ECF-200W-17-0044
Revision 0

Capture-Zone and Particle-Tracking Analysis for the U Plant Pump and Treat System using a sub model from the 2017 Updated Central Plateau Model

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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Contents

1 Purpose **1**

2 Methodology **1**

2.1 Local-Scale Model Construction 1

2.2 Capture Zone Analysis 4

3 Assumptions and Inputs **4**

3.1 Model Domain 4

3.2 Boundary and Initial Conditions 4

3.3 Extraction Wells 6

3.4 Simulation Period 6

3.5 Hydraulic Evaluation Data 6

4 Software Applications **6**

4.1 Approved Software 6

4.1.1 Description 6

4.1.2 Software Installation and Checkout 7

4.1.3 Statement of Valid Software Application 7

5 Calculation **7**

6 Results/Conclusions **8**

6.1 Base Case Simulation 8

6.2 Optimized Well Location Simulation 13

6.3 Hydraulic Evaluation 18

6.4 Capture Zone Analysis 24

7 References **26**

Attachments

A. **Stress Periods in the U Plant Local-Scale Model** 28

B. **Software Installation and Checkout** 32

Figures

Figure 1. Area of the Central Plateau Groundwater Flow Model Extracted to form the U Plant Local-Scale Model 3

Figure 2. Horizontal Grid Discretization for the U Plant Local-Scale Submodel 5

Figure 3. Simulated Water Table for the U Plant Local-Scale Model for Year 4 after the Start of Pumping, Base Case (12/31/2016) 9
Figure 4. Simulated Water Table for the U Plant Local-Scale Model for Year 15 after the Start of Pumping, Base Case (12/31/2027) 10
Figure 5. Simulated Water Table for the U Plant Local-Scale Model for Year 25 after the Start of Pumping, Base Case (12/31/2037) 11
Figure 6. Simulated Water Table for the U Plant Local-Scale Model for Year 26 after the Start of Pumping, Base Case (12/31/2038) 12
Figure 7. Simulated Water Table for the U Plant Local-Scale Model for Year 125 after the Start of Pumping, Base Case (12/31/2137) 13
Figure 8. Simulated Water Table for the U Plant Local-Scale Model for Year 4 after the Start of Pumping, Optimized Well Location Scenario (12/31/2016) 14
Figure 9. Simulated Water Table for the U Plant Local-Scale Model for Year 15 after the Start of Pumping, Optimized Well Location Scenario (12/31/2027) 15
Figure 10. Simulated Water Table for the U Plant Local-Scale Model for Year 25 after the Start of Pumping, Optimized Well Location Scenario (12/31/2037) 16
Figure 11. Simulated Water Table for the U Plant Local-Scale Model for Year 26 after the Start of Pumping, Optimized Well Location Scenario (12/31/2038) 17
Figure 12. Simulated Water Table for the U Plant Local-Scale Model for Year 125 after the Start of Pumping, Original Well Location Scenario (12/31/2137) 18
Figure 13. Wells Used for the Hydraulic Evaluation and Triangles for Hydraulic Gradient Calculations. 19
Figure 14. Comparison of Simulated and Measured Water Table Response for Selected Monitoring Wells in the U Plant Vicinity 20
Figure 15. Hydraulic Gradient Comparison for Simulated and Measured Water Levels at Selected Wells in the U Plant Vicinity 21
Figure 15 (cont'd). Hydraulic Gradient Comparison for Simulated and Measured Water Levels at Selected Wells in the U Plant Vicinity 22
Figure 15 (cont'd). Hydraulic Gradient Comparison for Simulated and Measured Water Levels at Selected Wells in the U Plant Vicinity 23
Figure 16. Simulated Capture Zones for the for the U Plant Extraction Wells Determined Using Reverse Particle Tracking from Year 26 to Year 1 24
Figure 17. Simulated Capture Zones for the for the U Plant Extraction Wells, Optimized Well Locations, Determined Using Reverse Particle Tracking from Year 26 to Year 1 25

Tables

Table 1. U Plant Local-Scale Model Simulations 8

Terms

AWLN	Automated Water Level Network
CHPRC	CH2M Hill Plateau Remediation Company
CP	Central Plateau
ECF	environmental calculation file
EDA	Environmental Dashboard Application
Fm, fm	Formation (formal), formation (informal)
GWV	Groundwater Vistas
HISI	Hanford Information Systems Inventory
MNW2	Multi-Node Well 2
NAVD88	North American Vertical Datum of 1988
OU	operable unit
TMR	telescopic mesh refinement
USGS	U.S. Geological Survey
WMA	waste management area

1 Purpose

The purpose of this environmental calculation file (ECF) is to document the construction and results of a local-scale groundwater flow model for the U Plant Groundwater Extraction System, which operates within the 200-UP-1 Groundwater Operable Unit (OU) at the Hanford Site. This system began operating in 2015, consists of two extraction wells, 299-W19-113 and 299-W19-114. The wells are currently operating at flow rates of approximately 55 and 110 gpm, respectively. More information regarding groundwater contamination at WMA S-SX and operation of the groundwater extraction system can be found in DOE/RL-2016-09, *Hanford Site Groundwater Monitoring Report for 2015*, and DOE/RL-2016-20, *Calendar Year 2015 Annual Summary Report for the 200-ZP-1 and 200-UP-1 Operable Unit Pump-and-Treat Operations*.

The purpose of this local-scale model is to assess and optimize system performance with flow and transport simulation. The modeling consisted of two parts: hydraulic modeling of the flow system and transport modeling of the plumes. This ECF documents the hydraulic modeling; the transport modeling will be documented in a separate ECF. The hydraulic modeling was performed using MODFLOW 2000, a finite difference groundwater flow model developed by the U.S. Geological Survey (USGS) (Harbaugh et al. [2000], *MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process*). Particle tracking was performed using MODPATH Version 6 which was also developed by the USGS (Pollock [2012], *User Guide for MODPATH Version 6 – A Particle-Tracking Model for MODFLOW*).

The local-scale model was developed by the process of telescopic mesh refinement (TMR) from the most recent version of the Central Plateau (CP) model (CP-47531, *Model Package Report: Central Plateau Model, Version 8.4.5*). With this approach, the portion of the CP model grid surrounding the U Plant vicinity was extracted and made into a local-scale model of higher grid resolution. Thus, the local-scale model is embedded within the regional CP model. Water levels simulated by the CP model at the edges of this grid became the specified boundary conditions for the local model. Because the CP model simulates operation of the 200 West Pump and Treat (in the 200-ZP-1 OU), the effect of this system on the water table in the U Plant vicinity is accounted for by changes in the local boundary conditions, even though the full extent of the 200 West Pump and Treat is not explicitly simulated by the local model.

After construction of the local-scale model, a hydraulic evaluation was performed whereby simulated water levels and hydraulic gradients in the vicinity of U Plant were compared to field water level measurements and hydraulic gradients calculated from those measurements. This allowed for an assessment of whether the flow system was represented in the local-scale model well enough for the intended modeling purpose.

The remainder of this ECF describes the construction of the local-scale model, documents the results of the hydraulic evaluation, and presents a capture zone analysis for the currently operating extraction wells.

2 Methodology

This section describes how the U Plant local-scale model was constructed from the CP model. It also describes how the capture zone analysis was performed.

2.1 Local-Scale Model Construction

Model simulations were performed through the year 2137, which is the end of the 125-year cleanup timeframe for CP groundwater beginning in 2012 when the 200 West Pump and Treat began operating.

Thus, the CP model was extended to run through year 2137 to provide boundary conditions for the local-scale model. The extension of the CP model to year 2137 is documented in ECF-200W-17-0043, *Capture-Zone and Particle-Tracking Analysis for the 200-UP-1/200-ZP-1 Areas Using the 2017 Updated Central Plateau Model.*

After the CP model was run to year 2137, the local-scale model was constructed by the TMR process using the following steps:

1. Particle tracking was performed in the CP model to determine the extent to which existing plumes at U Plant may migrate to year 2137. This determined the size of the submodel (Figure 1).
2. The local-scale model was extracted from the CP model using the TMR option of the Groundwater Vistas™[1] (GWV) software. Cell properties and specified head boundary conditions were automatically interpolated from the CP model onto the extracted grid by GWV.
3. The CP model has cell dimensions of 100 x 100 m throughout. Using GWV, the grid for the local-scale model was discretized to be 5 x 5 m in the area encompassing the U Plant groundwater extraction system and the existing plume boundaries. Away from this area, the grid becomes progressively larger to a maximum of 25 x 25 m.
4. The specified head boundary values and the initial heads were re-interpolated onto the refined grid from the parent model using the TMR update process in GWV. All specified head boundary conditions were removed from layers 1 and 2.
5. The CP model is vertically discretized into seven layers. The water table in the domain of the local-scale model occurs in layer 3. Using GWV, two additional layers were added to the local-scale model near the water table to allow for better vertical resolution of the plumes in the transport modeling. This was done as follows:
    a. Layer 3 was evenly divided into two layers using GWV, creating a new layer 3 and 4 out of the original layer 3. The bottom of the new layer 3 was set to a constant elevation of 122.5 meters. This constant was selected to ensure layer 3 remains saturated based upon maximum drawdown of the original model.
    b. The bottom of the new layer 3 at 122.5 meters was lower than the bottom of the original layer 3 in one line of cells on the southern boundary of the model. To address the resulting negative thickness, in those cells, the bottom of the new layer 3 was adjusted to 123 meters. This adjustment corrected the cell thickness without adjusting the bottom of the original layer 3, allowing the discretization of the model without effecting the hydraulic properties.
    c. Layer 5 (original layer 4) was divided evenly into layers 5 and 6.
    d. The constant head boundary data for the newly-created layers 4 and 6 was automatically set to 0 by GWV. The values for layer 4 were copied from layer 3, and the values for layer 6 were copied from layer 5; each new layer was simply a discretized slice of the original layer, and as such, the boundary conditions remained the same.

[1] Groundwater Vistas is a product of Environmental Simulations, Inc., Reinholds, PA.

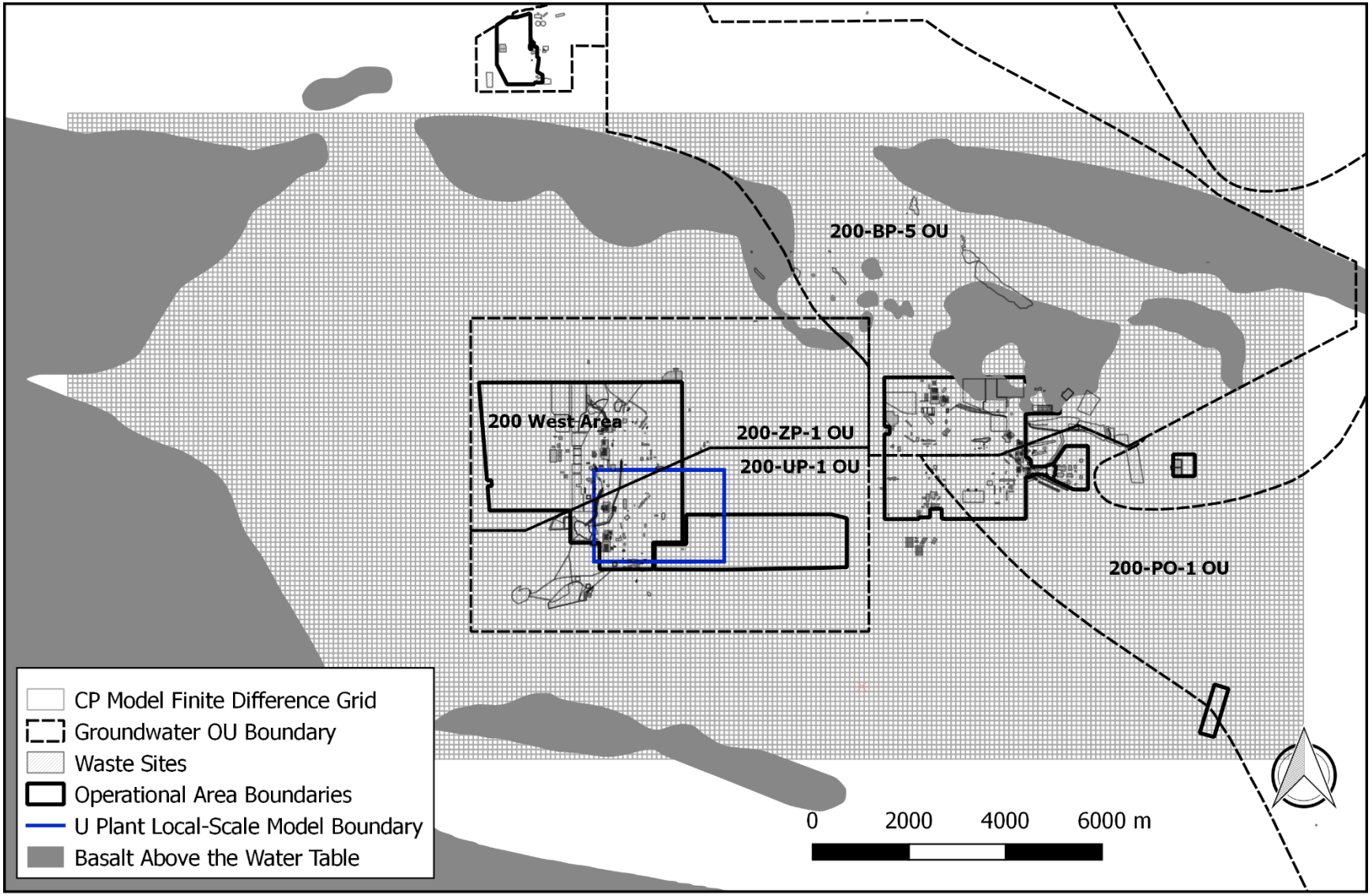


Figure 1. Area of the Central Plateau Groundwater Flow Model Extracted to form the U Plant Local-Scale Model

2.2 Capture Zone Analysis

Capture zones for the U Plant extraction wells were determined by particle tracking using MODPATH. Reverse particle tracking was used where particles were released around the wells and tracked backward in time to determine the region of the aquifer flowing into the wells. For each well, 12 particles were released in year 2037 and tracked backwards in time to year 2012 representing the 25-year planned operational period for the system. Starting locations for the particles consisted of a circle of radius 2.5 m centered on each extraction well with the particles evenly distributed about the circle. Vertically, the particles were released near the bottom of Layer 3. This ensured the particles did not reach the water table during transport. If that were to happen, particle tracking would be halted because there is recharge in the model which causes the upgradient direction near the water table to be into the vadose zone.

3 Assumptions and Inputs

The domain and structure of the U Plant local-scale model is described in the following subsections.

3.1 Model Domain

The U Plant local-scale model domain extends 2,700 m east-west and 1,900 m north-south. The lower left corner of the domain has coordinates of 566,550 m east and 133,950 m north (Washington State Plane, South Zone [4602]). The horizontal grid discretization is shown in Figure 2. The area around the 2015 uranium plume extents has a cell size of 5 x 5 m, to characterize the transport with finer discretization. From the 5 x 5 m cells, the row spacing increases to 7 m (for 5 rows and/or columns), then 10 m (5), 15 m (2), 20 m (3), and 25 m, and the column spacing increases to 7 m (5), then 10 m (4), 15 m (2), 20 m (1), and 25. Limiting the cell sizes to no more than 25 m ensured no cell had an aspect ratio of greater than 5, which is desired for transport modeling.

The CP model is vertically discretized into seven layers. To better represent contaminant plumes in the upper part of the aquifer, two additional layers were added to the U Plant local-scale model as described in Section 2.1.

3.2 Boundary and Initial Conditions

Specified head boundary conditions were used to transfer the hydraulic simulation results of the CP model to the boundaries of the local-scale model. These conditions were set automatically as part of the TMR process in GWV. Because the water table is below some or all of the cells in these layers, all specified head boundary conditions were removed from layers 1 & 2, as described in Section 2. The cells on the model domain boundary in layer 2 will fill or drain as needed from below. Layer 1 is always dry.

Initial conditions (i.e., the starting head values) were extracted from the CP model simulation results for 1/1/2012 as part of the TMR process in GWV.

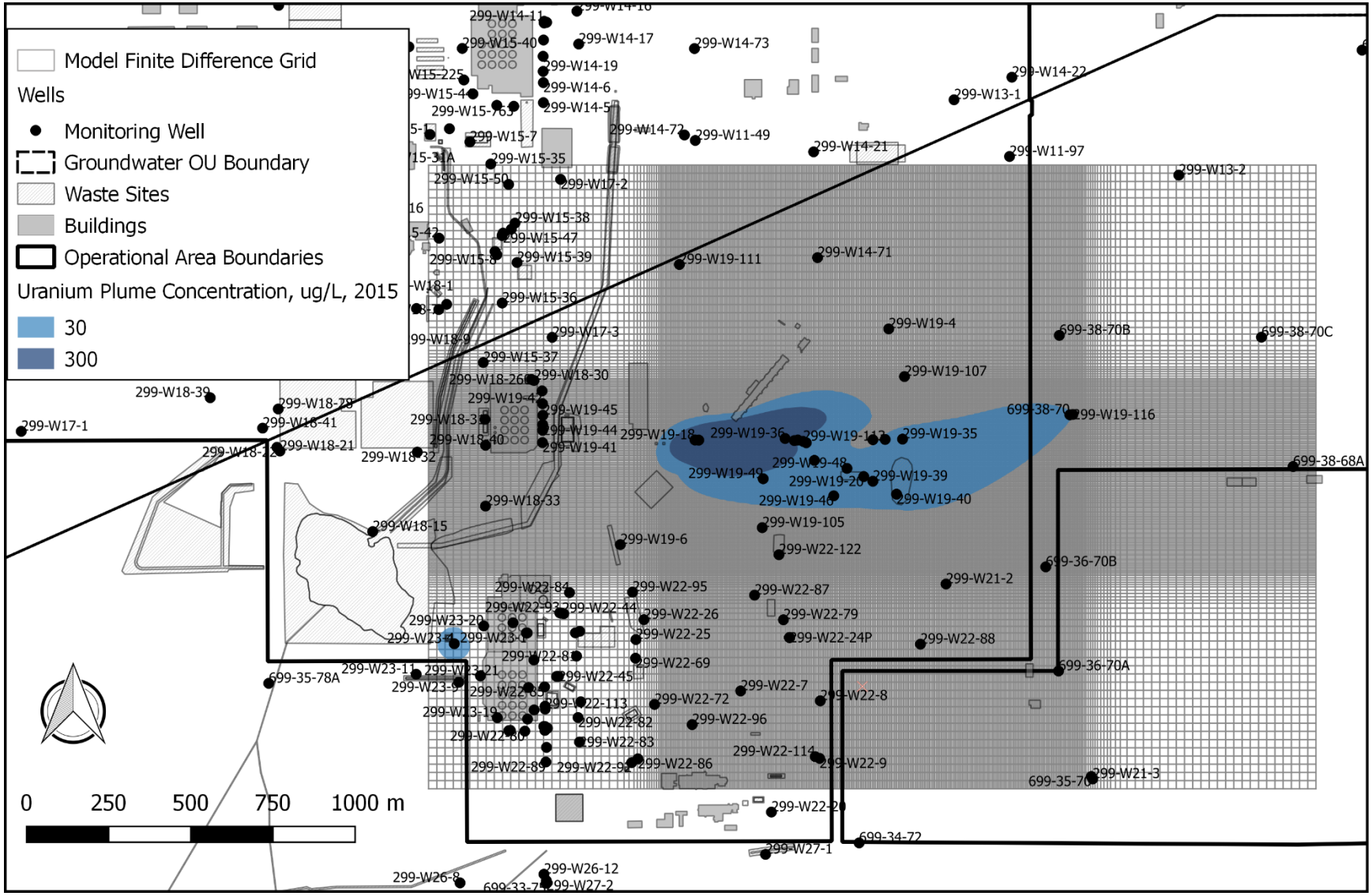


Figure 2. Horizontal Grid Discretization for the U Plant Local-Scale Submodel

3.3 Extraction Wells

There are nine extraction wells within the model domain: 299-W19-113 and 299-W19-114 near U Plant; 299-W22-90, 299-W22-91, and 299-W22-92 comprising the WMA S-SX Groundwater Extraction System; and 299-W15-46, 299-W17-2, and 299-W17-3, which are part of the ZP-1 carbon tetrachloride removal system. Input data for these wells were identical to that used in the CP model through 2016, after which extraction volumes and durations were modified to simulate the scenarios outlined in Table 1.

3.4 Simulation Period

Operation of pumping wells at the U Plant began in fall of 2015, and the nearby WMA S-SX Groundwater Extraction System began operating during 2012. The cleanup timeframe for CP groundwater is 125 years, so the U Plant local-scale model simulations begin on 1/1/2012 and end 125 years later on 12/31/2137. This time period is divided into 97 stress periods. Monthly stress periods are used from January 2012 through December 2016. Annual stress periods are then used until the end of the 25 years of planned operation of the 200 West Pump and Treat (December 2037) and for 5 years thereafter (December 2042). This is followed by three 5-year stress periods and eight 10-year stress periods to December 2137. The stress periods are listed in Appendix A.

3.5 Hydraulic Evaluation Data

A hydraulic evaluation of the local-scale model results was used to verify that the flow system is adequately represented in the local model for the intended purpose. The evaluation period was 2012 through 2016. Field water level measurements collected manually and used for the hydraulic evaluation were obtained from the Hanford Environmental Information System database using the Environmental Dashboard Application (EDA) accessible at https://ehs.hanford.gov/eda/. Some wells have automated water level measuring equipment (i.e., pressure transducers) installed as part of the Automated Water Level Network (AWLN) and these data were obtained from the Hanford Virtual Library. The data were used to determine water level trends (manual and AWLN) and calculated hydraulic gradients (manual only) for comparison to model results. Monitoring wells used for the hydraulic evaluation are described in Section 6.1.

4 Software Applications

MODFLOW-2000-MST and MODPATH Version 6 software programs were used for this environmental calculation. These are CH2M HILL Plateau Remediation Company (CHPRC) approved software, managed and used in compliance with the requirements of PRC-PRO-IRM-309, Controlled Software Management. GWV and Microsoft Excel®[2] were used as desktop calculators.

The following supporting information is provided for MODFLOW-2000-MST and MODPATH Version 6.

4.1 Approved Software

Required descriptions for approved calculation software used in this work are provided below.

4.1.1 Description

MODFLOW

[2] Microsoft Excel is a registered product of the Microsoft Corporation.

- Software Title: MODFLOW-2000-MST
- Software Version: CHPRC Build 8 (executable file: mf2k-mst-chprc08dp.exe)
- Hanford Information System Inventory (HISI) Identification Number: 2517 (Safety Software, Level C)
- Workstation type and property number: Personal Computer, 00857
- Authorized User: Mary C. Weber
- CHPRC Software Control Documents:
    - CHPRC-00257, *MODFLOW and Related Codes Functional Requirements Document*
    - CHPRC-00258, *MODFLOW and Related Codes Software Management Plan*
    - CHPRC-00259, *MODFLOW and Related Codes Software Test Plan*
    - CHPRC-00260, *MODFLOW and Related Codes Requirements Traceability Matrix*
    - CHPRC-00261, *MODFLOW and Related Codes Acceptance Test Report*

4.1.2 Software Installation and Checkout

Approved Safety Software packages (MODFLOW) and the controlled version of the support software (MODPATH) were checked out in accordance with procedures specified in CHPRC-00258. Executable files were obtained from the software owner who maintains the configuration-managed copies in MKS Integrity™[3], installation tests identified in CHPRC-00259 performed and successful installation confirmed, and Software Installation and Checkout Forms were completed and approved for installations used to perform model runs reported in this calculation.

4.1.3 Statement of Valid Software Application

The preparers of this calculation brief attest that the software identified above, and used for the calculations described in this calculation brief, is appropriate for the application and used within the range of intended uses for which it was tested and accepted by CHPRC.

Because MODFLOW is graded as Level C software, use of this software is required to be logged in the HISI. Accordingly, this environmental calculation has been logged by the software owner in the HISI under Identification Number 2517.

5 Calculation

Two hydraulic simulations were modeled for the U Plant local-scale model, each with associated reverse particle track analysis. These runs are described in Table 1 and the results are described in Section 6.

[3] PTC, The Product Development Company, MKS Integrity, Integrity and all other PTC product names and logos are trademarks or registered trademarks of Parametric Technology Corporation or its subsidiaries in the United States and in other countries.

Table 1. U Plant Local-Scale Model Simulations

Name	Description
Base Case	Hydraulic base case simulation from 1/1/2012 through 12/31/2137 (125 years since the start of the active remedy). Pumping from the U Plant, ZP-1, and WMA S SX extraction wells occurs for 25 years (ending 12/31/2037), same as the planned duration of the 200 West Pump and Treat. Reverse particle track analysis was simulated for wells 299-W19-113 and 299-W19-114.
Optimized Well Location	Same as the base case simulation, except in 2017, pumping at all wells was turned off except for wells 299-W19-113, 299-W19-114, and 299-W19-125. From 2017 to 2037, pumping at these wells was set to 50 gpm at 299-W19-113, 100 gpm at 299-W19-114, and 50 gpm at 299-W19-125. ECF-200UP1-17-0011 indicated that pumping at well 299-W19-125 improved the ability of the system to recover the portion of the plume at or above 300μg/L. Reverse particle track analysis was simulated for each of these wells.

6 Results/Conclusions

In this section, results of the model simulations are presented and evaluated.

6.1 Base Case Simulation

Results of the base case simulation are shown as water table maps for the U Plant vicinity in Figure 3 through Figure 7 for years 2016 (2 years of pumping at U Plant, 4 years of pumping at WMA S-SX), 2027 (13 years of pumping at U Plant, 15 years of pumping at WMA S-SX), 2037 (22 years of pumping at U Plant, 25 years of pumping at WMA S-SX), 2038 (first year of no pumping), and 2137 (year 125). The maps depict drawdown around the extraction wells. After pumping ceases in year 25, the water table around the extraction wells recovers quickly and flow resumes a more easterly direction.

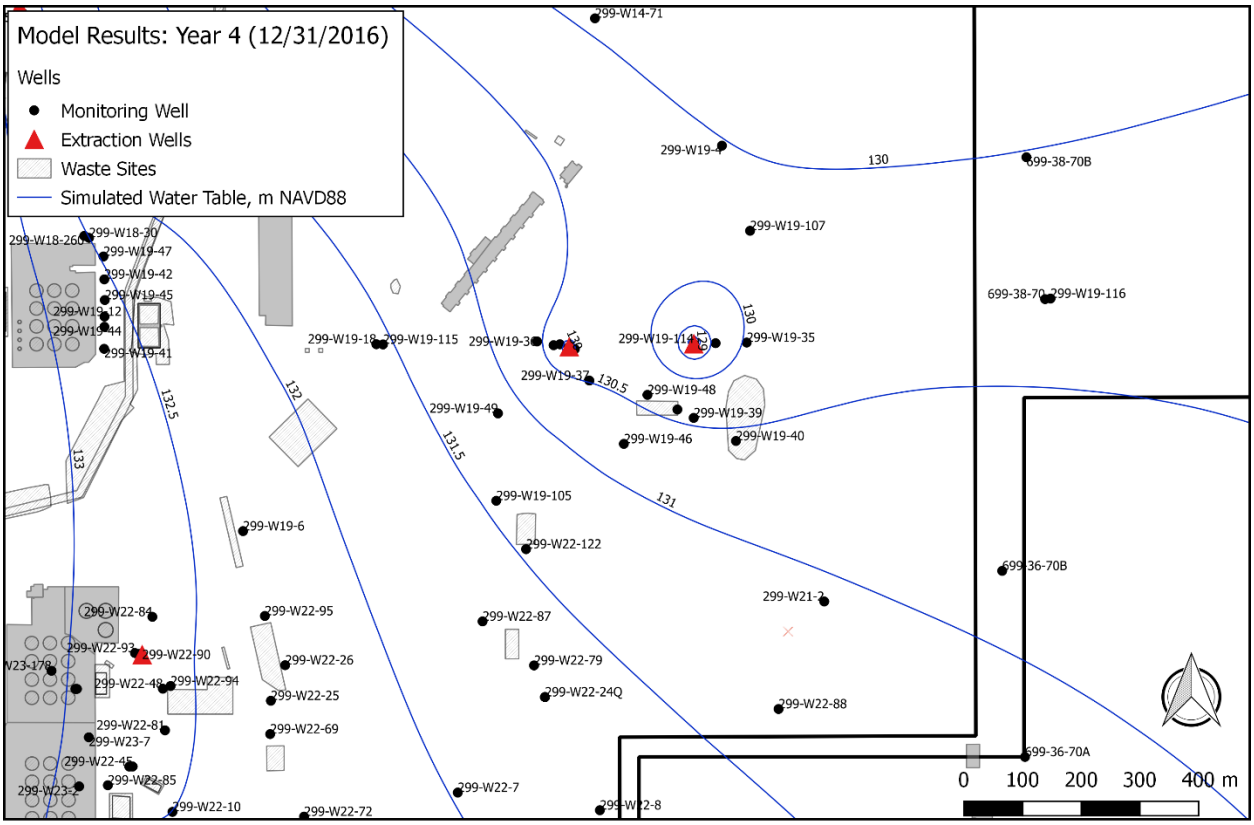


Figure 3. Simulated Water Table for the U Plant Local-Scale Model for Year 4 after the Start of Pumping, Base Case (12/31/2016)

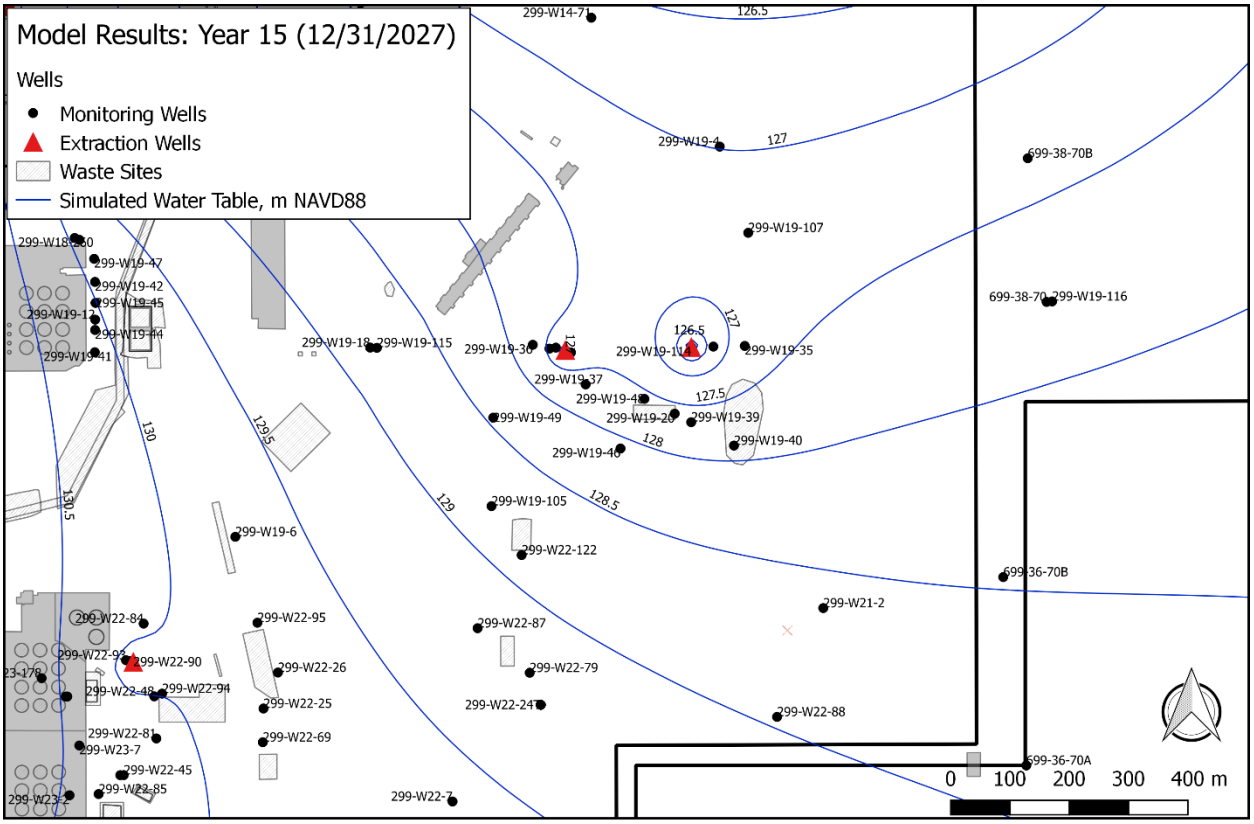


Figure 4. Simulated Water Table for the U Plant Local-Scale Model for Year 15 after the Start of Pumping, Base Case (12/31/2027)

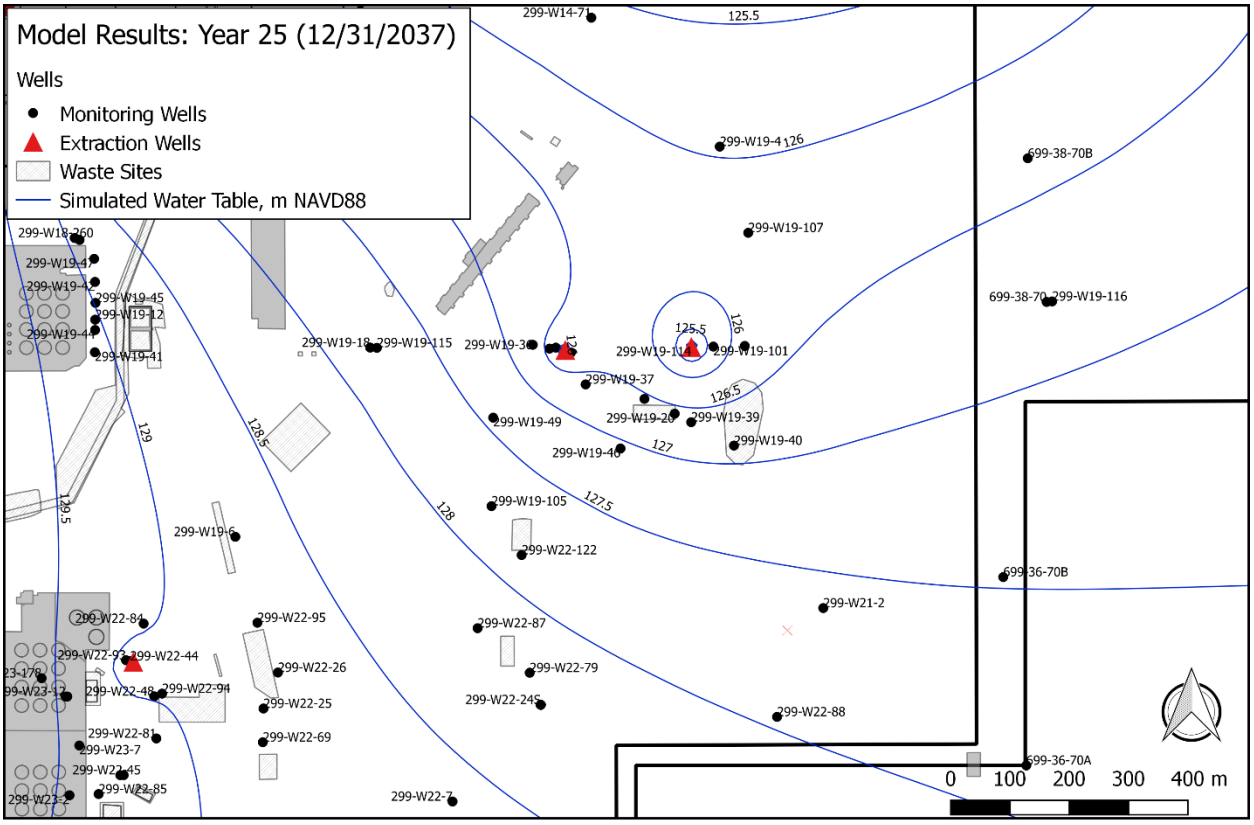


Figure 5. Simulated Water Table for the U Plant Local-Scale Model for Year 25 after the Start of Pumping, Base Case (12/31/2037)

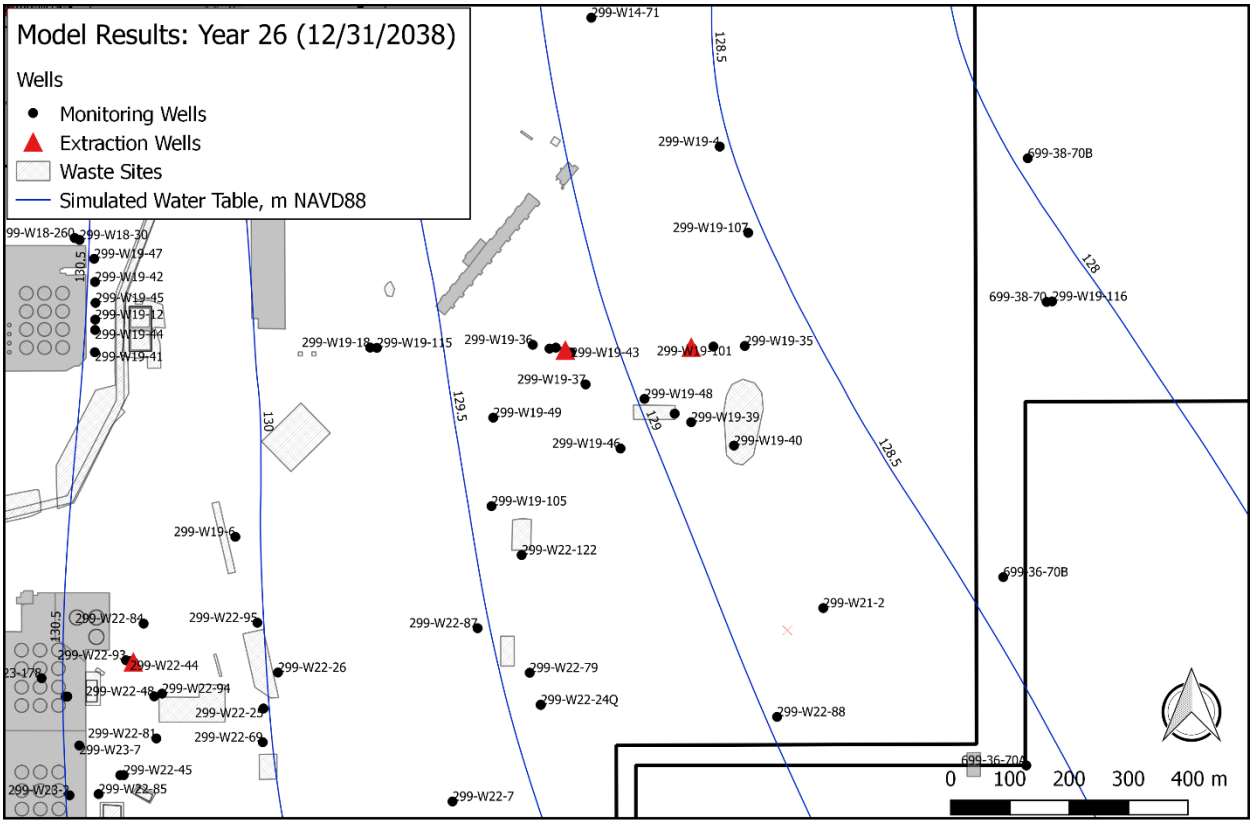


Figure 6. Simulated Water Table for the U Plant Local-Scale Model for Year 26 after the Start of Pumping, Base Case (12/31/2038)

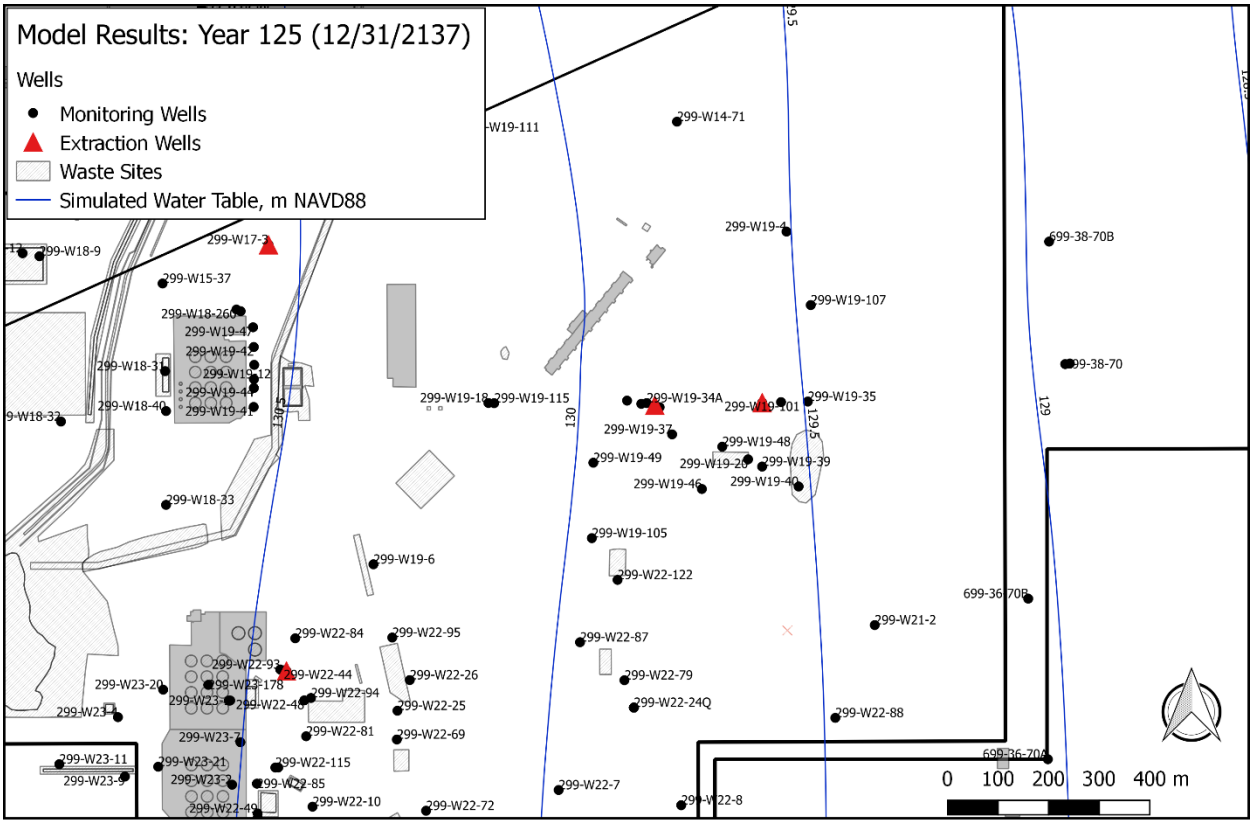


Figure 7. Simulated Water Table for the U Plant Local-Scale Model for Year 125 after the Start of Pumping, Base Case (12/31/2137)

6.2 Optimized Well Location Simulation

Results of the optimized well location simulation are shown as water table maps for the U Plant vicinity in Figure 8 through Figure 12 for years 2016 (2 years of pumping at U Plant, 4 years of pumping at WMA S-SX), 2027 (13 years of pumping at U Plant, 15 years of pumping at WMA S-SX), 2037 (22 years of pumping at U Plant, 25 years of pumping at WMA S-SX), 2038 (first year of no pumping), and 2137 (year 125). The maps depict drawdown around the extraction wells. After pumping ceases in year 25, the water table around the extraction wells recovers quickly and flow resumes a more easterly direction, in a similar manner as the base case.

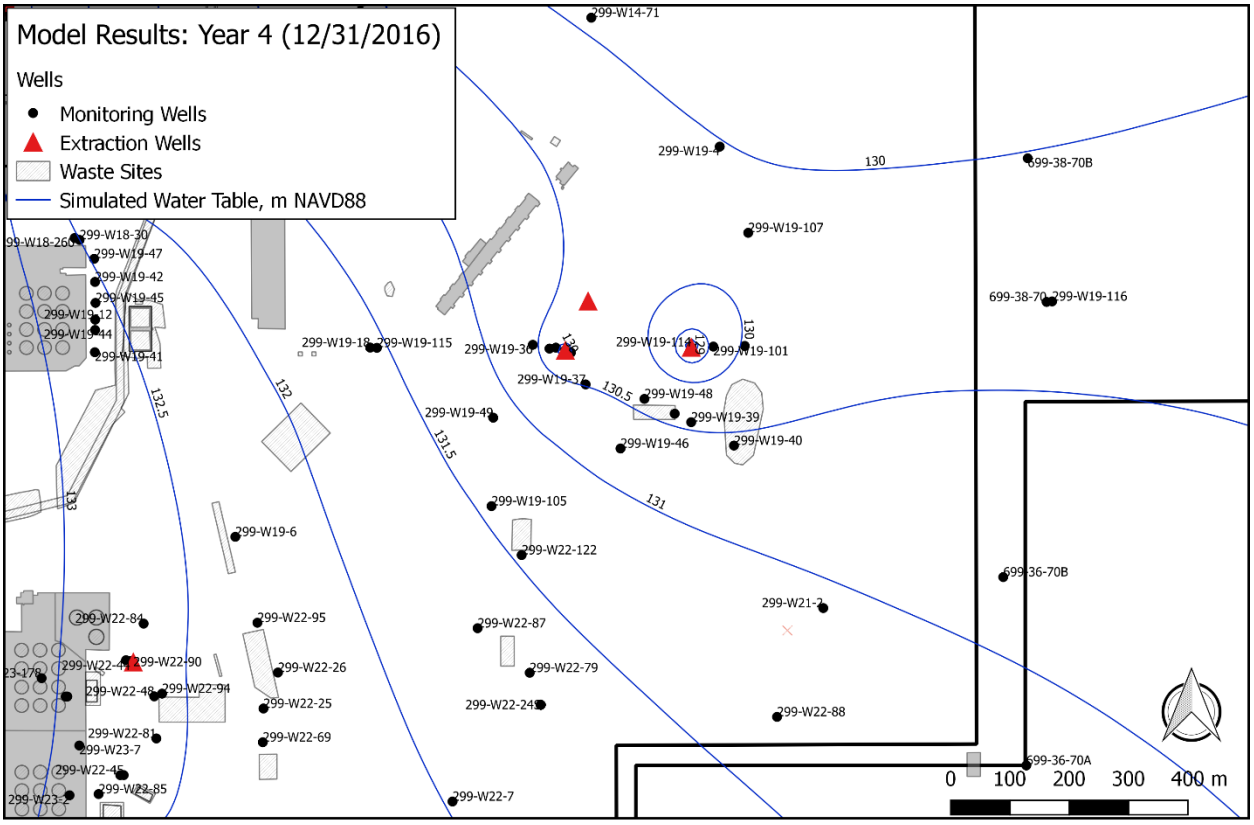


Figure 8. Simulated Water Table for the U Plant Local-Scale Model for Year 4 after the Start of Pumping, Optimized Well Location Scenario (12/31/2016)

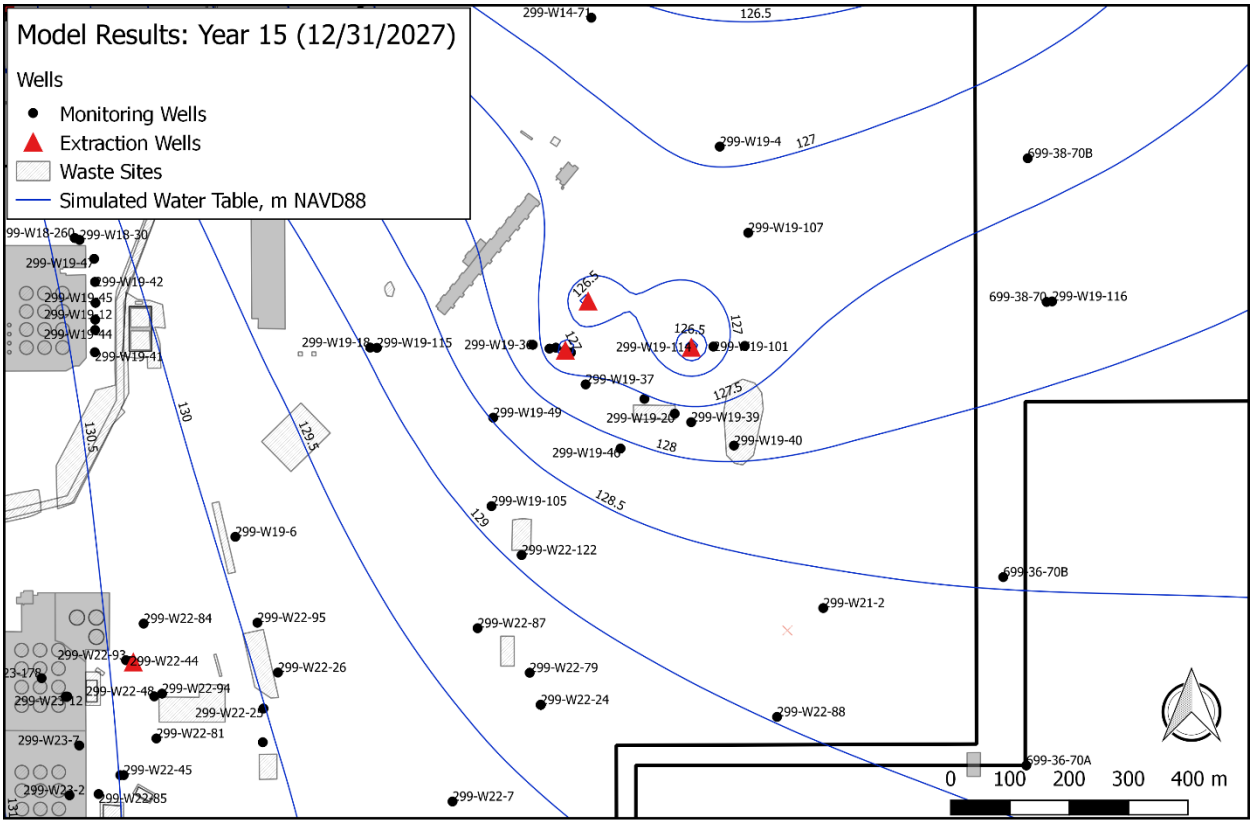


Figure 9. Simulated Water Table for the U Plant Local-Scale Model for Year 15 after the Start of Pumping, Optimized Well Location Scenario (12/31/2027)

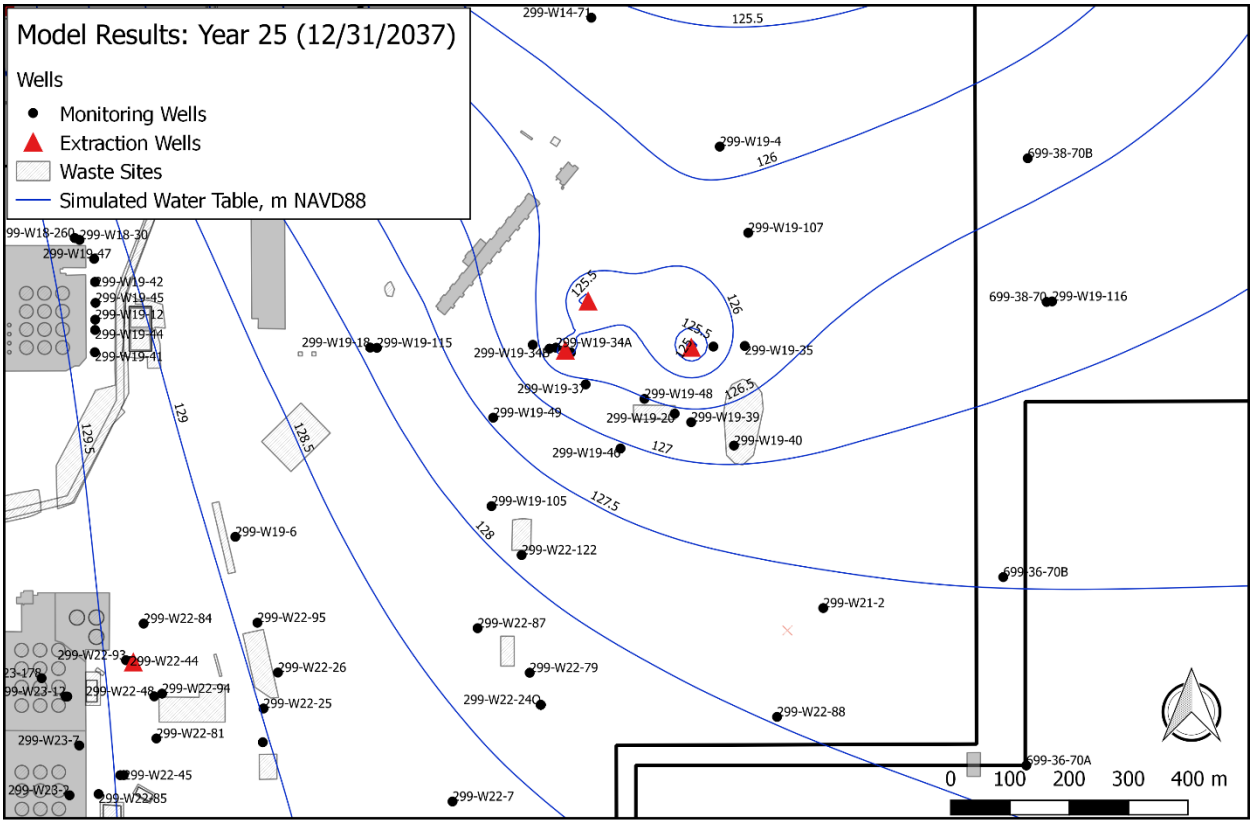


Figure 10. Simulated Water Table for the U Plant Local-Scale Model for Year 25 after the Start of Pumping, Optimized Well Location Scenario (12/31/2037)

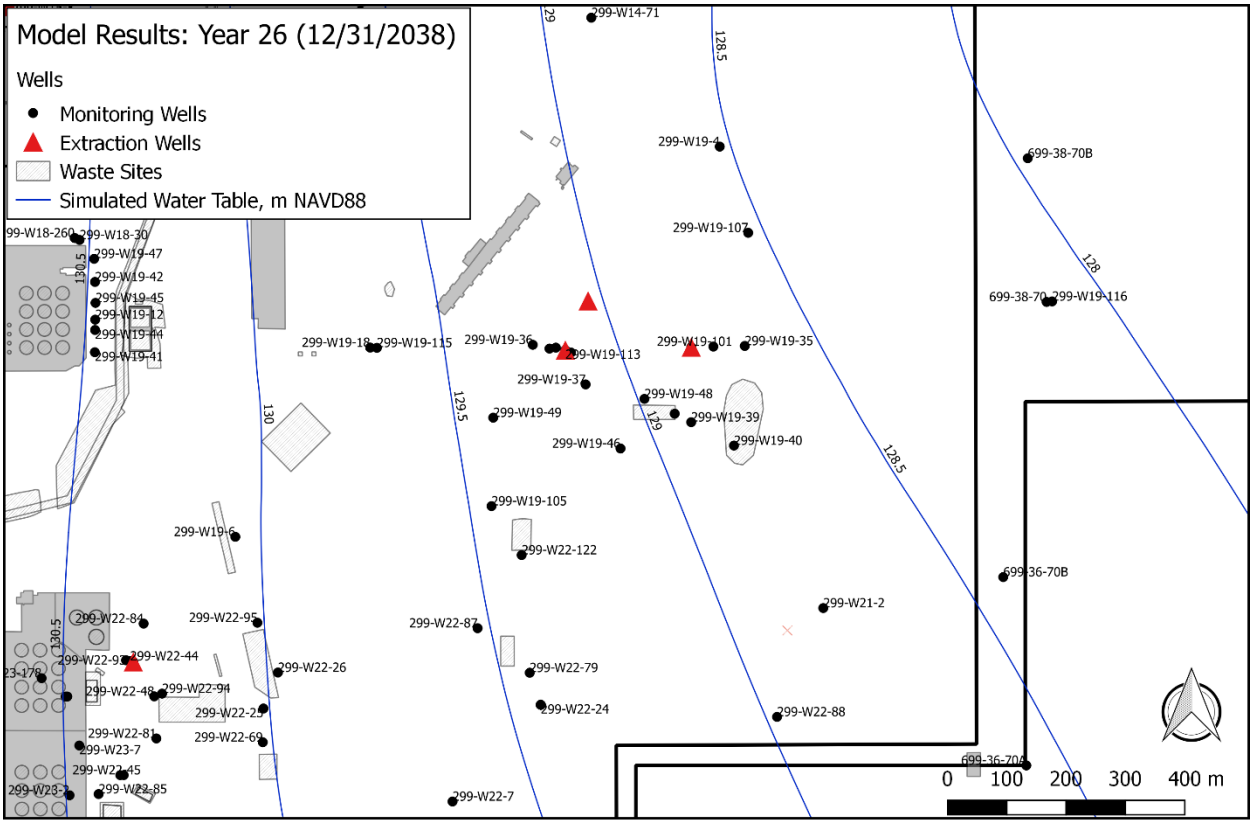


Figure 11. Simulated Water Table for the U Plant Local-Scale Model for Year 26 after the Start of Pumping, Optimized Well Location Scenario (12/31/2038)

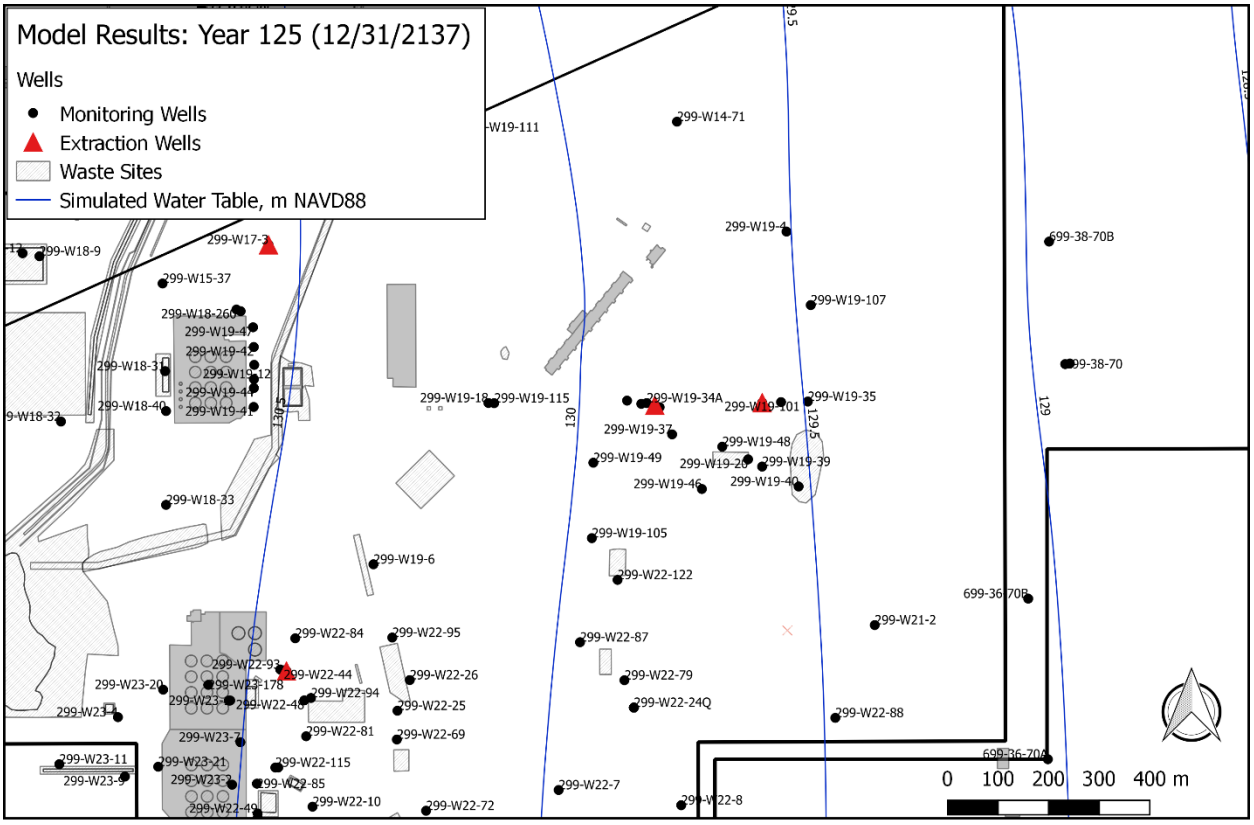


Figure 12. Simulated Water Table for the U Plant Local-Scale Model for Year 125 after the Start of Pumping, Original Well Location Scenario (12/31/2137)

6.3 Hydraulic Evaluation

Model evaluation is the process whereby simulation results are compared to field measured data to determine if the model represents field conditions well enough for its intended purpose. The purpose of the U Plant local-scale model simulations is to assess and optimize performance of the groundwater extraction system using transport modeling based on the simulated groundwater flow field.

The simulated flow field was evaluated by comparing simulated and measured water level responses and calculated hydraulic gradients. The monitoring wells for which water level measurements were obtained are shown in Figure 13. This figure also shows the groups of three wells (i.e., triangles) used for the gradient calculations. Figure 14 shows charts of simulated and measured water level changes for 2012 through 2016. During this time, well water levels were responding to drawdown from the wells at U Plant, WMA S-SX, as well as the larger 200 West Pump and Treat in the 200-ZP-1 OU. The modeled results are in excellent agreement with the measured values, overall. Simulated values at 299-W19-43, 299-W19-34A, and 699-36-70B do not have as close of a fit as those seen below after pumping begins at U Plant, but still follow the same trend as the measured data.

Results of the hydraulic gradient comparisons are shown in Figure 15[4]. Two charts are provided for each triangle, the first shows the gradient magnitude and the second shows the gradient direction. The

[4] The first well names on the charts in Figure 15 are the complete well names; subsequent well names in the title are abbreviated if the prefix is the same, otherwise the full name is provided.

agreement between the gradients using simulated and measured water levels is excellent near extraction well 299-W19-114 (charts titled “299-W19-39, -48, & -101”). The agreement is not as good near extraction well 299-W22-93 (charts titled “299-W19-43, -48, & -49”). The magnitude of the hydraulic gradients calculated near this well are larger using the simulated results compared to field measurements.

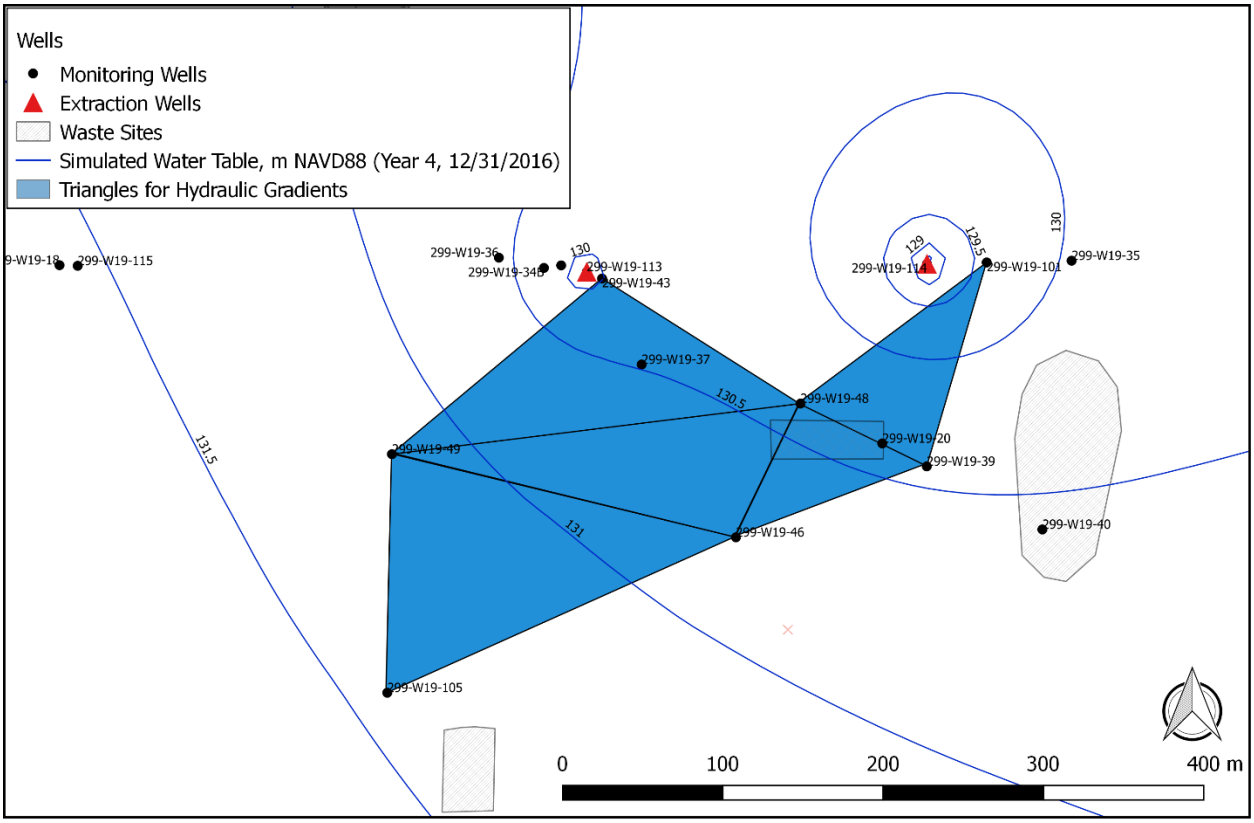


Figure 13. Wells Used for the Hydraulic Evaluation and Triangles for Hydraulic Gradient Calculations

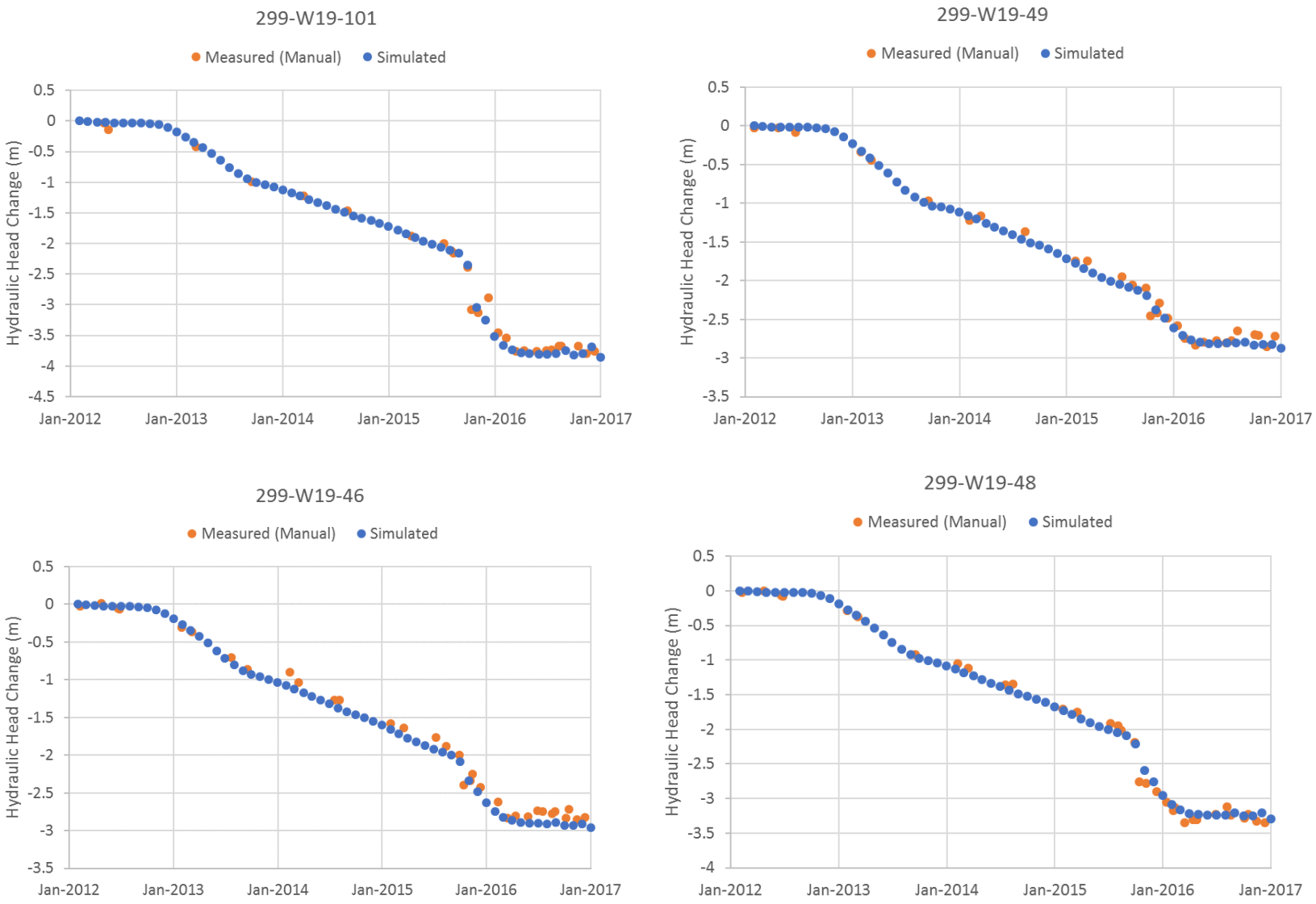


Figure 14. Comparison of Simulated and Measured Water Table Response for Selected Monitoring Wells in the U Plant Vicinity

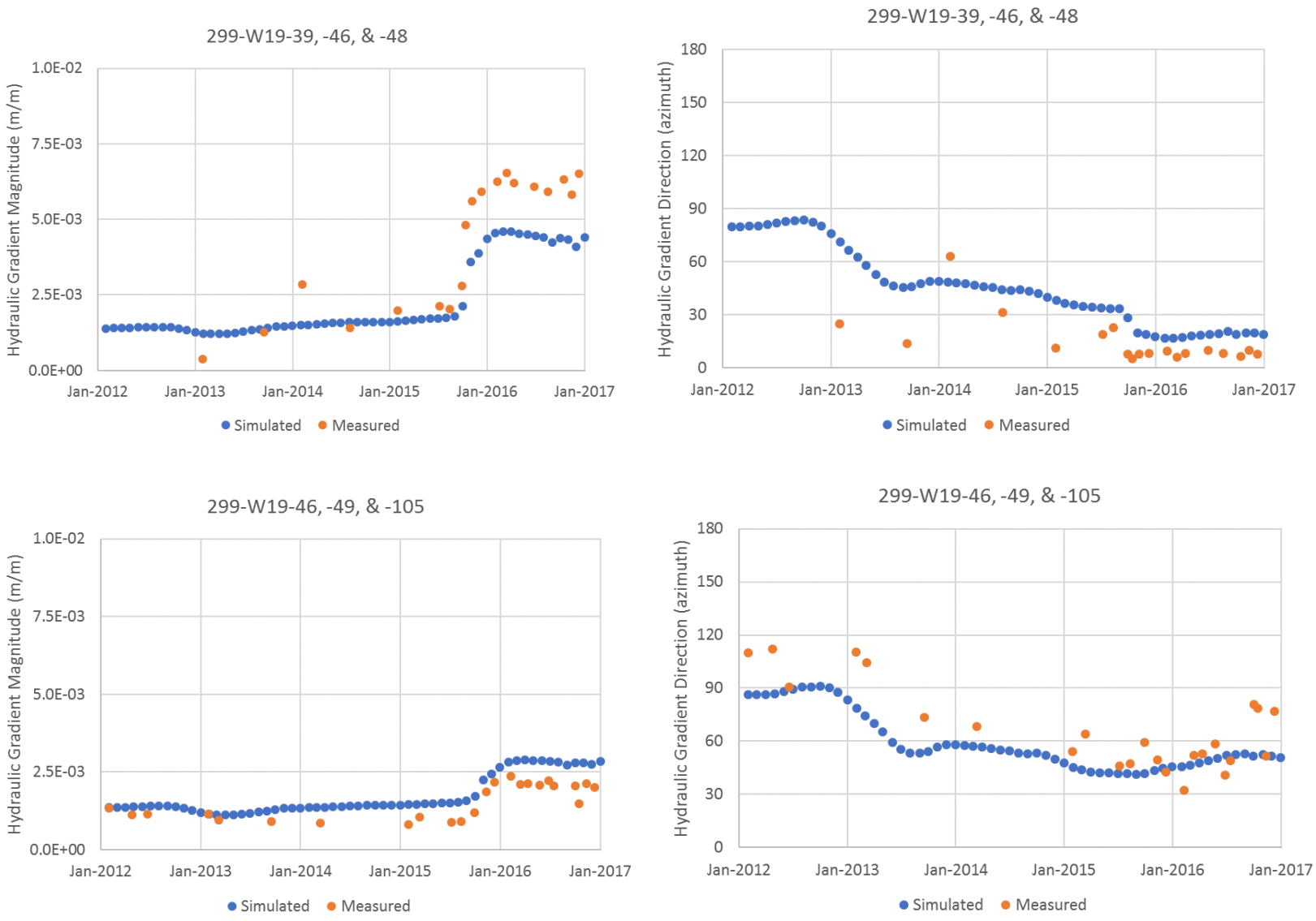


Figure 15. Hydraulic Gradient Comparison for Simulated and Measured Water Levels at Selected Wells in the U Plant Vicinity

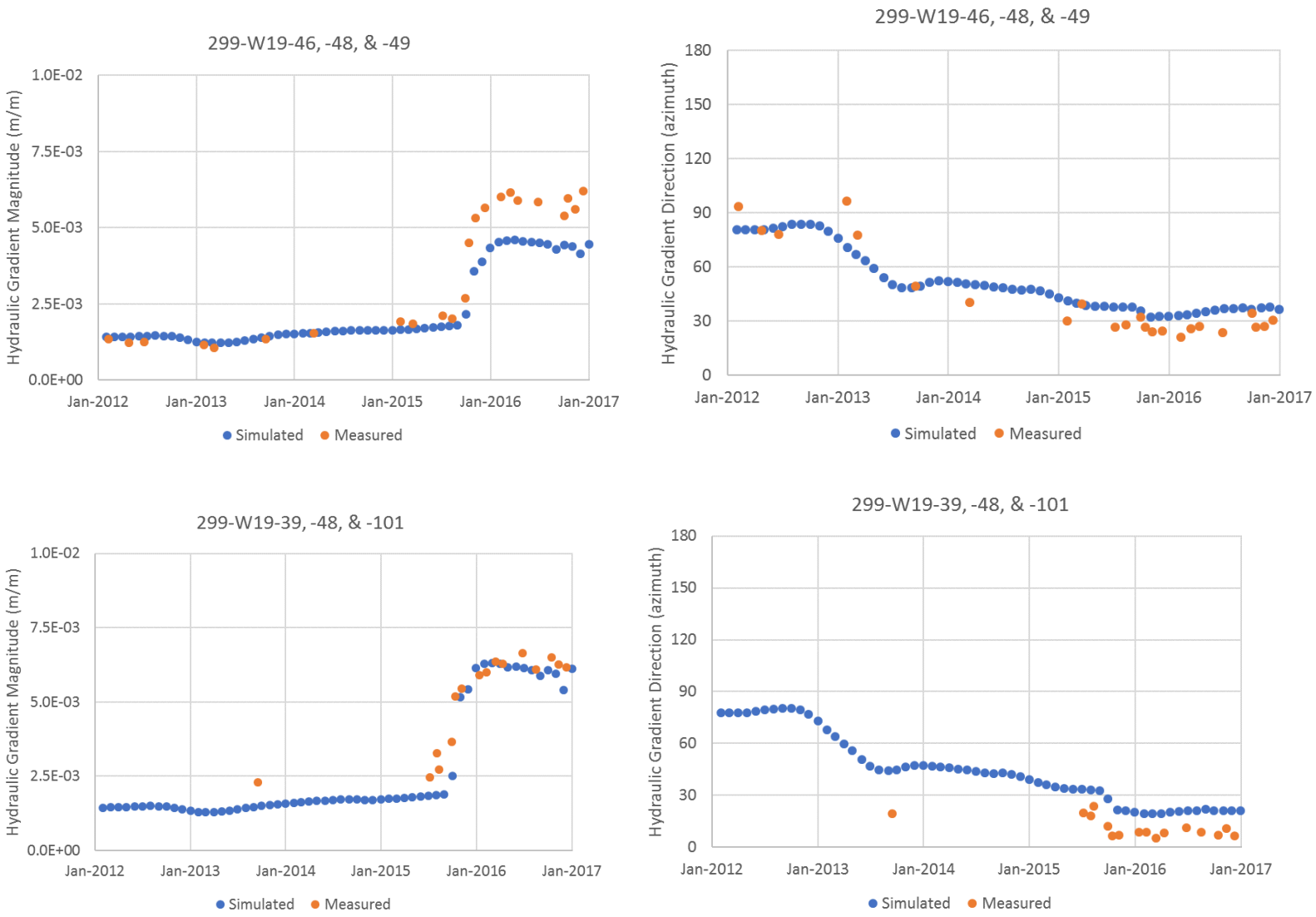
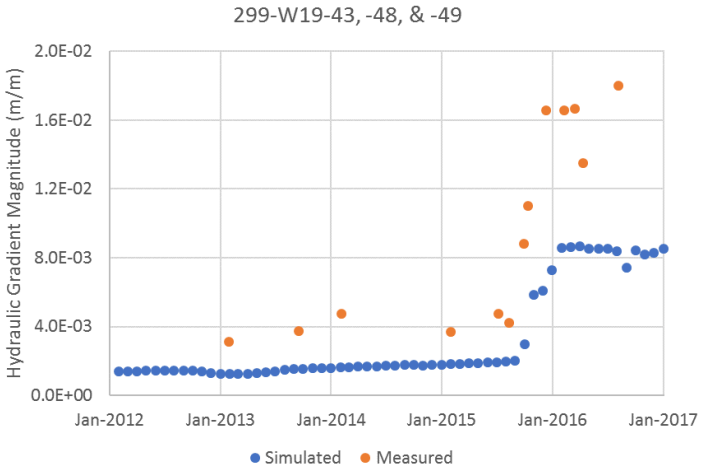


Figure 15 (cont'd). Hydraulic Gradient Comparison for Simulated and Measured Water Levels at Selected Wells in the U Plant Vicinity



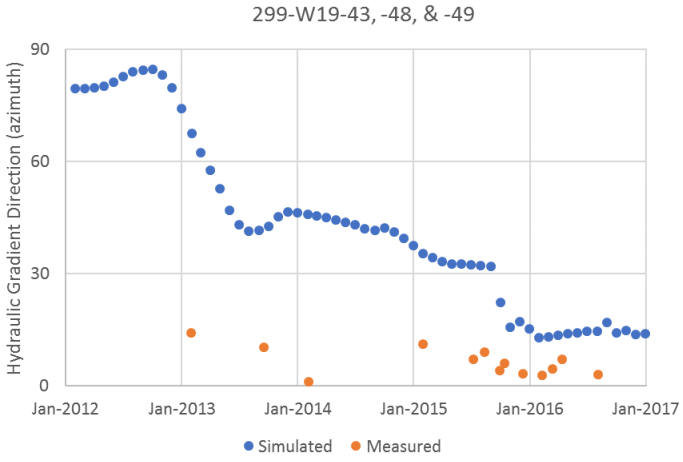


Figure 15 (cont'd). Hydraulic Gradient Comparison for Simulated and Measured Water Levels at Selected Wells in the U Plant Vicinity

6.4 Capture Zone Analysis

The capture zone was analyzed for both the base case and optimized well locations scenarios. As described in Section 2.2, this was done with reverse particle tracking in which particles were released around each extraction well 15 years after the start of pumping (the original planned duration for the system) and tracked backward in time to year 2012. The results are shown in Figure 16 and Figure 17.

As demonstrated in Figure 17, the capture zone produced by the optimized extraction well locations has a broader coverage relative to the base case capture zone. Unlike the base case capture zone, all of the uranium plume containing concentrations > 300 (µg/l) lay within the capture zone produced by the optimized extraction well locations.

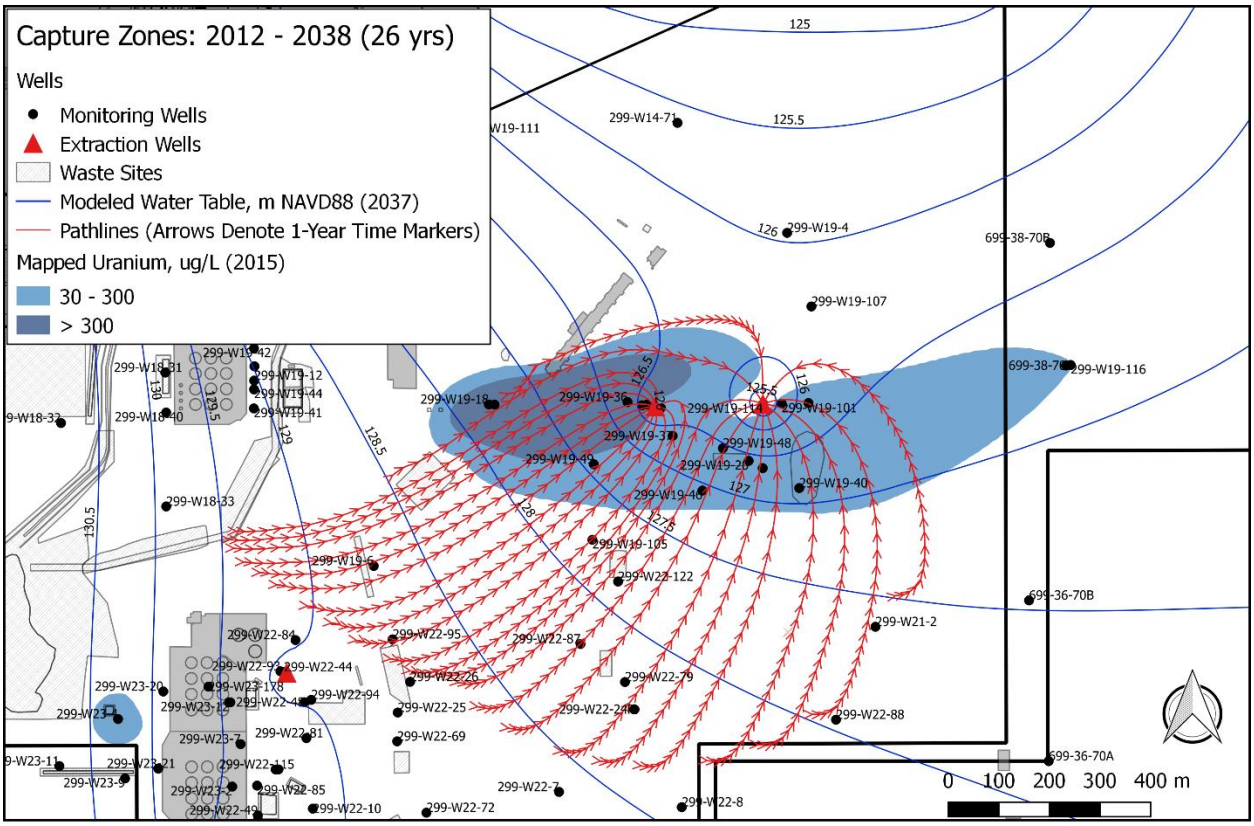


Figure 16. Simulated Capture Zones for the for the U Plant Extraction Wells Determined Using Reverse Particle Tracking from Year 26 to Year 1

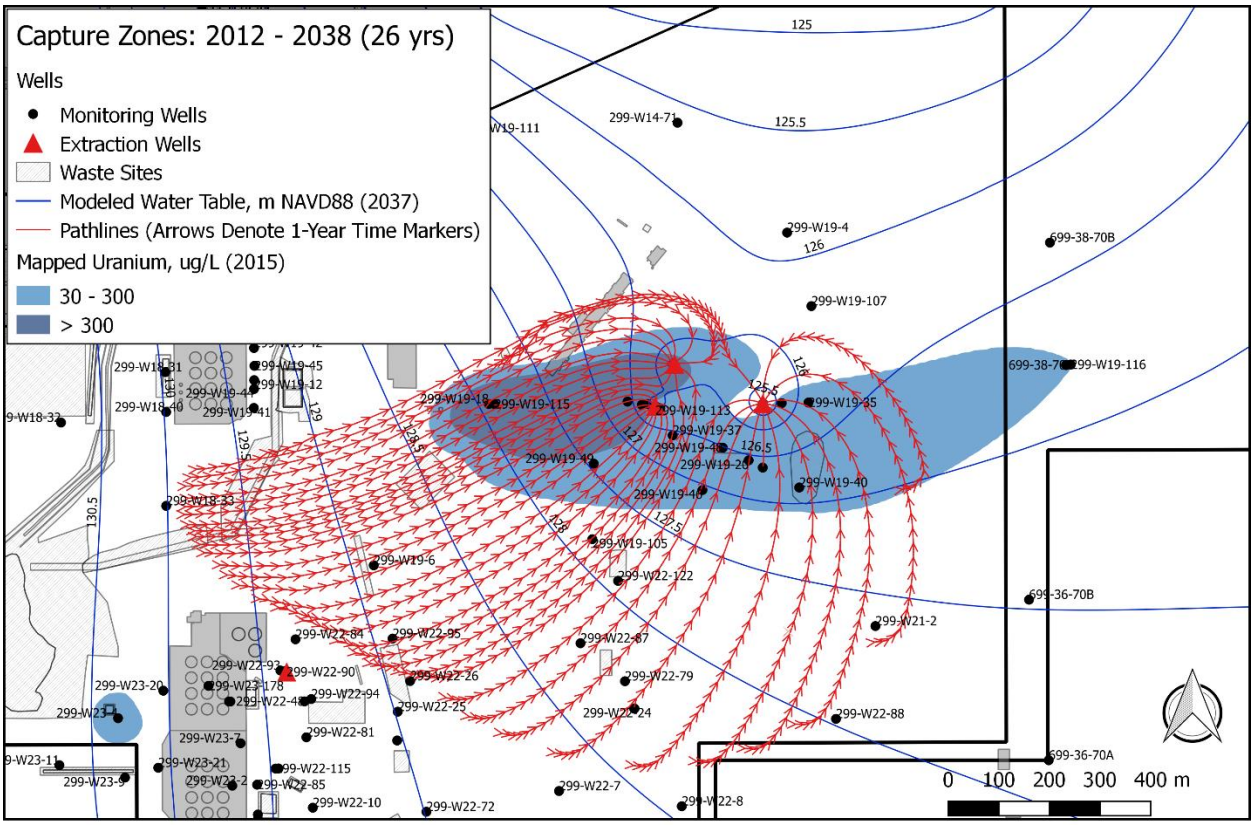


Figure 17. Simulated Capture Zones for the for the U Plant Extraction Wells, Optimized Well Locations, Determined Using Reverse Particle Tracking from Year 26 to Year 1

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Attachment A

Stress Periods in the U Plant Local-Scale Model

Table A-1 lists the stress periods in the U Plant local-scale model, the length of each period, start and end dates, and the total elapsed time. These are the same as in the CP model extended to year 2137.

Table A-1. Stress Periods in the U Plant Local-Scale Model

Stress Period Number	Length (days)	Length (years)	Start Date	End Date (Inclusive)	Elapsed Days	Elapsed Years
1	31	0.08	1/1/2012	1/31/2012	31	0.08
2	29	0.08	2/1/2012	2/29/2012	60	0.16
3	31	0.08	3/1/2012	3/31/2012	91	0.25
4	30	0.08	4/1/2012	4/30/2012	121	0.33
5	31	0.08	5/1/2012	5/31/2012	152	0.42
6	30	0.08	6/1/2012	6/30/2012	182	0.50
7	31	0.08	7/1/2012	7/31/2012	213	0.58
8	31	0.08	8/1/2012	8/31/2012	244	0.67
9	30	0.08	9/1/2012	9/30/2012	274	0.75
10	31	0.08	10/1/2012	10/31/2012	305	0.83
11	30	0.08	11/1/2012	11/30/2012	335	0.91
12	31	0.08	12/1/2012	12/31/2012	366	1.00
13	31	0.08	1/1/2013	1/31/2013	397	1.08
14	28	0.08	2/1/2013	2/28/2013	425	1.16
15	31	0.08	3/1/2013	3/31/2013	456	1.25
16	30	0.08	4/1/2013	4/30/2013	486	1.33
17	31	0.08	5/1/2013	5/31/2013	517	1.42
18	30	0.08	6/1/2013	6/30/2013	547	1.50
19	31	0.08	7/1/2013	7/31/2013	578	1.58
20	31	0.08	8/1/2013	8/31/2013	609	1.67
21	30	0.08	9/1/2013	9/30/2013	639	1.75
22	31	0.08	10/1/2013	10/31/2013	670	1.83
23	30	0.08	11/1/2013	11/30/2013	700	1.91
24	31	0.08	12/1/2013	12/31/2013	731	2.00
25	31	0.08	1/1/2014	1/31/2014	762	2.08
26	28	0.08	2/1/2014	2/28/2014	790	2.16
27	31	0.08	3/1/2014	3/31/2014	821	2.25
28	30	0.08	4/1/2014	4/30/2014	851	2.33
29	31	0.08	5/1/2014	5/31/2014	882	2.42
30	30	0.08	6/1/2014	6/30/2014	912	2.50
31	31	0.08	7/1/2014	7/31/2014	943	2.58
32	31	0.08	8/1/2014	8/31/2014	974	2.67

Table A-1. Stress Periods in the U Plant Local-Scale Model

Stress Period Number	Length (days)	Length (years)	Start Date	End Date (Inclusive)	Elapsed Days	Elapsed Years
33	30	0.08	9/1/2014	9/30/2014	1,004	2.75
34	31	0.08	10/1/2014	10/31/2014	1,035	2.83
35	30	0.08	11/1/2014	11/30/2014	1,065	2.91
36	31	0.08	12/1/2014	12/31/2014	1,096	3.00
37	31	0.08	1/1/2015	1/31/2015	1,127	3.08
38	28	0.08	2/1/2015	2/28/2015	1,155	3.16
39	31	0.08	3/1/2015	3/31/2015	1,186	3.25
40	30	0.08	4/1/2015	4/30/2015	1,216	3.33
41	31	0.08	5/1/2015	5/31/2015	1,247	3.42
42	30	0.08	6/1/2015	6/30/2015	1,277	3.50
43	31	0.08	7/1/2015	7/31/2015	1,308	3.58
44	31	0.08	8/1/2015	8/31/2015	1,339	3.67
45	30	0.08	9/1/2015	9/30/2015	1,369	3.75
46	31	0.08	10/1/2015	10/31/2015	1,400	3.83
47	30	0.08	11/1/2015	11/30/2015	1,430	3.91
48	31	0.08	12/1/2015	12/31/2015	1,461	4.00
49	31	0.08	1/1/2016	1/31/2016	1,492	4.08
50	29	0.08	2/1/2016	2/29/2016	1,521	4.16
51	31	0.08	3/1/2016	3/31/2016	1,552	4.25
52	30	0.08	4/1/2016	4/30/2016	1,582	4.33
53	31	0.08	5/1/2016	5/31/2016	1,613	4.42
54	30	0.08	6/1/2016	6/30/2016	1,643	4.50
55	31	0.08	7/1/2016	7/31/2016	1,674	4.58
56	31	0.08	8/1/2016	8/31/2016	1,705	4.67
57	30	0.08	9/1/2016	9/30/2016	1,735	4.75
58	31	0.08	10/1/2016	10/31/2016	1,766	4.83
59	30	0.08	11/1/2016	11/30/2016	1,796	4.91
60	31	0.08	12/1/2016	12/31/2016	1,827	5
61	365	1	1/1/2017	12/31/2017	2,192	6
62	365	1	1/1/2018	12/31/2018	2,557	7
63	365	1	1/1/2019	12/31/2019	2,922	8
64	366	1	1/1/2020	12/31/2020	3,288	9
65	365	1	1/1/2021	12/31/2021	3,653	10
66	365	1	1/1/2022	12/31/2022	4,018	11
67	365	1	1/1/2023	12/31/2023	4,383	12
68	366	1	1/1/2024	12/31/2024	4,749	13

Table A-1. Stress Periods in the U Plant Local-Scale Model

Stress Period Number	Length (days)	Length (years)	Start Date	End Date (Inclusive)	Elapsed Days	Elapsed Years
69	365	1	1/1/2025	12/31/2025	5,114	14
70	365	1	1/1/2026	12/31/2026	5,479	15
71	365	1	1/1/2027	12/31/2027	5,844	16
72	366	1	1/1/2028	12/31/2028	6,210	17
73	365	1	1/1/2029	12/31/2029	6,575	18
74	365	1	1/1/2030	12/31/2030	6,940	19
75	365	1	1/1/2031	12/31/2031	7,305	20
76	366	1	1/1/2032	12/31/2032	7,671	21
77	365	1	1/1/2033	12/31/2033	8,036	22
78	365	1	1/1/2034	12/31/2034	8,401	23
79	365	1	1/1/2035	12/31/2035	8,766	24
80	366	1	1/1/2036	12/31/2036	9,132	25
81	365	1	1/1/2037	12/31/2037	9,497	26
82	365	1	1/1/2038	12/31/2038	9,862	27
83	365	1	1/1/2039	12/31/2039	10,227	28
84	366	1	1/1/2040	12/31/2040	10,593	29
85	365	1	1/1/2041	12/31/2041	10,958	30
86	365	1	1/1/2042	12/31/2042	11,323	31
87	1826	5	1/1/2043	12/31/2047	13,149	36
88	1827	5	1/1/2048	12/31/2052	14,976	41
89	1826	5	1/1/2053	12/31/2057	16,802	46
90	3652	10	1/1/2058	12/31/2067	20,454	56
91	3653	10	1/1/2068	12/31/2077	24,107	66
92	3652	10	1/1/2078	12/31/2087	27,759	76
93	3653	10	1/1/2088	12/31/2097	31,412	86
94	3651	10	1/1/2098	12/31/2107	35,063	96
95	3653	10	1/1/2108	12/31/2117	38,716	106
96	3652	10	1/1/2118	12/31/2127	42,368	116
97	3653	10	1/1/2128	12/31/2137	46,021	126

Attachment B

Software Installation and Checkout

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM

Software Owner Instructions:

Complete Fields 1-13, then run test cases in Field 14. Compare test case results listed in Field 15 to corresponding Test Report outputs. If results are the same, sign and date Field 19. If not, resolve differences and repeat above steps.

Software Subject Matter Expert Instructions:

Assign test personnel. Approve the installation of the code by signing and dating Field 21, then maintain form as part of the software support documentation.

GENERAL INFORMATION:

1. Software Name: MODFLOW and Related Codes Software Version No.: Bld 8

EXECUTABLE INFORMATION:

2. Executable Name (include path):

Following executable files in directory: _____

MD5 Signature (unique ID)	Executable File Name	
919F74196F5FB5BF0364FC373011B507	mf2k-chprc08dpl.exe	MODFLOW-2000 double precision
EAF037703ADD2C62CDD9CBC47468D2F6	mf2k-chprc08spl.exe	MODFLOW-2000 single precision
4E7F29DD5496D2CBA7144ADACB13DAAD	mf2k-mst-chprc08dpv.exe	MODFLOW-2000-MST single prec
CEB80288C616E0552E4CE5A2D4719387	mf2k-mst-chprc08spv.exe	MODFLOW-2000-MST double prec
ECA9828530B68D2D7C34078C019D5D0C	mt3d-chprc08dpl.exe	MT3DMS double precision
0920CC235862665D9400A3FC80F682DD	mt3d-chprc08spl.exe	MT3DMS single precision
5C61432D2C898E83DDFE242C52A755AB	mt3d-mst-chprc08dpv.exe	MT3DMS-MST double precision
68F89DAF2E6913D2578DE53CBD34FBA0	mt3d-mst-chprc08spv.exe	MT3DMS-MST single precision

3. Executable Size (bytes): MD5 signatures listed above uniquely identify executable files

COMPILATION INFORMATION:

4. Hardware System (i.e., property number or ID):

Vendor Provided (SSP&A)

5. Operating System (include version number):

Vendor Provided (SSP&A)

INSTALLATION AND CHECKOUT INFORMATION:

6. Hardware System (i.e., property number or ID):

PSC-Xenon; Intera Property Number 00857

7. Operating System (include version number):

Windows 10

8. Open Problem Report? ◉ No ○ Yes PR/CR No.

TEST CASE INFORMATION:

9. Directory/Path:

10. Procedure(s):

CHPRC-00259 Rev 3, MODFLOW and Related Codes Software Test Plan

11. Libraries:

N/A (static linking)

12. Input Files:

MF-ITC-1 and MT-ITC-1 inputs

13. Output Files:

MF-ITC-1 and MT-ITC-1 outputs

Page 1 of 2 A-6005-149 (REV 0)

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: MODFLOW and Related Codes Software Version No.: Bld 8

14. Test Cases:

MF-ITC-1 (both standard and MST versions of MODFLOW)- run for single & double precision
MT-ITC-1 - run for single and double precision

15. Test Case Results:

FC: no differences encountered x8 - PASS.

16. Test Performed By: Mary Weber

17. Test Results: (●) Satisfactory, Accepted for Use ( ) Unsatisfactory

18. Disposition (include HISI update): INSTALLATION ADDED TO APPROVED USER LISTS FOR HISI #2517 (MODFLOW) AND #2518 (MT3DMS). [illegible]

Prepared By:

19. [signature]	WE Nichols	13 FEB 2017
Software Owner (Signature)	Print	Date

20. Test Personnel:

Mary Weber	M Weber	13 FEB 2017
Sign	Print	Date
Sign	Print	Date
Sign	Print	Date

Approved By:

21.	N/R (CHPRC-00258 Rev 3)	
Software SME (Signature)	Print	Date

Page 2 of 2 A-6005-149 (REV 0)