5498611
-96.7803888

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? NA
   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: July 1, 20 21
    Estimated total well depth 310 feet. Estimated water well capacity: 600 gallons per minute
    Pump column diameter: 6-8 inches. Well casing diameter: 12 inches.

<u>**DO NOT BEGIN CONSTRUCTION UNTIL AN APPROVED PRELIMINARY WELL CONSTRUCTION PERMIT FORM IS RETURNED TO THE LANDOWNER**</u>

See Other Side

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: 4.12.2021 Signature of Applicant: Amy Ostermeyer

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 §46-653.

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 ________

Supporting Documentation For LPSNRD Groundwater Reservoir Water Well Permits

Class I Permit

☐ 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).

Class II Permit

☒ A copy of the well log to determine the geologic formation.

☐ An accurate static water level.

☐ An aquifer test with at least observation well, and all necessary drawdown and pumping data, as required by the District. Aquifer test must be designed by and supervised a licensed professional geologist or engineer.

☐ 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.

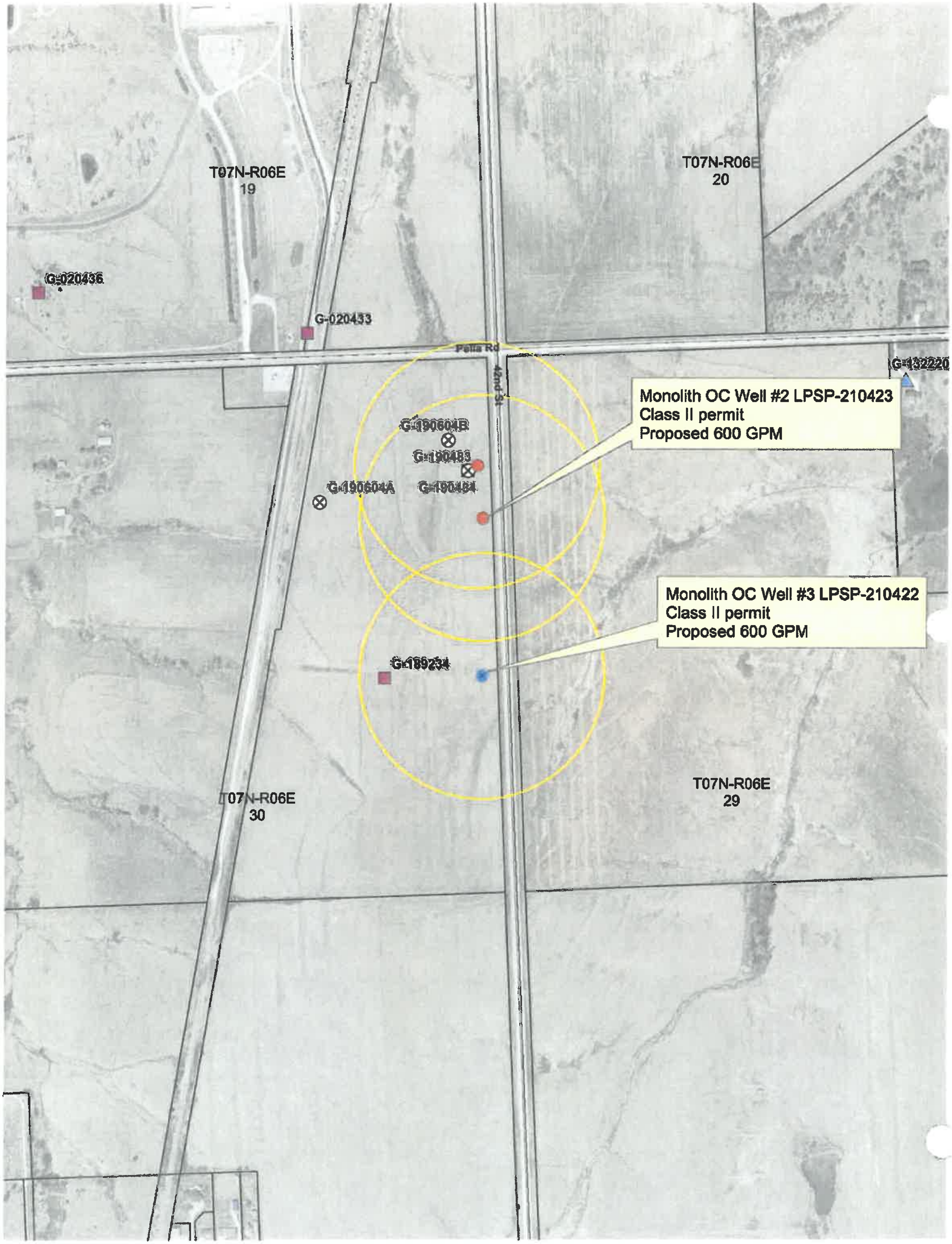
Name, Address and License Number of the Licensed Professional Geologist or Engineer

Brian P. Dunnigan, PE
601 P Street, Suite 200
Lincoln NE 68508
License # E-6179

Salt Water Well Permit

☐ Water quality analysis of samples from a qualified laboratory. Samples are to be taken during pumping at various pumping rates. One sample each shall be taken at a pumping rate of 5 gallon per minute or less, at 50% of designed pumping rate, and at 100% of the designed pumping rate. Results to be attached include Sodium (Na), Chloride (Cl), and Total Dissolved Solids (TDS).

☐ Water quality analysis of samples from a qualified laboratory. Samples are to be taken during a 24 hour pump test at 100% of the designed pumping rate. One sample each shall be taken within the first 15 minutes of the beginning of the test, within 15 minutes of the halfway point of the test, and within 15 minutes of the end of pumping. Results to be attached include Sodium (Na), Chloride (Cl), and Total Dissolved Solids (TDS).



T07N-R06E
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G-020436
G-020433
Pella Rd
42nd St
G-132220
Monolith OC Well #2 LPSP-210423
Class II permit
Proposed 600 GPM
G-190604B
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G-190604A
G-190484
Monolith OC Well #3 LPSP-210422
Class II permit
Proposed 600 GPM
G-189234
T07N-R06E
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T07N-R06E
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OC 2 new wells
Write a description for your map.
Legend
OC2 Well #2
OC2 Well #3
Google Earth
500 ft
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Monolith Nebraska LLC
Request for Variance
Variance #014

ariance Re uest

Variance #014

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

REQUEST FOR VARIANCE – OC2 WELL 2 APPLICATION

Landowner Name: Lurhs Hallam Investments, LLC, Leased to the applicant, Monolith Nebraska LLC

(See Lease Agreement & Letter submitted to the District on 3/12/2021)

Address: 27077 SW 42nd Street **Phone:** (402) 598.5511

City: Hallam **State & Zip:** Nebraska, 68516

Field Information:

Legal: NE ¼ NE ¼, **Section 30, Township** 7 North, **Range** 6 East, Lancaster **County**

Groundwater Rules and Regulations: Section C Rule 2

Explanation of Variance Request (Use additional pages if needed):

(c)(i)(A)(2) As indicated by the well log information the geology from well log #2 is substantially similar to the well log information from well #1.

(c)(i)(A)(3) As indicated by the well log information the geology from well log #2 is substantially similar to the well log information from well #1.

(c)(i)(A)(4) As indicated by the well log information the geology from well log #2 is substantially similar to the well log information from well #1.

(c)(i)(A)(5) As indicated by the well log information the geology from well log #2 is substantially similar to the well log information from well #1.

Please refer to the attached Professional Engineer Statement.

Required Attachments:

Aerial Photo (required)	☒ Y	N
Map of Adjoining Landowners (Name and Addresses)	☒ Y	N
Signed Acknowledgement of Notice by Adjoining Landowners / Well owners	☒ Y	N

Non-refundable $500 Variance Request Fee ☒ Y N

Landowner Signature: *R. 2. Jubbs* Date: 4/14/2021

Amy Ostermeyer - applicant 4.12.2021

LPSNRD Use Only: LPSNRD Approval: *[signature], 4/27/21*	Date: ______

At the April 21, 2021 Board meeting, the Board of Directors voted to separate the components of the two variance requests as proposed by the Water Resources Subcommittee. The Board granted a variance to Monolith Nebraska LLC for proposed wells OC2 #2 (LPSP-210423) and OC2 #3 (LPSP-210422), specifically Section C, Rule 2(c) (i)(A)(3) ("aquifer test"), and Section C, Rule 2 (c)(i)(A)(5) ("hydrogeologic analysis report") but tabled the decision regarding the variance request for proposed wells OC2 #2 (LPSP-210423) and OC2 #3 (LPSP-210422), specifically Section C, Rule 2(c)(i)(A)(2) ("accurate static water level measurement"), and Section C, Rule 2 (c)(i)(A)(4) ("water quality samples") until the next monthly Board meeting (May 2021).

olsson

April 12, 2021

Amy Ostermeyer
Vice President of Human Resources
Monolith Materials, Inc.
134 South 13th Street
Suite 700
Lincoln, NE 68508

Dear Ms. Ostermeyer:

The Olsson team has reviewed the well log information provided by Sargent Drilling (attached) for the wells identified as OC2 Well 2 and OC2 Well 3 and has compared this information to the well log information for OC2 Well 1 (originally referred to as Test Well 1R, also attached). The attached figure provides a generalized comparison of the geologic conditions encountered in the three test borings that have been conducted on the Monolith property (as well as the Observation Well).

Based on the comparison of the well logs for OC2 Well 2 and OC2 Well 3 to the well log for OC2 Well 1, it can be concluded that the underlying geology at each of the well locations is substantially similar and therefore, the hydrogeologic characteristics for all three wells will be substantially similar. For this reason, the information required under Section C, Rule 2 (c)(i)(A)(2) – (5) that has already been submitted for OC2 Well 1 can be used to evaluate the well applications for OC2 Well 2 and OC2 Well 3.

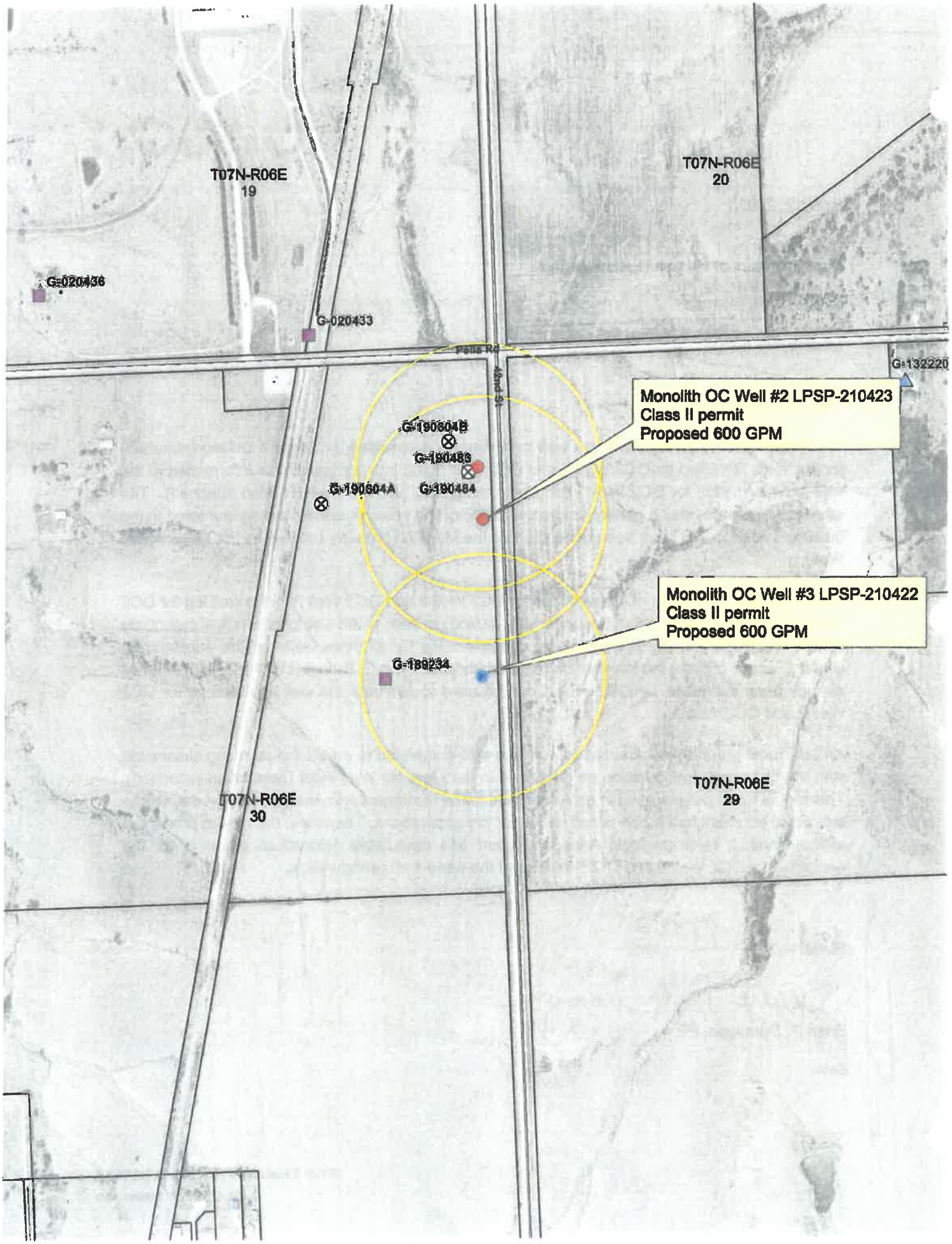
An additional groundwater flow model run was also completed to reflect the pumping associated with the three-well configuration as described in the Monolith Well Field Description (attached). This model run is documented in an Addendum to the Hydrogeologic Analysis Report that will be submitted pursuant to the rule noted above for the applications. Therefore, the results presented in the Monolith Hydrogeologic Analysis Report and associated Addendum are valid for the evaluation of OC2 Well 2 and OC2 Well 3 and the three-well configuration.

Sincerely,

Brian P. Dunnigan

Brian P. Dunnigan, PE

Encls.


T07N-R06E
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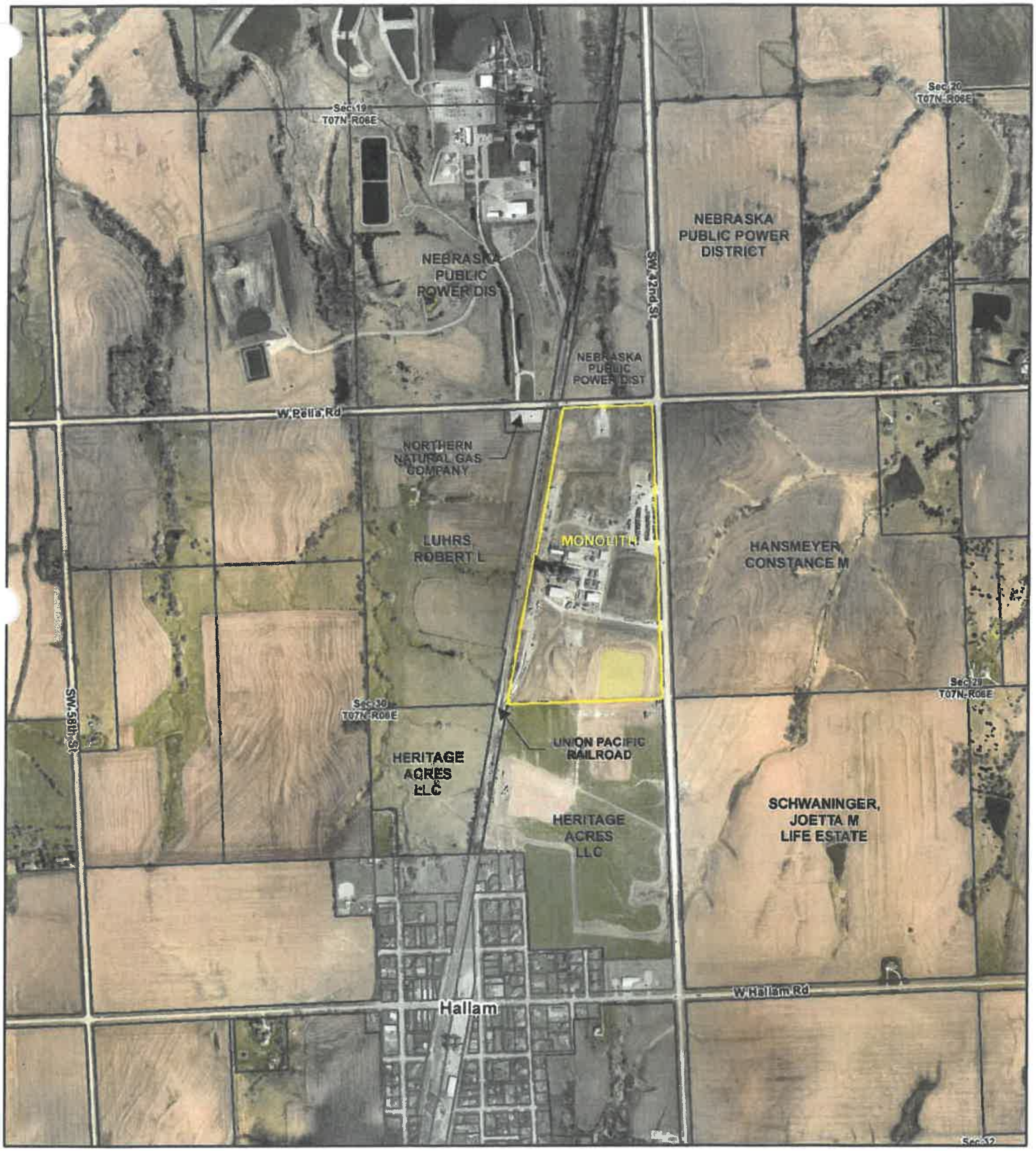
G-190484
Monolith OC Well #3 LPSP-210422
Class II permit
Proposed 600 GPM
G-189234
T07N-R06E
29
T07N-R06E
30

Review - Monolith (NE Sec 30, T7N-R6E, Lancaster), Adjacent Landowners



Map By: LPSNRD, sdr - April 2021

Monolith Property	Parcel Lines

0 — 0.5 Miles

MONOLITH

Lincoln Office
134 S. 13th Street, Suite 700
Lincoln, NE 68508
monolithmaterials.com

April 12, 2021

RE: NOTICE OF REQUEST FOR VARIANCE FOR WATER WELL PERMIT

Dear Landowner:

Monolith Nebraska LLC ("Monolith") is seeking a variance for water well permits from the Lower Platte South Natural Resources District ("LPSNRD"). A copy of the Variance Request that will be provided to the LPSNRD is enclosed for your review.

Monolith is located at 27077 SW 42nd Street, Hallam, NE 68368 and intends to drill three (3) wells at that location. As an adjoining landowner, you are being provided this Notice in accordance with the requirements of the LPSNRD. If you would like additional information regarding the operation of these wells and the impacts created by them, please contact Monolith at the address above.

Please sign below to acknowledge that you have received this Notice and please return this Notice to us in the enclosed stamped envelope. Please keep the enclosed Variance Request for your records.

______________________________ ______________________
Heritage Acres LLC – Signature Date

____
Heritage Acres LLC – Printed Name

Heritage Acres LLC
Attn: Farmers National Co
PO Box 542016
Omaha, NE 68154

7020 1810 0001 0572 3414

U.S. Postal Service™
CERTIFIED MAIL® RECEIPT
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For delivery information, visit our website at www.usps.com®.

Hallam, NE 68368

OFFICIAL USE

Certified Mail Fee	$3.60
Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$0.00
☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$
Postage	$0.55
Total Postage and Fees	$7.00

0500 15

Postmark Here: LINCOLN NE 68501 APR 12 2021 USPS — 04/12/2021

Sent To: Joette S Life Estate
Street and Apt. No., or PO Box No.: 9505 SW 42nd St.
City, State, ZIP+4®: Hallam, NE 68368

PS Form 3800, April 2015 PSN 7530-02-000-9047 — See Reverse for Instructions

7020 1810 0001 3247 9605

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Lincoln, NE 68508

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Certified Mail Fee	$3.60
Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$0.00
☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$
Postage	$0.75
Total Postage and Fees	$7.20

0500 15

Postmark Here: LINCOLN NE 68501 APR 12 2021 USPS — 04/12/2021

Sent To: NPPD dba US Bank NA Format Ranch Management
Street and Apt. No., or PO Box No.: 233 S 13th #1012
City, State, ZIP+4®: Lincoln, NE 68508

PS Form 3800, April 2015 PSN 7530-02-000-9047 — See Reverse for Instructions

7020 1810 0001 0572 3391

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Lincoln, NE 68522

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Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$0.00
☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$
Postage	$0.55
Total Postage and Fees	$7.00

0500 15

Postmark Here: LINCOLN NE 68501 APR 12 2021 USPS — 04/12/2021

Sent To: Constance M Hausmeyer
Street and Apt. No., or PO Box No.: 734 SW 23rd St
City, State, ZIP+4®: Lincoln, NE 68522

PS Form 3800, April 2015 PSN 7530-02-000-9047 — See Reverse for Instructions

7020 1810 0001 0572 3407

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Omaha, NE 68142

OFFICIAL USE

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Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$0.00
☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$
Postage	$0.55
Total Postage and Fees	$7.00

0500 15

Postmark Here: LINCOLN NE 68501 APR 12 2021 USPS — 04/12/2021

Sent To: Robert L Luhrs
Street and Apt. No., or PO Box No.: 5376 N 122nd Ave Cir
City, State, ZIP+4®: Omaha NE 68142

PS Form 3800, April 2015 PSN 7530-02-000-9047 — See Reverse for Instructions

7020 1810 0001 0572 3360

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Columbus, NE 68602

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Certified Mail Fee	$3.60
Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$0.00
☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$
Postage	$0.55
Total Postage and Fees	$7.00

0500 15

Postmark Here: LINCOLN NE 68501 APR 12 2021 USPS — 04/12/2021

Sent To: NPPD
Street and Apt. No., or PO Box No.: PO Box 499
City, State, ZIP+4®: Columbus, NE 68602

PS Form 3800, April 2015 PSN 7530-02-000-9047 — See Reverse for Instructions

7020 1810 0001 0572 3445

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Omaha, NE 68103

OFFICIAL USE

Certified Mail Fee	$3.60
Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$0.00
☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$
Postage	$0.55
Total Postage and Fees	$7.00

0500 15

Postmark Here: LINCOLN NE 68501 APR 12 2021 USPS — 04/12/2021

Sent To: Northern Natural Gas Co
Street and Apt. No., or PO Box No.: PO Box 3330
City, State, ZIP+4®: Omaha, NE 68103

PS Form 3800, April 2015 PSN 7530-02-000-9047 — See Reverse for Instructions

7020 1810 0001 1212 9933

U.S. Postal Service™
CERTIFIED MAIL® RECEIPT
Domestic Mail Only

For delivery information, visit our website at www.usps.com®.

Omaha, NE 68179

OFFICIAL USE

Certified Mail Fee	$3.60
Extra Services & Fees (check box, add fee as appropriate)	$2.85
☐ Return Receipt (hardcopy)	$ $0.00
☐ Return Receipt (electronic)	$ $0.00
☐ Certified Mail Restricted Delivery	$ $0.00
☐ Adult Signature Required	$ $0.00
☐ Adult Signature Restricted Delivery	$ $0.00
Postage	$0.75
Total Postage and Fees	$7.20

Postmark Here: LINCOLN NE 68501, 0500 30, APR 15 2021, USPS, 04/15/2021

Sent To: UPRR Co Attn Chris Samuelson
Street and Apt. No., or PO Box No.: 1400 Douglas St. #Stop 1640
City, State, ZIP+4®: Omaha, NE 68179-1640

PS Form 3800, April 2015 PSN 7530-02-000-9047 See Reverse for Instructions

Monolith Nebraska LLC
Request for Variance
Variance #015

Variance #015

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

REQUEST FOR VARIANCE – OC2 WELL 3 APPLICATION

Landowner Name: Lurhs Hallam Investments, LLC, Leased to the applicant, Monolith Nebraska LLC (See Lease Agreement & Letter submitted to the District on 3/12/2021)

Address: 27077 SW 42nd Street **Phone:** (402) 598.5511

City: Hallam **State & Zip:** Nebraska, 68516

Field Information:

Legal: SE ¼ NE ¼, **Section** 30, **Township** 7 North, **Range** 6 East, Lancaster **County**

Groundwater Rules and Regulations: Section C Rule 2

Explanation of Variance Request (Use additional pages if needed):

(c)(i)(A)(2) As indicated by the well log information the geology from well log #3 is substantially similar to the well log information from well #1.

(c)(i)(A)(3) As indicated by the well log information the geology from well log #3 is substantially similar to the well log information from well #1.

(c)(i)(A)(4) As indicated by the well log information the geology from well log #3 is substantially similar to the well log information from well #1.

(c)(i)(A)(5) As indicated by the well log information the geology from well log #3 is substantially similar to the well log information from well #1.

Please refer to the attached Professional Engineer Statement.

Required Attachments:

Aerial Photo (required)	☒ Y	N
Map of Adjoining Landowners (Name and Addresses)	☒ Y	N
Signed Acknowledgement of Notice by Adjoining Landowners / Well owners	☒ Y	N

Non-refundable $500 Variance Request Fee ☒ Y N

Landowner Signature: R. J. Juhre Date: 4/14/2021

Amy Ostermeyer - applicant 4-12-2021

LPSNRD Use Only:
LPSNRD Approval: 4/27/21 Date: ______

At the April 21, 2021 Board meeting, the Board of Directors voted to separate the components of the two variance requests as proposed by the Water Resources Subcommittee. The Board granted a variance to Monolith Nebraska LLC for proposed wells OC2 #2 (LPSP-210423) and OC2 #3 (LPSP-210422), specifically Section C, Rule 2(c)(i)(A)(3) ("aquifer test"), and Section C, Rule 2 (c)(i)(A)(5) ("hydrogeologic analysis report") but tabled the decision regarding the variance request for proposed wells OC2 #2 (LPSP-210423) and OC2 #3 (LPSP-210422), specifically Section C, Rule 2(c)(i)(A)(2) ("accurate static water level measurement"), and Section C, Rule 2 (c)(i)(A)(4) ("water quality samples") until the next monthly Board meeting (May 2021).

olsson

April 12, 2021

Amy Ostermeyer
Vice President of Human Resources
Monolith Materials, Inc.
134 South 13th Street
Suite 700
Lincoln, NE 68508

Dear Ms. Ostermeyer:

The Olsson team has reviewed the well log information provided by Sargent Drilling (attached) for the wells identified as OC2 Well 2 and OC2 Well 3 and has compared this information to the well log information for OC2 Well 1 (originally referred to as Test Well 1R, also attached). The attached figure provides a generalized comparison of the geologic conditions encountered in the three test borings that have been conducted on the Monolith property (as well as the Observation Well).

Based on the comparison of the well logs for OC2 Well 2 and OC2 Well 3 to the well log for OC2 Well 1, it can be concluded that the underlying geology at each of the well locations is substantially similar and therefore, the hydrogeologic characteristics for all three wells will be substantially similar. For this reason, the information required under Section C, Rule 2 (c)(i)(A)(2) – (5) that has already been submitted for OC2 Well 1 can be used to evaluate the well applications for OC2 Well 2 and OC2 Well 3.

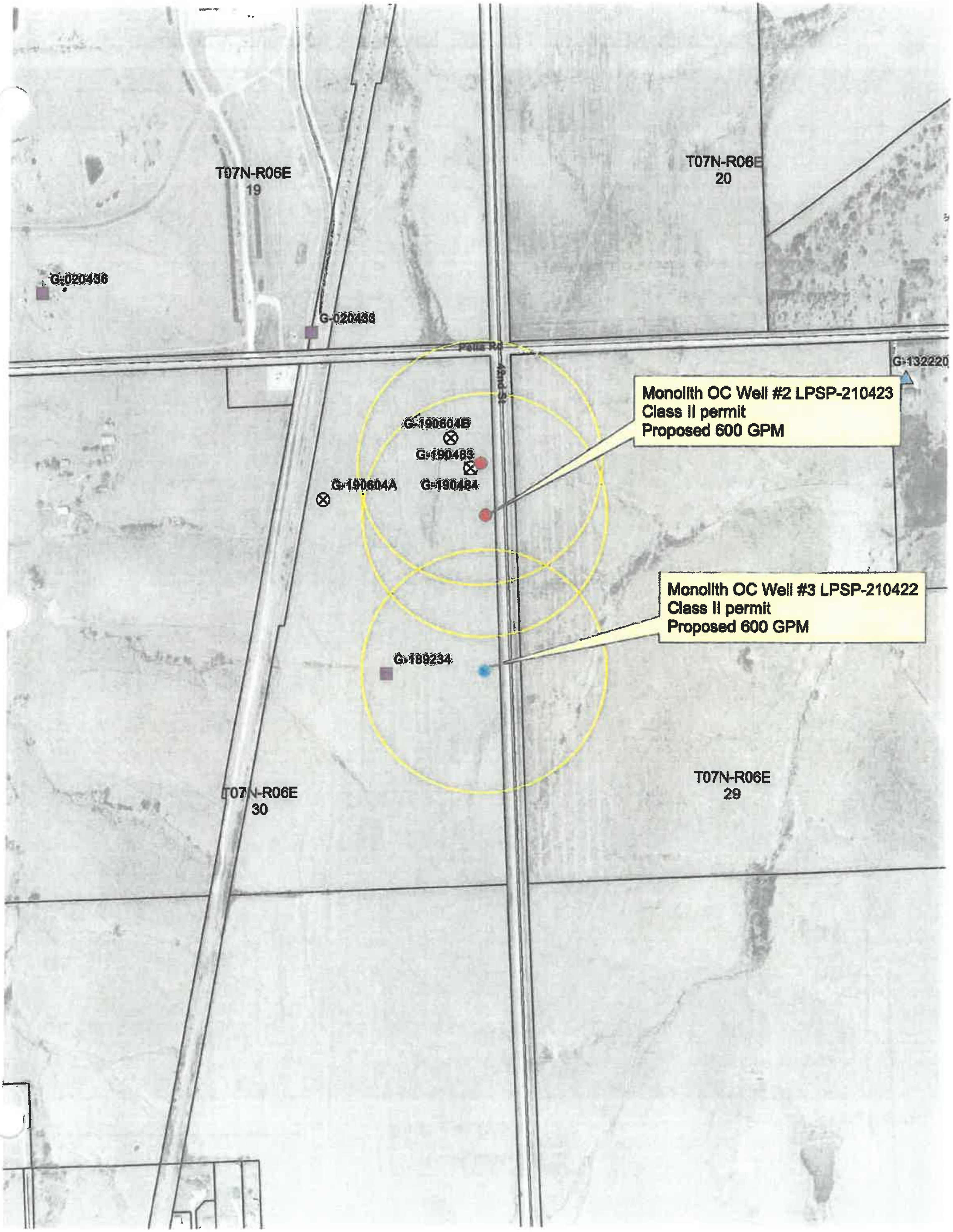
An additional groundwater flow model run was also completed to reflect the pumping associated with the three-well configuration as described in the Monolith Well Field Description (attached). This model run is documented in an Addendum to the Hydrogeologic Analysis Report that will be submitted pursuant to the rule noted above for the applications. Therefore, the results presented in the Monolith Hydrogeologic Analysis Report and associated Addendum are valid for the evaluation of OC2 Well 2 and OC2 Well 3 and the three-well configuration.

Sincerely,

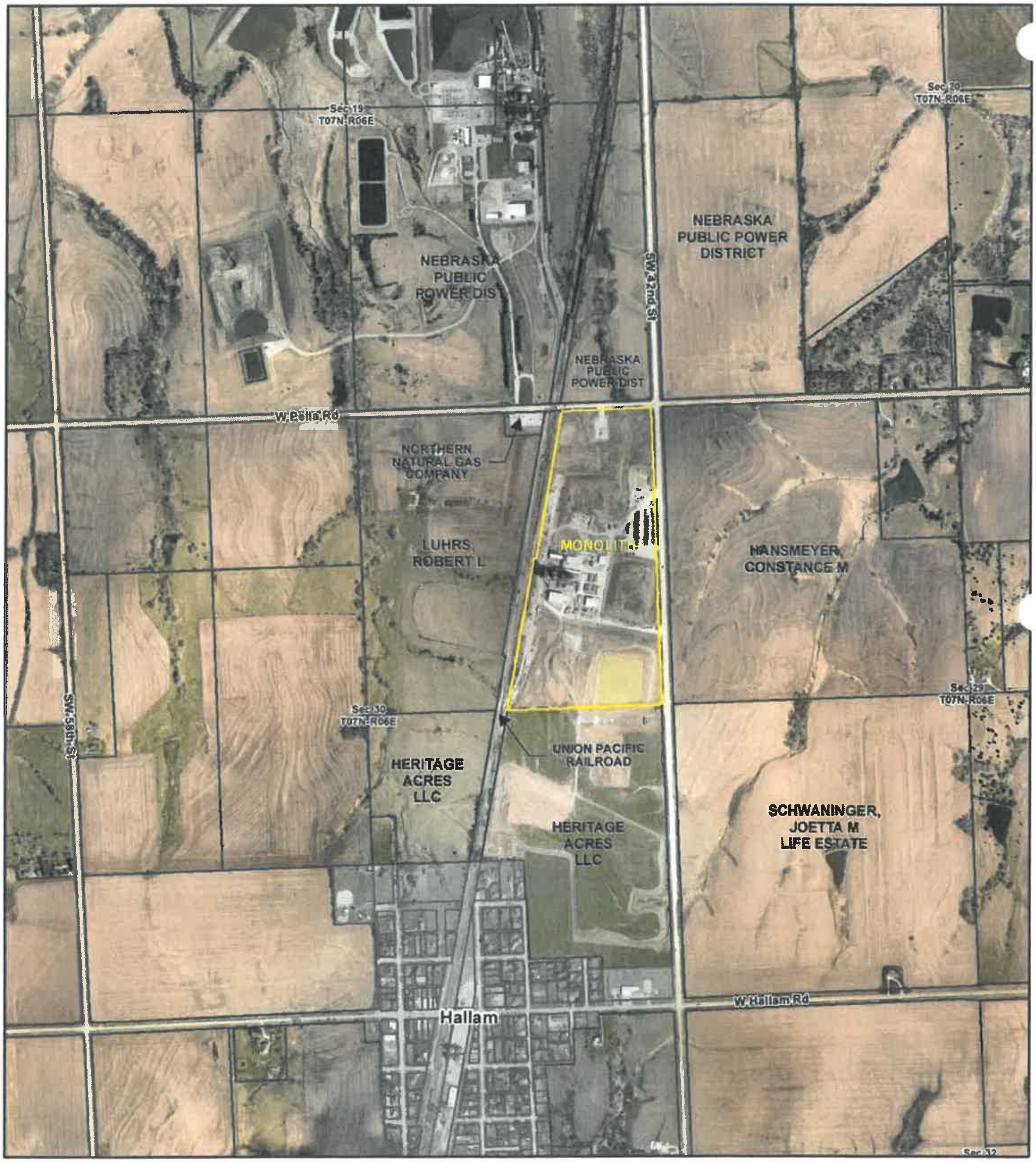
Brian P. Dunnigan

Brian P. Dunnigan, PE

Encls.


T07N-R06E
19
T07N-R06E
20
G-020436
G-020433
Pella Rd
42nd St
G-132220
Monolith OC Well #2 LPSP-210423
Class II permit
Proposed 600 GPM
G-190604B
G-190483
G-190604A
G-190484
Monolith OC Well #3 LPSP-210422
Class II permit
Proposed 600 GPM
G-189234
T07N-R06E
30
T07N-R06E
29

Review - Monolith (NE Sec 30, T7N-R6E, Lancaster), Adjacent Landowners



Map By: LPSNRD, sdr - April 2021

Monolith Property

Parcel Lines

0 0.5 Miles

MONOLITH

Lincoln Office
134 S. 13th Street, Suite 700
Lincoln, NE 68508
monolithmaterials.com

April 12, 2021

RE: NOTICE OF REQUEST FOR VARIANCE FOR WATER WELL PERMIT

Dear Landowner:

Monolith Nebraska LLC ("Monolith") is seeking a variance for water well permits from the Lower Platte South Natural Resources District ("LPSNRD"). A copy of the Variance Request that will be provided to the LPSNRD is enclosed for your review.

Monolith is located at 27077 SW 42nd Street, Hallam, NE 68368 and intends to drill three (3) wells at that location. As an adjoining landowner, you are being provided this Notice in accordance with the requirements of the LPSNRD. If you would like additional information regarding the operation of these wells and the impacts created by them, please contact Monolith at the address above.

Please sign below to acknowledge that you have received this Notice and please return this Notice to us in the enclosed stamped envelope. Please keep the enclosed Variance Request for your records.

Heritage Acres LLC – Signature　　　　Date

Heritage Acres LLC – Printed Name

Heritage Acres LLC
Attn: Farmers National Co
PO Box 542016
Omaha, NE 68154

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City, State, ZIP+4®: Hallam, NE 68368

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Postage $0.55

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Sent To: Robert L Luhrs

Street and Apt. No., or PO Box No.: 7376 N 122nd Ave Cir

City, State, ZIP+4®: Omaha, NE 68142

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Total Postage and Fees $7.00

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Street and Apt. No., or PO Box No.: PO Box 499

City, State, ZIP+4®: Columbus, NE 68602

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Omaha, NE 68103

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Postage $0.55

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Sent To: Northern Natural Gas Co

Street and Apt. No., or PO Box No.: PO Box 3330

City, State, ZIP+4®: Omaha, NE 68103

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☐ Return Receipt (electronic)	$0.00
☐ Certified Mail Restricted Delivery	$0.00
☐ Adult Signature Required	$0.00
☐ Adult Signature Restricted Delivery	$0.00
Postage	$0.75
Total Postage and Fees	$7.20

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Sent To: UPRR Co Attn Chris Samuelson

Street and Apt. No., or PO Box No.: 1400 Douglas St, Stop 1640

City, State, ZIP+4®: Omaha, NE 68179-1640

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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

May 20, 2021

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

Dear Amy:

The Lower Platte South NRD Board of Directors has agreed to approve your withdrawal of the variance requests that were tabled at the April 21, 2021 Board of Directors meeting. The Board has agreed to make these two components, specifically Section C, Rule 2(c)(i)(A)(2) ("accurate static water level measurement"), and Section C, Rule 2 (c)(i)(A)(4) ("water quality samples") conditions of well permits OC2 Wells #2 and #3.

The Board has also determined that no additional information is required prior to the submission of the final well permit applications for OC2 Wells #1,2, and 3. We look forward to receiving the final well permit applications on June 4th, 2021.

Please feel free to give me a call if you have any questions.

Sincerely,

Paul D. Zillig
General Manager

PDZ/pz

ydro eolo ic Analysis Report

olsson®

April 27, 2021

Amy Ostermeyer
Vice President of Human Resources
Monolith Materials, Inc.
134 South 13th Street
Suite 700
Lincoln, NE 68508

Dear Ms. Ostermeyer:

With this letter I am submitting the Monolith Hydrogeologic Analysis Report and Addendum (Report). This Report satisfies the requirements of Section C, Rule 2 (c)(i)(A)(5) of the *Lower Platte South Natural Resources District Ground Water Rules & Regulation – Revised Effective Date: January 15, 2020*. This rule states:

> 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. The report must be prepared by a licensed professional geologist or engineer with experience in such analysis.

As discussed in the Report, the hydrogeologic analysis does not indicate potential short or long-term detrimental effects to the aquifer. These conclusions are based on the hydrogeologic analysis that uses the best available science and are in conformance with the limit "trigger" established by the district's *Ground Water Management Plan - 1995* to the amount of decline that is allowed.

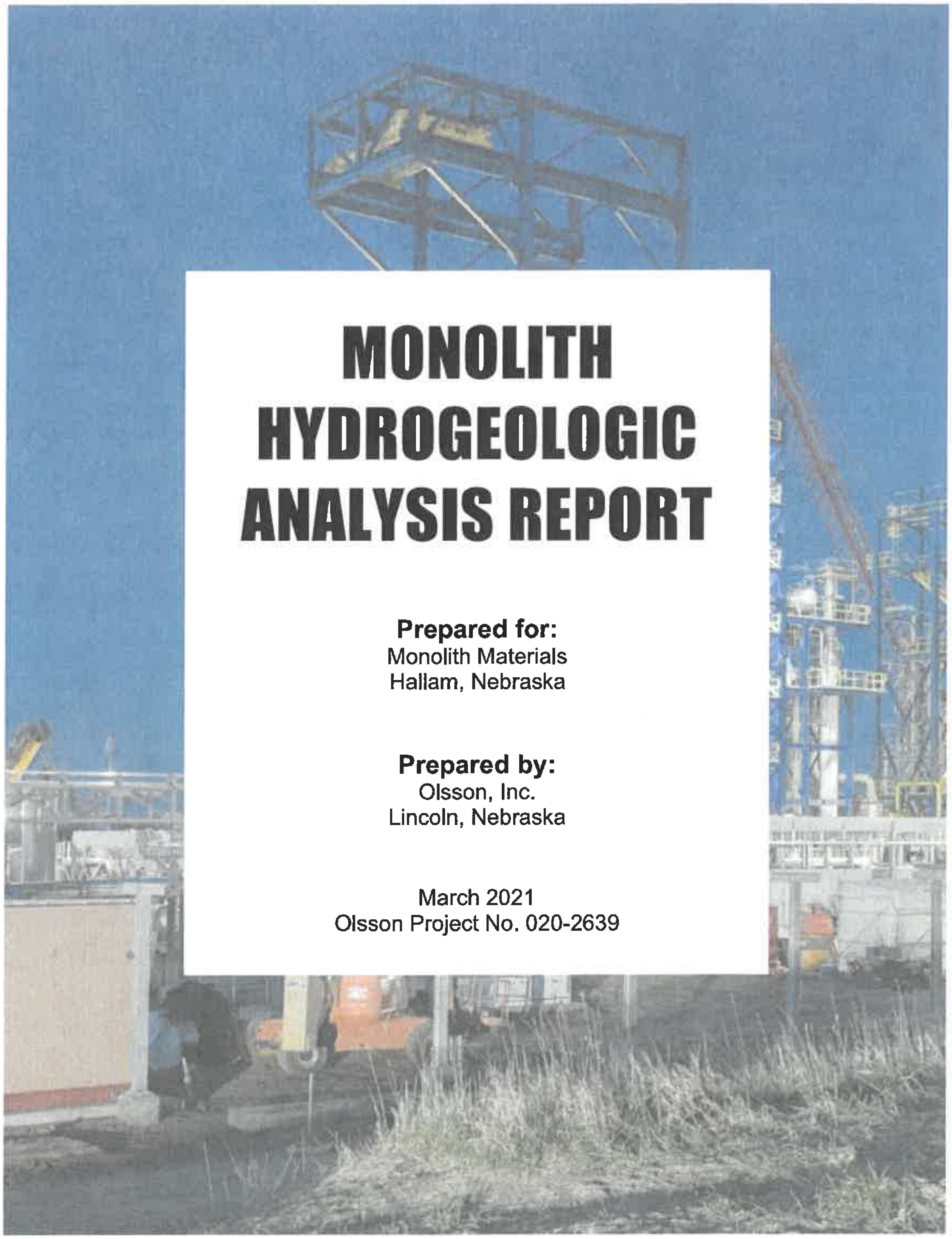
It has been our pleasure at Olsson to work on this important Report. Please let us know if there is anything else that you need.

Sincerely,

Brian P. Dunnigan

Brian P. Dunnigan, PE

Encl.



MONOLITH HYDROGEOLOGIC ANALYSIS REPORT

Prepared for:
Monolith Materials
Hallam, Nebraska

Prepared by:
Olsson, Inc.
Lincoln, Nebraska

March 2021
Olsson Project No. 020-2639

olsson

1. CONTENTS

Executive Summary ES-1
1. Introduction 1
   1.1 Project Introduction 1
   1.2 Project Scope and Objectives 1
   1.3 Report Organization 2
2. Methods 4
   2.1 Hydrogeologic Data Assessment and Mapping 4
      2.1.1 Geographic Setting and Land Use 4
      2.1.2 Hydrology 4
      2.1.3 Soils and Geology 6
      2.1.4 Aquifers 9
      2.1.5 Previous Modeling Efforts 11
   2.2 Refined Groundwater Model Development 17
      2.2.1 Model Code and Applications 17
      2.2.2 Model Discretization 18
      2.2.3 Boundary Conditions 27
      2.2.4 Evapotranspiration, Recharge, and Pumping Inputs 29
      2.2.5 Aquifer Parameters 33
3. Results 35
   3.1 Model Calibration 35
      3.1.1 Calibration Targets 35
      3.1.2 Calibration Approach 35
      3.1.3 Calibration Results 36
   3.2 Modeling Results 47
      3.2.1 Operational Scenarios Evaluated 48
      3.2.2 Water Budget 49
      3.2.3 Aquifer Impacts 50
4. Discussion 53
5. References 59

PROFESSIONAL CIVIL ENGINEER
BRIAN P. DUNNIGAN
E-6179
STATE OF NEBRASKA
5/25/2021

LIST OF FIGURES

Figure ES.1 Change in water levels in aquifers in Nebraska, predevelopment to 2019. ....ES-2
Figure 1.1 Location Map 3
Figure 2.1 The measured and computed baseflow for the Salt Creek at Roca stream gage in the LPMT model (NDNR 2018). 5
Figure 2.2 Geologic time scale and shallow bedrock stratigraphy within Lancaster County.........6
Figure 2.3 Bedrock map of the study area..8
Figure 2.4 Geologic Cross Section through Southern Lancaster County adapted from Divine 2014..9
Figure 2.5 Location of the principal aquifers within the LPSNRD from Druliner, 2001................10
Figure 2.6 LPMT model domain map 12
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) 13
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. 14
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)..15
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)..16
Figure 2.11 Refined model grid map 20
Figure 2.12 Refined model grid around the Monolith project 21
Figure 2.13 Layer 1 Active Cell Map 22
Figure 2.14 Layer 2 Active Cell Map 23
Figure 2.15 Layer 3 Active Cell Map 24
Figure 2.16 Layer 4 Active Cell Map 25
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. 26
Figure 2.18 Refined model boundary conditions map...28
Figure 2.19 Recharge applied to the model from 1986-2019...29
Figure 2.20 Spatial distribution and magnitude of pumping simulated in the LPMT model in July 2013..30
Figure 2.21 Spatial distribution and magnitude of pumping simulated in the refined model in July 2013..30
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...31
Figure 2.23 Average pumping depth comparison between metered and modeled pumping in the LPSNRD...32
Figure 2.24 Monthly pumping simulated in the refined model on a per acre basis....................33
Figure 2.25 Aquifer pumping test and observation (OB) well locations (EA 2020). 34
Figure 3.1 Pilot points used in the hydraulic conductivity PEST calibration. 37
Figure 3.2 Distribution of the absolute residuals..38
Figure 3.3 Final distribution of hydraulic conductivity in layer 2. 39
Figure 3.4 Final distribution of hydraulic conductivity in layer 4. 40
Figure 3.5 Distribution of dry cells in layer 1 at the end of the model simulation.......................41

Figure 3.6. Distribution of dry cells in layer 2 of the model at the end of the simulation. 42
Figure 3.7 The cumulative water budget for the calibrated model simulation. 44
Figure 3.8 Water levels at the end of the calibrated model simulation period. 45
Figure 3.9 Average residuals of the difference in observed and simulated water levels at target well locations. 46
Figure 3.10 Simulated stream baseflow in Salt Creek. 47
Figure 3.11 Simulated cumulative pumping in the future scenario model. 48
Figure 3.12 Proposed Monolith well pumping used in the future scenario model. 49
Figure 3.13 Cumulative water budget for the future scenario with Monolith pumping. 50
Figure 3.14 Future scenario water level changes with variable Monolith pumping. 51
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. 52
Figure 4.1 The average depth to groundwater and number of measurements taken in the LPSNRD's monitoring well program. 55
Figure 4.2 The monitoring well network included in the LPSNRD GWMP. 56
Figure 4.3 Water level changes during the future scenario in irrigation wells within a 3-mile radius of the Monolith plant site. 57
Figure 4.4 Water level changes during the future scenario for the closest (green) and furthest (grey) NPPD wells from the Monolith site. 58
Figure 4.5 Water level changes during the future scenario for the two municipal wells in Hallam. 58

LIST OF TABLES

Table 2.1 The MODFLOW-USG files that compose the refined groundwater model. 18
Table 2.2 Historical data used to fill in the 2014-2019 time period. 26
Table 3.1 Weighting scheme used for water level calibration targets. 35
Table 3.2 Final calibration statistics. 36
Table 3.3 The cumulative water budget for the final model simulation in acre-feet per year. 43
Table 3.4 The cumulative water budget for the future model simulation scenarios in acre-feet per year. 49

LIST OF APPENDICES

Appendix A OC2 Water Use Estimation from Monolith Presentation
Appendix B Comparisons of Modeled and Metered Pumping in the LPSNRD
Appendix C Technical Memorandum on Aquifer Pumping Test
Appendix D Modeled and Observed Water Levels at Target Locations

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.

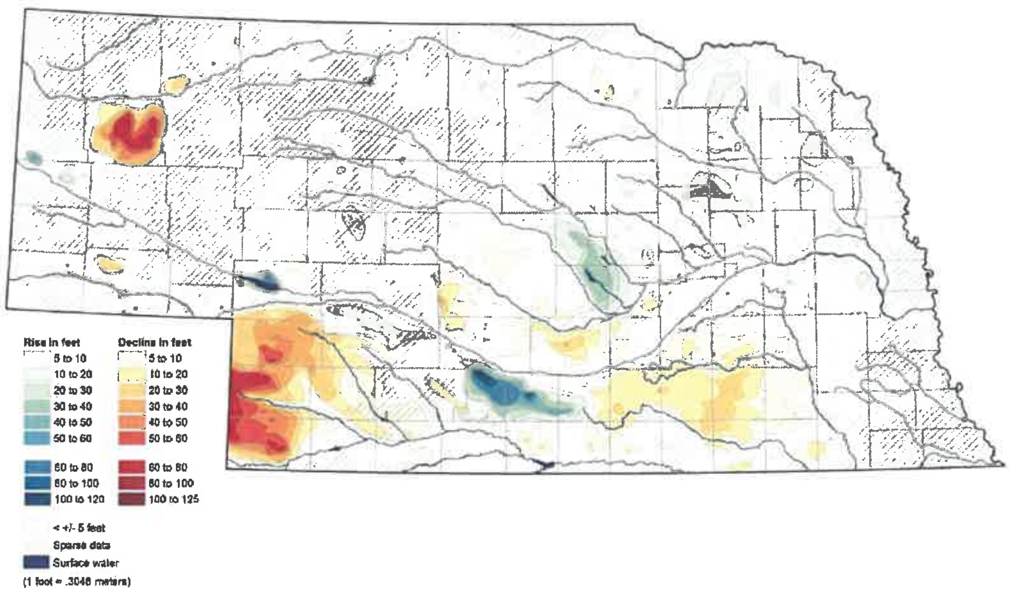


Figure ES.1 Change in water levels in aquifers in Nebraska, predevelopment to 2019.

Monolith has estimated that its water usage will average 320-400 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 320-400 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).

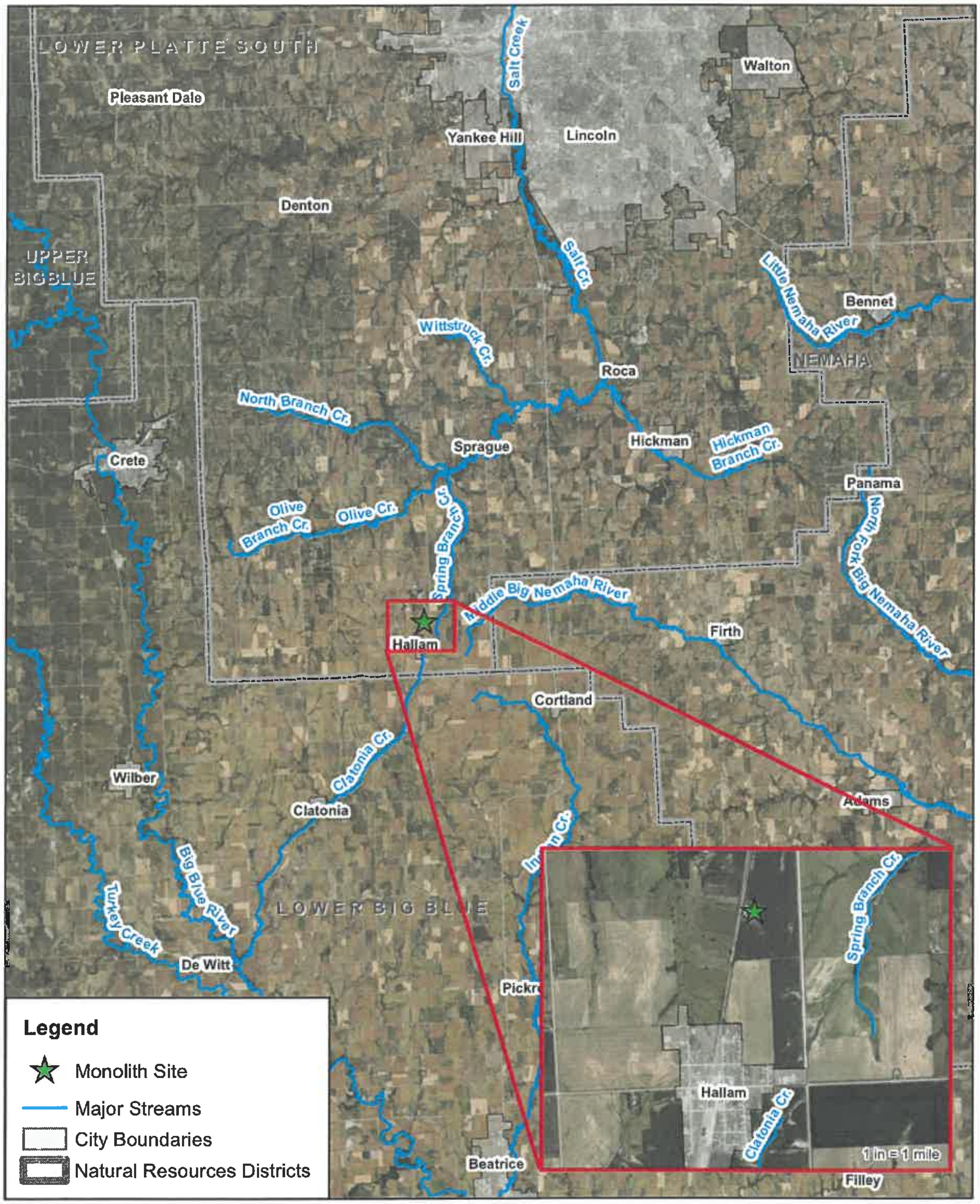
Operation of the plant will require non-contact cooling water to be pumped into the plant, piped through the cooling tower, and discharged to a nearby stream. Preliminary feasibility and conceptual design estimates of non-contact cooling water needed to operate the plant have been refined to arrive at a detailed design estimate for annual water use. The current annual water use estimate needed to operate the plant is up to 320-400 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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0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet
ESRI World Imagery

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.

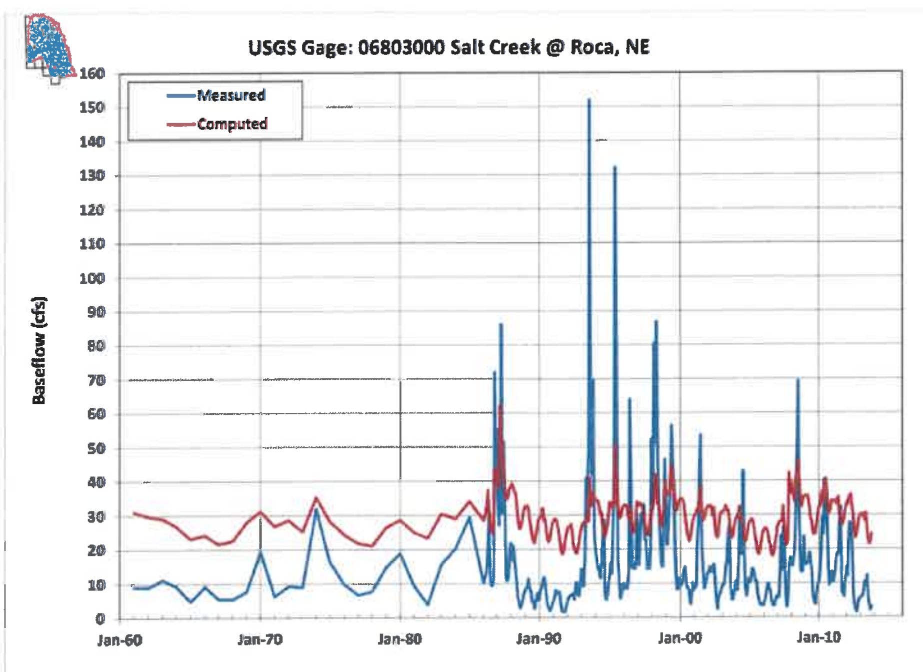


Figure 2.1 The measured and computed baseflow for the Salt Creek at Roca stream gage in the LPMT model (NDNR 2018).

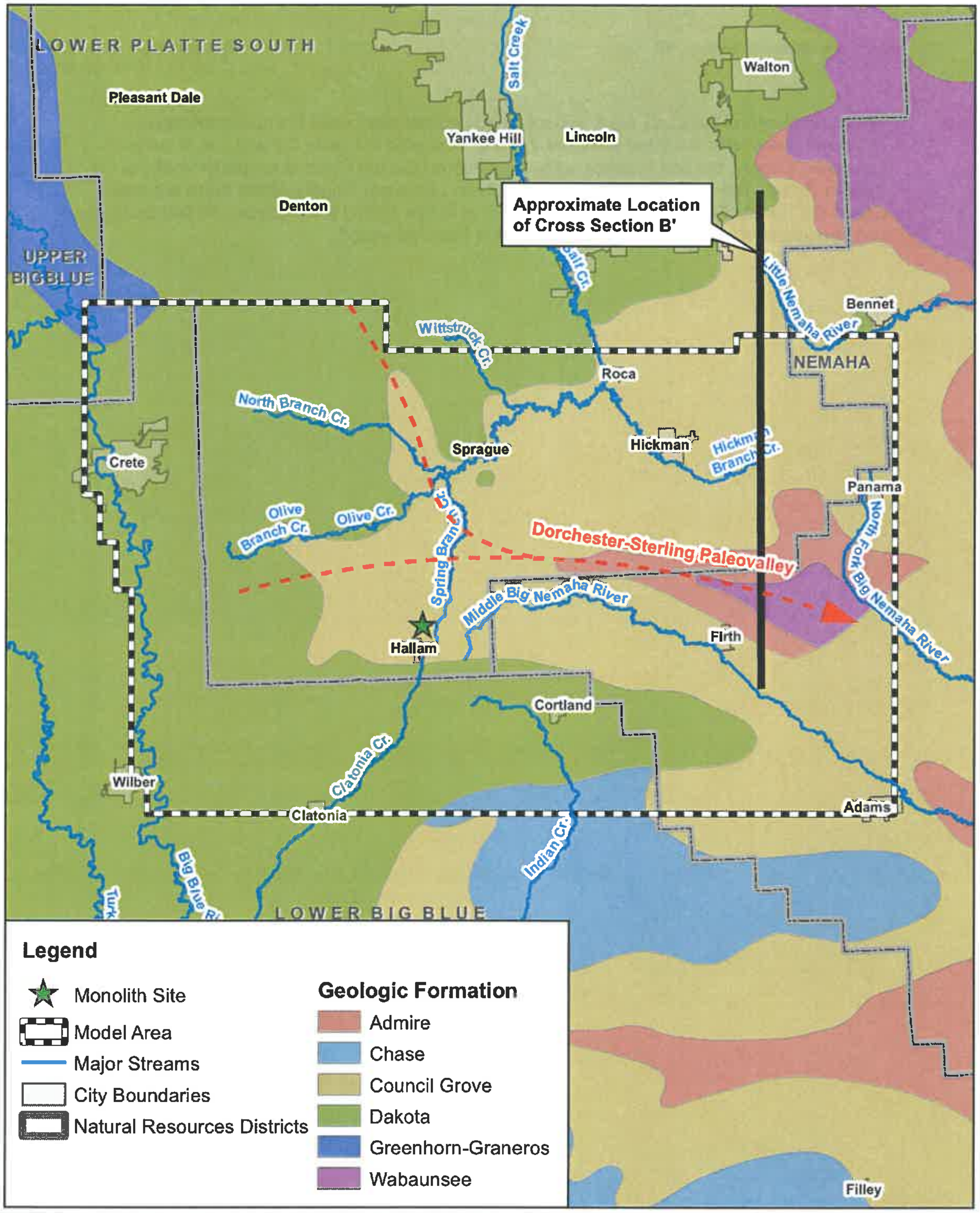
2.1.3 Soils and Geology

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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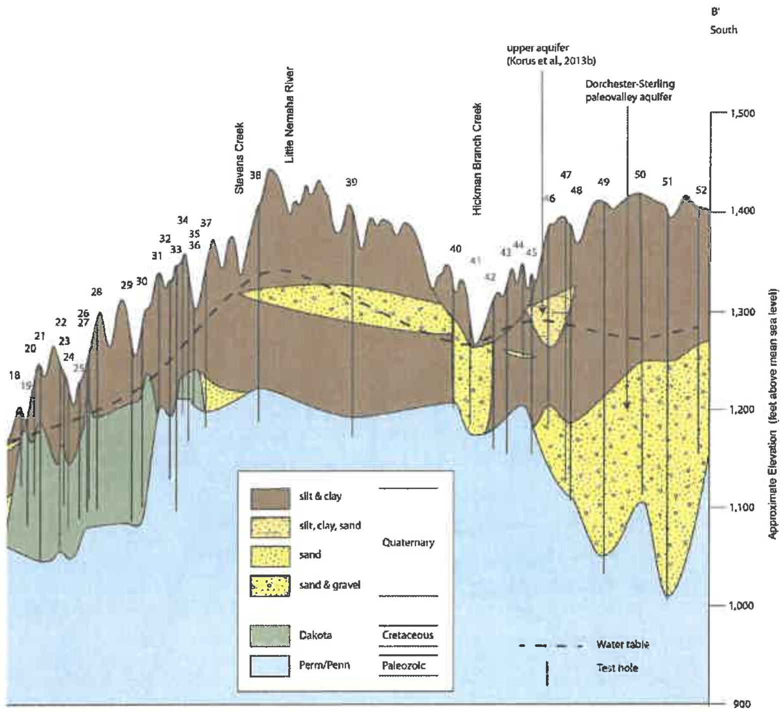

Figure 2.4 Geologic Cross Section through Southern Lancaster County adapted from Divine 2014.

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).

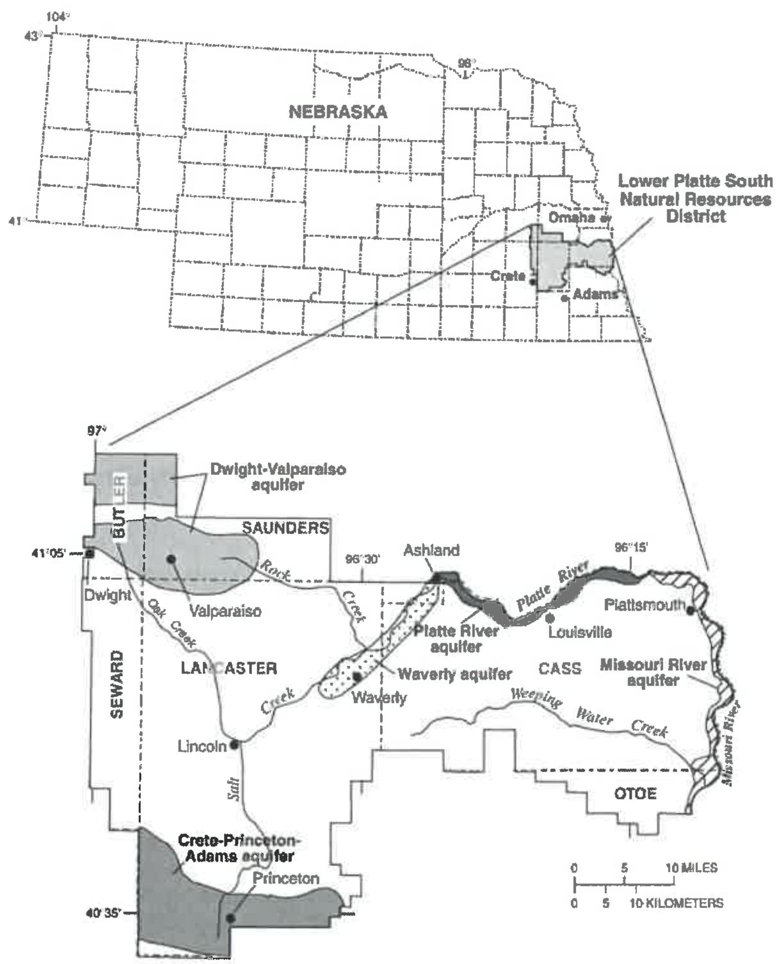

Figure 2.5 Location of the principal aquifers within the LPSNRD from Druliner, 2001.

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.

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LPMT Model Domain Map
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.6

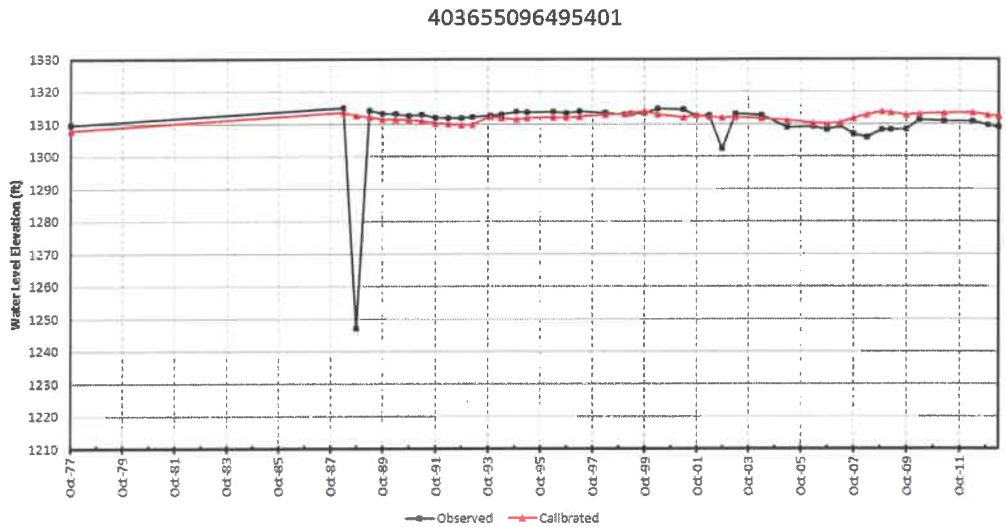


Figure 2.7 Example calibration dataset from the LPMT model for a well near Hallam. (Note: the strong departure in long-term average water levels during 1988 is likely a data transcription error or some similar issue with data quality.) (NDNR 2018)

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 320-400 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.

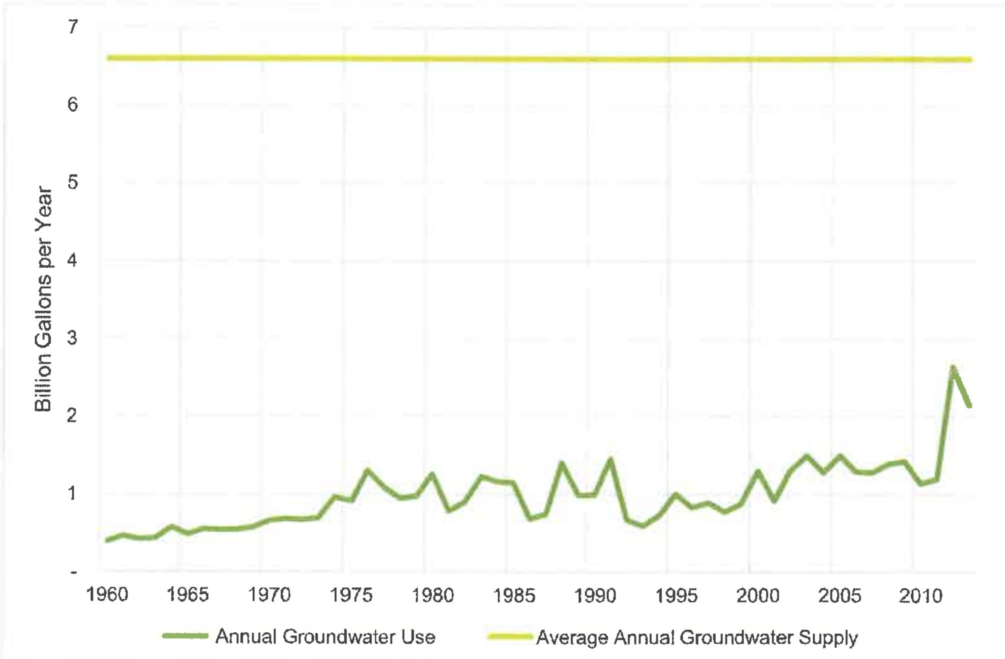


Figure 2.8 Comparison of average annual groundwater supply and annual groundwater use for the CPA aquifer area of Lancaster County in the LPMT model.

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.

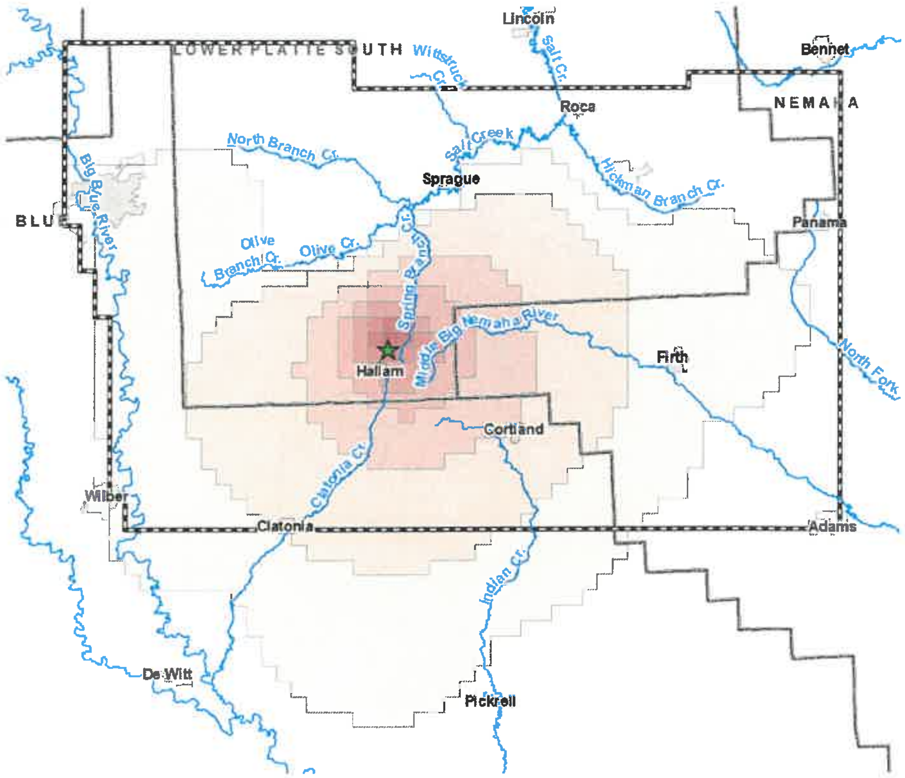


Figure 2.9 Water level change resulting from a well pumping 320 million gallons per year after 50 years. Changes range from -0.1 feet in the palest peach area to -7.5 feet in the immediate vicinity of the well. (GET 2020)

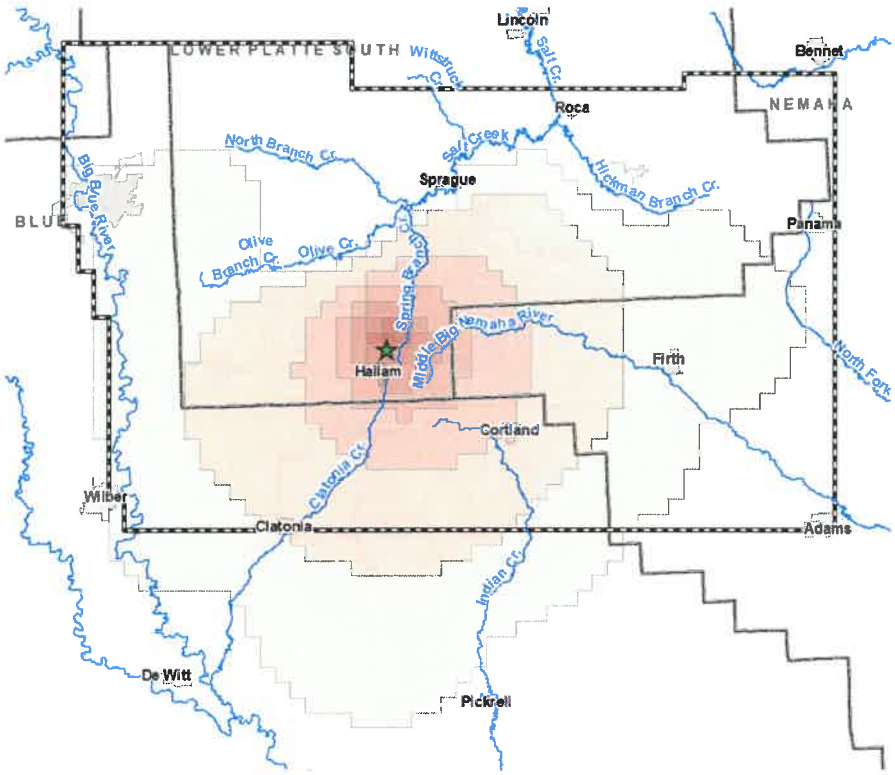


Figure 2.10 Water level change resulting from a well pumping 400 million gallons per year after 50 years. Changes range from -0.1 feet in the palest peach area to -9.4 feet in the immediate vicinity of the well. (GET 2020)

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.

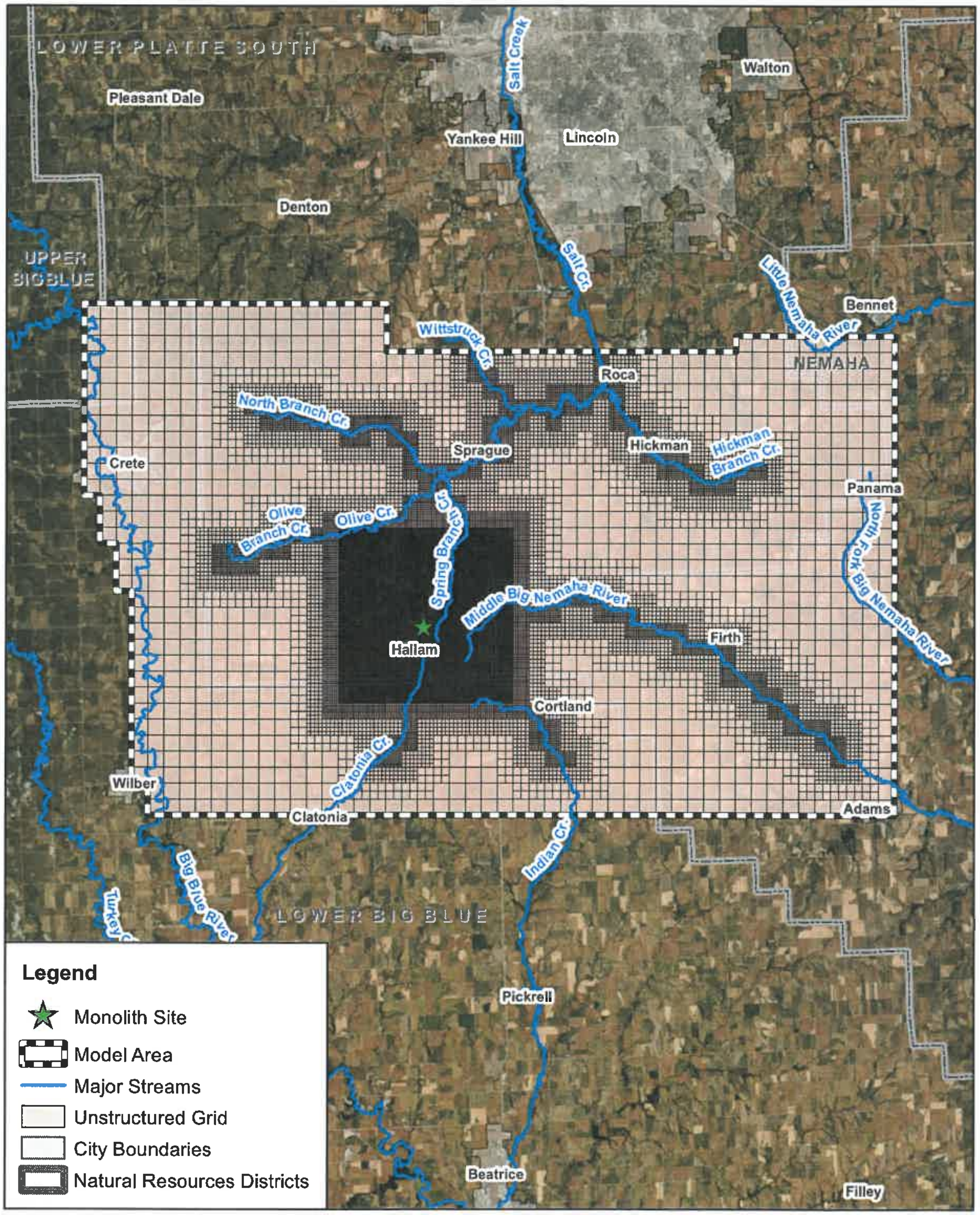
MODFLOW File	Description
BAS	Basic Package: this file is used to specify the locations of active, inactive, and specified head cells as well as the initial heads in all cells.
CLN	Connected Linear Network Process: this file specifies the location of one-dimensional connected features and how they should 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).



olsson

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

FIGURE 2.11

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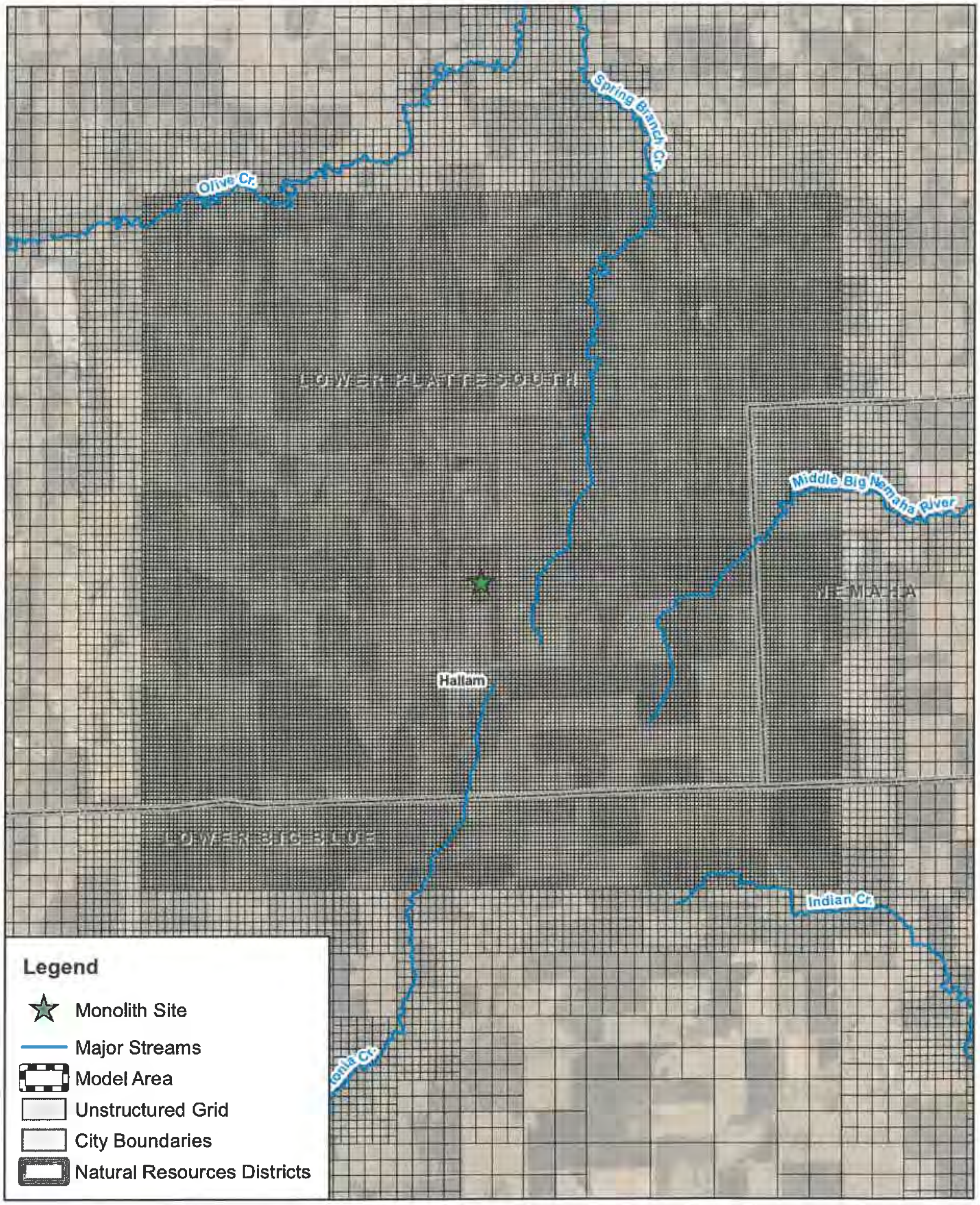

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N

0 0.25 0.5 1 Miles

1 in = 1 miles

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Refined Model Grid - Project Site

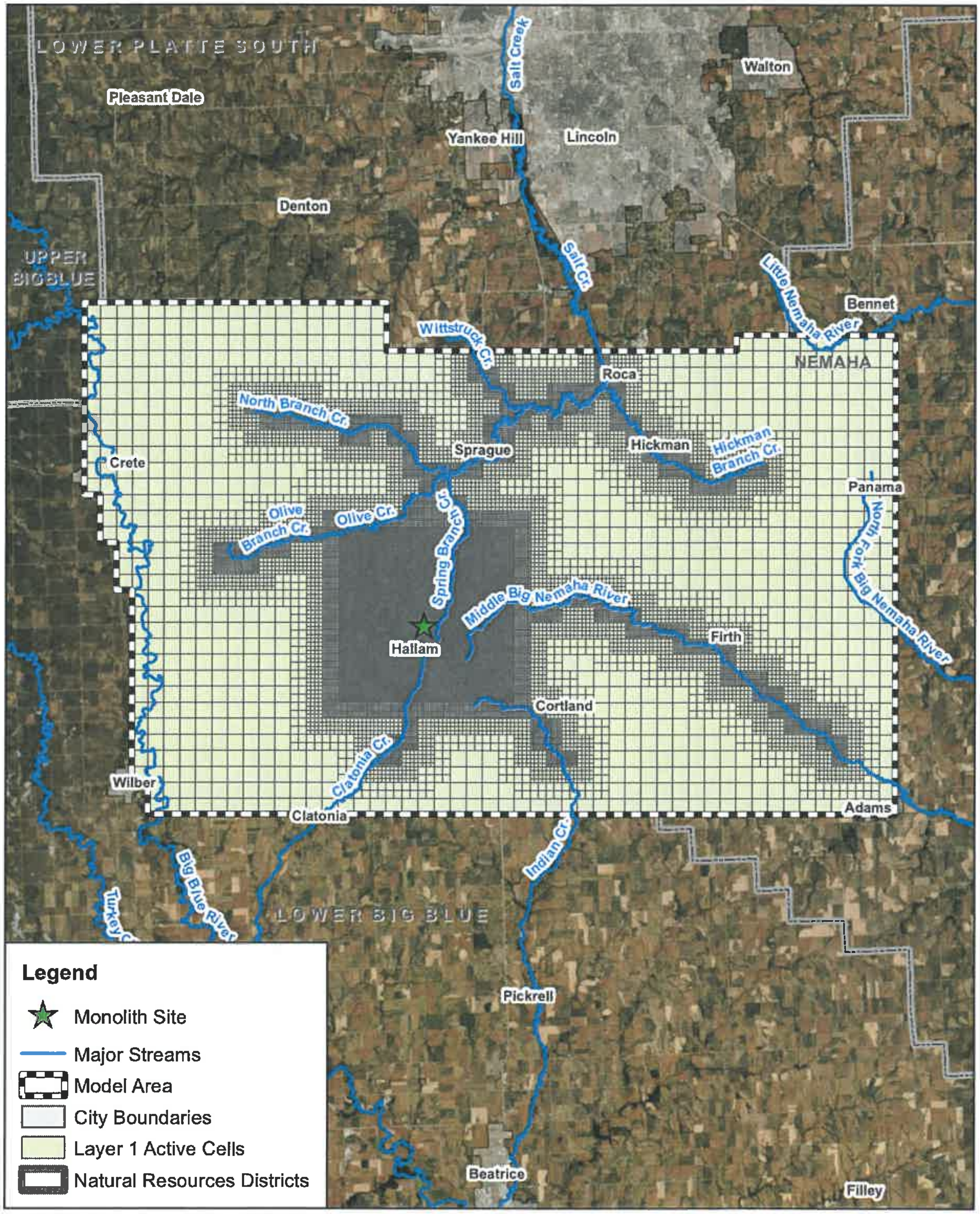
Monolith OC2

Groundwater Modeling Report

Lancaster County, NE

FIGURE

2.12



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N

0 1 2 4 Miles

1 in = 4 miles

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Layer 1 Active Cells

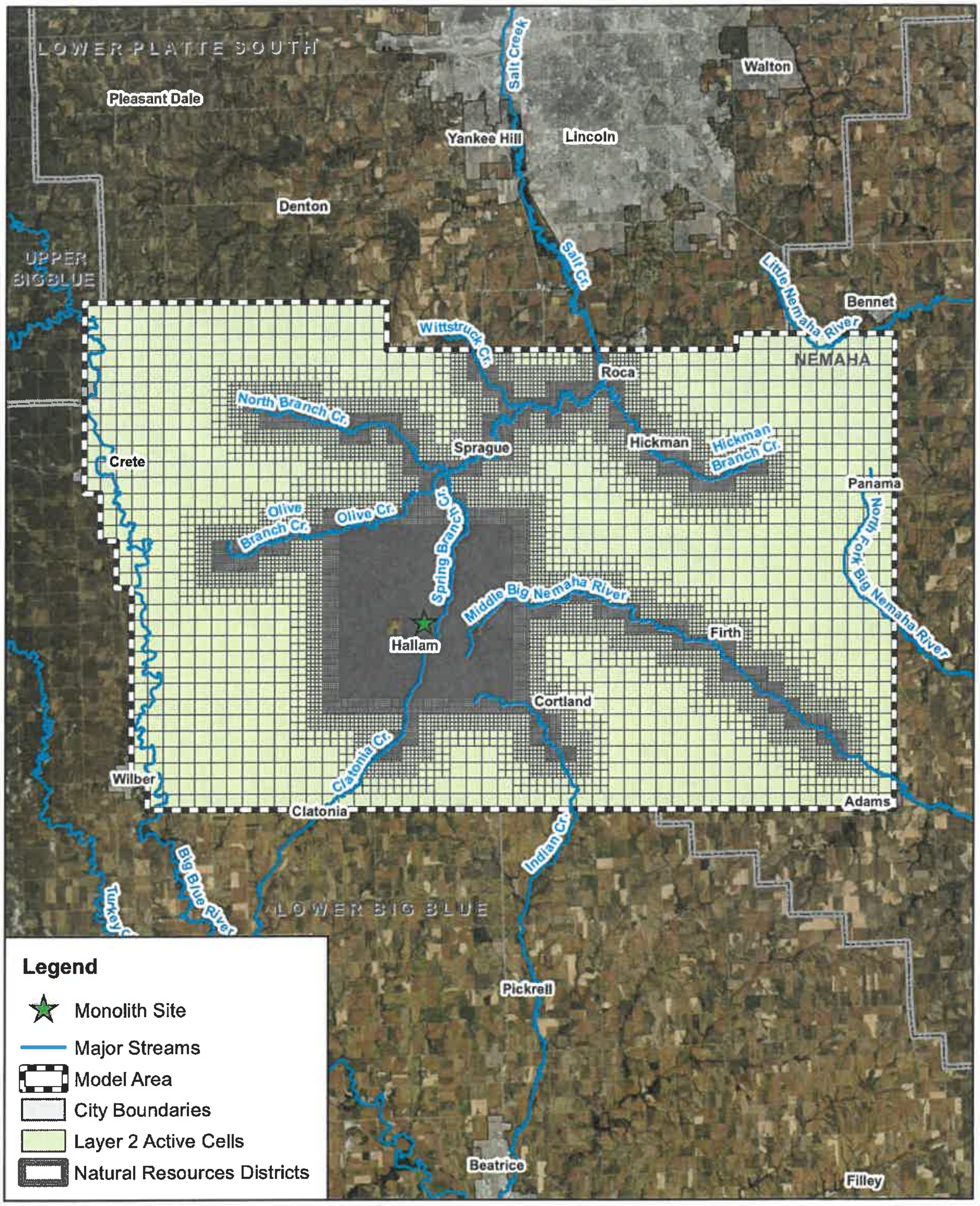
Monolith OC2

Groundwater Modeling Report

Lancaster County, NE

FIGURE

2.13



olsson

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

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

FIGURE
2.14

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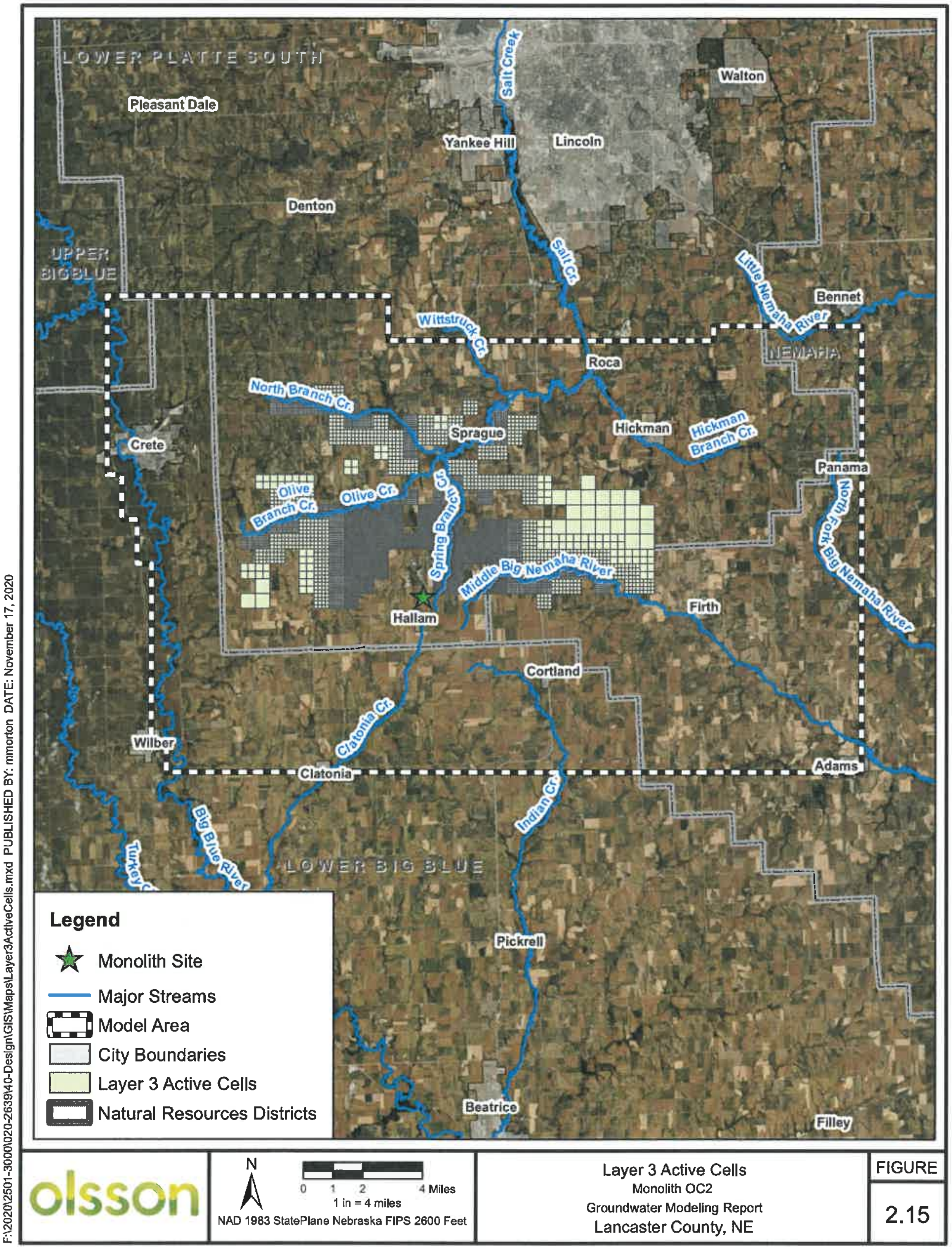
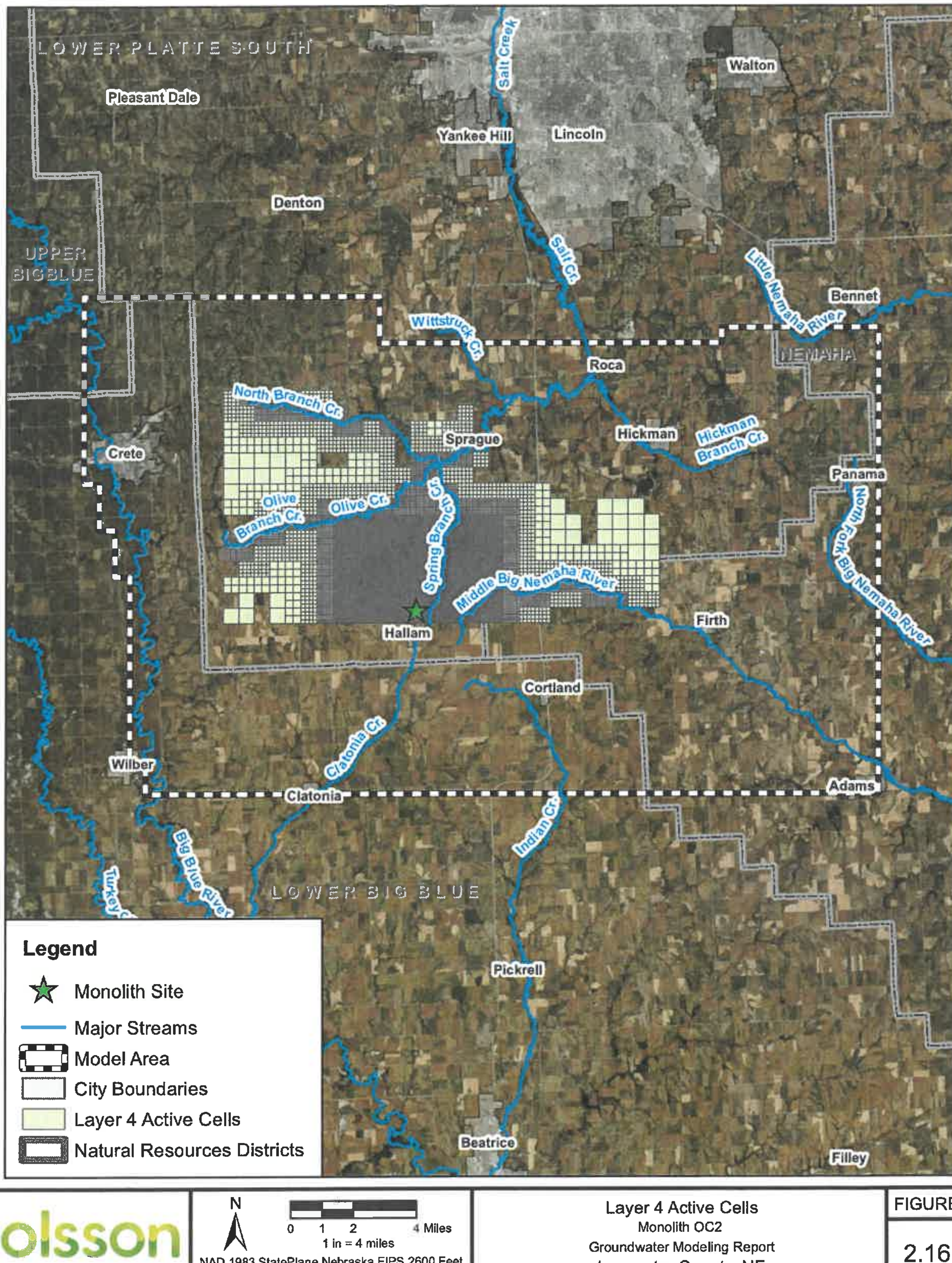


Layer 3 Active Cells
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 2.15



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

FIGURE 2.16

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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

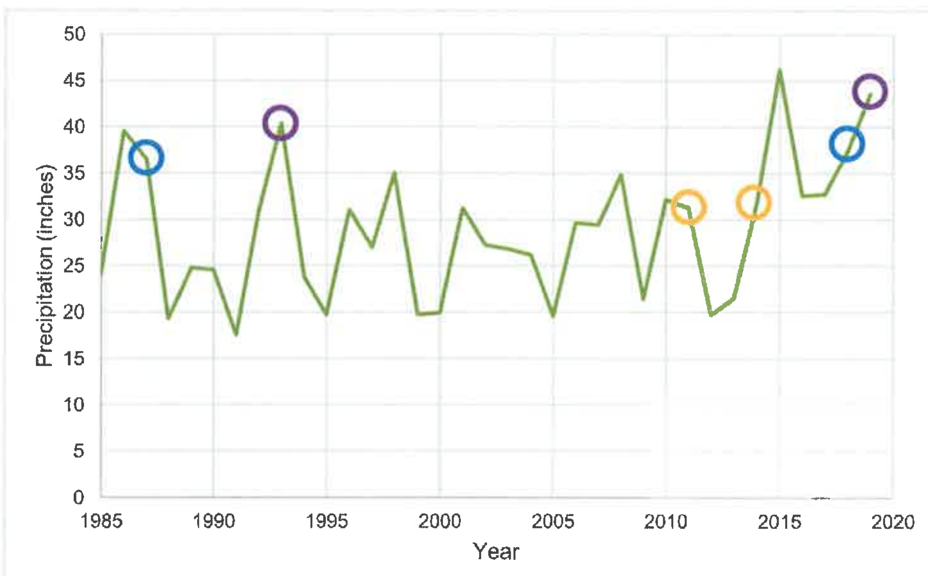


Figure 2.17 Precipitation used in the model from 1985-2019. From 2014-2019, historical years with similar precipitation totals were chosen. Examples are marked by the colored circles.

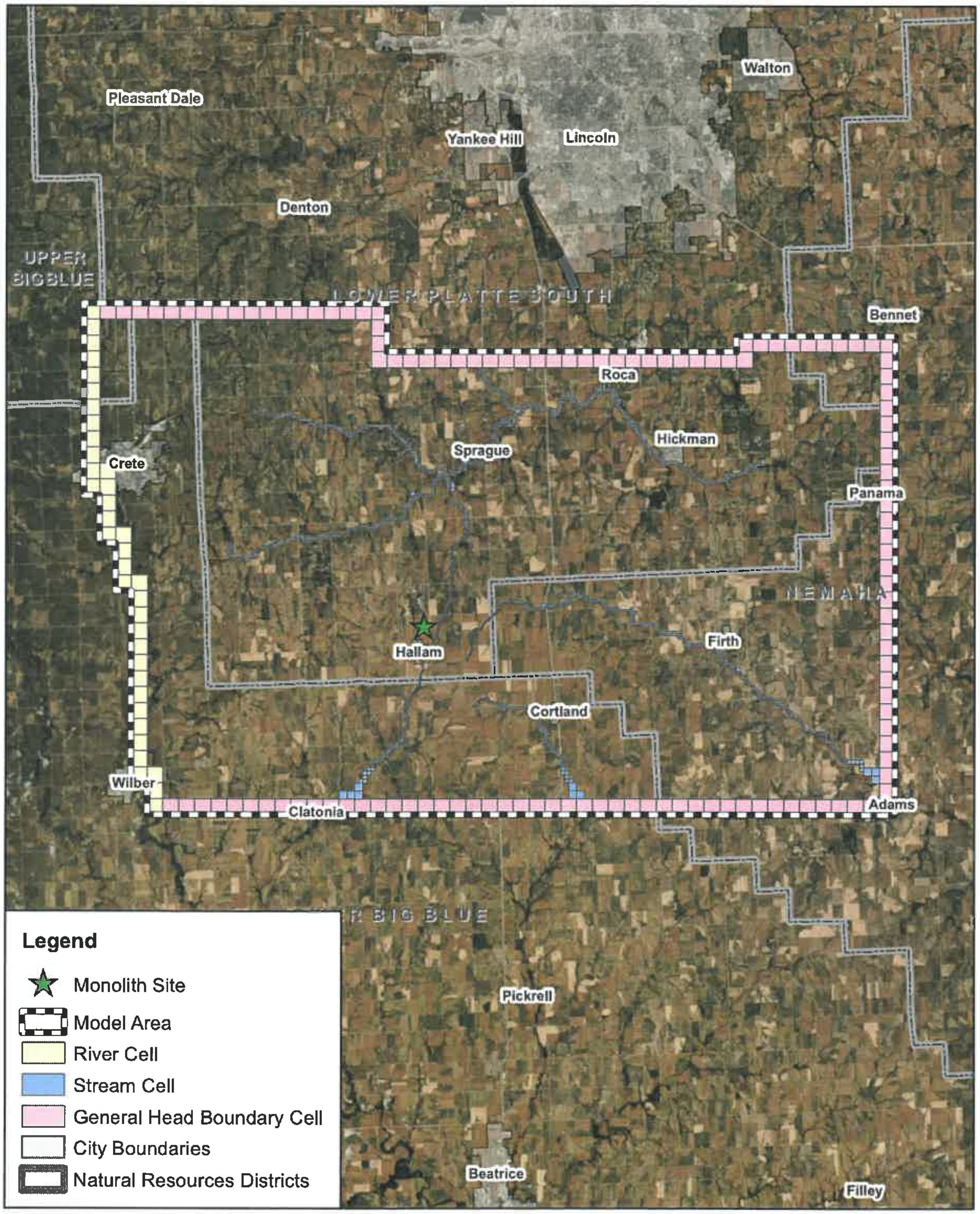
2.2.3 Boundary Conditions

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 to 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.



olsson

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

Boundary Conditions
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE
2.18

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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.

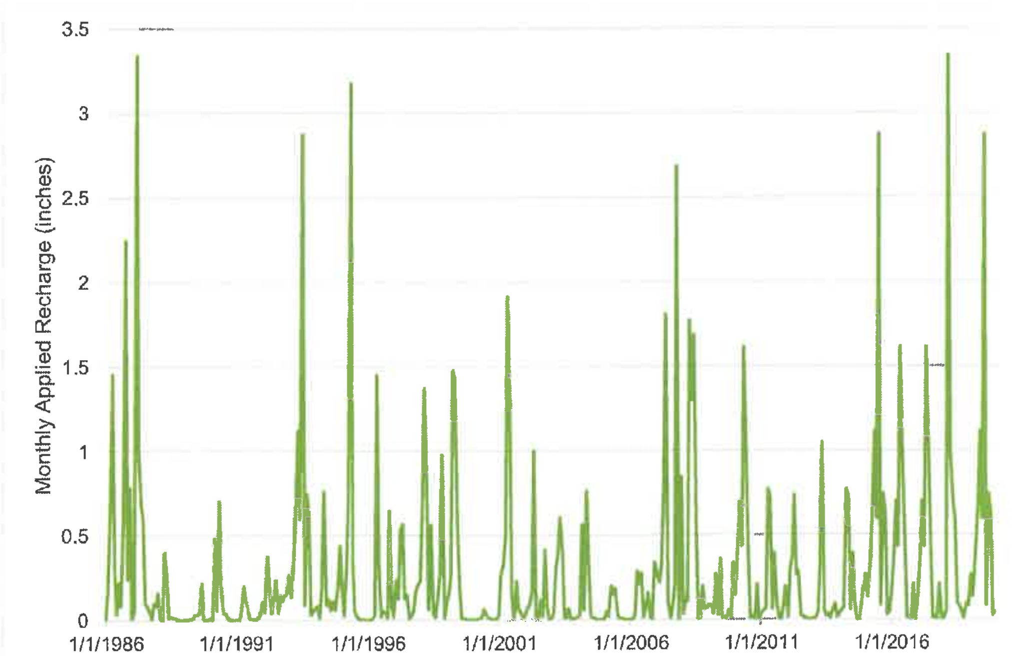


Figure 2.19 Recharge applied to the model from 1986-2019

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.

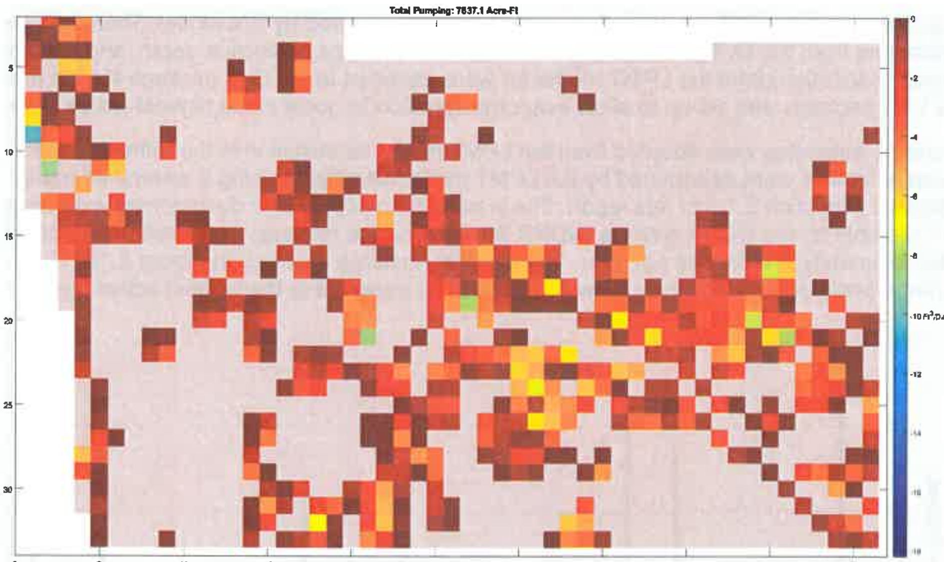


Figure 2.20 Spatial distribution and magnitude of pumping simulated in the LPMT model in July 2013.

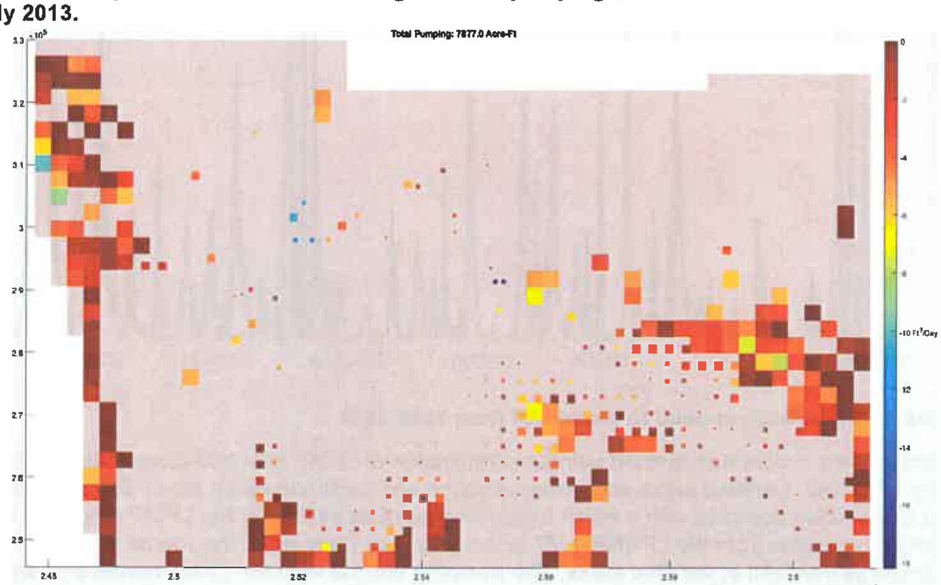


Figure 2.21 Spatial distribution and magnitude of pumping simulated in the refined model in July 2013.

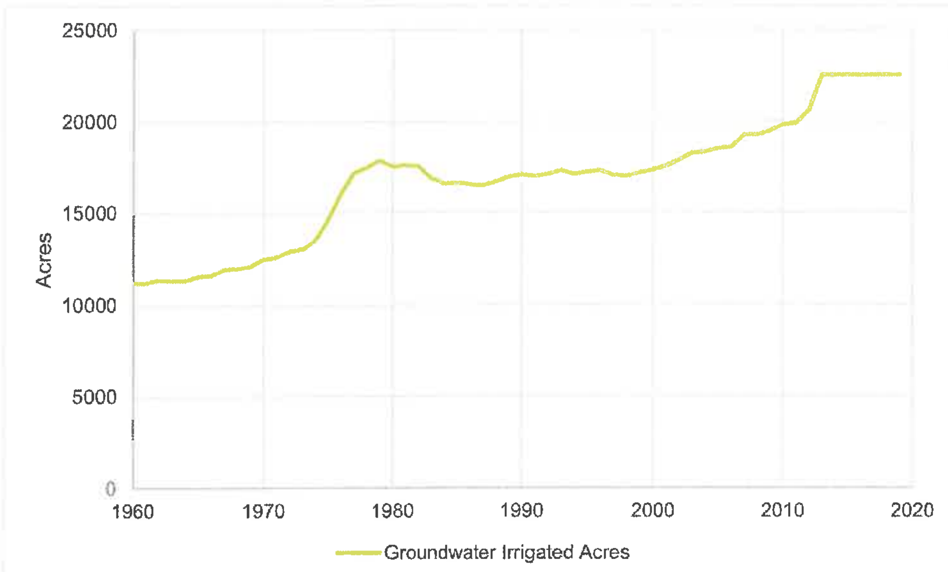


Figure 2.22 A time series of the number of groundwater irrigated acres simulated within the model from 1960-2019. The last dataset available is from 2013 so those years were repeated for 2014-2019.

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

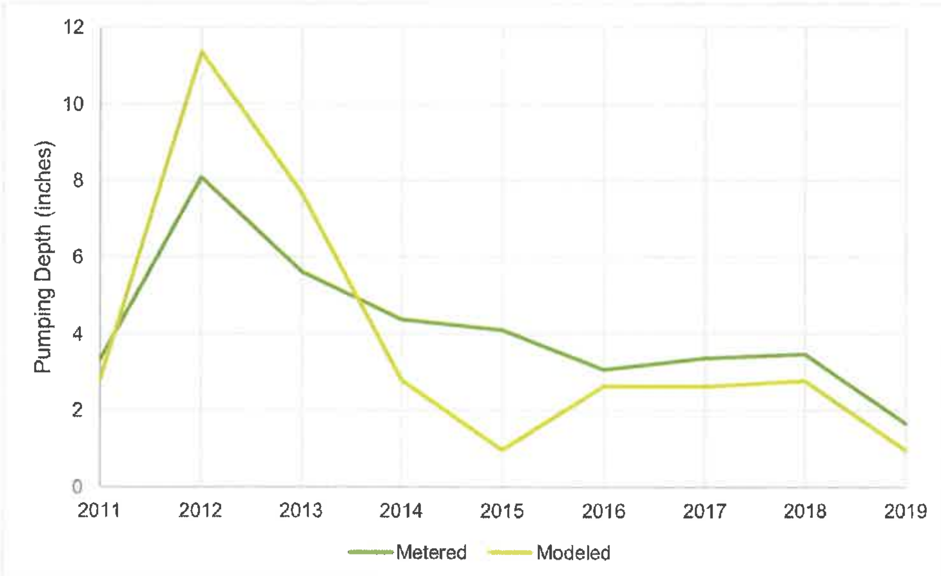


Figure 2.23 Average pumping depth comparison between metered and modeled pumping in the LPSNRD.

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.

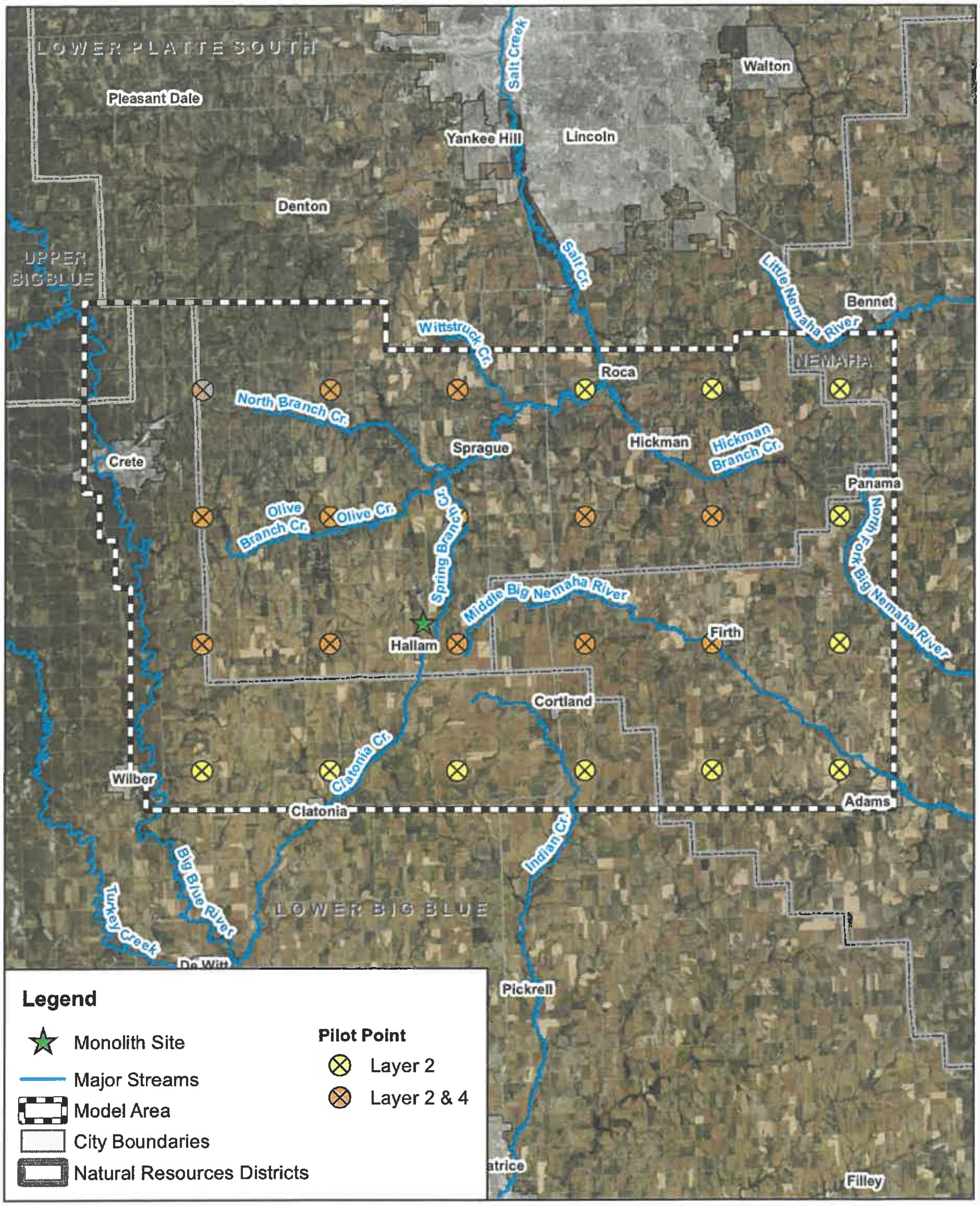
The second approach started with a series of pilot points that were meant to represent the actual value for hydraulic conductivity. These pilot points were given an initial value of 100 feet per day and allowed to vary anywhere between 20 and 200 feet per day. After several PEST iterations it became 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



olsson

N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Pilot Points

Monolith OC2

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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.

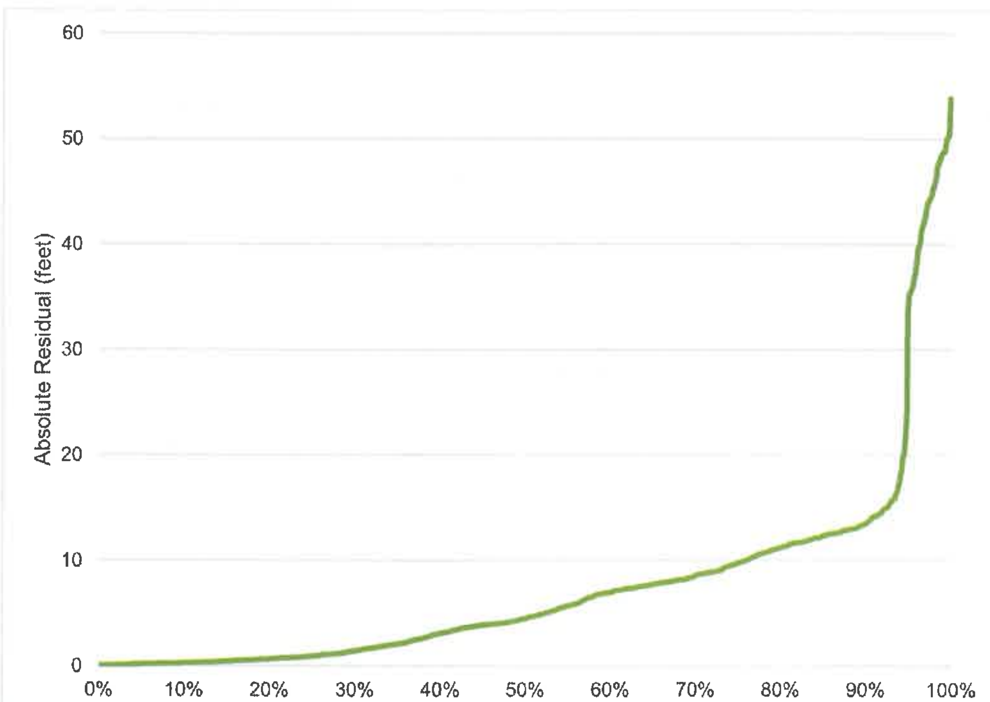
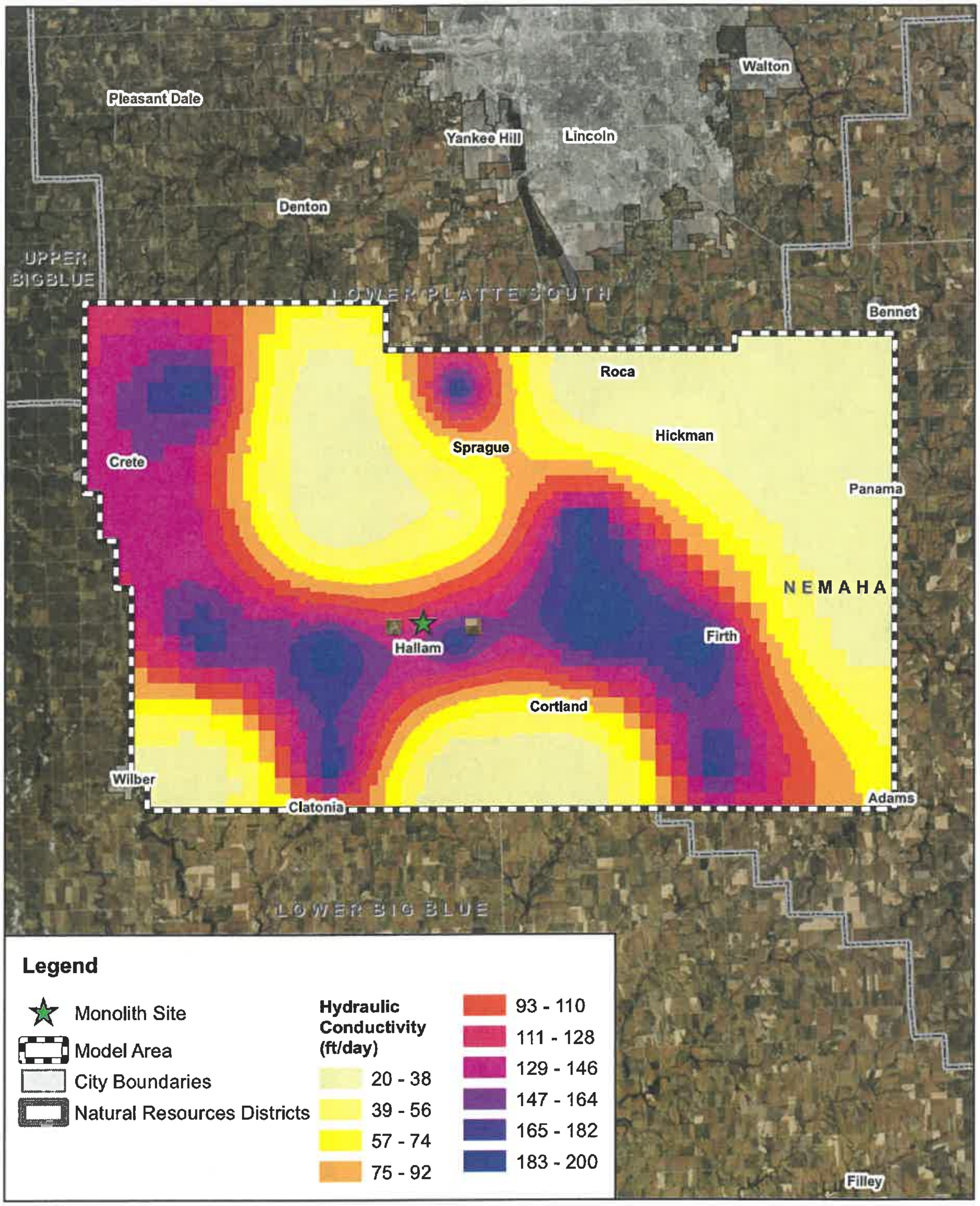


Figure 3.2 Distribution of the absolute residuals.



olsson

Layer 2 Hydraulic Conductivity
Monolith OC2
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Lancaster County, NE

FIGURE 3.3

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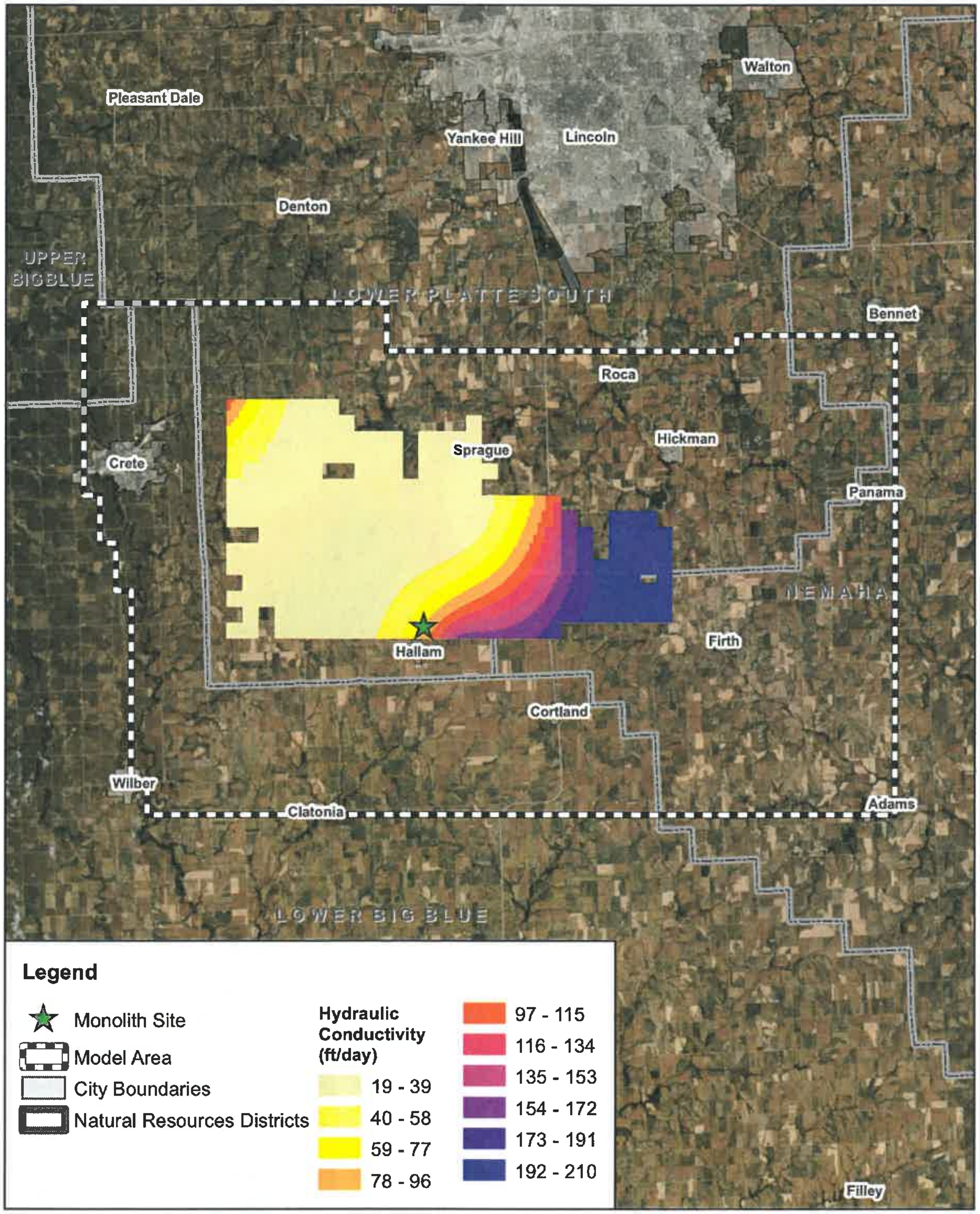

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olsson

N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Layer 4 Hydraulic Conductivity

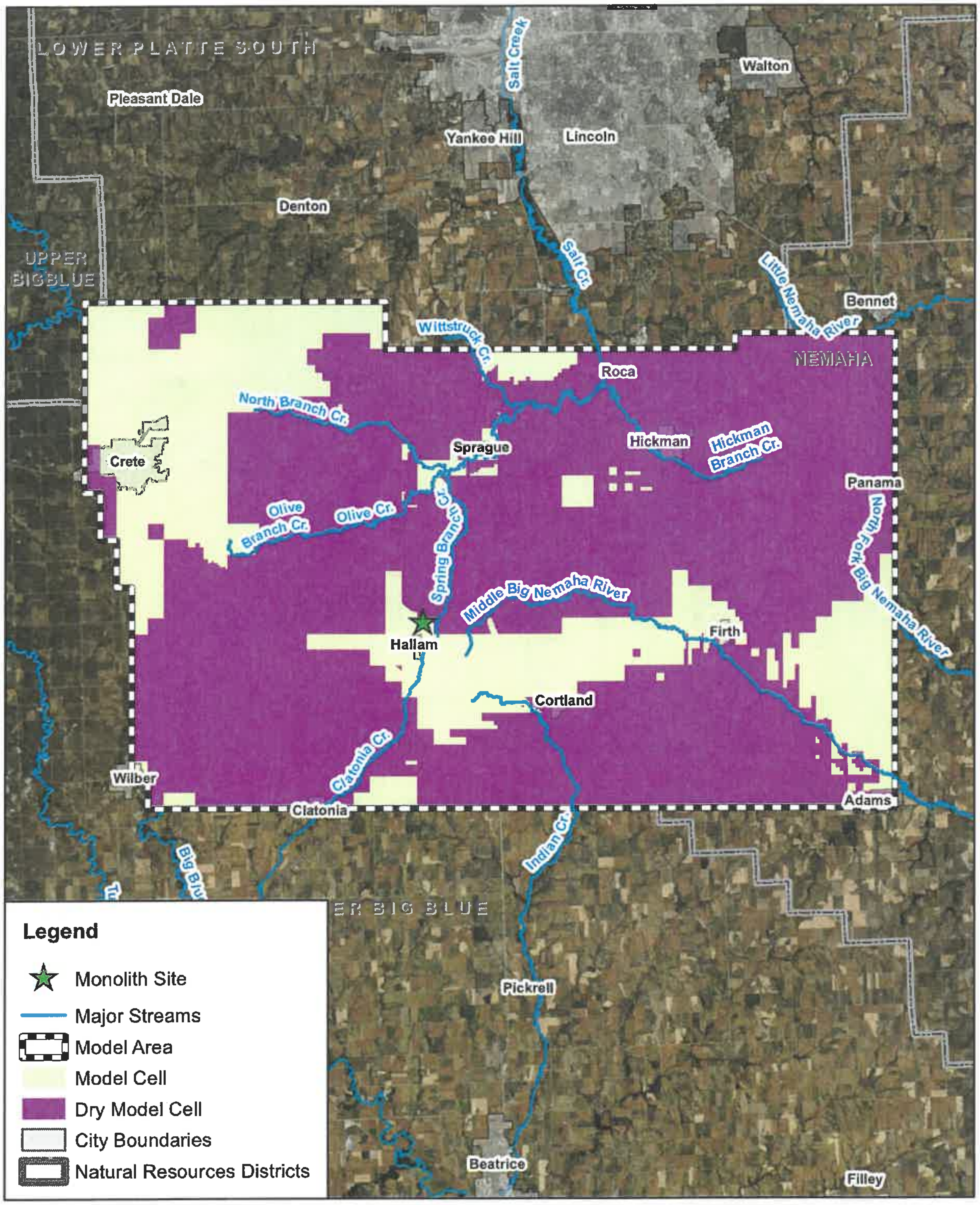
Monolith OC2

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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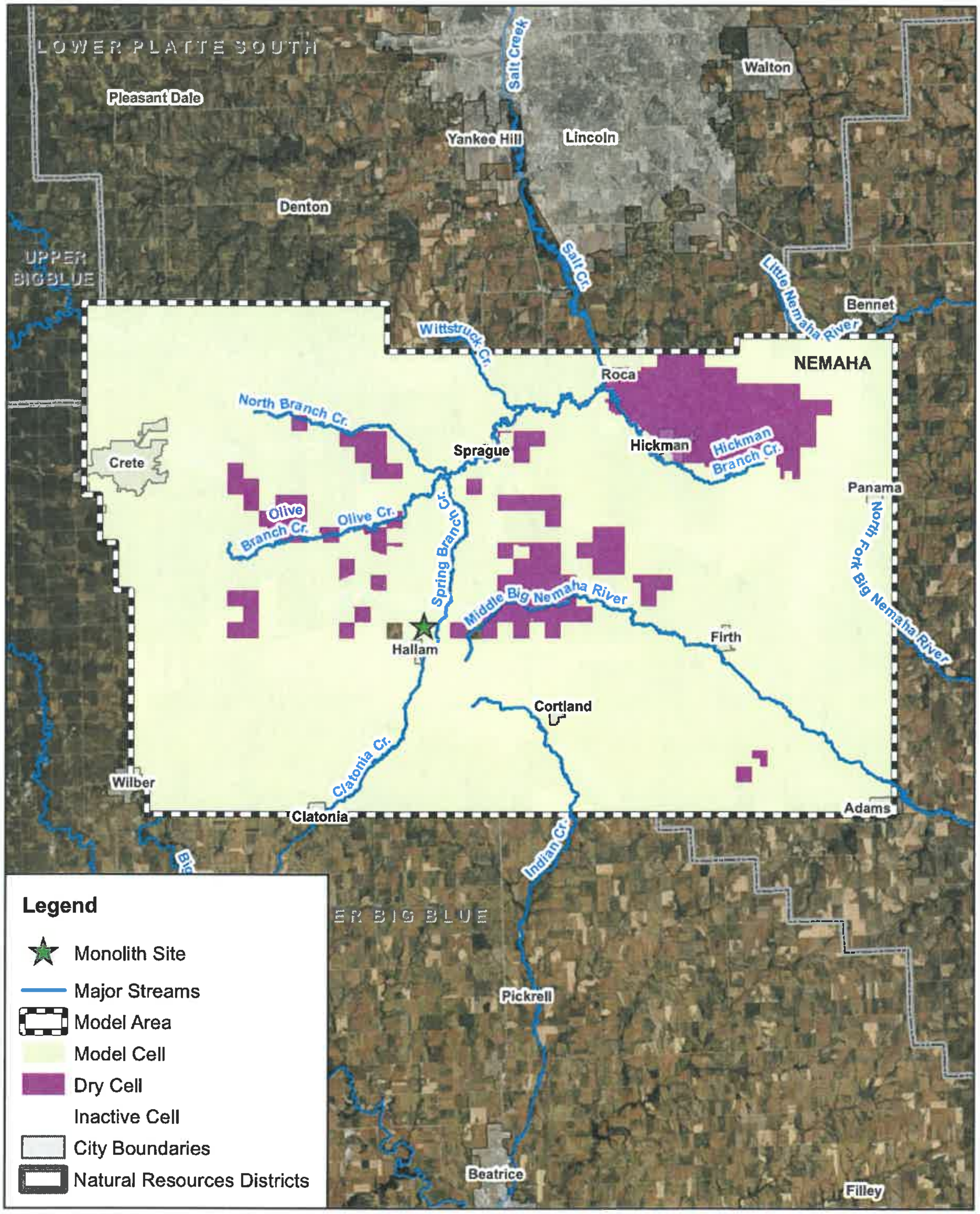

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N

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.

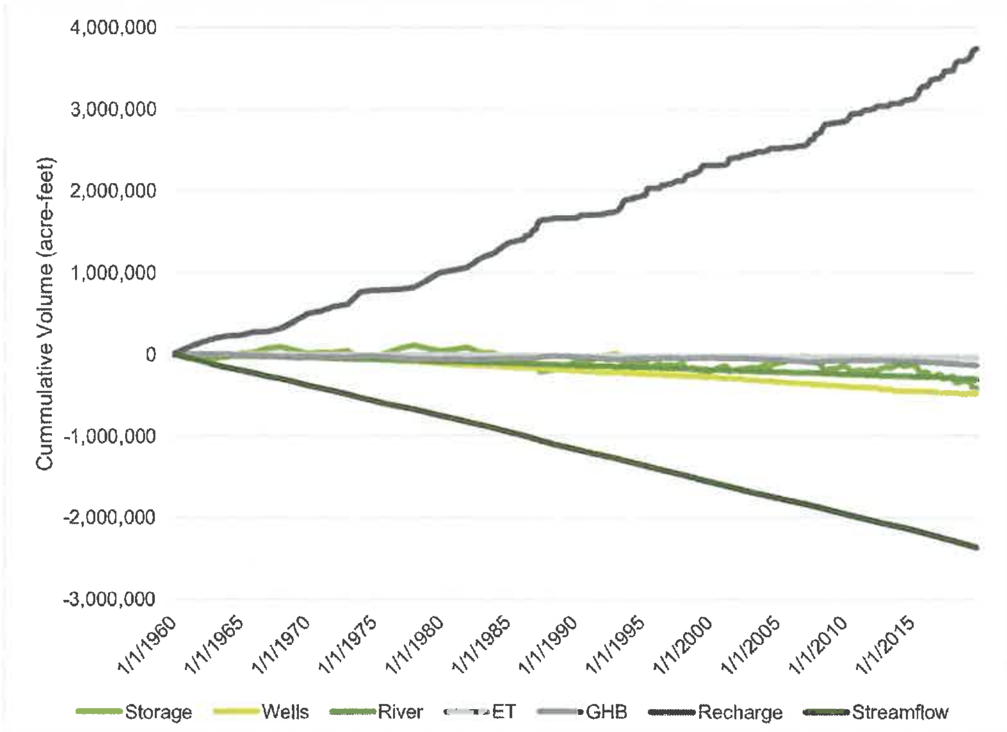
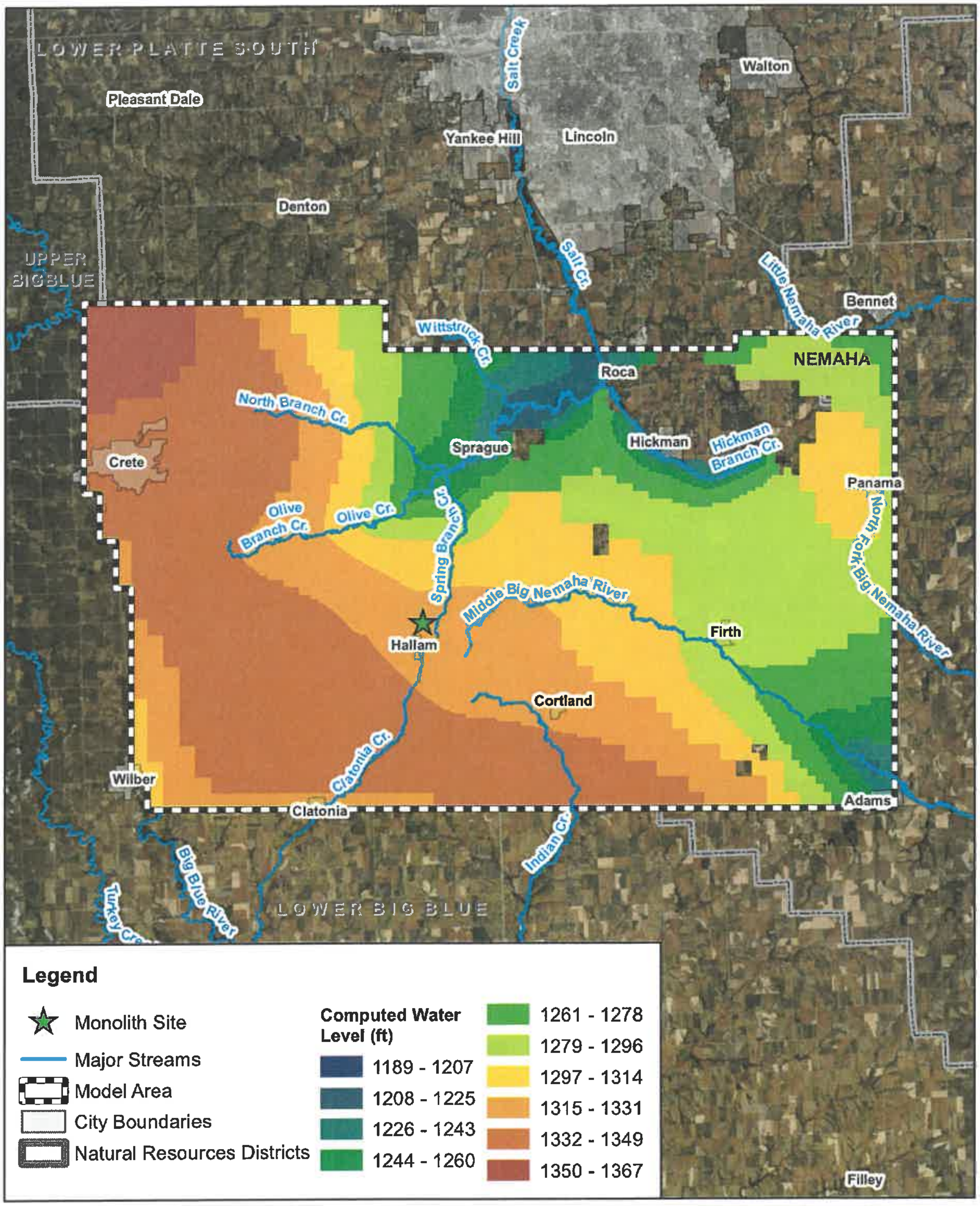


Figure 3.7 The cumulative water budget for the calibrated model simulation.



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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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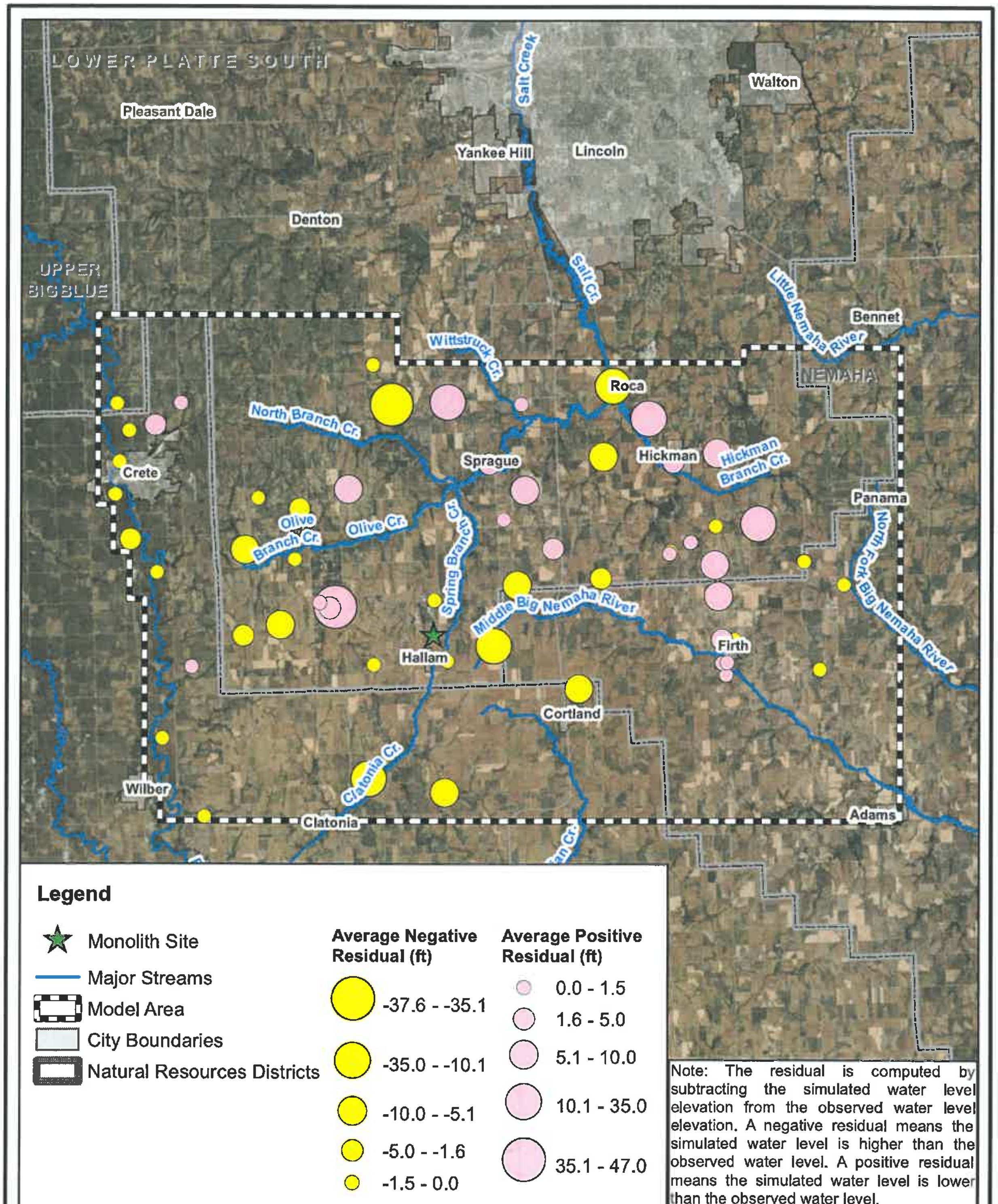

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Water Level Targets
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE
3.9

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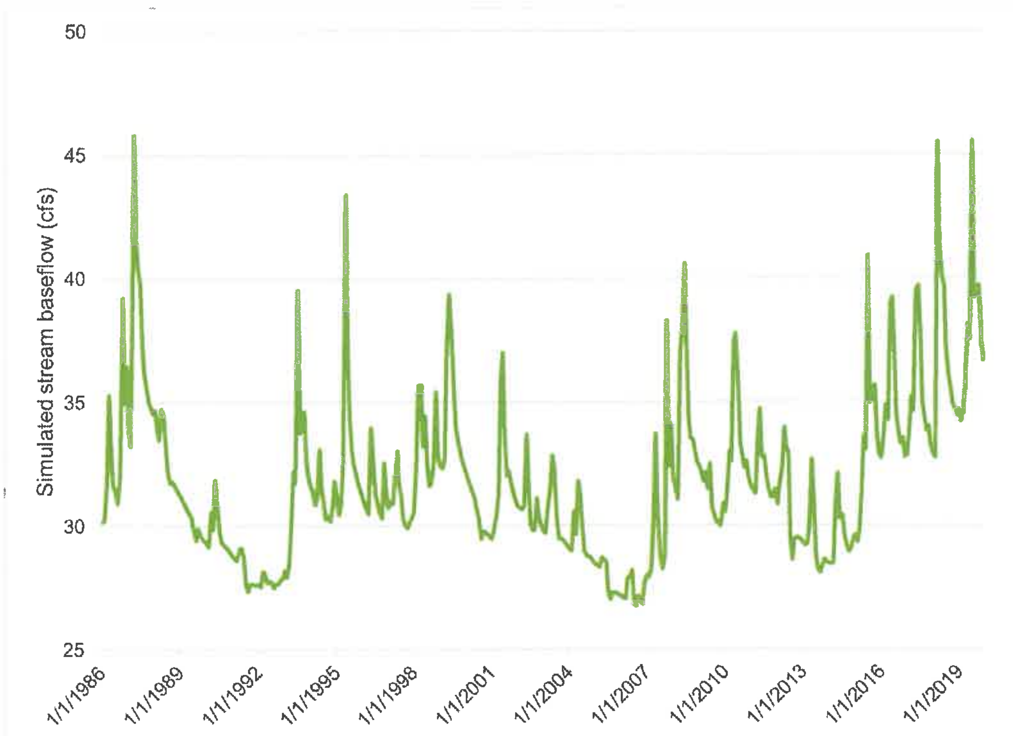


Figure 3.10 Simulated stream baseflow in Salt Creek.

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.

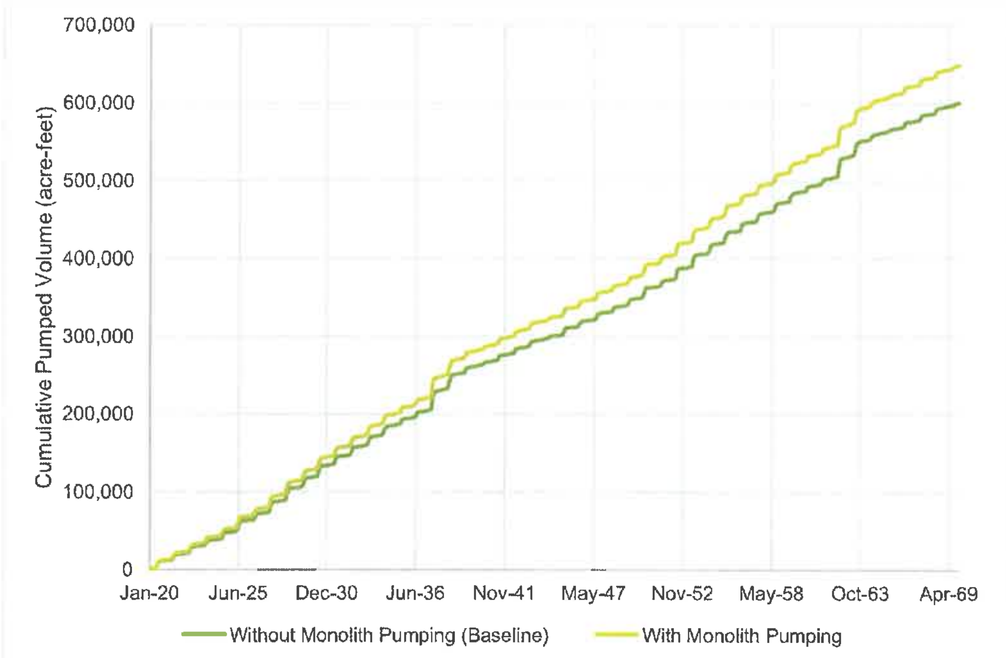


Figure 3.11 Simulated cumulative pumping in the future scenario model.

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.

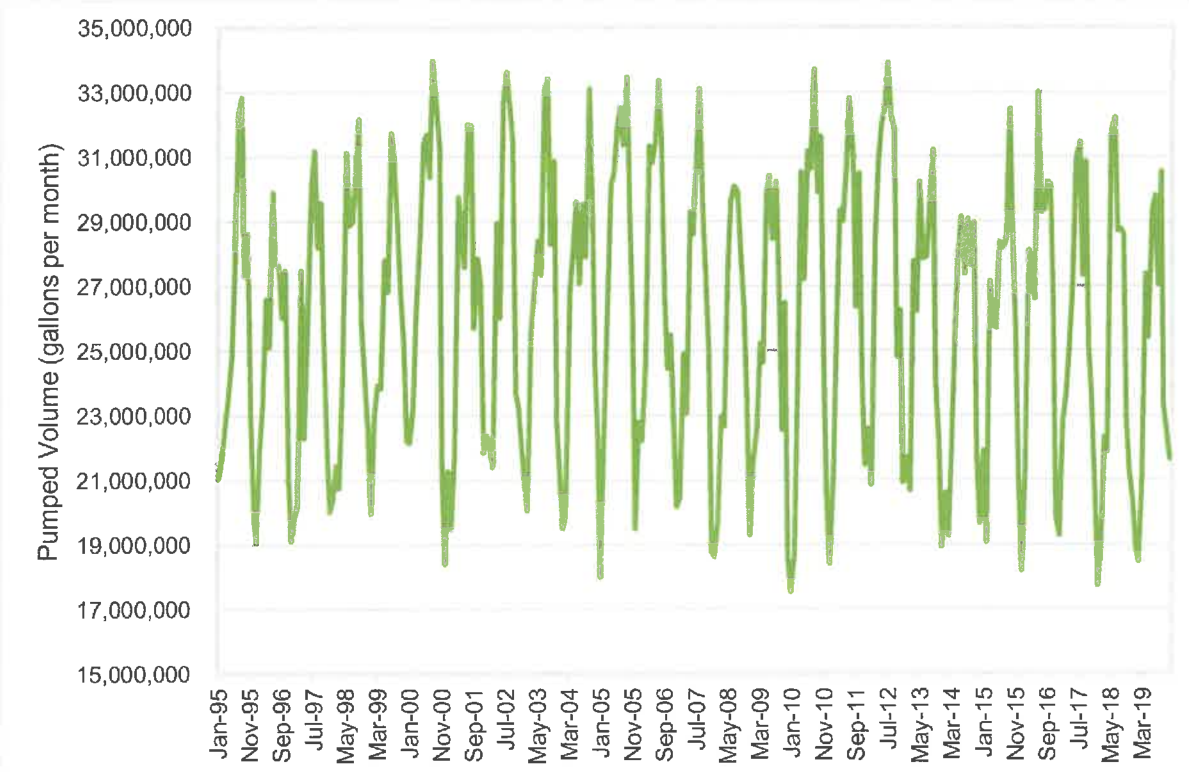


Figure 3.12 Proposed Monolith well pumping used in the future scenario model.

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.

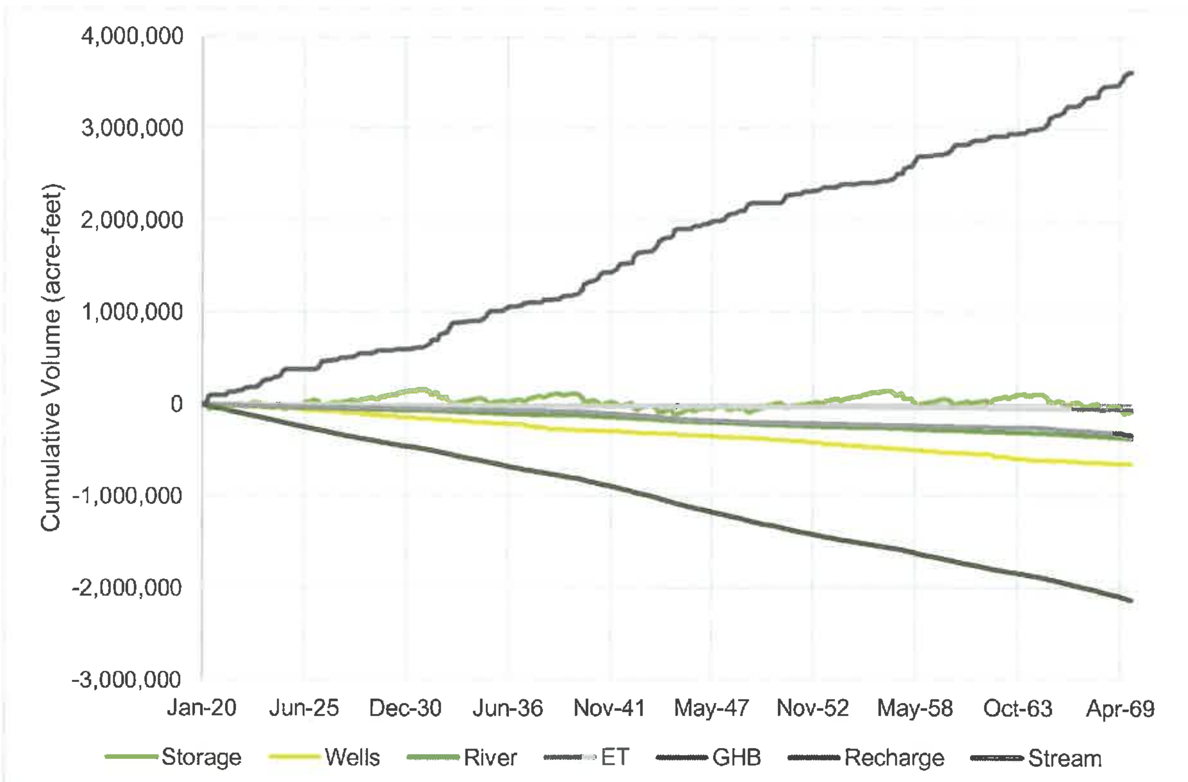
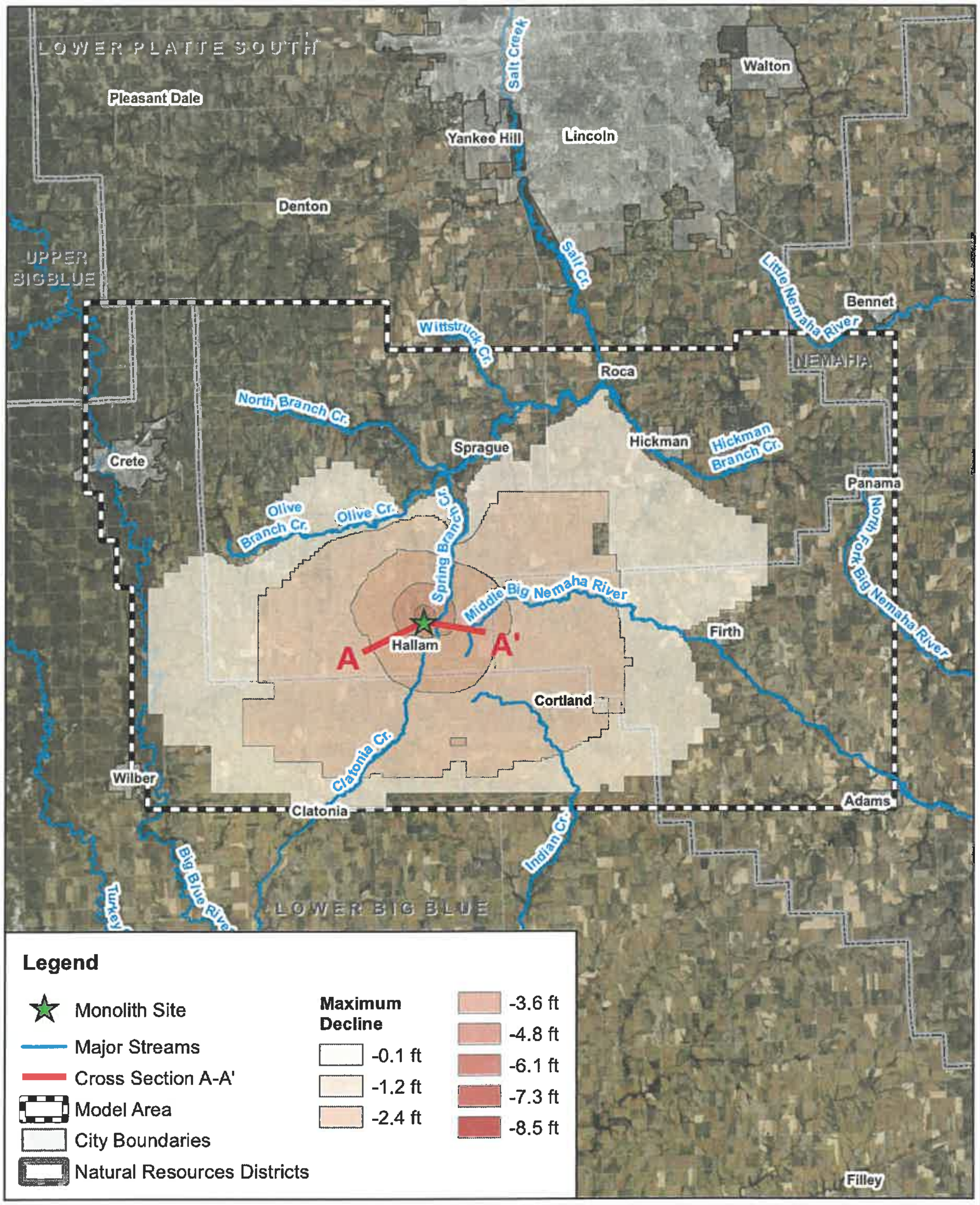


Figure 3.13 Cumulative water budget for the future scenario with Monolith pumping.

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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N

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

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

FIGURE 3.14

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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.

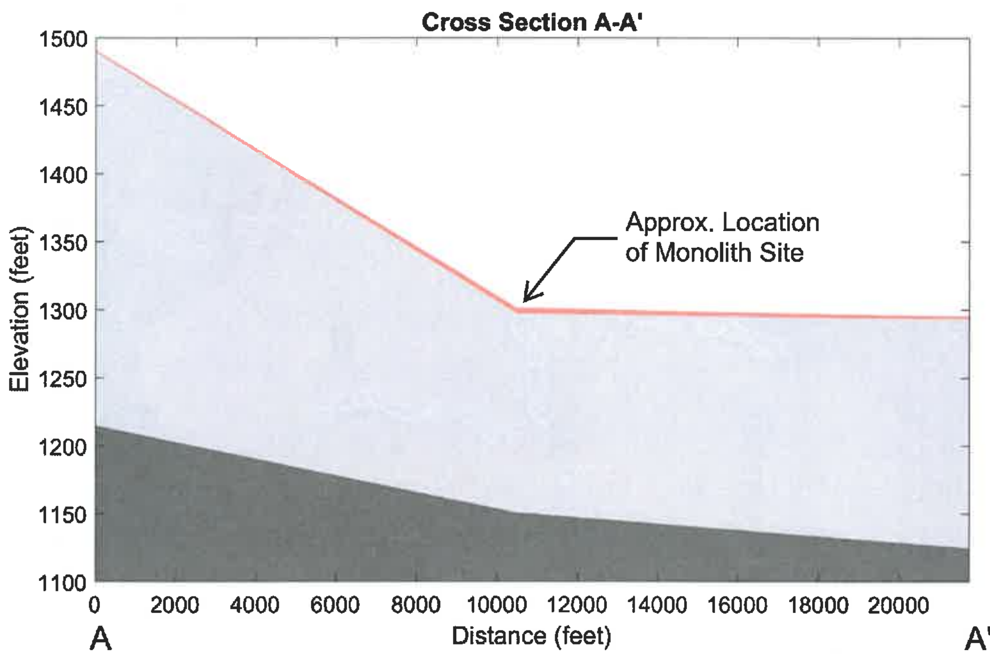


Figure 3.15. Cross section showing the saturated thickness remaining (blue) above the bedrock (grey) after 50 years of pumping at Monolith and the portion of the current saturated thickness that will be dewatered (pink) after 50 years of pumping at Monolith.

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.

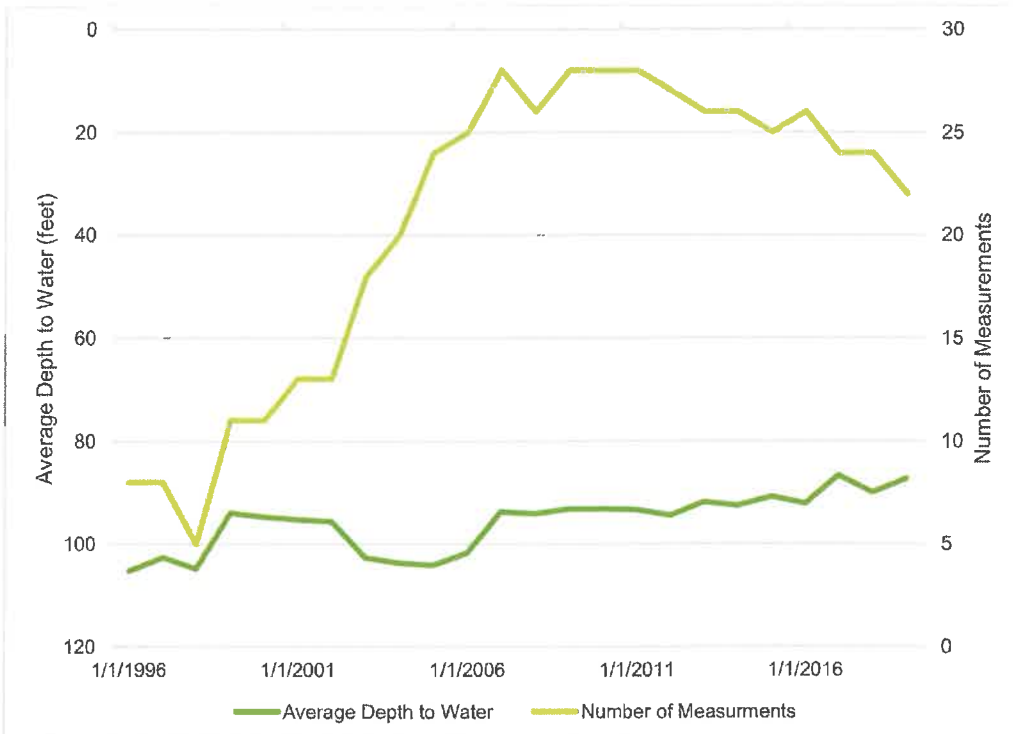
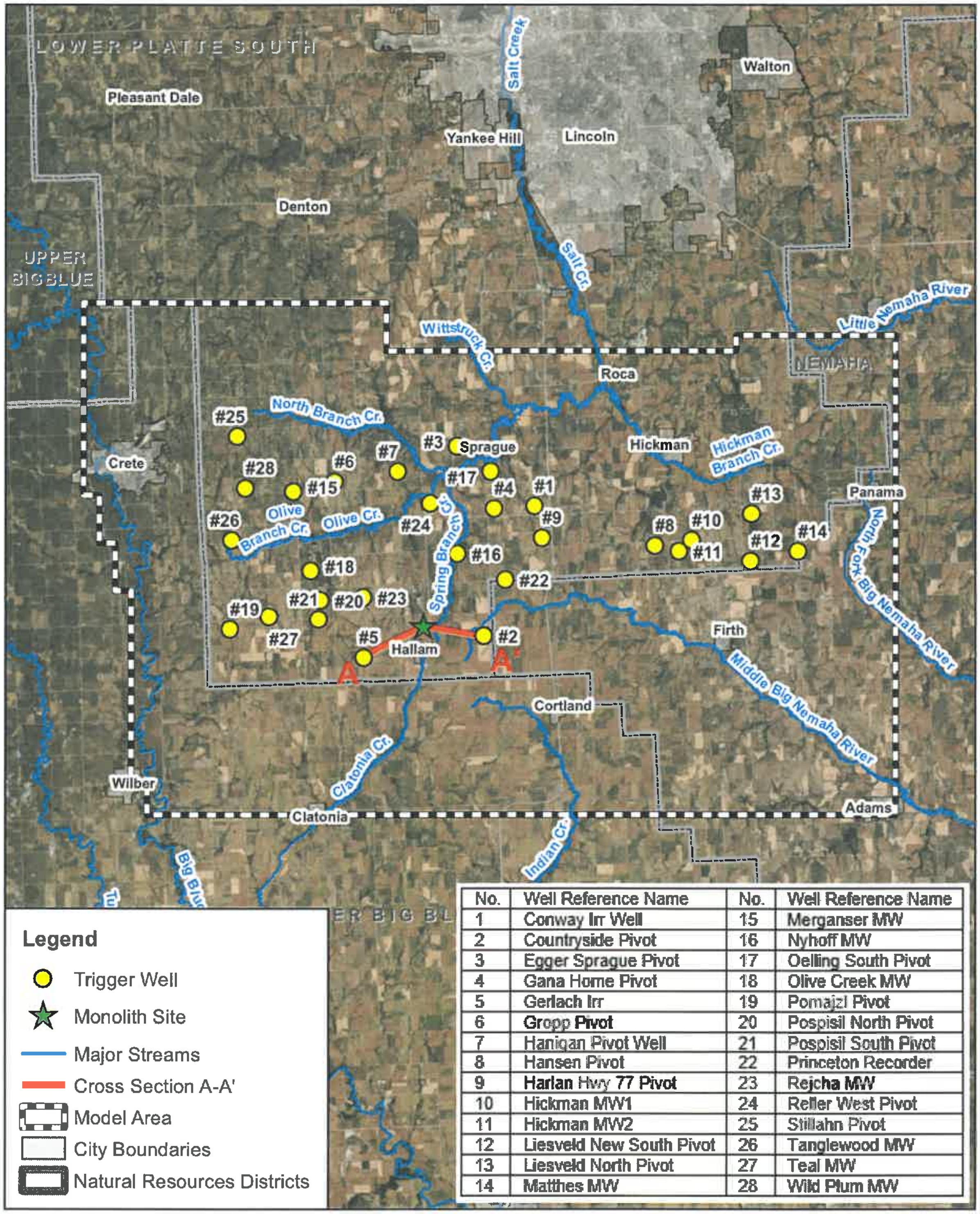


Figure 4.1 The average depth to groundwater and number of measurements taken in the LPSNRD's monitoring well program.



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.

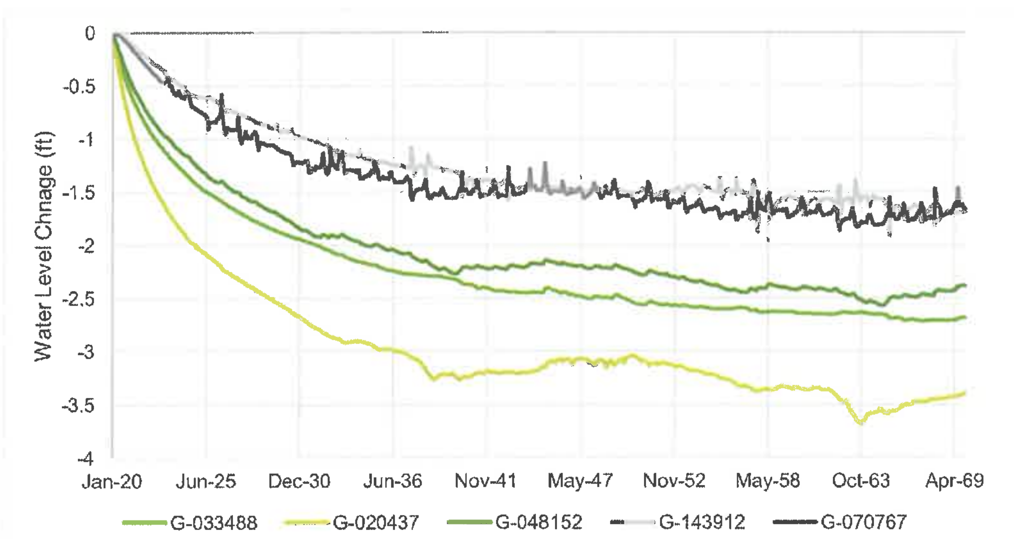

Figure 4.3 Water level changes during the future scenario in irrigation wells within a 3-mile radius of the Monolith plant site.

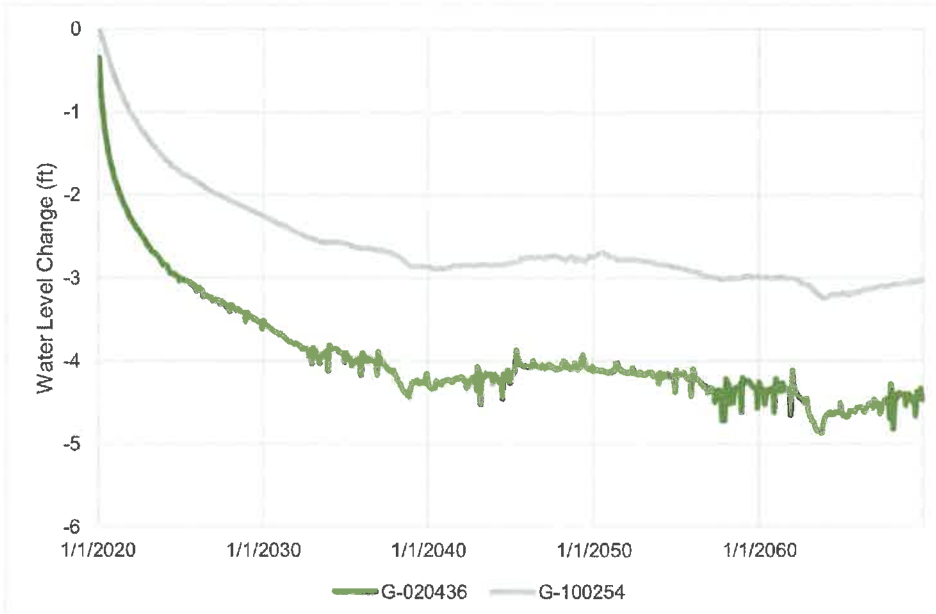

Figure 4.4 Water level changes during the future scenario for the closest (green) and furthest (grey) NPPD wells from the Monolith site.

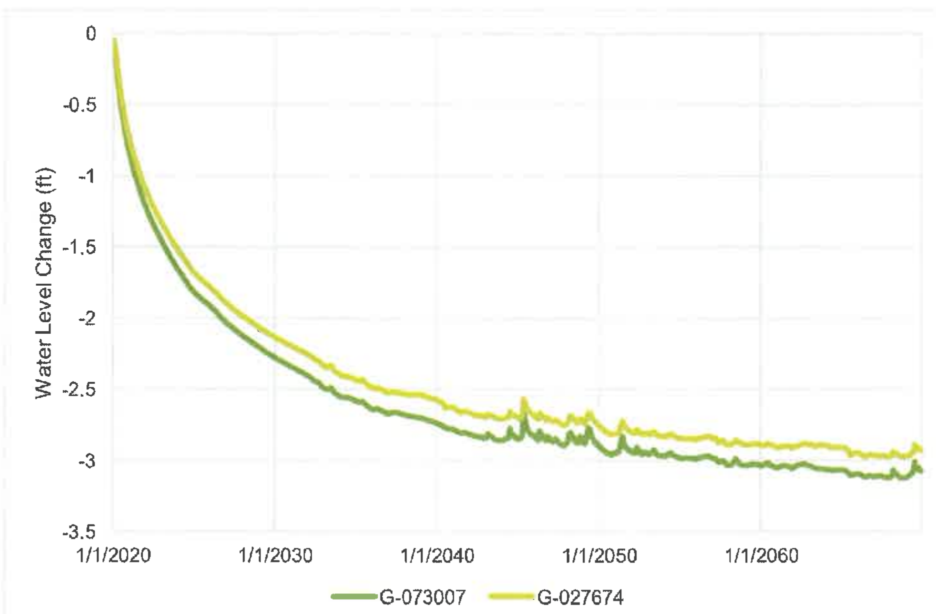

Figure 4.5 Water level changes during the future scenario for the two municipal wells in Hallam.

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MONOLITH HYDROGEOLOGIC ANALYSIS REPORT

Monolith Materials, Hallam, Nebraska

March 2021

Olsson Project No. 020-2639

APPENDIX A

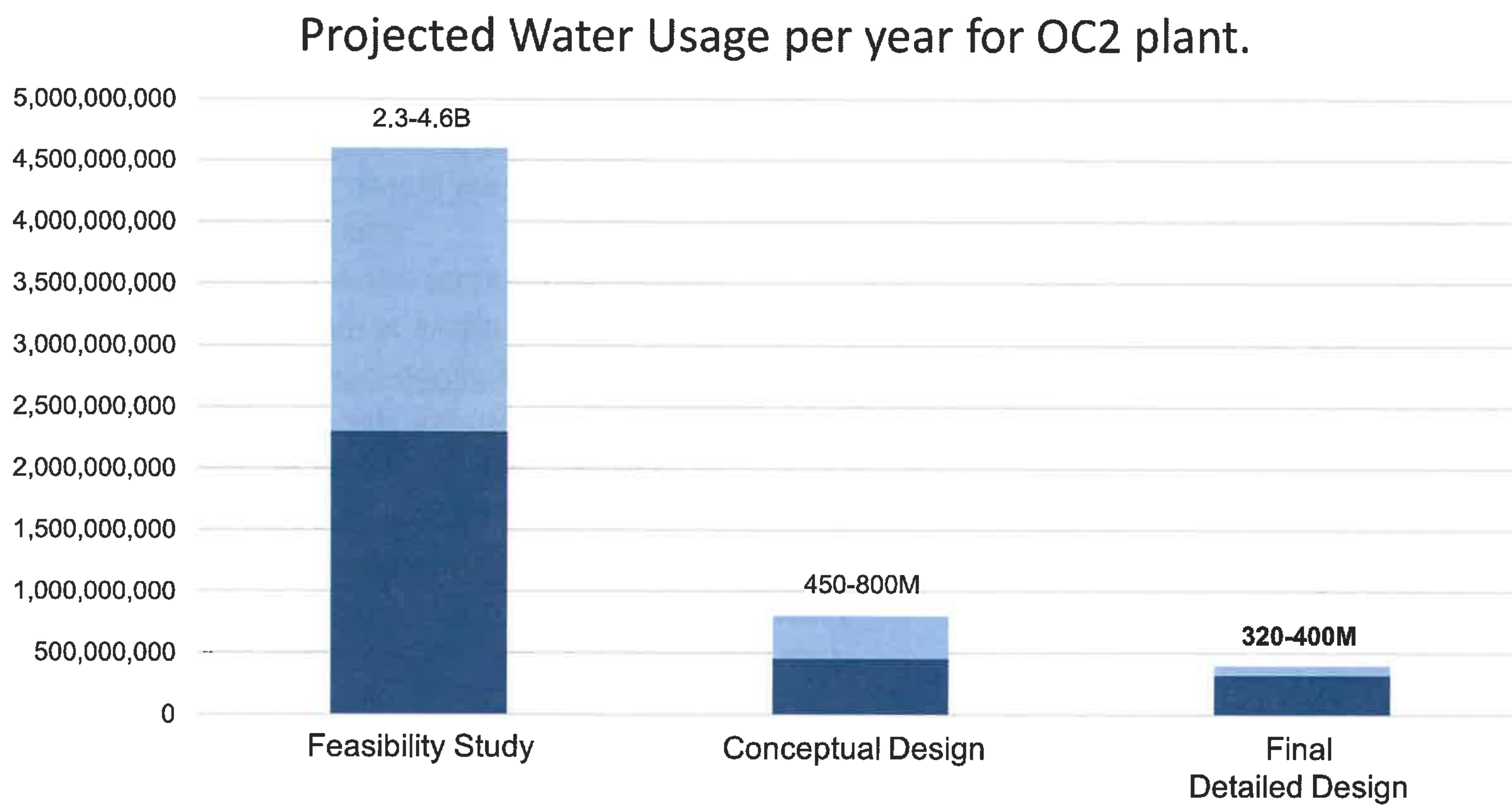
OC2 Water Use Estimation from Monolith Presentation

Appendix A

OC2 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

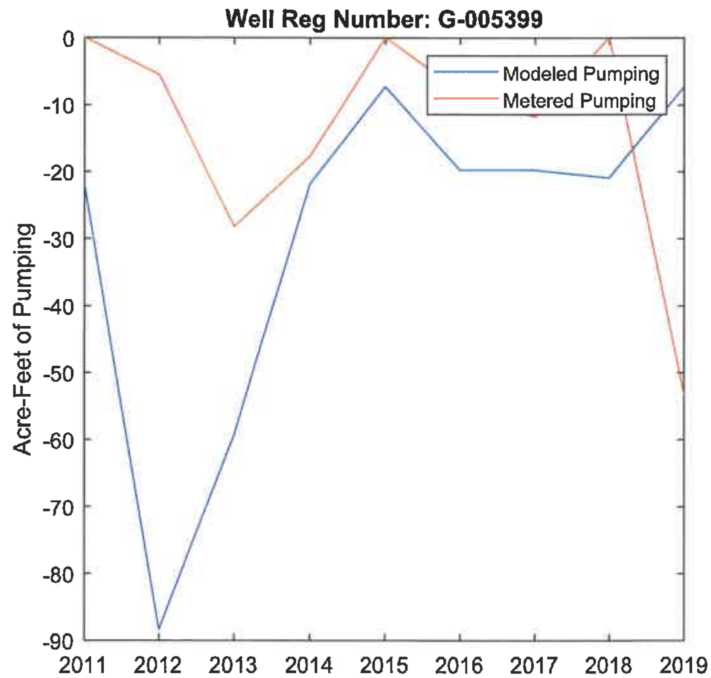
OC2 Water Usage Design Development



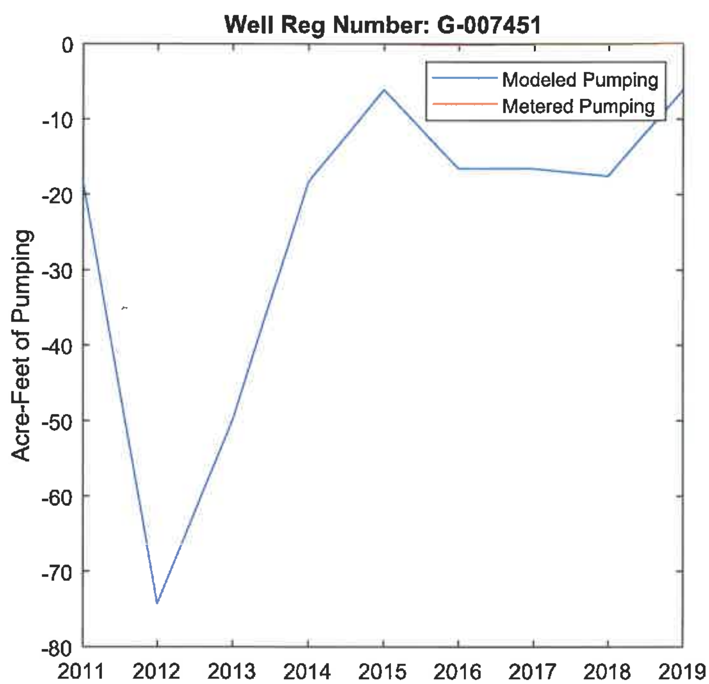
Application B

APPENDIX B

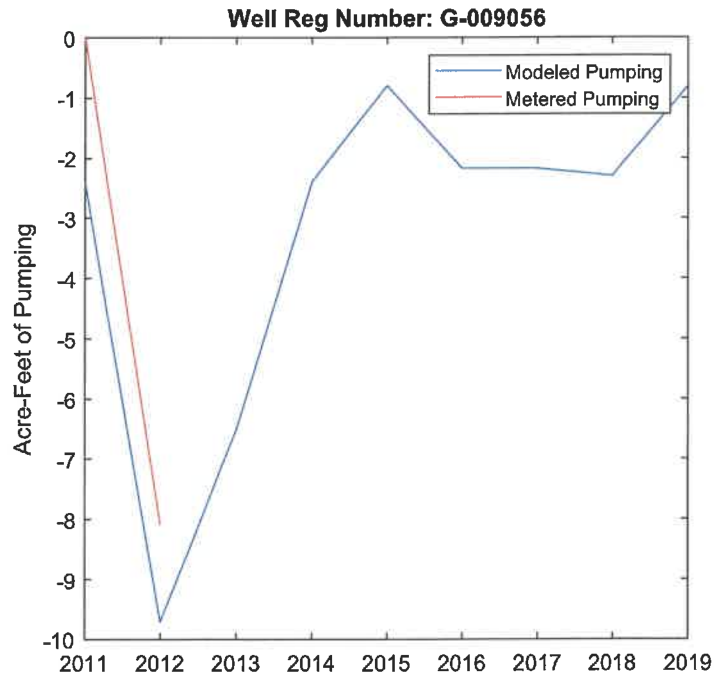
Comparisons of Modeled and Metered Pumping in the LPSNRD



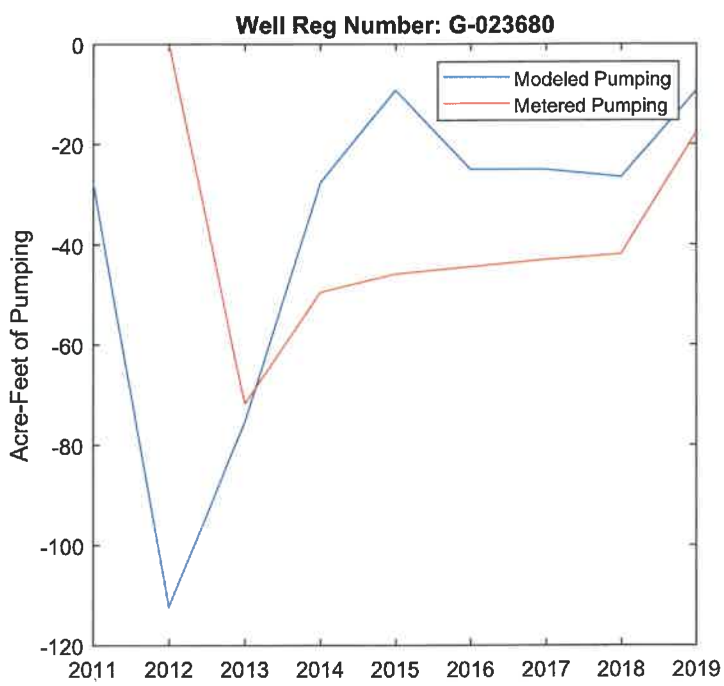
Well Reg Number: G-005399
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
2011
2012
2013
2014
2015
2016
2017
2018
2019



Well Reg Number: G-007451
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
-80
2011
2012
2013
2014
2015
2016
2017
2018
2019



Well Reg Number: G-009056
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
2011
2012
2013
2014
2015
2016
2017
2018
2019



Well Reg Number: G-023680
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
2011
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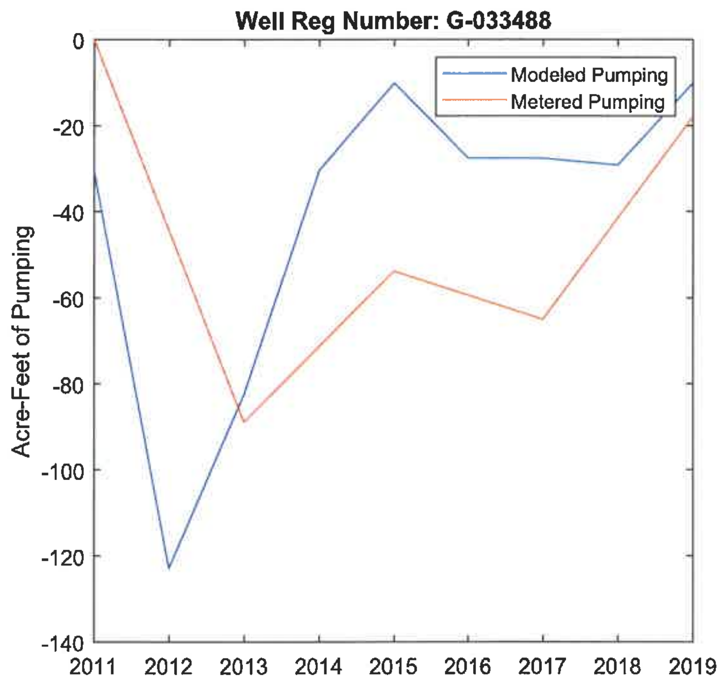
2015
2016
2017
2018
2019


Well Reg Number: G-033488
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
2011
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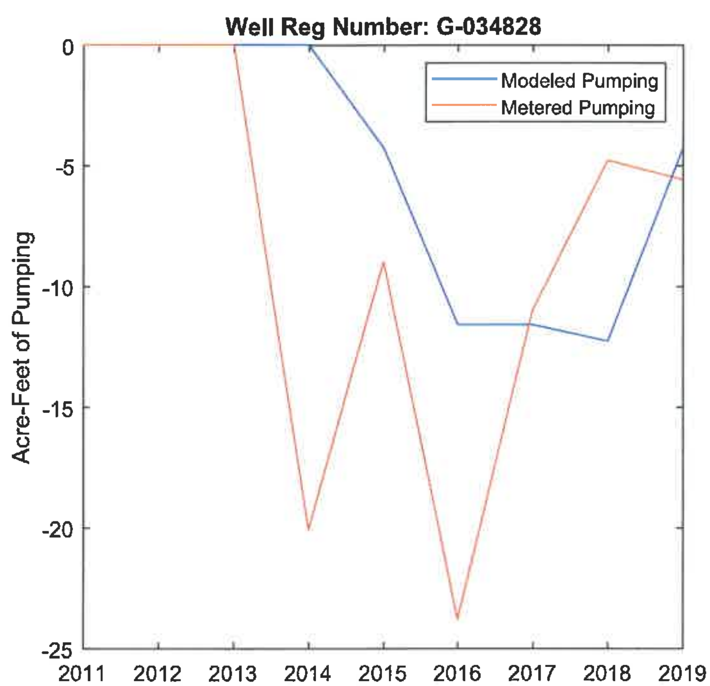
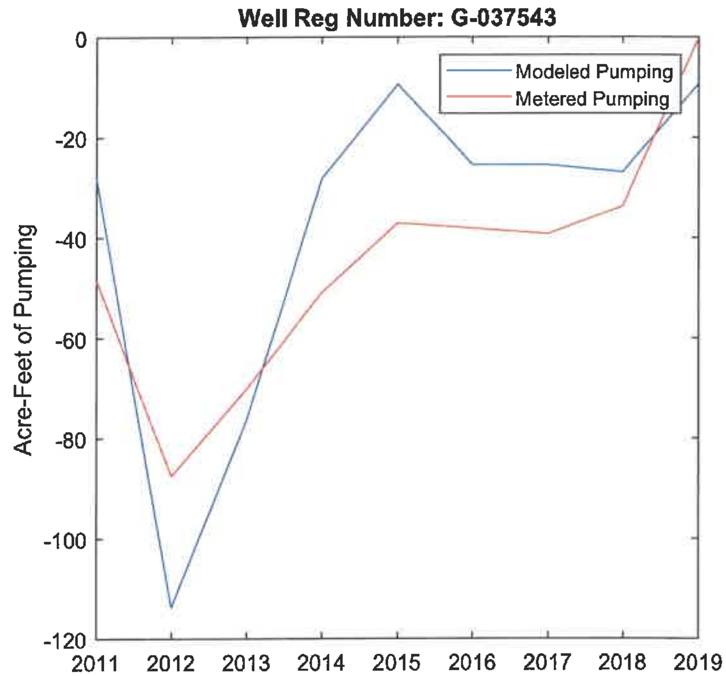
2015
2016
2017
2018
2019


Well Reg Number: G-034828
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-5
-10
-15
-20
-25
2011
2012
2013
2014
2015
2016
2017
2018
2019


Well Reg Number: G-037543
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
2011
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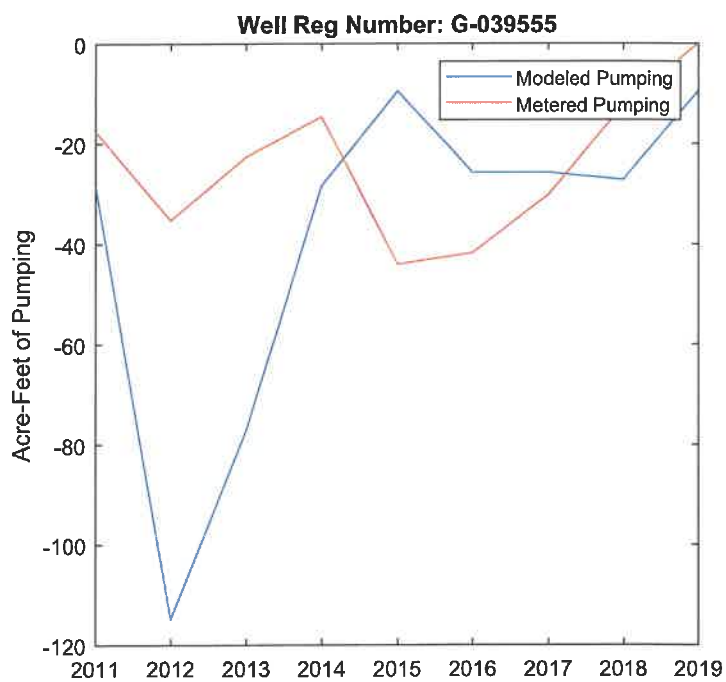
2015
2016
2017
2018
2019


Well Reg Number: G-039555
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
2011
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2015
2016
2017
2018
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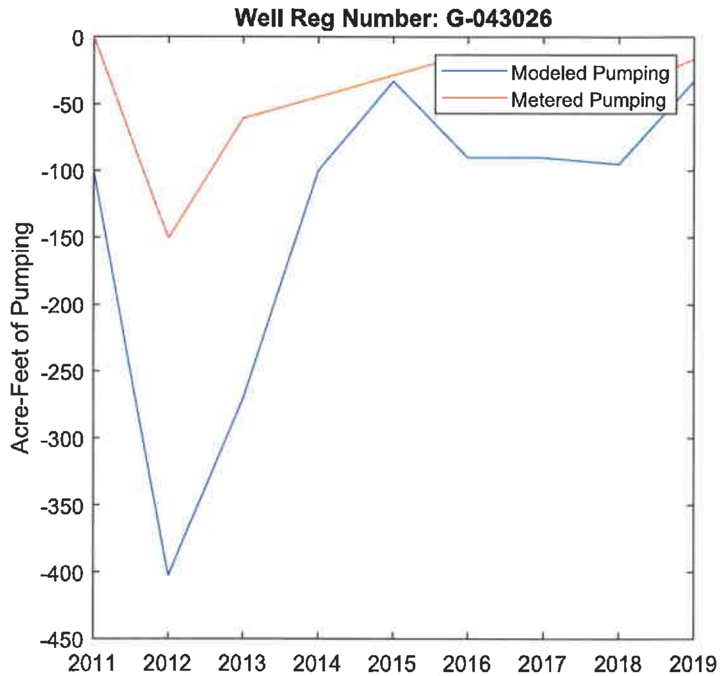
Well Reg Number: G-043026
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
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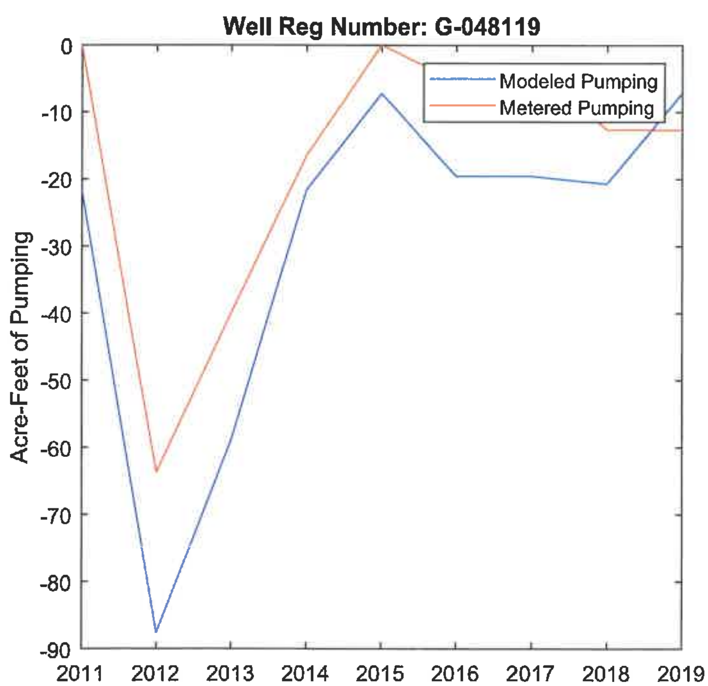
2015
2016
2017
2018
2019


Well Reg Number: G-048119
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
2011
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2013
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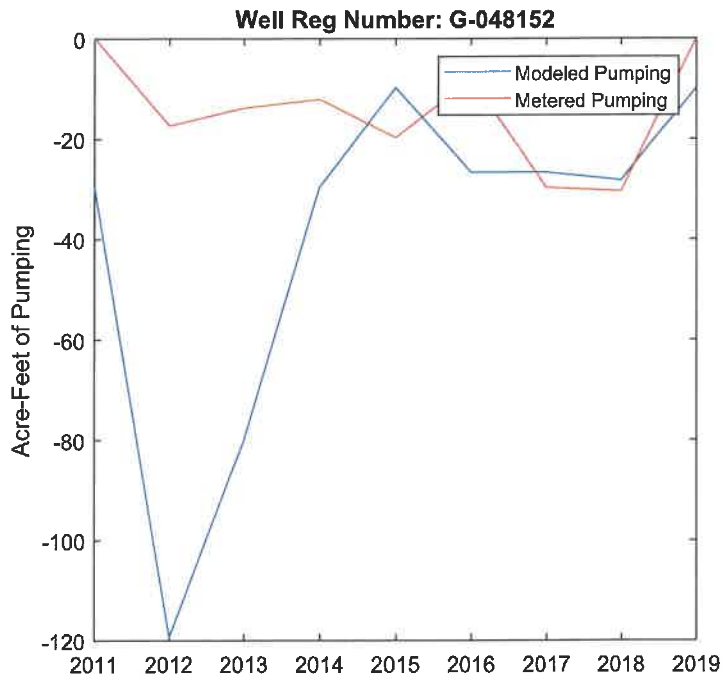
2015
2016
2017
2018
2019


Well Reg Number: G-048152
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
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2016
2017
2018
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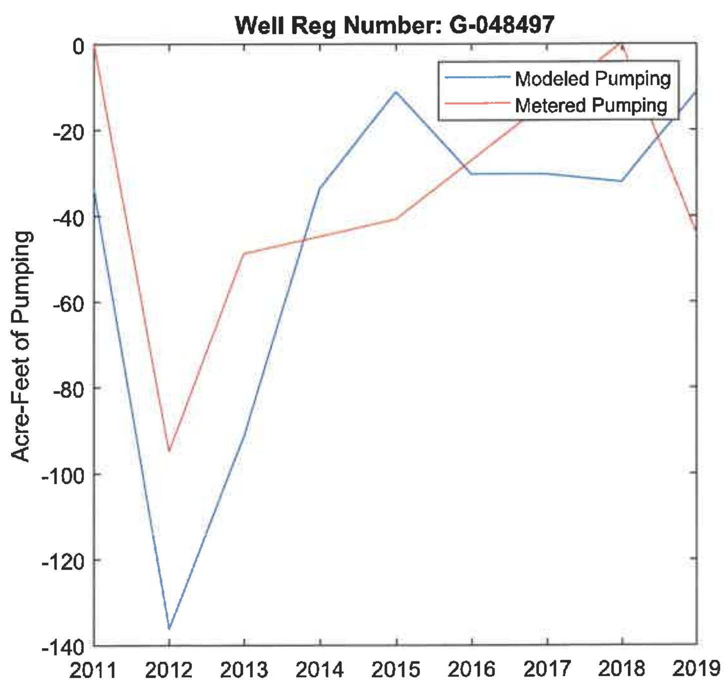
Well Reg Number: G-048497
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
2011
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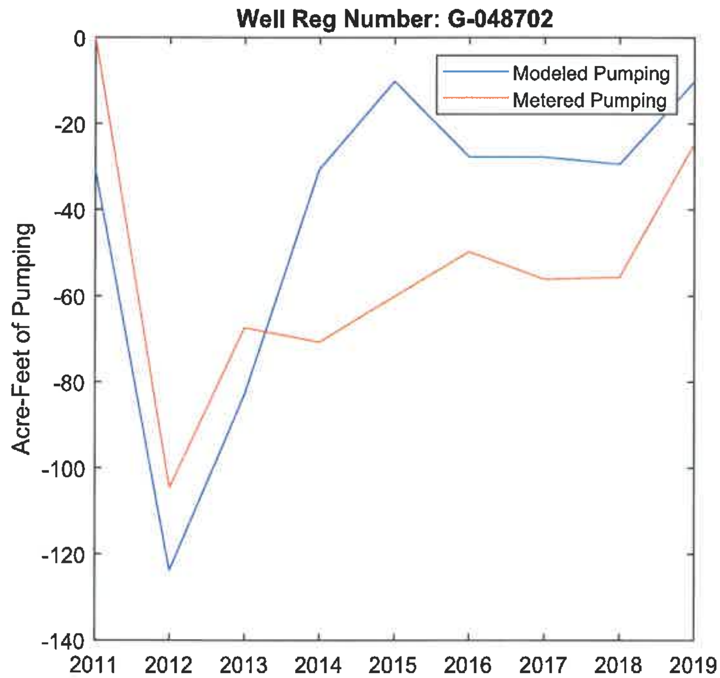
2015
2016
2017
2018
2019



Well Reg Number: G-048702
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
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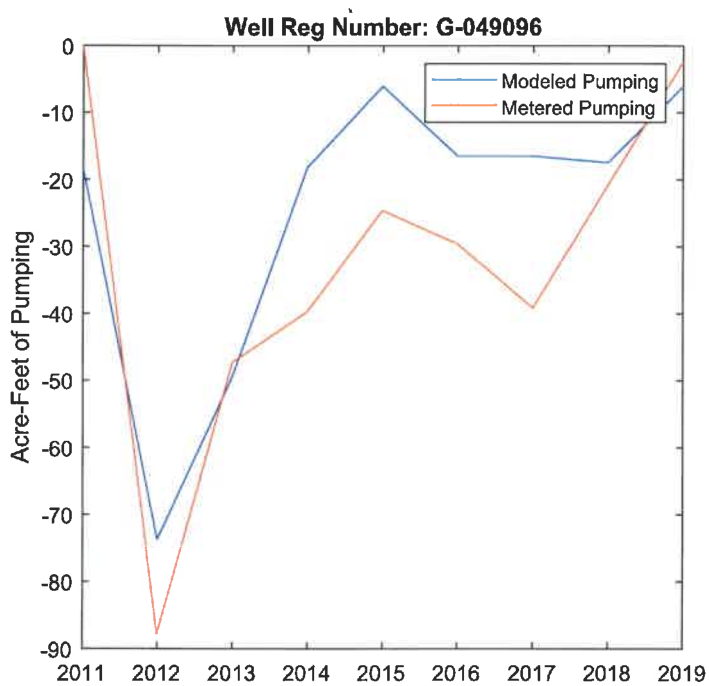
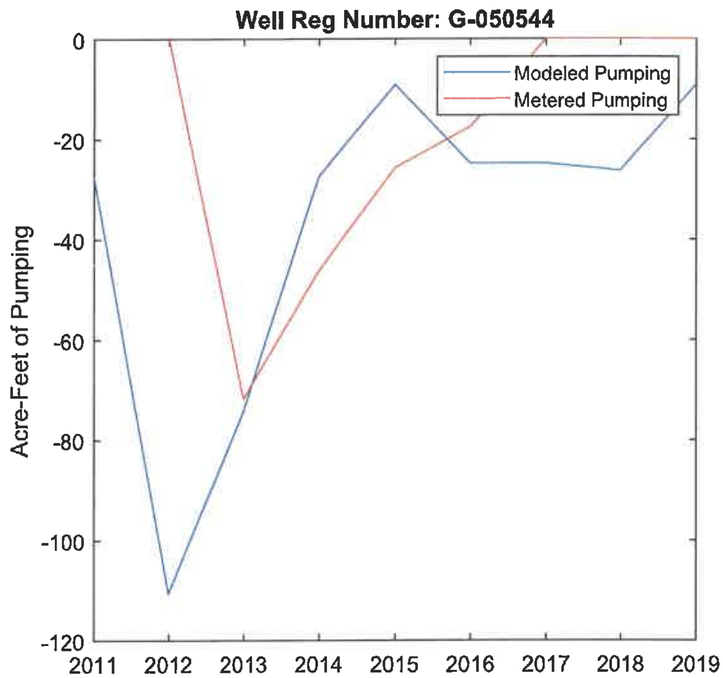
2015
2016
2017
2018
2019



Well Reg Number: G-049096
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
2011
2012
2013
2014
2015
2016
2017
2018
2019


Well Reg Number: G-050544
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
2011
2012
2013
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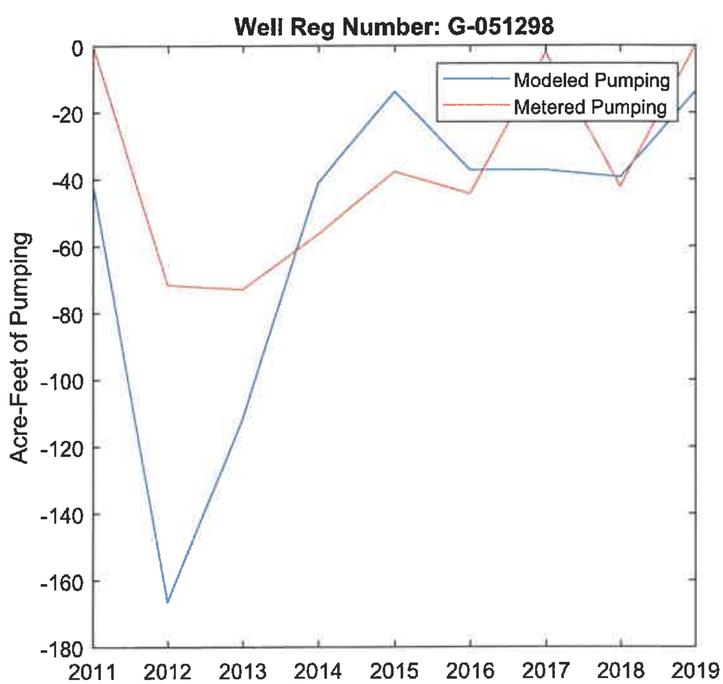
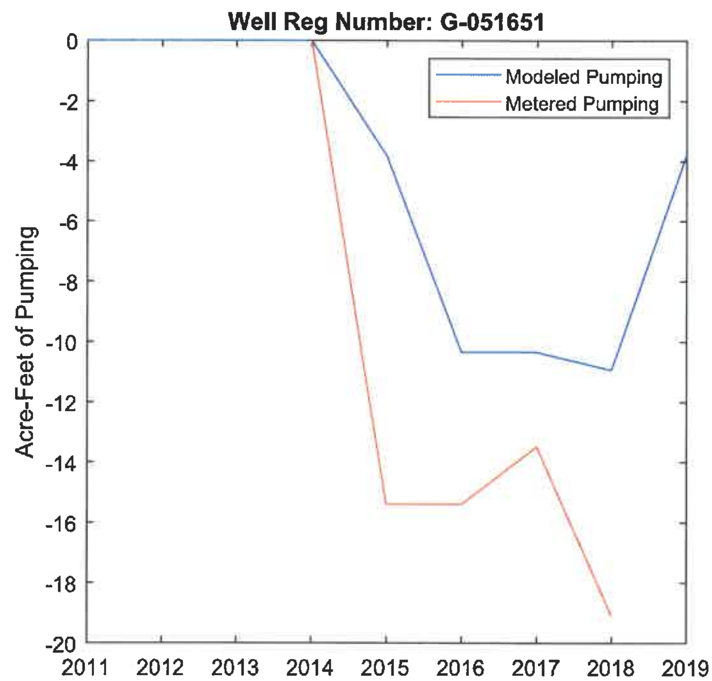
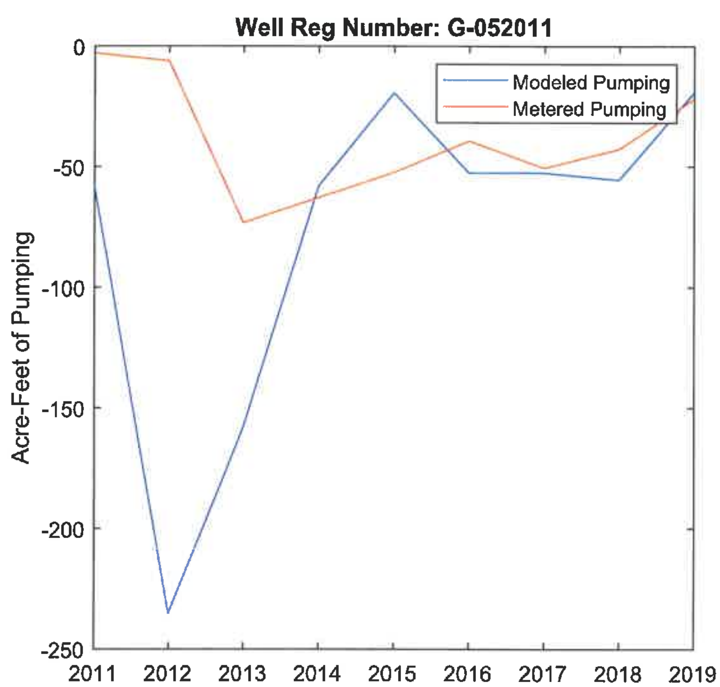
2016
2017
2018
2019
Modeled Pumping
Metered Pumping

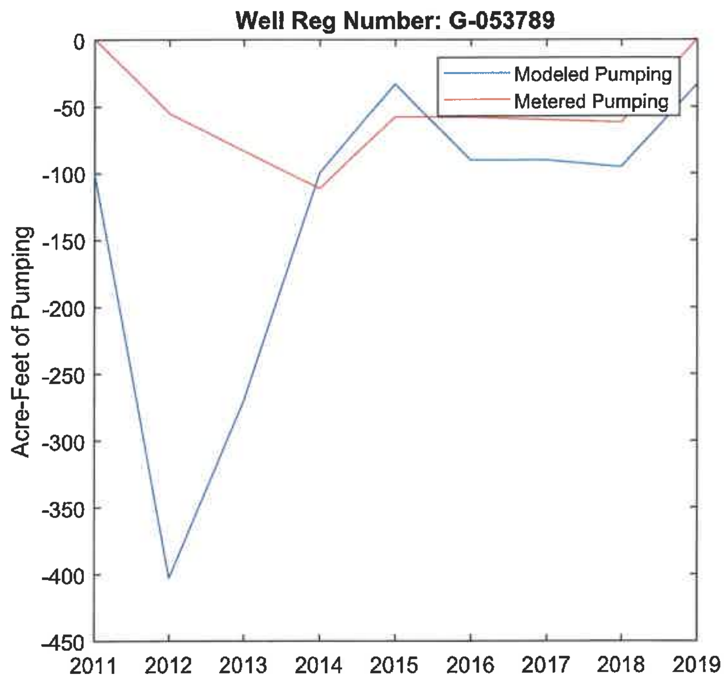

Well Reg Number: G-051298
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
2011
2012
2013
2014
2015
2016
2017
2018
2019
Modeled Pumping
Metered Pumping

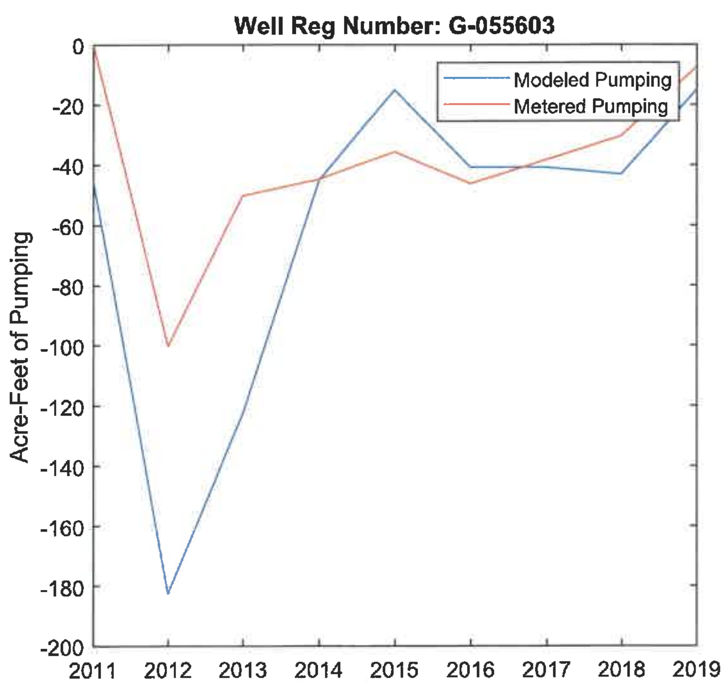


Well Reg Number: G-051651
Acre-Feet of Pumping
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
2011
2012
2013
2014
2015
2016
2017
2018
2019
Modeled Pumping
Metered Pumping



Well Reg Number: G-052011
Acre-Feet of Pumping
0
-50
-100
-150
-200
-250
2011
2012
2013
2014
2015
2016
2017
2018
2019
Modeled Pumping
Metered Pumping


Well Reg Number: G-053789
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
2011
2012
2013
2014
2015
2016
2017
2018
2019


Well Reg Number: G-055603
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
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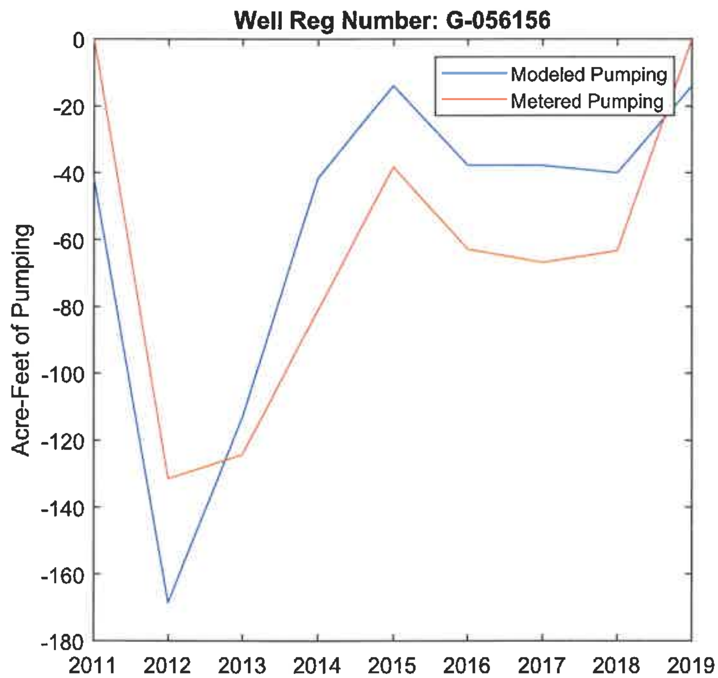
2012
2013
2014
2015
2016
2017
2018
2019


Well Reg Number: G-056156
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
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2012
2013
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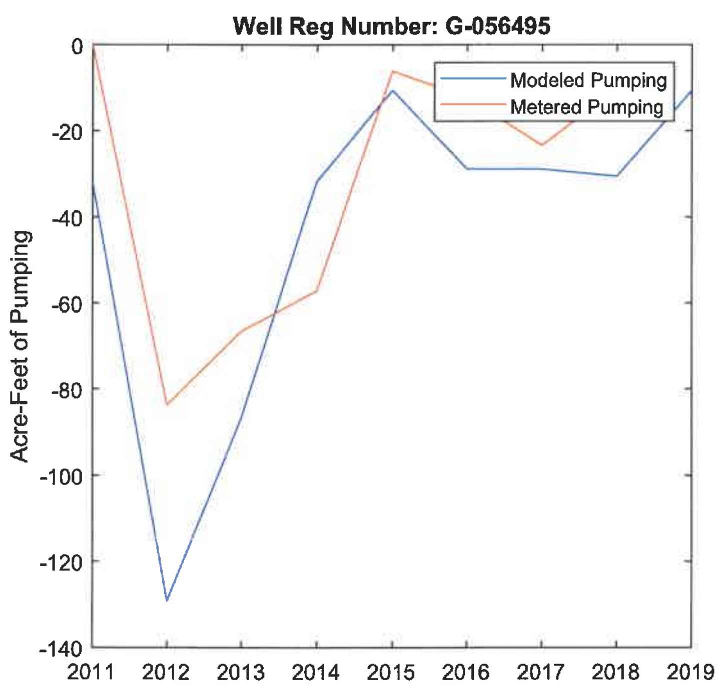
2015
2016
2017
2018
2019


Well Reg Number: G-056495
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
2011
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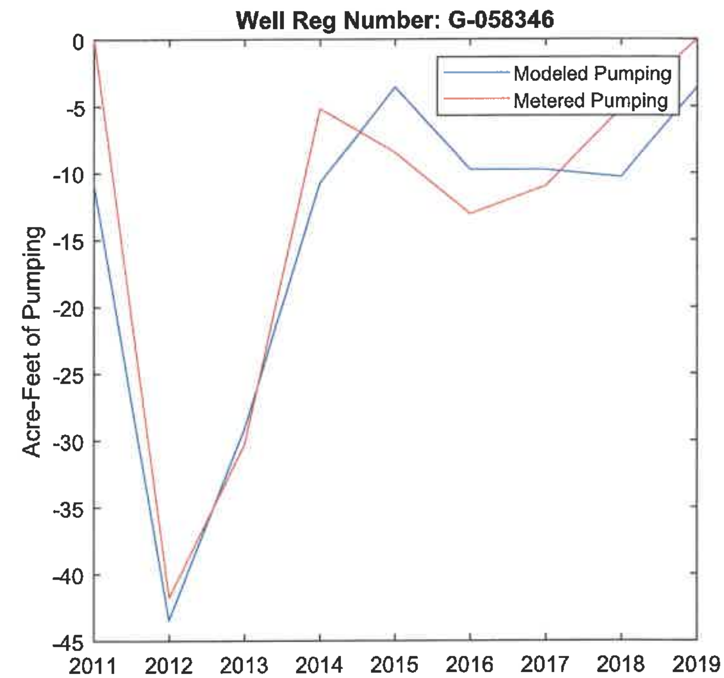
2015
2016
2017
2018
2019


Well Reg Number: G-058346
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2011
2012
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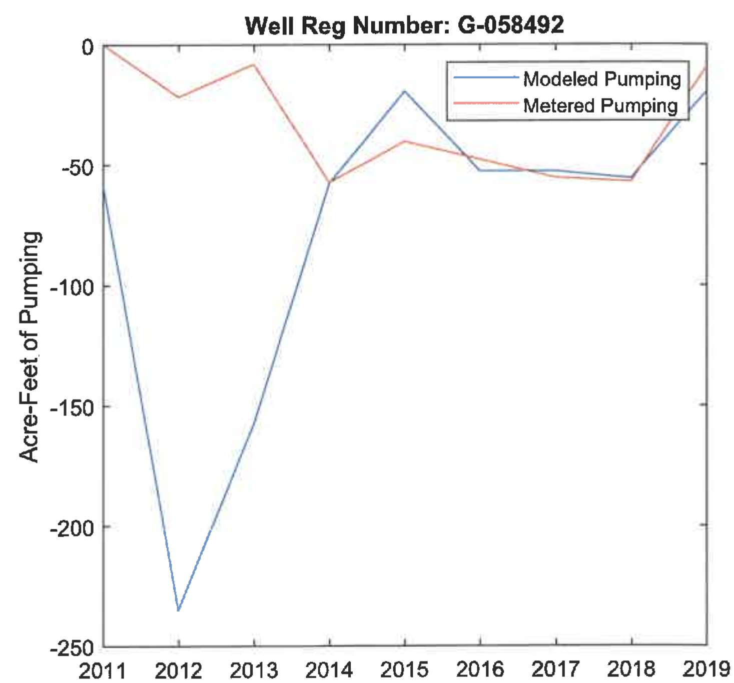
2015
2016
2017
2018
2019


Well Reg Number: G-058492
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-50
-100
-150
-200
-250
2011
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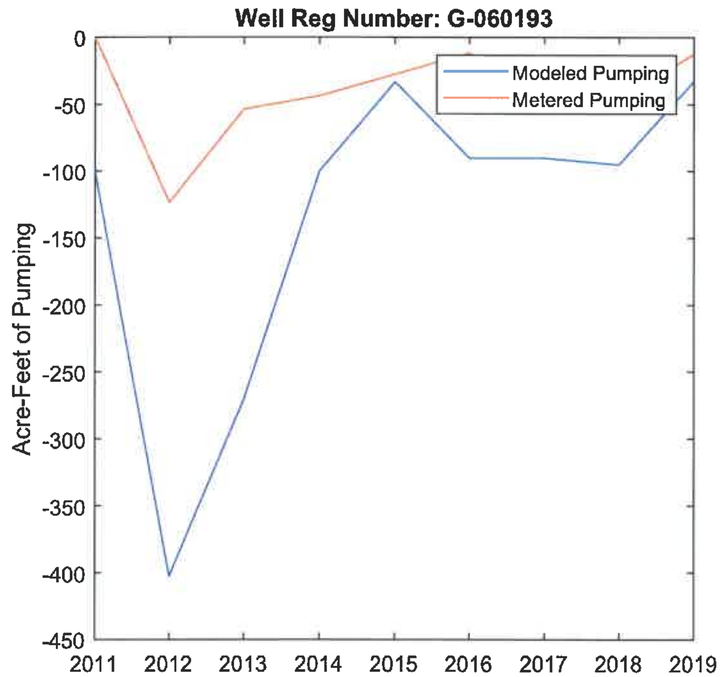
2015
2016
2017
2018
2019


Well Reg Number: G-060193
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
2011
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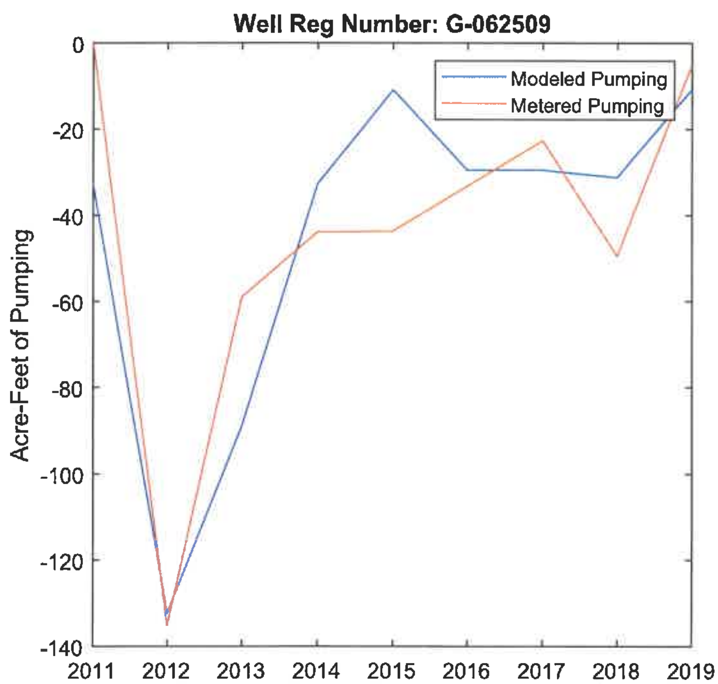
2015
2016
2017
2018
2019


Well Reg Number: G-062509
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
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-60
-80
-100
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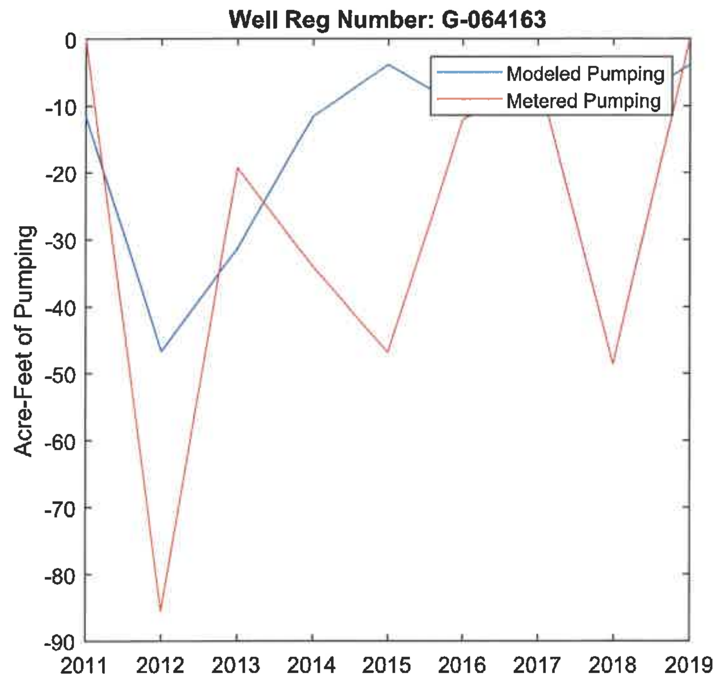
2015
2016
2017
2018
2019


Well Reg Number: G-064163
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
2011
2012
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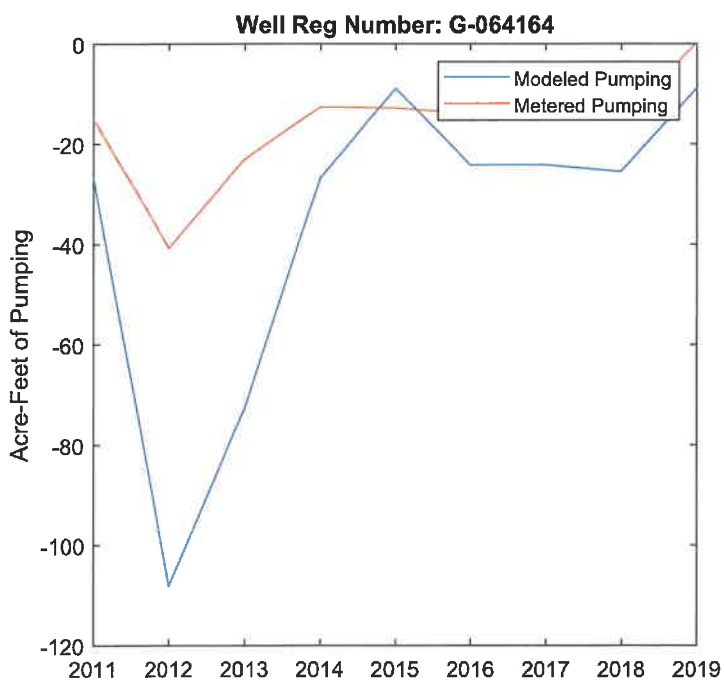
2015
2016
2017
2018
2019


Well Reg Number: G-064164
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
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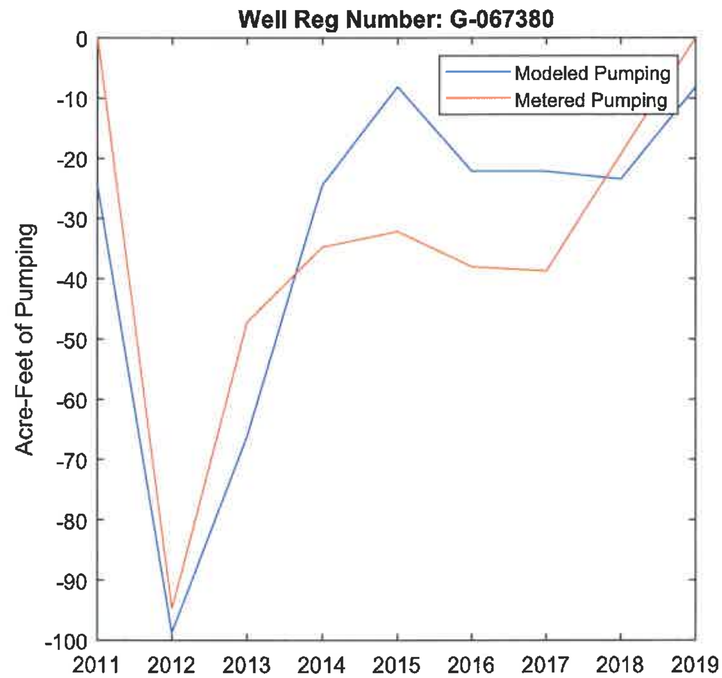
2015
2016
2017
2018
2019



Well Reg Number: G-067380
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
-80
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-100
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2015
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2018
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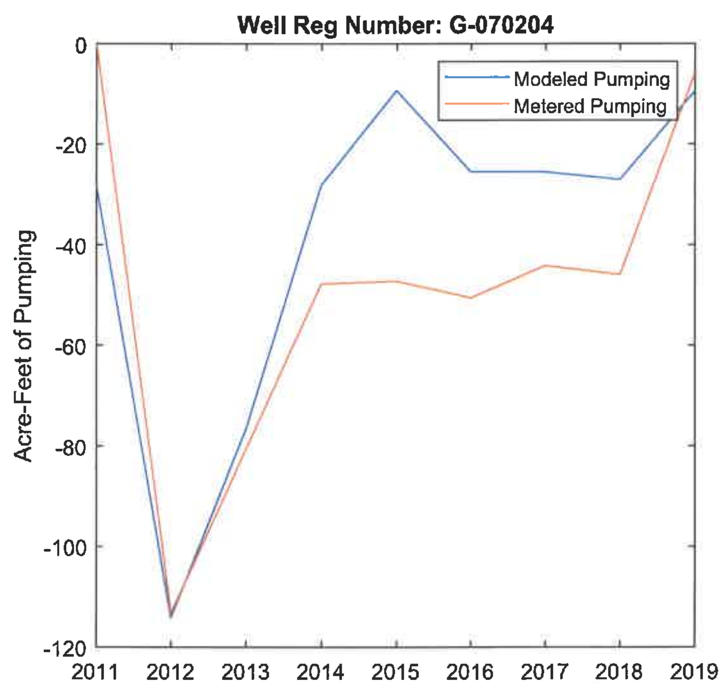

Well Reg Number: G-070204
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
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-20
-40
-60
-80
-100
-120
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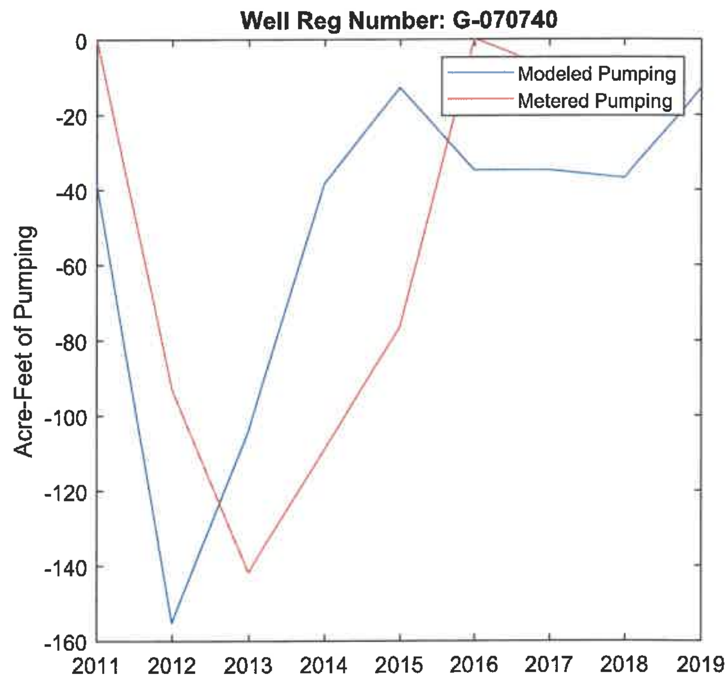
2016
2017
2018
2019



Well Reg Number: G-070740
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
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-60
-80
-100
-120
-140
-160
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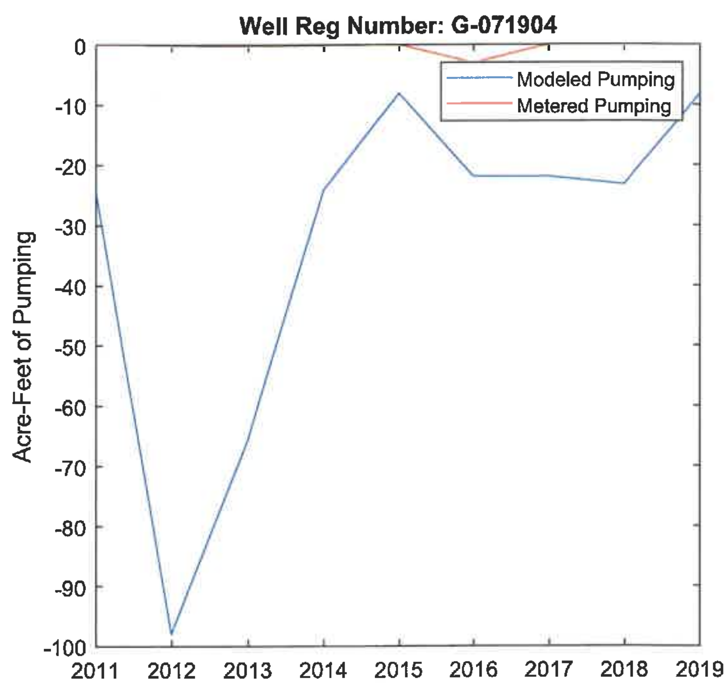
2015
2016
2017
2018
2019



Well Reg Number: G-071904
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
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-60
-70
-80
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-100
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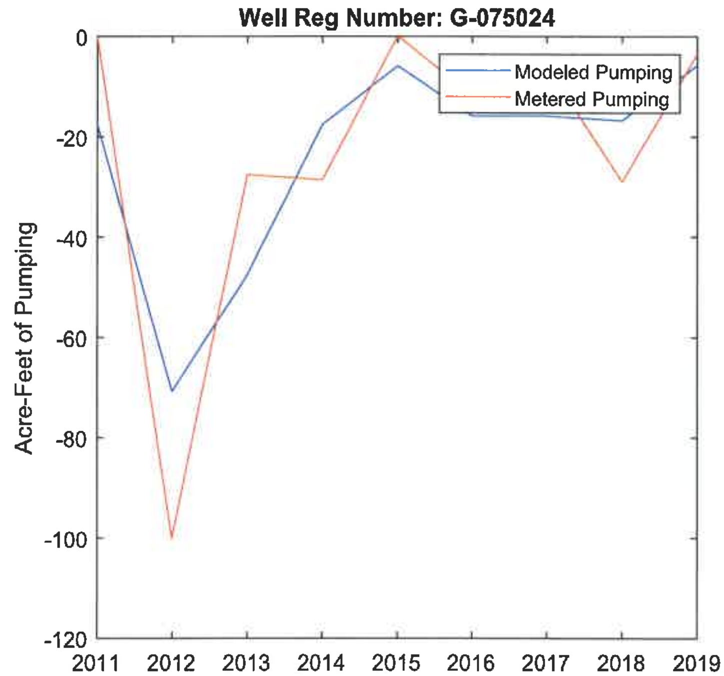
2015
2016
2017
2018
2019


Well Reg Number: G-075024
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
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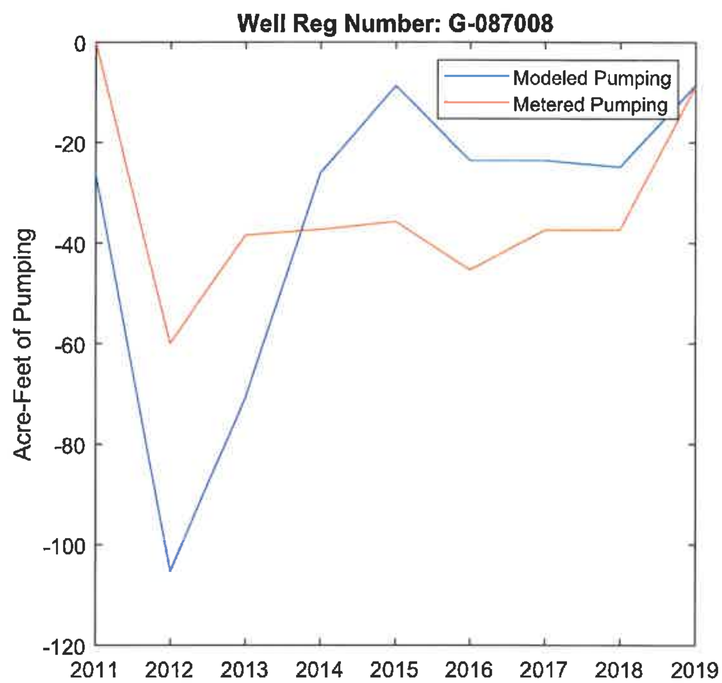
2017
2018
2019


Well Reg Number: G-087008
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
2011
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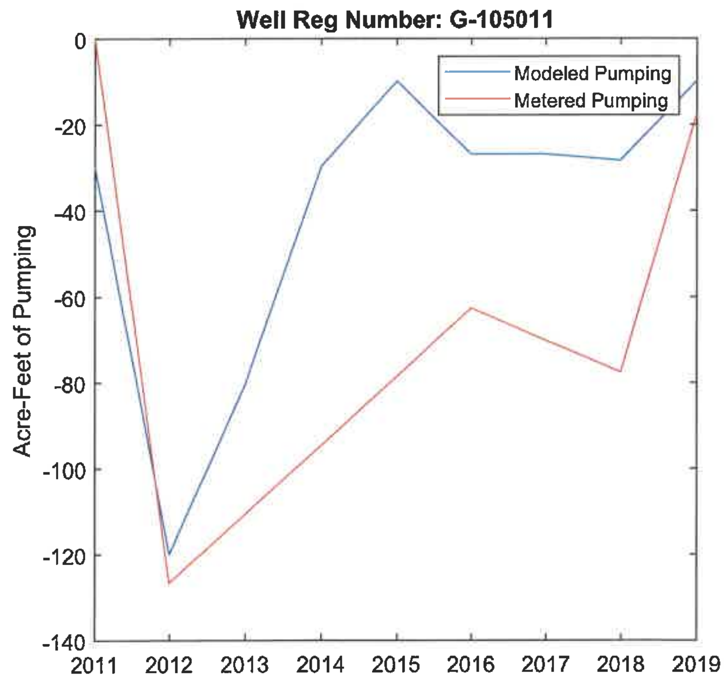
2016
2017
2018
2019



Well Reg Number: G-105011
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
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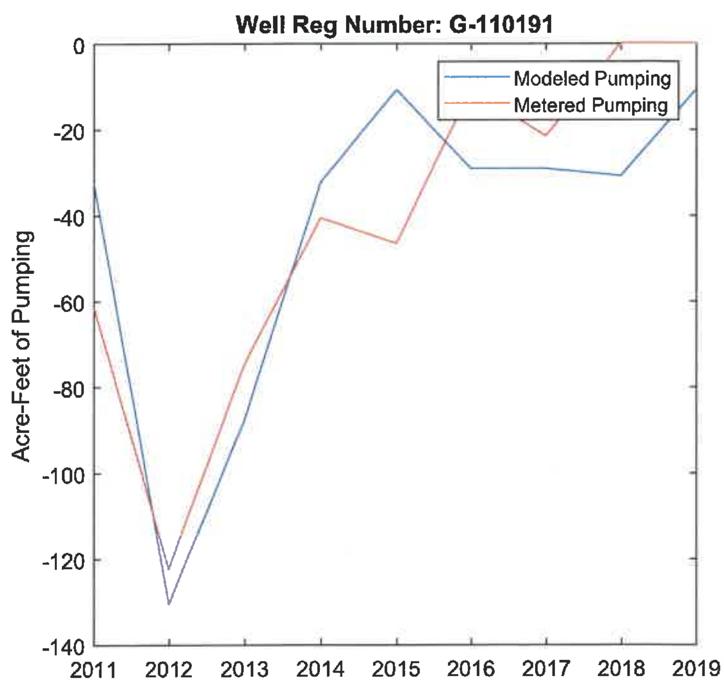
2015
2016
2017
2018
2019



Well Reg Number: G-110191
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
2011
2012
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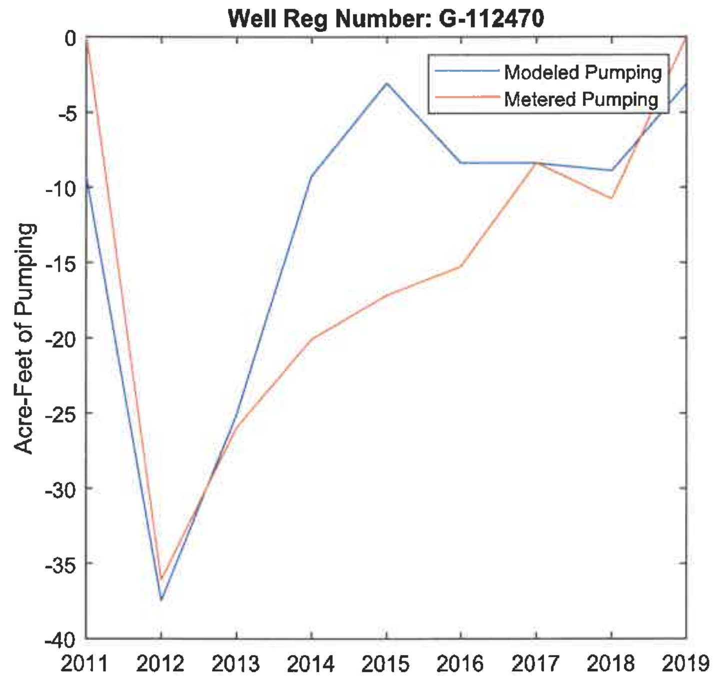
2015
2016
2017
2018
2019



Well Reg Number: G-112470
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-5
-10
-15
-20
-25
-30
-35
-40
2011
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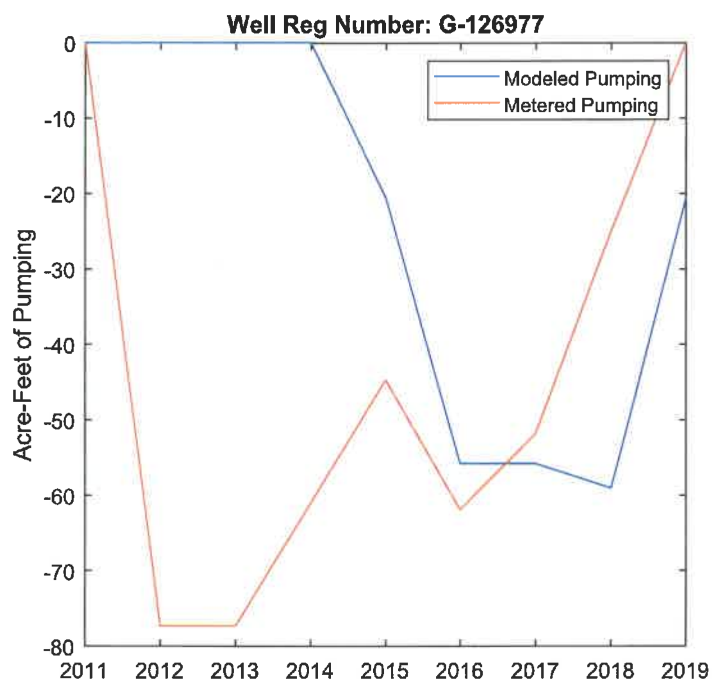
2015
2016
2017
2018
2019



Well Reg Number: G-126977
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
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-40
-50
-60
-70
-80
2011
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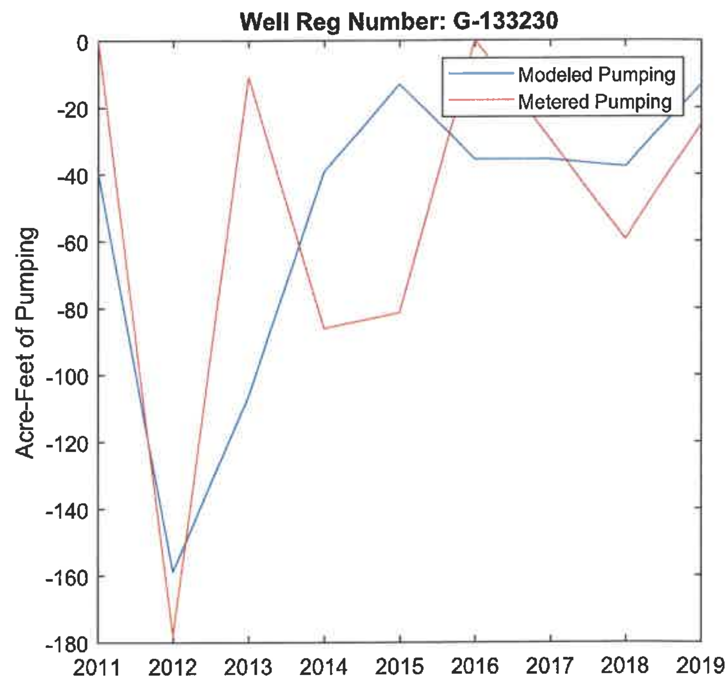
2015
2016
2017
2018
2019



Well Reg Number: G-133230
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
2011
2012
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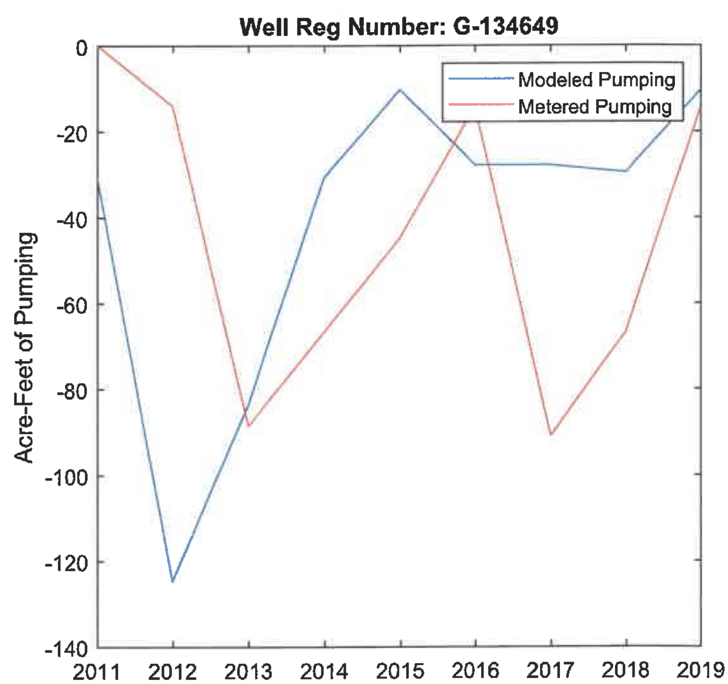
2015
2016
2017
2018
2019



Well Reg Number: G-134649
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
2011
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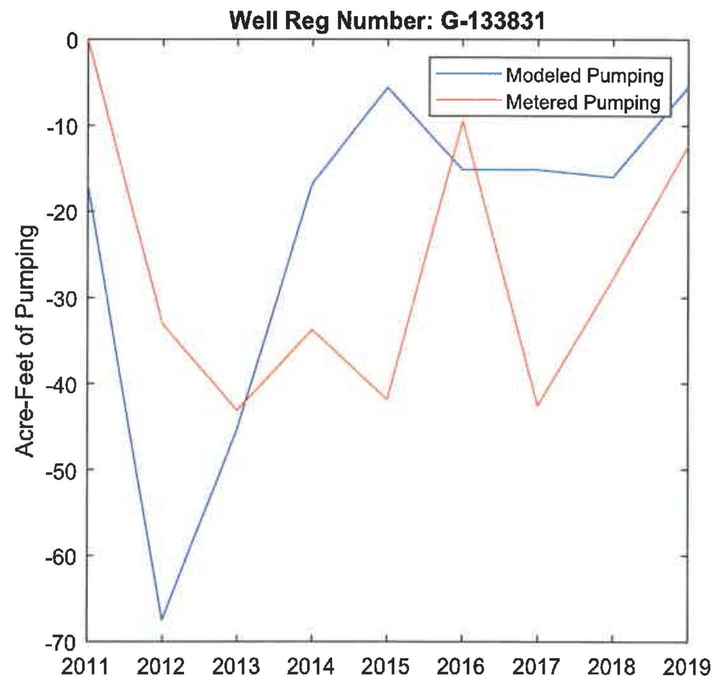
2016
2017
2018
2019


Well Reg Number: G-133831
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
-20
-30
-40
-50
-60
-70
2011
2012
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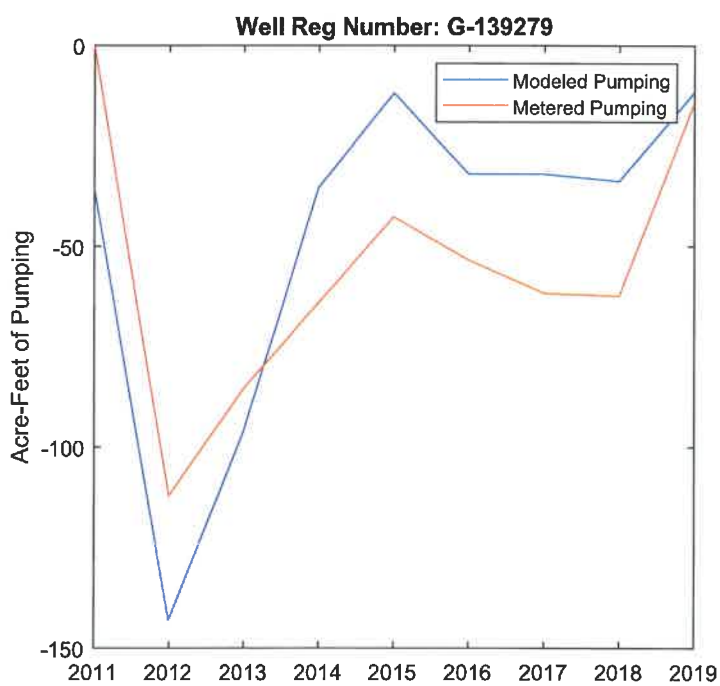
2015
2016
2017
2018
2019


Well Reg Number: G-139279
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-50
-100
-150
2011
2012
2013
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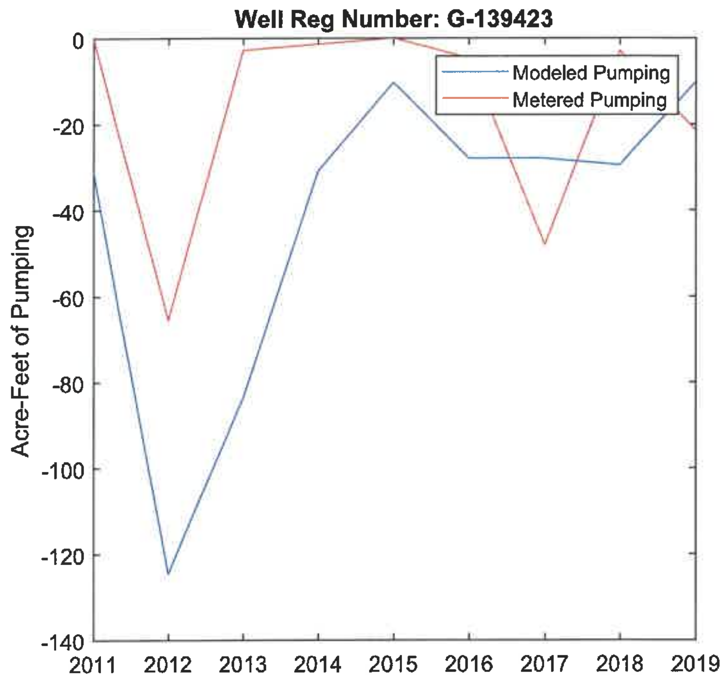
2015
2016
2017
2018
2019


Well Reg Number: G-139423
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-20
-40
-60
-80
-100
-120
-140
2011
2012
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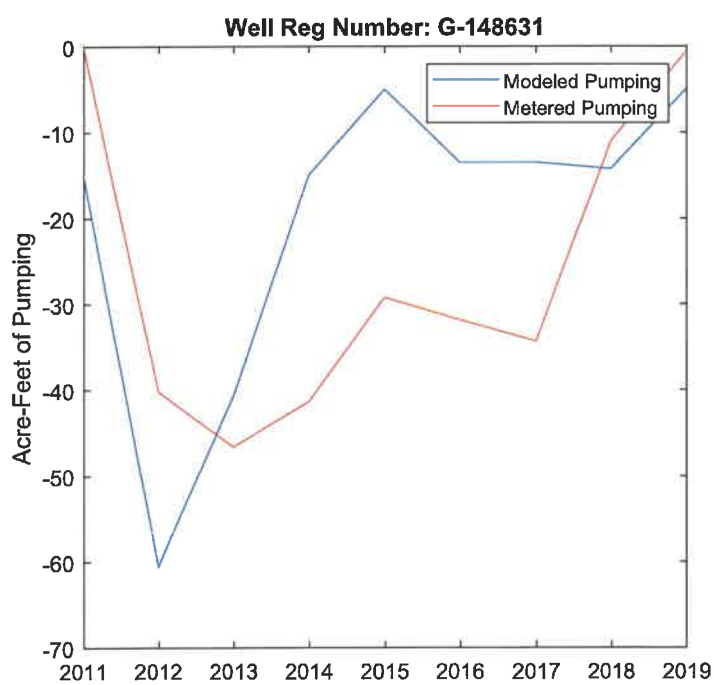
2015
2016
2017
2018
2019


Well Reg Number: G-148631
Modeled Pumping
Metered Pumping
Acre-Feet of Pumping
0
-10
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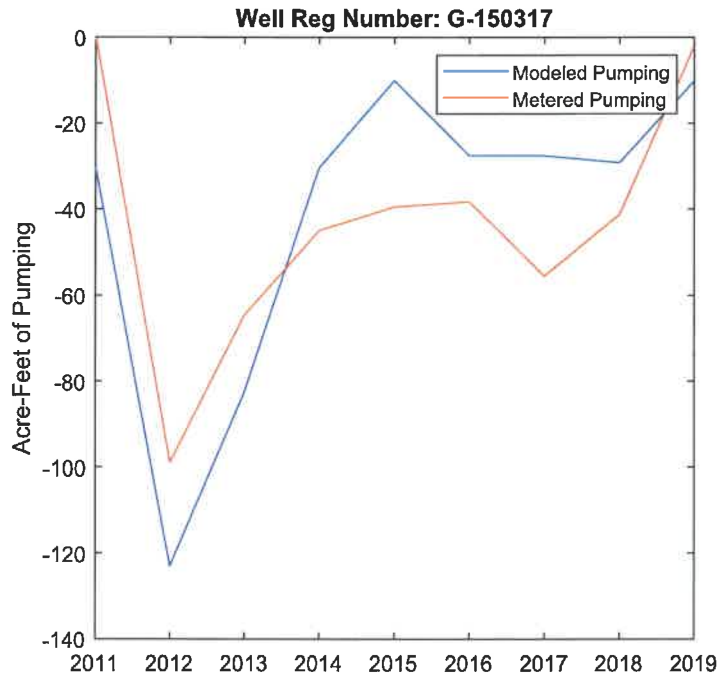

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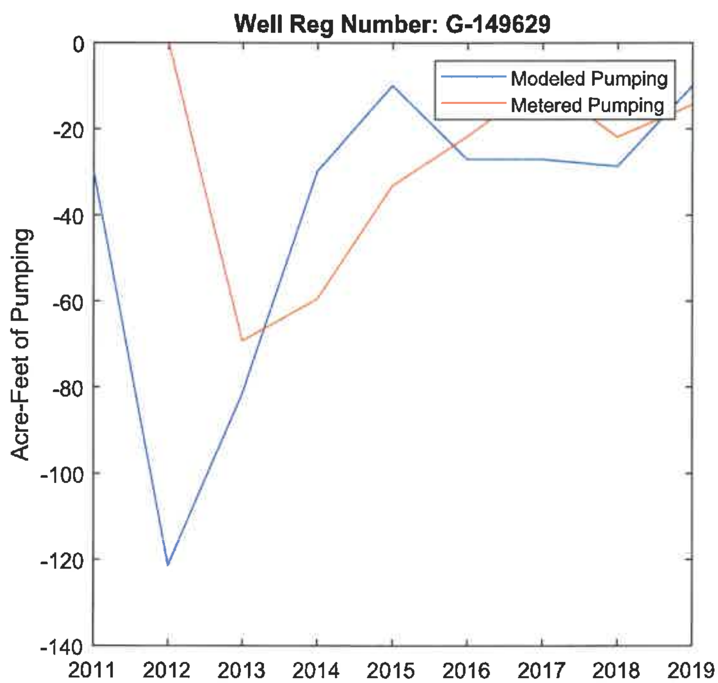

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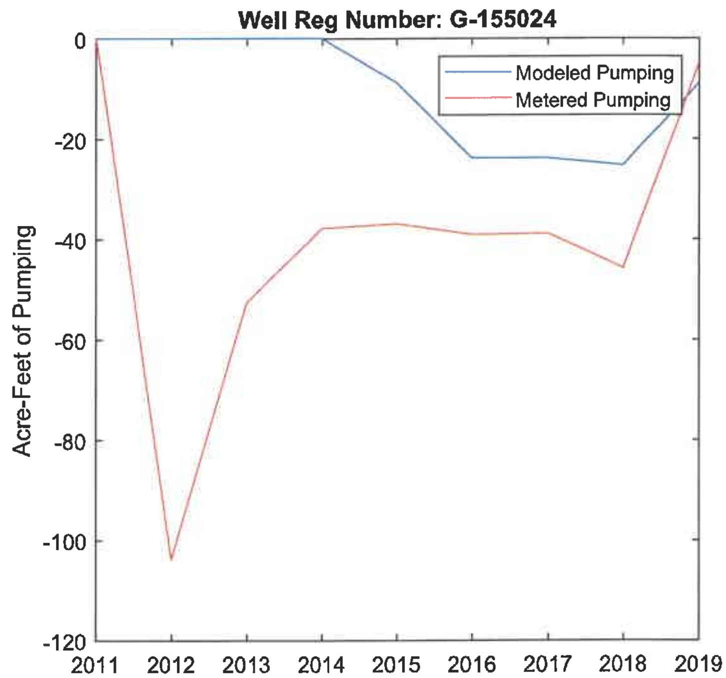

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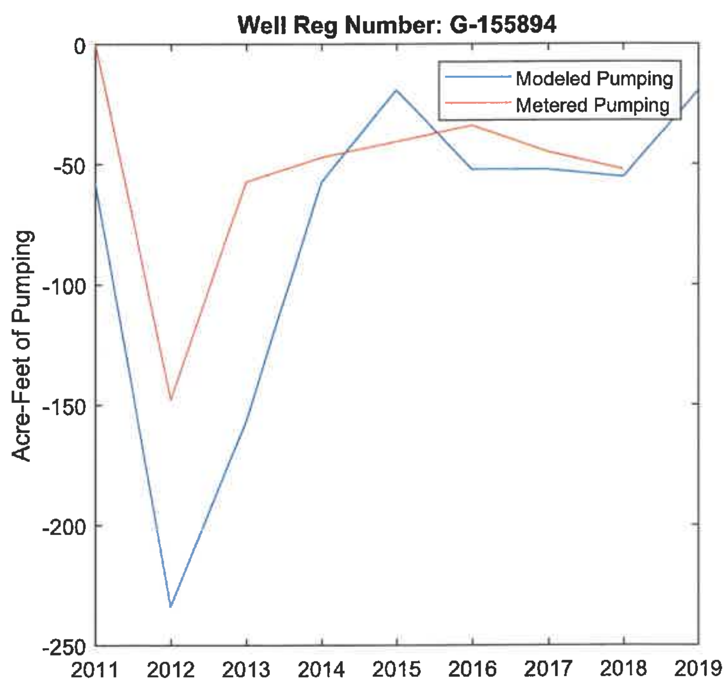

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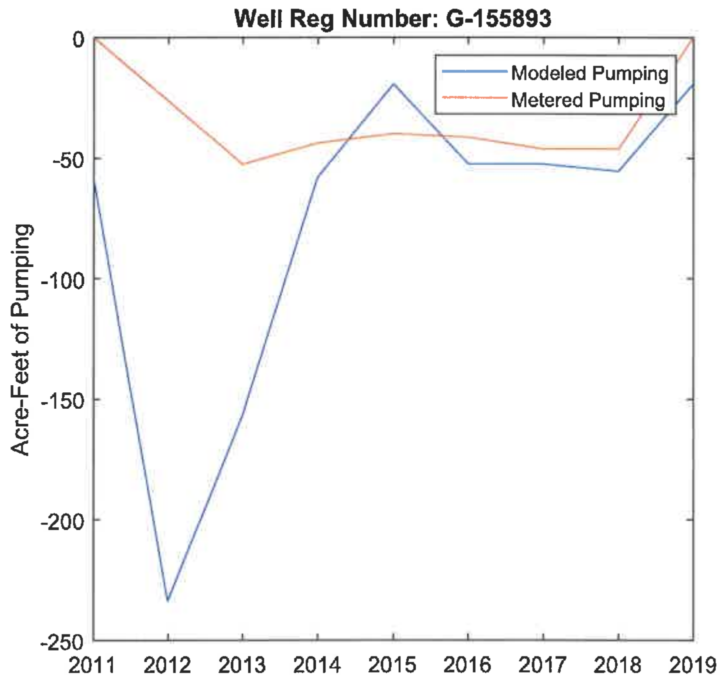
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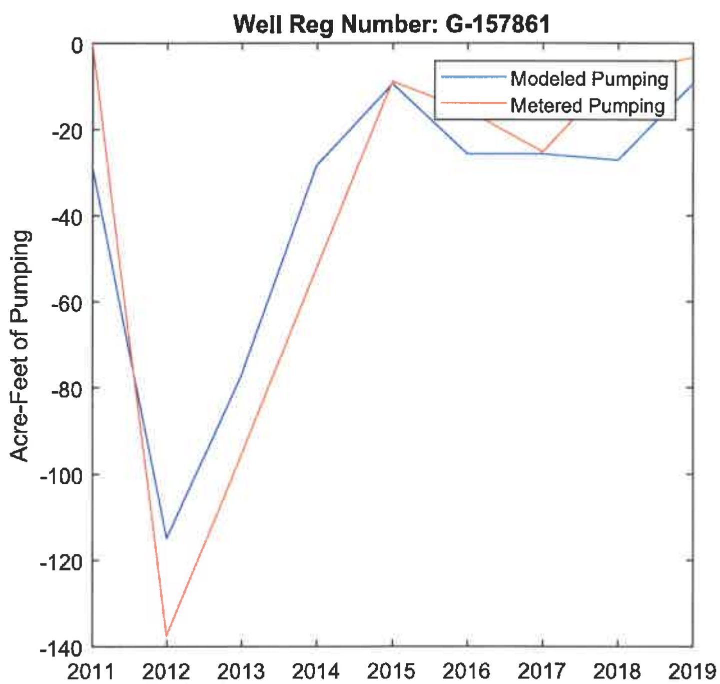
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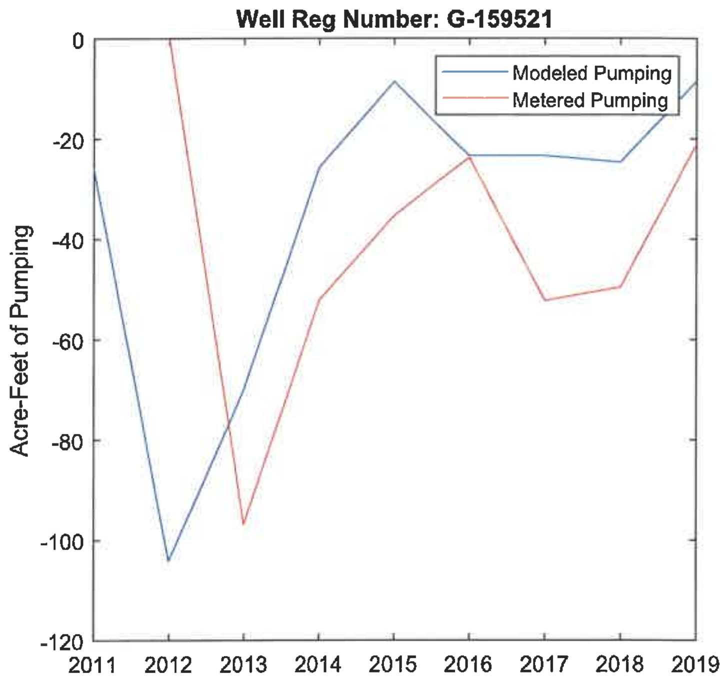
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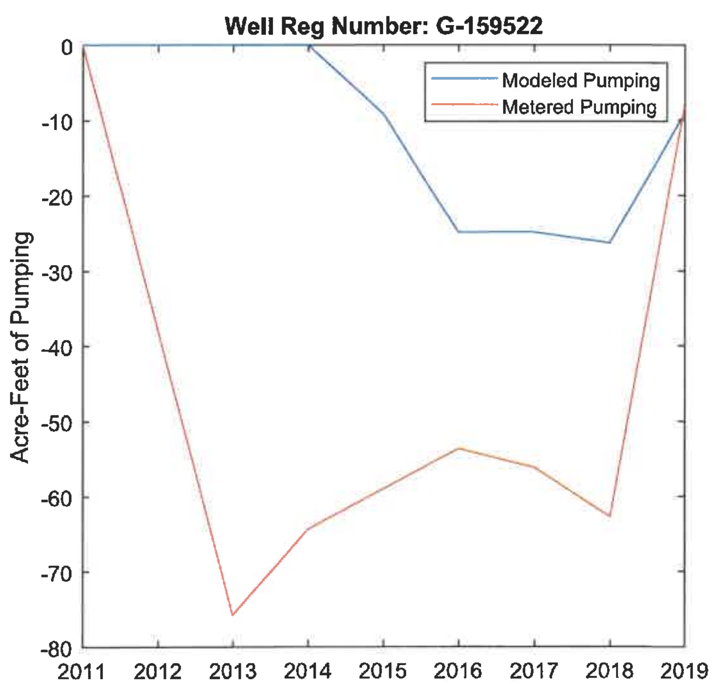
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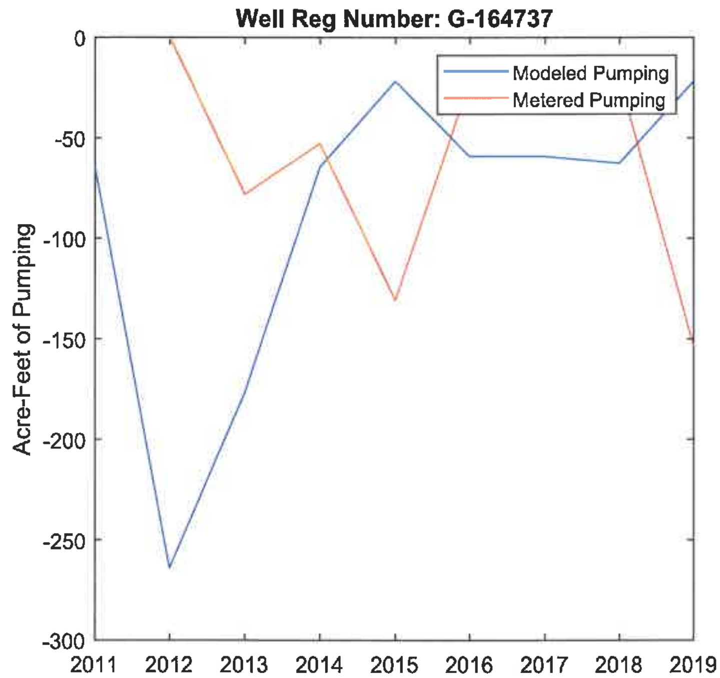
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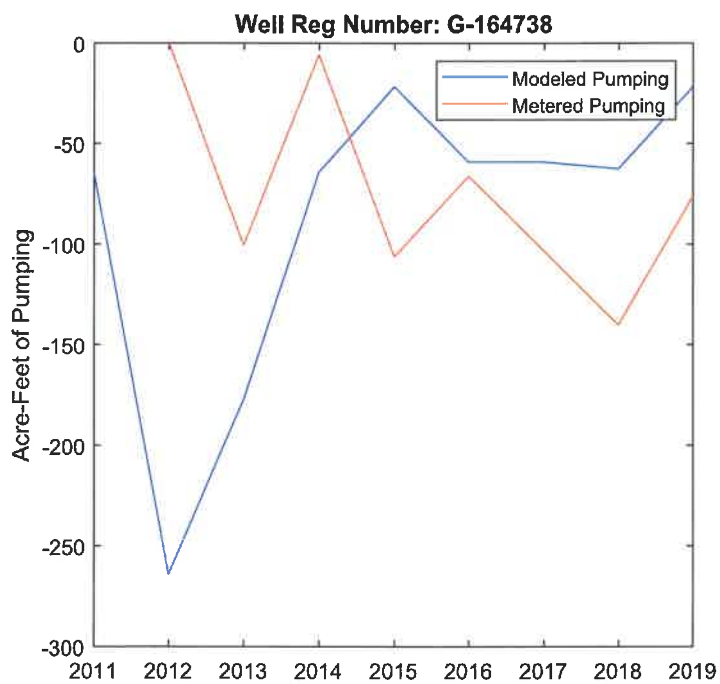
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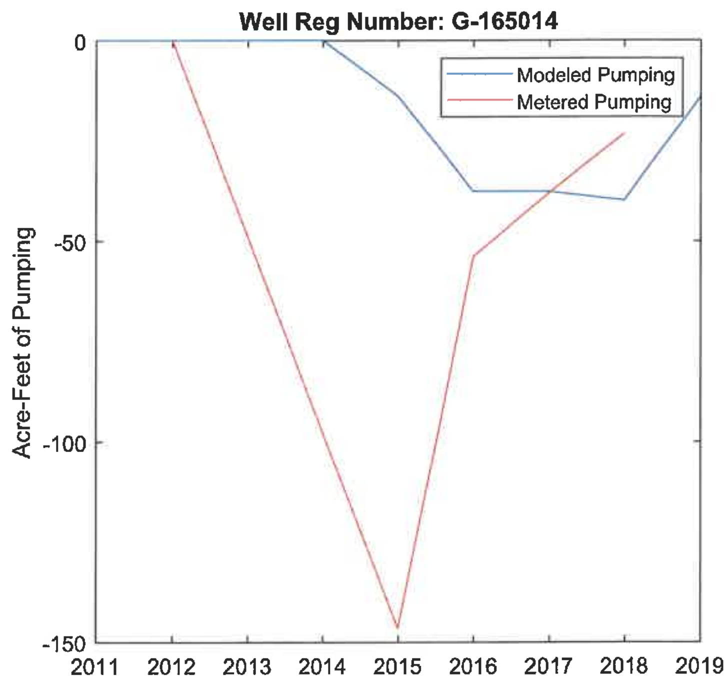
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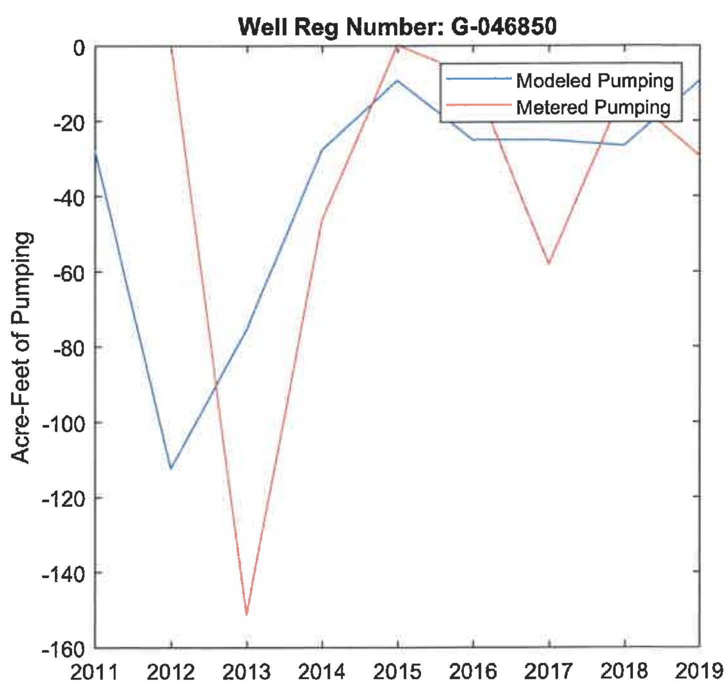
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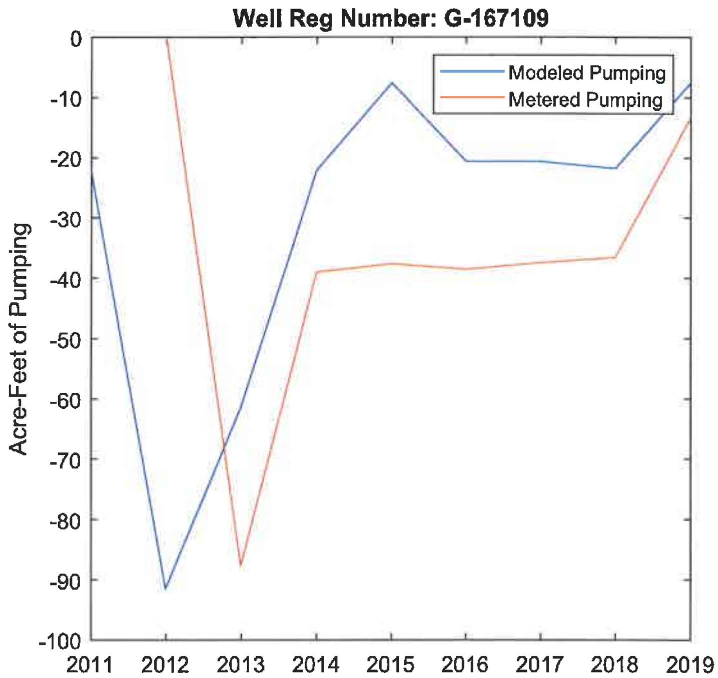
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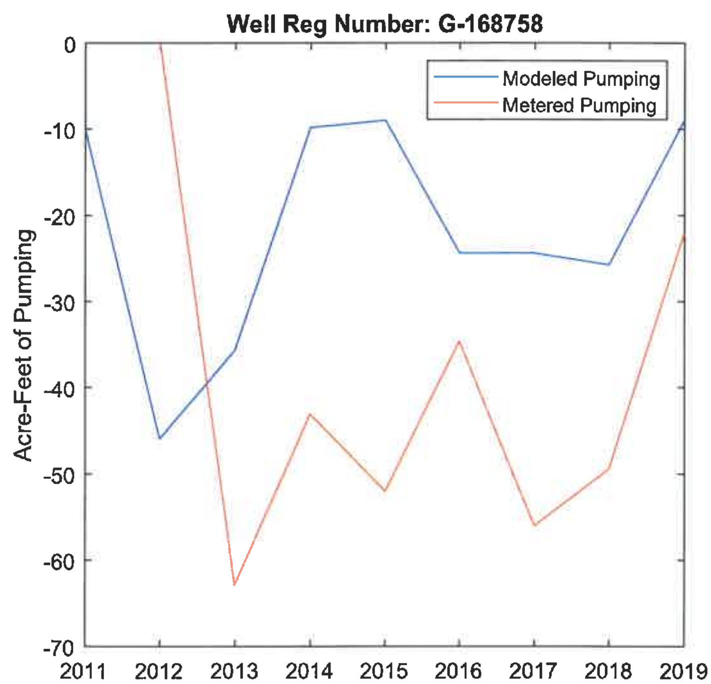
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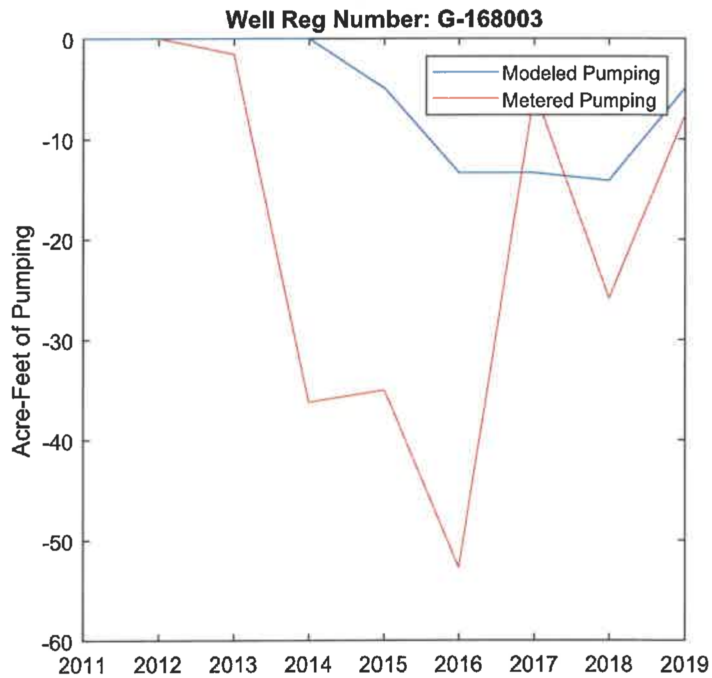
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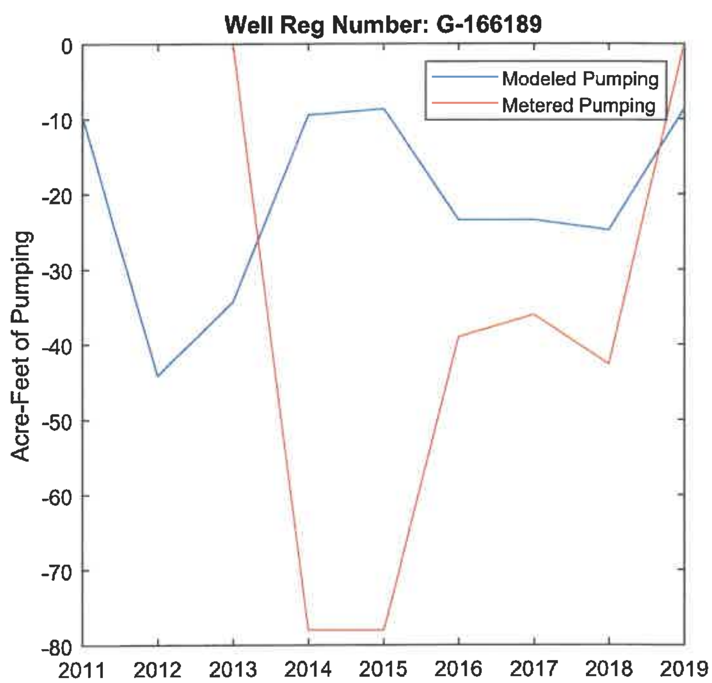
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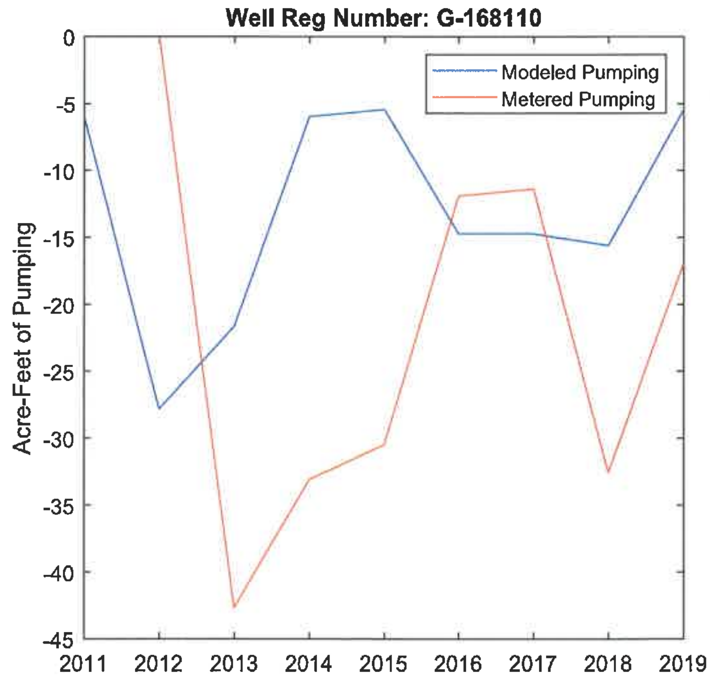

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Acre-Feet of Pumping
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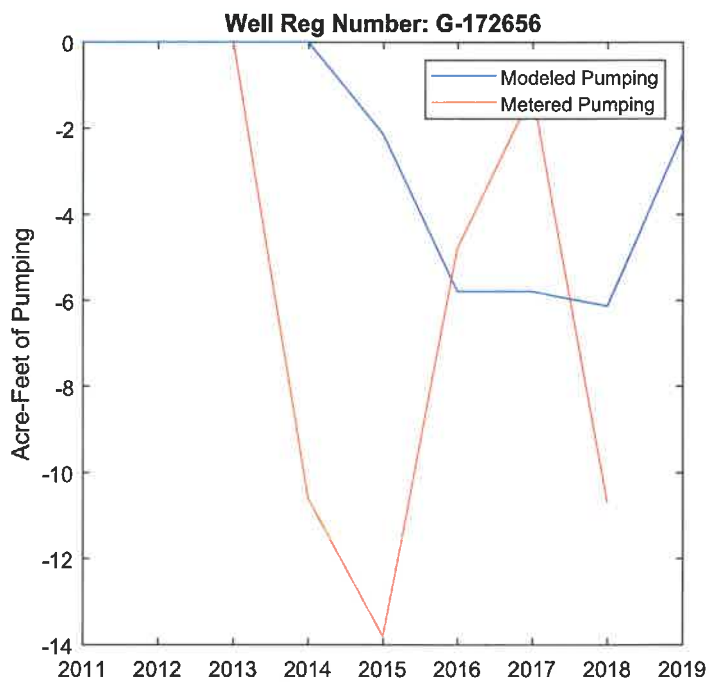

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Acre-Feet of Pumping
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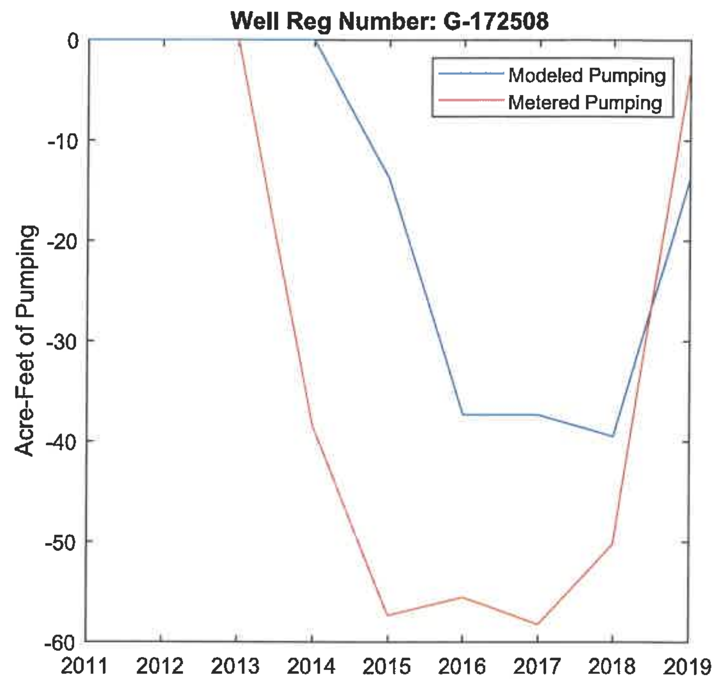
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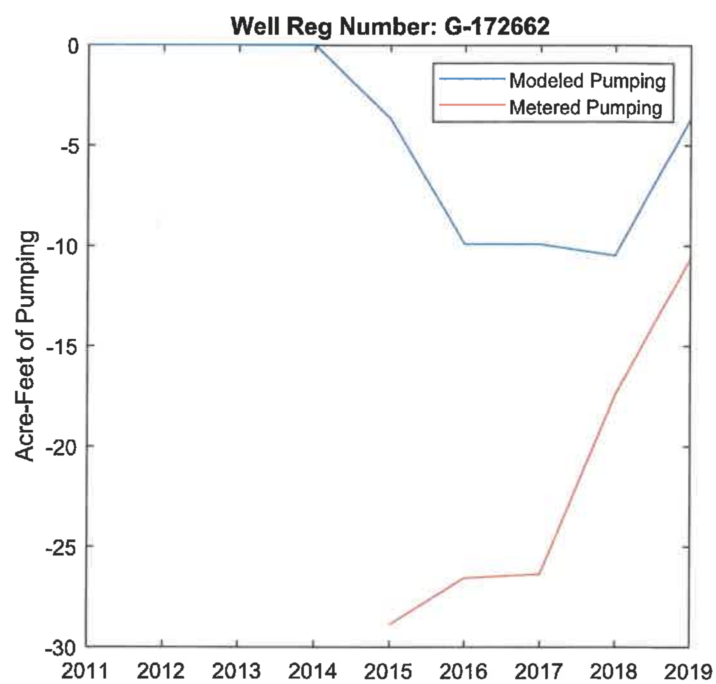
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Acre-Feet of Pumping
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-5
-10
-15
-20
-25
-30
2011
2012
2013
2014
2015
2016
2017
2018
2019

APPENDIX C
Technical Memorandum on Aquifer Pumping Test

Appendix C

Technical Memorandum
Aquifer Pumping Test Procedures, Analysis, and Results

Monolith Nebraska LLC
Hallam, Nebraska

Prepared for
Monolith Nebraska LLC
134 S 13th Street, Suite 700
Lincoln, Nebraska 68508

Prepared by
EA Engineering, Science, and Technology, Inc., PBC
221 Sun Valley Boulevard, Suite D
Lincoln, Nebraska 68528
(402) 476-3766

September 2020
Revision: 01
EA Project No. 1602602.0002

CONTENTS

Page

1. INTRODUCTION 1

1.1 PURPOSE 1
1.2 CHRONOLOGY OF FIELD ACTIVITIES 1

2. FIELD METHODS 3

2.1 STEP-RATE PUMPING TEST 3
2.2 CONSTANT-RATE PUMPING TEST 3
2.3 PUMPED WATER DISCHARGE 4
2.4 SAMPLING AND ANALYSIS OF GROUNDWATER 4

3. METHODS OF DATA ANALYSIS 5

3.1 STEP-RATE TEST 5
3.2 CONSTANT-RATE TEST 5

4. AQUIFER PUMPING TEST RESULTS 6

5. SUMMARY 7

6. REFERENCES 8

TABLES

1 Test Well Completion Information
2 Step-Rate Test - Drawdown and Recovery Data – Manual Gauging
3 Step-Rate Test – Water Quality Data
4 Constant Rate Test - Drawdown and Recovery Data – Manual Gauging
5 Constant Rate Test – Water Quality Data
6 Constant Rate Test – Pumping Rate Data

FIGURE

1 Site Map

ATTACHMENTS

1 Well Installation Records
  a. Well Boring Logs and Construction Diagrams
  b. Well Development Forms
  c. Well Permit
2 Photographic Log
3 Step-Rate Pumping Test Analysis
4 Analytical Laboratory Report
5 Constant Rate Pumping Test Analyses
6 Step- and Constant-Rate Test Data Files for Transducer Measurements (Electronically provided)

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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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 (^{0}C)	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.

^{0}C = 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 (^{0}C)	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

FILE PATH: DRAWING2.DWG [8.5X11 VERTICAL REPORT] MATHER, JASON 9/15/2020 4:59 PM

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FIGURE 1
SITE MAP

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										

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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
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 CaCO3, 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										

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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
			2.5Y4/1	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										

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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
			2.5Y4/1	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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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
			2.5Y5/1	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: 7/6/2020

Completion Date: 6/30/2020

Well ID: Observation

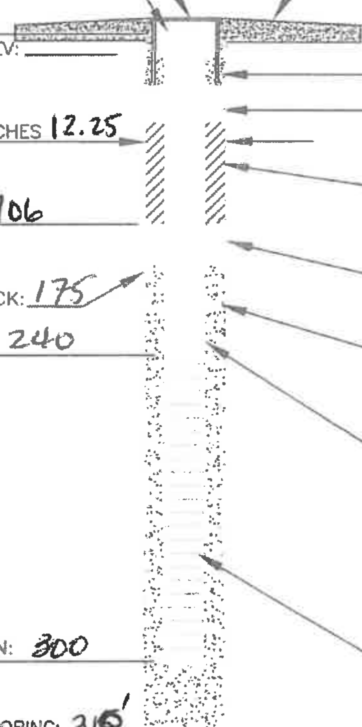
Drilling Method: ~~X-XX-XXXX~~ Rotary

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

DIAMETER OF BORE HOLE: INCHES 12.25

____ FT

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										

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

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

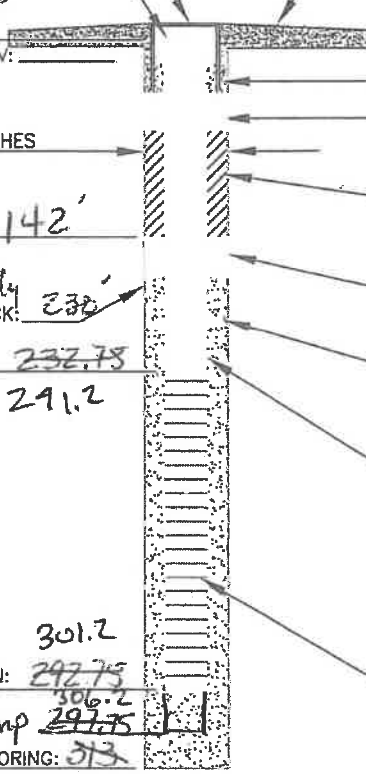
Drilling Method: Reverse Rotary

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

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

FT

~~TOP OF~~ SEAL: 142'

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

approximately TOP OF FILTER PACK: 230'

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

TOP OF SCREEN: ~~232.75~~ 241.2

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

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

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: 6"	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~~ ~~≈ 2800~~ ~~≈ 3600~~ 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.

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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	1315 AU	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

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

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 *	~~10 Volumes~~ Raise 5 ft.	~~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.

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FIELD RECORD OF WELL DEVELOPMENT

Project Name: Monolith OB Well	Project No: 602602/0002	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:

~~1443~~, 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) ~~1645~~	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	9.28 ~~10.36~~	10.67				
Turbidity (NTU)	18.9	52.5	23.5 NTU			
ORP (mV)	78.2	102.1				

* ~~1443~~ 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~~
* 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 Muscigale	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	~~1248~~ 1348	~~1300~~ 1400	~~1301~~ 1401
Depth to Water (ft)							
Purge Rate (gpm)							
Volume Purged (gal)							
pH	7.67	7.62	7.75	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	0.672	0.578	0.665
Turbidity (NTU)	overrange (-112)	-111	overrange	2816	1148	1392	1267

Parameter	7 Volumes	8 Volume	9 Volumes	10 Volumes (Raise 10 feet)	11 Volumes	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	0.673	0.676
Turbidity (NTU)	2237	1430	~~20~~ 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	144.5
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	115.1	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 Mescigle	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	0.675	0.672	0.691
Turbidity (NTU)	705	612	2683AU	2675AU	2805AU	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	1961 AU		

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)	8.46	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: 7hrs 41mins.

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	>					
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)		1120AU	22.6	9.74	10.85	11.02	6.89

Parameter	7 Volumes	8 Volume	9 Volumes	10 Volumes	11 Volumes	12 Volumes	13 Volumes
Time (min)	0906	0919	0941	0956	Next Screen 1021	1048	Next Screen 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	24.0
DO mg/L	1.62	11.17	<1.00	6.69	13.28	21.13	13.42	—	-	1.99	2.15
ORP	244.8	280.6	287.5	294.7	294.6	302.5	296.2	217.1	185.0	171.7	193.4

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 41 min

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.: 1602602/000[illegible]	Date: 8/27/20[illegible]
EA Personnel: David 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
%DO	29.1	43.1	29.9	40.4	41.9	24.7	25.0	28.0	29.6
DO mg/L	2.63	4.02	2.74	3.80	3.86	2.31	2.31	2.65	2.80
ORR	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 Mascialle	Project No.:	Date: 8/28/2020
EA Personnel: David Mascialle	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)

Increase to 500 gpm | 700 gpm

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes	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	7625 ~~7,600~~	9760 ~~9,600~~	24,940	37,590	38,320	50,680
pH	6.22	7.03	6.87	7.09	7.06	6.57	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)	61,240	71,800	79,544	94,590	109,410	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

Margin notes: 32 min @ 305 = 9,760; 30 min @ 506 = 15180; 30 min @ 704 = 21120

Comments and Observations:

	0800	0825	0832	0902	0927	0932	0947
DO %	26.8	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	194.2	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	3.52
ORP	175.5	167.5	162.2	165.4	153.6	130.6	142.6

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 915 gpm

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)	17.37	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

6/12/2020
Date

NRD – Preliminary Well Construction Permit site inspection by:

Inspector

6-25-20
Date

Preliminary Well Construction Permit Approval

LPSP-200412
Preliminary Permit Number

Paul D. Zillig, General Manager

July 10, 2020
Date

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

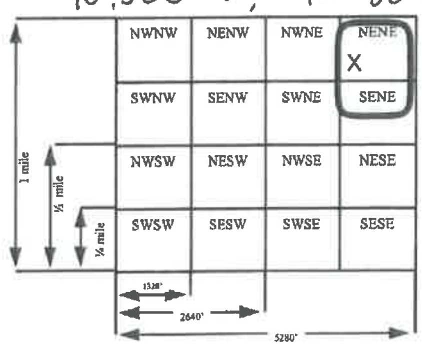
5. **PURPOSE OF WELL (indicate one)**
   ( ) Public Water Supply ( ) Irrigation ( ) Domestic ( ) Livestock
   ( ) Dewatering (over 90 days) ( ) Geothermal ( ) Monitoring ( ) Aquaculture (✓) Industrial
   ( ) Recovery ( ) Other ______

40.550568, -96.78045

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

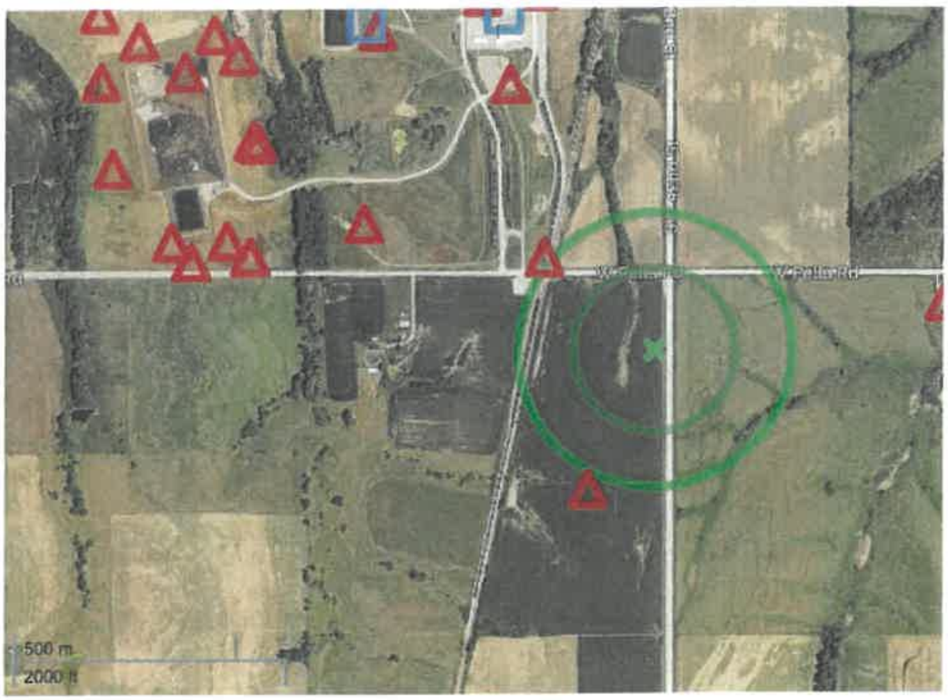
10. **SPECIFICATIONS OF INTENDED WELL AND PUMP:**
    Approximate date when construction will begin: June 22, 20 2020
    Estimated total well depth 310 feet. Estimated water well capacity: 800 gallons per minute
    Pump column diameter: 6-8 inches. Well casing diameter: 12 inches.

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 Prelimina



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 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 Ground ter 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 #83 3125 Portia Street, Lincoln, Nebraska 68501-3581. Please take the time to fill out the information correctly. An incomplete or defect application will be returned by the District, with 60 days being allowed for resubmission. All permits shall be issued by the District v or without conditions attached, or denied no later than 30 days after receipt of a complete and properly prepared application pursuant §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 comm 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 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 wat 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 irrigat 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 registere irrigation water well; No industrial water well shall be drilled within 1,000 feet of a registered irrigation or industrial water well pursuant to -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 register by the water well contractor constructing the well with the Nebraska Department of Natural Resources within 60 days after the water well i 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 construct water the same tract of land as the abandoned water well which is being replaced. As of August 13, 1996 replacement wells <u>DO</u> need a per 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 designe 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 pe 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 & Regulat

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

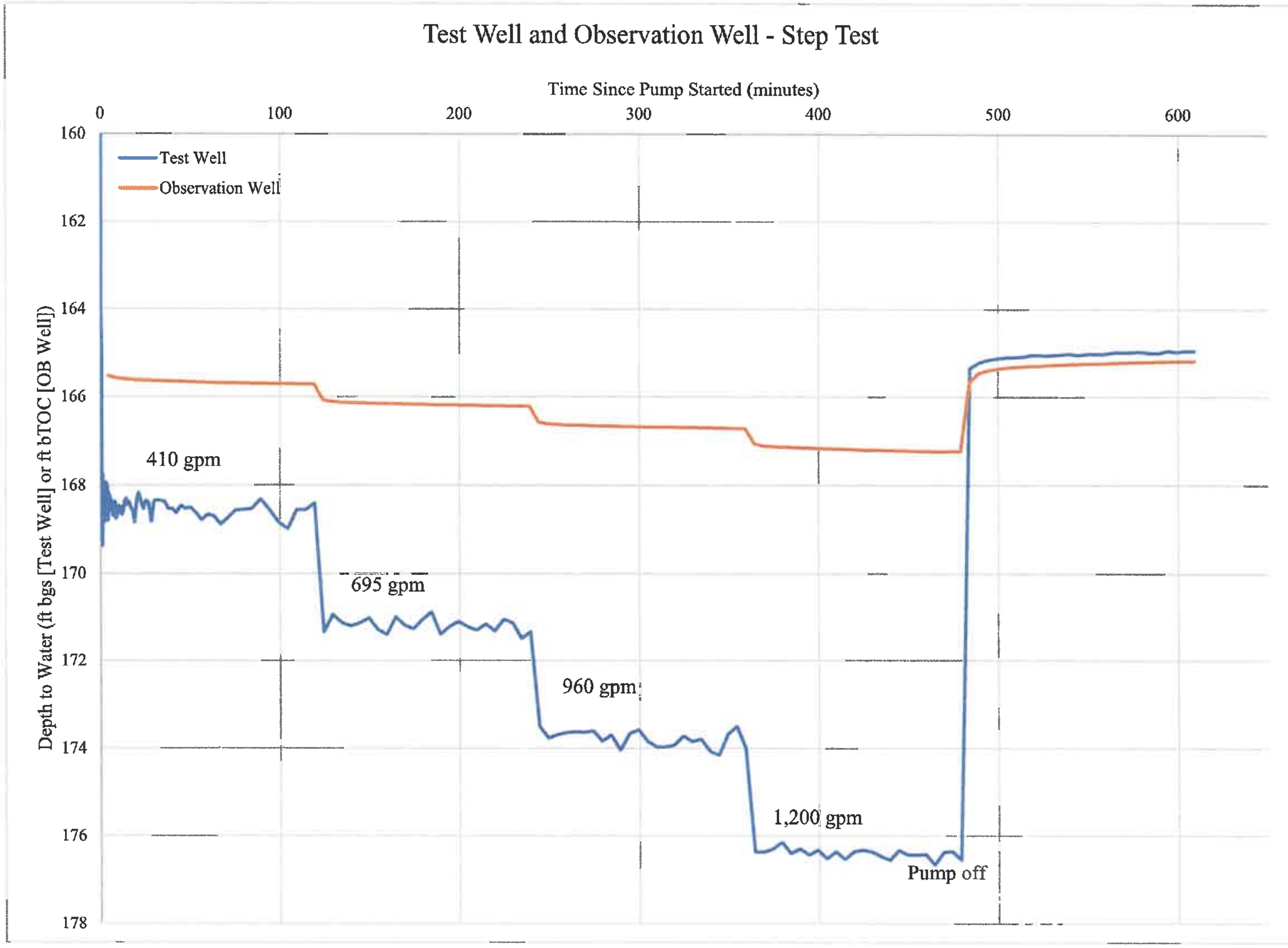
Photograph No. 5: Observation well with water level meter and transducer.
Date: 09-02-20 Direction: NA

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
160
162
164
166
168
170
172
174
176
178
Depth to Water (ft bgs [Test Well] or ft bTOC [OB Well])
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)

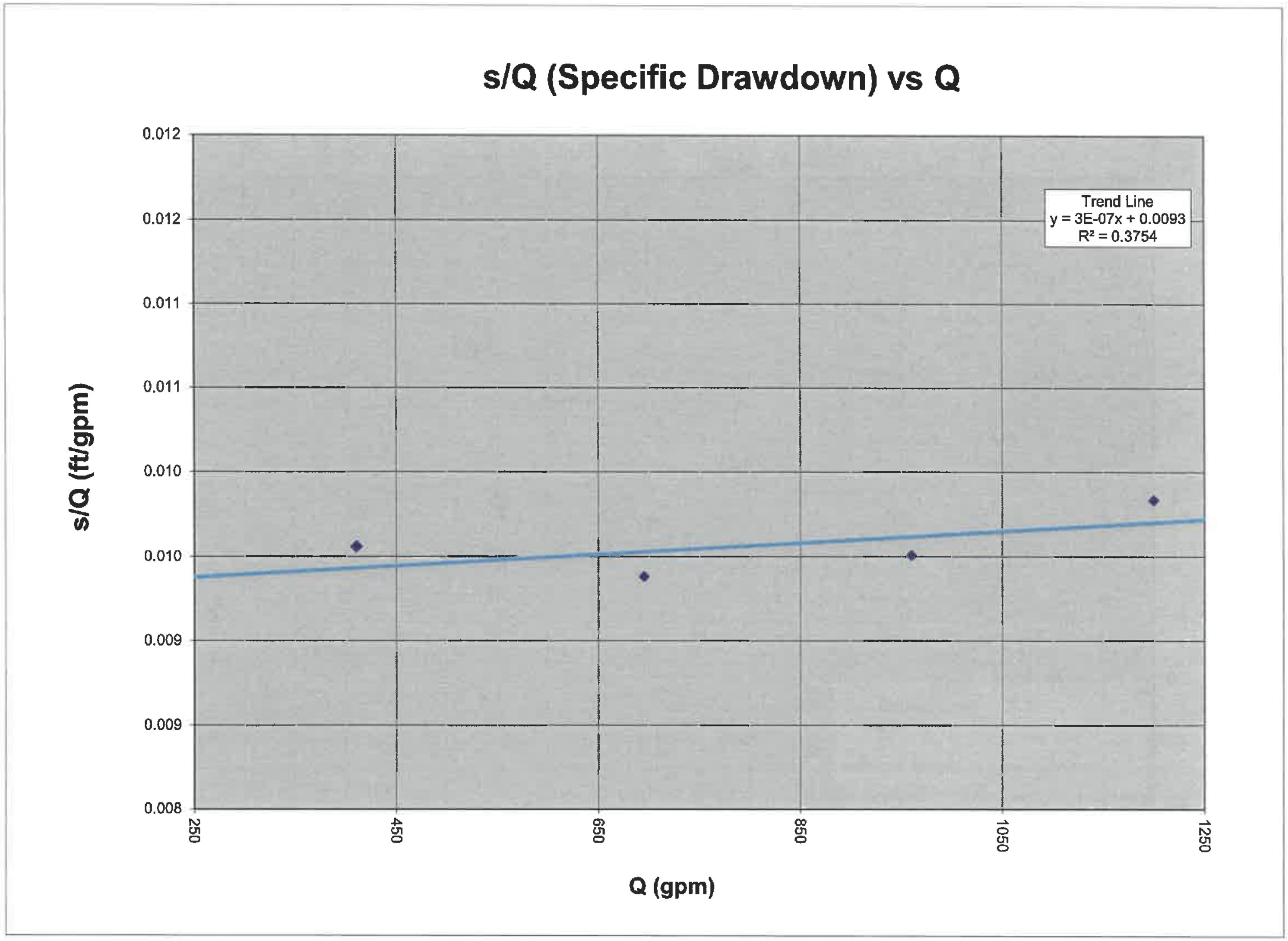
BQ = formation loss

CQ^2 = well loss

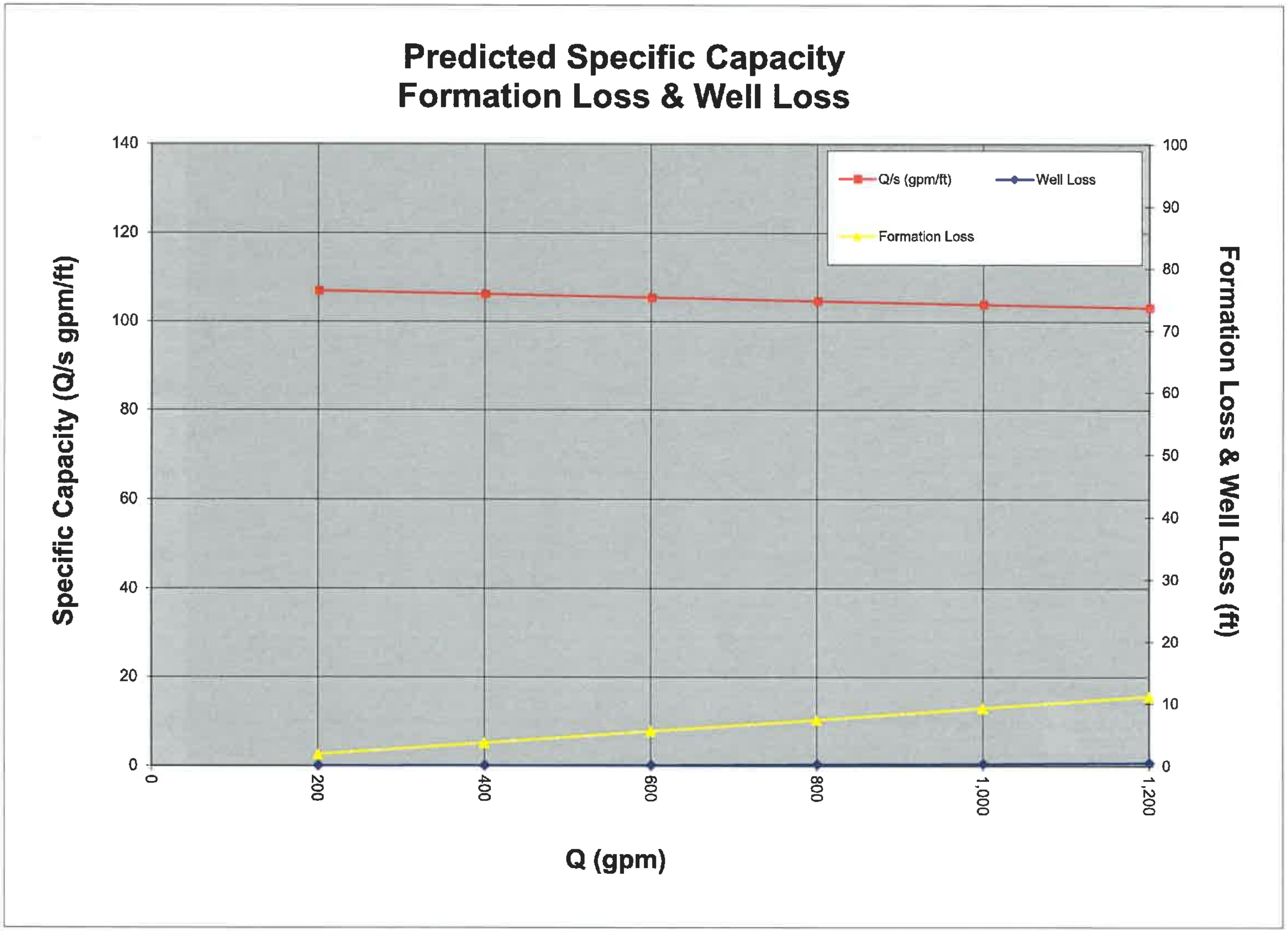
Q (gpm)	Theoretical Drawdown s (ft)	Specific Capacity Q/s (gpm/ft)	Formation Loss BQ	Well Loss CQ^2
200	1.9	106.8	1.8584071	0.013695
400	3.8	106.1	3.72	0.05
600	5.7	105.3	5.58	0.12
800	7.7	104.5	7.43	0.22
1000	9.6	103.8	9.29	0.34
1200	11.6	103.1	11.15	0.49

Well Efficiency (Roscoe Moss p. 305)

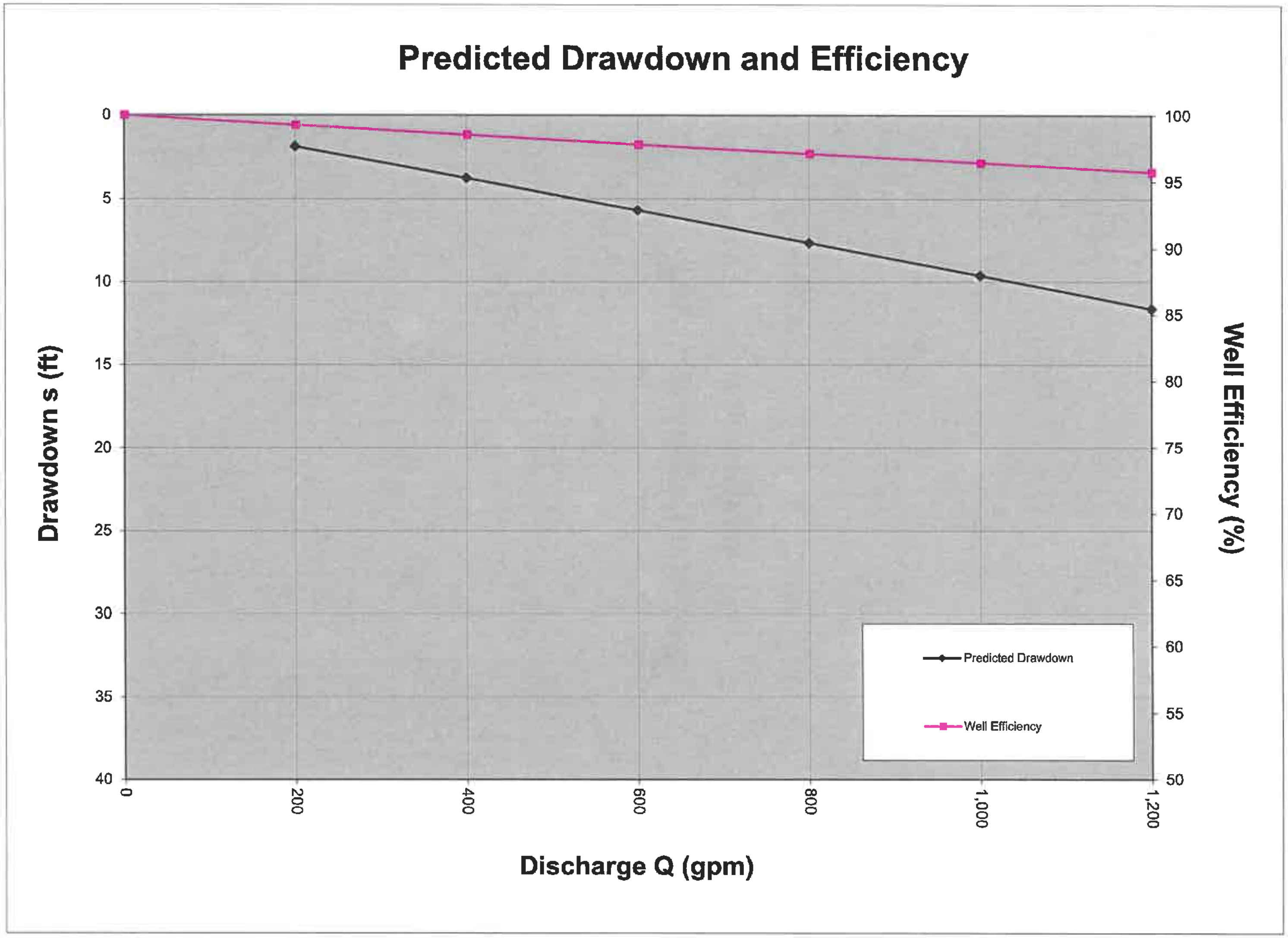
Q (gpm)	Efficiency
0	100
200	99.2684534
400	98.54753229
600	97.83700682
800	97.13665375
1000	96.44625619
1200	95.76560335



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



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

WARRANTY AND LIMITS OF LIABILITY - In accepting analytical work, we warrant the accuracy of test results for the sample as submitted. THE FOREGOING EXPRESS WARRANTY IS EXCLUSIVE AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. WE DISCLAIM ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING A WARRANTY OF FITNESS FOR PARTICULAR PURPOSE AND WARRANTY OF MERCHANTABILITY. IN NO EVENT SHALL EUROFINS LANCASTER LABORATORIES ENVIRONMENTAL, LLC BE LIABLE FOR INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF PROFIT OR GOODWILL REGARDLESS OF (A) THE NEGLIGENCE (EITHER SOLE OR CONCURRENT) OF EUROFINS LANACASTER LABORATORIES ENVIRONMENTAL AND (B) WHETHER EUROFINS LANCASTER LABORATORIES ENVIRONMENTAL HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES. We accept no legal responsibility for the purposes for which the client uses the test results. No purchase order or other order for work shall be accepted by Eurofins Lancaster Laboratories Environmental which includes any conditions that vary from the Standard Terms and Conditions, and Eurofins Lancaster Laboratories Environmental hereby objects to any conflicting terms contained in any acceptance or order submitted by client.

Jennifer Pursel

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

Table of Contents

Cover Page 1
Table of Contents 3
Definitions/Glossary 4
Case Narrative 5
Detection Summary 6
Client Sample Results 7
QC Sample Results 8
QC Association Summary 11
Lab Chronicle 12
Certification Summary 13
Method Summary 14
Sample Summary 15
Chain of Custody 16
Receipt Checklists 17

Definitions/Glossary

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

Job ID: 410-13225-1
SDG: Monolith

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

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

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
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

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

Accreditation/Certification Summary

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

Unless 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	Laboratory
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

Client Contact: Jamie Suing	Sampler: David M Masciale
Company: EA Engineering, Science, and Technology	Phone:
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#:

Lab PM: Hower, Kay G
E-Mail: kayhower@eurofinsus.com
Carrier Tracking No(s):
COC No: 410-9444-2719 1
Page: Page 1 of 1
Job #:

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	EME

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

13

Login Sample Receipt Checklist

Client: EA Engineering, Science, and Technology

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

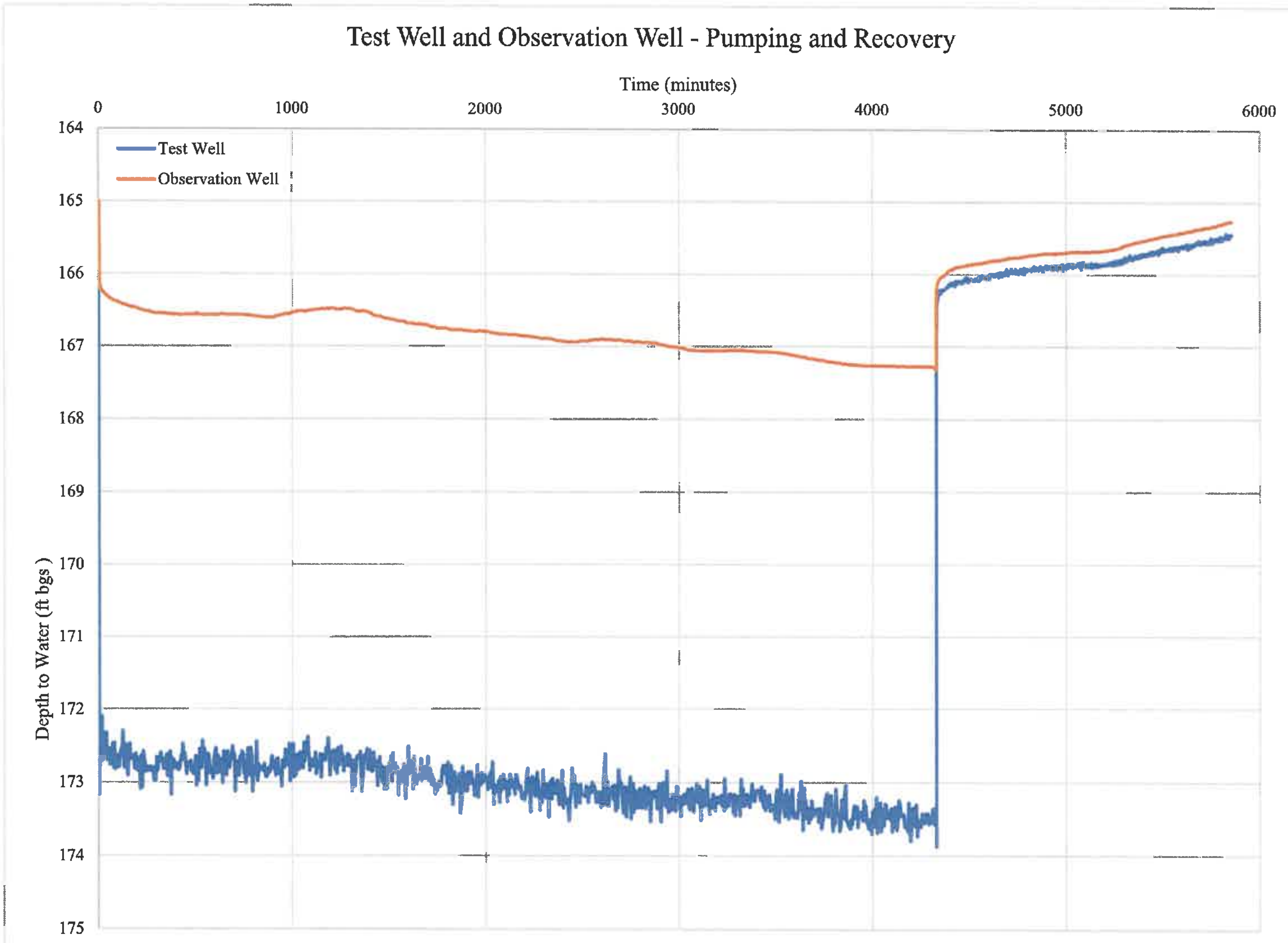
Login Number: 13225
List Number: 1
Creator: Rivera, Tatiana

List Source: Eurofins Lancaster Laboratories Env

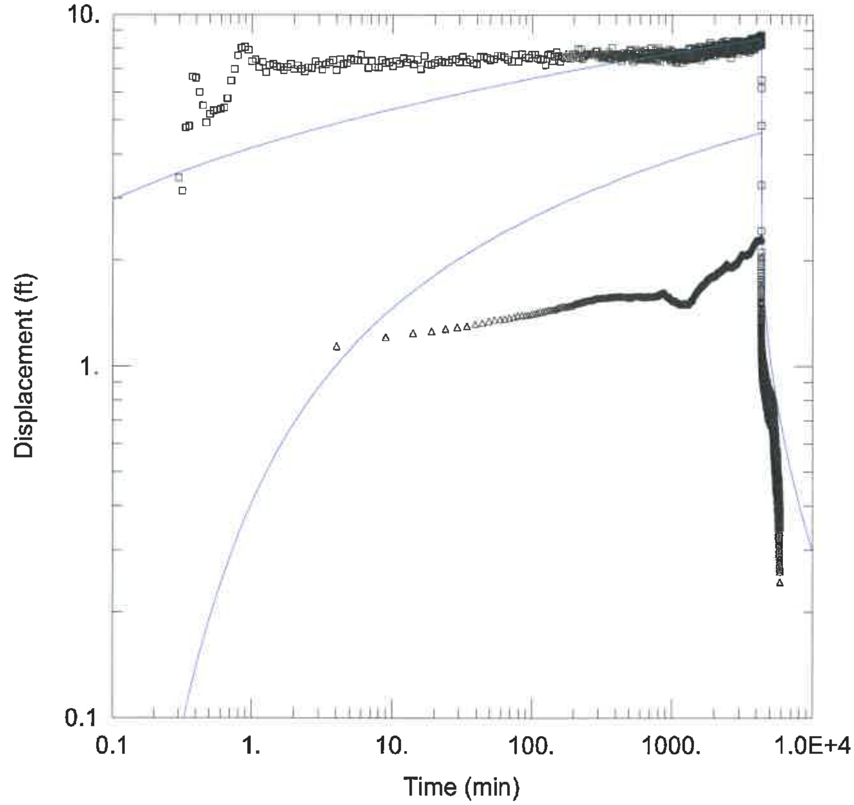
Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable (</=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

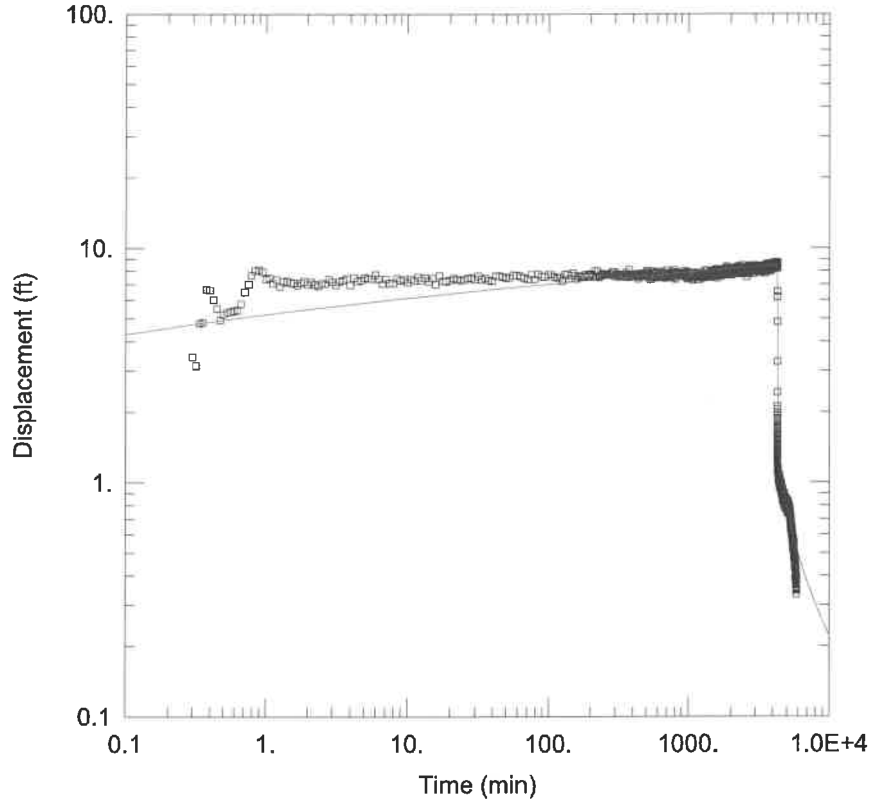
Observation Wells

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

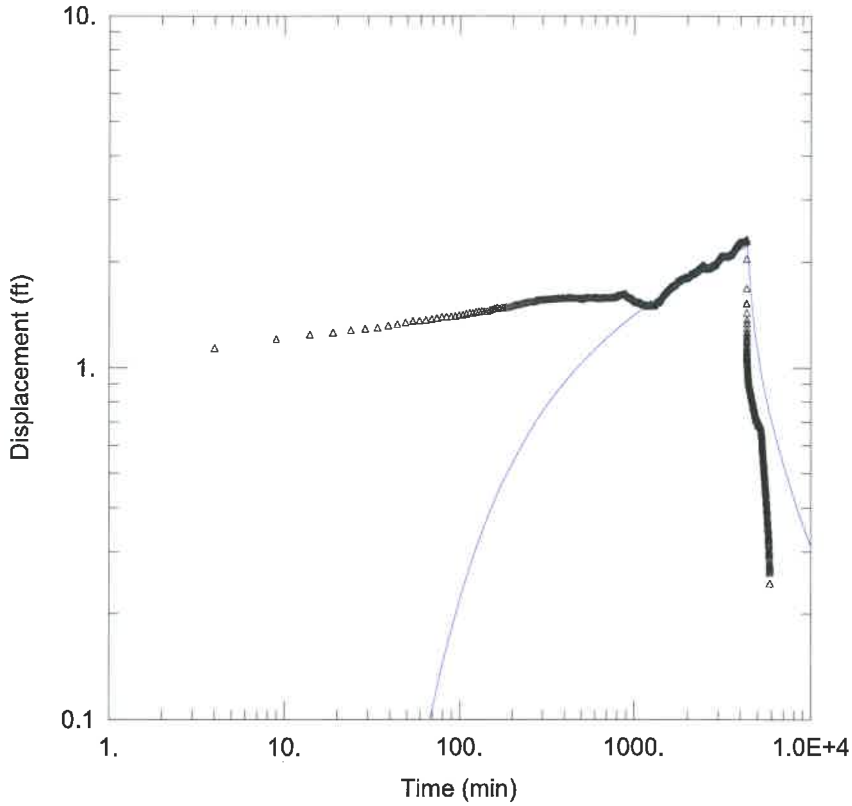
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 21.73 ft^2/min
Kz/Kr = 1.

S = 7.198E-8
b = 60. ft



Observation Well - Constant Rate Test

Data 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

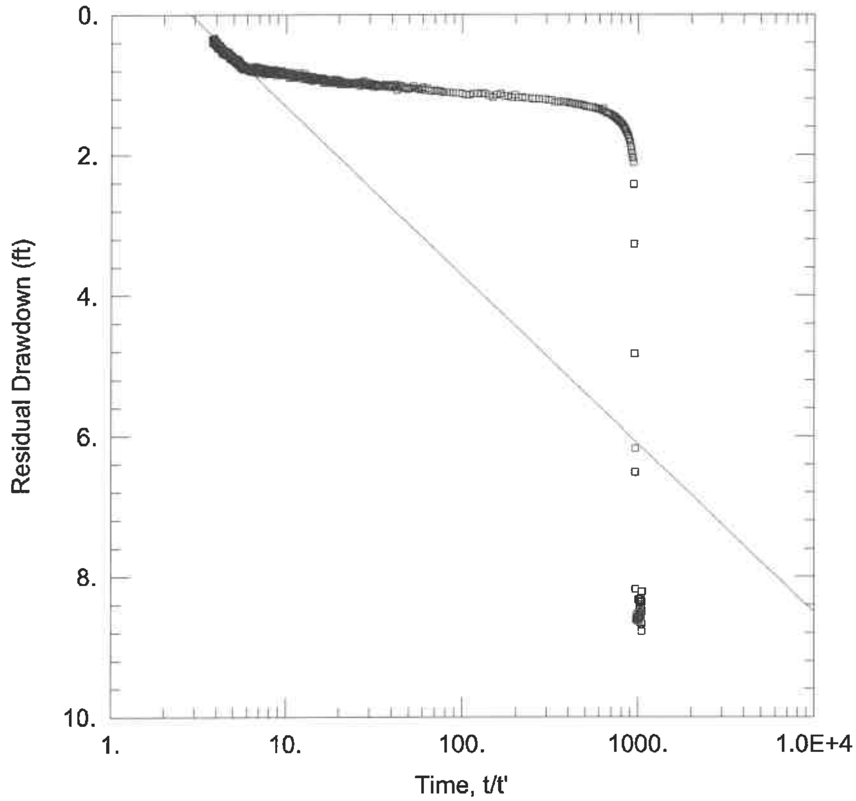
Observation Wells

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

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 15.5 ft^2/min
S = 2.33
Kz/Kr = 1.
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

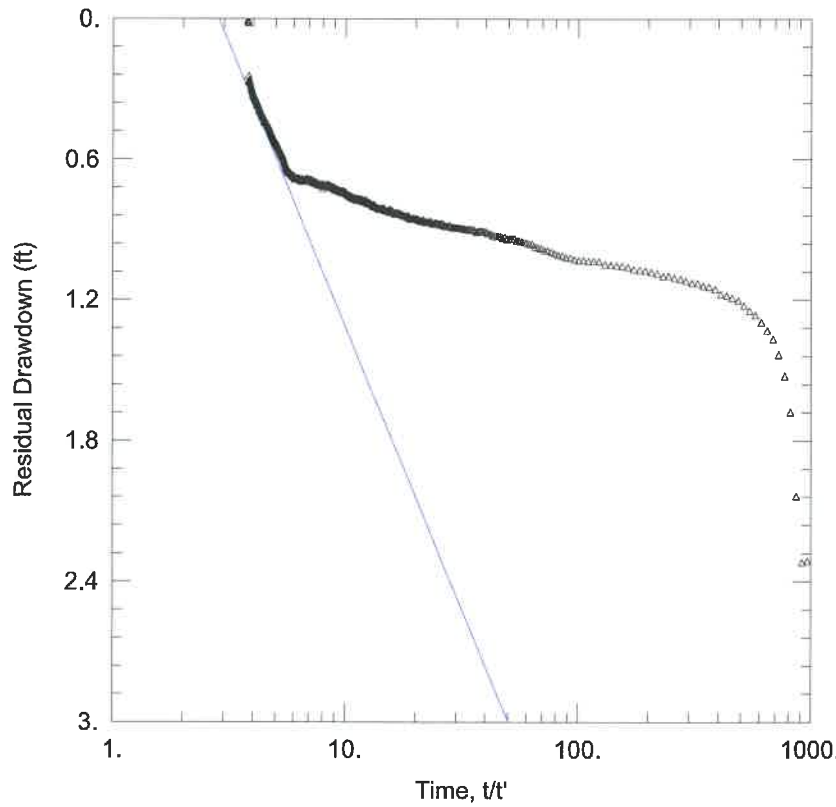
SOLUTION

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

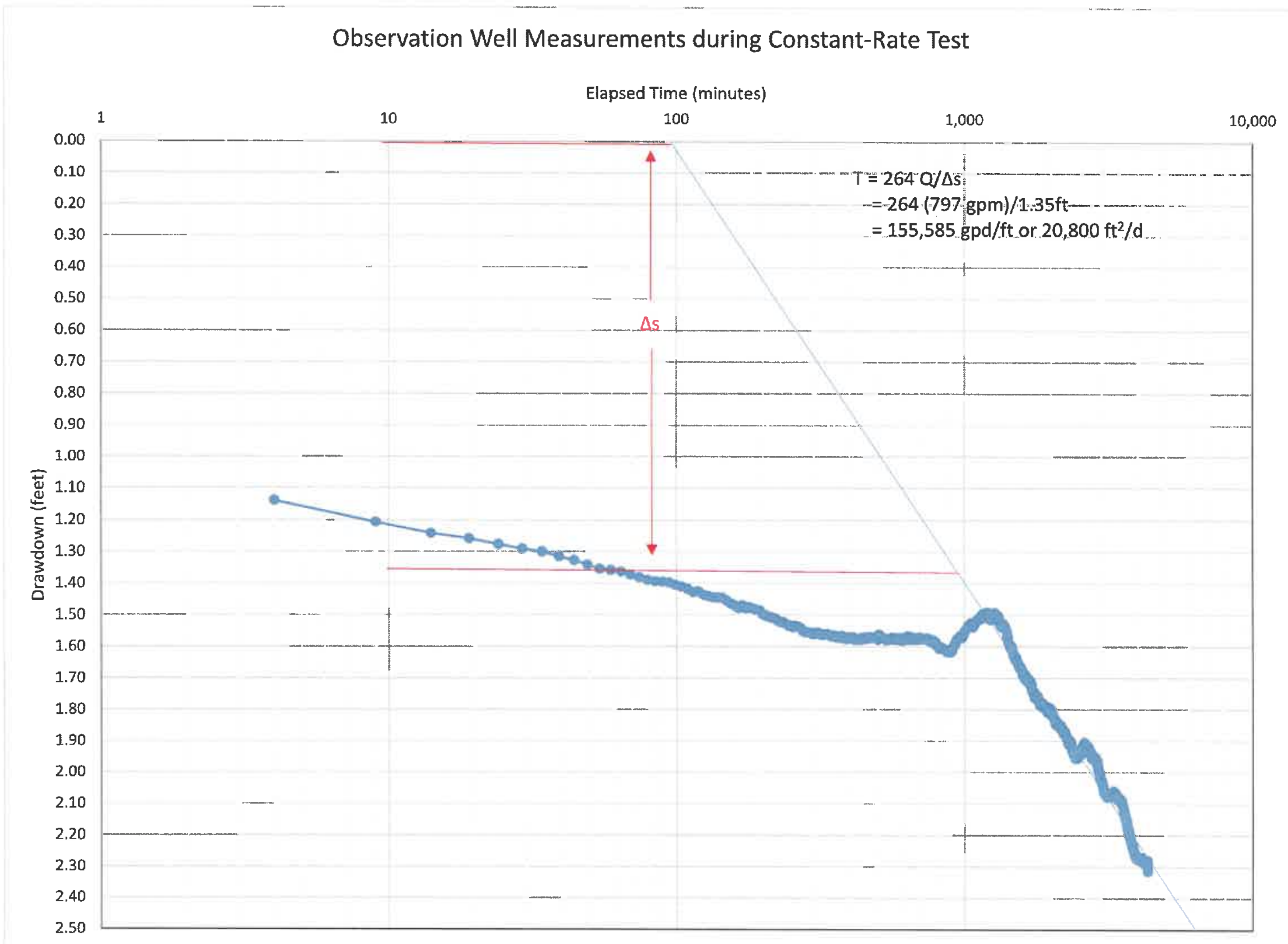
SOLUTION

Aquifer Model: Confined

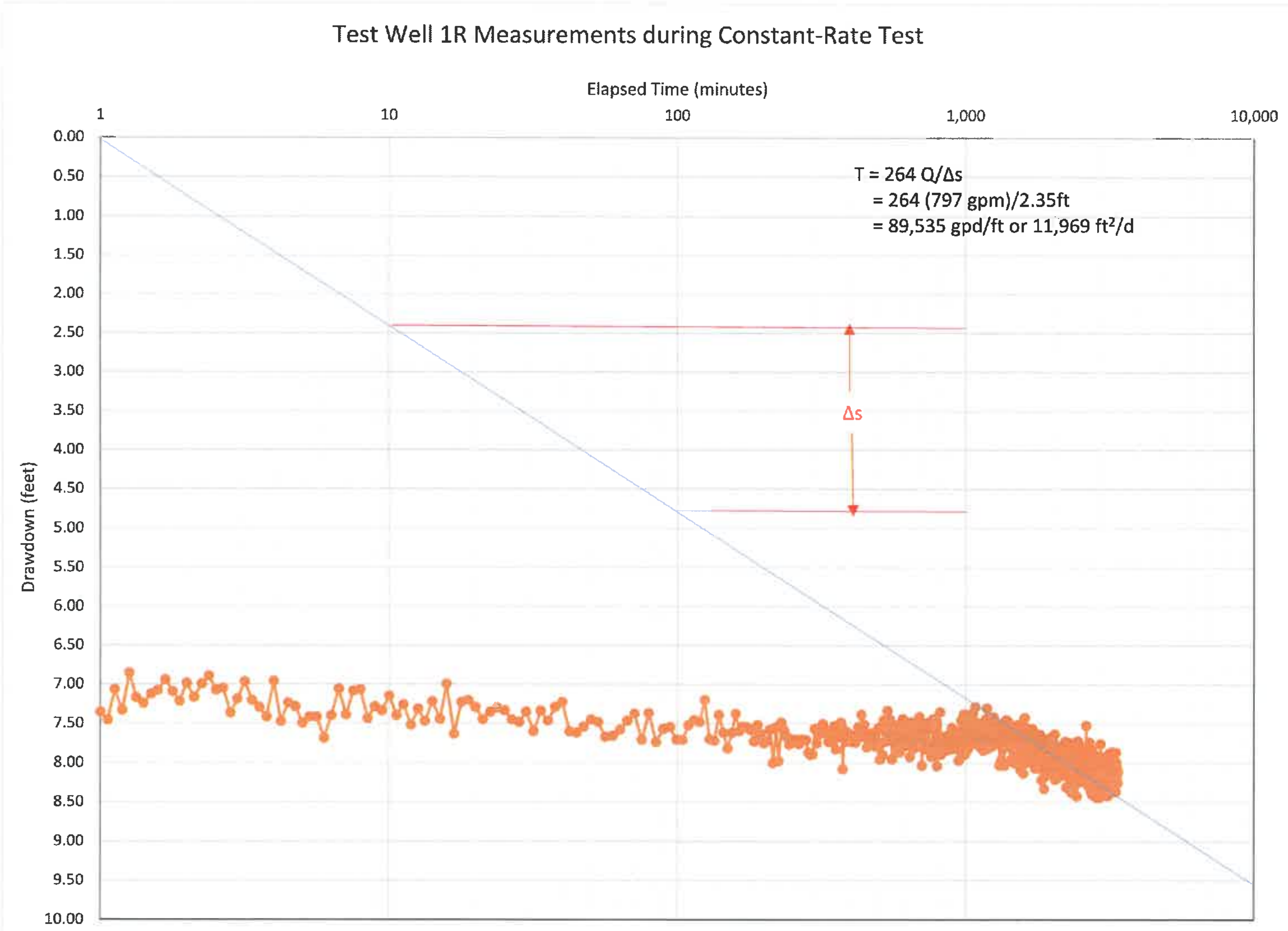
Solution Method: Theis (Recovery)

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

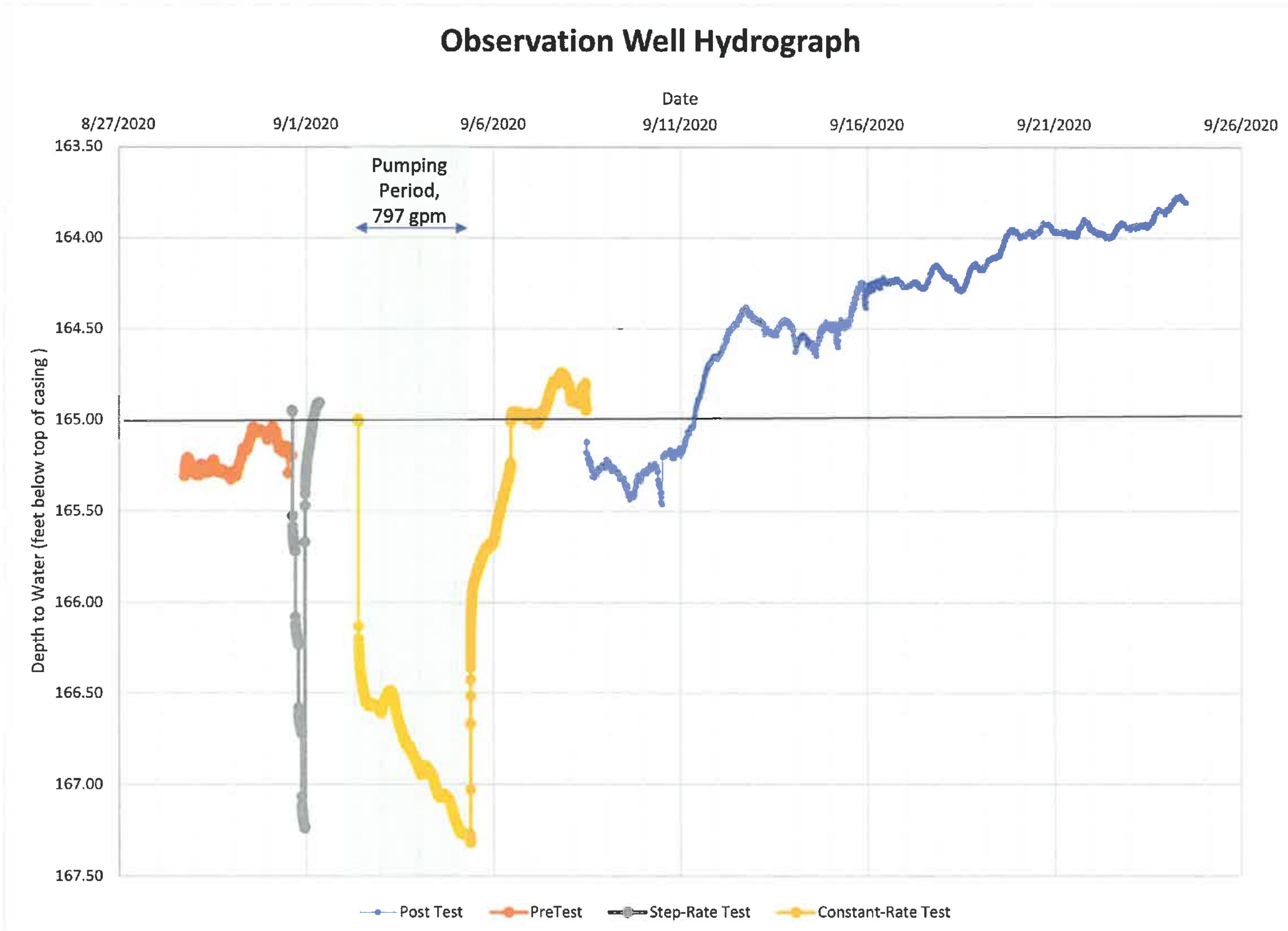
References

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.

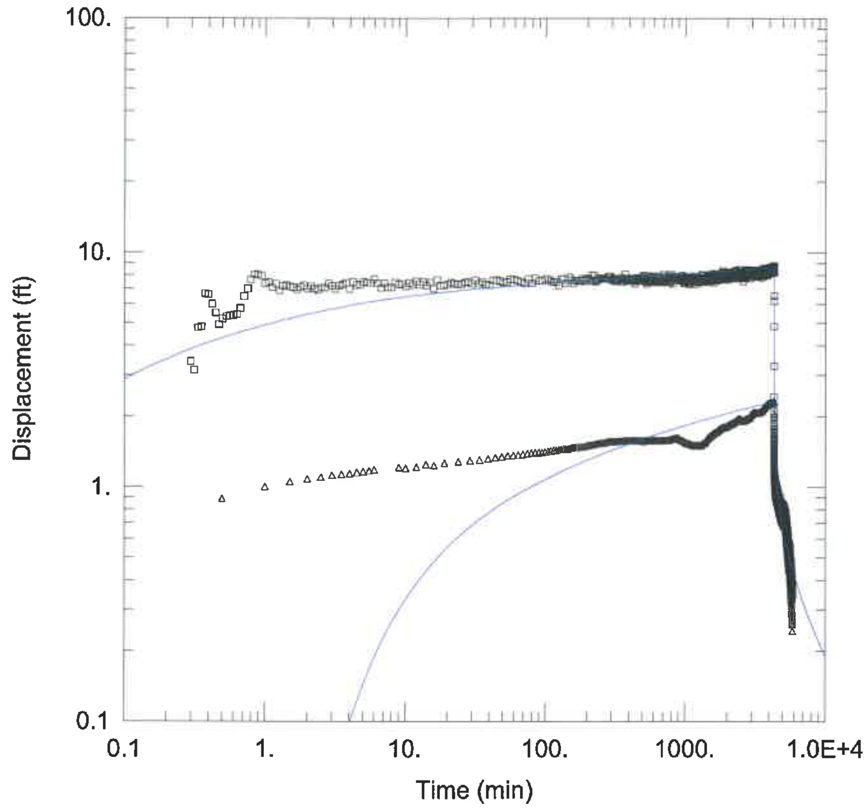
Neuman, S.P., 1974. Effect of partial penetration on flow in unconfined aquifers considering delayed gravity response, Water Resources Research, vol. 10, no. 2, pp. 303-312.

Attachment A
Observation Well Hydrograph



Observation Well Hydrograph
Date
8/27/2020
9/1/2020
9/6/2020
9/11/2020
9/16/2020
9/21/2020
9/26/2020
163.50
164.00
164.50
165.00
165.50
166.00
166.50
167.00
167.50
Depth to Water (feet below top of casing)
Pumping Period, 797 gpm
Post Test
PreTest
Step-Rate Test
Constant-Rate Test

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

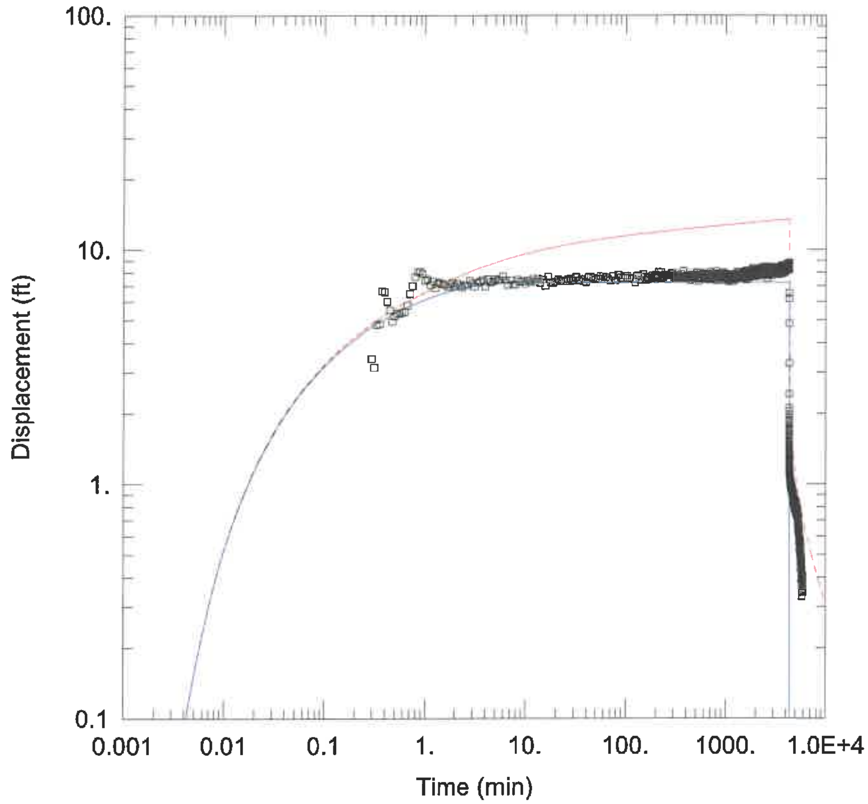
SOLUTION

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

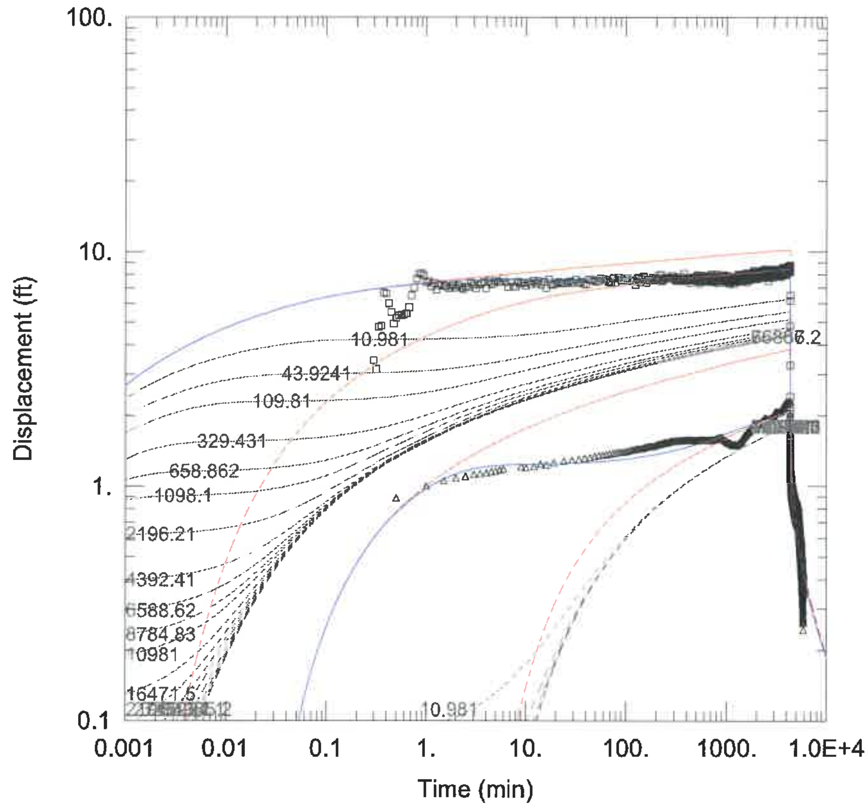
Observation Wells

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

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 15.64 ft^2/min
S = 0.1717
r/B = 0.1
Kz/Kr = 0.3
b = 175. ft



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
Sy = 0.2031
S = 0.001288
Kz/Kr = 0.3022

Attachment C
Aquifer Parameter Estimates

Section 4. Aquifer Parameter Estimates

Well	Method	Software	Data	T (gpd/ft)	T (ft^2/day)	K ft/day	S	Sy
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

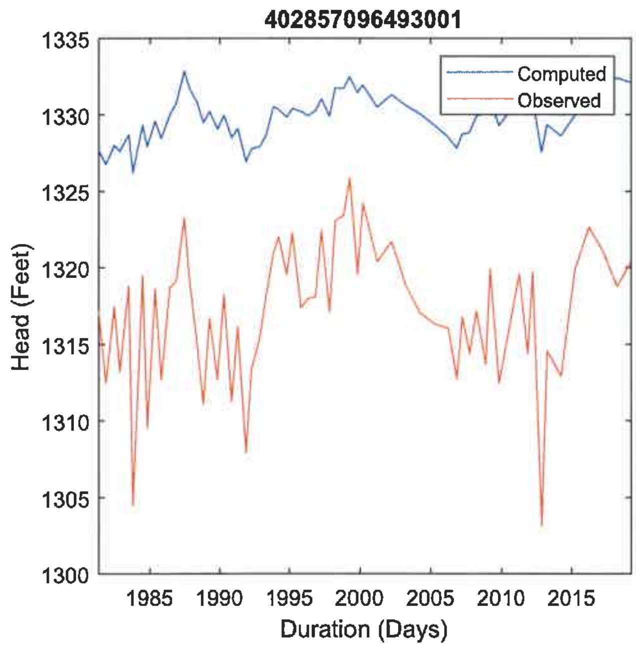
gpd/ft = gallons per day/foot

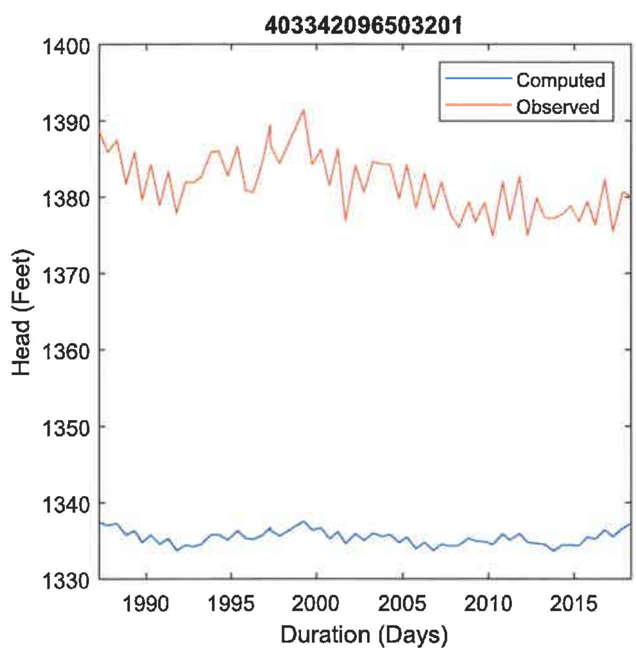
K values estimated by dividing T by estimated saturated thickness of 175 ft screen (Divine and Korus 2012).

Appendix D

APPENDIX D

Modeled and Observed Water Levels at Target Locations


402857096493001
Computed
Observed
Head (Feet)
Duration (Days)
1335
1330
1325
1320
1315
1310
1305
1300
1985
1990
1995
2000
2005
2010
2015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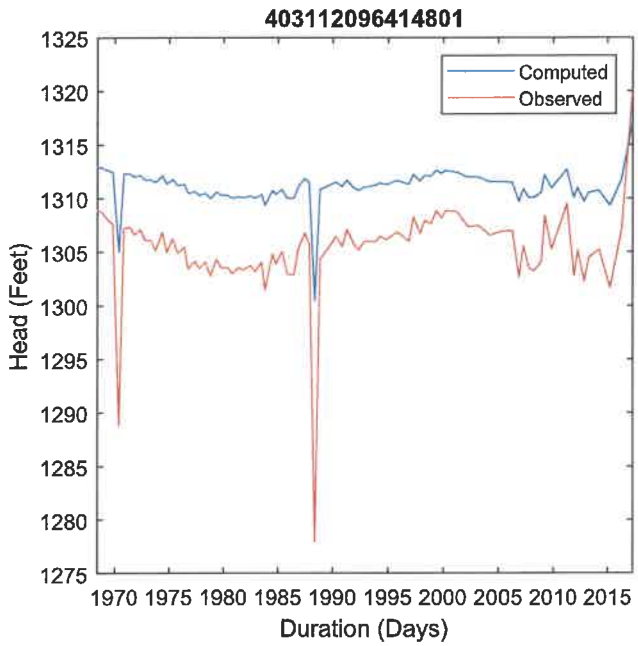
Duration (Days)
1400
1390
1380
1370
1360
1350
1340
1330
1990
1995
2000
2005
2010
2015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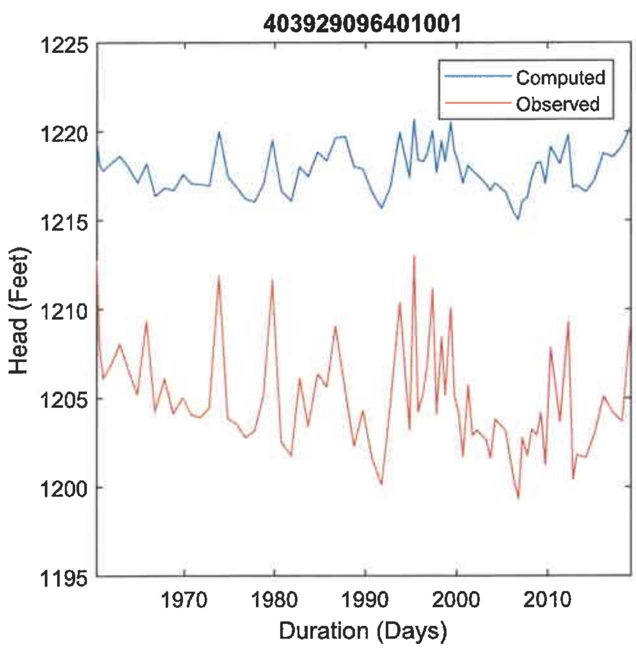
Observed
Head (Feet)
1325
1320
1315
1310
1305
1300
1295
1290
1285
1280
1275
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Duration (Days)


403929096401001
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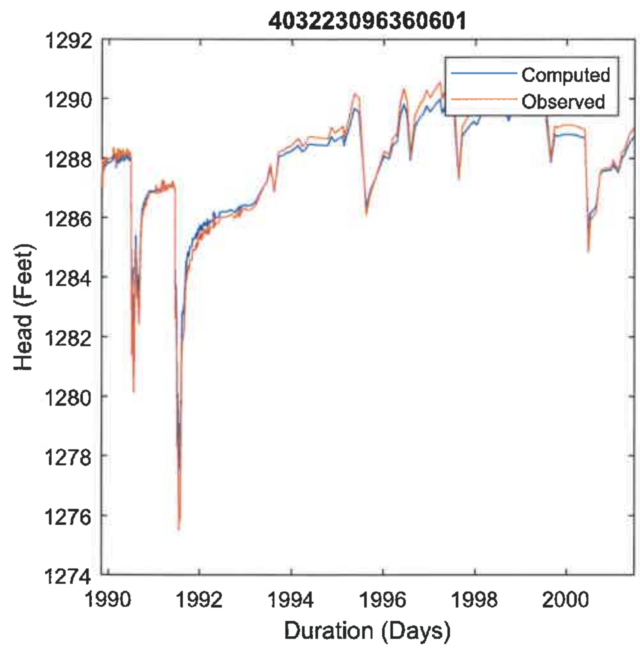
Observed
Head (Feet)
1225
1220
1215
1210
1205
1200
1195
1970
1980
1990
2000
2010
Duration (Days)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Observed
Head (Feet)
1292
1290
1288
1286
1284
1282
1280
1278
1276
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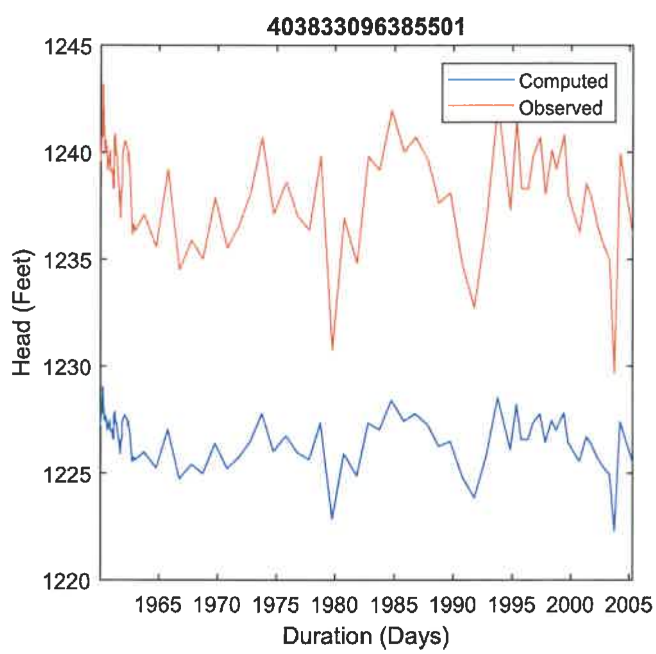
1992
1994
1996
1998
2000
Duration (Days)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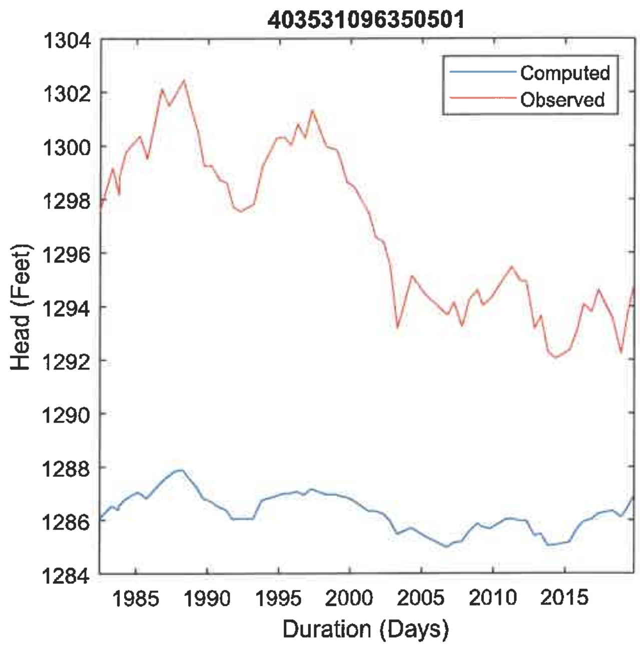
Observed
Head (Feet)
1245
1240
1235
1230
1225
1220
1965
1970
1975
1980
1985
1990
1995
2000
2005
Duration (Days)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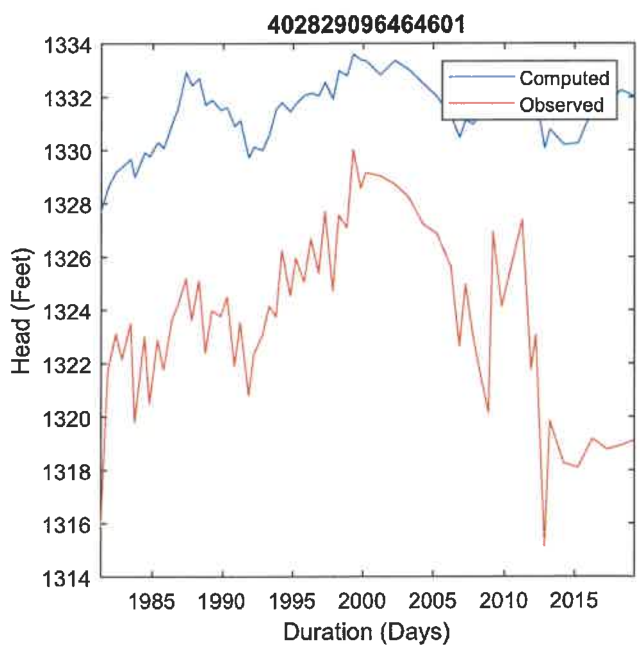
Observed
Head (Feet)
1304
1302
1300
1298
1296
1294
1292
1290
1288
1286
1284
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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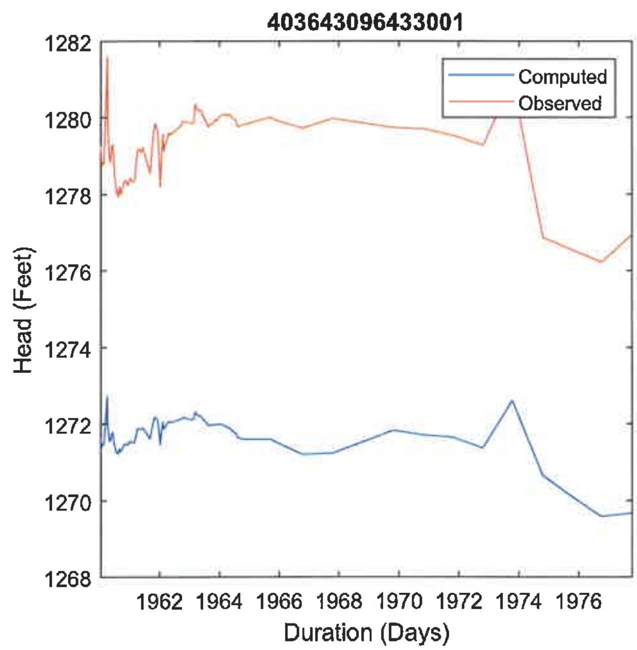
Observed
Head (Feet)
1334
1332
1330
1328
1326
1324
1322
1320
1318
1316
1314
1985
1990
1995
2000
2005
2010
2015
Duration (Days)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Observed
Head (Feet)
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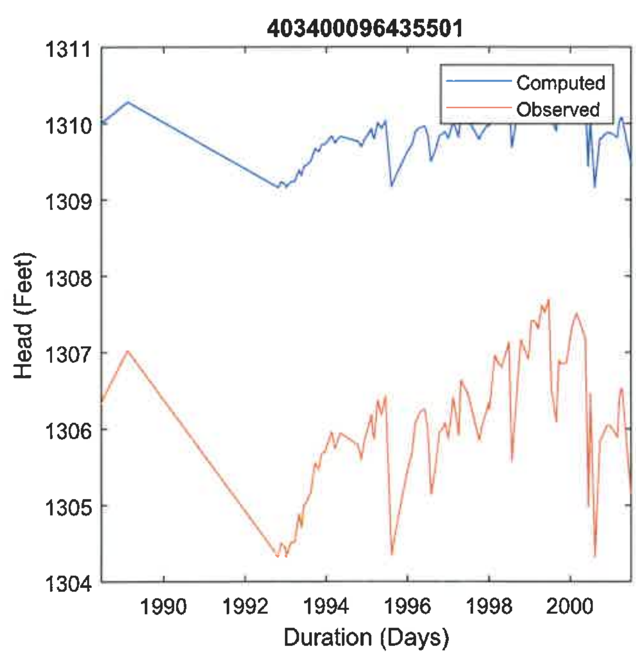
1280
1278
1276
1274
1272
1270
1268
1962 1964 1966 1968 1970 1972 1974 1976
Duration (Days)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Observed
Head (Feet)
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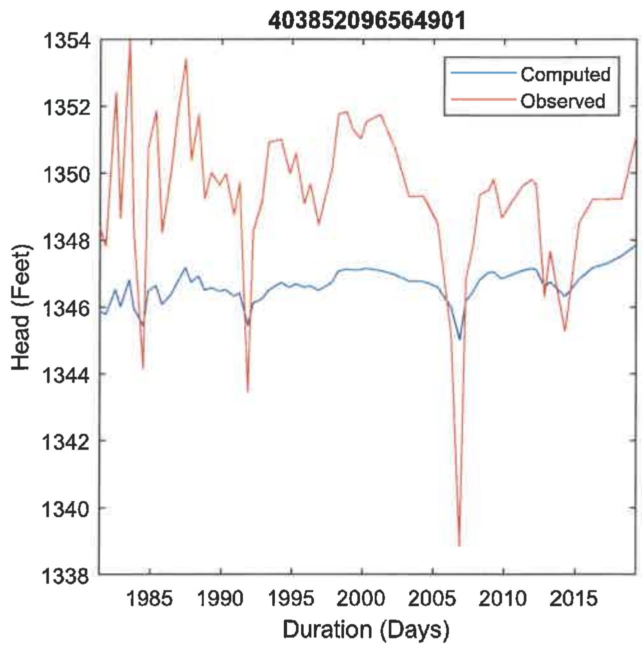
1310
1309
1308
1307
1306
1305
1304
1990 1992 1994 1996 1998 2000
Duration (Days)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Observed
Head (Feet)
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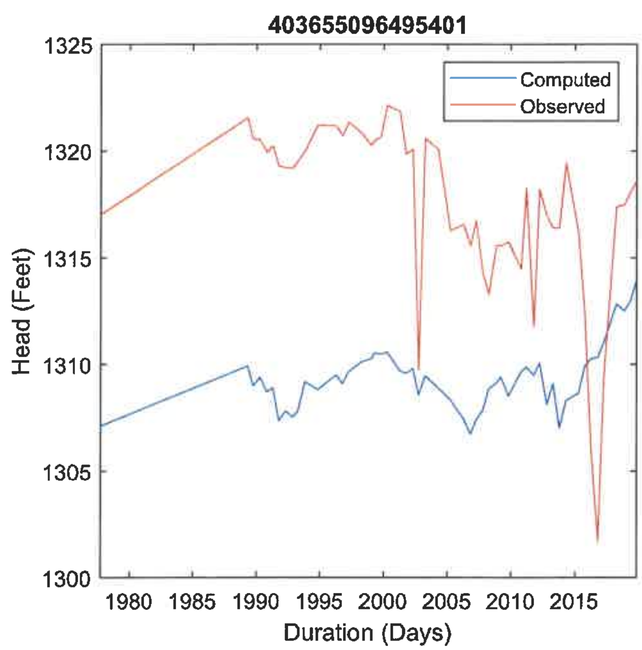
1352
1350
1348
1346
1344
1342
1340
1338
1985 1990 1995 2000 2005 2010 2015
Duration (Days)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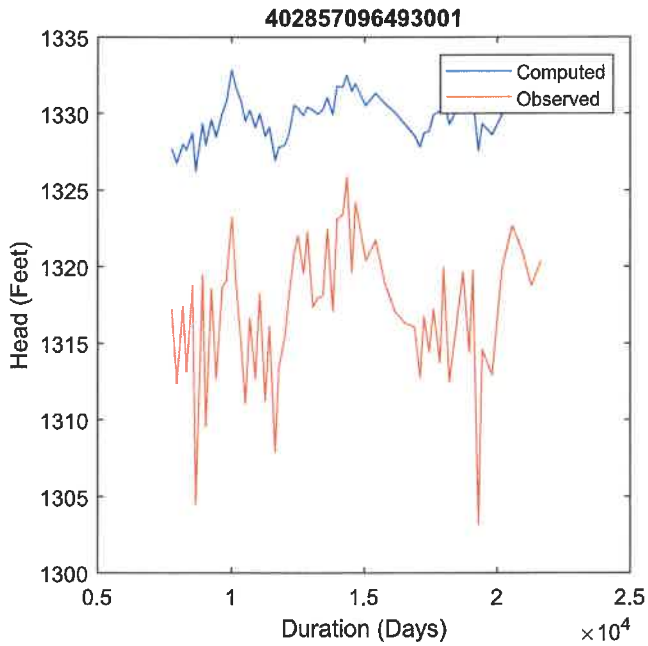
1320
1315
1310
1305
1300
1980 1985 1990 1995 2000 2005 2010 2015
Duration (Days)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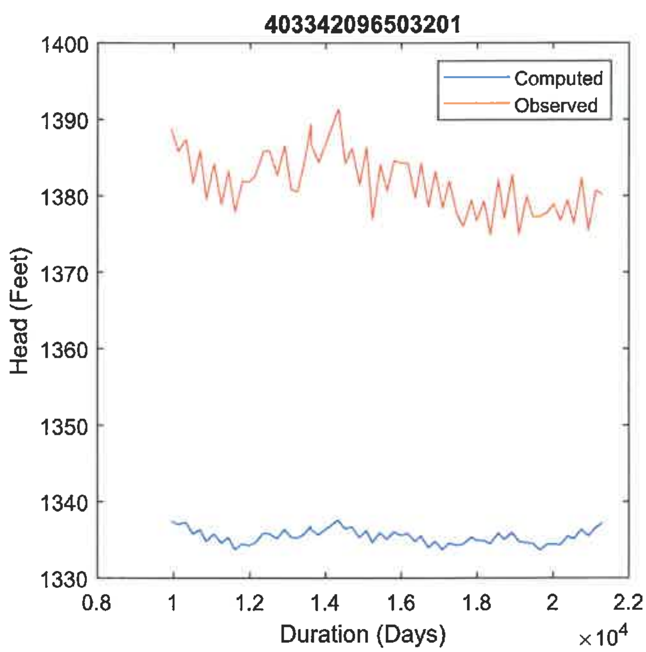
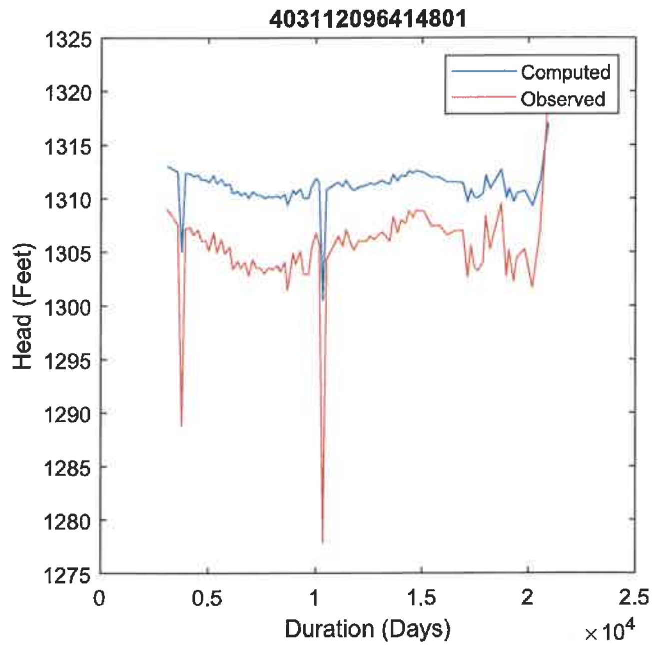
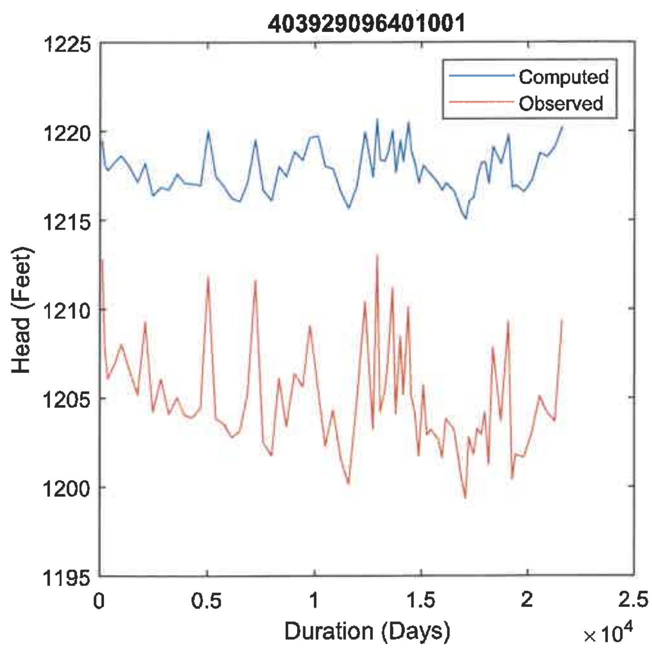
Computed
Observed
Head (Feet)
1335
1330
1325
1320
1315
1310
1305
1300
0.5
1
1.5
2
2.5
Duration (Days)
×10^4


403342096503201
Computed
Observed
Head (Feet)
1400
1390
1380
1370
1360
1350
1340
1330
0.8
1
1.2
1.4
1.6
1.8
2
2.2
Duration (Days)
×10^4



403112096414801
Computed
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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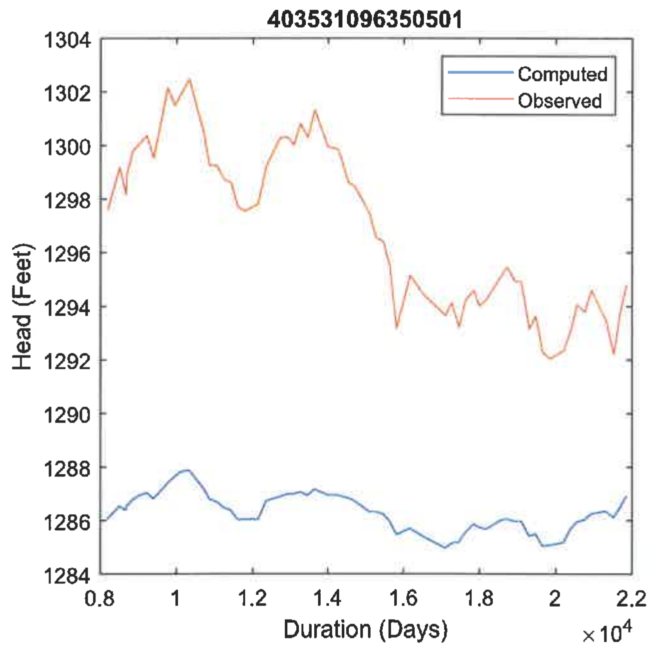
Computed
Observed
Head (Feet)
1225
1220
1215
1210
1205
1200
1195
0
0.5
1
1.5
2
2.5
Duration (Days)
$\times 10^4$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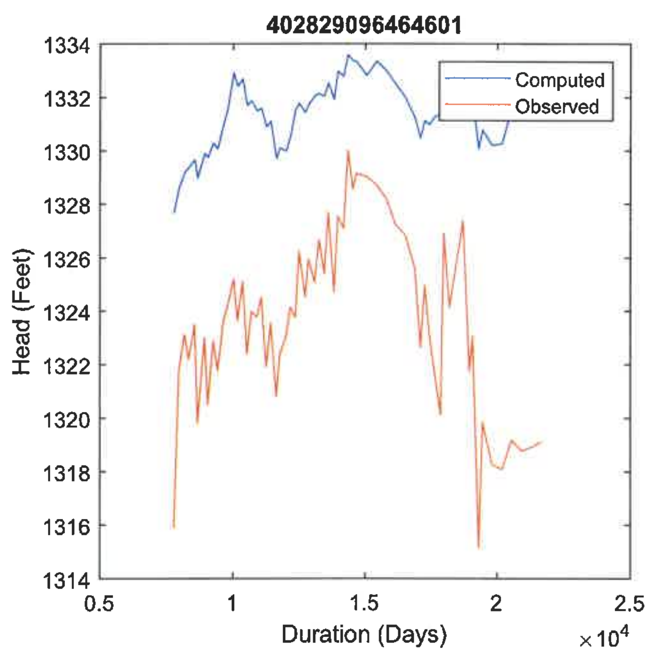
Computed
Observed
Head (Feet)
1304
1302
1300
1298
1296
1294
1292
1290
1288
1286
1284
0.8
1
1.2
1.4
1.6
1.8
2
2.2
Duration (Days)
$\times 10^4$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Computed
Observed
Head (Feet)
1334
1332
1330
1328
1326
1324
1322
1320
1318
1316
1314
0.5
1
1.5
2
2.5
Duration (Days)
$\times 10^4$

Motions

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

March 25, 2021

Amy Ostermeyer
Vice President
Monolith – Lincoln Office
134 S. 13th Street, Suite 700
Lincoln, NE 68508

RE: Monolith Well Permit – additional information

Dear Amy:

Thank you to you and your team for participating in last night's NRD Special Board Meeting. More good discussion and education about the groundwater resources around the Monolith Olive Creek facility.

At the meeting the Board decided that the following additional information is required for the current Monolith Well Permit application. Accordingly, it is necessary and desirable that:

1. The Monolith Application submit a more detailed sensitivity analysis as recommended in LRE Water Review Recommendation 1.
2. The Monolith Application include (1) further gradient analysis of interaction of the CPA aquifer in the area with bedrock aquifers to support its assumption of little or no interaction with bedrock aquifers, (2) the likelihood of gradient reversal to upward flow direction if the further analysis shows downward gradient or little to no interaction. If bedrock well water level measurements do not exist, then identify the basis for any assumption that the gradient is downward or that there is little to no interaction of the CPA aquifer in the area with bedrock aquifers.
3. The Monolith Application include details of any groundwater monitoring plan Monolith intends to develop and implement to address future potential changes in groundwater quality and quantity at the Site and surrounding area. Further, that such details are responsive to changes in groundwater quality (as observed in points 1–3) of the recommendation.
4. The Monolith Application include details of wells and a well interference plan as provided in Recommendation 6 (the area to be considered will be increased from 1.5 miles to 3.0 miles from the site).
5. That Monolith provide additional information on (1) the use of future climate in the Monolith Hydrogeologic Analysis, and (2) the general effect of future climate on the CPA aquifer, and

6. That Monolith provide additional information on the potential for upwelling in the immediate vicinity (as that term is used on p. 57) of the Monolith well over the 50-year period of its future scenario.

Several of those items listed refer to the Recommendations of LRE Water and their review of the Monolith Materials Inc. Groundwater Flow Model, please let me know if you need a copy of that review or have other questions. Please provide me with a draft of the additional information you plan to provide so I can have LRE Water and others review your proposed response.

Sincerely,

Paul D. Zillig
General Manager

PDZ/pz

Addendum

MONOLITH HYDROGEOLOGIC ANALYSIS REPORT

Addendum

Prepared for:

Monolith Materials
Hallam, Nebraska

Prepared by:

Olsson, Inc.
Lincoln, Nebraska

April 2021
Olsson Project No. 020-2639

olsson®

TABLE OF CONTENTS

Summary 1
1. Purpose 3
2. Recommendations from LRE Water 3
3. Motions from the LPSNRD Board Of Directors 7
4. Wellfield Scenarios 11
5. References 19

LIST OF FIGURES

Figure 1 The difference in simulated water levels at well G-073007 (Hallam municipal well) when hydraulic conductivity in Layers 1 and 3 are reduced by a factor of 10. 4
Figure 2 Water level in well G-073007 (Hallam municipal well) over the 50-year Future Model simulation 10
Figure 3 Water level change after 50 years under the 320 MGY (Scenario A) simulation 13
Figure 4 Water level change after 50 years under the 400 MGY (Scenario B) simulation 14
Figure 5 Predicted drawdown at Hallam's municipal wells after 50 years under Scenario B. 16
Figure 6 Pumping rate at the Monolith site in Scenario C overlaid on the pumping rate from the future scenario in the Report. 17
Figure 7 Drawdown in feet and the difference between the original future scenario and Scenario C at a Hallam municipal well. 18

LIST OF TABLES

Table 1 The cumulative water budget for the future model simulation scenarios in acre-feet per year 15

APPENDICES

Appendix A Groundwater Monitoring Plan
Appendix B Groundwater Protection Plan

SUMMARY

This addendum includes further analysis and clarification of the results summarized in the *Monolith Hydrogeologic Analysis Report* (Report). The Report was prepared pursuant to the Lower Platte South Natural Resources Districts (LPSNRD) Rules and Regulations governing well permits. The proposed water use for Monolith requires a Class 2 Permit because Monolith will require more than 250 acre-feet per year of water to support their manufacturing process. A Class 2 permit requires "[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." The LPSNRD Rules and Regulations further stipulate that for a Class 2 Permit (in addition to the other requirements) the "application for a permit … *shall be granted* unless *the district finds* … [t]he hydrogeologic analysis indicates potential short or long-term detrimental effects to the aquifer …(emphasis added)."

The LPSNRD also has a Groundwater Management Plan (Plan), which states "[t]he dependency of water users in the LPSNRD on a sufficient supply of good quality water now and in the future has spurred the Board of Directors to adopt a policy of proactive groundwater management." The Plan further outlined that [t]he LPSNRD has designated areas of management for both groundwater quality and quantity [and] has established a limit "trigger" to the amount of contamination or decline *that is allowed* …(emphasis added)." The first trigger for the Crete-Princeton-Adams (CPA) Aquifer is defined as:

> *… 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, 0% of the monitoring network wells in the CPA aquifer have declined by more than 8% of their saturated thickness for two consecutive years. As documented in the Report, the maximum impact to the existing monitoring well network due to the Monolith water use would be that two of the monitoring wells could experience an 8% decline over the next 50 years. However, that is only 7% of the monitoring wells in the network, falling well short of the 30% required to meet the first management trigger. Therefore, based on the policies and rules of the LPSNRD, the proposed Monolith water use should be allowed.

The LPSNRD contracted with LRE Water to provide a peer review of the groundwater model (Model) developed as part of the Monolith Hydrogeologic Analysis. Following the review of the draft report LRE Water has issued their report titled *Review of the Monolith Materials Inc. Groundwater Flow Model.* Notably, the LRE Water report contains the following conclusions:

> *Conclusion #1: The Model calibration to observed groundwater level data is adequate to meet the objectives based on our modeling experience.*
>
> *Conclusion #5: The model also reasonably represents regional drawdown in the CPA aquifer due to the Monolith Well …*
>
> *Conclusion #6: The assumptions included … into Olsson's Future Model are adequate for reasonably reliable drawdown predictions.*

The report also contains six recommendations that we address in Section 2 below.

In addition, the LPSNRD held a special board meeting on 3/24/2021 to discuss any additional information that they would like Monolith to submit with their final well permit application. Six items were identified and those are addressed in Section 3 below. To prevent confusion, and because none of these recommendations or requests result in any change to the conclusion of the Report, the draft Report has been finalized as it was submitted on December 8, 2020, and all additional requests for information are contained in this addendum.

1. PURPOSE

This addendum includes further detail and analysis of the results summarized in the *Monolith Hydrogeologic Analysis Report* (Report). Following the review of the draft Report, six recommendations were made by LRE Water in their report titled *Review of the Monolith Materials Inc. Groundwater Flow Model* (LRE Report). In addition, during a special board meeting of the LPSNRD on March 24, 2020, the board approved six motions requesting additional information or clarification. The purpose of this addendum is to address these recommendations and requests. It is intended that this document be used in conjunction with the main Report.

2. RECOMMENDATIONS FROM LRE WATER

LRE Water was retained by the Lower Platte South Natural Resources District (LPSNRD) to complete a peer-review and evaluation of the groundwater flow model and accompanying hydrogeologic analysis report. Their findings were summarized and provided to Monolith Materials, Inc. (Monolith). Included in the LRE Report were the six recommendations outlined below. Accompanying the recommendations are responses to each along with supporting information.

2.1 Recommendation 1: Complete a more detailed sensitivity analysis on the following:

a) scale of the hydraulic conductivity in model layers 1 and 3; b) horizontal/vertical hydraulic conductivity ratio in all layers.

The distribution of hydraulic conductivity in the final model was determined based on a parameter estimation routine. The primary purpose of the parameter estimation was to find the spatial distribution of hydraulic conductivity in model layers 2 and 4, the layers representing the aquifer materials. The horizontal hydraulic conductivity was initially specified at a spatially constant 10 ft/day for layers 1 and 3. Initially, the parameter estimation routine was allowed to vary the horizontal hydraulic conductivity of that constant value in layers 1 and 3, however it was found that the model was not sensitive to these parameters.

From the standpoint of the impact of groundwater use in the CPA aquifer, the important question regarding the hydraulic conductivity in layers 1 and 3 is whether the assumed values in the groundwater model are too high, and if assumed values were decreased, what impact would that have on modeled water levels in the CPA aquifer. To answer this question, the future model simulation (the baseline future model scenario with the addition of Monolith pumping) was rerun with hydraulic conductivity values for layers 1 and 3 reduced by an order of magnitude to assess model sensitivity to changes in hydraulic conductivity of these layers. The calibrated groundwater model used values of 10 feet/day and 1 foot/day for the horizontal and vertical hydraulic conductivity, respectively. So, the new simulation was changed so that horizontal and vertical hydraulic conductivity were reduced to 1 foot per day and 0.1 feet per day, respectively. This approach allows for a comparison between the impact of the addition of the Monolith water use to this reduction in hydraulic conductivity in Layers 1 and 3 (see Figure 1).

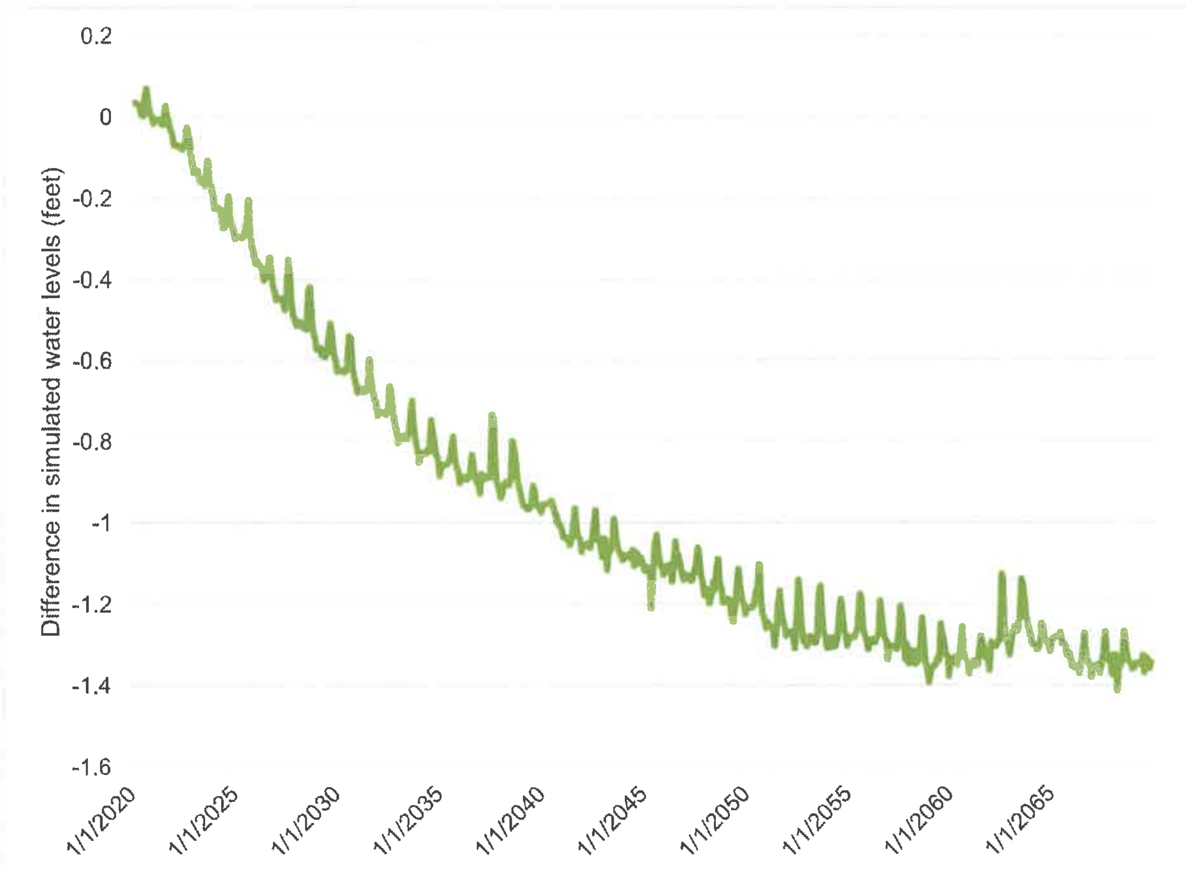


Figure 1 The difference in simulated water levels at well G-073007 (Hallam municipal well) when hydraulic conductivity in Layers 1 and 3 are reduced by a factor of 10.

The difference starts at zero because the starting heads for each simulation are the same, then it very slowly (over the first 25 years) increases to about one foot before stabilizing at around 1.25 feet. In other words, when this difference is compared to the predicted impact at this well due to the addition of the Monolith water use (which is approximately three feet, see Report Figure 4.5) its magnitude is only half despite the dramatic decrease in hydraulic conductivity for layers 1 and 3 in the model. This demonstrates the fact that simulated water levels in for the

CPA aquifer in the Monolith groundwater model are very insensitive to the specified hydraulic conductivity in Layers 1 and 3.

As for the second recommendation, to review the model sensitivity to the ratio of horizontal to vertical hydraulic conductivity in all layers, the construction of the model was conservative in that the vertical hydraulic conductivity is less than the horizontal hydraulic conductivity by a factor of ten in all layers. Standard values for this ratio range from three to ten, and any assumption of a lower ratio than ten would likely result in a slightly lower water level response to changes in stress in the CPA aquifer in the Monolith model. There is no evidence to support a value for this ratio of larger than ten. Given this, and the results summarized above that looked at reducing both the horizontal and vertical hydraulic conductivity layers 1 and 3 (the non-aquifer layers), the sensitivity of the model to the ratio of horizontal to vertical hydraulic conductivity is low and any realistic changes to this assumption would only lessen the predicted impact of added withdrawals on the CPA aquifer.

2.2 Recommendation 2: Provide an addendum with directions for exact replication of future drawdown simulations presented by model results.

The future drawdown scenario was constructed by using the calibration period model (1960-2019) as the basis. For exact replication of the future scenarios presented in the Report, the following steps should be taken:

1. All model files, with the exception of the WEL file, were built by repeating the calibration model data from 1995-2019 for a 50-year simulation.
2. The WEL file was made by using the certified irrigated acres spatial dataset provided by the LPSNRD and assigning a theoretical pumping demand per acre to each parcel. Because the certified acres dataset was only available in the LPSNRD, two methodologies were employed to fill in pumping data across the model area.
    a. Within the LPSNRD, the pumping demand per acre was calculated by summing the monthly pumped volume in a given calibration model stress period and dividing it by the total number of active certified irrigated acres. The demand per acre was then used in conjunction with the certified acres from 2019 to hold constant the current level of development.
    b. Outside of the LPSNRD, the most recent irrigated acres dataset available is the 2013 land use from the Lower Platte-Missouri Tributaries (LPMT) regional groundwater model. The same monthly pumping demand per

acre used within the LPSNRD was applied to the 2013 LPMT groundwater irrigated acres to simulate pumping outside of the LPSNRD.

3. Municipal and industrial pumping from the calibration model period 1995-2019 was repeated and added to the WEL file for the future pumping scenario.
4. To represent the Monolith pumping, a well was added to the model at the approximate location of the Monolith site. The pumping schedule for the Monolith well was determined using historical temperature data and operational design data from Monolith. The daily temperature record from 1995-2019 documented by a weather station near Crete (named CRETE 4 ESE, NE US) was downloaded from the High Plains Regional Climate Center website. Combined with the design data supplied by Monolith, a 25-year pumping schedule was developed and repeated for the full 50-year future scenario model.

2.3 Recommendation 3: Less model refinement or discretization for ease of use.

This recommendation will be considered for any future applications.

2.4 Recommendation 4: Better characterize the gradient between the bedrock units and the CPA aquifer in the area.

While there is no known data regarding water levels in the bedrock aquifer underlying the CPA aquifer, an assessment of the interaction between the bedrock aquifer and the CPA aquifer can be made utilizing the Lower-Platte Missouri Tributaries (LPMT) groundwater model. As documented in the report on the LPMT groundwater model titled *Groundwater Model for the Central and Northern Parts of the Lower Platte River and Missouri River Tributary Basins*, the gradient between the bedrock aquifer and the principal aquifer (including the CPA aquifer) is generally upward across the majority of eastern Nebraska (NDNR 2018). Detailed analysis of the LPMT model in the area covered by the CPA aquifer in Lancaster County reveals the bedrock aquifer is constantly discharging to the CPA aquifer at a rate of approximately 27 acre-feet per month, or 0.054 inches per year.

2.5 Recommendation 5: Develop a groundwater monitoring plan.

See the monitoring plan attached to this addendum as Appendix A.

2.6 Recommendation 6: Identify and document details on all private and public supply wells within 1 ½ miles of the pumping site. Provide a well interference contingency plan.

See the well protection plan attached to this addendum as Appendix B.

3. MOTIONS FROM THE LPSNRD BOARD OF DIRECTORS

3.1 Motion 1: The Monolith Application submit a more detailed sensitivity analysis as recommended in LRE Water Review Recommendation 1.

See section 2.1.

3.2 Motion 2: The Monolith Application include (1) further analysis of interaction of the CPA aquifer in the area with bedrock aquifer to support its assertion of little or no interaction with bedrock aquifers, (2) the likelihood of gradient reversal to upward flow direction if the further analysis shows downward gradient or little to no interaction.

Section 2.1.3 of the Hydrogeologic Analysis Report describes the geology of the area and Figure 2.3 presents the bedrock map of the area. As described in Section 2.4, the bedrock aquifer generally discharges to the principal aquifer across most of eastern Nebraska, as is the case for the CPA aquifer based on the results of the LPMT groundwater modeling (NDNR 2018). However, the rate of discharge appears to be extremely low (0.054 inches per year on average). The report on the LPMT groundwater model states: "As expected, the overall rates of groundwater flow in the bedrock units are much smaller than in the principal aquifer." Therefore, it is highly unlikely that there would be any significant increase in the rate of discharge, given the "sluggish" flow rates within the bedrock aquifer that would control the availability of water from the bedrock aquifer. Moreover, given the extremely low current rate of discharge, even a relatively large percentage increase in the upward flow of water from the bedrock aquifer to the CPA aquifer would not result in a significantly large amount of additional upward flow.

3.3 Motion 3: The Monolith Application include details of any groundwater monitoring plan Monolith intends to develop and implement to address future potential changes in groundwater quality and quantity at the Site and surround area.

See the monitoring plan attached to this addendum as Appendix A.

3.4 Motion 4: The Monolith Application include details of wells and a well interference plan as provided in Recommendation 6 (the area to be considered will be increased from 1.5 miles to 3.0 miles from the site).

See the well protection plan attached to this addendum as Appendix B.

3.5 Motion 5: That Monolith provide additional information on (1) the use of future climate in the Monolith Hydrogeologic Analysis, and (2) the general effect of future climate on the CPA aquifer.

Actual future climate in eastern Nebraska is inherently unknowable. However, it is generally recognized in water resources management that a recent period of climate is most representative of the potential future climate conditions. Also, it has been documented by the Nebraska Department of Natural Resources that a 25-year period of climate conditions provides for a representative period of wet, normal, and dry years. Therefore, the Future Model for the Monolith hydrogeologic analysis was set up using the climate conditions experienced during 1995-2019. The model started at the beginning of 2020 with the modeled water levels from the end of 2019 from the historic calibration model. As noted above, the LRE Water Review supported the use of the Future Model for the purpose of predicting the likely drawdown that would result from Monoliths water use.

As for the general effect of future climate on the CPA aquifer, water levels are likely to fluctuate somewhat based on the occurrence of wet and dry periods. See for example Figure 2, which is a plot of the predicted water levels in well G-073007 (one of the water supply wells for the Village of Hallam). The 25-year climate pattern has periods of water level increases and decreases, with the water level ending up being about three feet higher after 50 years. Moreover, the dips in water levels representing the dry periods are more than made up for by subsequent wet periods, so that during the second two periods of drought (occurring around 2057 and 2065), water levels bottom out at levels that are higher than the low water levels experienced during the first two periods of drought (occurring around 2032 and 2040). While not shown on Figure 2, these first two low water levels simulated in the Future Model are greater than the water level lows experienced during the actual years these droughts represent (around 2004 and 2012).

The reason for the general upward trend in water levels in the historic and future models is the general upward trend in precipitation being experienced in eastern Nebraska and much of the northern Midwest. In fact, the six-year period between 2014 and 2019 is generally the wettest six-year period experienced in eastern Nebraska in 120 years of climatic records. This is consistent with the general predictions that come from global climate circulation models, which predict that eastern Nebraska is likely to experience greater precipitation into the future.

The actual water level variability that will be experienced in the CPA aquifer may not turn out to be as optimistic as the model prediction contained in Figure 2. However, that does not change the predicted impact of the Monolith water use on the CPA aquifer, as that prediction does not depend on a certain climate pattern. This is because the prediction of the Monolith water use impact is done by subtracting the results in one model run (without the Monolith water use) from another model run (with the Monolith water use), thereby canceling out the underlying climate pattern (assuming the model behaves linearly, which it appears to do) and isolating the predicted impact of the Monolith water use on the CPA aquifer. As discussed in Section 1, this impact is not expected to cause the CPA aquifer to be "triggered" into being a Phase 2 management area, because it is not expected to cause more than an 8% decline in saturated thickness in 30% or more of the monitoring wells in the CPA aquifer. However, if a prolonged dry period should occur in the future, the groundwater management triggers may be reached due to reduced recharge. If this should occur, the aquifer would enter Phase 2 management would be triggered and all existing water users would share in needed reductions in water use under the correlative rights doctrine which governs groundwater management in Nebraska.

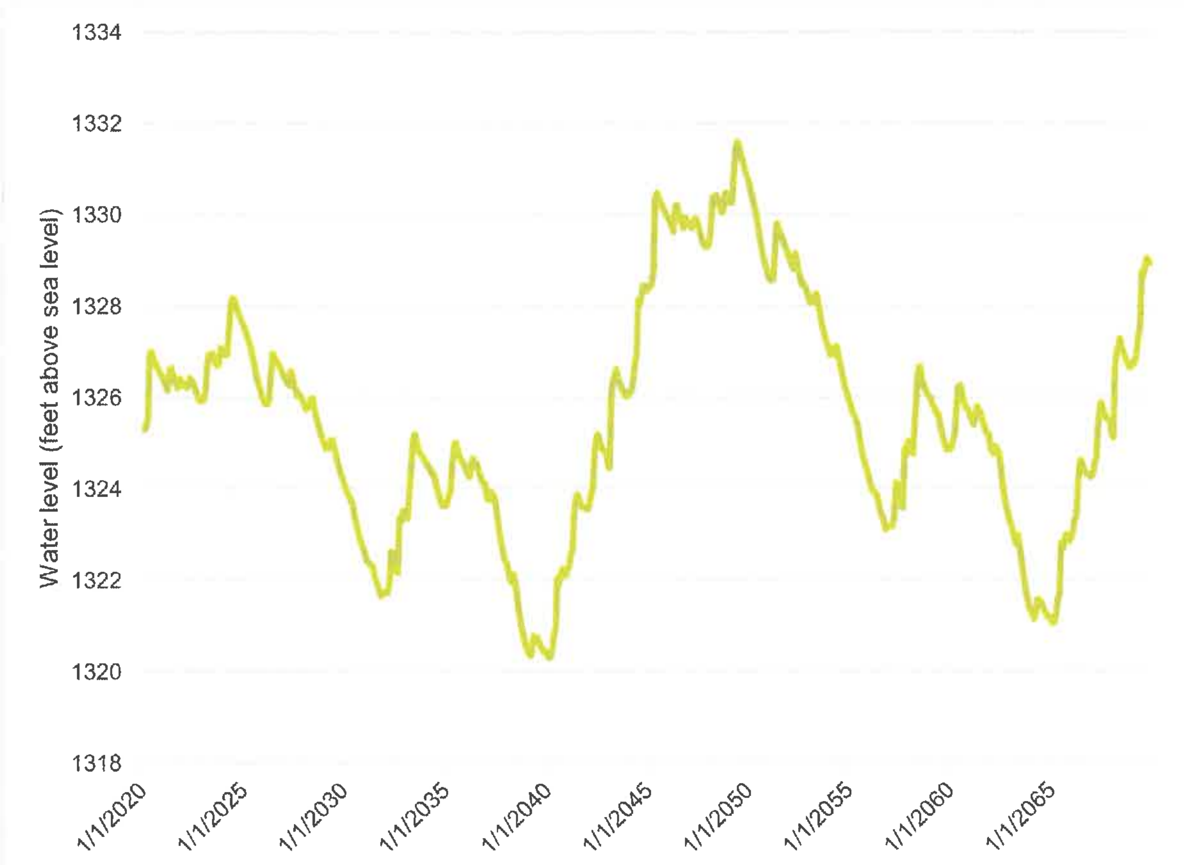


Figure 2 Water level in well G-073007 (Hallam municipal well) over the 50-year Future Model simulation.

3.6 Motion 6: That Monolith provide additional information on the potential for upwelling in the immediate vicinity (as that term is used on page 57 [of the Monolith Hydrogeologic Report]) of the Monolith well over the 50-period of its future scenario.

The Monolith Hydrogeologic Analysis Report states on page 57:

> *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.*

In the Monolith Future Model, a decline of 8.5 feet is experienced in the model cell that contains the well simulating Monolith's water use. Groundwater model cells are 165 feet by 165 feet (or approximately 0.6 acres) in the area of the Monolith site. This model cell (along with many surrounding cells) is wholly contained within the property on which Monolith intends to construct its Olive Creek 2 manufacturing facility. Given the extremely limited spatial extent of the area in the "immediate vicinity" of the Monolith well, and for the reasons described in Sections 2.4 and 3.2, this level of drawdown is not expected to cause new upwelling of water from the bedrock aquifer to the principal aquifer.

4. WELLFIELD SCENARIOS

Monolith anticipates annual water usage between 320-400 million gallons per year during the operation of Olive Creek 2. An estimated 30 million gallons or less will be used in total for construction purposes of the Olive Creek 2 facility between the start of construction and an anticipated completion date of Q1 2024. Following construction, most of the water will be used for cooling of equipment, and usage will vary depending on ambient conditions and plant production level. Ambient temperature and humidity factor into the cooling water usage at the plant. Higher temperatures will require more water to keep equipment cool, so water usage will vary between day and night, and through the year as temperatures change with the seasons. If the plant is operating at a production level that uses 700 gallons per minute (gpm) during the day in Spring, the same production level could use 1,100 gpm during the hottest mid-day temperatures in summer or 500 gpm in the middle of winter.

While OC2 is designed to operate 12 carbon black reactors simultaneously, the facility will not always operate in this condition. Regular maintenance outages and other operational factors will require reactors to be shut down periodically. With fewer equipment to keep cool, the water usage at the plant will decrease until equipment is restarted.

Considering that ambient conditions and plant operation will vary the water usage at OC2, a service water tank is used to ensure there is always enough water to meet demand. A single well pump supplying this tank at 600 gpm will meet demand in many cases, but a second well supplying 600 gpm will be used to maintain the required level in the service water tank on those hotter days when plant production levels require more water for cooling. A third well is included for redundancy and operational cycling.

To facilitate the permitting of the total of three wells that Monolith will require to operate their facility, three additional future simulations were conducted at the request of the LPSNRD. Scenarios A, B, and C described below simulate varying levels of pumping at one or three locations on the Monolith site.

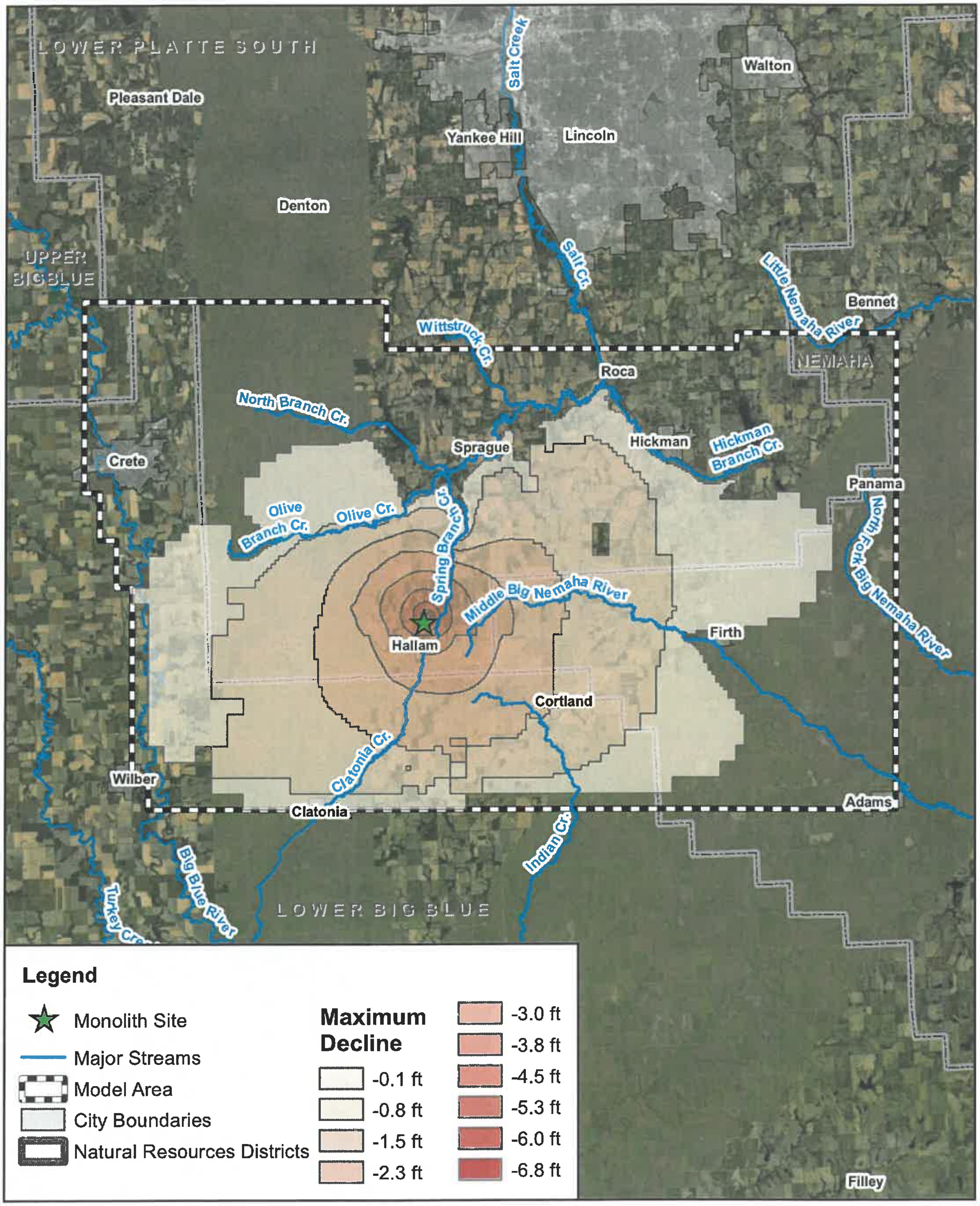
4.1 Future Scenario A

Under Scenario A, 320 million gallons per year was divided evenly between three wells pumping approximately 203 gpm on average. This scenario represents the low end of the operational range Monolith will pump from the wellfield. Drawdown in this scenario is shown in Figure 3.

Maximum drawdown after 50 years reaches about 6.8 feet in the immediate vicinity of the three wells, which is less than the drawdown simulated in the future scenario in the Report (8.5 feet).

4.2 Future Scenario B

In Scenario B, 400 million gallons per year was divided evenly between three wells pumping approximately 254 gpm on average. This scenario represents the highest amount of pumping that Monolith might require from the wellfield. Drawdown in this scenario is shown in Figure 4. Maximum drawdown is slightly greater than in the future scenario included in the Report (8.6 feet versus 8.5 feet). However, the maximum drawdown is experienced in three model cells (the cells that contain the three wells) as opposed to the one model cell experiencing maximum drawdown in the original future scenario with only one well. Visual comparison with the drawdown map in the Report (Figure 3.14) reveals a very similar drawdown pattern and extent. The cumulative water budget for the 50-year simulation period (2020-2069) is presented in Table 1. Model budget terms along with average annual values are shown for both the baseline and Scenario B. To aid in comparison to the future model simulation from the Report, the difference between the baseline scenario and the monolith pumping scenario is displayed for this Scenario B simulation and the simulation in the Report.



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N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Future Declines With Monolith Pumping at Three Wells (320 MGY)
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 3

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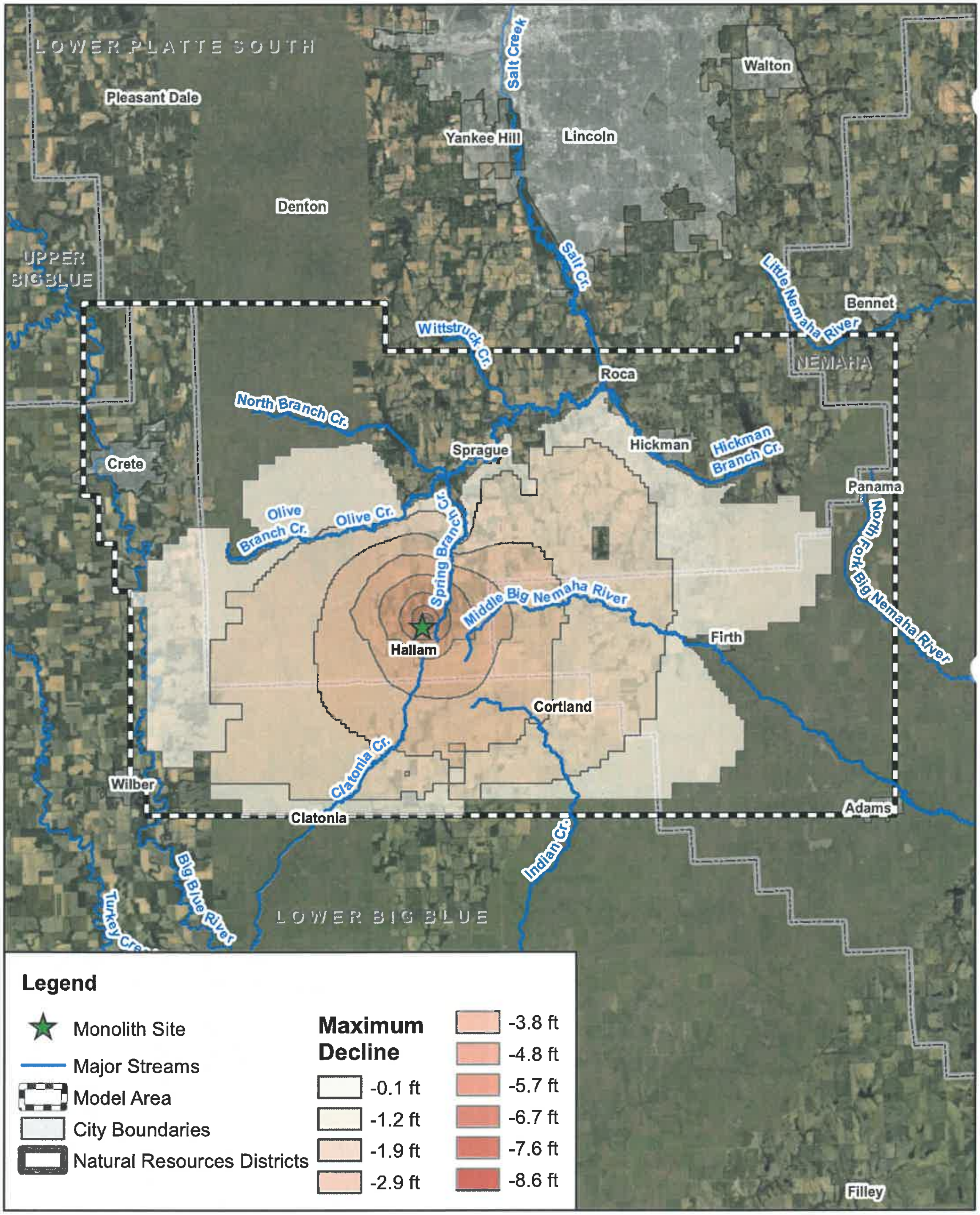

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N

0 1 2 4 Miles

1 in = 4 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Future Declines With Monolith Pumping at Three Wells (400 MGY)
Monolith OC2
Groundwater Modeling Report
Lancaster County, NE

FIGURE 4

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Table 1 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)	Scenario B Value (acre-feet per year)	Difference (acre-feet per year)	Difference from Report (acre-feet per year)
Storage	-1,889	-1,499	-390	-301
Wells	-12,016	-13,246	1230	959
River	-7,452	-7,395	-56	-45
Evapotranspiration	-1,130	-1,124	-6	-4
General Head Boundary	-6,839	-6,638	-201	-157
Recharge	72,309	72,309	0	0
Stream Leakage	-42,983	-42,406	-576	-453
Total (In-Out)	-1	-1	0	0

As the groundwater pumping in Scenario B is approximately 25% greater than the scenario in the Report, the difference between the baseline scenario and the Monolith pumping scenario for the computed budget terms (e.g., storage, baseflow) is also approximately 25% greater.

For comparison of predicted drawdown from the Report, Figure 5 provides the predicted drawdown for the two municipal wells in Hallam for this additional scenario (compare with Figure 4.5 in the Report). The total drawdown after 50 years is approximately 25% greater under this scenario (3.75 feet versus 3 feet). This level of additional drawdown would not change any of the conclusions contained in the Report.

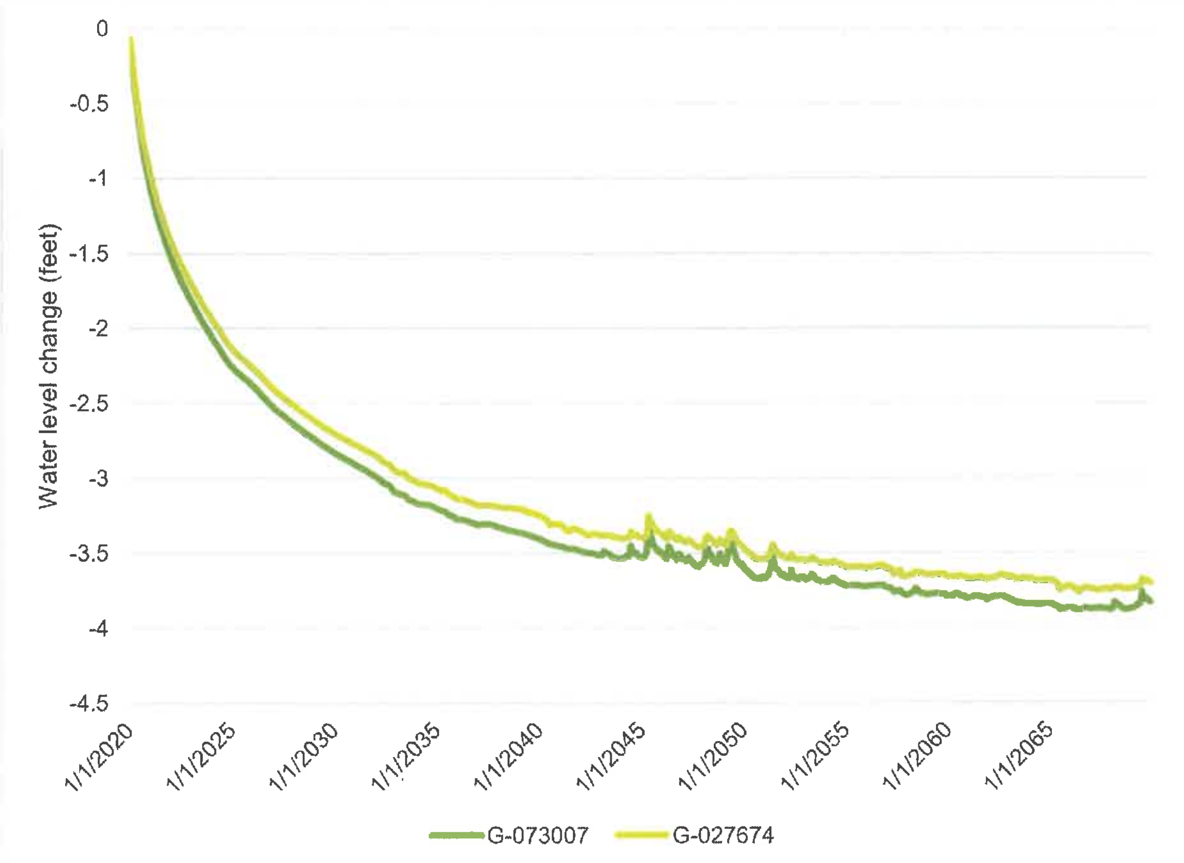


Figure 5 Predicted drawdown at Hallam's municipal wells after 50 years under Scenario B.

4.3 Future Scenario C

Under Scenario C, one well pumping a constant 1200 gpm from April to September for a hypothetical future year was simulated. This scenario is meant to represent an extreme example of the impact of heavy, continued pumping at the Monolith site in the event of a hot summer and does not represent a realistic scenario that Monolith ever intends to operate under. The pumping rate compared to the original pumping rate of the future scenario in the Report is shown in Figure 6.

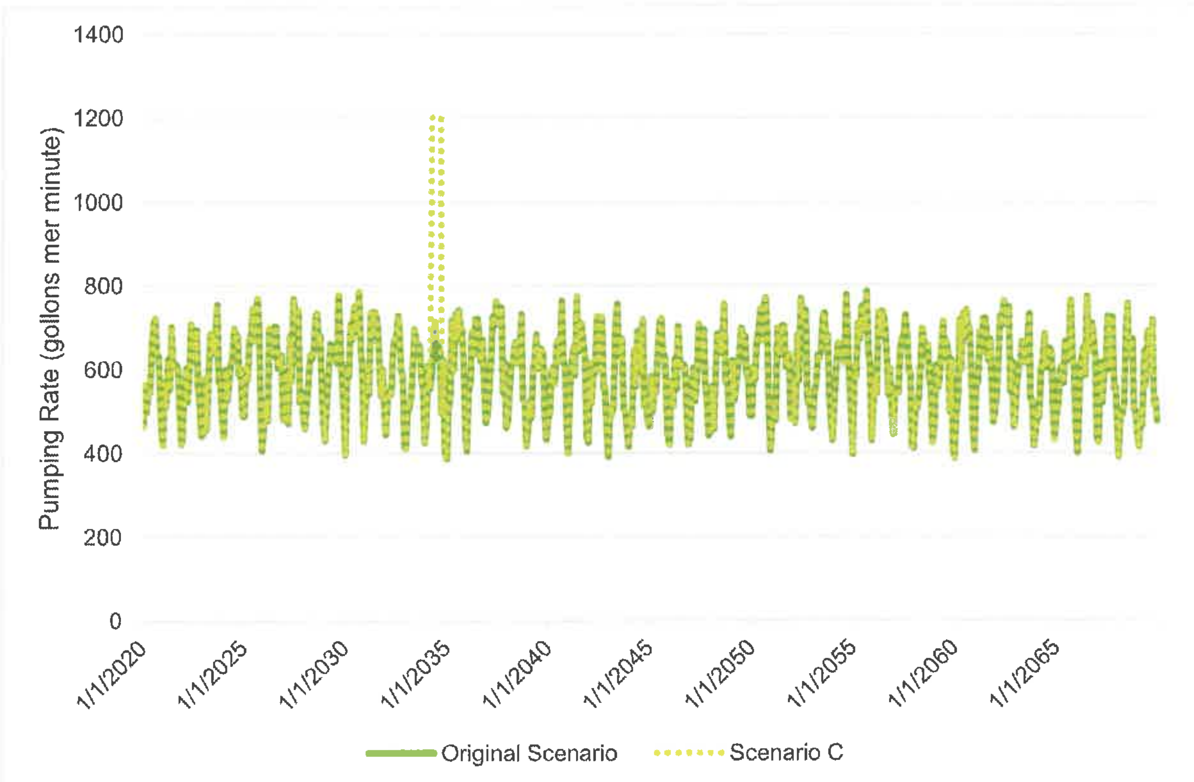


Figure 6 Pumping rate at the Monolith site in Scenario C overlaid on the pumping rate from the future scenario in the Report.

Model results from this modified pumping schedule show an additional 0.5 feet of drawdown at the Hallam municipal well site during the year of increased pumping. Additional drawdown gradually lessens to two inches or less within 18 months of the increased pumping (Figure 7).

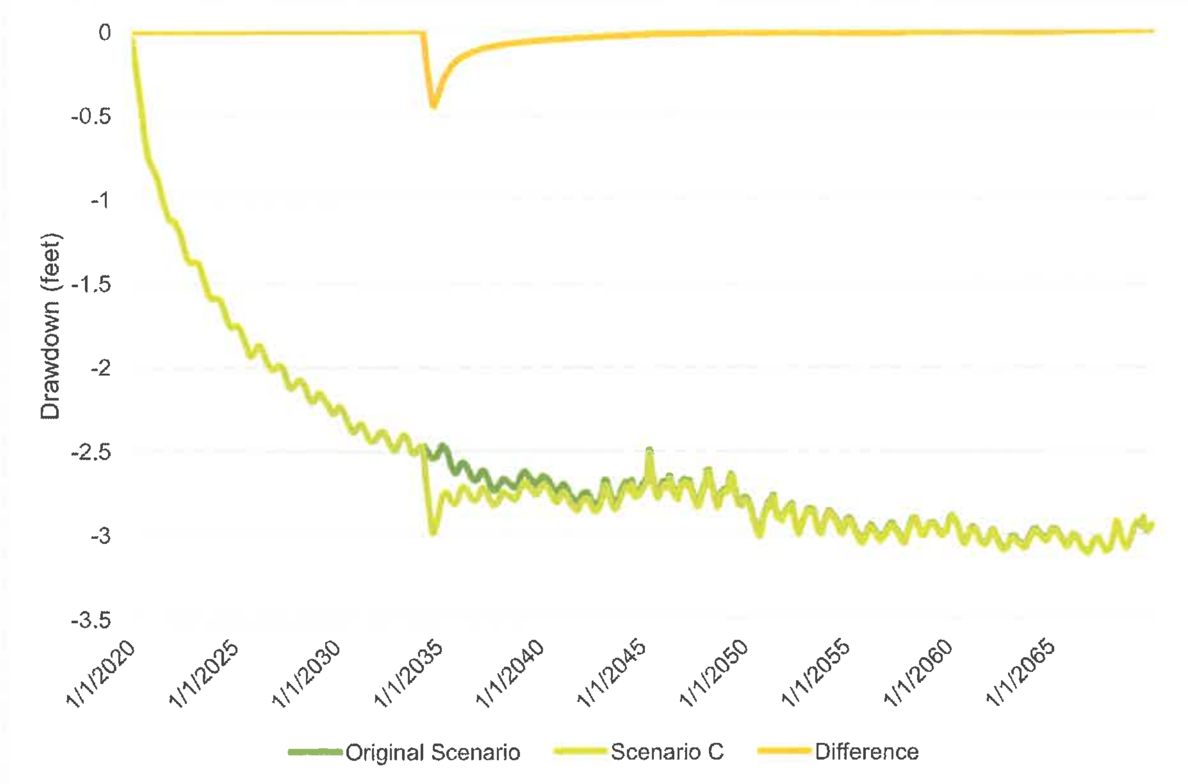


Figure 7 Drawdown in feet and the difference between the original future scenario and Scenario C at a Hallam municipal well.

5. REFERENCES

LRE Water. (2021). “Review of the Monolith Materials Inc. Groundwater Flow Model.” <https://www.lpsnrd.org/sites/default/files/lre_lsp_model_review_feb_23_2021.pdf>

Nebraska Department of Natural Resources (NDNR). (2018). “Groundwater Model for the Central and Northern Parts of the Lower Platte River and Missouri River Tributary Basins.” < https://dnr.nebraska.gov/Lower-Platte-Missouri-Tributaries-Groundwater-Model >

PROFESSIONAL CIVIL ENGINEER
BRIAN P. DUNNIGAN
E-6179
STATE OF NEBRASKA
04/27/2021

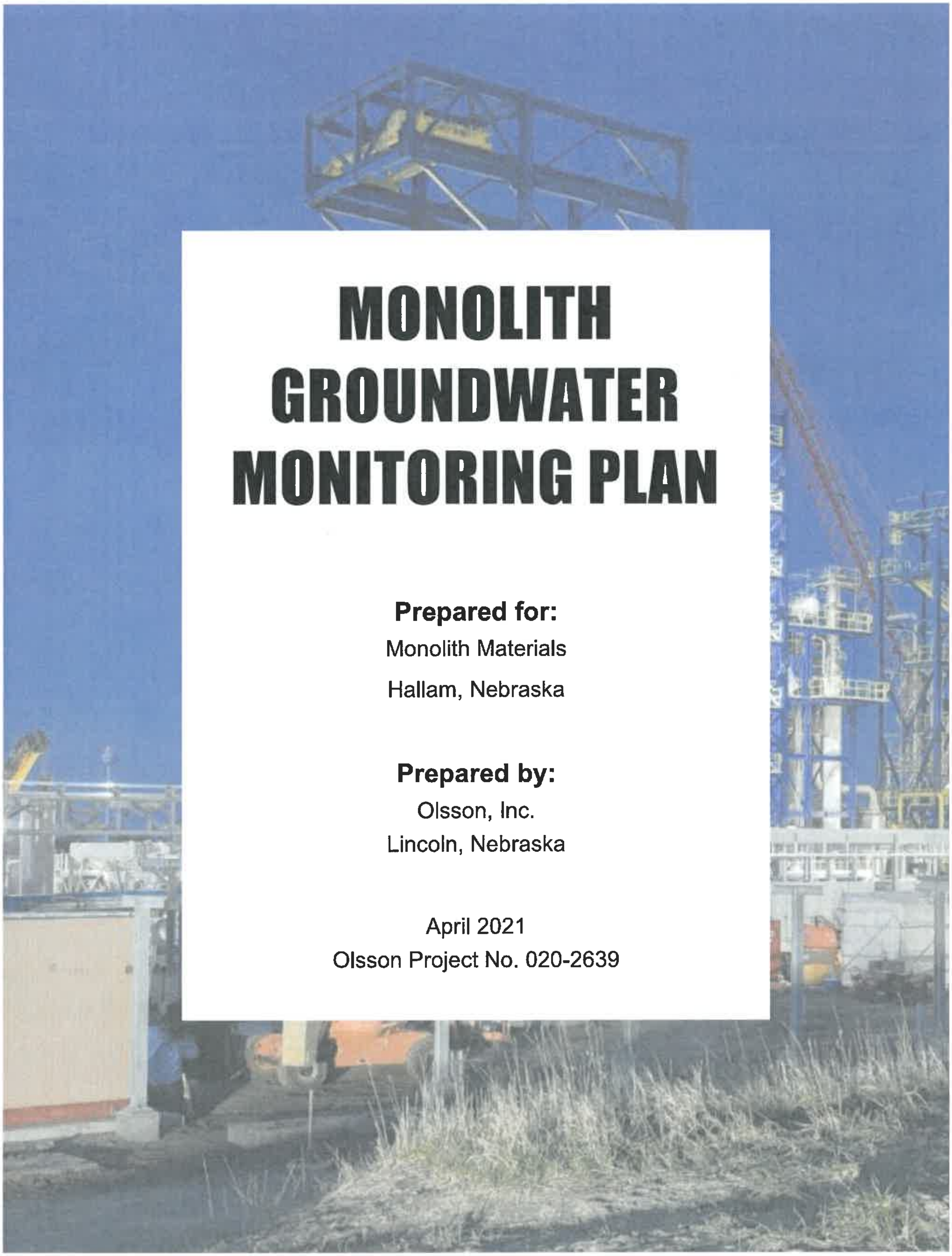
MONOLITH HYDROGEOLOGIC ANALYSIS REPORT - ADDENDUM

Monolith Materials, Hallam, Nebraska

April 2021

Olsson Project No. 020-2639

APPENDIX A
Groundwater Monitoring Plan



MONOLITH GROUNDWATER MONITORING PLAN

Prepared for:

Monolith Materials

Hallam, Nebraska

Prepared by:

Olsson, Inc.

Lincoln, Nebraska

April 2021

Olsson Project No. 020-2639

olsson

TABLE OF CONTENTS

1. Introduction 1
   1.1 Monitoring Area 1
   1.2 Proposed Monitoring Locations 3
2. Monitoring Instrumentation 3
3. References 4

LIST OF FIGURES

Figure 1 Recommended monitoring zones around the Monolith site. 2
Figure 2 A Paige Wireless device coupled with a pressure transducer on a monitoring well in western Nebraska. 3

LIST OF TABLES

Table 1 LPSNRD trigger wells within the 3-mile radius Monitoring Area. (Data provided by the LPSNRD via email communication, October 15, 2020) 1

1. INTRODUCTION

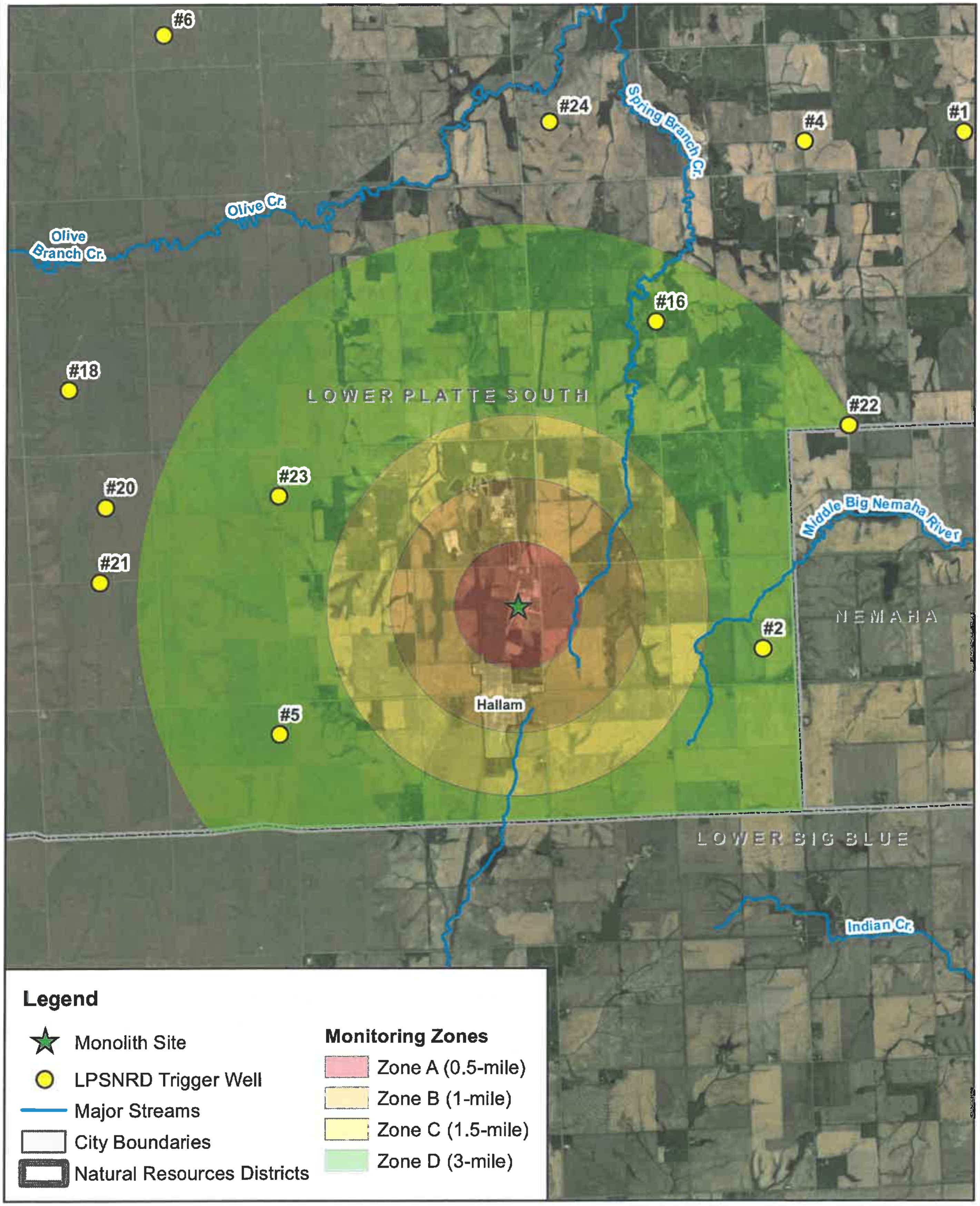
The purpose of this Groundwater Monitoring Plan (Plan) is to outline how Monolith Materials Inc. (Monolith) intends to monitor groundwater levels and water quality in a 3-mile radius of the Monolith site. This Plan proposes the addition of three monitoring wells within specified monitoring zones around the Monolith facility to bolster the existing monitoring network maintained by the Lower Platte South Natural Resources District (LPSNRD). It is anticipated that the Plan will be in place and operational within one year of the granting of the water well permits. The success of this Plan relies on the LPSNRD partnering with Monolith to conduct an annual review of data collected from the monitoring network.

1.1 Monitoring Area

The monitoring area covered by this Plan was established based on the recommendation from the LPSNRD Board of Directors of a 3-mile radius around the Monolith site. Originally recommended by LRE Water in their report titled *Review of the Monolith Materials Inc. Groundwater Flow Model*, the 1.5-mile radius was expanded to a 3-mile radius (see Figure 1). Only the portion of the 3-mile radius within the LPSNRD is considered as part of this Plan. Five wells currently a part of the LPSNRD monitoring network are identified in Figure 1 as "trigger wells" and detailed in Table 1. These five wells (and others) are used in the LPSNRD's Groundwater Management Plan (GMP), as evaluation points to determine what phase of groundwater management the surrounding area is to be held to (LPSNRD 1995).

Table 1 LPSNRD trigger wells within the 3-mile radius Monitoring Area. (Data provided by the LPSNRD via email communication, October 15, 2020)

Trigger Well No.	Registration No.	Well Name	Saturated Thickness (ft)	Lat	Lon
#2	G-048152	Countryside Pivot	194.63	40.542	-96.747
#5	G-143912	Gerlach Irr	113.16	40.534	-96.820
#16	G-131380	Nyhoff MW	253.47	40.579	-96.761
#22	G-070767	Princeton Recorder	268.43	40.567	-96.733
#23	G-131364	Rejcha MW	106.25	40.561	-96.818



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Recommended Monitoring Zones
Monolith OC2
Groundwater Monitoring Plan
Lancaster County, NE

FIGURE 1

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1.2 Proposed Monitoring Locations

The Plan area has been divided into four monitoring zones (A, B, C, and D) which form concentric rings around the Monolith site out to three miles (Figure 1). Upon review of the Plan area, it is evident that Zone D has a good distribution of monitoring locations represented by the LPSNRD's trigger wells. Additional wells would add the most value to the monitoring network if they were placed within zones A, B, and C. It is recommended that three new wells (one per zones A, B, and C) be installed to fill in the monitoring network distribution. The exact placement of these wells will depend on landowner cooperation. The new monitoring well closest to the Monolith site will be a nested well which will provide additional information on any vertical gradients that may exist or form.

2. MONITORING INSTRUMENTATION

Figure 2 A Paige Wireless device coupled with a pressure transducer on a monitoring well in western Nebraska.

Each new monitoring well will be outfitted with a device from Paige Wireless that transmits a water level reading in real-time (Figure 2). The device is combined with a pressure transducer that is dropped down into the well column. Once the monitoring well location is selected, the static water level must be determined to select an appropriate cable length for the pressure transducer. The Paige Wireless device sends the water level reading in 1-hour increments using Long Range Wide Area Network (LoRaWAN) technology. LoRaWAN offers a low cost communications network to send small data packets across miles. The data is stored using cloud computing and accessible through an online platform that will be made available to the LPSNRD. Monolith will be responsible for maintaining the Paige Wireless devices and ensuring collection and review of the data. Wells will be tested for water quality in a manner consistent with the LPSNRD's water quality program. For the first few years of the program, the samples will be collected on a quarterly basis (or on a more frequent basis as specified by the LPSNRD). For water coming into the system at the Olive Creek 2 facility, water will be monitored manually by the operations team. In addition, a water treatment vendor will be identified to periodically sample the influent for water quality to ensure the water treatment processes are appropriately calibrated.

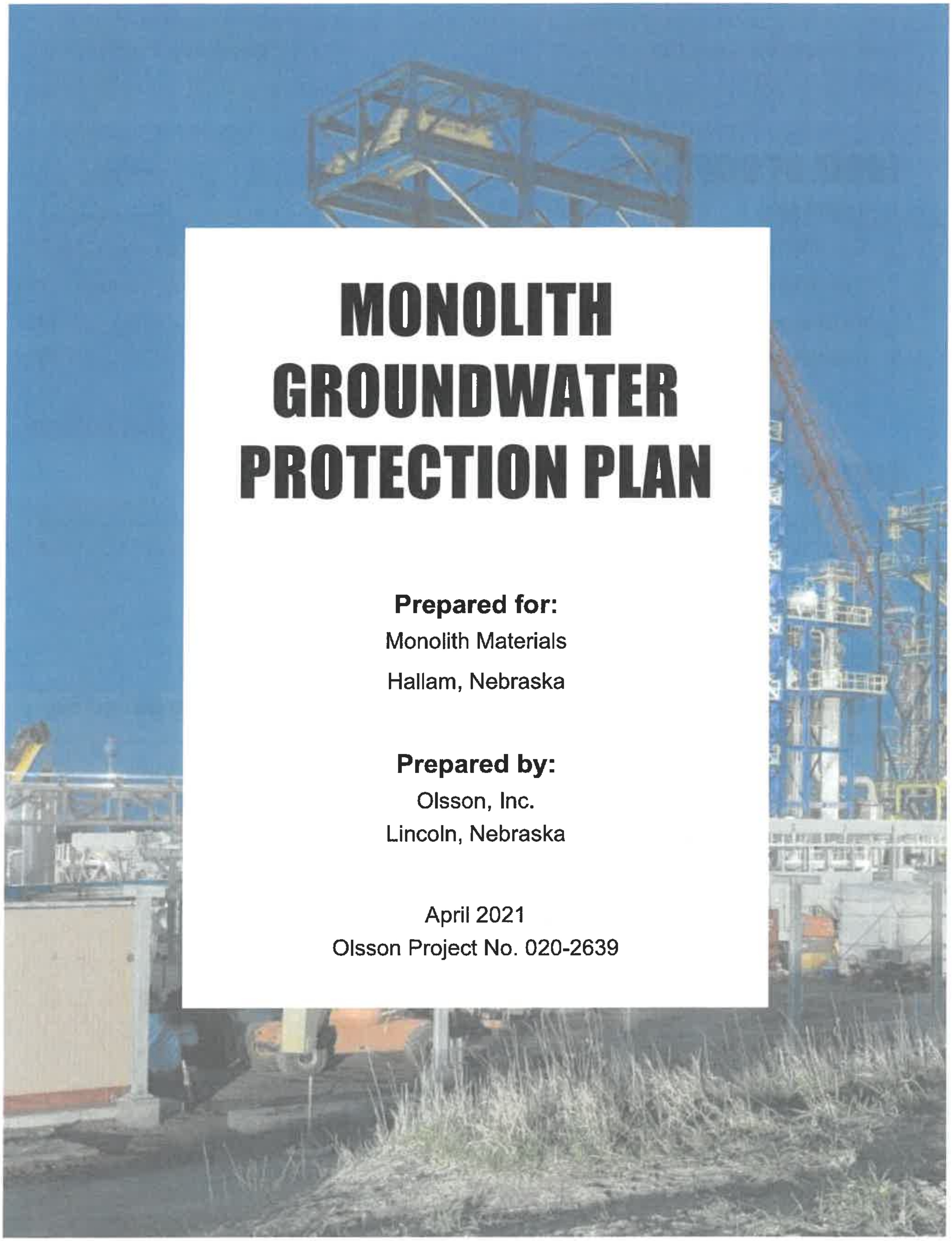
Water level readings (including historic data) from the monitoring network devices will be used to establish a baseline of water levels in the area without Monolith pumping. Once production begins at the Monolith facility, water levels will be compared to the baseline to determine whether changes can be attributed to pumping at Monolith or some other water use. Water level readings at the proposed monitoring wells will be reported annually to the LPSNRD in full transparency.

3. REFERENCES

Lower Platte Natural Resources District (LPSNRD). (1995). "Ground Water Management Plan." < https://www.lpsnrd.org/sites/default/files/files/1/gwmpsummary.pdf >

LRE Water. (2021). "Review of the Monolith Materials Inc. Groundwater Flow Model." <https://www.lpsnrd.org/sites/default/files/lre_lsp_model_review_feb_23_2021.pdf>

APPENDIX B
Groundwater Protection Plan



MONOLITH GROUNDWATER PROTECTION PLAN

Prepared for:

Monolith Materials

Hallam, Nebraska

Prepared by:

Olsson, Inc.

Lincoln, Nebraska

April 2021

Olsson Project No. 020-2639

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TABLE OF CONTENTS

1. Introduction 1
    1.1 Plan Area 1
    1.2 Well Inventory 1
2. Well Protection Response 10
3. References 10

LIST OF FIGURES

Figure 1 Groundwater Protection Plan area surrounding the Monolith site. 2
Figure 2 Plan area including active, registered domestic and irrigation wells. 3

LIST OF TABLES

Table 1 Inventory of active registered domestic and irrigation wells within a 3-mile radius of the Monolith site. (NDNR 2021) 4

ATTACHMENTS

Monolith Well Protection Agreement – Domestic Wells
Monolith Well Protection Agreement – Irrigation Wells

1. INTRODUCTION

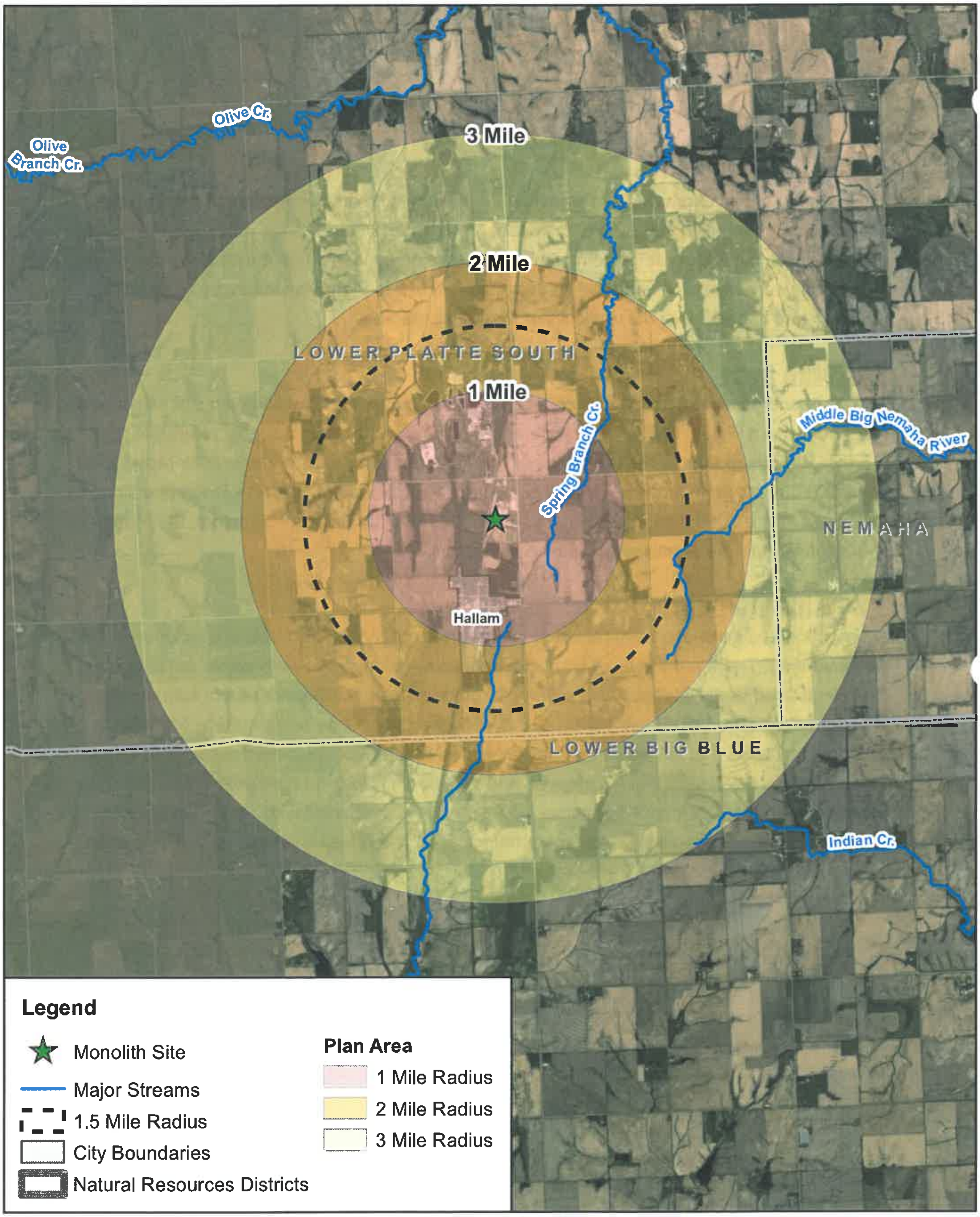
The purpose of this Groundwater Protection Plan (Plan) is to outline the steps Monolith Materials, Inc. (Monolith) will take in the event of well interference issues within a 3-mile radius of the Monolith site. Monolith is committed to addressing concerns that may arise and working with landowners to resolve potential issues. Included in this Plan is an inventory of all active irrigation and domestic supply wells within the Plan area.

1.1 Plan Area

This Plan addresses potential well interference due to pumping at the Monolith site within a 3-mile radius (see Figure 1). Radii of 1-mile and 2-miles are shown as a spatial reference. The 1.5-mile radius represents the area originally recommended by LRE Water in their report titled *Review of the Monolith Materials Inc. Groundwater Flow Model* (LRE 2021). Upon direction from the Lower Platte South Natural Resources District (LPSNRD) Board of Directors, the Plan area was expanded to the 3-mile radius shown in Figure 1.

1.2 Well Inventory

All irrigation and domestic wells registered as active as of March 26, 2021, are included in the well inventory. There are a total of 61 active irrigation and domestic wells within the plan area. The Registered Well Database was retrieved from the Nebraska Department of Natural Resources' website. An annual review of this well inventory will be completed by Monolith to add any new wells that fall within the Plan area (see Figure 2). Information about each well such as static water level, pumping water level, and total depth is included in Table 1. Monolith has initiated the process of identifying active, unregistered wells that fall within the Plan area to establish communication with landowners not included in this well inventory. Monolith's effort will be expanded to include a 3-mile radius.



olsson

N

0 0.25 0.5 1 Miles

1 in = 1 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Plan Area

Monolith OC2

Groundwater Protection Plan

Lancaster County, NE

FIGURE

1

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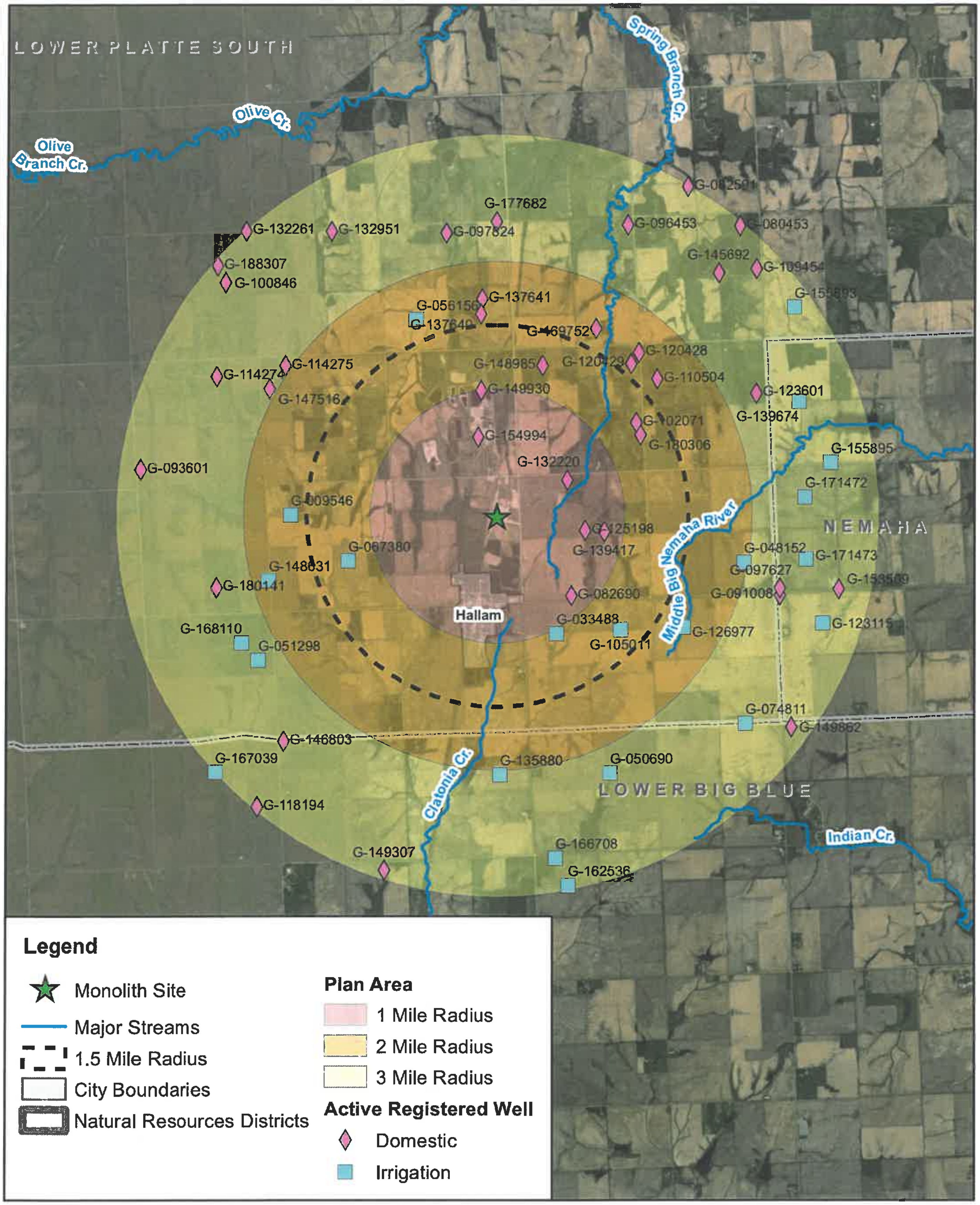

olsson

N

0 0.25 0.5 1 Miles

1 in = 1 miles

NAD 1983 StatePlane Nebraska FIPS 2600 Feet

Well Inventory

Monolith OC2

Groundwater Protection Plan

Lancaster County, NE

FIGURE

2

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Table 1 Inventory of active registered domestic and irrigation wells within a 3-mile radius of the Monolith site. (NDNR 2021)

No.	Reg. No.	Use	NRD	Pump Rate (gpm)	Pump Column Dia. (in)	Pump Depth (ft)	Total Depth (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Lat	Lon
1	G-009546	Irrigation	Lower Platte South	900	8	N/A	310	180	220	40.549	-96.814
2	G-033488	Irrigation	Lower Platte South	1000	8	N/A	282	188	197	40.534	-96.775
3	G-048152	Irrigation	Lower Platte South	900	8	N/A	300	150	190	40.541	-96.747
4	G-050690	Irrigation	Lower Big Blue	750	7	N/A	329	185	300	40.518	-96.768
5	G-051298	Irrigation	Lower Platte South	1200	8	N/A	273	166	194	40.532	-96.820
6	G-056156	Irrigation	Lower Platte South	1500	8	N/A	208	40	140	40.570	-96.795
7	G-067380	Irrigation	Lower Platte South	1280	8	N/A	358	181	190	40.543	-96.806
8	G-074811	Irrigation	Lower Big Blue	800	8	N/A	301	168	200	40.523	-96.748
9	G-080453	Domestic	Lower Platte South	50	5	N/A	141	64	80	40.580	-96.746

No.	Reg. No.	Use	NRD	Pump Rate (gpm)	Pump Column Dia. (in)	Pump Depth (ft)	Total Depth (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Lat	Lon
10	G-082591	Domestic	Lower Platte South	30	6	80	186	38	N/A	40.584	-96.753
11	G-082690	Domestic	Lower Platte South	25	N/A	N/A	303	180	220	40.538	-96.773
12	G-091008	Domestic	Nemaha	22	1	220	282	162	190	40.537	-96.742
13	G-093601	Domestic	Lower Platte South	30	1	80	123	59	80	40.554	-96.837
14	G-096453	Domestic	Lower Platte South	15	4	3	171	50	75	40.580	-96.762
15	G-097627	Domestic	Nemaha	10	1	200	273	158	165	40.538	-96.742
16	G-097824	Domestic	Lower Platte South	18	1	80	107	25	48	40.580	-96.790
17	G-100846	Domestic	Lower Platte South	15	1	140	231	112	115	40.575	-96.823
18	G-102071	Domestic	Lower Platte South	15	1	160	200	115	135	40.558	-96.762
19	G-105011	Irrigation	Lower Platte South	1200	8	240	304	179	204	40.534	-96.766

No.	Reg. No.	Use	NRD	Pump Rate (gpm)	Pump Column Dia. (in)	Pump Depth (ft)	Total Depth (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Lat	Lon
20	G-109454	Domestic	Lower Platte South	10	1	160	201	81	100	40.575	-96.743
21	G-110504	Domestic	Lower Platte South	20	1.25	160	202	92	110	40.563	-96.759
22	G-114275	Domestic	Lower Platte South	12	1	200	229	147	170	40.566	-96.814
23	G-114274	Domestic	Lower Platte South	12	1	120	178	88	95	40.565	-96.825
24	G-118194	Domestic	Lower Big Blue	20	1.25	120	131	90	115	40.516	-96.821
25	G-120428	Domestic	Lower Platte South	20	1.25	160	206	92	110	40.566	-96.762
26	G-120429	Domestic	Lower Platte South	20	1.25	160	212	105	120	40.564	-96.763
27	G-123115	Irrigation	Nemaha	800	N/A	N/A	356	N/A	220	40.534	-96.735
28	G-123601	Domestic	Lower Platte South	10	1	180	276	126	130	40.561	-96.744
29	G-125198	Domestic	Lower Platte South	30	1.25	200	254	159	170	40.546	-96.770

No.	Reg. No.	Use	NRD	Pump Rate (gpm)	Pump Column Dia. (in)	Pump Depth (ft)	Total Depth (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Lat	Lon
30	G-126977	Irrigation	Lower Platte South	1200	8	250	287	170	208	40.534	-96.756
31	G-132261	Domestic	Lower Platte South	20	1.25	140	212	87	90	40.581	-96.820
32	G-132220	Domestic	Lower Platte South	20	1.25	180	272	136	140	40.551	-96.773
33	G-132951	Domestic	Lower Platte South	15	1.25	140	205	81	85	40.581	-96.807
34	G-135880	Irrigation	Lower Big Blue	700	8	270	303	N/A	270	40.518	-96.784
35	G-137641	Domestic	Lower Platte South	15	1	180	240	103	130	40.572	-96.785
36	G-139674	Irrigation	Nemaha	800	6	220	320	164	220	40.559	-96.738
37	G-137640	Domestic	Lower Platte South	15	1.25	160	263	101	130	40.571	-96.785
38	G-139417	Domestic	Nemaha	35	1.25	200	236	144	154	40.545	-96.768
39	G-145692	Domestic	Lower Platte South	15	1.25	140	192	68	80	40.574	-96.749
40	G-146803	Domestic	Lower Big Blue	10	1.25	160	163	115	130	40.523	-96.817

No.	Reg. No.	Use	NRD	Pump Rate (gpm)	Pump Column Dia. (in)	Pump Depth (ft)	Total Depth (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Lat	Lon
41	G-154994	Domestic	Lower Platte South	50	3	205	240	136	187	40.557	-96.786
42	G-148631	Irrigation	Lower Platte South	1050	8	240	292	189	212	40.541	-96.818
43	G-147516	Domestic	Lower Platte South	12	1.25	200	239	152	152	40.563	-96.817
44	G-149307	Domestic	Lower Big Blue	15	1	145	180	135	135	40.508	-96.802
45	G-148985	Domestic	Lower Platte South	10	1.25	180	256	140	160	40.565	-96.776
46	G-149862	Domestic	Lower Big Blue	17	1.25	220	320	168	190	40.522	-96.741
47	G-149930	Domestic	Lower Platte South	20	1.25	220	260	147	157	40.562	-96.785
48	G-153509	Domestic	Nemaha	40	2	240	296	160	190	40.538	-96.733
49	G-155893	Irrigation	Lower Platte South	900	8	180	258	102	114	40.570	-96.738
50	G-155895	Irrigation	Nemaha	1200	8	210	267	147	169	40.552	-96.733
51	G-162536	Irrigation	Lower Big Blue	415	6	260	280	148	246	40.505	-96.775

No.	Reg. No.	Use	NRD	Pump Rate (gpm)	Pump Column Dia. (in)	Pump Depth (ft)	Total Depth (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Lat	Lon
52	G-167039	Irrigation	Lower Big Blue	500	6	170	180	126	150	40.520	-96.827
53	G-166708	Irrigation	Lower Big Blue	225	3	260	270	170	250	40.508	-96.777
54	G-171472	Irrigation	Nemaha	1200	8	220	360	164	164	40.548	-96.737
55	G-171473	Irrigation	Nemaha	1200	8	220	306	170	188	40.541	-96.738
56	G-168110	Irrigation	Lower Platte South	1200	8	220	280	162	175	40.534	-96.822
57	G-169752	Domestic	Lower Platte South	20	1.25	120	201	71	90	40.569	-96.768
58	G-177682	Domestic	Lower Platte South	20	1.25	140	170	66	76	40.581	-96.782
59	G-180141	Domestic	Lower Platte South	20	1.25	180	220	153	163	40.541	-96.826
60	G-180306	Domestic	Lower Platte South	15	1.25	180	205	133	143	40.556	-96.762
61	G-188307	Domestic	Lower Platte South	15	1.25	160	178	92	118	40.577	-96.824

2. WELL PROTECTION RESPONSE

Monolith and the LPSNRD will agree to an annual Monitoring Program. This Program will create and provide publicly available information that will be used to make decisions to avoid, or respond to and protect, negative impacts to surrounding wells. The Monitoring Program will include establishing baseline water level conditions for each well prior to Monolith's expected water use. This plan will be updated annually (See Monitoring Program) through the operation of the facility. This data, along with examination of each well by a professional driller will be used to determine the extent to which any impact to a well owner's operation is determined to be due to Monolith's usage. If the impact is due to Monolith's usage, Monolith will agree on a mitigation strategy following the recommendation of the professional driller. (See Attachment 1, Monolith Well Protection Agreement – Domestic Wells, Monolith Well Protection Agreement – Irrigation Wells).

Monolith will offer well owners within the 3-mile radius Monitoring area the opportunity to enter into Well Protection Agreements (Agreements). The offers to enter into the Agreements will be open for the duration of the operation of the Olive Creek Facility. Examples of these Agreements are attached hereto.

The Agreements establish the process, conditions, and actions to be undertaken to ensure wells can safely and efficiently operate now and into the future. Monolith has already offered all registered domestic and irrigation well owners, including the Village of Hallam, within 1.5-miles of the Olive Creek Facility an opportunity to enter into the Agreements. Monolith will extend these offers to all domestic and irrigation well owners within the 3-mile radius Monitoring area upon direction from the LPSNRD Board of Directors.

3. REFERENCES

LRE Water. (2021). "Review of the Monolith Materials Inc. Groundwater Flow Model." <https://www.lpsnrd.org/sites/default/files/lre_lsp_model_review_feb_23_2021.pdf>

Nebraska Department of Natural Resources (NDNR). (2021). "Registered Well Database." <https://www.nebraskamap.gov/datasets/registered-wells-dnr> (March 26, 2021).

Olsson. (2021). "Monolith Groundwater Monitoring Plan:"

ATTACHMENT 1

Monolith Well Protection Agreement – Domestic Wells

Monolith Well Protection Agreement – Irrigation Wells

WATER PROTECTION AGREEMENT – DOMESTIC WELL USERS

This Water Protection Agreement – Domestic Well Users (hereinafter the "Agreement") is made and entered into this ____ day of ____________, 20_____ ("Effective Date"), by and between Monolith Materials, a Nebraska corporation, its successors and assigns (hereinafter "Monolith") and _____________, the owner of the domestic well(s) located on the real property described herein, its successors and assigns (hereinafter the "Owner") (each individually a "Party" and collectively the "Parties").

WHEREAS, Monolith owns and is developing a manufacturing plant near Hallam, Nebraska (hereinafter the "Plant"); and

WHEREAS, the daily operation of the Plant requires an adequate groundwater supply and Monolith will construct three (3) wells adjacent to the Plant to be operated throughout the each year of the Plant's operation; and

WHEREAS, the Owner owns the domestic well(s) located on the real property as described within this Agreement; and

WHEREAS, Monolith has hired engineering firm Olsson and Associates to develop a groundwater model (hereinafter, the "Groundwater Model"), designed to evaluate the potential groundwater impacts to the area surrounding the Plant, which is based on expected normal Plant operations that result in the use of 400 million gallons of water per year; and

WHEREAS, said Groundwater Model indicates that the operation of Monolith's wells may cause impacts to the groundwater resources in the vicinity of the Plant thereby reducing the amount of groundwater available to the domestic well(s) of the Owner; and

WHEREAS, the Groundwater Model has determined the impacts to the Owner to be a groundwater drawdown of less than ____ feet after fifty years of operation; and

WHEREAS, Monolith is committed to protecting the groundwater resources that supply all existing wells within the vicinity of the Plant and as such desires to establish a protection plan for the benefit of the domestic well(s) of the Owner that could be impacted by Monolith's operation of its wells;

NOW, THEREFORE, in consideration of the foregoing conditions, the Parties agree as follows:

1. Owner's Domestic Wells. The Owner owns the following described property located in Lancaster County, Nebraska: [legal] (the "Owner's Property"). Owner owns the following domestic well(s) which are located on the Owner's Property:

   [well registration numbers] (the "Owner's Domestic Well(s)")

2. Owner's Obligations.

   a. The Owner represents that all registered water well(s) used for domestic purposes are listed in Section 1 above.

   b. The Owner hereby agrees to notify Monolith upon experiencing any reduced accessibility to the groundwater that supplies Owner's Domestic Well(s). Such notice shall be provided as soon as possible.

   c. The Owner hereby grants to Monolith, its employees, officers, agents, consultants, and representatives, the right of ingress and egress to the Owner's Domestic Well(s) during the term of this Agreement, and the authority to enter upon the Owner's Property where the Owner's Domestic Well(s) are located, at a mutually agreed upon time, without any further permission necessary or notice given, for the purpose of consulting with the Owner, inspecting the Owner's Domestic Well(s), or any other purpose necessary to ensure the provisions of this Agreement are fully complied with.

3. Monolith's Obligations.

   a. In the event that the Owner notifies Monolith of reduced accessibility to the groundwater that supplies Owner's Domestic Well(s), Monolith will engage in an investigation of the actual impact to the Owner's Domestic Well(s) to determine whether the impacts are a result of the operation of the Plant wells and to assess the actual impact to the groundwater levels, if any.

   b. Upon the conclusion of the investigation, if Owner's Domestic Well(s) have experienced a reduction in groundwater access, Monolith will take action to protect the continued function and use of Owner's Domestic Well(s). Said protection may include:

      i. Deepening the existing Owner's Domestic Well(s) that are experiencing a reduction in groundwater access, or

      ii. Constructing a suitable secondary well to compensation for any groundwater access lost by the existing Owner's Domestic Well(s).

   c. Monolith will be solely responsible for all costs associated with implementing any protection action necessitated to protect the Owner's Domestic Well(s).

   d. Monolith will continuously engage in monitoring the groundwater levels throughout the area surrounding the Plant through the utilization of the Groundwater Model and additional data.

e. Monolith will continue to work with Lower Platte South Natural Resources District to evaluate hydrologic conditions in the area and refine the Groundwater Model.

f. Monolith agrees to incorporate this Agreement as a condition to any permits issued by the Lower Platte South

4. Term. The Term of the Agreement shall be for a period of ninety-nine (99) years or the cessation of the Plant's operations, whichever comes first.

5. Sale, Assignment, or Transfer. This Agreement shall be binding upon the heirs, executors, administrators, successors, or assigns of the Owner and of Monolith.

6. Notice. All notices, requests, and other communications provided for or permitted under this Agreement shall be in writing and shall be (a) personally delivered, (b) sent by first class United States mail, or (c) transmitted by e-mail, in each case addressed to the party to whom notice is being given as its mailing or e-mail address as set forth below:

   a. If to Monolith: [contact information]
   b. If to Owner: [contact information]

7. Entire Agreement. This Agreement constitutes the entire agreement among the Parties with reference to the subject matter hereof, and supersedes all prior and contemporaneous understandings or agreements, oral or written, among the Parties with respect to the subject matter of this Agreement.

8. Governing Law. The validity, interpretation, and performance of this Agreement and each of its provisions shall be governed by the laws of the state of Nebraska.

9. Venue. The Parties agree that any action arising out of or related to this Agreement brought by the Owner against Monolith shall be brought only in the federal or state courts in and for the State of Nebraska

10. Waiver. The waiver of one breach of any term, condition, covenant, obligation, or provision of this Agreement shall not be considered to be a waiver of that or any other term, condition, covenant, obligation, or provision or of any subsequent breach thereof.

11. Severability. If any provision of this Agreement or any portion of such provision or the application thereof to any person or circumstance is held invalid, the remainder of the Agreement (or the remainder of such provision) and the application thereof to other persons or circumstances shall not be affected thereby.

Signature Page to Follow

MONOLITH MATERIALS **OWNER**

By:__________________________ __________________________

Title:__________________________ __________________________

Date:__________________________ Date:__________________________

STATE OF NEBRASKA)
) ss.
COUNTY OF _________)

Before me, a notary public qualified in said county, personally came _________ ________________________, __________________________________, of Monolith, a corporation, known to me to be the officer and identical person who signed the foregoing instrument, and acknowledged the execution thereof to be his voluntary act and deed as such officer and the voluntary act and deed of said corporation.

Witness my hand and notarial seal on __________________________, 20___.

____

Notary Public

STATE OF NEBRASKA)
) ss.
COUNTY OF __________)

Before me, a notary public qualified in said county, personally came ______________________, and ________________________ of ___________________ ________________________________, known to me to be the identical person(s) who signed the foregoing instrument and acknowledged the execution to be their voluntary act and deed.

Witness my hand and notarial seal on __________________________, 20___.

____
Notary Public

WATER PROTECTION AGREEMENT – IRRIGATION WELL USERS

This Water Protection Agreement – Irrigation Well Users (hereinafter the "Agreement") is made and entered into this ____ day of ____________, 20_____ ("Effective Date"), by and between Monolith Materials, a Nebraska corporation, its successors and assigns (hereinafter "Monolith") and _____________, the owner of the irrigation well(s) located on the real property described herein, its successors and assigns (hereinafter the "Owner") (each individually a "Party" and collectively the "Parties").

WHEREAS, Monolith owns and is developing a manufacturing plant near Hallam, Nebraska (hereinafter the "Plant"); and

WHEREAS, the daily operation of the Plant requires an adequate groundwater supply and Monolith will construct three (3) wells adjacent to the Plant to be operated throughout the each year of the Plant's operation; and

WHEREAS, the Owner owns the irrigation well(s) located on the real property as described within this Agreement; and

WHEREAS, Monolith has hired engineering firm Olsson and Associates to develop a groundwater model (hereinafter, the "Groundwater Model"), designed to evaluate the potential groundwater impacts to the area surrounding the Plant, which is based on expected normal Plant operations that result in the use of 400 million gallons of water per year; and

WHEREAS, said Groundwater Model indicates that the operation of Monolith's wells may cause impacts to the groundwater resources in the vicinity of the Plant thereby reducing the amount of groundwater available to the irrigation well(s) of the Owner; and

WHEREAS, the Groundwater Model has determined the impacts to the Owner to be a groundwater drawdown of less than ____ feet after fifty years of operation; and

WHEREAS, Monolith is committed to protecting the groundwater resources that supply all existing wells within the vicinity of the Plant and as such desires to establish a protection plan for the benefit of the irrigation well(s) of the Owner that could be impacted by Monolith's operation of its wells;

NOW, THEREFORE, in consideration of the foregoing conditions, the Parties agree as follows:

1. Owner's Irrigation Wells. The Owner owns the following described property located in Lancaster County, Nebraska: [legal] (the "Owner's Property"). Owner owns the following irrigation well(s) which are located on the Owner's Property:

   [well registration numbers] (the "Owner's Irrigation Well(s)")

2. <u>Owner's Obligations.</u>

   a. The Owner represents that all registered water well(s) used for irrigation purposes are listed in Section 1 above.

   b. The Owner hereby agrees to notify Monolith upon experiencing any reduced accessibility to the groundwater that supplies Owner's Irrigation Well(s). Such notice shall be provided as soon as possible.

   c. The Owner hereby grants to Monolith, its employees, officers, agents, consultants, and representatives, the right of ingress and egress to the Owner's Irrigation Well(s) during the term of this Agreement, and the authority to enter upon the Owner's Property where the Owner's Irrigation Well(s) are located, at a mutually agreed upon time, without any further permission necessary or notice given, for the purpose of consulting with the Owner, inspecting the Owner's Irrigation Well(s), or any other purpose necessary to ensure the provisions of this Agreement are fully complied with.

3. <u>Monolith's Obligations.</u>

   a. In the event that the Owner notifies Monolith of reduced accessibility to the groundwater that supplies Owner's Irrigation Well(s), Monolith will engage in an investigation of the actual impact to the Owner's Irrigation Well(s) to determine whether the impacts are a result of the operation of the Plant wells and to assess the actual impact to the groundwater levels, if any.

   b. Upon the conclusion of the investigation, if Owner's Irrigation Well(s) have experienced a reduction in groundwater access, Monolith will take action to protect the continued function and use of Owner's Irrigation Well(s). Said protection may include:

      i. Deepening the existing Owner's Irrigation Well(s) that are experiencing a reduction in groundwater access, or

      ii. Constructing a suitable secondary well to compensation for any groundwater access lost by the existing Owner's Irrigation Well(s).

   c. Monolith will be solely responsible for all costs associated with implementing any protection action necessitated to protect the Owner's Irrigation Well(s).

   d. Monolith will continuously engage in monitoring the groundwater levels throughout the area surrounding the Plant through the utilization of the Groundwater Model and additional data.

e. Monolith will continue to work with Lower Platte South Natural Resources District to evaluate hydrologic conditions in the area and refine the Groundwater Model.

f. Monolith agrees to incorporate this Agreement as a condition to any permits issued by the Lower Platte South

4. Term. The Term of the Agreement shall be for a period of ninety-nine (99) years or the cessation of the Plant's operations, whichever comes first.

5. Sale, Assignment, or Transfer. This Agreement shall be binding upon the heirs, executors, administrators, successors, or assigns of the Owner and of Monolith.

6. Notice. All notices, requests, and other communications provided for or permitted under this Agreement shall be in writing and shall be (a) personally delivered, (b) sent by first class United States mail, or (c) transmitted by e-mail, in each case addressed to the party to whom notice is being given as its mailing or e-mail address as set forth below:

   a. If to Monolith: [contact information]
   b. If to Owner: [contact information]

7. Entire Agreement. This Agreement constitutes the entire agreement among the Parties with reference to the subject matter hereof, and supersedes all prior and contemporaneous understandings or agreements, oral or written, among the Parties with respect to the subject matter of this Agreement.

8. Governing Law. The validity, interpretation, and performance of this Agreement and each of its provisions shall be governed by the laws of the state of Nebraska.

9. Venue. The Parties agree that any action arising out of or related to this Agreement brought by the Owner against Monolith shall be brought only in the federal or state courts in and for the State of Nebraska.

10. Waiver. The waiver of one breach of any term, condition, covenant, obligation, or provision of this Agreement shall not be considered to be a waiver of that or any other term, condition, covenant, obligation, or provision or of any subsequent breach thereof.

11. Severability. If any provision of this Agreement or any portion of such provision or the application thereof to any person or circumstance is held invalid, the remainder of the Agreement (or the remainder of such provision) and the application thereof to other persons or circumstances shall not be affected thereby.

Signature Page to Follow

MONOLITH MATERIALS **OWNER**

By:_______________________________ _______________________________

Title:_______________________________ _______________________________

Date:_______________________________ Date:_______________________________

STATE OF NEBRASKA)
) ss.
COUNTY OF _________)

Before me, a notary public qualified in said county, personally came _________ _______________________, _______________________________, of Monolith, a corporation, known to me to be the officer and identical person who signed the foregoing instrument, and acknowledged the execution thereof to be his voluntary act and deed as such officer and the voluntary act and deed of said corporation.

Witness my hand and notarial seal on _________________________, 20___.

____

Notary Public

STATE OF NEBRASKA)
) ss.
COUNTY OF __________)

Before me, a notary public qualified in said county, personally came ______________________, and ________________________ of ___________________ _______________________________, known to me to be the identical person(s) who signed the foregoing instrument and acknowledged the execution to be their voluntary act and deed.

Witness my hand and notarial seal on __________________________, 20___.

____

Notary Public

LRE Final

Review of the Monolith Materials Inc. Groundwater Flow Model

Prepared for:
Lower Platte South Natural Resource District

February 2021

The technical material in this report was prepared by or under the supervision and direction of the undersigned:

Jacob Bauer, P.G. (WY #3902)

Hydrogeologist | Project Manager

LRE Water

Clinton Meyer – Staff Hydrogeologist, LRE Water
Dave Hume P.G. (NE # 0186) – Sr. Project Manager and VP Midwest Operations, LRE Water

LRE WATER
CONNECTING WATER TO LIFE

TABLE OF CONTENTS

Section 1: Introduction 4
1.1 Purpose of Review 4
1.2 Model Background 5
Section 2: Model Objective and Choice of Modeling Code 5
Section 3: Model Inputs 6
3.1 Extent, Spatial Discretization, and Temporal Discretization 6
3.2 Geology, Model Thickness, and Bedrock Flow Interactions 6
3.3 Wells and Targets 8
3.4 Model Properties and Comparison to Pumping Test Results 8
3.5 Boundary Conditions 9
3.5.1 Stream Package (STR) 9
3.5.2 River Package (RIV) 9
3.5.3 General Head Boundary Package (GHB) 9
3.5.4 Evapotranspiration Package (EVT) 9
3.5.5 Recharge Package (RCH) 9
Section 4: Model Output: Water Level and Streamflow Changes due to Monolith Future Pumping Operations 10
Section 5: Summary and Conclusions 11
Section 6: Recommendations 12
Section 7: References 13

LIST OF TABLES

Table 1: Water Budget Comparison

LIST OF FIGURES

Figure 1- Model Active Cells and Pumping Well Location
Figure 2- Hydrogeologic Cross Section Transects
Figure 3- Hydrogeologic Cross Sections A-A' and B-B'
Figure 4- Hydrogeologic Cross Section C-C'
Figure 5- Model Budget Comparison
Figure 6- Layer 1 Drawdown
Figure 7- Layer 2 Drawdown
Figure 8- Layer 3 Drawdown
Figure 9- Layer 4 Drawdown
Figure 10- Total Drawdown

APPENDIX

Appendix A

SECTION 1: INTRODUCTION

1.1 PURPOSE OF REVIEW

This Review of the Monolith Materials, Inc. (Monolith) Groundwater Flow Model Report (Report) documents LRE Water's (LRE) peer-review and evaluation of Olsson Inc.'s (Olsson) groundwater flow model (Model) that was completed on behalf of Monolith. The Model was created as part of a hydrogeologic analysis to simulate future groundwater conditions associated with the additional pumping that will be required to meet the water demands of the proposed expansion of Monolith's facility. The modeling approach and Model construction, input parameters, calibration, and resulting estimation of the likely impacts of the additional withdrawal are documented in Olsson's December 2020, Draft Monolith Hydrogeologic Analysis Report (Olsson Report).

The facility, referred to herein as the Site, is located in the Lancaster County just north of the Village of Hallam, Nebraska in the southwest corner of the Lower Platte South Natural Resources District (LPSNRD). LRE was retained by the LPSNRD to complete the review and this Report.

The purpose of LRE's review is to ensure the Model is based on currently available scientific information and the results can be replicated. LRE's review involved evaluation of the Model:

1. Objective and model code,
2. Input parameters,
3. Appropriateness of aquifer and hydraulic boundary conditions,
4. Simulation results for water levels and flows, and
5. Applicability for simulating water level changes in response to the proposed pumping and project operations at the Site.

The Model was built and refined using the MODFLOW-Unstructured Grid (USG) program, which is a version USGS's modeling software code, MODFLOW, which is the standard in the groundwater modeling industry. Much of the Nebraska Department of Natural Resources (DNR, 2018) existing Lower Platte Missouri Tributary (LPMT) Model was used as the starting point for construction of the refined model MODFLOW files. More details on the Model are provided in Olsson (2020) and in this Report.

The Model files were provided to LRE by Olsson as the following zip archive:

- MonolithCal: Calibrated version of the initial Model including MODFLOW input and output files for the time period 1960-2019.
- MonolithFuture: Version of the Model used to compare the differences a no pumping scenario and a pumping scenario for the 50-year time period from 2020 through 2069.
- Additional Files: Olsson also provided a MODFLOW input WEL file that has the Monolith pumping well (Monolith Well), and an older version of the Model in Groundwater Vistas Graphical User Interface (GUI) format.

1.2 MODEL BACKGROUND

The Model was developed by modifying the LPMT Model that simulated groundwater flow and the interaction of groundwater with surface waters across a larger region. Olsson modified the LPMT by converting it into a MODFLOW-USG version, decreasing the model extent, refining the cell size where a resolution increase was desired, altering the hydraulic conductivity (k) distribution, adding relevant aquifer and hydrologic boundary conditions, and incorporating publicly available information to inform the sources and sinks of water in the region during a 60-year time period prior to 2020. This was done using a combination of Groundwater Vistas GUI, Olsson's proprietary modeling software "Get" (https://get.olsson.com), and MATLAB (https://www.mathworks.com/). The MonolithFuture.zip file used the data compiled in the initial calibration Model and used the most recent 25 years of climate data and the irrigation pumping data from 2013 throughout the Model.

The focus of this Review is on the Model files used to simulate future conditions because that was the version of the Model used to estimate the effects of pumping from the Site.

LRE used a combination of FloPy (Python MODFLOW module), Groundwater Vistas, and Esri's Arcmap to evaluate the efficacy of the Model. We note that initial or starting heads were not discussed in the Olsson Report (2020) and were not provided as a separate file for the initial calibrated Model and the predictive or future Model. We therefore assumed that the calibration run final heads are the pumping and no pumping future run starting heads. While not critical for our evaluation, we recommend providing additional information on replicating the Model runs in a brief addendum.

SECTION 2: MODEL OBJECTIVE AND CHOICE OF MODELING CODE

The objective of the Model is to evaluate the changes to the groundwater levels or heads in Quaternary-age buried sand gravel aquifer system, referred to in the LPSNRD's Rules and Regulations as the Crete-Princeton-Adams (CPA) aquifer, and flow in hydraulically connected surface water bodies as a result of the planned increase of pumping at the Site. The CPA aquifer changes were evaluated in the area surrounding the Monolith Well location at the Site. Olsson notes that while they may have as many as three wells, the total production can be approximated with a single pumping well that pumps at the combined demand of all Monolith Wells, therefore we refer to this combined system as the "Monolith Well". As a secondary objective the Model seeks to evaluate where the source(s) of water are coming from when pumping occurs. This is expressed as the timing and magnitude of the reduction in groundwater outflow to the rivers and streams in the area.

Thoughtful selection of a numerical modeling code for simulating groundwater flow is required and a code should be selected with the overall objectives of the simulations in mind (Anderson et al., 2015). The modeling code utilized for the analyses included MODFLOW-USG Beta Version 2.0.0 also known as MODFLOW-USG-Transport. MODFLOW-USG is a publicly-available, widely-accepted USGS groundwater flow numerical modeling code that was specifically developed to allow grids other than the orthogonal structured grids required by previous MODFLOW versions to be used for groundwater flow simulations. While no contaminant fate and transport, or particle tracking packages were activated in the Model, the base MODFLOW-USG code is a good choice to allow for grid discretization and greater resolution.

We agree that MODFLOW-USG is an appropriate code for the Model.

SECTION 3: MODEL INPUTS

This section discusses our review of the inputs to the Model.

3.1 EXTENT, SPATIAL DISCRETIZATION, AND TEMPORAL DISCRETIZATION

The extent and spatial discretization of the Model is shown on **Figure 1.** The projected geographic coordinate system utilized is State Plane Nebraska FIPS 2600. The units are in feet (ft). The southeast corner of the model is located at 245520 ft Northing and 2477635 ft Easting. The spatial discretization is variable and ranges from 165 ft square to 2640 ft square. The smallest discretization surrounds the streams and the Monolith Well on the Site.

The model encompasses a total active model area of approximately 373 square miles and adequately bounds the influence of the Monolith Well location. The temporal discretization consists of 600 transient stress periods. Each stress period has one-time step and is 30.43 days long.

By comparing the results for a Model run with and without the pumping schedule of the Monolith Well we are able to determine the potential impacts due to changes in the CPA aquifer or other sources of water.

It is our opinion that the set-up of the extent, spatial, and temporal discretization allow for an adequate assessment of the Model objectives.

3.2 GEOLOGY, MODEL THICKNESS, AND BEDROCK FLOW INTERACTIONS

To assist in our evaluation of the conceptual hydrogeology of the Model domain, LRE constructed three hydrogeologic cross sections through the locations shown on **Figure 2**. The cross sections are referenced at A-A', B-B', and C-C' and are shown on **Figures 3 and 4.** Based on our review of geologic information, including borehole logs, the cross sections, and peer reviewed publications, it is our opinion that the structure of the CPA aquifer represented in the Model represents the known geology adequately.

The Quaternary material including the CPA aquifer is represented in the Model as four layers. The first and third layers represent low-permeable loess and/or glacial till (i.e., silt and clay). The second and fourth layers represent the CPA aquifer sand and gravel units. The base of the Model terminates at bedrock, which is sandstone and shale of the Cretaceous-age Dakota Group just to the south, west and north of the Site. Permian-age limestone and shale of the Council Grove Group underlie the Site and to the east.

The Model bottom and Model top of the sand and gravel units that makeup CPA aquifer are reasonable and consistent with the local hydrogeologic and surface topographical conditions. Groundwater levels and depth to groundwater within the Model domain vary greatly because of the large scale represented and the variability of measurements over time and the land surface, but reasonably represent the groundwater flow field across area. The CPA aquifer is modeled with the top two layers unconfined and the bottom two confined. The total CPA aquifer thickness varies, but appears to be reasonable for the meeting the objectives of the Model. The active model cells have a wettability type specified as "non-wettable", which is appropriate for this simulation.

In discussion with the LPSNRD, water chemistry considerations including the higher concentration of Total Dissolved Solids (TDS) within bedrock units was highlighted as a potential concern. The Model does not explicitly consider this potential inflow, and the potential for the Monolith wells to affect this flow. The final paragraph of the Olsson Report states:

> *"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."*

As discussed later in this report, we agree that the Model simulates that the primary source of water to the Monolith well is a decrease in discharge to streams. However, the Model does not simulate any interaction with bedrock groundwater because the bedrock units are not a part of the Model flow simulation. Exclusion of the bedrock units is based on an assumption that there is little interaction between the deeper bedrock flow system and the surficial CPA aquifer, which may be reasonable. However, in our opinion it would be useful to characterize the gradient (i.e. flow direction) between the bedrock units and the CPA aquifer in the area if bedrock wells exist. If the gradient is currently downward from the CPA into the bedrock units, and is expected to remain downward during future pumping, it is reasonable to assume that there may not be significant impacts to CPA-Aquifer water quality. However, if the gradient is upward, or is expected to change directions from downward to upward, additional monitoring of water quality is recommended. We note that during the 72-hour pumping test at the site, a steady increase in the Specific Conductivity of the water was observed, which likely correlates with steadily increasing levels of TDS and possible bedrock groundwater interaction.

It is our opinion that the physical structure of the CPA aquifer within the model extent is reasonably adequate for model simulations to achieve the desired objectives if the assumption of little to no interaction with bedrock aquifers is justified. If the recommended gradient analysis shows the likelihood of a gradient reversal from downward to upward, further analysis or monitoring is recommended.

3.3 WELLS AND TARGETS

The main calibration target for the Model was groundwater level observations. Pilot points were used along with the parameter estimating tool (PEST) to calibrate 87 targets with multiple water level observations. The calibration process focused on the hydraulic conductivity (k) to range between 20 and 210 ft/day for the CPA aquifer units to match the observed water levels. The full calibration process is not reviewed in this Report. Instead we compared the calibrated values to estimates obtained from the aquifer pumping test (Test) analysis contracted by Olsson to EA Engineering, Science, and Technology, Inc., PBC (EA). In our opinion, the calibrated model properties are appropriate (however, as discussed later in this Report, an additional sensitivity analysis is recommended).

Two files representing groundwater well pumping (WEL files) were provided to compare the pumping and no-pumping scenario in the Model. The no-pumping scenario has 430 wells that represent the current local water use from irrigation, industrial, and municipal use. The pumping scenario adds the proposed Monolith Well pumping at an average of 595 gpm, and ranges throughout the 50 years with a minimum of 393 gpm in January and 774 gpm in September. In general, the pumping rates are highest in the summer and fall and lowest in the winter months, which is based on Monolith's predicted use of the Monolith Well.

3.4 MODEL PROPERTIES AND COMPARISON TO PUMPING TEST RESULTS

The hydraulic conductivity (k) of the four model layers ranges from 1 ft/day to 210.5 ft/day. Layers 1 and 3 represent a lower permeability silt and clay whose horizontal hydraulic conductivity (k_h) was set to 10 ft/day, and vertical hydraulic conductivity (k_v) was set to 1 ft/day. Layers 2 and 4 are separate units that makeup the CPA aquifer, but have similar scales in k_h that ranges from 20 ft/day to 200 ft/day, and 19.4 ft/day to 210.5 ft/day respectively. The ratio of k_h / k_v for both aquifer units ranges from 1.2 to 328 throughout the Model domain.

The range in k_h chosen to bound the PEST calibration of Layers 2 and 4 was based off of the pumping Test at the Site and hydrogeological reports of the area. A review of the Test was completed by LRE. We generally agree with the approach and analysis done by EA and believe it is acceptable and reasonably represents the CPA aquifer system. It is noted that the Test did not stress the CPA aquifer as significantly as would have been desired to get a better calibration under stressed conditions. We note that the maximum displacement of the 72-hour Test at 800 gpm was less than 9 feet in a 60-foot thick aquifer, which is similar to the amount of drawdown predicted from Monolith's pumping in the Model (note that Monolith's long-term average pumping is approximately 600 gpm). Under long term production, regional drawdown could exceed the drawdown observed during this Test. A longer term Test could be considered to stress the CPA aquifer more significantly.

Based on the available data, LRE believes that the k_h value used for the aquifer layers are adequate for the purpose of the Model.

When reviewing the k_h and k_v of the silt and clay, layers 1 and 3, we noted that a uniform 10 ft/day and 1 ft/day, respectively may be misrepresenting the lithology. Based on our experience, silty clays often have lower k_h and have greater k_h / k_v ratios. LRE recommends sensitivity analysis of the k_h and k_v of Layers 1 and 3 to ensure that it does not have a significant impact on the overall result from the Model.

The specific storage (Ss) in Layer 1 is 0.001 and is set to 0.00001 for all other layers. Layer 1 and Layer 2 are unconfined and their specific yield (Sy) is set to 0.2. These storage values are reasonable for the purpose of this Olsson Future Model.

In summary, the model parameters appear appropriate, however an additional set of sensitivity runs for K_v is recommended.

3.5 BOUNDARY CONDITIONS

3.5.1 Stream Package (STR)

Several major streams are represented as 13 stream segments with the stream package in the Model. The conductance of each reach of stream (cell) was calculated by multiplying; streambed thickness (2 feet), width of all steams (50 feet), the length of stream within the cell, and streambed hydraulic conductivity (250 ft/day). Slope of the streams were calculated by average slope of the elevation from beginning and end. River Bed Conductance was set to 10,000 ft^2/day with a 5-foot river bed thickness.

3.5.2 River Package (RIV)

The river package was used to simulate the western boundary condition of the model with the exception of a few general head boundary cells. The Big Blue River flows from the north to the south within the model domain.

3.5.3 General Head Boundary Package (GHB)

The North, South, and Eastern boundaries of the model are set as general head boundaries. The general head elevation was specified as the head elevation of the LPMT model for the corresponding month. The general head conductance was specified as 10,000 ft^2/day.

3.5.4 Evapotranspiration Package (EVT)

This model used the same Evapotranspiration package values that were used in the larger model (LPMT model) that this one was based on. It is LREs opinion that this is a reasonable assumption.

3.5.5 Recharge Package (RCH)

The regional recharge to the alluvial aquifer from precipitation was modeled with the MODFLOW Recharge (RCH) package. The recharge in this model is the same as the LPMT model with an average of about 3.8 inches per year.

In summary, the boundary condition packages used in the model are reasonable, and parameter values for these packages appear reasonable based on our experience.

SECTION 4: MODEL OUTPUT: WATER LEVEL AND STREAMFLOW CHANGES DUE TO MONOLITH FUTURE PUMPING OPERATIONS

One of the main objectives of the Model was to quantify the difference in water levels within the CPA aquifer system surrounding the Site after 50 years of pumping from the Monolith Well. LRE was able to successfully compare the results of a pumping and a no-pumping scenario in this calibrated model to compare 1) where the water is coming from in the model when producing water through the proposed production well, and 2) the regional drawdown of the CPA aquifer system after 50 years of pumping, comparing them to the results presented by Olsson (2020).

Another main object of the Model is to simulate the effect of pumping on surface streams. To review this, we compared the modeled water budget for the Monolith pumping and no-Monolith-pumping scenarios. The model budget difference highlights the source of water to the Monolith Well. The differences from pumping can be seen in **Figure 5** and **Table 1.** The surface water contributions (River and Streams) account for 52% of the water pumped from the Monolith Well over 50 years. Water coming from aquifer storage accounts for 31%. The remaining significant portion (16%) comes from the General Head Boundaries from the North, South, and East. Our results are identical to the results presented by the Model. The predicted reduction in stream flow of 452 acre-feet per year is equivalent to a reduction of approximately 0.6 cubic feet per second (cfs). The impact to the GHB Boundaries of 157 acre-feet per year is equal to an additional 0.2 cfs which is likely to manifest as a reduction in outflow to streams outside of the model domain. Together, these comprise a total predicted stream flow reduction of approximately 0.8 cfs.

A water table drawdown map was created for each layer in the Model, comparing the final time step at the end of 50 years (**Figures 6-9**). The drawdown in all layers (**Figure 10**) was used to create a full drawdown map. Comparing these results to figure 3.14 in the Olsson (2020), (**Appendix A**) we find that they are very similar, but not exactly the same. The first difference is that Appendix A shows the contour interval with a maximum decline of -0.1 feet, but it is not shown. The second is that the maximum drawdown in all layers on the final time step of the Model is 6.9 feet near the Monolith Well. **Appendix A** shows contours up to -8.5 feet and that amount of drawdown is referenced in the Discussion section of the Olsson (2020). Lastly some of the contour intervals are slightly different from each other. These differences in **Figure 10** and **Appendix A** do not change our opinion on the overall Model. We suspect that the minor differences we encountered are due to differences in initial heads, contouring methods, or the exact time used for the drawdown analysis. These minor differences to not affect the overall conclusions of our analysis, however, we recommend providing a model addendum to document exactly how Olsson's drawdown maps were developed.

SECTION 5: SUMMARY AND CONCLUSIONS

Based on our evaluation of the Model we have reached the following conclusions:

1. The Model calibration to observed groundwater level data is adequate to meet the objectives based on our modeling experience.
2. The Quaternary material including the CPA aquifer is represented in the Model as four layers. Based on our review of geologic information, including borehole logs and peer reviewed publications it is our opinion that the structure of the CPA aquifer in the Model represents the known geology adequately.
3. The simulated groundwater level conditions in the Model are reasonable and adequately demonstrate where the sources of water come from for a Monolith Well pumping at an average rate of 595 gpm, and ranging throughout the 50-year simulation period from a minimum of 393 gpm in January to 774 gpm in September.
4. The surface water contributions (River and Streams) account for 52% of the water pumped from the Monolith Well over 50 years. Water coming from aquifer storage accounts for 31%. The remaining significant portion (16%) comes from the General Head Boundaries from the North, South, and East. The total reduction in streamflow predicted by the model is approximately 0.8 cfs. Our results are identical to the results presented by the Model.
5. The Model also reasonably represents regional drawdown in the CPA aquifer due to the Monolith Well pumping at an average rate of 595 gpm, and ranging throughout the 50-year simulation period from a minimum of 393 gpm in January to 774 gpm in September.
6. The assumptions included directly and indirectly into Olsson's Future Model are adequate for reasonably reliable drawdown predictions
7. It is our opinion that the physical structure of the CPA aquifer within the model extent is reasonably adequate for model simulations to achieve the desired objectives if the assumption of little to no interaction with bedrock aquifers can be strengthened. If the recommended gradient analysis shows the likelihood of a gradient reversal from downward to upward, further analysis or monitoring is recommended.
8. The extent, boundary conditions, and calibration to water level observations incorporated into Model, in LRE's opinion, is appropriate for the achieving Model objectives if it can be shown that bedrock interactions are minimal or downward.

SECTION 6: RECOMMENDATIONS

Based on our evaluation of the Model we recommend the following:

1. Complete a more detailed sensitivity analyses on the following:
   a. Scale of hydraulic conductivity in model layers 1 and 3 (low-permeability layers); and,
   b. Horizontal / vertical hydraulic conductivity ratio (kh/kv) in all layers.

2. Provide an addendum with directions for exact replication of future drawdown simulations presented by Model results. This will be useful for documenting and comparing the current model results.
3. For future reference, we recommend the current Model have less Model refinement or discretization (i.e., grid and cell size) to make it more "user friendly". It is likely that the same results will be achieved with a simpler model.
4. Better characterize the gradient (i.e. flow direction) between the bedrock units and the CPA aquifer in the area if bedrock well water level measurements exist. If the gradient is currently downward from the CPA into the bedrock units, and is expected to remain downward during future pumping, it is reasonable to assume that there may not be significant impacts to CPA aquifer water quality. However, if the gradient is upward, or is expected to change directions from downward to upward, additional monitoring of water quality is recommended.
5. LRE recommends that a groundwater monitoring plan be developed and implemented before the Monolith Well begins operating. The plan should be designed to address future potential changes in groundwater quality and quantity at the Site and surrounding area. The plan is recommended based on changes to groundwater quality (indicated by elevated total dissolved solids) that have 1) occasionally been observed in the general area of the Site that may have been a result of pumping and leakage from the underlying bedrock (personal communication with LPSNRD staff), 2) the increase in the specific conductance in the Monolith Well during the 72-hour aquifer pumping test, and 3) because the Model does not include bedrock, and therefore cannot predict leakage from the underlying bedrock where the poor water quality may be originating.
6. Identify and document details (i.e., owner, location, depth, pump setting, static water levels) on all private and public supply wells within 1 ½ miles of the Site, and provide a well interference contingency plan in the event that any issues should occur to these wells as a result of the Monolith Well pumping.

SECTION 7: REFERENCES

The following references were relied upon when performing this model review:

FloPy.https://www.usgs.gov/software/flopy-python-package-creating-running-and-post-processing-modflow-based-models

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, NJ, Prentice-Hall, 604 p.

Olsson, Inc. December 2020 Monolith Hydrogeologic Analysis Report (DRAFT). Prepared for Monolith Materials Hallam, Nebraska.

Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2013, MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.

Modeling Files Relied Upon

The following electronic files were relied upon when performing our Model review:

MonolithCal.zip and MonolithFuture.zip

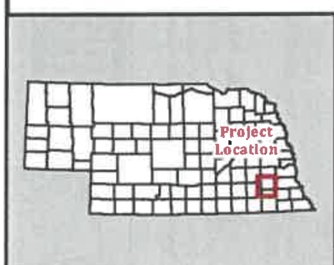
Groundwater Vistas (GWV) MMusg_Final.gwv file. Groundwater Vistas Graphical User Interface (GUI) (Environmental Simulations, Inc., http://www.groundwatermodels.com/)

ScenarioWellFile.WEL file, for pumping scenario

MODFLOW USG – Beta Version Executable Version 2.0, Based on MODFLOW 2005 Version 1.11.0

Table 1: Water Budget Comparison

Budget Source or Sink	Without Pumping Totals	With Pumping Totals	Difference	Percent of Total
	acre-ft per 50 years	acre-ft per 50 years	acre-ft per year	
Wells	-600,800.75	-648,773.19	-959.45	-100.0%
Stream	-2,149,153.33	-2,126,533.45	452.40	47.2%
Storage	-94,452.05	-79,424.48	300.55	31.3%
GHB	-341,970.01	-334,122.57	156.95	16.4%
River	-372,596.62	-370,353.30	44.87	4.7%
Evapotranspiration	-56,524.94	-56,305.39	4.39	0.5%
Recharge	3,615,452.02	3,615,461.45	0.19	0.0%
Total (IN - OUT)	-46.95	-50.84	-0.08	0.0%



Monolith Production Well
Active Grid
Active Model Outline

This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

FIGURE 1
ACTIVE GRID
AND WELL LOCATION

LRE WATER

5041LPS01
Feb 2021

D:\GIS\GIS\Lower_Platte_South_NRD_Monolith\maps\5041LPS0101C.mxd 2/22/2021 3:05:32 PM NAD 1983 UTM Zone 14N

- NeDNR Well on Cross Section
- CSD Test Hole on Cross Section
- Public Water Supply Well
- Cross Section Transect
- NRD Boundary

Bedrock Formation Name

Cret.	Greenhorn-Graneros Shale	Undifferentiated Interbedded Shales, Limestones, and Sandstones
	Dakota Formation	
Permian	Chase Group	
	Council Grove Group	
	Admire Group	
Penn.	Wabaunsee Formation	

N

0 3 Miles

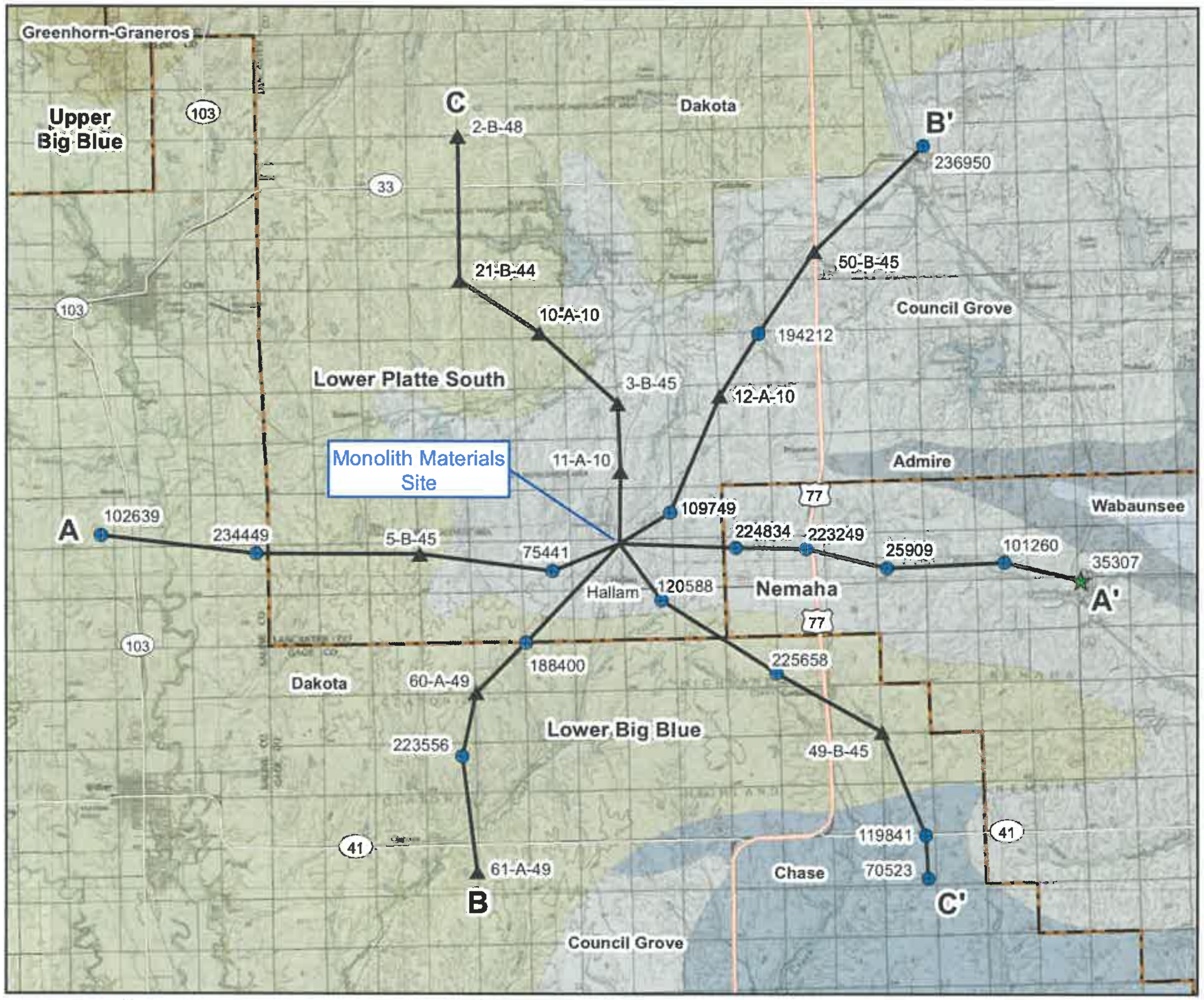
Notes:

Sources:

First encountered bedrock from University of Nebraska-Lincoln School of Natural Resources database.

Service Layer Credits: Copyright© 2013 National Geographic Society, i-cubed

Well locations from Nebraska Department of Natural Resources wells database, and test hole locations from the University of Nebraska-Lincoln Conservation and Survey Division database.



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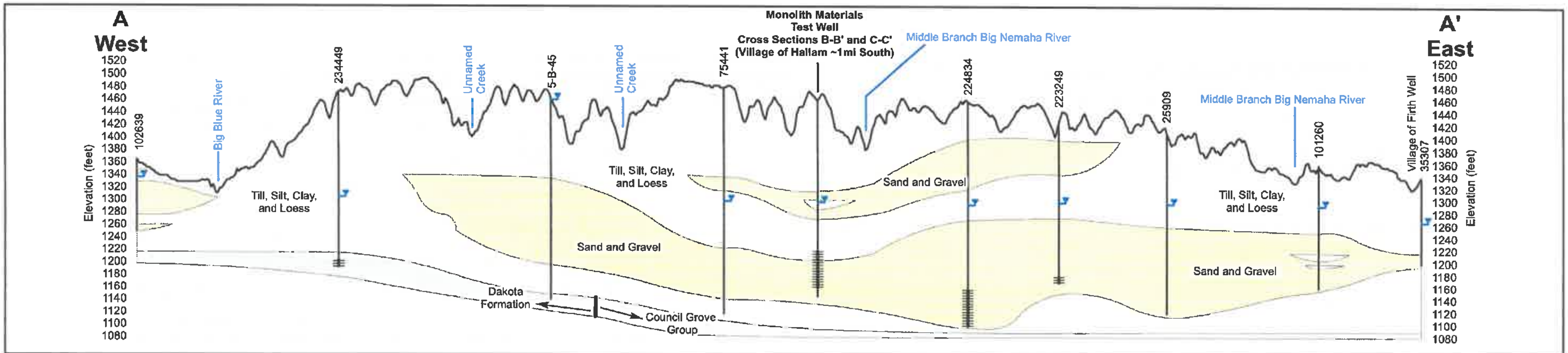
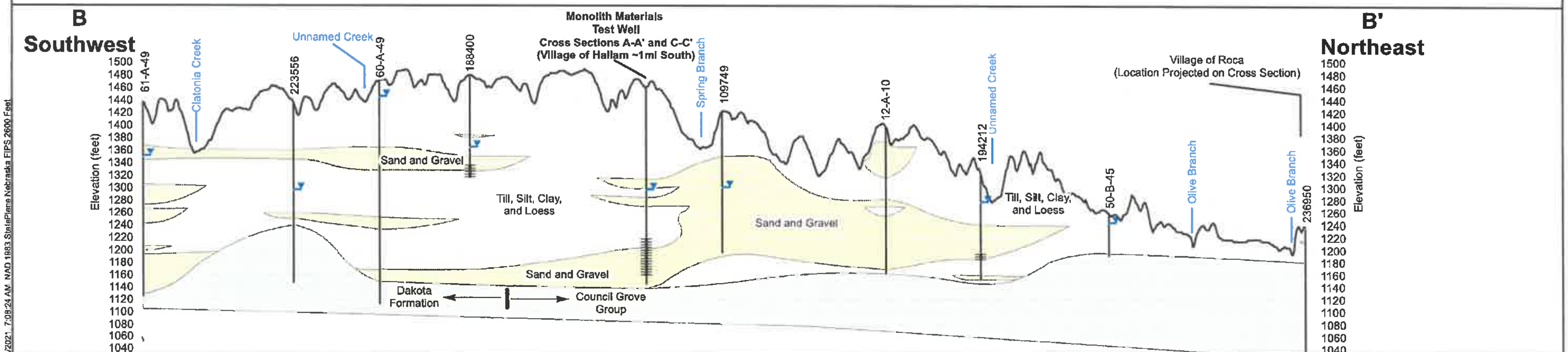
Prepared By:
LRE Water
Innovative Water Resource Solutions
Minnesota Office
Minneapolis - Saint Paul
(612) 805-0919

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT
MONOLITH MATERIALS 3RD PARTY HYDROGEOLOGIC REVIEW
HALLAM, NEBRASKA

SITE LOCATION
AND HYDROGEOLOGIC CROSS SECTION TRANSECT LOCATIONS

FILE: 5041LPS0101C.MXD	DATE: 2/22/2021	FIGURE: 2





Geologic Contact (interpreted based on geologic logs, and all contacts are inferred)

Till, Silt, Clay, Loess (may have sandy fractions)

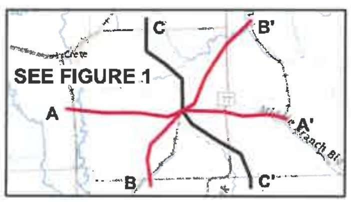
Sand and Gravel (may have silty, clayey or limestone fractions)

Bedrock (Limestone, Sandstone, or Shale)

Undifferentiated

Potentiometric Surface (Measured at Installation Date)

Screen



Notes:

Cross sections drafted using geologic logs from the Nebraska Department of Natural Resources All Wells Database and from the University of Nebraska-Lincoln Conservation Survey Division Test Hole Database. All geologic contacts are inferred and based on available information.

Sources:

-First bedrock contact from University of Nebraska-Lincoln School of Natural Resources. https://snr.unl.edu/data/geographygis/geology.aspx
-Cross Section Transects: Digitized and snapped to well or test hole locations.
-Grade Profile: Extracted from 30-meter DEM from University Nebraska-Lincoln School of Natural Resources.
-Service Layer Credits: Copyright: © 2013 National Geographic Society
USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed May, 2020.
-Well and Test Hole Locations: Nebraska Department of Natural Resources All Wells Database, and University of Nebraska-Lincoln Conservation Survey Division Test Hole Database.

0 8,000 Feet

1 inch = 8,000 feet horizontal

1 inch = 160 feet vertical (40 scale on engineer's ruler)

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CONNECTING WATER TO LIFE

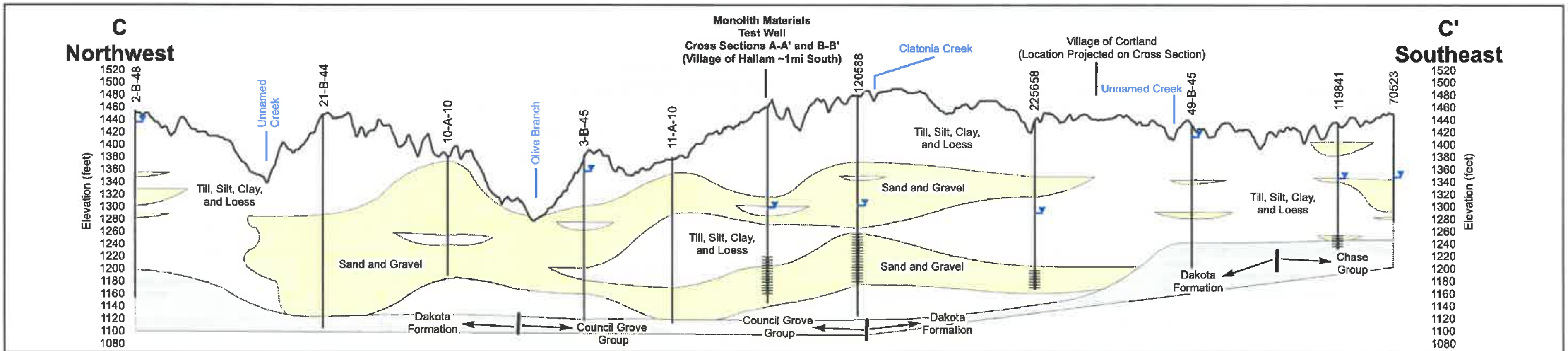
Prepared By:
LRE Water
Innovative Water Resource Solutions
Minneapolis - Saint Paul, Minnesota
(612) 805-0919

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT
MONOLITH MATERIALS 3RD PARTY HYDROGEOLOGIC REVIEW
HALLAM, NEBRASKA

HYDROGEOLOGIC CROSS SECTIONS A-A' AND B-B'

FILE: 5041LPS0101B - xsects A and B.MXD	DATE: 2/23/2021	FIGURE: 3

D:\GIS\GIS\Lower Platte South NRD Monolith... 5041LPS0101B - xsects A and B.mxd 2/23/2021 7:08:24 AM NAD 1983 StatePlane Nebraska FIPS 2600 Feet



Geologic Contact (interpreted based on geologic logs, and all contacts are inferred)

Till, Silt, Clay, Loess (may have sandy fractions)

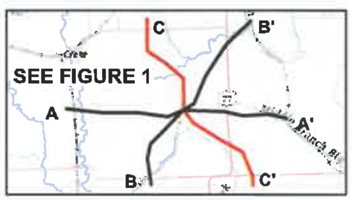
Sand and Gravel (may have silty, clayey or limestone fractions)

Bedrock (Limestone, Sandstone, or Shale)

Undifferentiated

Potentiometric Surface (Measured at Installation Date)

Screen



0 8,000 Feet

1 inch = 8,000 feet horizontal

1 inch = 160 feet vertical (40 scale on engineer's ruler)

Notes:

Cross sections drafted using geologic logs from the Nebraska Department of Natural Resources All Wells Database and from the University of Nebraska-Lincoln Conservation Survey Division Test Hole Database. All geologic contacts are inferred and based on available information.

Sources:

-First bedrock contact from University of Nebraska-Lincoln School of Natural Resources, https://snr.unl.edu/data/geographygis/geology.aspx

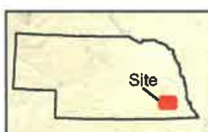
-Cross Section Transects: Digitized and snapped to well or test hole locations.

-Grade Profile: Extracted from 30-meter DEM from University Nebraska-Lincoln School of Natural Resources.

-Service Layer Credits: Copyright: © 2013 National Geographic Society

USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed May, 2020.

-Well and Test Hole Locations: Nebraska Department of Natural Resources All Wells Database, and University of Nebraska-Lincoln Conservation Survey Division Test Hole Database.



LRE WATER
CONNECTING WATER TO LIFE

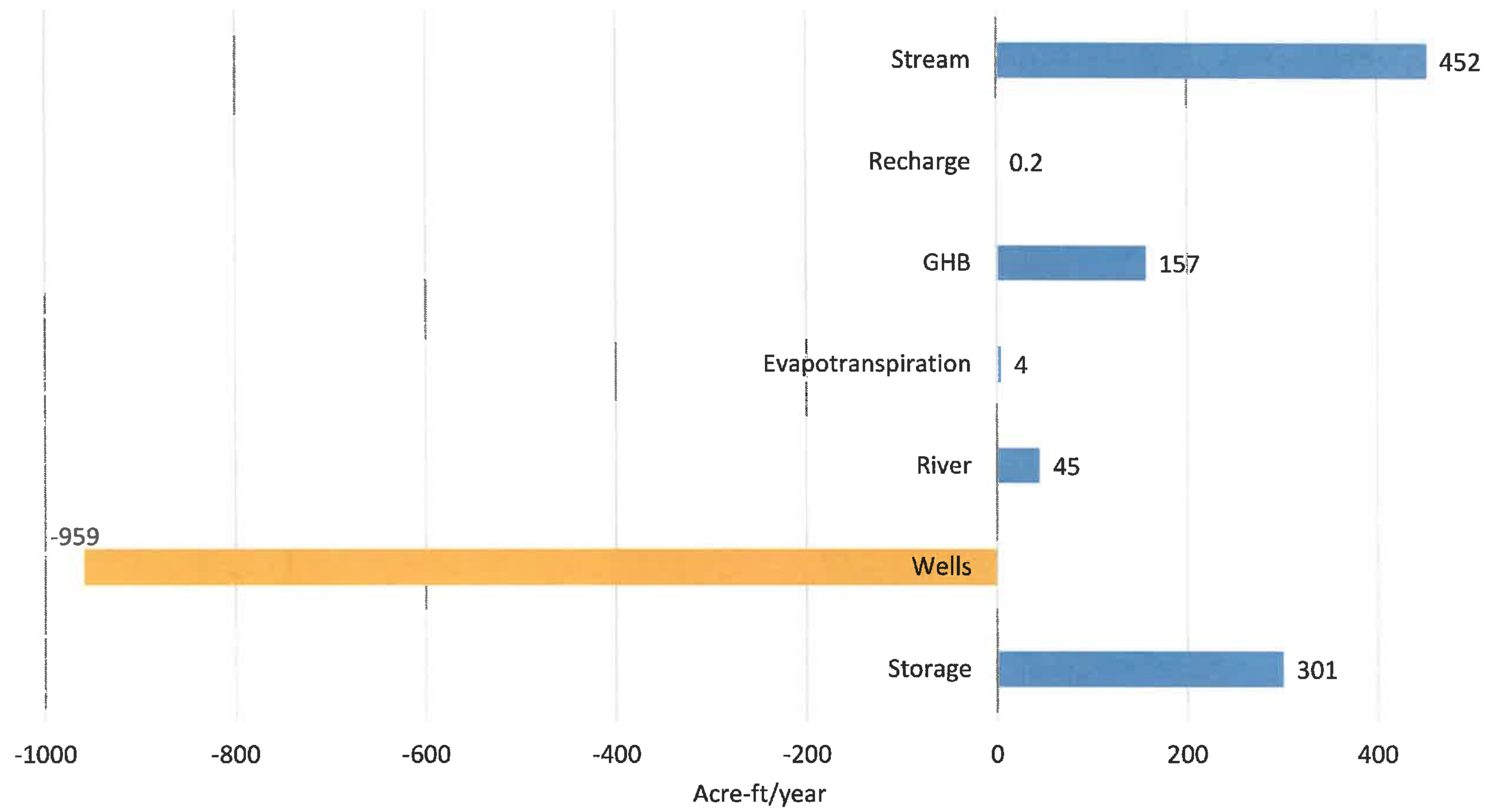
Prepared By:
LRE Water
Innovative Water Resource Solutions
Minneapolis - Saint Paul, Minnesota
(612) 805-0919

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT
MONOLITH MATERIALS 3RD PARTY HYDROGEOLOGIC REVIEW
HALLAM, NEBRASKA

HYDROGEOLOGIC CROSS SECTIONS C-C'

FILE: 5041LPS0101D - xsect C.MXD	DATE: 2/23/2021	FIGURE: 4

D:\GIS\GIS\Lower Platte South NRD Monolith\...\5041LPS0101D - xsect C.mxd 2/23/2021 7:08:43 AM NAD 1983 StatePlane Nebraska FIPS 2600 Feet



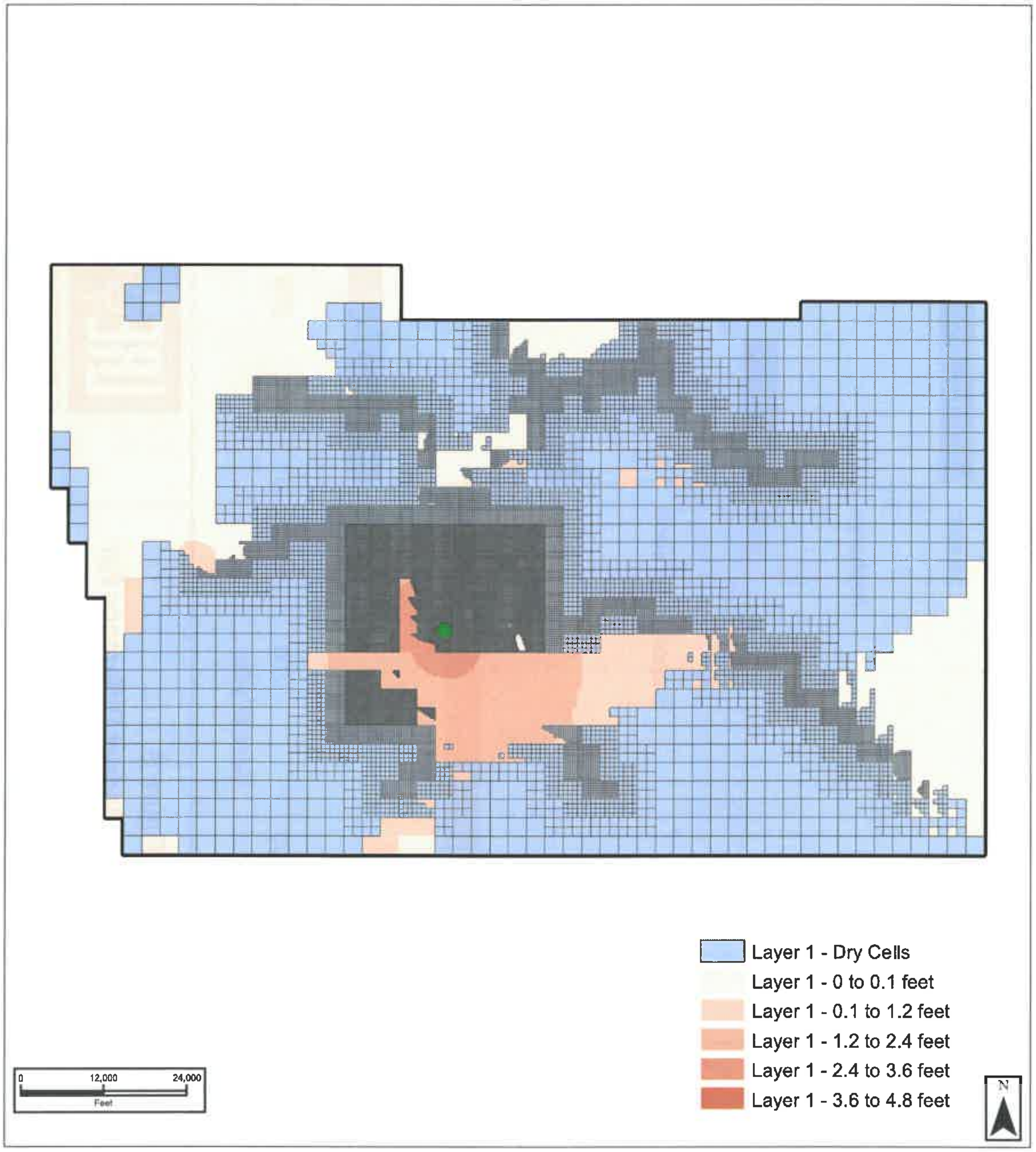
DATE: 2/8/2021

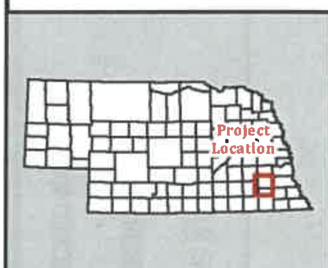
AUTHOR: CDM

CHECKED BY: JB

Figure 5
Cumulative Water Budget Difference For Pumping and Non-Pumping Scenarios (acre-ft/year)

LRE WATER
CONNECTING WATER TO LIFE
1221 Auraria Parkway, Denver, CO
80204





Monolith Production Well

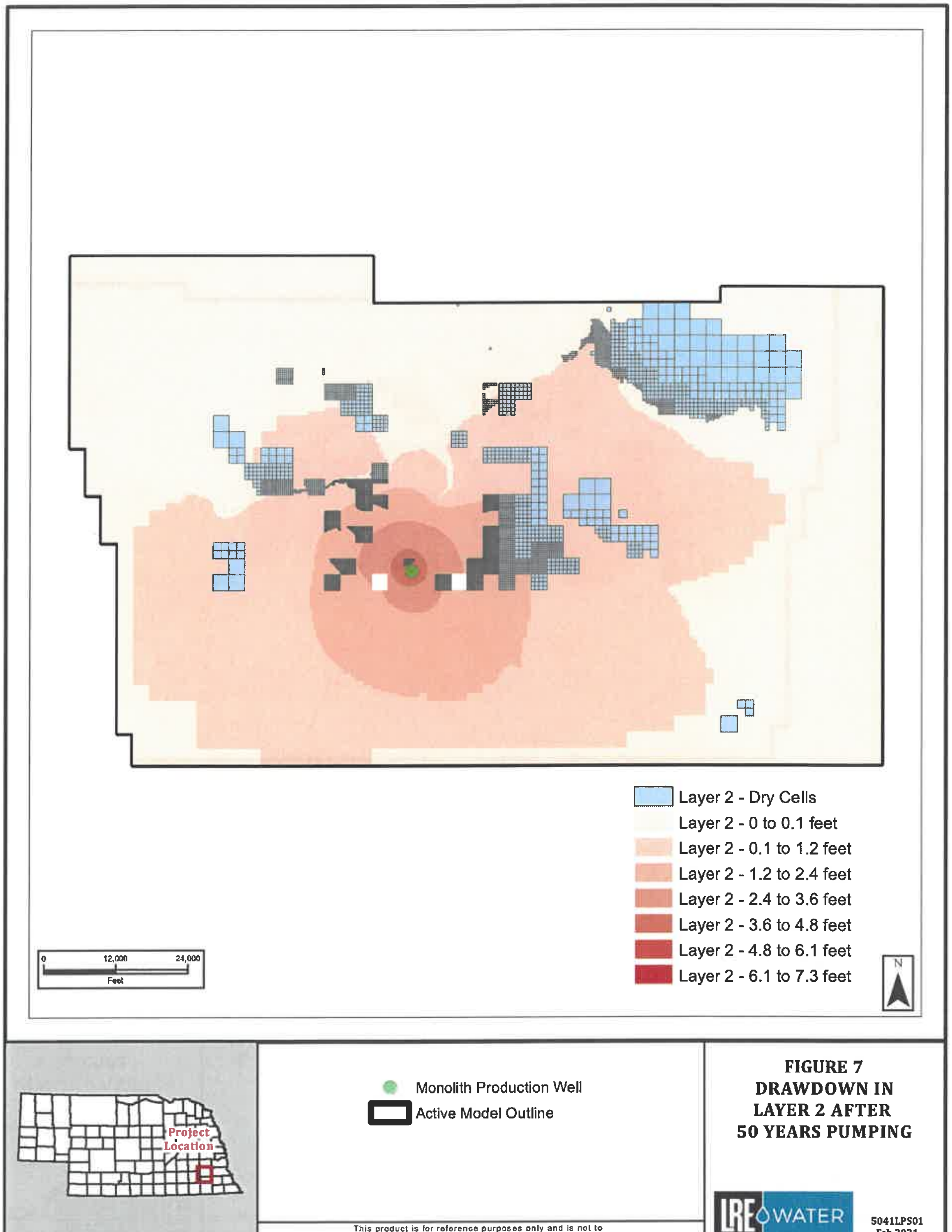
Active Model Outline

This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

FIGURE 6
DRAWDOWN IN LAYER 1 AFTER 50 YEARS PUMPING

LRE WATER

5041LPS01
Feb 2021

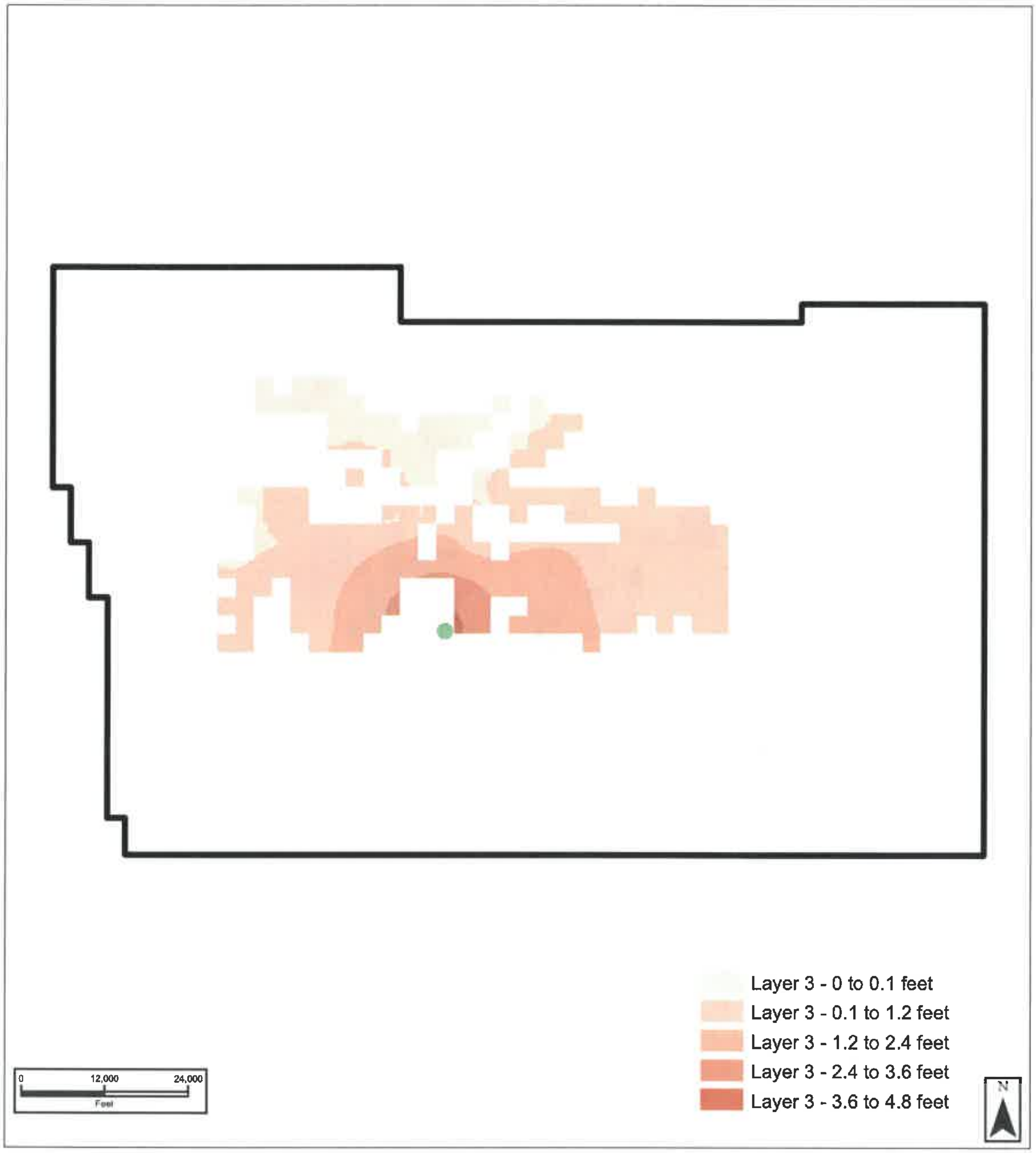


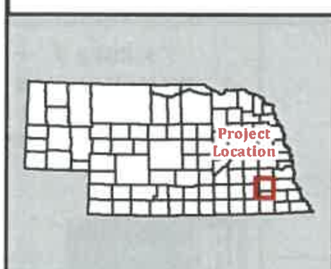
This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

FIGURE 7
DRAWDOWN IN LAYER 2 AFTER 50 YEARS PUMPING

LRE WATER

5041LPS01
Feb 2021





Monolith Production Well

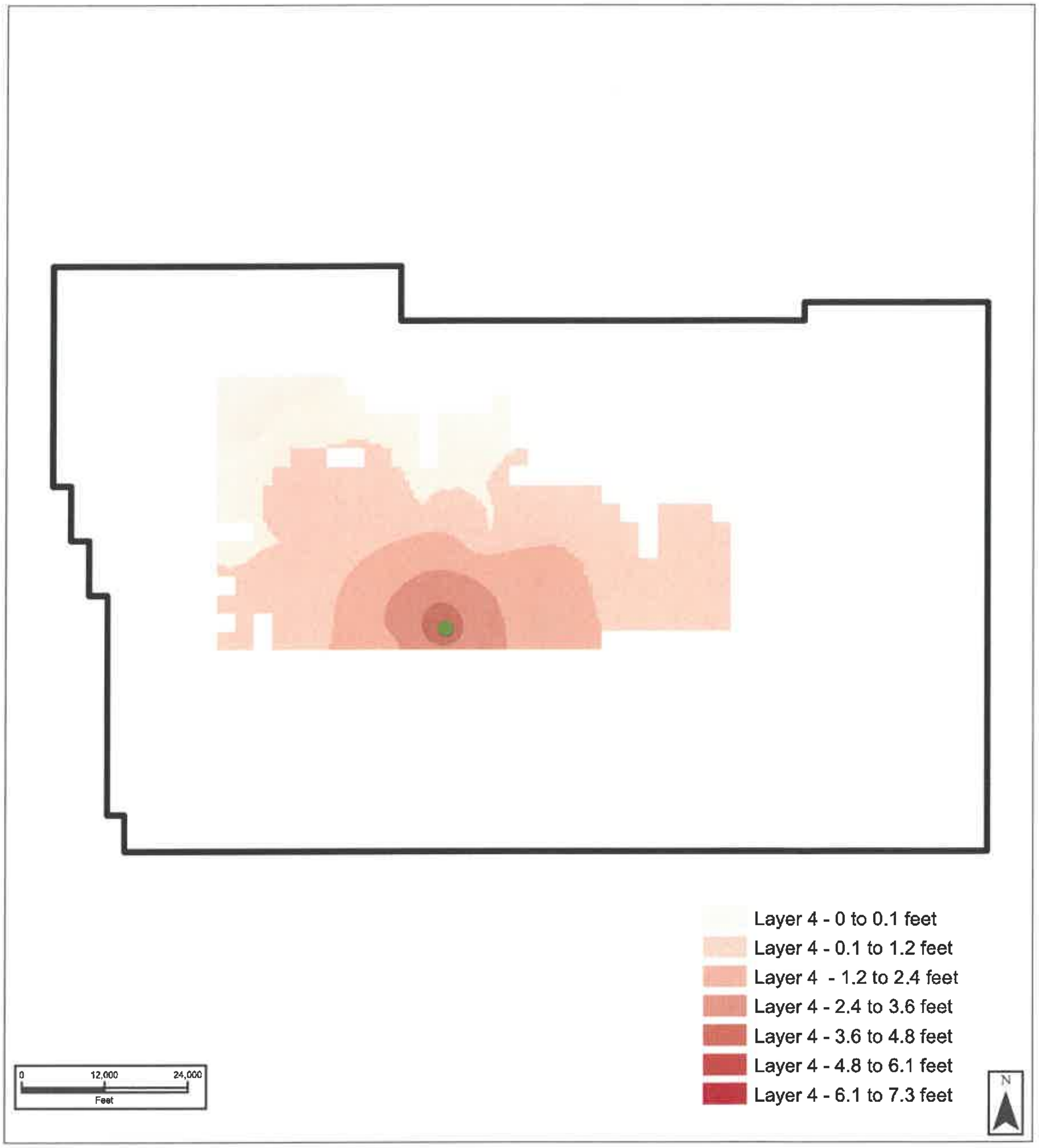
Active Model Outline

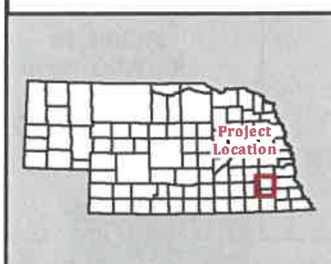
This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

FUIGURE 8
DRAWDOWN IN LAYER 3 AFTER 50 YEARS PUMPING

LRE WATER

5041LPS01
Feb 2021





Monolith Production Well

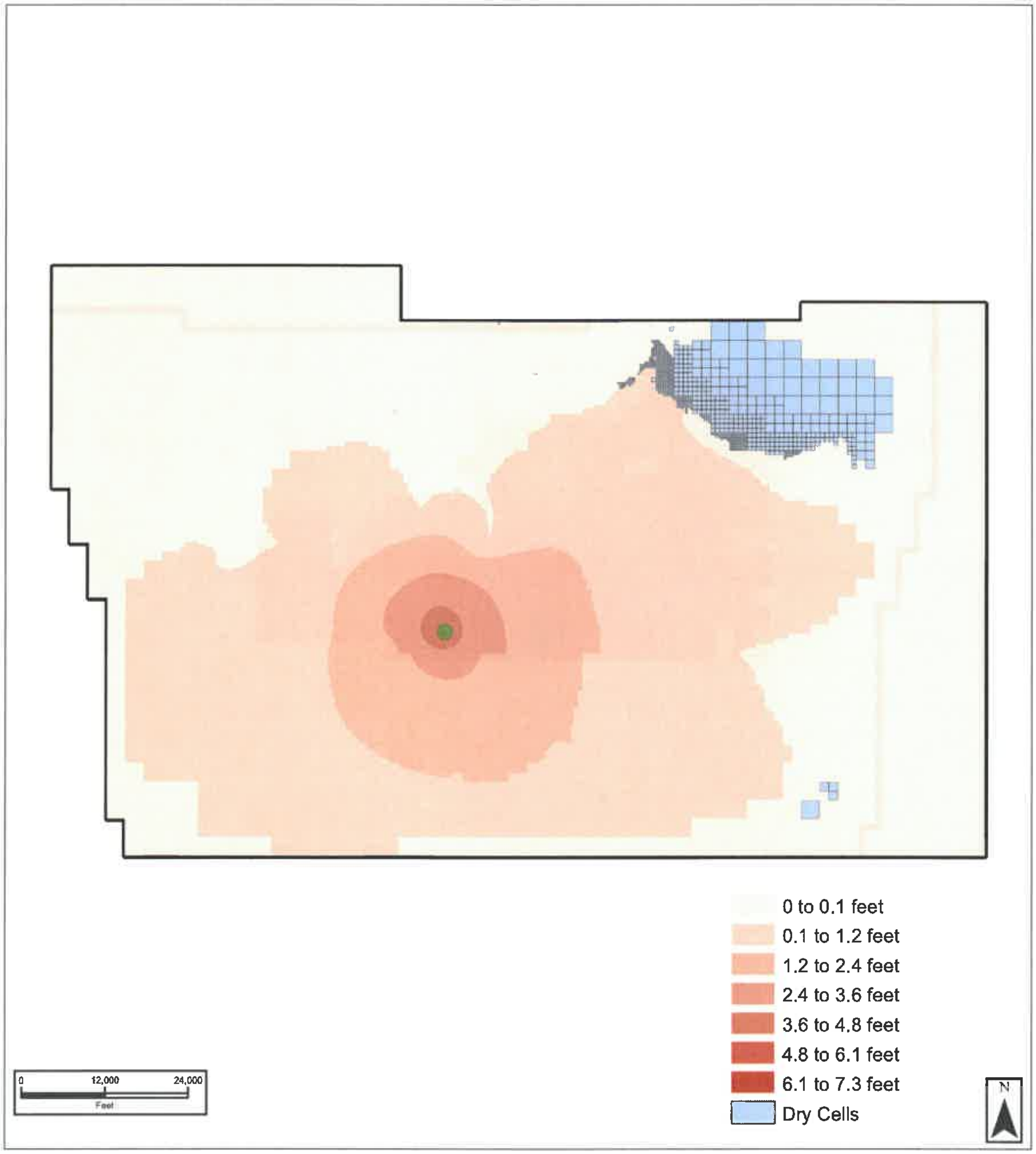
Active Model Outline

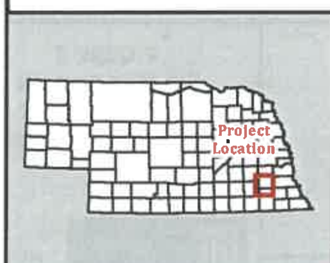
This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

FIGURE 9
DRAWDOWN IN LAYER 4 AFTER 50 YEARS PUMPING

LRE WATER

5041LPS01
Feb 2021





Monolith Production Well

Active Model Outline

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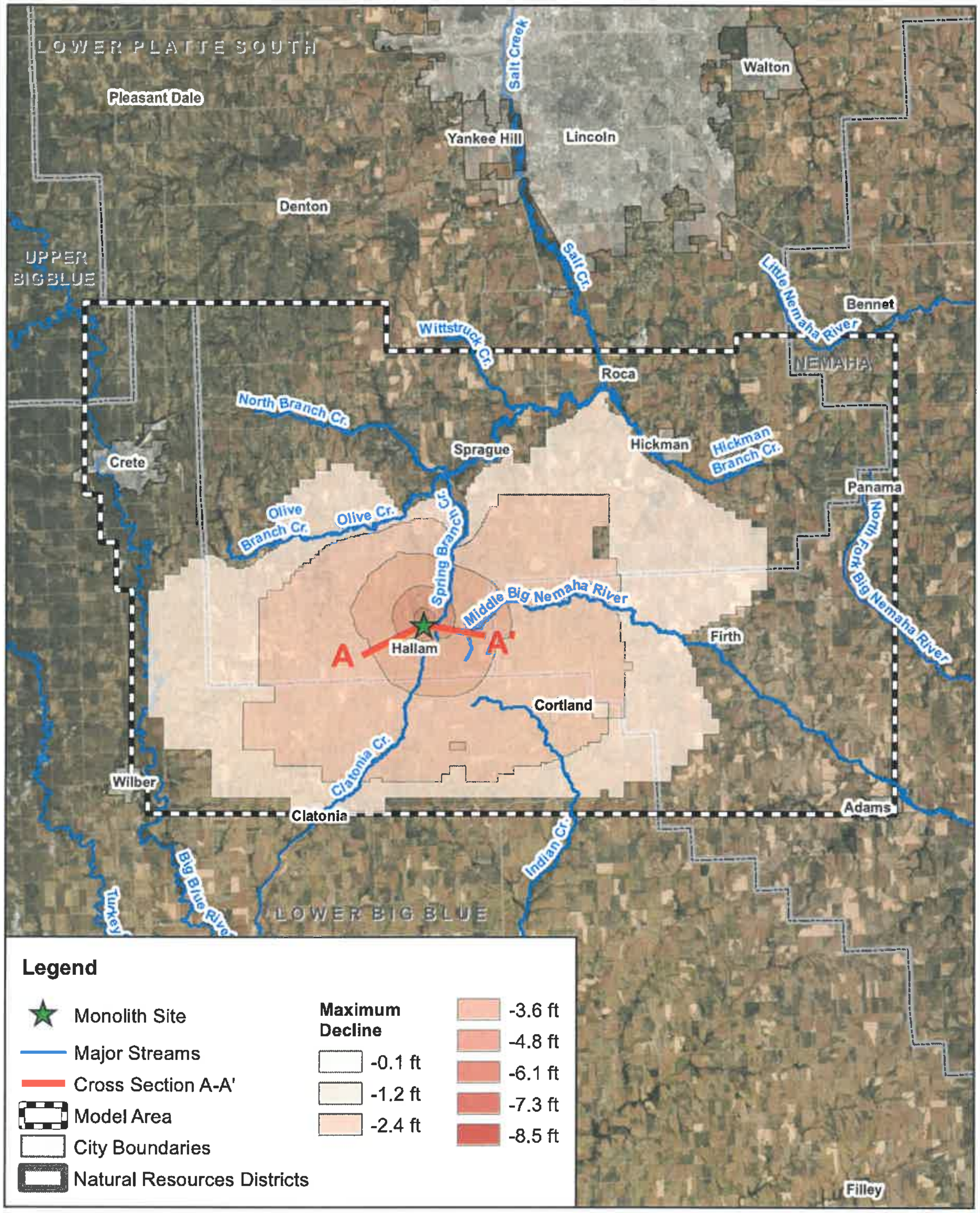
FIGURE 10
DRAWDOWN IN ALL LAYERS
50 YEARS PUMPING

LRE WATER

5041LPS01
Feb 2021

Appendix A



olsson

N

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

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

FIGURE
3.14

F:\2020\2501-3000\020-2639\40-Design\GIS\Maps\FutureScenarioDrawdown.mxd PUBLISHED BY: mmorton DATE: December 07, 2020

CONNECTING WATER TO LIFE

Memorandum

To:	Dick Ehrman and Dan Schulz - LPSNRD
From:	Clinton Meyer, Jacob Bauer - LRE Water
Reviewed by:	Dave Hume - LRE Water
Date:	5/14/21
Project:	Monolith Wells and Pumping Evaluation
Subject:	LRE Water Summary and Response to Olsson's Monolith Hydrogeologic Analysis Report Addendum (Final) and Additional Requested Model Runs

INTRODUCTION

The purpose of this memorandum is to provide the Lower Platte South Natural Resources District (LPSNRD) with LRE Water's (LRE) review of Olsson, Inc.'s (Olsson) Monolith Hydrogeologic Analysis Report Addendum (final Addendum) that was submitted to LPSNRD on April 28, 2021 on behalf of Monolith Materials (Monolith) and in support of Monolith's application for new water supply wells.

The final Addendum was prepared by Olsson following LRE and LPSNRD's review of Olsson's draft Addendum submitted to LPSND on April 2, 2021. The draft Addendum was prepared in response to requests for additional information following review of Olsson's December 2020 Hydrogeologic Analysis Report (Report), and a follow up meeting between with LPSNRD staff, Monolith, Olsson and LRE on April 12, 2021. Following this meeting, Olsson provided the model files that were reviewed by LRE.

COMMENTS ON ADDITIONAL MODEL RUNS

The final Addendum addresses final requests and describes Olsson's additional groundwater model runs that focus on the following, which are referenced herein and defined as follows:

- **Future Scenario A: Three-Well Moderate Demand -** Pumping demand is distributed across three wells at 320 million gallons per year (MGY) or 609 gallons per minute (gpm) each rather than one well as discussed in Olsson's Report.
    - This scenario captures the potential drawdown within the CPA aquifer. It is reasonable to expect that the maximum drawdown of the aquifer in the wells

and immediate area of the Monolith facility would decrease if the pumping was distributed spatially in three wells.

- **Future Scenario B: Three-Well High Demand -** Pumping demand is supported using three wells pumping at a combined rate of 762 gpm rather than one well, which supports a potential increase in the total pumping rate due to changes in planned operations at Monolith to 400 MGY.

  - This scenario also captures the potential drawdown within the CPA aquifer. It is reasonable to expect that the maximum drawdown of the aquifer in the wells and immediate area of the Monolith facility would decrease if the pumping was distributed spatially in three wells rather than one.

  - This run shows a minor increase in drawdown further away from the Monolith wells compared to the Original Future Demand run and Scenario A.

- **Future Scenario C: Peak Demand** - Pumping demand is set to 1,200 gpm for a short period during the summer using one well, and was summated by running this on top of the Original Future Demand model in the Olsson's Report.

  - This run represents what Monolith may need to pump (up to 1,200 gpm) during a particularly hot summer. This scenario was represented by using the Original Future Demand run and adding 6 months of pumping from one well at 1,200 gpm from April through August in the 14^{th} year of the 50 year model.

  - Reviewing the interpretations for Scenario C it becomes apparent that any additional drawdowns from a short period of time pumping at 1200 gpm will eventually return to the original overall prediction of total drawdown within 18 months. We agree with this interpretation and do not believe an additional 0.5 feet added to the 8.6 feet is significant.

CONCLUSIONS ON ADDITIONAL MODELING FINAL ADDENDUM

LRE reviewed the final Addendum, and for documentation purposes, we provide the following conclusions regarding Olsson's responses to LRE's recommendations and LPSNRD's Board of Director's motions to Olsson's Report:

1. LRE received output files for the three additional model runs listed above. The output files received were the MODFLOW "WEL" and "LST" files of each run. LRE reviewed these runs and compared them to the Original Future Demand run detailed in Olsson's Report. A summary of the runs are listed in Table 1. Based on our review of the input well pumping files, and the associated model output files, the model files were constructed properly and accurately represent the scenario run.

2. The requested sensitivity runs were completed by Olsson, and it is our opinion that the updated sensitivity runs incorporate a reasonable range of possible model parameters. In our opinion, further sensitivity runs are not required.

3. The explanation and directions provided by Olsson on the replication of future drawdown simulations are acceptable.

4. Olsson provides drawdown maps and drawdown versus time plots for Scenario A and Scenario B, and a difference drawdown over time graph for Scenario C.

5. In general, our opinion is that the additional model runs and information provided in the final Addendum capture the requests of the LPSNRD staff, LPSNRD Board of Directors, and LRE. The fact that the three-well models only have a constant pumping rate throughout the model time period as opposed to the variable rate based on predicted demand likely would not change the overall maximum drawdown after the 50 year period aside from some extremely local effects near Monolith's pumping well(s).

6. The additional information submitted regarding the upward gradient from the lower bedrock aquifers is sufficient and addresses the potential for large-scale changes in the upward gradient leading to regional issues in TDS values. Some small increases in TDS are a possibility in the immediate vicinity of the Monolith wells,

but these increases are unlikely to lead to regional issues. Monolith's groundwater monitoring plan will also be in place to monitor for possible changes in quality.

7. The monitoring and well interference protection plans described within Olsson's Addendum will provide protection to other water users and a reasonable level of aquifer monitoring to trigger and identify if drawdown from Monolith's pumping is exceeding threshold values. Upon implementation, the monitoring plan will track drawdown of Monolith's three-well pumping system over the next 50 years.

8. In LRE's opinion, the Report and Addendum addresses Monolith future water use on the CPA aquifer and accounts for the possible effects from climate change.

9. The final Addendum addresses all of LRE's original recommendations and questions.

TABLE 1. SUMMARY OF MODEL RUNS PROVIDED

Model Run	Scenario/ Model Run Name	Average Monolith Pumping Rate For 50 Years (MGY)	Percent Difference in Pumping from Original Model Reviewed	Note on Pumping Rate	Number of Monolith Wells Pumping	Predicted Maximum Drawdown Produced by Olsson
1	Original Future Demand*	312.64	-	Each time step has variable Monolith pumping based off of what Olsson considered to be predicted demand peaking one month at 774 gpm	1	Olsson's Dec. 2020 Draft Hydrogeologic Analysis Report: 8.5 feet
2	Scenario A: Three-Well Moderate Demand	320	2.35%	Constant pumping at every time step divided into 3 wells (i.e., combined sustained rate = 609 gpm, or 203 gpm each)	3	Final Addendum: 6.8 feet
3	Scenario B: Three-Well High Demand	400	27.30%	Constant pumping at 762 gpm every time step divided into 3 wells (i.e., combined sustained rate = 762 gpm)	3	Final Addendum: 8.6 feet
4	Scenario C: Original Future Monolith with Peak Demand	315.54	0.93%	Each time step has variable Monolith pumping based off of what Olsson considered to be predicted demand with 6 months of pumping at 1,200 gpm starting in April of the 14th year of the 50 year simulation	1	~ 0.5 feet additional drawdown at the Hallam wells

* LRE also received a Calibration Model to the Olsson Future Monolith Prediction, but that is not discussed here.
MGY - Million gallons per year

Summary of Communication

Nebraska State Legislature

SENATOR TOM BRANDT

District 32
State Capitol
PO Box 94604
Lincoln, Nebraska 68509-4604
(402) 471-2711
tbrandt@leg.ne.gov

COMMITTEES

Vice Chairperson - Agriculture
General Affairs
Judiciary
Building Maintenance

April 20, 2021

Lower Platte South Natural Resources District Board of Directors
c/o Paul Zillig
3125 Portia Street
Lincoln, NE 68521

RE: Monolith Well Permit Application

Dear Lower Platte South Natural Resources District Board of Directors,

Please accept this letter supporting Monolith's application for a well permit for its Olive Creek expansion project.

The Olive Creek 2 (OC2) facility will lead the nation – and in some cases, the world – in cleanly made carbon black, green hydrogen and low-carbon ammonia production. As a world-class, first-of-its-kind facility, OC2 will be a model that shows essential everyday materials can be created profitably while also meeting stringent marketplace and decarbonization demands.

I've discussed the results of the hydrogeological analysis conducted by Olsson with Monolith. I considered their results as both a state senator and an ag producer in the area. I'm satisfied the modeling supports the conclusion of minimal groundwater impact. I also believe Monolith's ongoing well monitoring efforts and offer of well protection agreements with area landowners, the Village of Hallam and NPPD are further evidence of their desire to be good stewards of the environment and good neighbors to those around them.

Over the last year, I've had the chance to meet with Monolith leadership on several occasions and tour their existing facility. I'm gratified by their unwavering commitment to safety, environmental transformation and transparency. That includes acknowledging those times when their facility is not meeting expectations and taking appropriate corrective actions.

Finally, there's no denying the significant, positive economic impact of OC2. A recent analysis by Dr. Eric Thompson at UNL's Bureau of Business Research indicates that the annual economic impact of OC2 is $338.9 million, including the creation of 264 jobs at the OC2 site and another 584 indirect jobs to support it.

I strongly encourage you to approve Monolith's well permit application for the OC2. Please don't hesitate to contact my office if you have any questions or concerns about my support.

Sincerely,

Tom Brandt

Senator Tom Brandt

Nebraska Public Power District

"Always there when you need us"

April 19, 2021

Mr. Paul Zillig, Manager
Lower Platte South NRD
PO Box 83581
3125 Portia Street
Lincoln NE 68521

Dear Mr. Zillig:

RE: Monolith Industrial Well Application

Nebraska Public Power District (NPPD) supports Monolith in their efforts to receive approval for an industrial well permit from the Lower Platte South NRD.

Monolith has kept NPPD informed throughout their groundwater impact modeling efforts and it is NPPD's opinion that Monolith's proposed industrial wells will not negatively impact NPPD's industrial wells used at Sheldon Station.

If you have any comments or questions, please contact me at my office (402) 563-5355 or on my cell phone (402) 910-7337.

Sincerely,

Joe L. Citta, Jr.
Director of Corporate Environmental
and Water Resources

cc: Deborah Eagan, LPSNRD Board of Directors Chair
Chris Cerverny, NPPD - Sheldon Station

GENERAL OFFICE
1414 15th Street / P.O. Box 499 / Columbus, NE 68602-0499
Telephone: (402) 564-8561 / **Fax**: (402) 563-5527
http://www.nppd.com

LPS NRD Water Resources Committee

October 14, 2020

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MONOLITH

1

Monolith Vision

Build a PROFITABLE and ENVIRONMENTALLY TRANSFORMATIVE business through INNOVATIVE TECHNOLOGY that produces ESSENTIAL EVERYDAY PRODUCTS delivered through PARTNERSHIPS WITH CUSTOMERS around the world.

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3

Contents

- Olive Creek Project
- OC2 Water Usage
- Modeling Update

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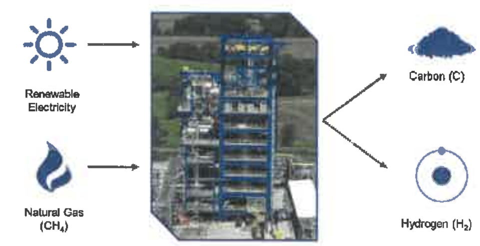
2

Monolith Market Approach

Low CO_2 Hydrogen & Carbon from Natural Gas



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4

The Olive Creek 1 Facility

Olive Creek 1 (OC1) Facility	
Capacity	14,000 tonnes/year
Completed	June 2020
Water Usage	23 million gallons/year
Jobs Created	40 full time
Investment	~$100M

OC1 is the first commercial scale, greenfield, carbon black production facility built in the U.S. in over 50 years, and the largest CO_2 free stand-alone hydrogen plant in the country.

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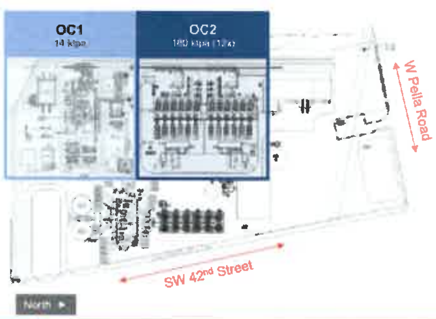
5

Proposed Olive Creek 2 (OC2) Facility



Olive Creek 2 (OC2) Key Metrics	
Ammonia	275,000 tonnes/yr
Carbon Black	180,000 tonnes/yr
Employment	100 direct; 500 indirect
Energy	100% renewable electricity
Anticipated Water Usage	320 – 400 million gallons/year
Construction Begin/End	Q2 2021/2024
Investment	>$1 billion

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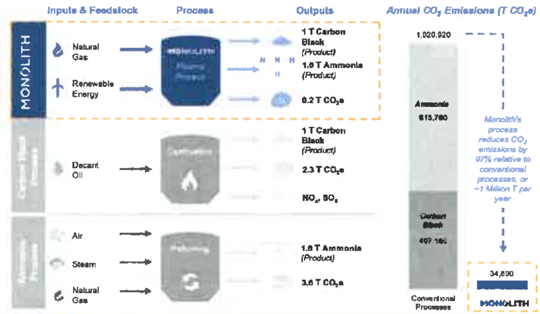
Clear Environmental Advantages



For reference changing to an Electric Vehicle saves 2.5 T of CO_2 per year.

The Olive Creek project has an equivalent CO_2 benefit as swapping 400,000 vehicles to Electric. More than all of Lancaster County's vehicles combined.

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7

OC2 Water Usage

- **Expected annual water usage**
  - 1,000-1,225 acre-feet per year (320-400 million gallons/year)
  - Cooling water system design is substantially complete.
  - No additional changes are expected to annual water usage.

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OC2 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

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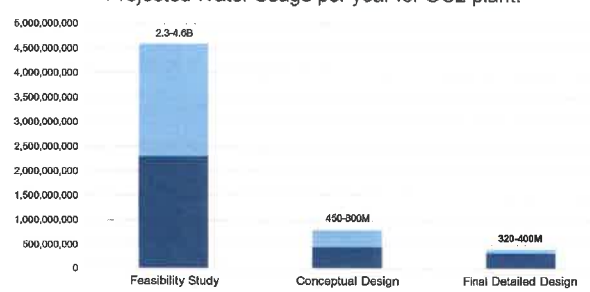
OC2 Water Usage Design Development

Projected Water Usage per year for OC2 plant.



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10

Water Modeling Update

- **Aquifer pump test** completed in September. Data was submitted to LPSNRD.
- **Groundwater modeling project** is currently underway with Olsson.
  - Target December 1, 2020, completion.
  - Analyzing 20- and 50-year impact on Crete-Princeton-Adams aquifer
  - Hydrogeologic analysis report to be submitted to the Lower Platte South Natural Resources District (LPSNRD) as required to complete the well permitting process.

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Water Modeling Background

- **Provide a holistic picture of Crete-Princeton-Adams aquifer**
  - Model impacts out 20-50 years
  - Evaluate entire aquifer in LPSNRD, not just localized impact
  - Considers sustaining all water users into the future
- **Leadership/Innovation**
  - Dr. Jim Schneider – 20+ years, former deputy director of NDNR
  - Brian Dunnigan – Nearly 40 years, former director of NDNR
  - Olsson proprietary Groundwater Evaluation Tool (GET)
- **Comprehensive Reporting/Transparency**
  - Construction & calibration of groundwater flow model
  - All refinements
  - Scenarios analysis
  - Allows for full replication

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12

Groundwater Flow Modeling - Timeline

- Initial Model Construction – **Complete**
- Refined Model Construction – *In Process*
- Model Calibration – *In Process*
- Modeling Report – Early November
- Modeling Scenarios – Late November
- Submission of final Hydrologic Analysis Report - Target Dec. 1, 2020

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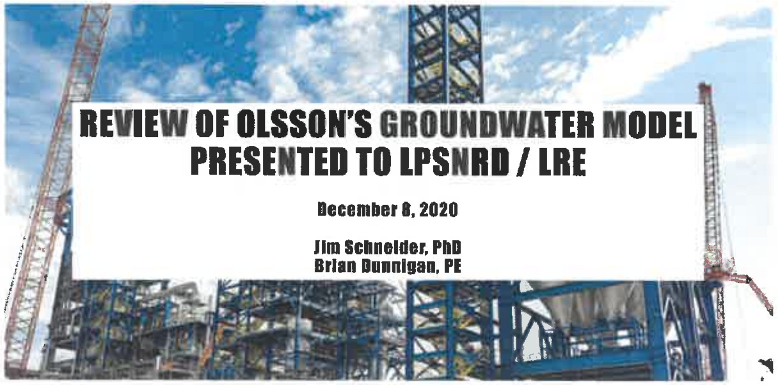

REVIEW OF OLSSON'S GROUNDWATER MODEL PRESENTED TO LPSNRD / LRE

December 8, 2020

Jim Schneider, PhD
Brian Dunnigan, PE

olsson

1

Hydrogeologic Analysis Report

- The requirements for a Class 2 permit shall be as follows and shall be included with the application:
  - (5) A hydrogeologic analysis report considering 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 shall be submitted by the Applicant.
- An application for a permit or late permit for any water well in a Ground Water Reservoir shall be granted unless the District finds any of the following conditions:
  - (vii) For a Class 2 Permit:
    - (A) ***The hydrogeologic analysis indicates potential short or long-term detrimental effects 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; and/or

olsson

2

olsson

3

olsson

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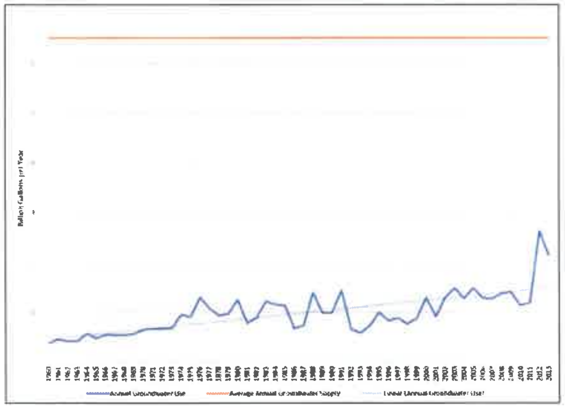
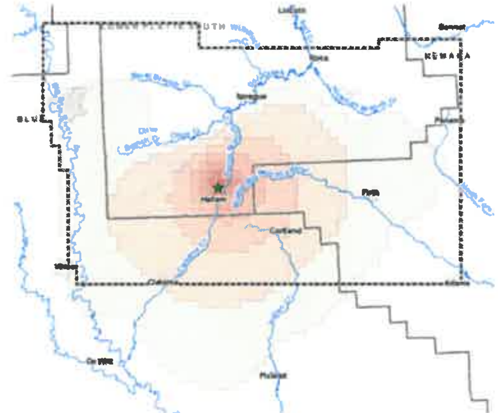

Annual Groundwater Use

5



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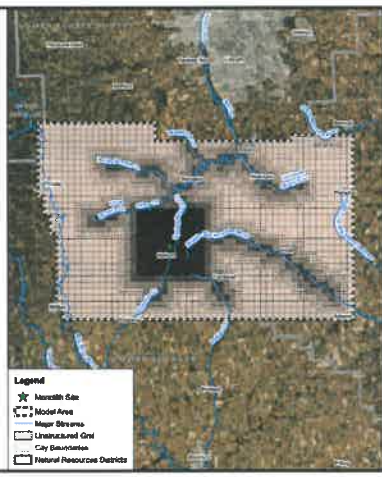
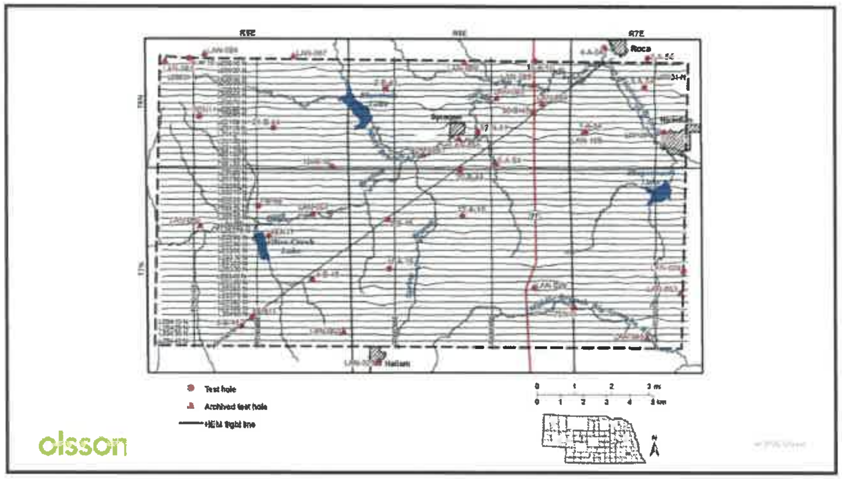

Legend
Monolith Site
Model Area
Major Streams
Unstructured Grid
City Boundaries
Natural Resources Districts

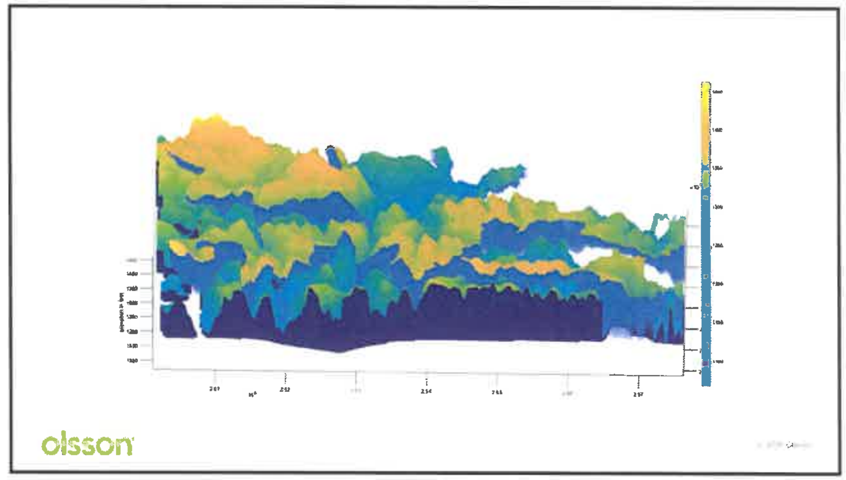
7


Legend
Monolith Site
Major Streams
Model Area
Unstructured Grid
City Boundaries
Natural Resources Districts

8


R5E
R6E
R7E
Roca
Hallam
Test hole
Archived test hole
HEM flight line
0 1 2 3 mi
0 1 2 3 4 5 km
olsson

9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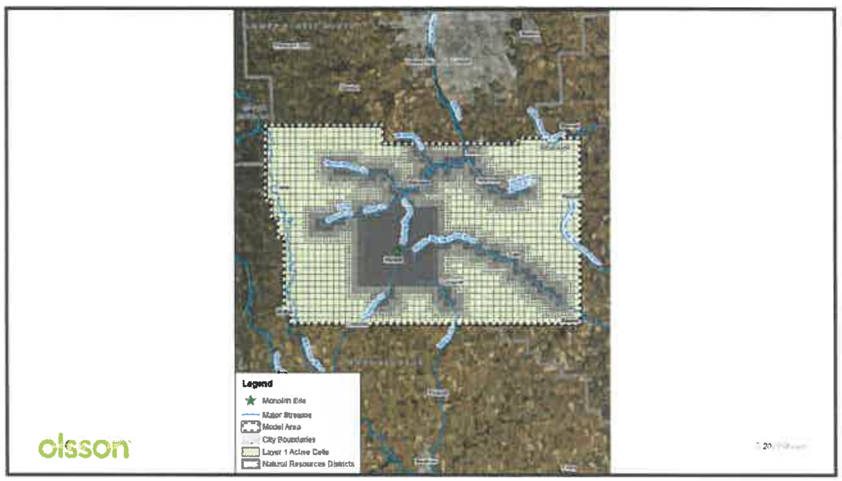
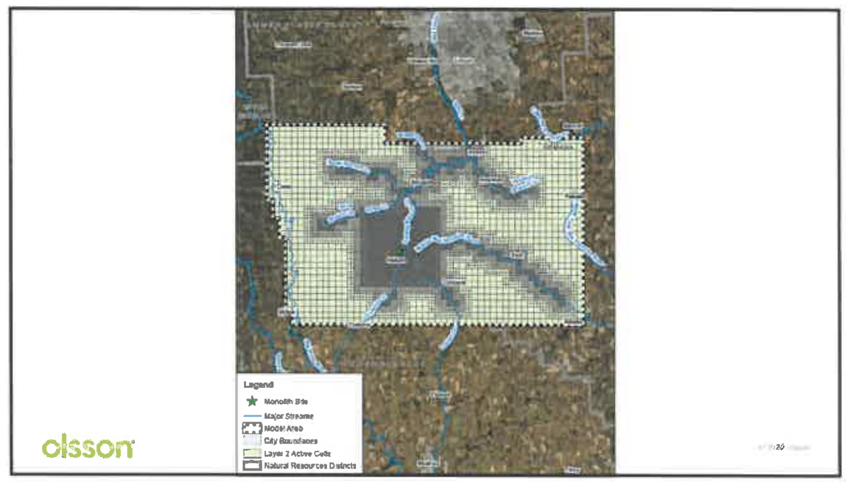

Legend
Monolith Site
Major Streams
Model Area
City Boundaries
Layer 1 Active Cells
Natural Resources Districts
olsson

11


Legend
Monolith Site
Major Streams
Model Area
City Boundaries
Layer 2 Active Cells
Natural Resources Districts
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12

olsson

13

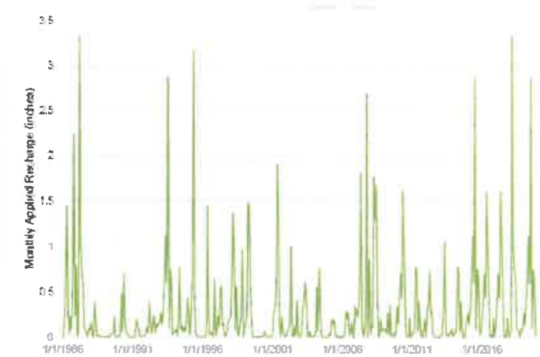
olsson

14

olsson

15

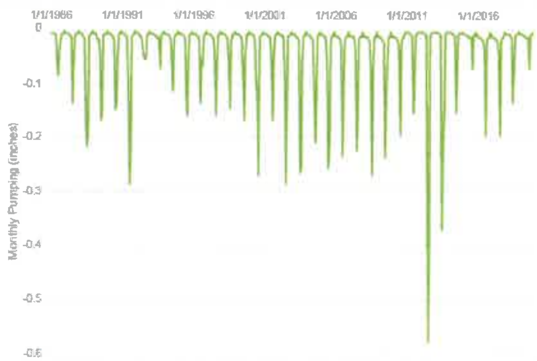
- Average Annual Recharge = 3.14 inches per year



olsson

16

- Average Annual Pumping = 0.4 inches per year
- This is based on all acres in model, not just irrigated acres



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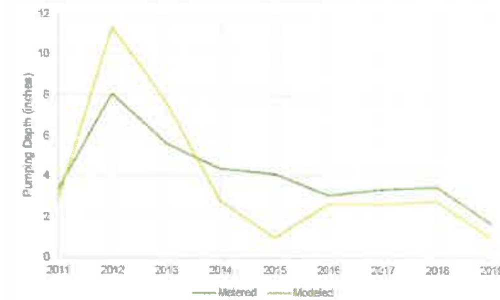
17

- Total metered = 37.1 inches
- Total modeled = 34.6 inches



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18

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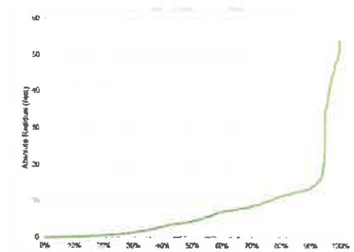
19

Calibration Results

Calibration Parameter	Result (ft)
Residual Mean	0.69
Absolute Residual Mean	7.26
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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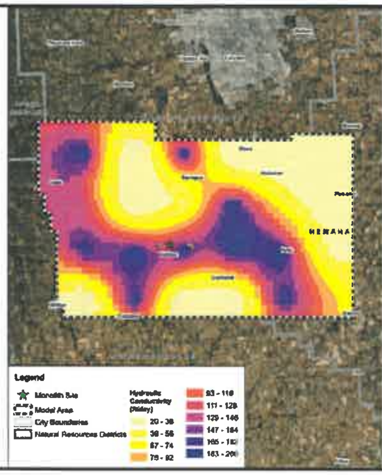
20



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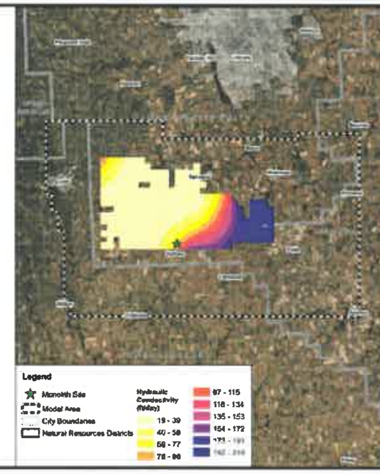

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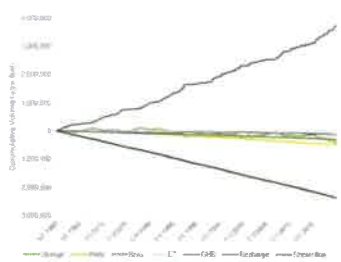
22

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



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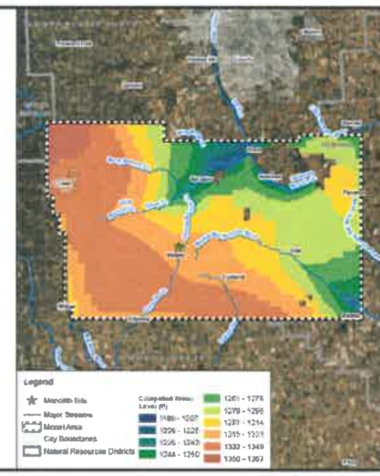

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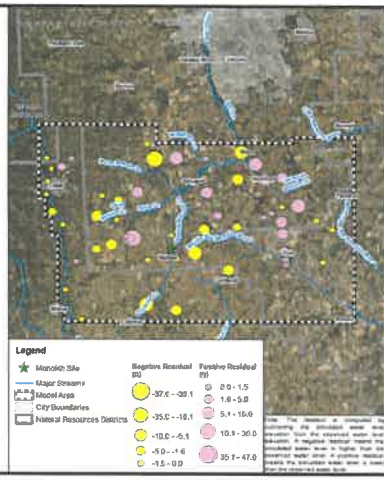

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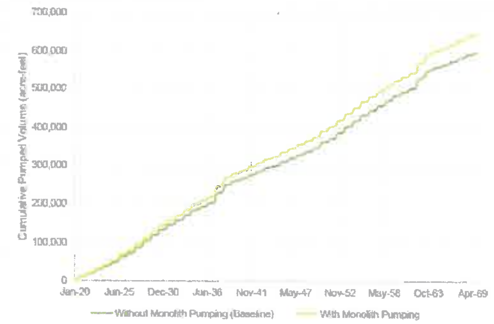
25

Future Scenario

- Future Baseline Pumping = ~12,000 acre-feet per year
- Monolith Average Pumping = ~960 acre-feet per year



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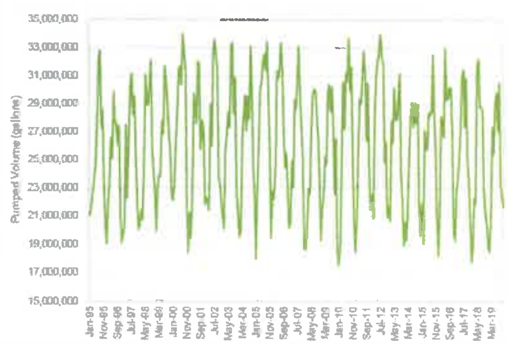
26

Future Scenario

- Monolith computed monthly pumping range based on expected cooling needs
- Used ranges and historic Temperatures to estimate future pumping schedule



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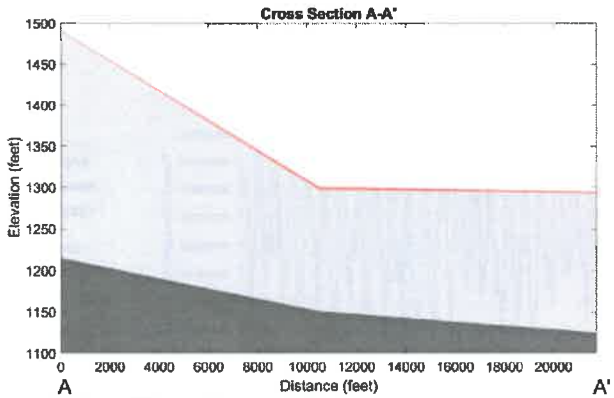

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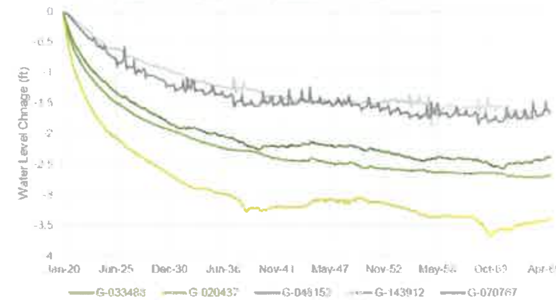
29

Nearby Irrigation Wells



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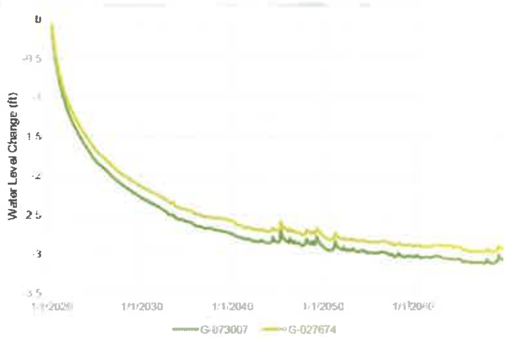
30

Hallam Municipal Wells



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31

Conclusion

- Hydrogeologic analysis indicates ***No*** potential short or long-term detrimental effects to the aquifer

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32

Questions?

33

34

Monolith Presentation to LPS NRD

March 2, 2021

MONOLITH

1

Discussion

- Company Overview
- Permitting Summary
- Hydrogeologic Analysis
- Questions

MONOLITH

2

Founded on Three Sound Principles

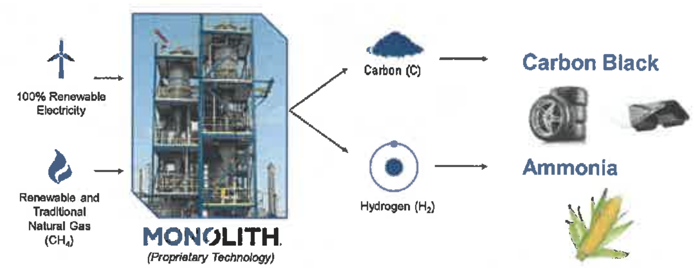
Monolith has developed a differentiated, proven and protected technology platform to upgrade natural gas to hydrogen and carbon products in a financially viable and environmentally advantaged way

3 MONOLITH

3

Monolith Market Approach

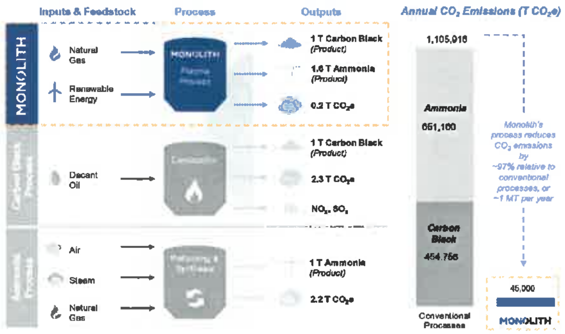
Low CO_2 Hydrogen & Carbon from Renewable Electricity and Natural Gas



4 MONOLITH

4

Olive Creek 2: Clear Environmental Advantages



The Olive Creek project has an estimated equivalent CO_2 benefit as swapping 400,000 gas-powered vehicles to electric every year.

Source: Environmental Protection Agency (EPA)

5

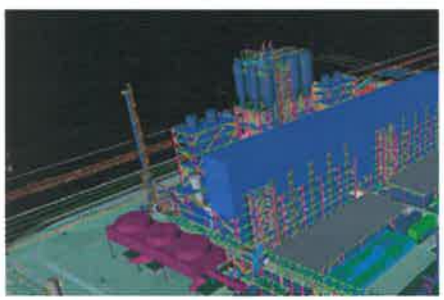
Olive Creek 1 Facility

Olive Creek 1 (OC1) Facility	
Capacity	14,000 tonnes/year
Completed	June 2020
Jobs Created	40+ full time jobs
Investment	~$100M

OC1 is the full first commercial scale, greenfield, carbon black production facility built in the U.S. in over 60 years, and the largest CO_2 free stand-alone hydrogen plant in the country.

6

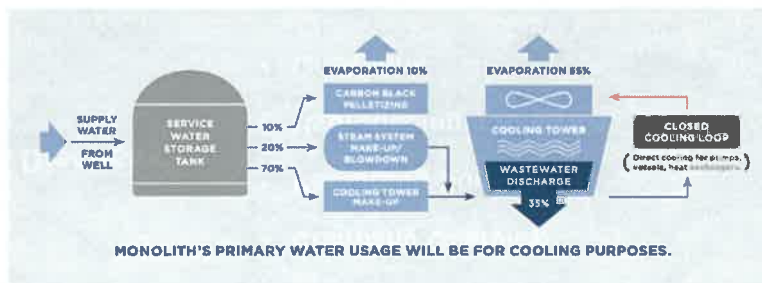
Proposed Olive Creek 2 (OC2) Facility



Olive Creek 2 (OC2) Anticipated Metrics	
Ammonia	275,000 tonnes/yr
Carbon Black	180,000 tonnes/yr
Employment	100 direct; 500 indirect
Energy	100% renewable electricity
Complete Construction	Q1 2024

7

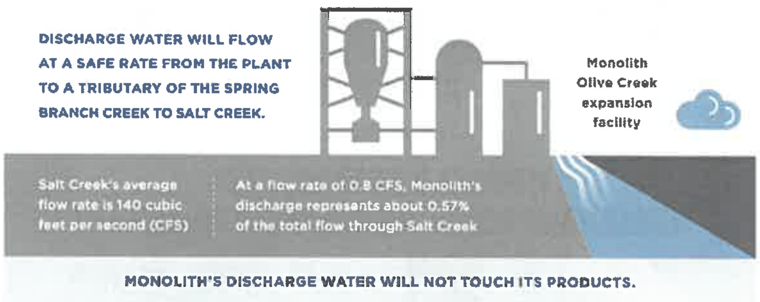
Water Usage



Not all stages of cooling water flow shown here. This illustration highlights some key stages.

8

Clean Discharge Water



9 MONOLITH

9

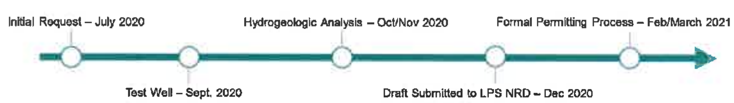
Current Permitting for OC2

- **Nebraska Dept. of Environment & Energy**
  - NPDES/Discharge Water Permit
- **Lancaster County**
  - Air permit
- **Village of Hallam**
  - Special Use Permit
- **Lower Platte South Natural Resources District**
  - Well/Groundwater Permit

10 MONOLITH

10

Monolith Permit Application Overview



- Preliminary well permit issued July 2020
  - 800 gpm well
  - Initiate testing required and the hydrogeologic analysis
  - Acknowledged likely need for additional wells

11 MONOLITH

11

Monolith Permit Application Overview

- Total annual usage: 320 – 400 million gallons/1,000 – 1,250 acre-feet
- Engineering determined need for a total of 3 wells
  - Includes the preliminary well and 2 additional wells
- The 2 additional wells support proper well operation and redundancy
  - Currently drilling two additional test borings
    - Near original well site – verify geology in those locations
  - Additional permits for these two wells will be filed with the final application

12 MONOLITH

12

Community Engagement

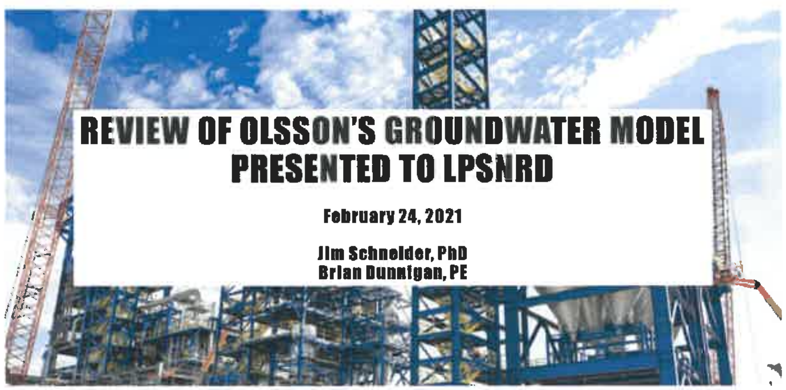
- Village of Hallam
- Hallam Area Landowners
- Nebraska Public Power District (NPPD)
- Surrounding NRDs
- Lancaster County Board
- City of Lincoln – Mayor's Office, Lincoln Transportation and Utility
- State of Nebraska – Department of Environment & Energy, Dept. Of Natural Resources, State Senators (including Brandt/Dorn)
- Federal Delegation

13

Hydrogeologic Analysis

A closer look at Monolith's groundwater usage

14



15

Hydrogeologic Analysis Report

- The requirements for a Class 2 permit shall be as follows and shall be included with the application:
  - (5) A hydrogeologic analysis report considering 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 shall be submitted by the Applicant.
- An application for a permit or late permit for any water well in a Ground Water Reservoir shall be granted unless the District finds any of the following conditions:
  - (vii) For a Class 2 Permit:
    - (A) ***The hydrogeologic analysis indicates potential short or long-term detrimental effects 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; and/or

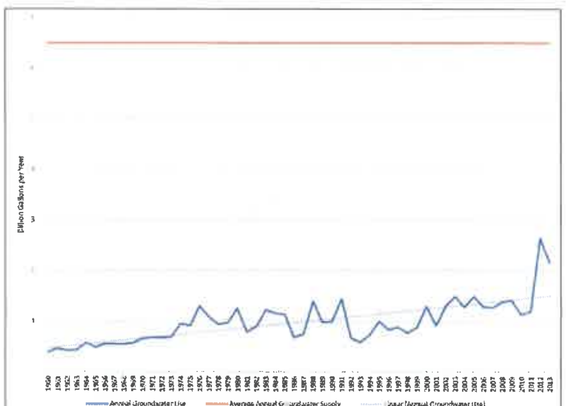
16


Legend
Monolith Site
Major Streams
Model Area
City Boundaries
Natural Resources Districts

17


LEWIS AND CLARK
LOWER ELKHORN
LOWER LOUP
LOWER PLATTE NORTH
LOWER PLATTE SOUTH
Legend
Monolith Site
Major Streams
City Boundaries
Monolith Model Area
LPMT Model Boundary
Natural Resources Districts

18



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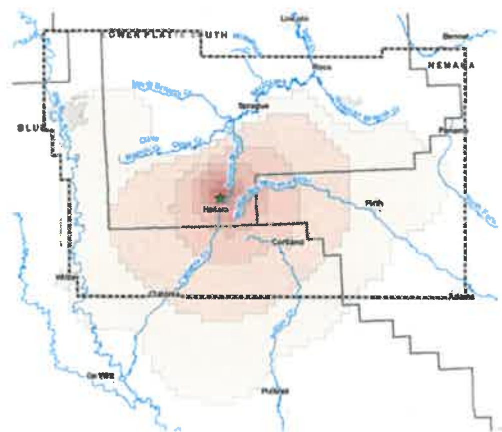
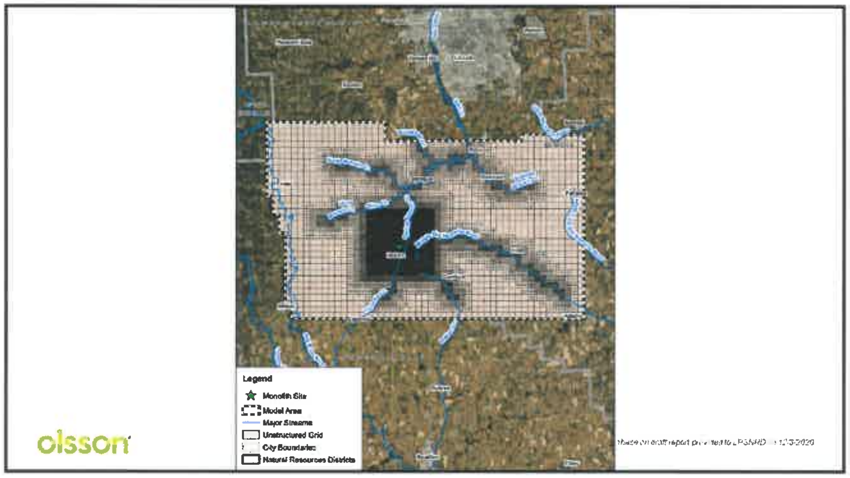
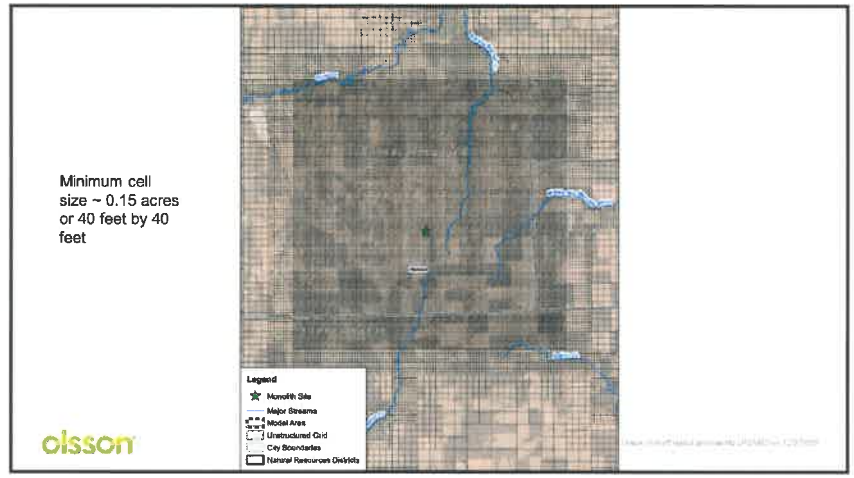

Hallam
Firth
Cortland

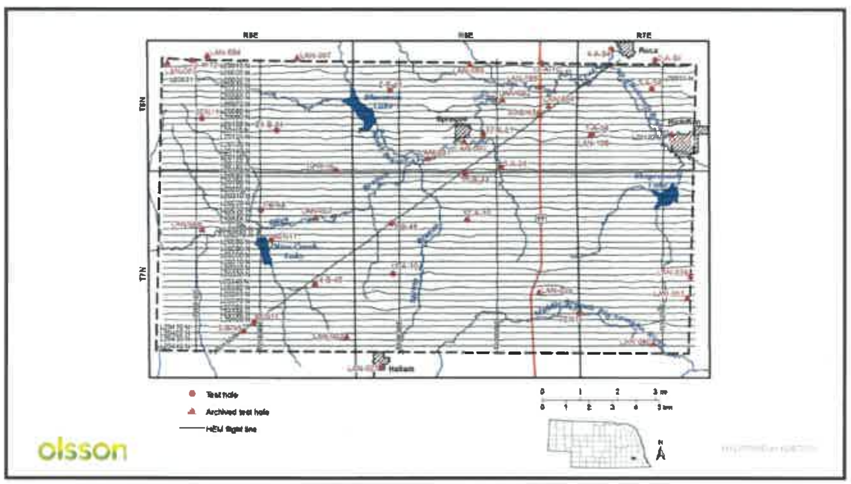
20


Legend
Monolith Site
Model Area
Major Streams
Unstructured Grid
City Boundaries
Natural Resources Districts
olsson

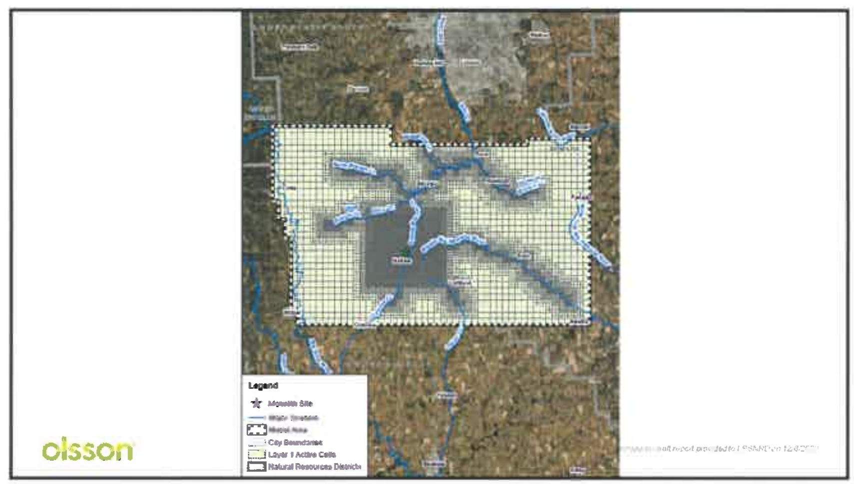
21


Minimum cell size ~ 0.15 acres or 40 feet by 40 feet
Legend
Monolith Site
Major Streams
Model Area
Unstructured Grid
City Boundaries
Natural Resources Districts
olsson

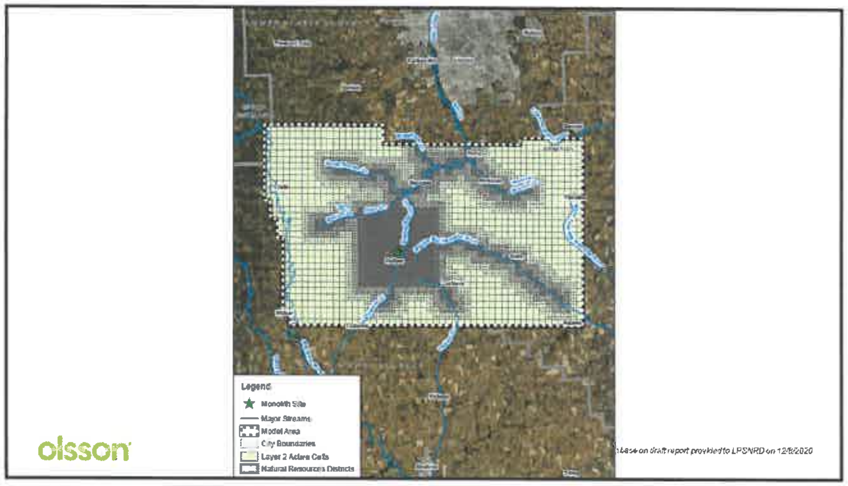
22


R5E
R6E
R7E
Test hole
Archived test hole
HEM flight line
olsson

23


Legend
Monolith Site
Model Area
City Boundaries
Layer 1 Active Cells
Natural Resources Districts
olsson

24


olsson
Legend
Monolith Site
Major Streams
Model Area
City Boundaries
Layer 2 Active Cells
Natural Resources Districts
base on draft report provided to LPSNRD on 12/8/2020

25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Legend
Monolith Site
Major Streams
Model Area
City Boundaries
Layer 3 Active Cells
Natural Resources Districts

26


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Legend
Monolith Site
Major Streams
Model Area
City Boundaries
Layer 4 Active Cells
Natural Resources Districts

27


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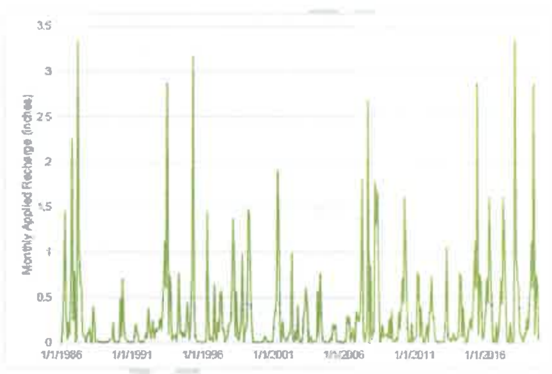
Legend
Monolith Site
Model Area
River Cell
Stream Cell
General Head Boundary Cell
City Boundaries
Natural Resources Districts

28

- Average Annual Recharge = 3.14 inches per year



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29

- Average Annual Pumping = 0.4 inches per year
- This is based on all acres in model, not just irrigated acres
- So, recharge is ~9 times the average annual historic pumping

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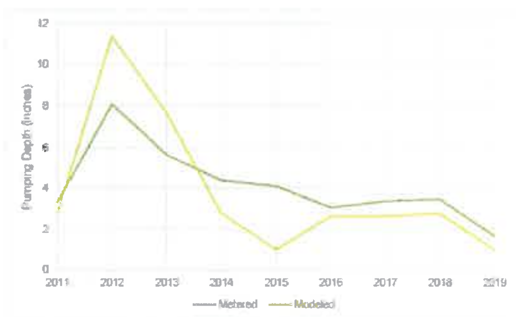
30

- Total metered = 37.1 inches
- Total modeled = 34.6 inches



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31

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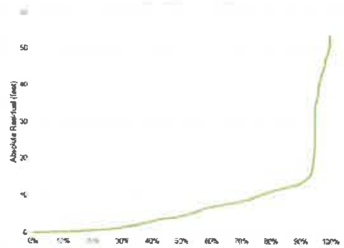
32

Calibration Results

Calibration Parameter	Result (ft)
Residual Mean	0.69
Absolute Residual Mean	7.25
Residual Standard Deviation	12.0
Sum of Squares	361,520
Root Mean Square (RMS) Error	12.1
Minimum Residual	-48.9
Maximum Residual	53.8
Range in Observations	285.4
Scaled Residual Standard Deviation	0.06
Scaled Absolute Residual Mean	0.04
Scaled RMS Error	0.06



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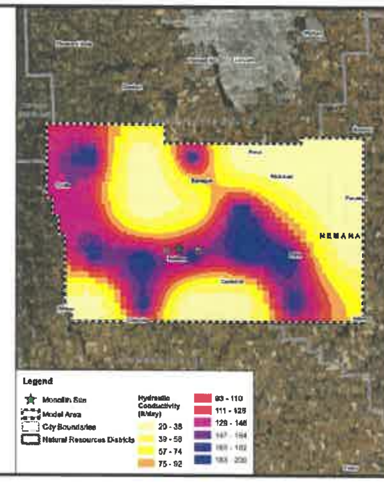
Information based on draft report provided to LPSNRD on 12/5/2020

33



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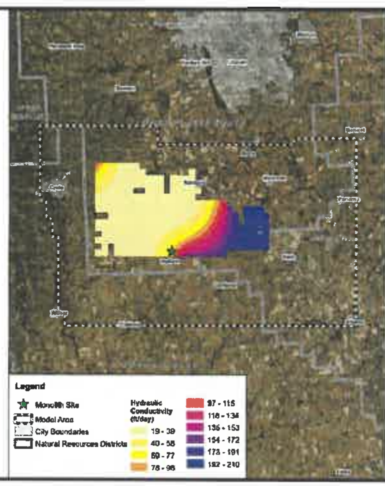
34



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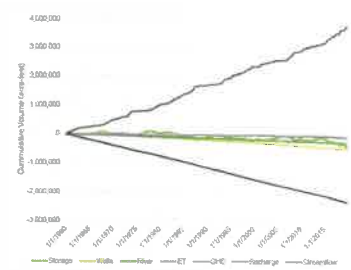
Information based on draft report provided to LPSNRD on 12/5/2020

35

Model Budget Term	Value (acre-feet per year)	Percent of Net Recharge
Storage	-6,722	12%
Wells	-8,058	N/A
River	-5,139	9%
Evapotranspiration	-757	1%
General Head Boundary	-2,305	4%
Recharge	62,414	N/A
Stream Leakage	-39,515	73%
Total	-2	0%

Net Recharge = Recharge + Pumping = ~54,500 acre-feet per year



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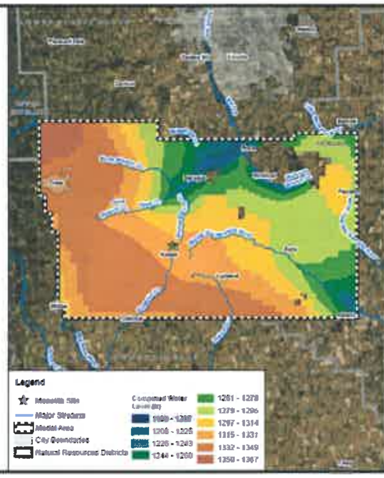
Information based on draft report provided to LPSNRD on 12/5/2020

36



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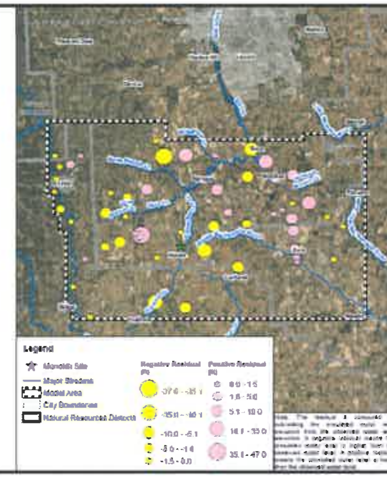
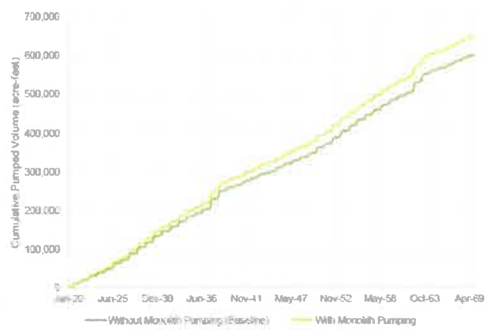


38

Future Scenario

- Average Historical Pumping = ~8,000 acre-feet per year
- Future Baseline Pumping = ~12,000 acre-feet per year
- Monolith Average Pumping = ~960 acre-feet per year
- Combined Pumping of ~13,000 acre-feet per year is ~20% of average annual historical recharge



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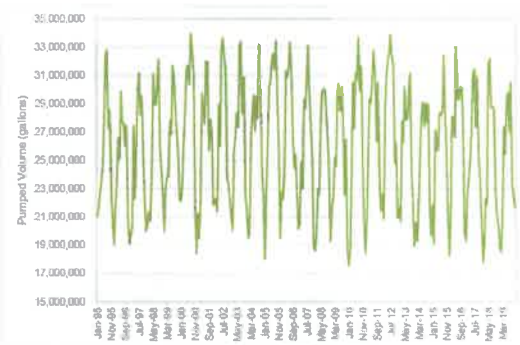
39

Future Scenario

- Monolith computed monthly pumping range based on expected cooling needs
- Used ranges and historic Temperatures to estimate future pumping schedule



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40

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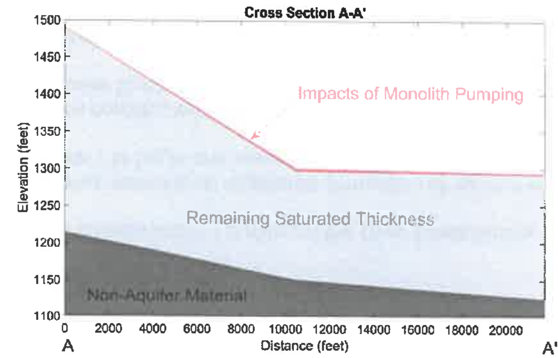
41

40 times
vertical
exaggeration



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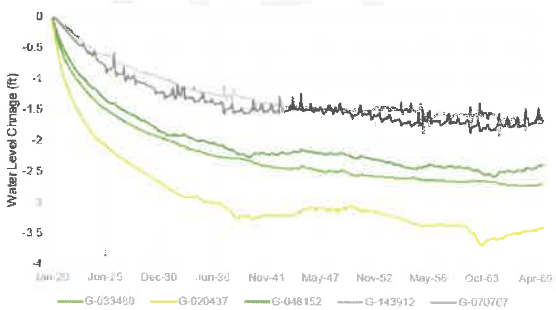
42

Nearby Irrigation Wells



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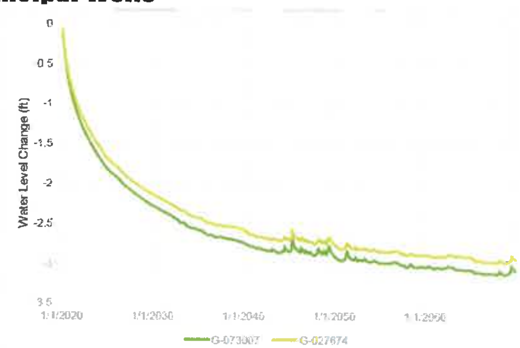
43

Hallam Municipal Wells



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44

What we heard from LRE

- Model is technically sound and acceptable for the intended use.
- Actionable recommendations
  - Additional sensitivity analysis would be good – agree and we have completed that
  - The effects on water quality should be evaluated – report has that, but will expand
  - Desktop assessment of impact to surrounding wells should be conducted – the model already does that
- After we fully review the final report, we will respond to all recommendations and finalize and submit our hydrogeologic analysis

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Information base on draft report [illegible] to LPSNRD on [illegible] 2020

45

Conclusion

- Hydrogeologic analysis indicates *No* potential short or long-term detrimental effects to the aquifer:
  - Science is sound – uses latest modeling supported by the best available data
  - The aquifer recharges, the groundwater is renewable
  - Monolith's expected water use leaves an abundance of available water in the aquifer for future uses

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46

Water Protection Agreements

- While a negative impact is not expected, Monolith has started contact with the Village of Hallam and nearby domestic well owners to offer and discuss entering in to water protection agreements
- Water protection agreements provide a legal framework that outlines the process and conditions under which we will resolve any potential negative water issues that may arise as a direct result of Monolith's water usage

47 MONOLITH

47

Water Protection Agreements

Who is eligible?

- Domestic well owners within 1.5 miles of the Olive Creek facility
- Letters are being mailed to all registered domestic well owners within range by March 1 to begin discussions
- If your well was constructed before 1993 and your well is within 1.5 miles of the Olive Creek facility it may not be registered.
  - Please contact Amy Ostermeyer at amy.ostermeyer@monolithmaterials.com to discuss your domestic well

48 MONOLITH

48

Questions

MONOLITH

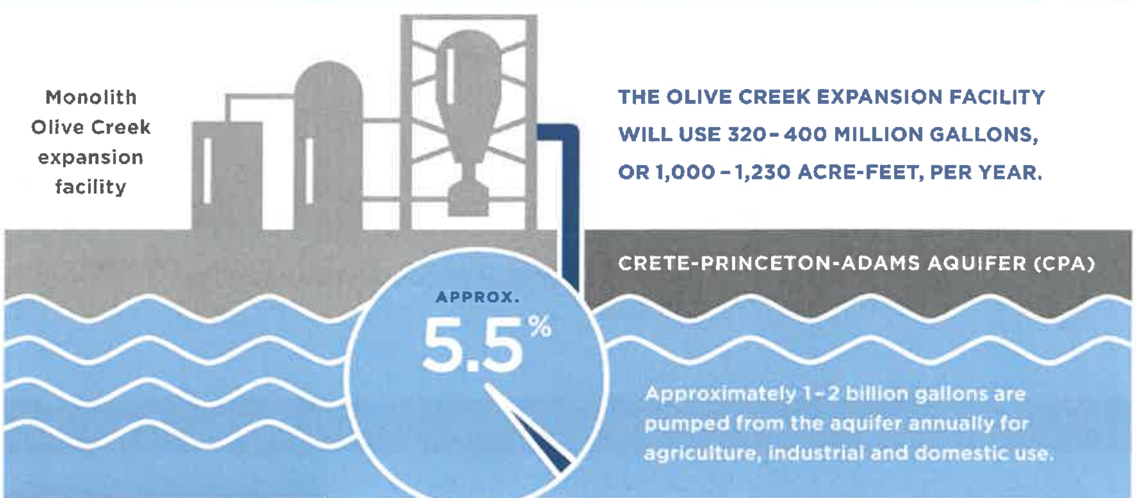
49

OUR WATER STORY

At Monolith, sustainability isn't just about the products we make; it also drives how we manufacture them. We built our company to create environmental transformation through innovative solutions, manufacturing cleanly made carbon black, anhydrous ammonia and hydrogen. That's where our water story begins – using modeling, engineering and technology to reduce water usage by 40% compared to the traditional manufacturing processes for these vital products. In addition, Monolith has gone to great lengths to ensure operations will not negatively impact our state's vital water resources. We commissioned Olsson to conduct a 50-year hydrogeologic analysis of the potential groundwater impact resulting from our proposed Olive Creek expansion.

40%
REDUCTION IN WATER USE

GROUND WATER USAGE — MINIMAL IMPACT



Monolith's water usage equals up to 10 center pivots. Statewide, Nebraska has 55,000*.

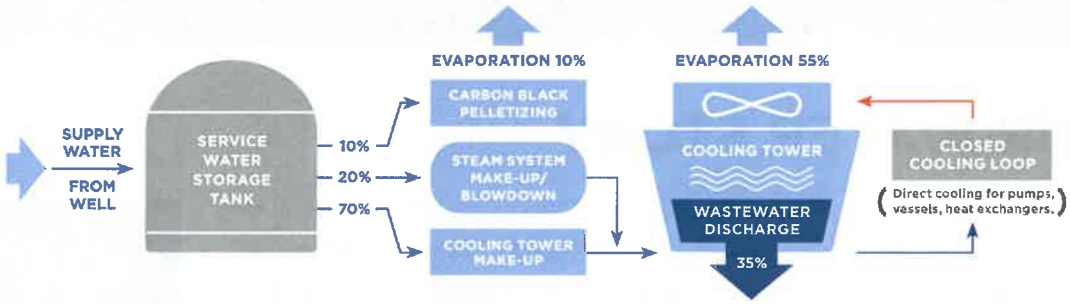
Monolith's usage will represent about 5.5% of the water available in the southern Lancaster County portion of the CPA Aquifer.

Annually, about 6.5 billion gallons of water flow through the southern Lancaster County section of the CPA Aquifer. It is constantly renewed through rainfall, snowmelt and water flowing in from other areas.

*Source: Nebraska Irrigation Fact Sheet, Department of Agricultural Economics, Sept. 2011, Report No. 190

MONOLITH

WATER USAGE



MONOLITH'S PRIMARY WATER USAGE WILL BE FOR COOLING PURPOSES.

Not all stages of cooling water flow shown here. This illustration highlights some key stages.

CLEAN DISCHARGE WATER

DISCHARGE WATER WILL FLOW AT A SAFE RATE FROM THE PLANT TO A TRIBUTARY OF THE SPRING BRANCH CREEK TO SALT CREEK.

Salt Creek's average flow rate is 140 cubic feet per second (CFS)

At a flow rate of 0.8 CFS, Monolith's discharge represents about 0.57% of the total flow through Salt Creek

MONOLITH'S DISCHARGE WATER WILL NOT TOUCH ITS PRODUCTS.

PERMITTING/REGULATING AUTHORITIES

MONOLITH IS SUBJECT TO THE FOLLOWING REGULATORY AND PERMITTING AUTHORITIES FOR BOTH ITS WATER USAGE AND DISCHARGE:

LOWER PLATTE SOUTH natural resources district

EPA United States Environmental Protection Agency

NEBRASKA DEPT. OF ENVIRONMENT AND ENERGY

For more details, visit **monolithmaterials.com/water**