ECF-200UP1-14-0032
Revision 0

Local-Scale Simulation of Uranium Plume Capture at the 200-UP-1 Uranium Pumpand- Treat Well Locations

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

CH2MHILL
Plateau Remediation Company
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Approved for Public Release;
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ENVIRONMENTAL CALCULATION COVER PAGE

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Preparer: H Rashid and JP McDonald	**Basis of Qualification:** Education & experience; H Rashid has completed CHPRC-required modeler training and has a CHPRC-qualified installation of MODFLOW & Related Codes, Build 6 (Checked by WE Nichols, 4/15/2014)
Checker: A Mayenna	**Basis of Qualification:** Education & experience
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Environmental Calculation File

Local-Scale Simulation of Uranium Plume Capture at the 200-UP-1 Uranium Pump-and-Treat Well Locations

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Copy of Software Installation and Checkout Form for MODFLOW & Related Codes Build 0006 Installation to Computer INTERA-00463 (User H Rashid) **28**

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Terms

CHPRC	CH2M HILL Plateau Remediation Company
CPGW Model	Central Plateau Groundwater Model
DOE	U.S. Department of Energy
ECF	environmental calculation file
HISI	Hanford Information System Inventory (environmental database)
HSU	hydrostratigraphic unit
MCL	maximum contaminant level
MNW2	Multi-Node Well (MODFLOW package)
MODFLOW	MODular three-dimensional finite-difference groundwater FLOW model (software)
MODPATH	particle tracking post processing code for MODFLOW (software)
SALDS	State Approved Liquid Disposal Site (facility)

1 Purpose

The purpose of this environmental calculation file (ECF) is to present the results of hydraulic capture modeling performed using a new local scale submodel derived from the Central Plateau Groundwater (CPGW) Model Version 6.3.3 (CP-47631, *Model Package Report: Central Plateau Groundwater Model Version 6.3.3*) and implemented in the CH2M HILL Plateau Remediation Company (CHPRC) approved version of MODFLOW-2000. The results of the model are intended to support the capture zone analysis of the uranium plume from the 216-U-1 and 216-U-2 Cribs in the vicinity of the U Plant at the US Department of Energy's (DOE's) Hanford Site shown in Figure 1. U Plant is located in the 200 West Area of the Hanford Site; a more detailed map of this location is shown in Figure 2. The hydraulic capture estimates presented in this calculation brief were generated with finer model grid spacing to verify the effectiveness of the proposed pump-and-treat system in ECF-200UP1-14-0031, *Optimization of 200-UP-1 Uranium Pump-and-Treat Well Locations with Resultant Contaminant Effluent Concentrations*, and will serve to guide subsequent refinement of the pump-and-treat system (i.e., location of wells, pumping rates, and screen intervals).

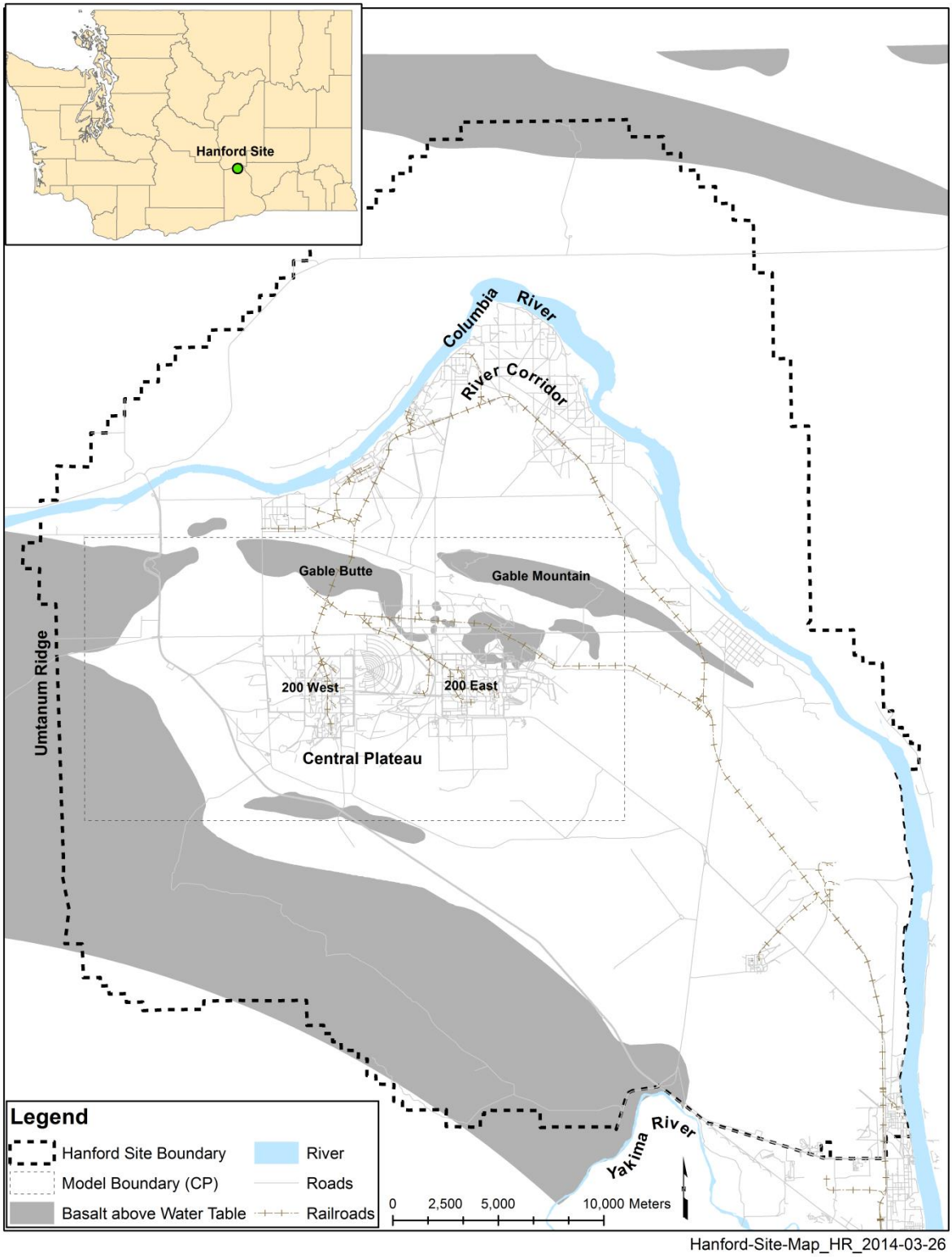

Figure 1. Hanford Site

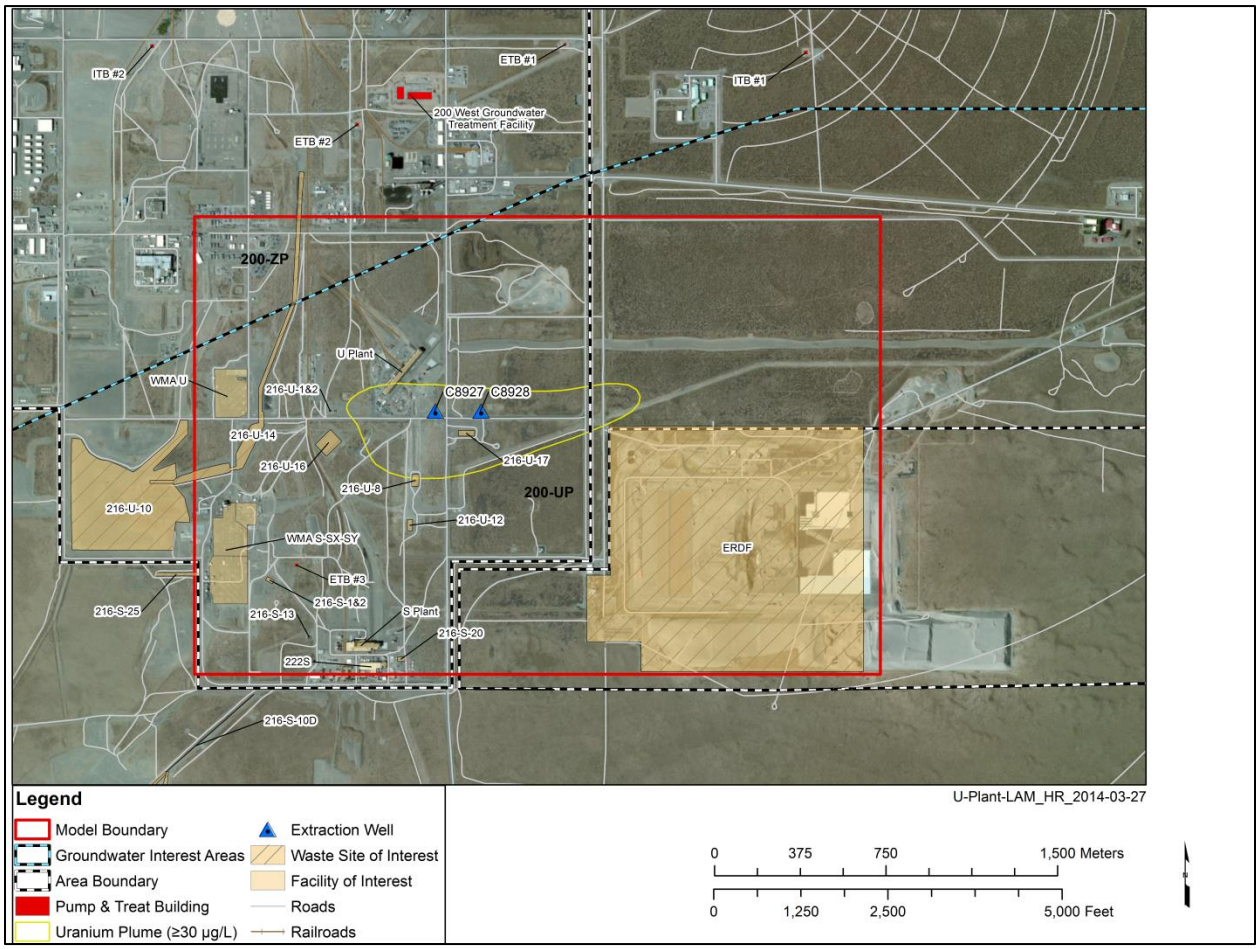

Figure 2. U Plant Vicinity Map

2 Background

The 216-U-1 and 216-U-2 Cribs were active in the 1950s and 1960s and received waste from uranium recovery operations at U Plant. The cribs received an estimated 4,000 kilograms of uranium during this time (DOE/RL-2009-122). When wastewater was disposed at the nearby 216-U-16 Crib (Figure 2) in the mid-1980s, it migrated north along a caliche layer and mobilized the technetium-99 and uranium in the vadose zone soil column beneath the 216-U-1 and 216-U-2 Cribs, which added contaminant mass to the groundwater plume (WHC-EP-0133, *U1/U2 Uranium Plume Characterization, Remedial Action Review and Recommendation for Future Action*; PNL-8073, *Hanford Site Ground-Water Monitoring for 1990*). A pump-and-treat system operated in the central portion of this plume from 1994 until 2011, and during this time, 220.5 kilograms of uranium were removed from the aquifer. The system was successful in reducing uranium concentrations in the aquifer to below 300 micrograms per liter.

The objective of the current remedial action is to capture or contain the uranium plume where it exceeds the maximum contaminant level (MCL) by 90th percentile or greater; hence the pump-and-treat interim action may be terminated when the concentration throughout the plume is below the 90th percentile of the

MCL. The current MCL for uranium is 30 micrograms per liter (µg/L). The results of the model provide estimates of the area of the plume captured and contained by the pump-and-treat system, and the time required for the pump-and-treat extraction wells to remove pore volumes of water from the targeted plume area(s).

The scope of this calculation is limited to hydraulic capture analysis. Simulation of contaminant transport of the local plume associated with U Plant is specifically excluded from this scope. The predictive modeling timeframe begins in calendar year 2014 and continues for 123 years to demonstrate capture performance.

There may be a continuing source of uranium coming from the vadose zone beneath the source cribs. The scope of this remedial action is only the groundwater. Remediation of the source will be addressed as part of the source operable unit.

Injection of treated groundwater into the aquifer occurs in the 200-ZP-1 groundwater operable unit injection wells, which are located outside of the model domain. Artificial recharge occurs at the State Approved Land Disposal Site (SALDS) that is located north of the 200 West Area's boundary, outside of the model domain. Injection wells in the U Plant vicinity may be drilled in the future to enhance system performance.

The remedial action will be utilizing two new extraction wells which are in the planning stage. The location, screen interval, and pumping rates are supplied by the modeling result of ECF-200UP1-14-0031.

3 Methodology

The U Plant submodel was constructed as follows:

1. CPGW Model was used as the base model. The model results of ECF-200UP1-14-0031 was used to get the location of two extraction wells, pumping rates for the wells, and well screen intervals
2. Groundwater Vistas' Telescopic Mesh Refinement (TMR) option was used to extract the submodel from the larger scale CPGW Model
3. The resulting head values of the CPGW Model in ECF-200UP1-14-0031 was used to calculate the Constant Head boundary for the submodel
4. The boundary of the submodel is located far enough from the uranium plume extraction wells so that pumping at the uranium extraction wells does not influence the boundary. The Constant Head boundaries extracted from both the CPGW Model (i.e., without the uranium extraction wells) and model results of ECF-200UP1-14-0031 (i.e., with the uranium extraction wells) were compared to check for any influence on the submodel boundary
5. The identified domain, depicted in Figure 3, was used to extract the submodel from the larger scale model
6. The finite-difference grid was refined to obtain higher resolution in the focus area of the submodel, namely the plume and extraction well locations
7. Hydraulic properties and boundary conditions were mapped onto the refined grid from the base model
8. MODFLOW dataset for the submodel was created using Groundwater Vistas and a forward-run was performed

9. Heads at different locations of the submodel, both uniform and refined grids, and the larger scale model were compared to ascertain the appropriateness of the submodel boundary, numerical stability of the submodel, and overall uniformity of simulated head trends
10. Submodel boundary and grid refinement were adjusted if any model boundary influence or numerical instability or irregularity of simulated head trends were observed. Steps 2 through 9 were repeated until all irregularities were resolved

Once the U Plant Groundwater submodel was developed, it was available for use to calculate hydraulic capture zones. The MODPATH software was used to calculate forward and reverse particle tracks leading to the extraction wells for the proposed design scenario. The particle tracks identify the area within the aquifer captured by the extraction wells as a function of time from commencement of pumping.

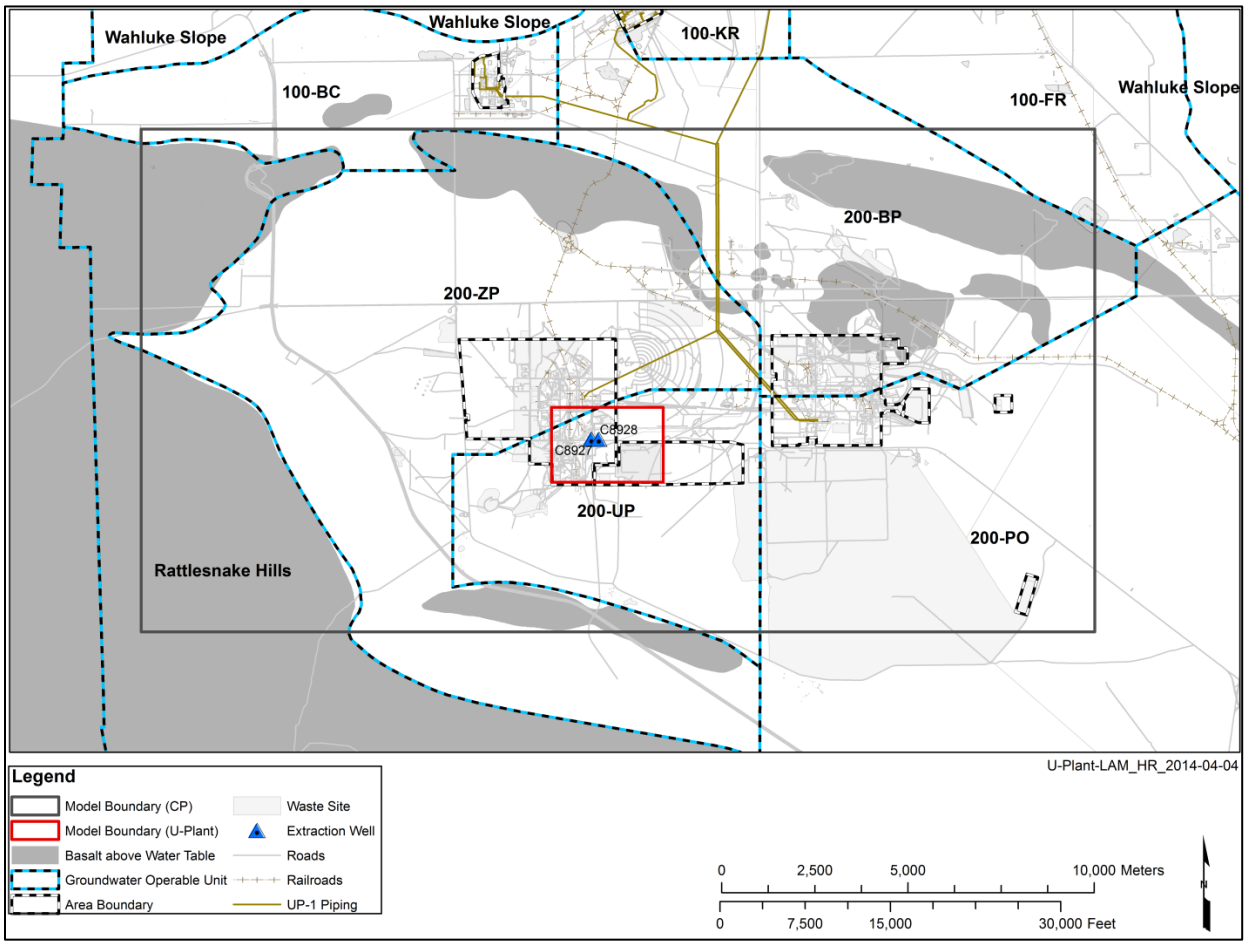

Figure 3. Central Plateau Groundwater Model Version 6.3.3 Domain and Coinciding U Plant Submodel Domain

4 Assumptions and Inputs

4.1 Submodel Domain

The submodel domain extends 3000 meters west to east, and 2000 meters south to north and is located as shown in Figure 2. This area represents the maximum areal extent, with some added buffer, to which the optimized extraction rates associated with the UP-1 Uranium Remedy-Remedial Design affected the results of the CPGW Model in ECF-200UP1-14-0031 (i.e., the submodel boundary is not impacted by the uranium extraction wells).

The local grid was refined from the extracted portion of the CPGW Model to provide suitable resolution for simulating details of hydraulic capture near the targeted uranium plume. The CPGW Model is discretized with a grid spacing of 100 by 100 m, and 7 layers. The U Plant submodel was refined to 2 by 2 m spacing at and near the extraction wells and uranium plume footprint; then gradually increased to 100 by 100 m spacing farther from the area of interest. The minimum (most southwest) corner of the domain sits at an easting of 566650 meters and a northing of 133850 meters, and their respective maximums are 569650 and 135850 meters (Washington state plane coordinate system, south zone). Figure 4 shows the horizontal gridding of the submodel along with the location of the wells, uranium plume footprint, and Constant Head boundary.

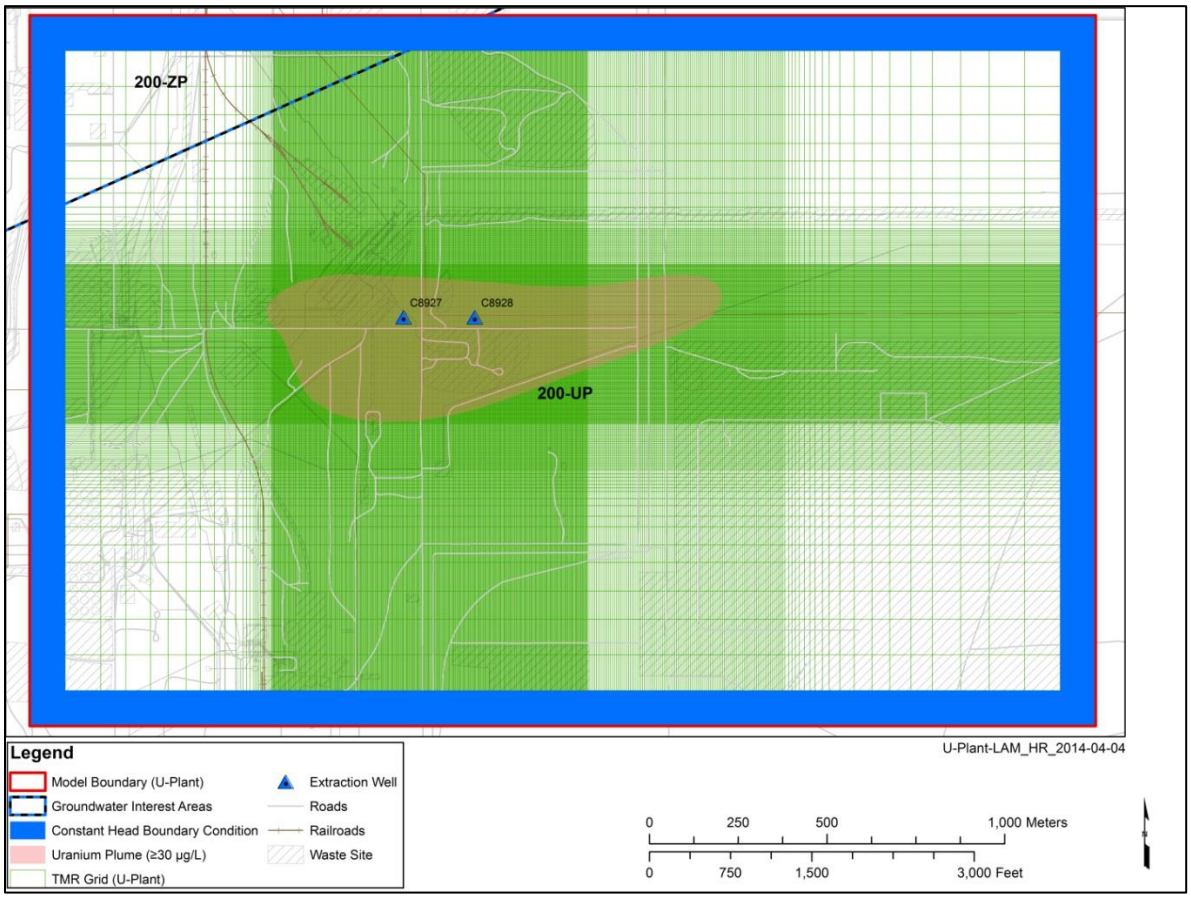

Figure 4. Horizontal Numerical Grid Discretization for the U Plant Submodel

The hydrogeologic unit identification and hydraulic parameters are consistent with those determined for the Central Plateau Groundwater Model. Layers 1 through 5 of the U Plant model are composed entirely of Ringold gravel Units E and C (BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*); including sand facies of the Upper Ringold Unit where it directly overlies the other E and C units. Layer 6 is composed of a finer grained unit Ringold Lower Mud including Ringold Units B and D (BHI-00184). Layer 7 is composed entirely of Ringold Unit A (BHI-00184), a gravel and sand facies that is dominated by sand in the western part of the Pasco Basin. An east-west aligned cross section (looking north) though the submodel is presented in Figure 5 (a vertical exaggeration of 20 was used) above. The cross section details the HSU, vertical grid spacing, and 2013 water table. Hydraulic Parameters are summarized in Table 1. Prior to startup of the 200-ZP-1 pump-and-treat system in July 2012, the hydraulic gradient in the U Plant area averaged 0.0012 m/m toward the east. The hydraulic gradient has changed in response to operation of the 200-ZP-1 system, and is now 0.016 m/m toward the northeast (March 2014).

Table 1. Hydraulic parameters for U Plant Submodel Hydrostratigraphic Units (HSUs)

Layers	Description/Unit	Porosity	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)
1-5	Unit 5: Ringold gravel Units E and C (BHI-00184); also includes sand facies of the Upper Ringold Unit where it directly overlies the other E and C units	0.15	5	0.5
6	Unit 8: Fine-grained Ringold Lower Mud including Ringold Units B and D (BHI-00184)	0.15	0.008	0.0008
7	Unit 9: Ringold Unit A (BHI-00184), a gravel and sand facies	0.15	4.8	0.48

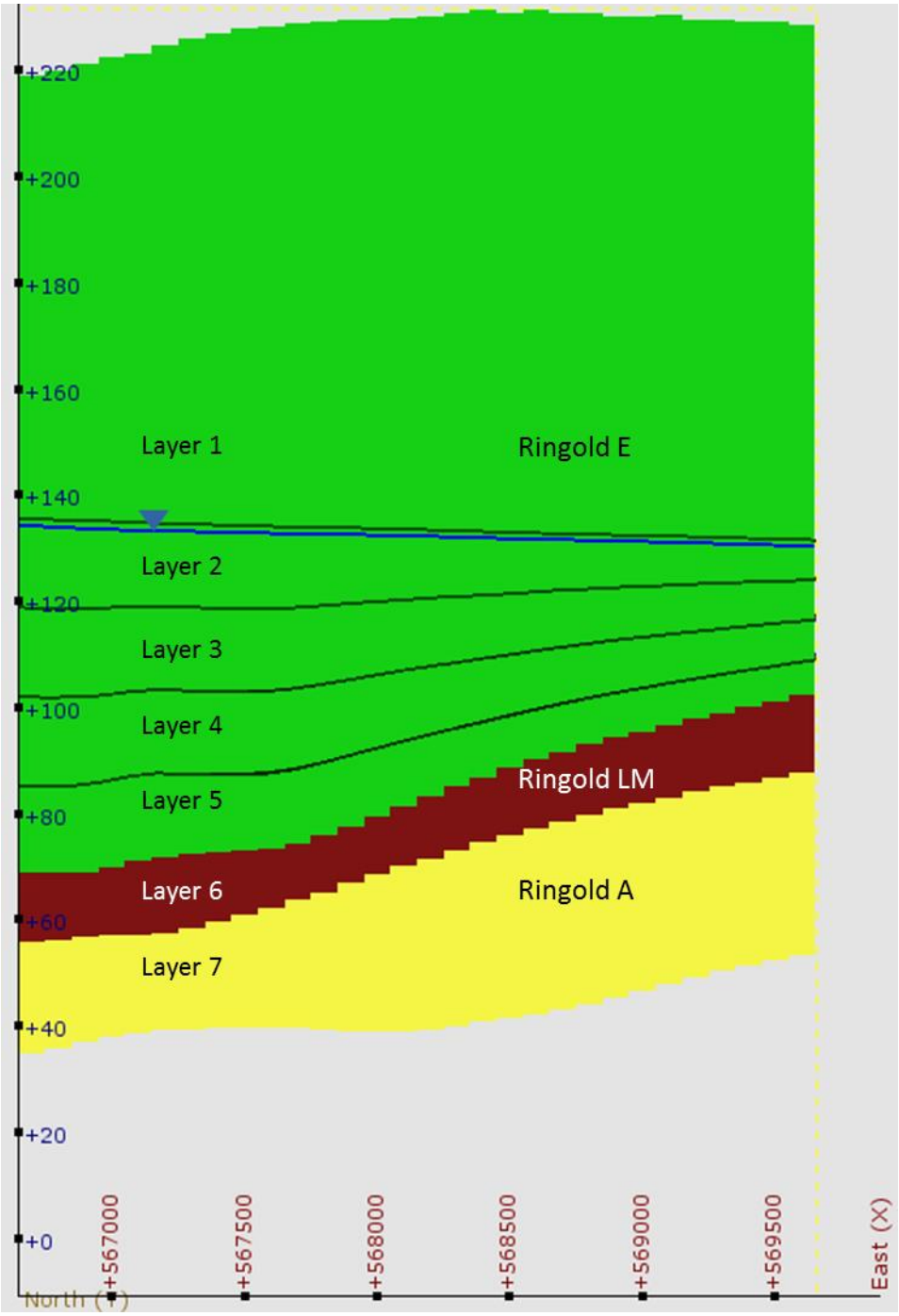

Figure 5. Vertical Numerical Grid Discretization for the U Plant Submodel

4.2 Boundary and Initial Conditions

The Central Plateau Groundwater Model version 6.3.3 and model result from ECF-200UP1-14-0031 provided the basis for the boundary and initial conditions of the U Plant submodel. Hydraulic head results from along the identified submodel boundary and concurrent with the timeframe of the remedial action were extracted from the CPGW Model. These results, interpolated to the refined grid of the

submodel, were adopted as prescribed head boundary conditions. These heads changed through time, depending on the results of the stress periods in the CPGW Model that coincide with the timeframe of the remedial action. Initial conditions for the submodel domain were extracted from the results of the CPGW Model for the time representing 2014.

4.3 Wells

The location and pumping rates for the two extraction wells were obtained from ECF-200UP1-14-0031. According to the ECF-200UP1-14-0031, Well C8927 (Easting 567700 and Northing 135000) and C8928 (Easting 567900 and Northing 135000) will be installed at the end of calendar year 2014. The predictive results in ECF-200UP1-14-0031 showed that 75 gpm (408.75 m^3/day) at each well would be the optimized pumping rate to achieve the remedial action goals. Figure 6, details their pumping rates and locations. Well C8927 is screened across Layer 2 in the model which is approximately 13 m thick and well C8928 is screened across both Layer 2 and Layer 3 where both layers are 13 m thick (i.e., total 26 m screen). However, the current water table contour shows that Layer 2 is not fully saturated (water table is approximately 3 m below the top of Layer 2) and it will decrease as extraction continues. Thus, for the submodel, the well installation plan is to place the well screen from 3.0 m (10 ft) to 18.3 m (60 ft) below the water table which is consistent with the existing saturated zone and expected water table drawdown. Pumping was not included in Layer 1 because the base of Layer 1 is above the existing water table (i.e., dry).

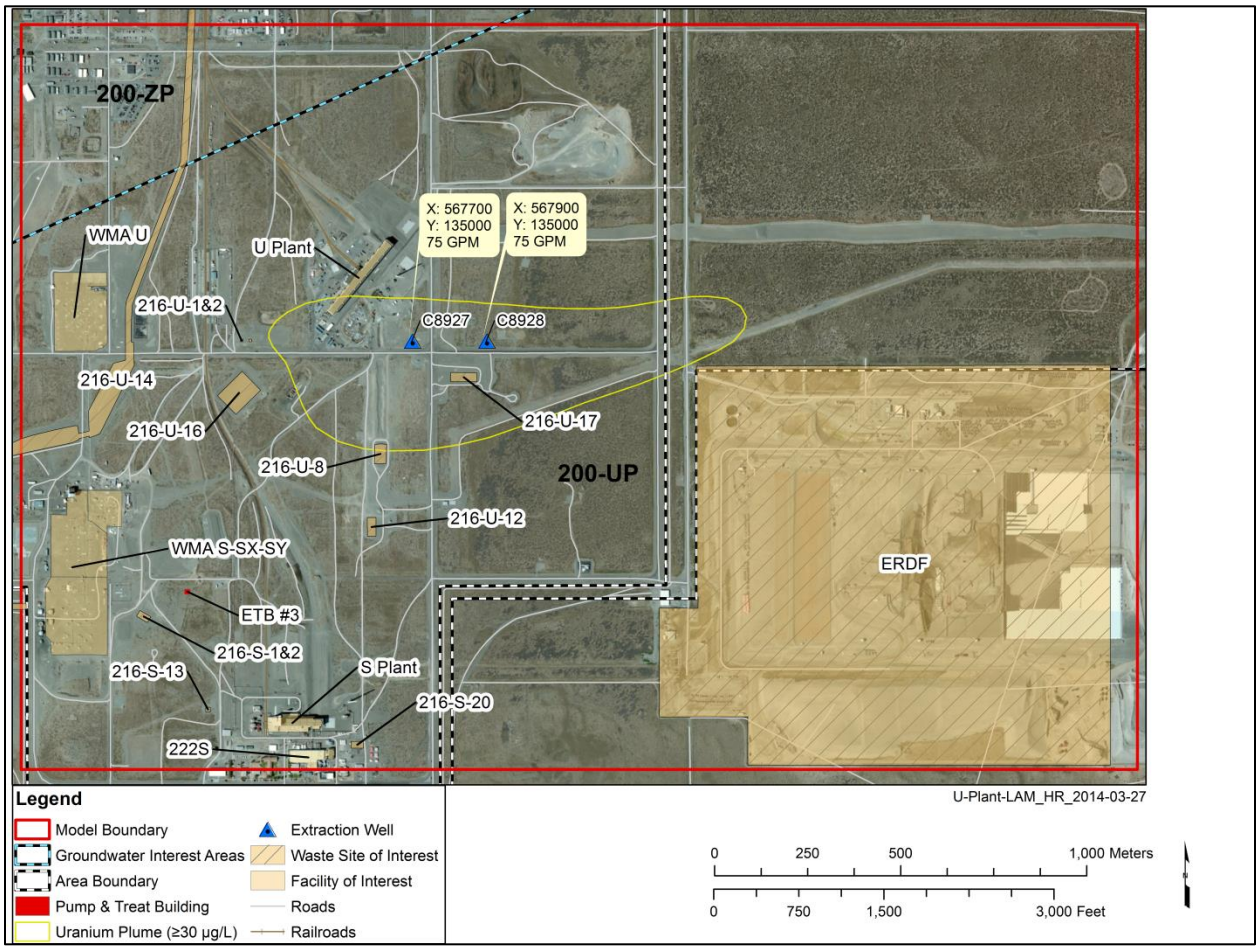

Figure 6. Extraction Well Locations and Pumping Rates under Base Run

5 Software Applications

MODFLOW-2000-MST, MODPATH-MST, and Groundwater Vistas™[1] software programs were used for this ECF. These are CHPRC approved software, managed and used in compliance with the requirements of PRC-PRO-IRM-309, *Controlled Software Management*. The following supporting information is provided.

5.1 Approved Software

For Approved Software used in this calculation, the required description is provided.

5.1.1 Description

MODFLOW

- Software Title: MODFLOW-2000-MST
- Software Version: CHPRC Build 0006 (mf2k-mst-chprc06dp.exe)
- Hanford Information System Inventory (HISI) Identification Number: 2517 (Safety Software, Level C)
- Authorized Workstation type and property number: Personal Computer, INTERA-00463
- Authorized User: H Rashid
- 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*

MODPATH

- Software Title: MODPATH-MST
- Software Version: CHPRC Build 0006 (modpath-mst-chprc06sp.exe)
- HISI Identification Number: N/A (Support Software; CHPRC-00258 Rev. 2)
- Authorized Workstation type and property number: N/A
- Authorized User: N/A
- CHPRC Software Control Documents:
    - CHPRC-00258, *MODFLOW and Related Codes Software Management Plan*

Groundwater Vistas™

- Software Title: Groundwater Vistas™
- Software Version: 5.51 Build 18b
- HISI Identification Number: N/A (Support Software; see CHPRC-00258)
- Authorized Workstation type and property number: N/A
- Authorized User: N/A

[1] Groundwater Vistas is a trademark of Environmental Systems, Inc.

- CHPRC Software Control Document:
    - CHPRC-00258, *MODFLOW and Related Codes Software Management Plan*

5.1.2 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 Rev. 2. Executable files were obtained from the Software Owner who maintains the configuration-managed copies in MKS Integrity™[2], 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. Copies of the Software Installation and Checkout Forms for approved users and installations used to perform this calculation are provided in Attachment 1 of this ECF.

5.1.3 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.

[2] MKS Integrity™ is a trademark of MKS, Incorporated.

6 Calculation

A MODPATH run with reverse particle tracking option was performed to see how much of the plume area was captured by the uranium extraction wells. The particles were placed at both well locations at the center of saturated thickness of Layer 2. The resulting capture zone of the MODPATH run is showed in Figure 7. Vertical movement of the particle with time is indicated by different color for each layer (e.g., green color indicates that the particle is in Layer 3) and each arrow indicates the horizontal distance travelled in a year. The capture zone figure shows that particles in well C8927 drop to Layer 3 at the beginning of the simulation and continue to travel along Layer 3 and Layer 4 for rest of the simulation period. This indicates that water level at well C8927 has decreased significantly as soon as pumping started. As the capture zone for the MODPATH run with reverse particle tracking option is not conclusive enough to understand whether Well C8927 is capturing particles from Layer 2 or not, a MODPATH run with forward particle tracking option was performed. The particles were placed around the edges of the uranium plume footprint at water table. Figure 8 shows the particles which are captured by the wells and which are not captured by the wells. Figure 8 also shows that the extraction wells are capturing most part of the western area of the uranium plume (high concentration area) except for a small portion of the north-west area and some portion of the eastern area. Both reverse and forward particle tracking results indicated that it would take around 5-8 years to capture the edges of the targeted plume area.

A three-dimensional view of the particle locations over time and the uranium plume (obtained from ECF-200UP1-14-0091, Initial Groundwater Plume Development (Uranium, Technetium-99, and Nitrate) to Support Fate and Transport Modeling for Remedial Design in the 200-UP-1 Groundwater Operable Unit) is shown in Figure 9 to demonstrate the capture zone in vertical direction. The particle locations in Figure 9 are extracted from MODPATH run with both reverse and forward particle tracking options. The particles for the reverse particle tracking were placed at both well locations at the center of saturated zone in Layer 2 and the particles for the forward particle tracking were placed around the edges of the uranium plume footprint at water table. Reverse particle tracking results in Figure 7 and Figure 9 clearly shows that the capture zone for the extraction well C8927 is significantly smaller than for extraction well C8928. A more detailed analysis on the well configuration, hydraulic head at well location over time, and pumping rate applied to model at each stress period was needed to address this issue. The narrow capture zone along with sharp drop in number of particle pathways in the vertical direction (reverse particle track) in well C8927, which is screened only at Layer 2, indicates that the drawdown at well C8927 is causing a thinner saturated zone in Layer 2. As a result, less water could be available for pumping at the designated 75 gpm rate. The MODFLOW model results were processed to extract the pumping rates for each stress period for each well. Actual pumping rates in the model differed from the designated 75 gpm rate. These rates varied over time ranging from 72.54 gpm to 20.52 gpm for well C8927 and from 75 gpm to 51.63 gpm for well C8928 (Figure 10).

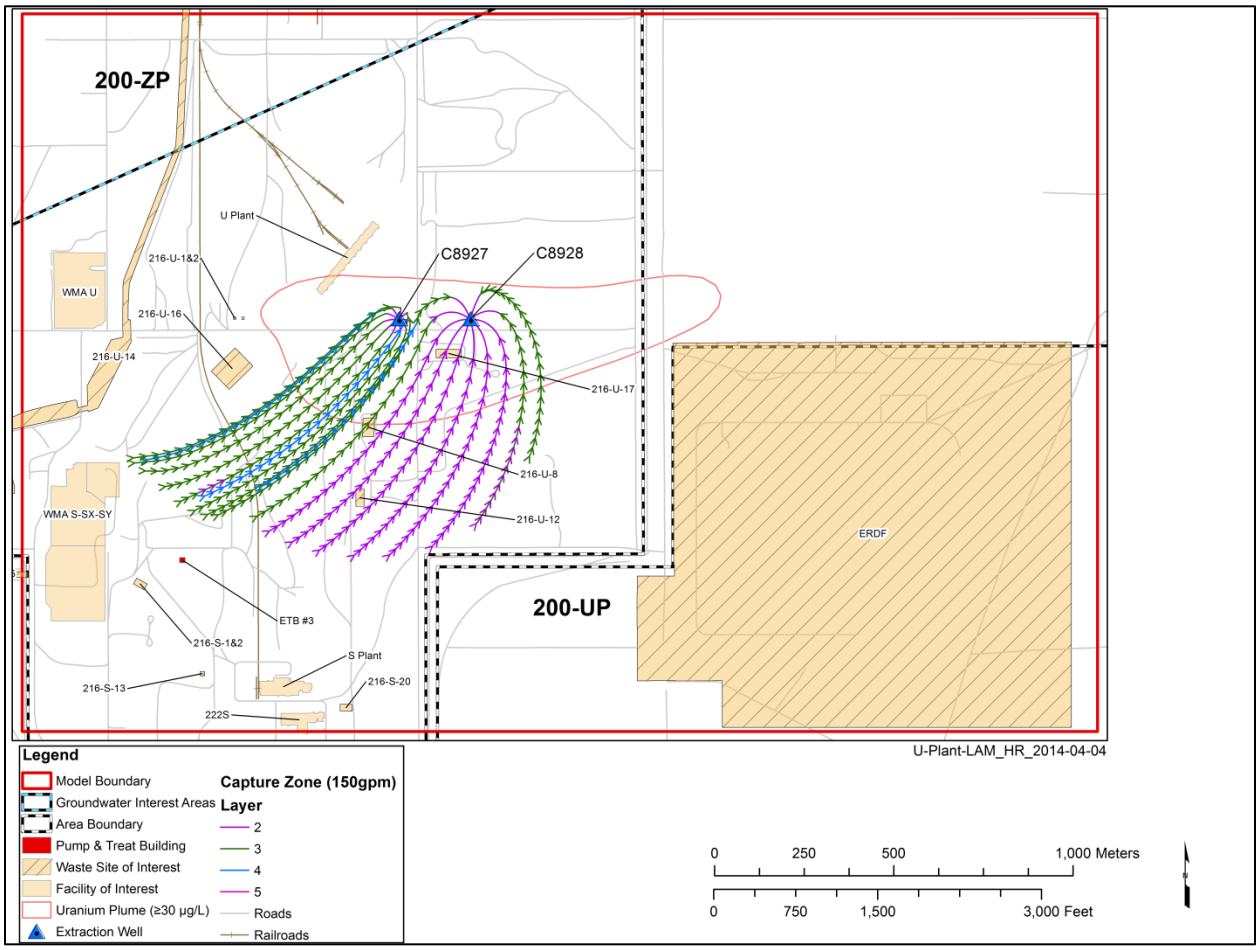

Figure 7. Predicted Hydraulic Capture Zone at 1-year Intervals for Base Case (reverse particle track)

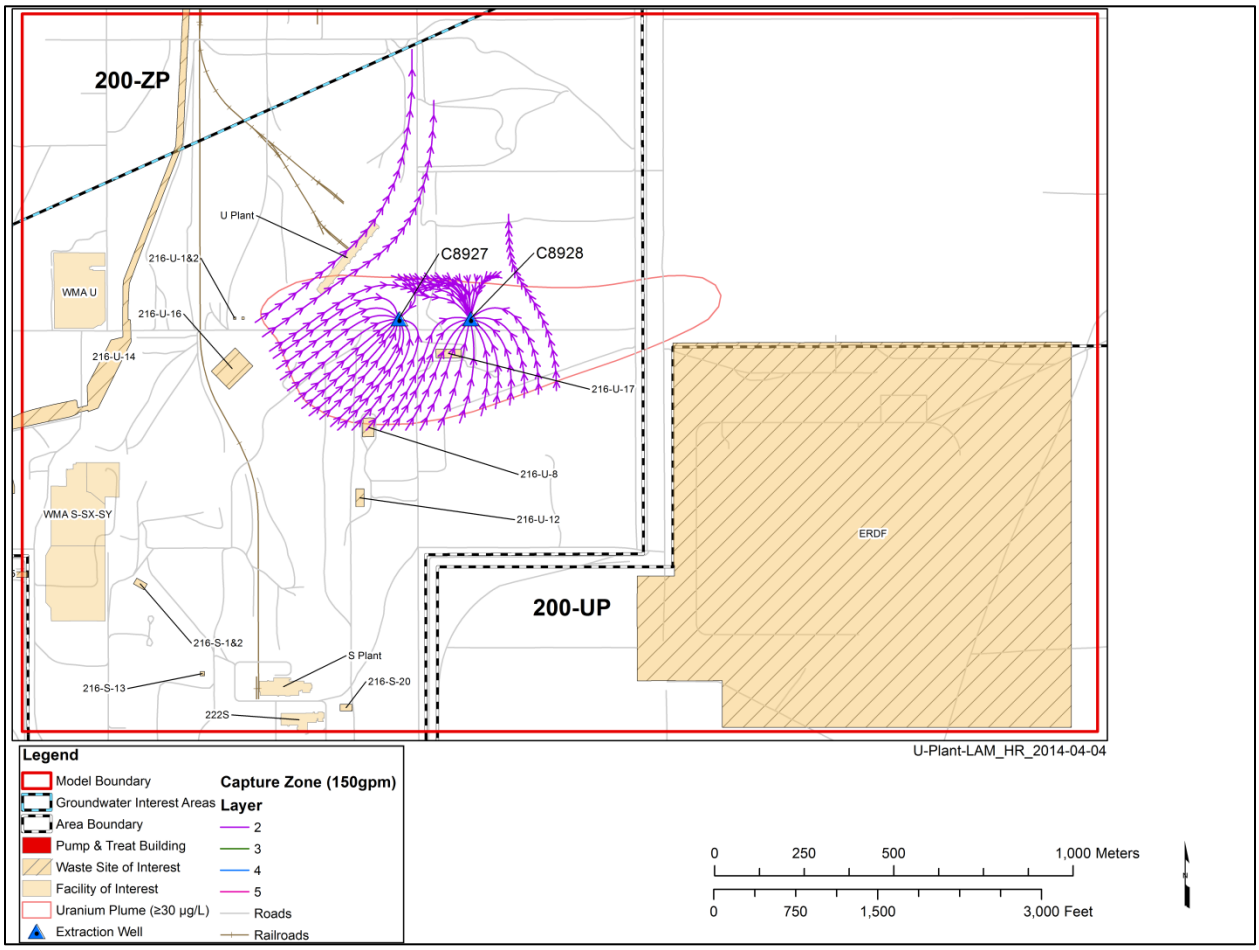

Figure 8. Predicted Hydraulic Capture Zone at 1-year Intervals for Base Case (forward particle track)

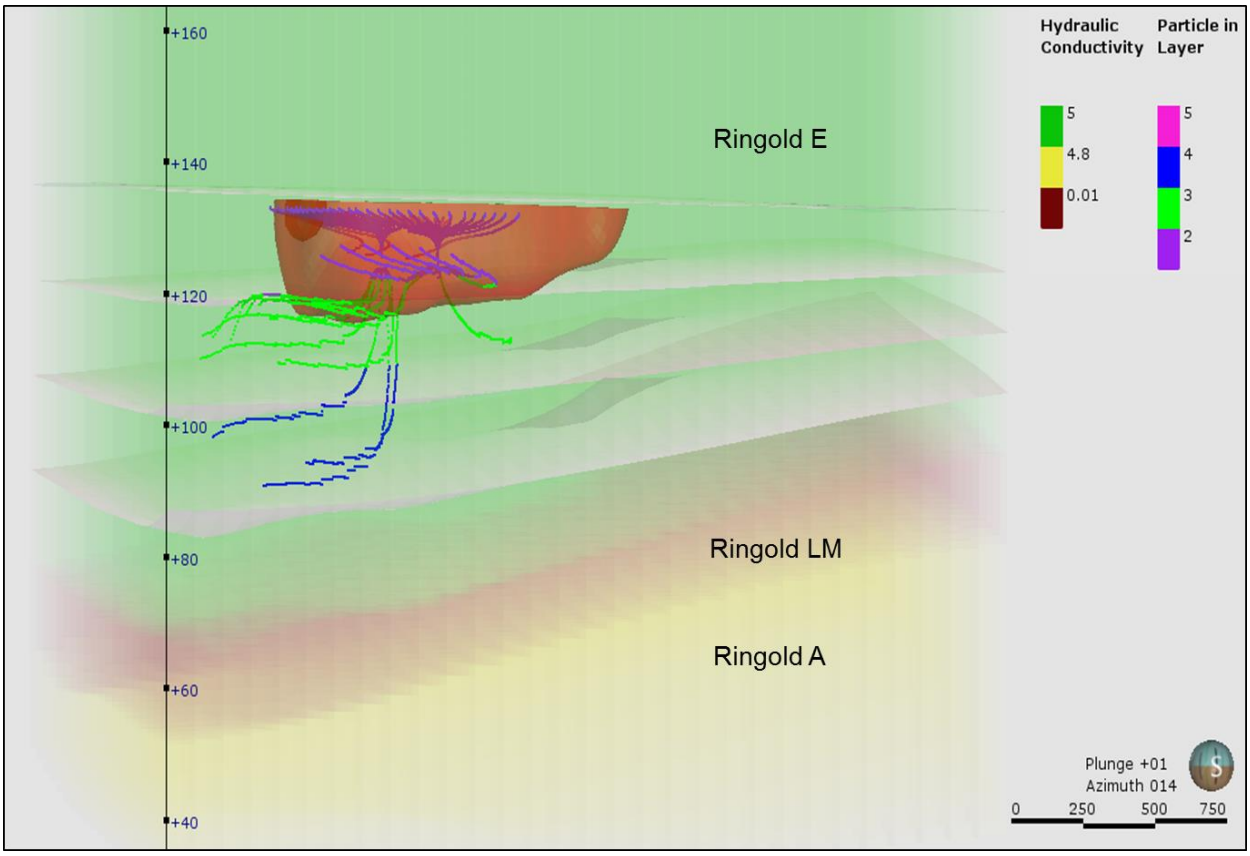

Figure 9. Three-dimensional View of the Capture Zone for the Reverse and Forward Particle Tracking

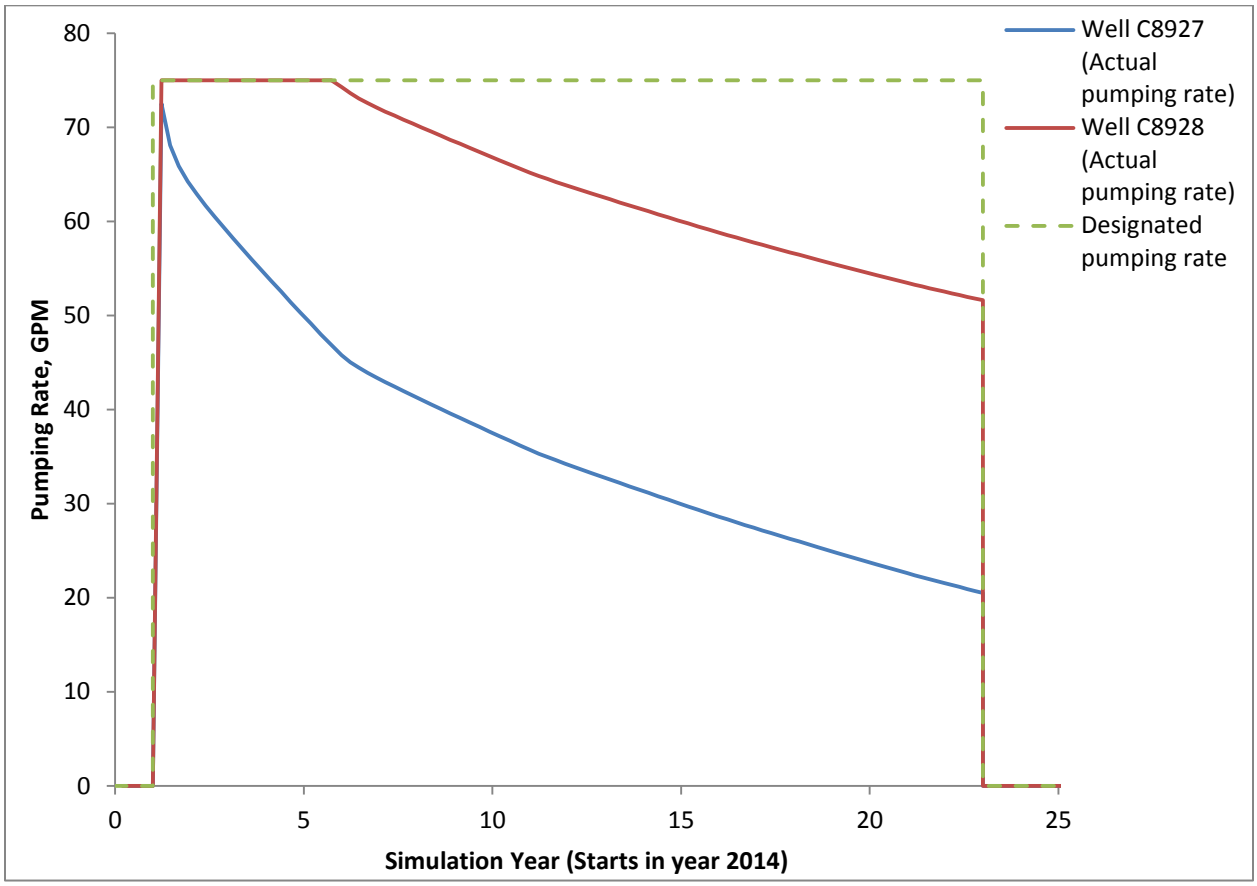

Figure 10. Pumping Rate Applied to the MODFLOW Model for the Uranium Extraction Wells (base run)

7 Sensitivity Analysis

MODFLOW model results of the local area submodel showed that well screen configuration of both wells need to be reconfigured to operate the extraction wells at 75 gpm for 22 years. Several sensitivity runs were performed to understand the effect on the actual pumping rate due to different well screen and pumping rate assigned at different layers. The detail description of the sensitivity runs are tabulated in Table 2.

Table 2. Comparison of sensitivity runs with Base run

No.	Description
Base Run	Well C8927 is screened across Layer 2 and well C8928 is screened at both Layers 2 and 3
Sensitivity Run 1	Both wells are screened across Layers 2 and 3
Sensitivity Run 2	Both wells are screened across Layers 2, 3, and 4
Sensitivity Run 3	Both wells are screened across Layers 2 and 3 (similar to sensitivity 1). Distribution of pumping rate in different layers are done such a way that the system can pump at its full capacity
Sensitivity Run 4	Both wells are screened across Layers 2 and 3 (similar to sensitivity 1). MNW2 package was used to get the optimized pumping rates at different layers

The comparison of the designated and actual pumping rates in the model is shown in Figure 11 (Well C8927) and Figure 12 (Well C8928). The figures clearly show that the well configurations in Sensitivity Runs 3 and 4 will be able to maintain a flow rate of 75 gpm from each well for 22 years. Both well configurations in Sensitivity Run 3 and Sensitivity Run 4 are essentially the same except pumping rate distribution for the later run was calculated by the MODFLOW MNW2 package. MODFLOW MNW2 package calculates the available water for pumping at each layer and assign the pumping rate at each layer. This process was done manually in Sensitivity Run 3 and Sensitivity Run 4 (using MODFLOW MNW2 package) was performed to validate the Sensitivity Run 3. For Sensitivity Run 4, a MODPATH run with reverse particle tracking option was performed to see the difference in capture zone between Base Run and Sensitivity Run 4. The particles were placed at both well locations at the center of the saturated thickness of Layer 2. The resulted capture zone of the MODPATH run is showed in Figure 13. Vertical movement of the particle with time is indicated by different color for each layer (e.g., purple color indicates that the particle is in Layer 2) and each arrow indicates the horizontal distance travelled in a year. A three-dimensional view of the particle locations over time and the uranium plume is shown in Figure 14 to demonstrate the capture zone in vertical direction. The particle locations in Figure 14 are extracted from MODPATH run with reverse particle tracking option (particles were placed at both well locations at the center of saturated thickness of Layer 2 and Layer 3).

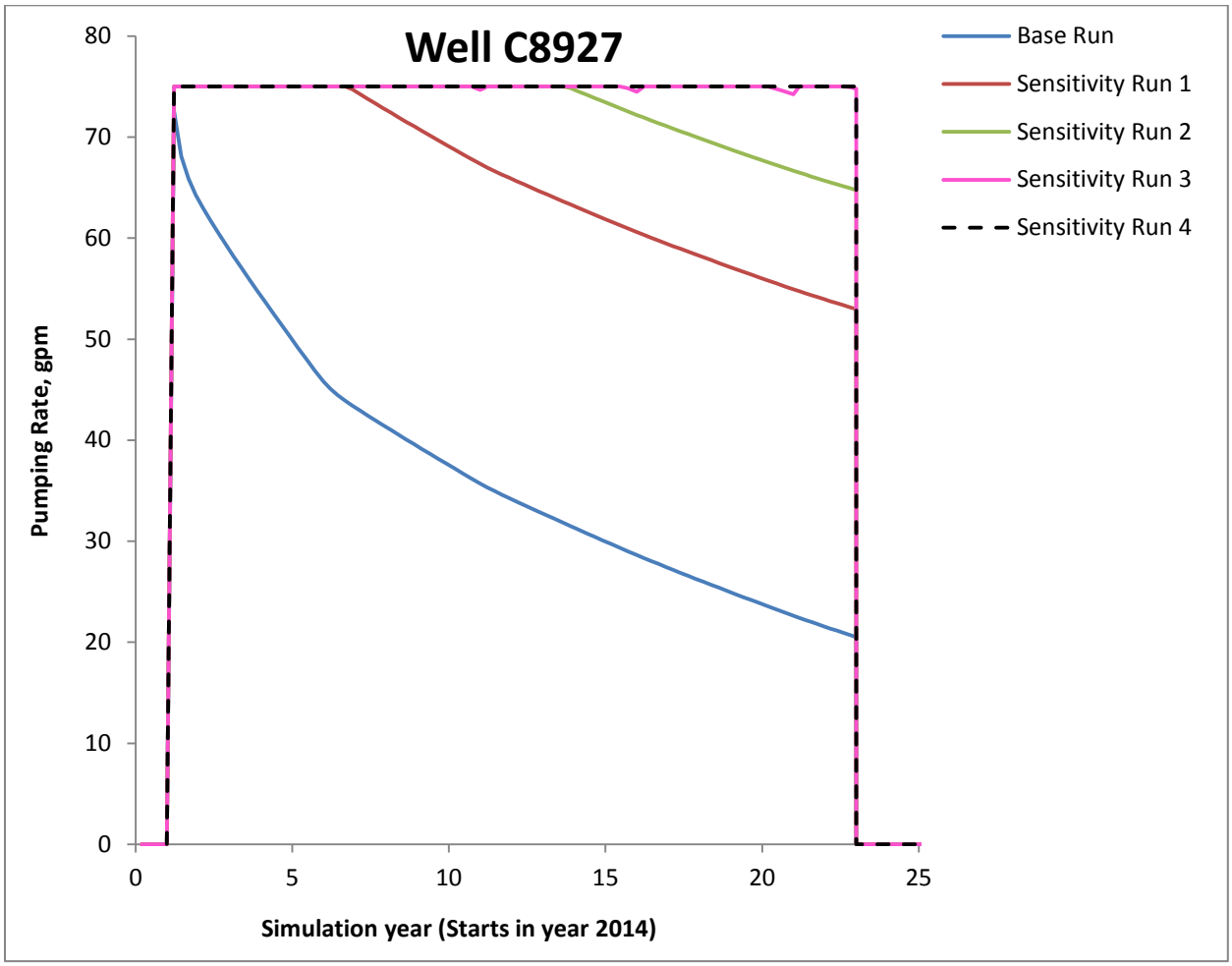

Figure 11. Comparison of Pumping Rates Applied to the MODFLOW Model for the Uranium Extraction Well C8927

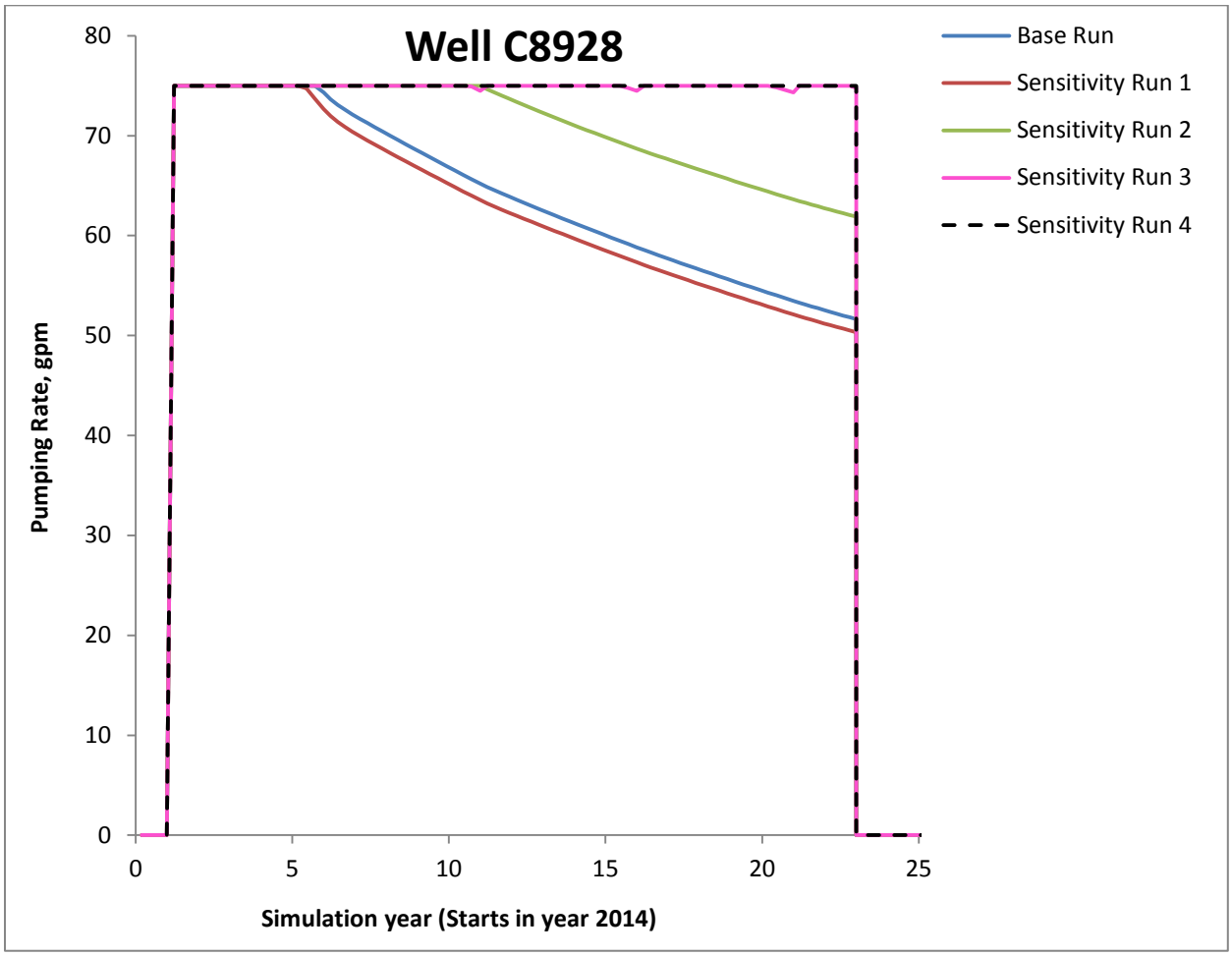

Figure 12. Comparison of Pumping Rates Applied to the MODFLOW Model for the Uranium Extraction Well C8928

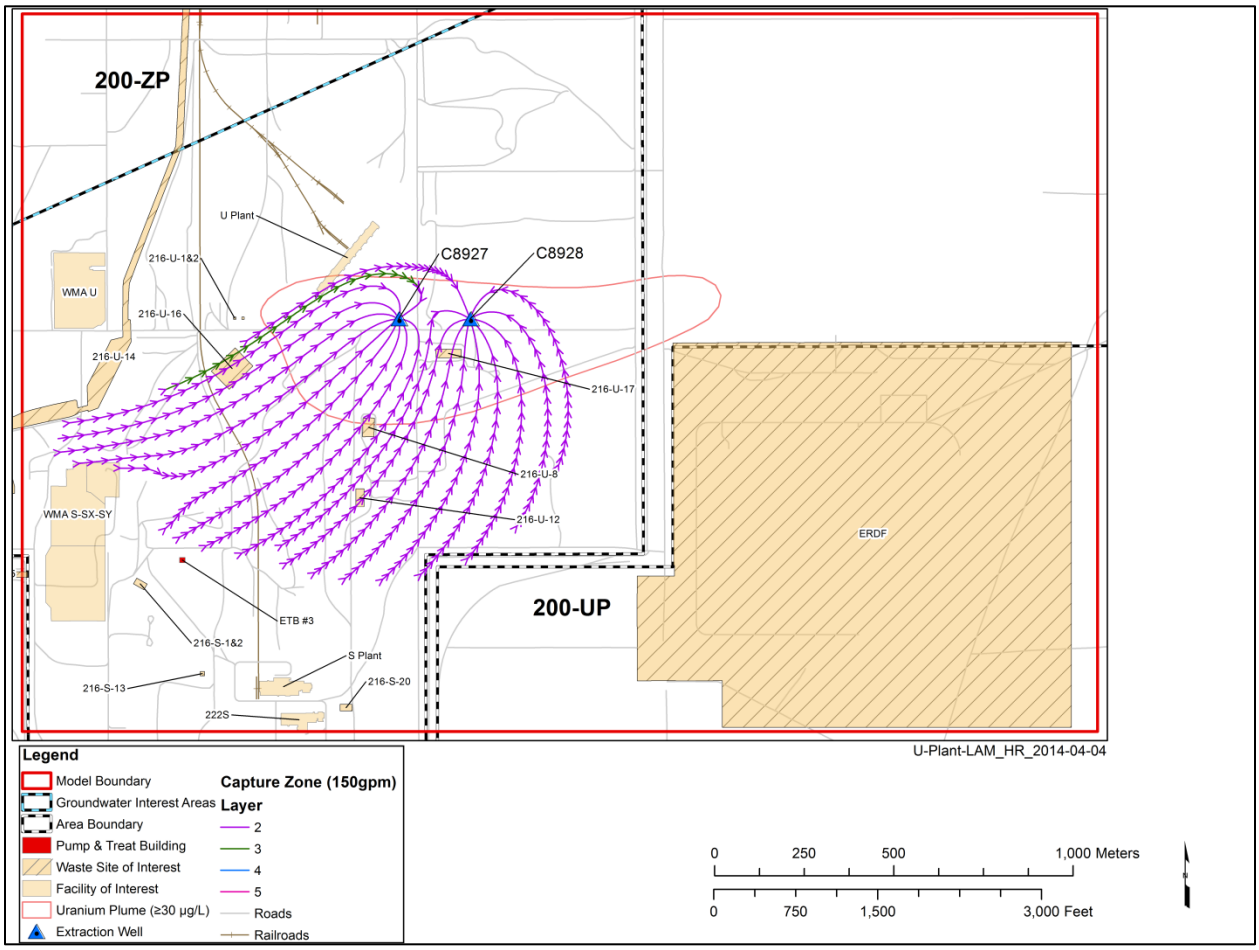

Figure 13. Predicted Hydraulic Capture Zone at 1-year Intervals for Sensitivity Run 4 (reverse particle tracking)

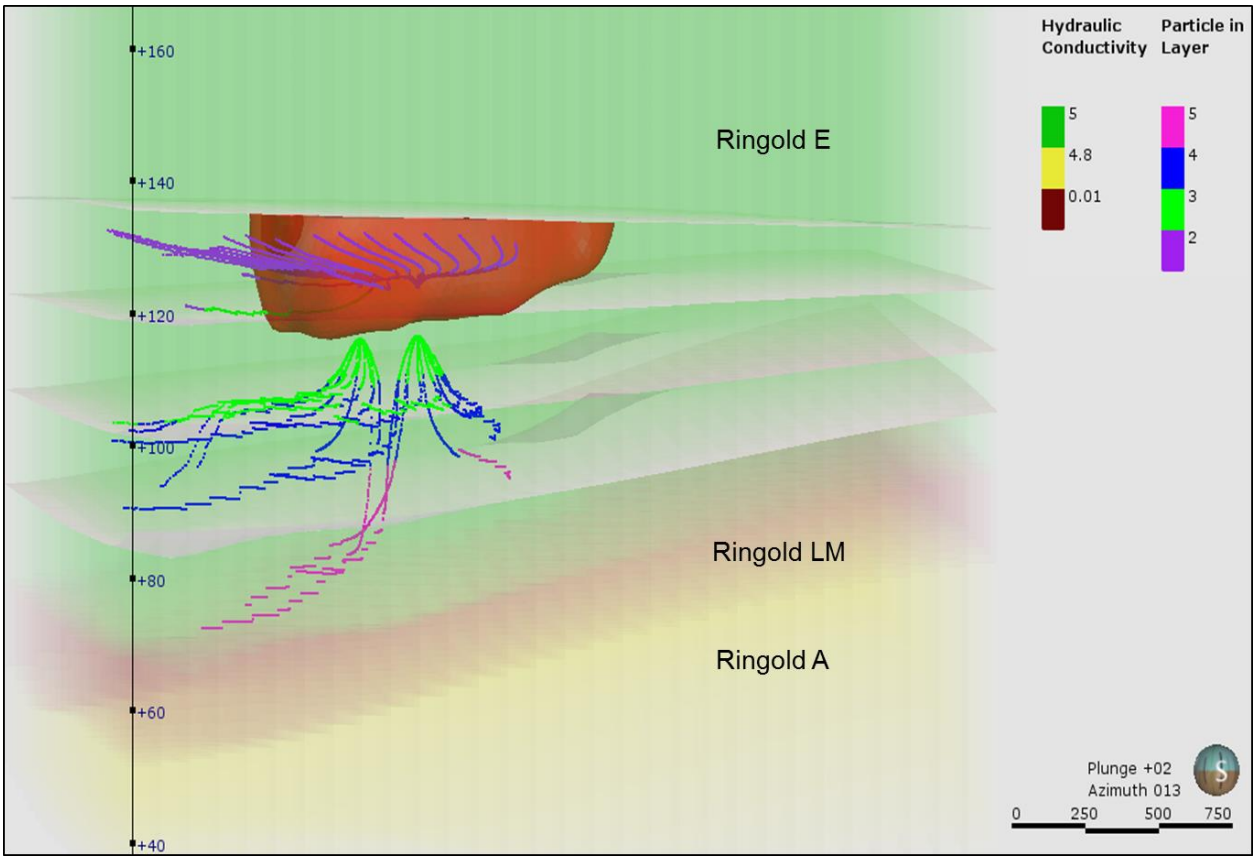

Figure 14. Three-dimensional View of the Capture Zone for Sensitivity Run 4 (reverse particle tracking)

8 Results/Conclusions

The simulation results suggest that this two-well configuration is capable of containing most of the high concentration portion of the uranium plume over time. The north-western portion that was not captured by the uranium extraction wells are moving towards the ZP-1 extraction wells and may get captured by the ZP-1 extraction wells depending on how long that system operates. The current well configuration will not be able to capture a large portion of the plume to the eastern side and according to the current flow direction this portion of the plume is expected to migrate towards north-east side of the model. Pumping rates actually implemented in the model were less than the pumping rates desired from those wells. That means, current well screen configuration, provided in the model by using MODFLOW well package, needs to be reconfigured to obtain the desired pumping rate. The sensitivity runs showed that both wells needs to be screened across Layer 2 and Layer 3 to obtain desired pumping rate of 75 gpm. In addition, pumping rate at each layer has to be assigned such a way that there is always enough water to pump at the desired rate. This can be achieved by manually adjusting the pumping rates at different layers (Sensitivity Run 3) or by using MODFLOW MNW2 package (Sensitivity Run 4).

9 References

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Attachment A

Copy of Software Installation and Checkout Form for MODFLOW & Related Codes Build 0006 Installation to Computer INTERA-00463 (User H Rashid)

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 6

EXECUTABLE INFORMATION:

2. Executable Name (include path):

Following executable files in directory: _____

MD5 Signature (unique ID)	Executable File Name
C3B75ADEBC7F41F15F006A0A3AED2D21	mf2k-chprc06dp.exe
C3141B0D41E084601DC2C8EB746B189F	mf2k-chprc06sp.exe
4F9E3D4A5ECF0360C8247C4279FE25F1	mf2k-mst-chprc06dp.exe
0E38BD210A582EF42CC79145C14F8E69	mf2k-mst-chprc06sp.exe
EE4D6CE61E07E0218F81822CE54499DE	modpath-mst-chprc06dp.exe
F83D1B16B26887A8C9579373D919DF4F	modpath-mst-chprc06sp.exe
D3337D49ED0AAA92E6FE6A6EB027647A	mt3d-mst-chprc06dp.exe
E6A66025170D441389642CC0A7B59749	mt3d-mst-chprc06sp.exe

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

COMPILATION INFORMATION:

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

WC95463; Dell Latitude Laptop

5. Operating System (include version number):

Windows 7 Enterprise Service Pack 1

INSTALLATION AND CHECKOUT INFORMATION:

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

HP Pavilion dv7 Notebook PC (INTERA - 00463)

7. Operating System (include version number):

Windows 7 Home Edition

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

TEST CASE INFORMATION:

9. Directory/Path:

C:\Software test\build-06\test

10. Procedure(s):

CHPRC-00259 Rev 2, 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

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: MODFLOW and Related Codes Software Version No.: Bld 6

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:

All tests returned identical results as base cases

16. Test Performed By: H Rashid

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

18. Disposition (include HISI update):

INSTALLATION ADDED TO HISI

Prepared By:

19.	WE Nichols	17 APRIL 2014
Software Owner (Signature)	Print	Date

20. Test Personnel:

S.M. Helalur Rashid	H Rashid	4/17/2014
Sign	Print	Date
Sign	Print	Date
	N/R (CHPRC-00259 Rev 2)	
Sign	Print	Date

Approved By:

21.		
Software SME (Signature)	Print	Date