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ECF-HANFORD-25-0040
Revision 0

Hanford Composite Analysis Special Studies FY 2025 - Groundwater Flow Simulation for use in a Comparison of Simulated Concentrations in the Saturated Zone Estimated by the Plateau-to-River Model Versions 8.3 and 9.1

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

Contractor for the U.S. Department of Energy
under Contract 89303320DEM000030

P.O. Box 1464
Richland, Washington 99352

ECF-HANFORD-25-0040
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Document Type: ECF Program/Project: CA FY2025 Special Analyses (Special Analyses for the Composite Analyses for FY 2025)

R. Lyons
INTERA, Inc.

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

Contractor for the U.S. Department of Energy
under Contract 89303320DEM000030

CPCCo
Central Plateau
Cleanup Company
P.O. Box 1464
Richland, Washington 99352

APPROVED
By S. Natalie Molina at 2:08 pm, Sep 08, 2025

Release Approval Date

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ENVIRONMENTAL CALCULATION COVER PAGE

CPCC-PRO-EP-40205

SECTION 1 - COMPLETED PRIOR TO CALCULATION BEING PERFORMED

Calculation Number: ECF-HANFORD-25-0040 Revision Number: 0

Project: CA FY2025 Special Analyses (Special Analyses for Composite Analyses for FY 2025

Date: 06/16/2025

Calculation Title:
Hanford Composite Analysis Special Studies FY 2025 - Groundwater Flow Simulation for use in a Comparison of Simulated Concentrations in the Saturated Zone Estimated by the Plateau-to-River Model Versions 8.3 and 9.1

Calculation Purpose:
The calculations run MODFLOW model v9.1 for next-generation saturated zone impact evaluation.

Will this calculation utilize an environmental model or risk assessment? ☒ Yes ☐ No

If "Yes" box is checked, forward this form **and** form A-6007-637, *Environmental Model Package Report Cover Page* to the Risk and Modeling Integration Manager with Section 1 completed for both forms.

ROLE ASSIGNMENTS AND QUALIFICATIONS SUMMARY

Preparer(s):

Name: Rick Lyons

Professional License(s): N/A

Brief Narrative of Experience: Richard Lyons is a hydrogeologist/groundwater modeler with eight years of experience in surface and subsurface modeling, calibration, and optimization. His experience includes conceptual and numerical groundwater flow and transport modeling and simulation, modeling of single and multi-phase fluid flow, model calibration and optimization, contaminant transport and particle tracking, water balance modeling, and programming for automation of hydrologic calibration, simulation, and analysis. He has additional experience in visualization and presentation of data and of model results.

Checker(s):

Name: David Adams

Professional License(s): N/A

Brief Narrative of Experience: Mr. Adams is a hydrologic scientist with project experience that includes flood inundation modeling and geologic reconnaissance / mapping in upstate New York. Mr. Adams is proficient in Excel, R, and multiple GIS software, with a passion for solving complex problems related to water resources and an extensive background in ground water storage research and science communication. David also has experience working with MODFLOW / MT3D and various third party graphical user interfaces and is comfortable in both Linux and Windows environments.

Senior Reviewer(s):

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

Name: Trevor Budge

Professional License(s): N/A

Brief Narrative of Experience: Trevor Budge's experience encompasses characterizing and modeling hydrologic and hydrogeologic systems in support of a wide range of water resources, environmental, and waste isolation projects. His work has included analyzing and optimizing remediation well configuration and operation, investigating long-term remediation costs, characterizing complex geological settings with the use of geophysical and remote sensing data, designing slurry walls and hydraulic barrier walls near sensitive water bodies, emergency planning-based modeling of catastrophic dam failures and large storm events, and developing geographic information system tools to efficiently process data and modeling results. These tasks have been completed using a wide range of numerical, analytical, and geostatistical tools. His knowledge of computer hardware and software, including GIS and programming languages, allows him to solve problems that arise specific to each project that cannot be resolved using standard out-of-the-box software and hardware. Trevor has completed projects for organizations ranging from small municipalities and local water authorities to state and federal government agencies, and he has authored and developed software applications used by the US Environmental Protection Agency and the US Department of Defense.

Responsible Manager:

Randal Fox	RANDAL FOX (Affiliate) Digitally signed by RANDAL FOX (Affiliate) Date: 2025.06.24 13:54:47 -07'00'
Print First and Last Name	*Signature / Date*

SECTIONS 2 - REVISION HISTORY

Revision No.	Description	Date
0	Initial Issue	7/29/2025

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

SECTION 3 - DOCUMENT REVIEW AND APPROVAL

Preparer(s):

Print First and Last Name	Position	Signature	Date
Rick Lyons	Hydrogeologist	Richard Lyons Digitally signed by Richard Lyons Date: 2025.07.18 10:26:35 -06'00'	

Checker(s):

Acting for David Adams

Print First and Last Name	Position	Signature	Date
David Adams	Hydrogeologist	RYAN NELL (Affiliate) Digitally signed by RYAN NELL (Affiliate) Date: 2025.07.29 14:03:56 -07'00'	

Senior Reviewer(s):

Print First and Last Name	Position	Signature	Date
Trevor Budge	Senior Hydrogeologist	TREVOR BUDGE (Affiliate) Digitally signed by TREVOR BUDGE (Affiliate) Date: 2025.08.01 10:33:53 -07'00'	

Responsible Manager:

Print First and Last Name	Position	Signature	Date
Randal Fox	CPCCo RM	RANDAL FOX (Affiliate) Digitally signed by RANDAL FOX (Affiliate) Date: 2025.08.18 09:37:51 -07'00'	

ENVIRONMENTAL MODEL/RISK ASSESSMENT COVER PAGE

CPCC-PRO-EP-40253

This cover page is to be appended to Form A-6005-812, *Environmental Calculation Cover Page*, for all environmental calculations that document use of an environmental model or risk assessment.

SECTION 1 - Completed PRIOR to calculation being performed.

When this section is completed, forward to Risk and Modeling Integration Manager along with initiated Form A-6005-812, *Environmental Calculation Cover Page*.

Calculation Number: ECF-HANFORD-25-0040	Revision Number: 0

Preparer(s):

Rick Lyons

Checker(s):

David Adams

Senior Reviewer(s):

NOTE: Risk & Modeling Integration Manager must approve the Senior Review before calculation is performed.

Trevor Budge

List all controlled use software graded Level D or higher and platforms to be used in this calculation:

HISI Number	Software Name	Platform
2517	MODFLOW	MOSS computing cluster
2518	MT3DMS	MOSS computing cluster
5690	ArcGIS Pro	INTERA 01153

SECTION 2 - Completed by the Risk & Modeling Integration Manager *(or Training Coordinator Designee)* PRIOR to calculation being performed.

Required training *(CPCC-00172 Appendix E)* for modelers completed for Preparer(s), Checker(s), and Senior Review(s):

Risk & Modeling Integration Manager or Designee Training Coordinator:

Chris Farrow — *Print First and Last Name*

CHRISTOPHER FARROW (Affiliate) Digitally signed by CHRISTOPHER FARROW (Affiliate) Date: 2025.07.08 12:46:32 -05'00' — *Signature / Date*

SECTION 3 - Completed by the Risk & Modeling Integration Manager *(or Integration Lead Designee)* PRIOR to calculation being performed.

Software Checkout and Installation for controlled use software listed in Section 1 confirmed.

Risk & Modeling Integration Manager or Designee Integration Lead:

Chris Farrow — *Print First and Last Name*

CHRISTOPHER FARROW (Affiliate) Digitally signed by CHRISTOPHER FARROW (Affiliate) Date: 2025.07.08 12:51:59 -05'00' — *Signature / Date*

(Return form to Responsible Manager)

SECTION 4 - Completed by the Risk & Modeling Integration Manager *(or Integration Lead Designee)* AFTER calculation is performed.

Application of controlled use software utilized in environmental calculation file is compliant.

List any changes in controlled use software listed in Section 1 for the completed calculation:

None.

Risk & Modeling Integration Manager or Designee Integration Lead:

Chris Farrow — *Print First and Last Name*

CHRISTOPHER FARROW (Affiliate) Digitally signed by CHRISTOPHER FARROW (Affiliate) Date: 2025.08.11 13:58:20 -05'00' — *Signature / Date*

ENVIRONMENTAL MODEL/RISK ASSESSMENT COVER PAGE (Continued)

SECTION 5 - Completed by the Risk & Modeling Integration Manager AFTER Environmental Calculation using an environmental model or risk assessment is completed.

Environmental calculation using environmental model or risk assessment conforms with requirements of CPCC-PRO-EP-40253.

Risk & Modeling Integration Manager:

Will Nichols	WILLIAM NICHOLS (Affiliate) Digitally signed by WILLIAM NICHOLS (Affiliate) Date: 2025.08.12 07:37:16 -07'00'
Print First and Last Name	*Signature / Date*

Contents

Attachments

Figures

Tables

Terms

CA	composite analysis
CPCCo	Central Plateau Cleanup Company
DOE	U.S. Department of Energy
ECF	Environmental Calculation File
EMMA	Environmental Modeling Management Archive
HISI	Hanford Information System Inventory
HMIS	Hanford Mission Integrated Solutions
LSQR	Least Squares Regression
MODFLOW	MODular Groundwater FLOW (code)
P&T	pump and treat
P2R	Plateau to River
RET	Recharge Evolution Tool
TMR	telescopic mesh refinement

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1 Purpose

In order to meet the requirements of U.S. Department of Energy (DOE) in DOE O 435.1, *Radioactive Waste Management,* a composite analysis (CA) must be completed for the Central Plateau at the Hanford Site. The CA requires estimates of fate and transport of radionuclides in the groundwater from multiple sources within the modeling domain. This Environmental Calculation File (ECF) details the application of the Plateau-to-River (P2R) Model (CP-57037, Rev. 3, *Model Package Report for the P2R Model: Version 9.1*) to predict the flow of groundwater on the Central Plateau for the 10,000-year simulation to support a special analysis associated with the Hanford Site CA. The simulated flow field will support the simulation of fate and transport of contaminants for comparison to the results obtained as part of the CA to evaluate impact of the updated version of the P2R Model.

2 Background

The technical approach for executing the saturated zone facet of the CA is documented in CP-60406, *Hanford Site Composite Analysis Technical Approach Description: Groundwater*. The description includes discussing the selection of the numerical modeling platform and the details regarding development of input parameters for use in the analysis. The approach calls for using the most current version of the P2R Model to simulate groundwater flow and transport for a 10,000-year predictive time period. CP-57037, Rev. 2, *Model Package Report: Plateau to River Model Version 8.3*, documents the development and calibration of the P2R Model. A recent update of the model from version 8.3 to version 9.1 altered various inputs to the P2R Model including grid structure, boundary conditions, and hydraulic properties. In order to evaluate the impact of these changes on the results of the CA, this special analysis comparing simulated concentration values calculated by the P2R Model to the previous version was completed. This document describes groundwater flow simulation conducted using P2R Model version 9.1 to simulate the predictive flow field for estimating the concentrations through fate and transport modeling.

3 Methodology

Development of the predictive flow field using the P2R Model is completed using the acquired computer software MODular Groundwater FLOW (MODFLOW) (USGS, 2000, *MODFLOW-2000, The U.S. Geological Survey Modular GroundWater Model: User Guide to Modularization Concepts and the Ground-Water Flow Process*) (see Chapter 5). The model simulates hydraulic head and groundwater fluxes on a cell-by-cell basis within the model domain. The details of the model extent and discretization are found below. The governing equations of MODFLOW are solved based on input parameters stored in the model files. Development and calibration of many of the model input parameters are documented in CP-57037. Those input parameters that differ from the parameter values documented in CP-57037 are discussed in Chapter 4 of this document. For details on other model input parameters please refer to CP-57037.

3.1 Model Domain and Discretization

The P2R Model domain has the following lateral extent and boundaries: extent north to south is 26.6 km (16.5 mi) and extent east to west is 37.6 km (23.3.3 mi). The lower left corner of the model domain is located at easting 557,800 m and at northing 116,200 m in the Washington State Coordinate System (NAD_1983_StatePlane_Washington_South_FIPS_4602). The vertical extent of the model comprises the subsurface sediments from ground surface to the uppermost unit of the Columbia River Basalt Group. The basalt that is assumed to constitute an impermeable lower boundary defines the base of the domain.

The model domain is discretized as a set of two overlapping finite difference grids. The two grids consist of the sitewide (SW) grid and the 200-BC-1 (BC) Area grid. Table 1 shows a summary of the discretization of the two grids. The SW grid is considered the “parent” grid of the BC Area “child” grid. While the grids are separate, they work in tandem to produce results as the P2R Model. These model grids were developed together for use with the P2R Model version 9.1 (CP-57037).

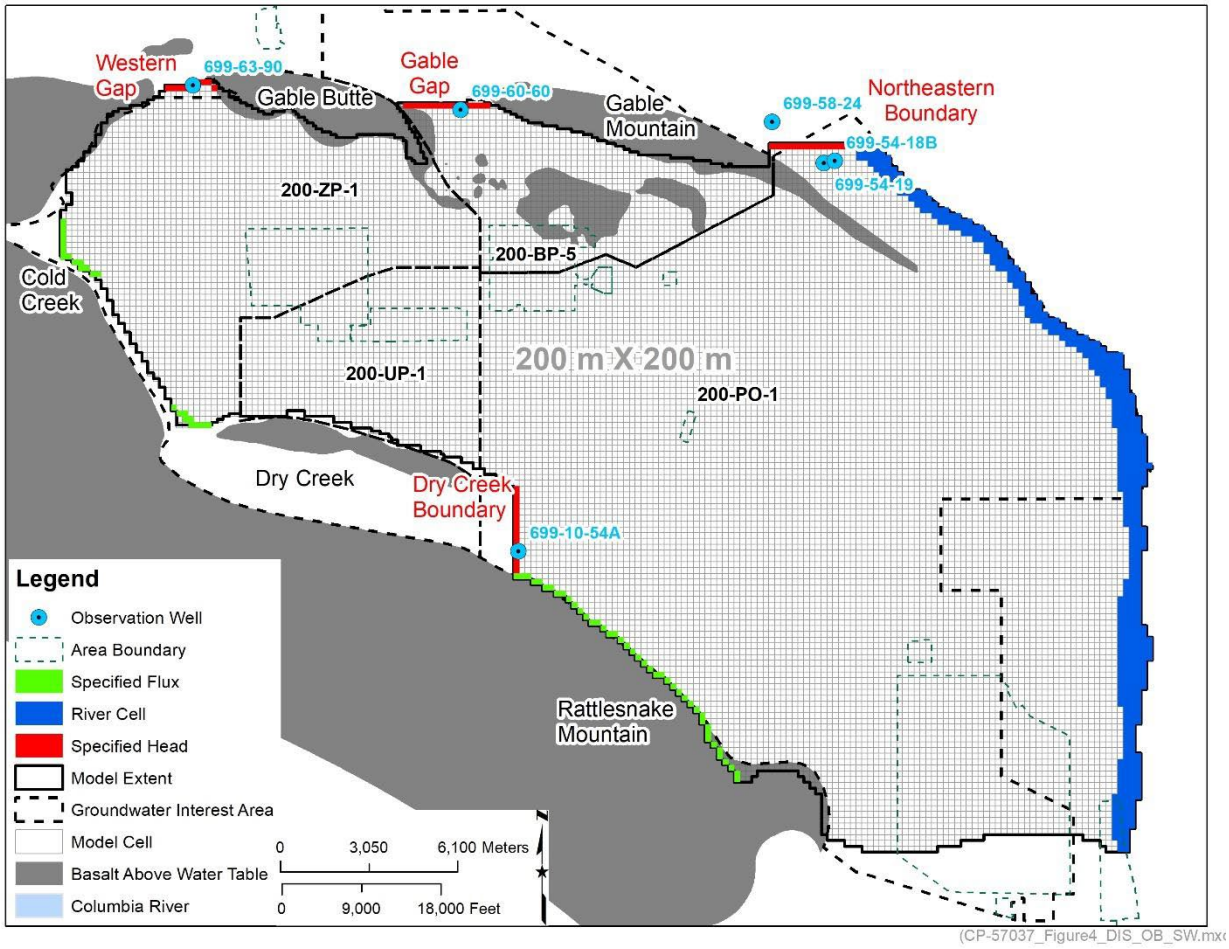
Table 1. Model Discretization for the Parent and Child Models Developed for the P2R Model Version 9.1

Model Grid (Acronym)	Model Type	Lower Left Corner *		Grid Dimensions			Individual Cell Size
		Easting (m)	Northing (m)	Layers	Rows	Columns	
Sitewide (SW)	Parent	557800	116200	8	133	188	200 m by 200 m (656.17 ft by 656.17 ft)
200-BC-1 (BC)	Child	564800	130200	8	236	304	50 m by 50 m (164.04 ft by 164.04 ft)

* Coordinate corresponds to the projection: State Plane Washington South FIPS 4602 (NAD83).

NAD83: *North American Datum of 1983*

Figure 1 shows the lateral extent of the P2R Model version 9.1 domain along with the groundwater operable units, lateral discretization, and boundary conditions. Vertical discretization is consistent between the two grids where they overlap. The model is vertically divided into eight layers between the ground surface elevation and the top of the uppermost basalt surface. The discretization of the vertical layers varies to represent the thickness of geologic formations found within the model domain.



Source: CP-57037, *Model Package Report: Plateau to River Groundwater Model, Version 9.1.*

Figure 1. P2R Version 9.1 Model Extent and Boundary Conditions

When presenting simulation results for model applications, the simulated results will be presented as one model. As described in CP-57037, the process of telescopic mesh refinement (TMR) is used to make the model discretization consistent and the methodology in this environmental calculation will be used to maintain consistency between the hydraulic properties assigned to the parent and child models.

3.2 Model Temporal Discretization

The temporal discretization for both models is the same, 1,052 years. Table 2 shows the start and end time for each stress period of the simulation. The overall purpose is to demonstrate that the model can reasonably replicate observed conditions in the aquifer throughout the history of operations and environmental remediation at the site.

Table 2. Temporal Discretization for the Parent and Child Models Developed for the P2R Model Version 9.1

Model Grid (Acronym)	Model Type	Simulation Dates		Stress Period Frequency	Description
		Start	End		
Sitewide (SW)	Parent	1/1/2018	1/1/12070	Variable	Simulates the groundwater flow in the saturated zone of the suprabasalt aquifer of the site to capture features, events, and processes that impact the large-scale groundwater flow from the Central Plateau to the Columbia River.
200-BC-1 (BC)	Child	1/1/2018	1/1/12070	Variable	Simulates the aquifer beneath both 200 West and East Areas on the Central Plateau to estimate flow and fate and transport that will inform decisions impacting operations that will help reach remedial targets for the Central Plateau.

4 Assumptions and Inputs

This section summarizes the inputs and assumptions that are specific to the calculations presented in this document. Features and inputs to the P2R Model (e.g., model layer elevations, hydraulic properties, specific storage, and specific yield) that did not change for the development of the predictive flow field are not presented. The principal inputs to the calculations are the following:

- Temporal discretization
- Boundary conditions
- Initial head
- Extraction and injection well flow rates by stress period

4.1 Temporal Discretization

The simulation period for the predictive flow model starts in 2018 and runs for 10,052 years, ending in 12070 (Table 3). A total of 101 stress periods were used with varying stress period length. The length of any stress period through 2570 matched the time periods taken by the Recharge Evolution Tool (RET) documented in ECF-HANFORD-15-0019, *Hanford Site-Wide Natural Recharge Boundary Conditions for Groundwater Models*. By staying consistent with the RET temporal discretization, major changes to land use were represented in the boundary conditions of the simulation.

Table 3. Temporal Discretization of Predictive Flow Model

Stress Periods	Duration (yr)	Description
1 to 82	82	82 transient annual stress periods that span from 2018 through 2099
83	35	1 transient stress period that spans from 2100 through 2134
84	16	1 transient stress period that spans from 2135 through 2150
85	343	1 transient stress period that spans from 2151 through 2493
86	23	1 transient stress period that spans from 2494 through 2516
87	3	1 transient stress period that spans from 2517 through 2519
88	1	1 transient annual stress period that spans the year 2520
89	4	1 transient stress period that spans from 2521 through 2524
90 to 91	2	2 transient annual stress periods that span from 2515 through 2526
92	2	1 transient stress period that span from 2527 through 2528
93	1	1 transient annual stress period that spans the year 2529
94	3	1 transient stress period that spans from 2530 through 2532
95	2	1 transient stress period that spans from 2533 through 2534
96	8	1 transient stress period that spans from 2535 through 2542
97	7	1 transient stress period that spans from 2543 through 2549
98 to 99	2	2 transient annual stress periods that span from 2550 through 2551
100	18	1 transient stress period that spans from 2552 through 2569
101	9,500	1 transient stress period that spans from 2570 through 12070

4.2 Boundary Conditions

Boundary conditions for the P2R Model were adjusted to match the temporal discretization needed to simulate 10,052 years into the future from site closure in calendar year 12070. Updated boundary conditions include the Columbia River boundary, specified heads, and the recharge. Each of these is discussed in the following sections.

4.2.1 Columbia River Boundary

The Columbia River acts as the eastern boundary condition for the P2R Model. The details on the river boundary features such as river cell location, river-stage elevation, river bottom elevation, and river sediment conductance are documented in CP-57037. The process for building the Columbia River boundary condition was kept same as the one documented in CP-57037. The river stage is determined by calculating the amount of flow in the river and using a flow vs. stage rating curve for each river cell to establish the river stage at those locations. The river flow value for the simulation period was kept constant to reflect a long-term average for the river. The river flow value was calculated as the 50^{th} percentile value of the average annual flow rate from 30 years of river gage data (1994 through 2023) at the Priest Rapids Dam gage location, which is just upstream of the Hanford Site.

4.2.2 Specified Heads

The basalt top elevation defines the bottom and most of the lateral boundaries of the model domain (depicted as dark, gray-colored regions in Figure 1). Four locations where the water table is above the top of the basalt are defined by specified head boundaries (shown as red shading in Figure 1).

For the historical period as documented in CP-57037, the specified head values at each of these specified head boundary locations were taken as the annual average observed head at observation wells near the boundary location. However, such observation data are not possible for the predictive model starting from 2020. For the Western Gap and Northeastern Boundary, a constant value of 122.48 m and 110.98 m (representative of the average since 1/1/2001 and 1/1/2002, respectively) were used, respectively. For the Gable Gap and southern boundary near Dry Creek, the specified heads were developed using an exponential equation defined by the observed trend at wells 699-60-60, and 699-10-54A, respectively. The parameters for the exponential equations were estimated using the Least Squares Regression (LSQR) fitting of the observed values. The following exponential equation was used for calculating the specified head boundary condition:

$$P_i = B + e^{[-X * (Y_i - Y_0)]} * (S - B) \quad \textbf{(Eq. 1)}$$

where:

P_i = the predicted head for the year *i*

B = the base head representing pre-Hanford (01/01/1945) water table

X = a fitting parameter

Y_i = the year of the specified head to be predicted

Y_0 = the starting year of the LSQR fitting dataset,

S = the starting head representative of the starting year, Y_0.

LSQR fitting parameters are listed in Table 4. The base head values representing the pre-Hanford water table elevations for wells 699-60-60 and 699-10-54A (Table 4) were estimated by linear regression of the early water-level measurements for each well and hindcasting to 01/01/1945. The observed head and the predicted head calculated using the corresponding fitted exponential equation are shown in Figure 2 at the northern specified head boundary at Gable Gap near Well 699-60-60 and in Figure 3 at the southern specified head boundary at Dry Creek near Well 699-10-54A.

Table 4. LSQR Fitting Parameters used for Predicting Specified Head at Gable Gap and Southern Boundary near Dry Creek

Parameters	Gable Gap	Dry Creek
B (m)	120.5	121.45
X (dimensionless)	0.0256	0.0077
Y_0 (yr)	2003.5	2003.5
S (m)	122.2	126.98

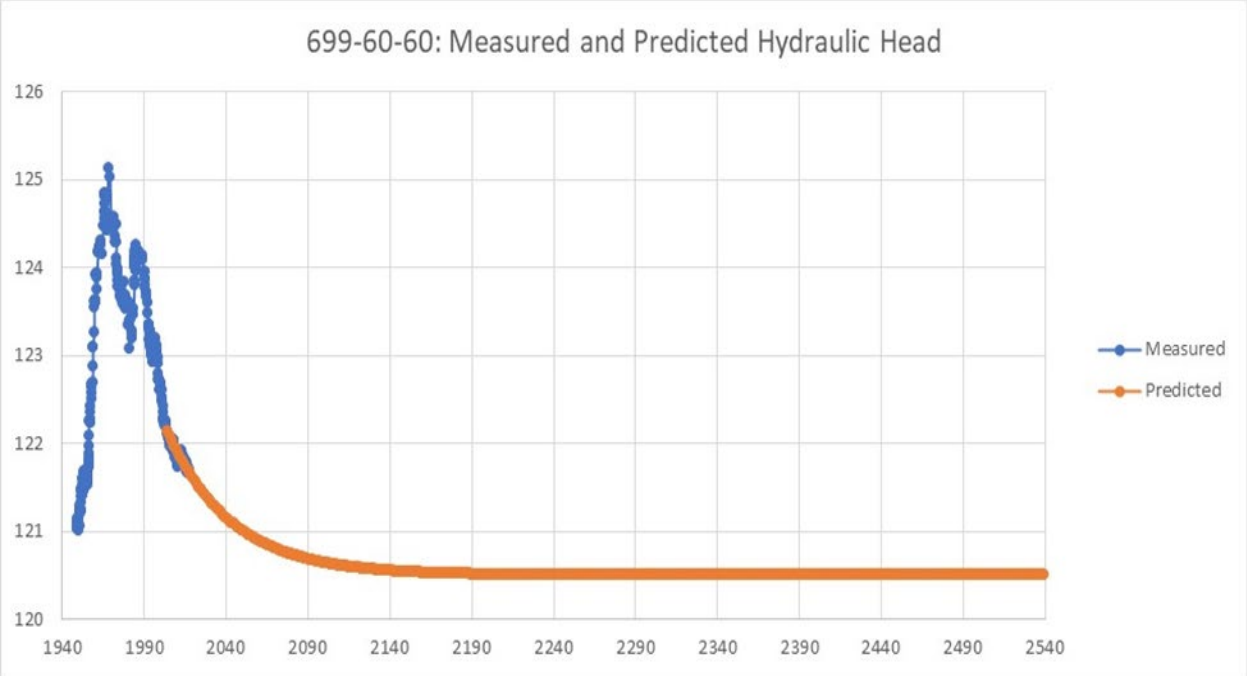


Figure 2. Observed Head Values and Estimated Exponential Regression Function at the Northern Specified Head Boundary at Gable Gap Near Well 699-60-60 for the Predictive Model

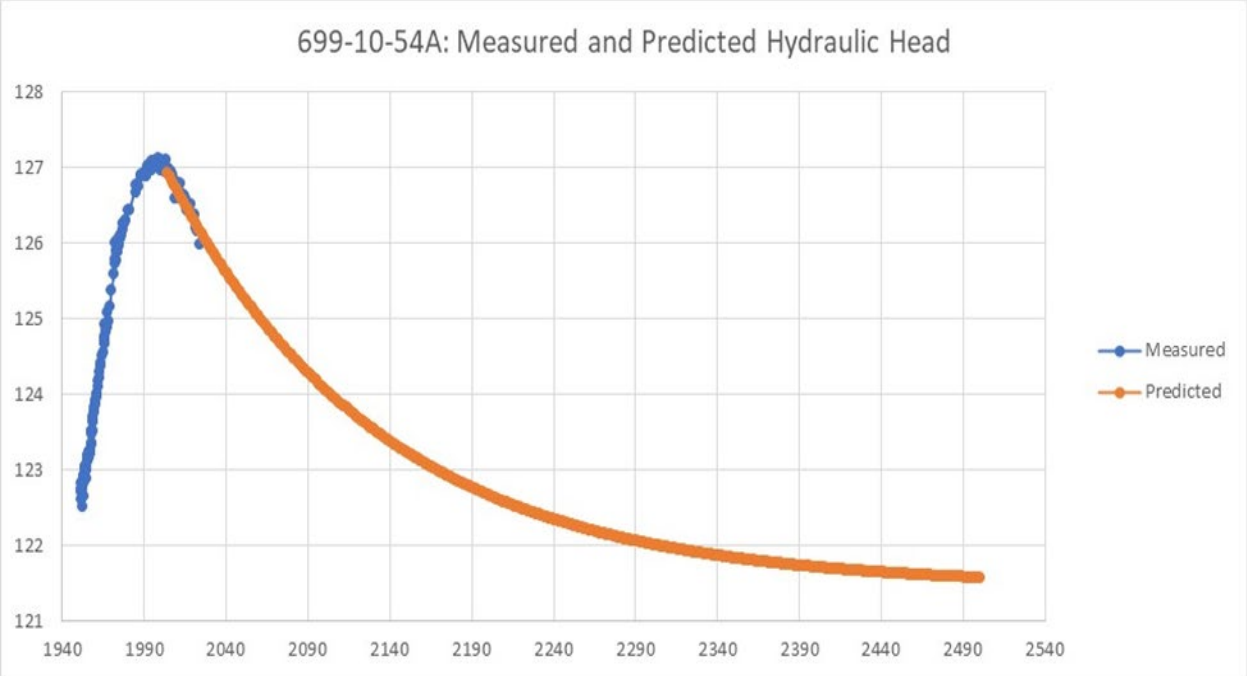


Figure 3. Observed Head Values and Estimated Exponential Regression Function at the Southern Specified Head Boundary at Dry Creek Near Well 699-10-54A for the Predictive Model

4.2.3 Recharge

Recharge at the water table in the P2R Model includes the contributions to total recharge from natural sources including meteoric and mountain front recharge, as well as anthropogenic sources associated with waste disposal, operations, and environmental cleanup activities at the site. The most recent estimate including all of these sources of recharge for the P2R Model spatial domain is documented in ECF-HANFORD-22-0092, *Predictive Flow Simulation with the P2R Model for the Cumulative Impact Evaluation Using Alternate Anthropogenic Recharge Estimates*. The estimates for recharge were updated to the new model grid domain of P2R Model version 9.1 from version 8.3 used in ECF-HANFORD-22-0092 by spatial weighted averaging.

4.3 Initial Head

The initial hydraulic head for the predictive model was extracted from the simulated head output of the historic calibration of the P2R Model version 9.1 (CP-57037) at the end of 2017. This coincided with stress period 75 timestep 1 of the P2R Model calibration simulation. The simulated output was modified to a format that is acceptable as MODFLOW input for the initial state variable for hydraulic head in the predictive simulation.

4.4 Pumping Scenarios

The predictive flow model simulations include both actual and projected injection and extraction of water to and from the aquifer to represent the operation of the 200 Area pump-and-treat (P&T) system on the Central Plateau. Magnitudes of the injection and extraction are taken from several sources. Extraction/injection rates for wells are documented in ECF-HANFORD-20-0049, *Description of Groundwater Calculations to Support Performance Assessment for the Calendar Year 2019 (CY 2019) 200 Areas Pump-and-Treat Report,* for calendar years 2018 and 2019; ECF-HANFORD-22-0043, *Description of Groundwater Calculations to Support Performance Assessment for the Calendar Year 2021 (CY 2021) 200 Areas Pump-and-Treat Report* for calendar years 2020 and 2021; and rates as documented in EMDT-BC-0083, *Correspondence of Alternative Injection and Extraction Rates for Calendar Years 2023 through 2037,* for calendar year 2022.

EMDT-BC-0083 is archived to the Hanford Site Environmental Modeling Management Archive (EMMA) internal file directory, and a copy of the cover sheet is available in Appendix A of this ECF. EMDT-BC-0083 also contains a forecast of rates from 2025 through 2037. Rates derived from these sources were formatted in a model input file using the Multi-Well Node Package of MODFLOW. Also, injection and extraction rates for the years 2023 and 2024 were updated to reflect actual rates recorded as part of the 200 Area P&T operations.

The injection rates were scaled to be equal to the total extraction for every year after 2022. This maintained the distribution of water observed during calendar year 2022 and balanced the predicted inflow and outflow from the treatment plant. After preliminary simulations were completed, interrogation of the model output indicated that well 699-38-64 could not sustain the simulated rate of injection. Therefore, the simulated injection rates for the predictive period (2025 through 2037) to 9 nearby wells (699-45-67B, 699-45-67, 699-44-67, 699-43-67, 699-40-67, 699-43-67B, 299-E20-1, 299-E20-2, 299-E11-1) were adjusted as the average of the total injection rates for the listed injection wells. The process of averaging the rates reduced the total injection rate at 699-38-64 to a rate that did not cause issues with simulation. Also, simulated injection rates at wells 299-E20-1, 299-E20-2, and 299-E11-1 were capped at 100 gpm based on previous assessments of impacts of these wells to the iodine-129 plume discussed in EMDT-BC-0083. Excess simulated injection above 100 gpm at these three wells was distributed to the other seven well locations. The file was altered to update the location (model row and column) of the wells because of the difference in lateral discretization of the model grid.

The resulting injection and extraction rates are summarized in Table 5.

Table 5. Extraction and Injection Rates for Each Stress Period

Date	2018	2019	2020	2021	2022	2023	2024	2025-2036	2037	2038-12070
Stress Period	1	2	3	4	5	6	7	8-19	20	21-101
Well Name										
299-E11-1	76.4	72.9	61.0	80.8	84.0	67.9	74.0	92.3	90.0	0.0
299-E20-1	71.7	71.4	81.9	80.0	77.2	67.9	74.0	92.3	82.7	0.0
299-E20-2	75.3	66.4	62.5	73.9	68.5	67.9	74.0	92.3	73.4	0.0
299-E25-240	0.0	0.0	0.0	0.0	0.0	0.0	-16.3	-65.0	-131.3	0.0
299-E27-157	0.0	0.0	0.0	0.0	0.0	0.0	-44.0	-175.0	-48.8	0.0
299-E33-268	0.0	0.0	-3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
299-E33-360	-162.8	-125.7	-71.3	-112.0	-108.1	-110.0	-110.0	-110.0	-82.5	0.0
299-E33-361	0.0	-35.3	-37.0	-50.3	-48.5	-50.0	-50.0	-50.0	-37.5	0.0
299-W10-35	108.5	119.0	117.1	106.4	120.4	126.4	137.9	171.9	129.0	0.0
299-W10-36	60.7	17.8	55.7	57.0	56.3	59.1	64.5	80.4	60.3	0.0
299-W11-49	-133.2	-114.7	-80.2	-96.3	-86.4	-91.0	-91.0	-91.0	-68.3	0.0
299-W11-50	-58.0	-55.9	-75.8	-91.4	-86.5	-104.0	-104.0	-104.0	-78.0	0.0
299-W11-90	-88.4	-87.6	-77.9	-91.0	-90.6	-90.0	-90.0	-90.0	-67.5	0.0
299-W11-92	-78.2	-96.1	-77.7	-117.7	-105.2	-111.0	-83.1	0.0	0.0	0.0
299-W11-96	-106.6	-78.2	-94.7	-89.5	-94.5	-97.0	-97.0	-97.0	-72.8	0.0
299-W11-97	-92.9	-103.6	-127.7	-118.5	-123.8	-129.0	-129.0	-129.0	-96.8	0.0
299-W11-106	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W11-107	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W12-2	-107.5	-95.9	-106.1	-114.6	-120.6	-118.0	-118.0	-118.0	-88.5	0.0
299-W12-3	-98.3	-90.1	-108.3	-104.1	-104.9	-111.0	-111.0	-111.0	-83.3	0.0
299-W12-4	-129.3	-121.7	-126.8	-121.4	-123.1	-125.0	-125.0	-125.0	-93.8	0.0
299-W12-5	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W13-5	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W14-20	-74.9	-99.7	-53.8	-80.8	-84.3	-80.0	-80.0	-80.0	-60.0	0.0
299-W14-21	-93.2	-89.7	-98.0	-100.0	-97.3	-102.0	-102.0	-102.0	-76.5	0.0
299-W14-22	-103.2	-102.5	-110.4	-106.9	-107.9	-110.0	-110.0	-110.0	-82.5	0.0
299-W14-28	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W14-29	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W14-30	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0

Table 5. Extraction and Injection Rates for Each Stress Period

Date	2018	2019	2020	2021	2022	2023	2024	2025-2036	2037	2038-12070
Stress Period	1	2	3	4	5	6	7	8-19	20	21-101
Well Name										
299-W14-31	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W14-32	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W14-73	-135.3	-82.7	-77.5	-63.3	-63.8	-65.0	-65.0	-65.0	-48.8	0.0
299-W14-74	-100.9	-95.7	-106.7	-106.3	-108.3	-108.0	-108.0	-108.0	-81.0	0.0
299-W14-75	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
299-W15-29	60.4	91.2	84.9	93.5	95.5	100.3	109.4	136.4	102.3	0.0
299-W15-225	-39.0	-79.9	-70.7	-107.8	-103.3	-110.0	-82.4	0.0	0.0	0.0
299-W15-226	168.6	142.9	132.6	133.1	141.4	148.4	161.9	201.9	151.4	0.0
299-W15-227	140.0	142.1	138.5	132.2	147.8	155.2	169.2	211.1	158.3	0.0
299-W15-228	109.8	111.0	108.4	102.3	115.4	121.1	132.1	164.7	123.5	0.0
299-W15-229	75.0	82.7	95.1	93.6	98.2	103.1	112.4	140.2	105.1	0.0
299-W17-2	0.0	-58.3	-71.1	-100.7	-97.7	-102.0	-92.0	-62.0	-46.5	0.0
299-W17-3	-73.2	-99.4	-75.1	-124.8	-117.3	-128.0	-95.8	0.0	0.0	0.0
299-W18-36	16.1	64.6	82.3	84.2	79.7	83.7	91.3	113.9	85.4	0.0
299-W18-38	66.3	44.9	72.6	71.1	70.2	73.7	80.4	100.3	75.2	0.0
299-W18-39	2.0	25.0	55.7	67.3	23.4	52.5	57.3	71.4	53.6	0.0
299-W18-41	133.4	115.5	126.6	119.9	125.9	132.2	144.1	179.7	134.8	0.0
299-W18-42	134.7	85.6	44.1	60.3	22.0	52.5	57.3	71.4	53.6	0.0
299-W18-43	139.6	69.5	39.6	46.8	51.0	53.5	58.4	72.8	54.6	0.0
299-W18-44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
299-W19-111	0.0	-7.6	-20.6	-28.0	-28.9	-26.0	-19.5	0.0	0.0	0.0
299-W19-113	-43.5	-46.6	-39.4	-33.1	-24.4	0.0	0.0	0.0	0.0	0.0
299-W19-114	-54.3	-71.6	-61.9	-56.4	-56.8	-50.0	-50.0	-50.0	-37.5	0.0
299-W19-123	0.0	0.0	0.0	0.0	0.0	-50.0	-50.0	-50.0	-37.5	0.0
299-W19-125	-49.4	-47.6	-48.6	-53.8	-52.4	-40.0	-40.0	-40.0	-30.0	0.0
299-W19-134	0.0	0.0	0.0	0.0	0.0	-50.0	-50.0	-50.0	-37.5	0.0
299-W22-90	-24.7	-20.5	-24.1	-24.8	-23.9	-25.0	-25.0	-25.0	-18.8	0.0
299-W22-91	-29.3	-29.5	-29.7	-28.9	-28.6	-30.0	-30.0	-30.0	-22.5	0.0
299-W22-92	-24.8	-24.4	-24.8	-24.9	-22.7	-25.0	-18.7	0.0	0.0	0.0

Table 5. Extraction and Injection Rates for Each Stress Period

Date	2018	2019	2020	2021	2022	2023	2024	2025-2036	2037	2038-12070
Stress Period	1	2	3	4	5	6	7	8-19	20	21-101
Well Name										
299-W5-1	-78.0	-86.4	-98.9	-91.2	-96.2	-99.0	-99.0	-99.0	-74.3	0.0
299-W6-13	57.9	54.5	39.5	53.6	47.0	49.3	53.8	67.1	50.3	0.0
299-W6-14	174.0	101.1	127.3	120.1	118.8	124.8	136.0	169.7	127.2	0.0
299-W6-15	-95.9	-75.3	-87.2	-81.9	-88.6	-90.0	-90.0	-90.0	-67.5	0.0
299-W7-14	104.7	83.6	81.1	87.3	98.7	103.6	112.9	140.8	105.6	0.0
699-38-64	90.4	101.7	88.0	131.4	127.7	67.9	74.0	92.3	136.7	0.0
699-40-67	39.3	78.2	71.8	102.5	96.5	67.9	74.0	92.3	103.4	0.0
699-40-70A	0.0	0.0	0.0	0.0	0.0	0.0	-25.1	-100.0	-75.0	0.0
699-42-67	57.3	101.0	78.0	121.2	107.7	113.1	123.3	153.8	115.4	0.0
699-43-67	21.7	47.6	27.3	41.7	41.3	67.9	74.0	92.3	44.2	0.0
699-43-67B	14.5	20.5	18.2	27.8	27.5	67.9	74.0	92.3	29.5	0.0
699-44-67	16.7	36.6	26.1	39.5	39.8	67.9	74.0	92.3	42.6	0.0
699-45-67	28.5	35.4	27.6	40.0	40.2	67.9	74.0	92.3	43.1	0.0
699-45-67B	3.9	33.4	39.5	41.0	43.7	67.9	74.0	92.3	46.8	0.0
699-46-68	41.5	59.2	51.0	70.2	70.7	74.2	80.9	101.0	75.7	0.0
699-47-78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
699-47-78B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
699-47-78C	0.0	0.0	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
699-48-70	0.0	-6.0	-75.4	-73.0	-70.6	-74.0	-74.0	-74.0	-55.5	0.0
699-49-69	20.6	50.2	61.0	81.0	90.4	94.9	103.5	129.0	96.8	0.0

Note: Extraction and injection rates are shown in gallons/minute.

5 Software Applications

MODFLOW, Microsoft® Excel®, ArcGIS®, Python®, and R software programs were used for this calculation. These are Central Plateau Cleanup Company (CPCCo) approved software, managed, and used in compliance with the policy regarding software (CP-66776, *MODFLOW and Related Codes: Build 9 Software Management Plan*). A copy of the Software Installation and Checkout Form for the MODFLOW installation used for this calculation is provided in Appendix B to this ECF.

The results of CPCCo acceptance testing (CP-66776) demonstrate that the MODFLOW and MT3DMS software are acceptable for the intended use by CPCCo. Installations of the software are operating correctly, as demonstrated by the completed Software Installation and Checkout form.

All model input files, selected output files, and other relevant files for the development of this ECF are archived to the EMMA internal file directory referenced under this ECF number and revision (ECF-HANFORD-25-0040, Rev. 0) in accordance with requirements of CPCCo's quality assurance modeling project plan.

5.1 Approved Software

For approved calculation software used in this calculation, the required descriptions are provided below.

5.1.1 MODFLOW Description

- **Software Title:** MODFLOW and MT3DMS
- **Software Version:** CPCCO Build 9 (executables “mf2k-mst-cpcc09dpl.x” and “mt3d-mst-cpcco09dpl.x”), double precision compilation
- **Hanford Information System Inventory (HISI) Identification Number:** 2517 (Safety Software, Level C) for MODFLOW and 2518 (Safety Software, Level C) for MT3DMS
- **Authorized Workstation Type and Property Number:** Moss Modeling Platform, Service Tag: B8V50R3
- **Authorized User:** R. Lyons
- **CPCCo Software Control Documents:** CP-66776, *MODFLOW and Related Codes: Software Management Plan*

5.1.2 ArcGIS Pro

ArcGIS Pro[1] (version 3.2.1) is a Grade D software item that is approved for use under Hanford Mission Integrated Solution (HMIS) Geopsatial & Ops. Site Systems (HISI #1583) under HNF-69989, *ArcGIS SMP*. There is currently no CPCCo Software Management Plan for the ArcGIS Pro Software. In accordance with its planning and procedures for software management, CPCCO and its subcontractors may accept another Hanford contractor’s Software Quality Assurance program for ArcGIS Pro because it is not safety software and the intended use of ArGIS Pro in this ECF is bounded by HMIS’ intended use for ArcGIS Pro. The intended use of this software was to create maps. The following describes the ArcGIS Pro-controlled visualization software.

® Microsoft and Excel are registered trademarks of the Microsoft Corporation in the United States and other countries.

® ArcGIS is a registered trademark, or service mark, of ESRI in the United States, the European Community, or certain other jurisdictions.

® Python is a trademark of the Python Software Foundation, Wilmington, Delaware.

[1] ArcGIS Pro refers to the professional release of ArcGIS software.

- **Software Title:** ArcGIS Pro
- **Software Version:** Version 3.2.1
- **HISI Identification Number:** 1583
- **Authorized Workstation Type and Property Number:** Windows 11 Business, Dell Latitude 5430, 12th Gen Intel® Core i7-1265U, 1.8 GHz, 10 Cores, 12 Logical Processor(s), 32 GB RAM; INTERA Property 01153.
- **Software Installation and Checkout:** No software installation and checkout for is required for ArcGIS Pro. Per HNF-69989, Installation Plan/Training. “ArcGIS Pro will be installed using an access controlled Software Distribution install. ArcGIS License Manager will be installed by an assigned analyst who has administrator access to the server on which the License Manager runs. The License Manager will be installed following vendor supplied installation instructions.” ArcGIS Pro was installed on the workstation by an HMIS administrator and did not require a software installation and checkout form nor formal installation testing.
- **Authorized User:** R. Lyons

5.1.3 Software Installation and Checkout

A copy of the *Software Installation and Checkout Form* for the authorized user and authorized workstation for the MODFLOW and MT3DMS software used that requires this documentation are provided in Attachment B to this ECF. Installation tests identified in CP-66776 are performed on the software to confirm successful installation. Software installation and checkout forms are required and must be approved for installations used to perform model runs. Approved users are registered in the HISI authorized users list for safety software.

No software installation and checkout form is required for ArcGIS Pro. Per HNF-69989, Section Installation Plan/Training, “ArcGIS Pro will be installed using an access-controlled Software Distribution install. ArcGIS License Manager will be installed by an assigned analyst who has administrator access to the server on which the License Manager runs. The License Manager will be installed following vendor supplied installation instructions.” The workstation ArcGIS Pro was installed on was done by an HMIS administrator and did not require a software installation and checkout form, nor formal installation testing.

5.2 Support Software

In accordance with CP-66776, the following support software were used in the following capacities as part of this calculation:

- Microsoft Excel - Used to tabulate injection and extraction rates for the table documented in Section 4.4.
- Python – Used to organize data from the MODFLOW simulation output and to create figures in Chapter 7.

5.3 Statement of Valid Software Application

The preparer of this calculation attests that the software identified above, and used for the calculations described in this calculation, is appropriate for the application and used within the range of intended uses for which it was tested and accepted by CPCCo. Because MODFLOW and MT3DMS are graded as Level C software, use of these software are 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 and 2518.

6 Calculation

MODFLOW simulations of the P2R Model version 9.1 predictive model were executed on the Moss Modeling Platform by invoking the installed executable and the input files. Simulation files and results were archived in the EMMA file directory under the document number for this ECF. Output files included the “flow-transport link” file needed to provide the flow field generated by the groundwater flow simulation to the fate and transport simulations.

7 Results/Conclusions

Hydrographs were created for nine locations throughout the model domain to illustrate the variation in hydraulic head over the simulated temporal domain. Figure 4 shows a map of the locations where hydrographs were placed to illustrate the model results. Hydrographs for these locations are shown in Figure 5 through Figure 13. Due to the length of the simulations and the fact that all the changes in boundary conditions occur in the first 500 years, the x-axis (time in simulated years) is shown on a log scale to emphasize early time periods. Each plot has a line for each model layer. If the line is not visible it is because it is equal to and thus directly beneath another time series.

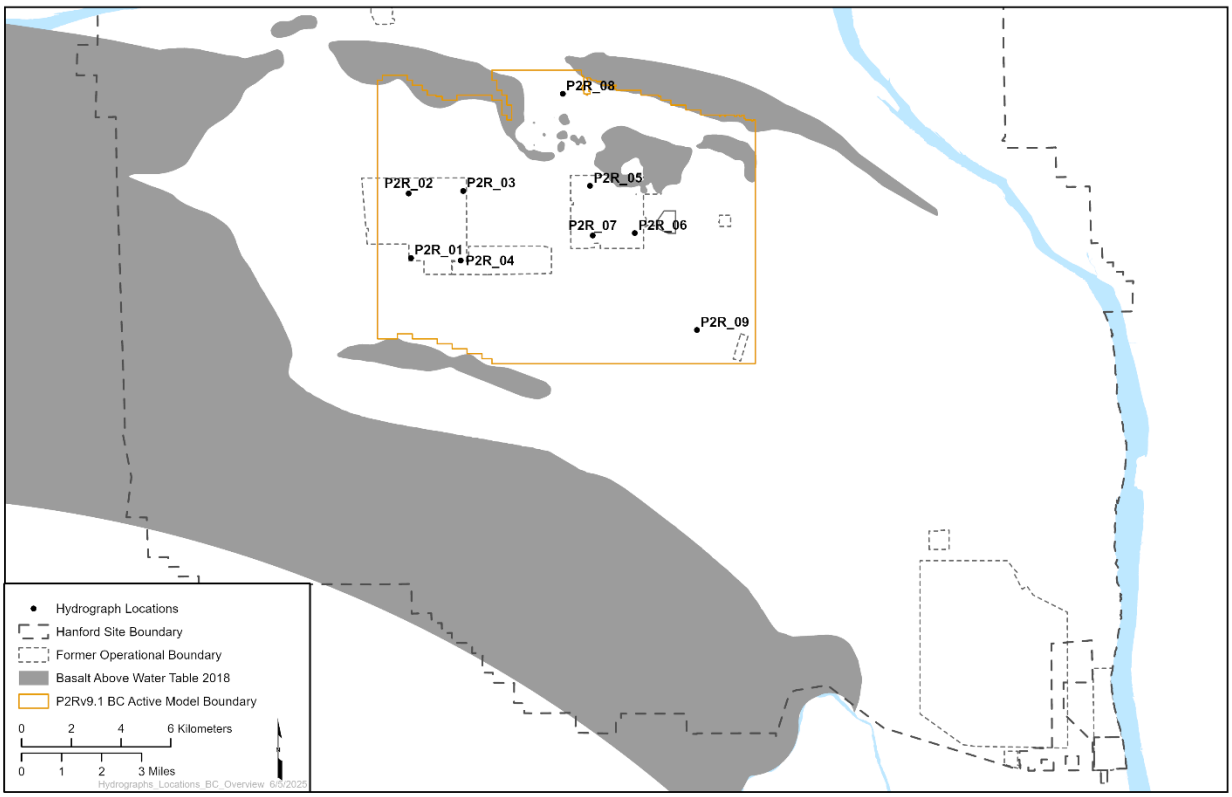


Figure 4. Location of Hydrographs Illustrating the Change in Head Over Time in the Predictive Simulation

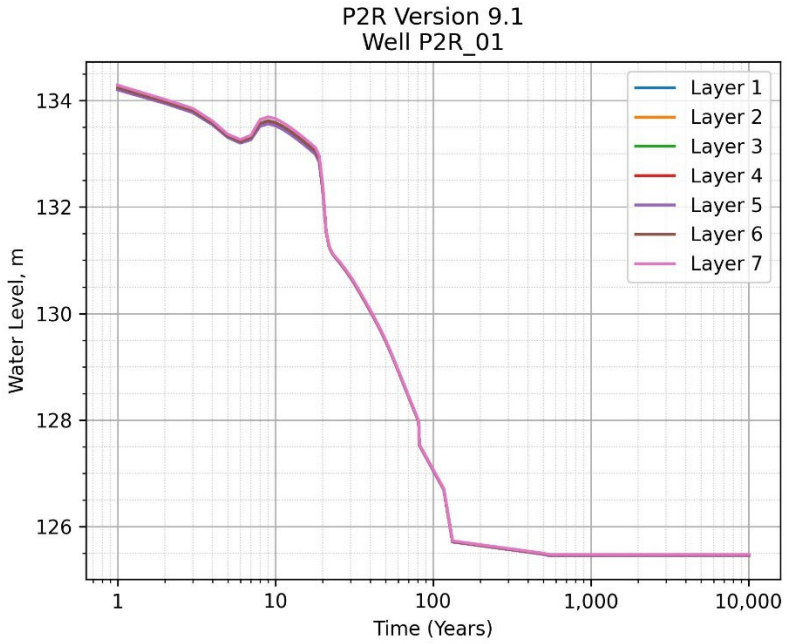


Figure 5. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_01

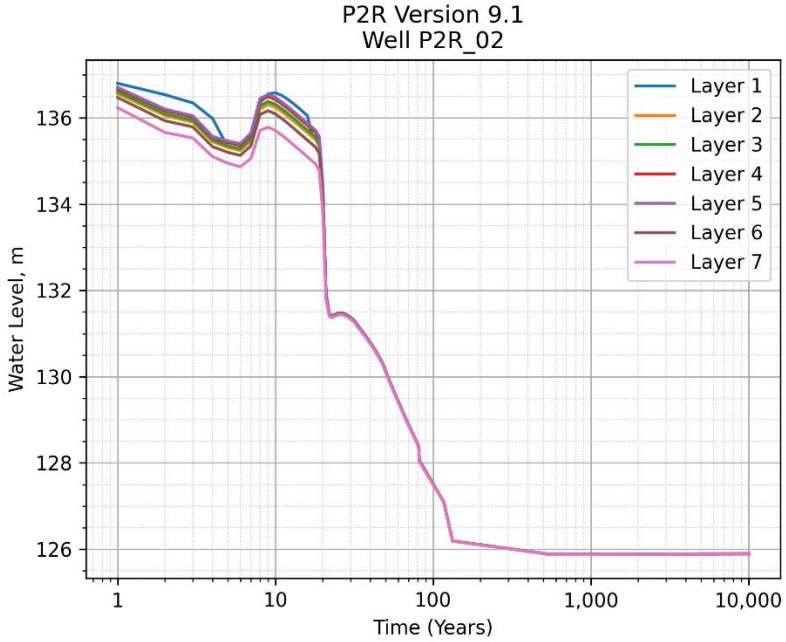


Figure 6. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_02

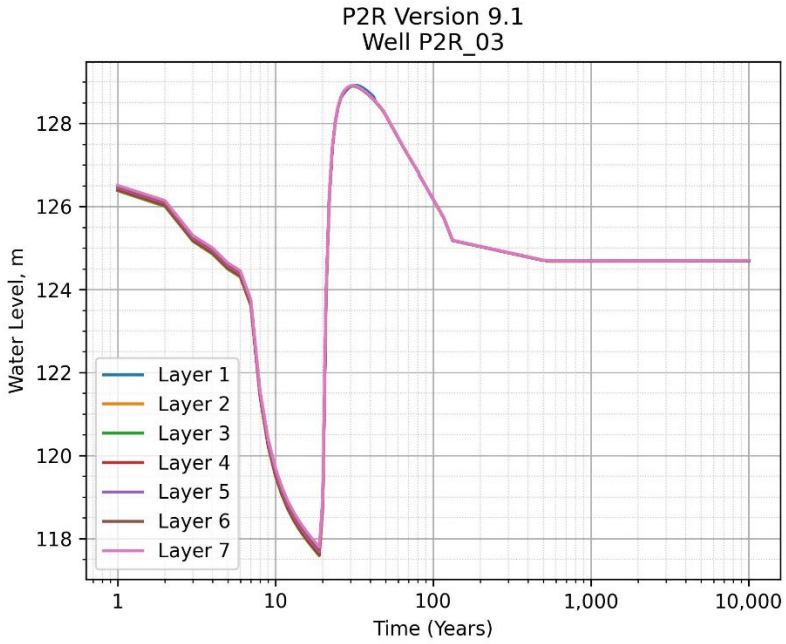


Figure 7. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_03

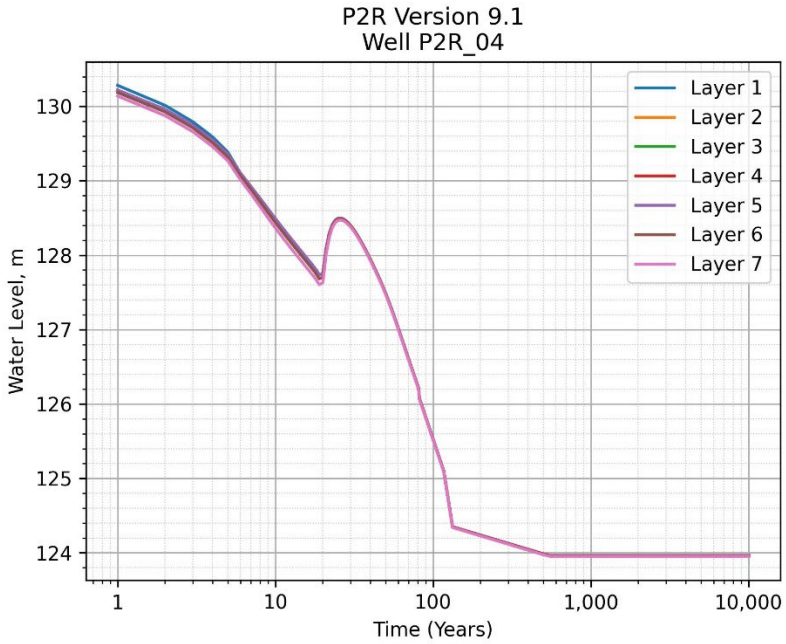


Figure 8. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_04

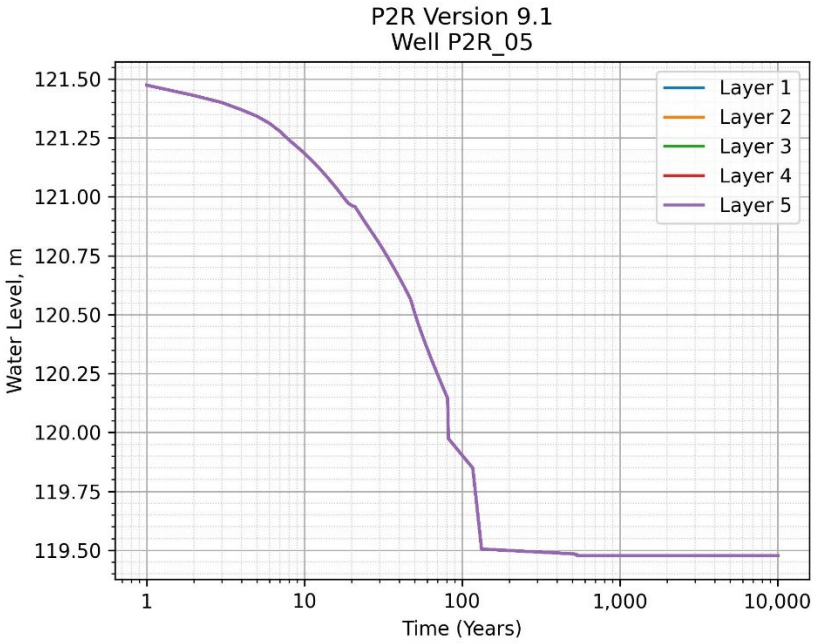


Figure 9. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_05

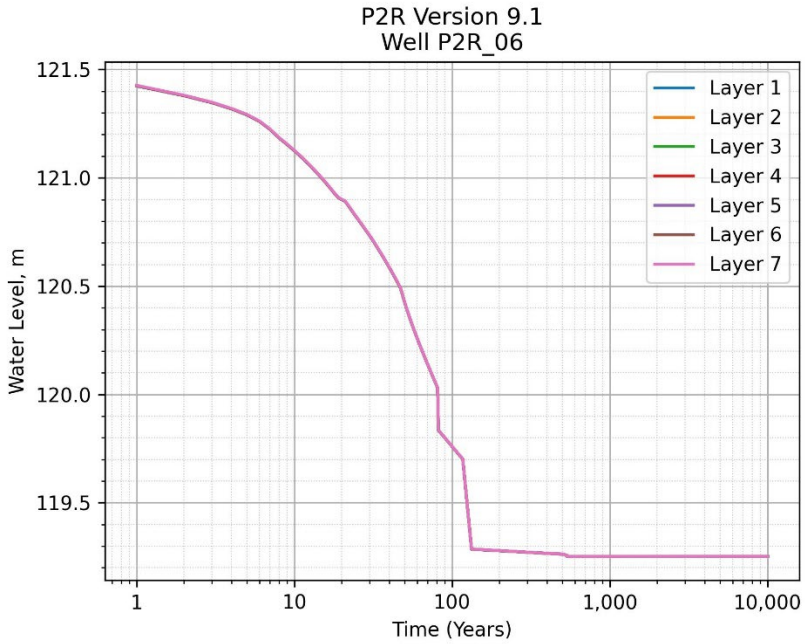


Figure 10. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_06

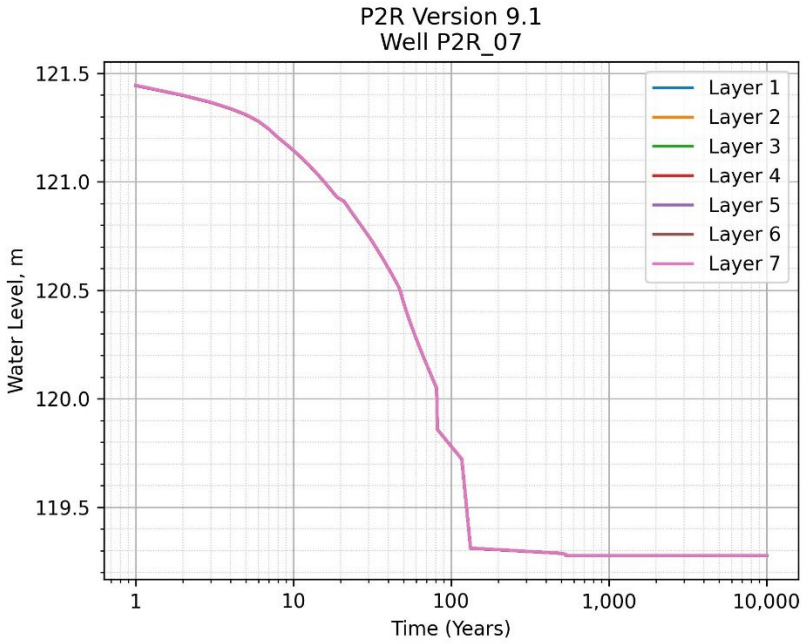


Figure 11. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_07

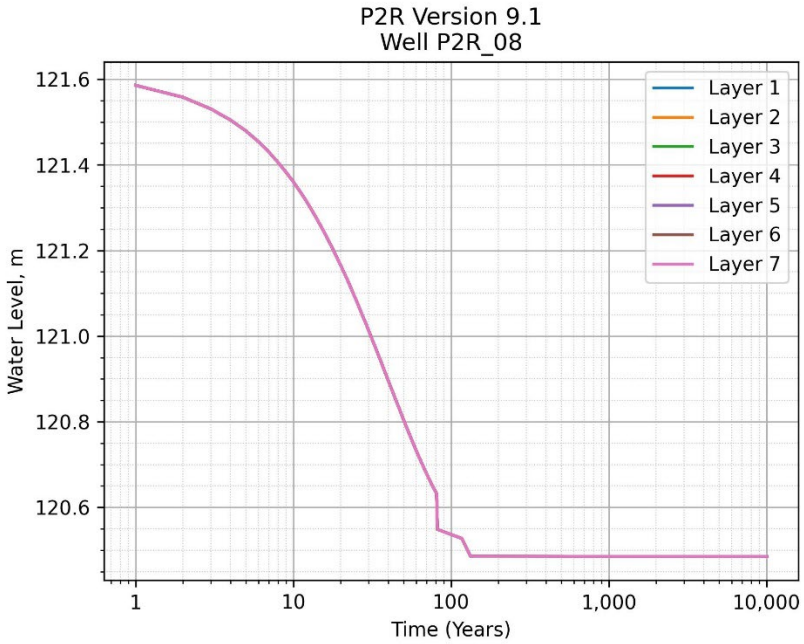


Figure 12. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_08

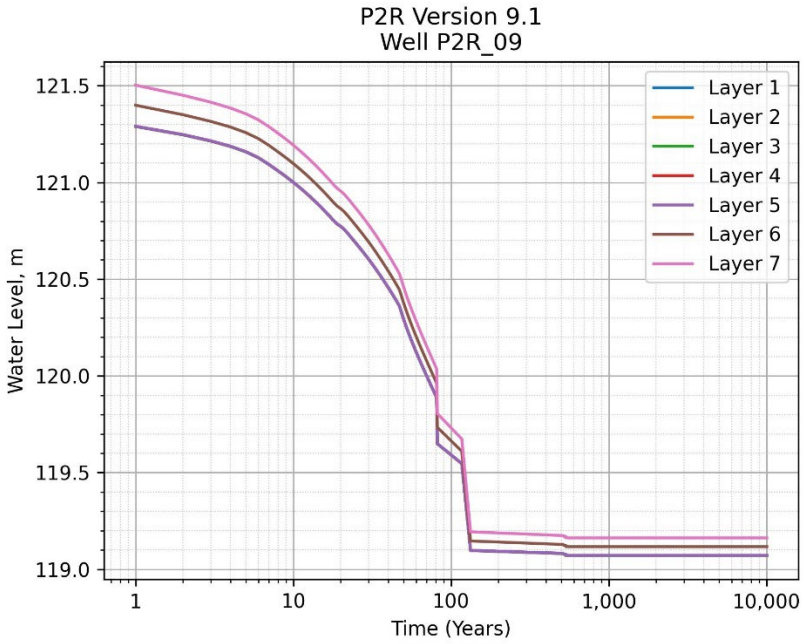


Figure 13. Hydraulic Head Over Time for Predictive Flow Simulation for Groundwater Flow Base Case of the Composite Analysis at Location P2R_09

8 References

CP-57037, 2020, *Model Package Report: Plateau to River Groundwater Model Version 8.3*, Rev. 2, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-03674.

CP-57037, 2024, *Model Package Report: Plateau to River Groundwater Model, Version 9.1*, Rev. 3, Central Plateau Cleanup Company, Richland, Washington . Available at: https://pdw.hanford.gov/document/AR-31096.

CP-60406, *Hanford Site Composite Analysis Technical Approach Description: Groundwater,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. https://www.osti.gov/servlets/purl/1412549

CP-66776, 2022, *MODFLOW and Related Codes: Build 9 Software Management Plan*, Rev. 0, Central Plateau Cleanup Company, Richland Washington.

DOE O 435.1 Chg 2 (AdminChg), 2021, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0435.1-BOrder-chg2-AdminChg/@@images/file.

ECF-HANFORD-15-0019, 2020, *Hanford Site-Wide Natural Recharge Boundary Conditions for Groundwater Models*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1632877.

ECF-HANFORD-20-0049, 2020, *Groundwater Pump and Treat (P&T) Report,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-04153.

ECF-HANFORD-22-0043, *Description of Groundwater Calculations to Support Performance Assessment for the Calendar Year 2021 (CY 2021) 200 Areas Pump-and-Treat Report*. Rev. 2, Central Plateau Cleanup Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-26351

ECF-HANFORD-22-0092, *Predictive Flow Simulation with the P2R Model for the Cumulative Impact Evaluation Using Alternate Anthropogenic Recharge Estimates*. Rev. 0, Central Plateau Cleanup Company, Richland, Washington.

HNF-69989, 2025, *ArcGIS SMP*, Rev. 1, Hanford Mission Integration Solutions, Richland, Washington.

USGS, 2000, *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model—User Guide to Modularization Concepts and the Ground-Water Flow Process*, Open-File Report 00-92, U.S. Geological Survey, Reston, Virginia. Available at: https://pubs.usgs.gov/of/2000/0092/report.pdf.

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Attachment A

Copy of EMDT-BC-0083, Rev. 0, Cover Sheet

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ENVIRONMENTAL MODELING DATA TRANSMITTAL COVER PAGE

No.: EMDT -BC-0083 Revision No: 0

(Request EMDT number for Modeling Team Leader)

Title: Correspondence of Alternative Injection and Extraction Rates for Calendar Years 2023 through 2037 Date: Feb 22, 2023

1. Data Description

Provide the description of data set or data type.

Data included selected injection and extraction rates and locations for wells associated with the Central Plateau pump-and-treat system at the Hanford Site. Rates reflect the estimate of operations for the time period 2023 through 2037.

2. Data Intended Use

Identify the data's intended use. Describe the rationale for its selection and how the data will be incorporated into a model, report, or database. Include discussion of the extent to which the data demonstrates the properties of interest.

The data will be used for modeling applications that predict impacts of pumping rates on fate and transport of contaminants on the Central Plateau.

3. Data Sources

List databases, documents, etc. - provide sufficient detail to enable data to be located by independent reviewer.

Several separate communications were received that constitute the final set of rates. These were received primarily through email correspondence and attachments. Below is a list of the correspondence and attachments:
Email_IntitialScenarioReceipt_GregRuskauff.pdf - correspondence communicating a spreadsheet populated with well locations and rates that was reviewed by CPCCo project scientists. Source of pumpingscenario-Rev3.xlsx
pumpingscenario-Rev3.xlsx - Attachment to email containing observed 2022 pumping distribution and the expected injection/extraction rates.
Email_RateAdjustment_PaulHumphreys.pdf - correspondence of alterations to selected extraction wells in 200-UP-1 OU including well locations Ext-1 and Ext-2 that were not in the initial spreadsheet.
Email_Ext-1_Ext-2_Details_JohnMcDonald.pdf - correspondence of the locations of wells Ext-1 and Ext-2.
Email_WellLocation200-East_JohnMcDonald.pdf - correspondence of the location of four wells not received with the initial spreadsheet (299-E27-157, 299-E25-240, 299-W19-123, and 299-W19-134). Source of WellSpecification.xlsx.
WellSpecification.xlsx - Attachment to email with construction details to 299-E27-157, 299-E25-240, 299-W19-123, and 299-W19-134.
Email_FinalWellLocation_MargoAye.pdf - correspondence communicating the location of planned extraction wells to be installed in the during operations. Source of ZPDrillSeq21_23.zip and ZPMP2022009.png.
ZPDrillSeq21_23.zip - Attachment to email containing a Shapefile with the locations of extraction wells for the 200-ZP-1 OU.
Email_Final_Rates_RandalFox.pdf - Email detailing rates that superseded some rates in other spreadsheets that were reviewed by DOE and set as the final rates for 200-West extraction wells.
"ZZP-1 and UP-1 Extraction Well Flow Rates_projected_3-15-2023.xlsx" - Spreadsheet attached to Email_Final_Rates_RandallFox.pdf that have the extraction rates for 200-West extraction wells.
Concurrence_For_200East_FinalRates.pdf - correspondence detailing the decision to reduce extraction in 200-East Area wellse from 410 as originally estimated to 400 per the reviewed total by DOE in "ZZP-1 and UP-1 Extraction Well Flow Rates_projected_3-15-2023.xlsx"

ENVIRONMENTAL MODELING DATA TRANSMITTAL COVER PAGE (Continued)

No.: EMDT -BC-0083 Revision No: 0

(Request EMDT number for Modeling Team Leader)

Title: Correspondence of Alternative Injection and Extraction Rates for Calendar Years 2023 through 2037 Date: Feb 22, 2023

4. Impact of Use or Nonuse of Data

Describe the importance of the data to the model, report, and/or conclusions which they support. Identify the value added and discuss the impacts of not using the data.

Use is critical to evaluate impacts of predicted operations on mass removal from contaminant plumes.

5. Prior Use

Identify the data's prior uses. Describe whether the data have been used in similar applications by the scientific or regulatory community. Include the associated verification processes and prior reviews and review results.

Initial release so no prior use of data.

6. Data Acquisition Method(s)

Describe the data acquisition method and associated QA/QC, considering the following:

a. Qualifications of personnel or organizations generating the data;
b. Technical adequacy of equipment and procedures used;
c. Environmental and programmatic conditions if germane to the data quality;
d. The extent to which acquisition processes reflect modeling requirements;
e. The quality and reliability of the measurement control program;
f. The degree to which independent audits of the process were conducted;
g. Extent and reliability of the associated documentation.

Data are estimates provided by project scientists assigned to operable units. As predictions the continued use of these predictions should be considered when observed extraction and injection rates are available.

For databases, identify query language used to obtain data from database (SQL, etc.), briefly describe the query description and attach copy.

7. Corroborating Data

Identify and discuss any corroborating datasets. Provide any documentation that confirms the corroborating data substantiate existing parameter values, distributions, or data quality.

None available at this time.

8. Data Quality Considerations

Discuss data quality considerations not identified in other sections. Include discussion of data quality indicators (i.e., accuracy, precision, representativeness, completeness, and comparability).

The estimates cover all wells involved in pump-and-treat operations on the Central Plateau. However, as predictions, the observed values should be considered when available.

9. Assumptions and Limitations on Data Use

Document known uncertainties, assumptions, constraints or limits on data.

ENVIRONMENTAL MODELING DATA TRANSMITTAL COVER PAGE (Continued)

No.: EMDT -BC-0083 Revision No: 0

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Title: Correspondence of Alternative Injection and Extraction Rates for Calendar Years 2023 through 2037 Date: Feb 22, 2023

9. Assumptions and Limitations on Data Use

Assumptions have been made regarding the location of some wells that have not been constructed and the rates at wells into the future. When available, the use of observed rates should be considered for applications.
For injection rates in the future, this data assumes that the relative distribution that occurs in 2022 carries on in the future.

DATA CONFIGURATION ITEM SUBMITTAL:

Data Provider Submittal:

Position: Senior Hydrogeologist

Trevor Budge
Print First and Last Name

TREVOR BUDGE (Affiliate)
Digitally signed by TREVOR BUDGE (Affiliate)
Date: 2024.04.03 17:18:41 -07'00'
Signature / Date

DATA CONFIGURATION ITEM REVIEW AND VERIFICATION:

10. Verification Process

Describe steps taken to verify that these data are appropriate for intended use, noting any limitations.

Data were reviewed for completeness and internal consistency and verified against transmittal information.

11. Summary of Data Review

The review shall ensure that the report meets the listed criteria. Consideration includes ensuring that the data collection method employed was appropriate for the type of data being considered an confidence in the data acquisition and subsequent processing methodology is warranted.

Is documentation technically adequate, complete, and correct? ☒ Yes ☐ No

Are uncertainties and limitations on appropriate use of data discussed? ☒ Yes ☐ No

Are the assumptions, constraints, bounds, or limits on the data identified? ☒ Yes ☐ No

APPROVAL OF DATA CONFIGURATION ITEM:

Data Reviewer Approval:

Position: Groundwater Modeler

Stephanie Tomusiak
Print First and Last Name

Stephanie Tomusiak
Digitally signed by Stephanie Tomusiak
Date: 2024.04.03 18:24:17 -06'00'
Signature / Date

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Attachment B

Software Installation and Checkout Form

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SOFTWARE INSTALLATION AND CHECKOUT

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. 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 Version No.: Bld 9

EXECUTABLE INFORMATION

2. Executable Name *(include path)*:

Following executable files in directory: [redacted]

MD5 Signature (unique ID)	Executable File Name	Code
2fade33e27978063a9a70ff8605e4c0c	mf2k-cpcc09dpl.x	MODFLOW-2000 Double Precision
80d670658425653bf5bcbb97ad2a2730	mf2k-mst-cpcc09dpl.x	MODFLOW-2000-MST Double Precision
40e821edc369bf7594c51c958086f58e	mf6-cpcc09	MODFLOW-6
682f0b1e9fcd6ac0b885f52a7ddfe821	mfusg-cpcc09dpl.x	MODFLOW-USG Double Precision
1be4b7d3fc81881ff0b97ff7e67bd3ff	mt3d-cpcc09dpl.x	MT3DMS Double Precision
1e468c4409ac913843ce783aabed819c	mt3d-mst-cpcc09dpl.x	MT3DMS-MST Double Precision

3. Executable Size *(bytes)*: MD5 signatures above uniquely identify each executable file

COMPILATION INFORMATION

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

Vendor provided.

5. Operating System *(include version number)*:

Vendor provided.

INSTALLATION AND CHECKOUT INFORMATION

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

Moss Modeling Platform
Server: (1) Dell PowerEdge R650 Server in Standard 2U Rack
Processors: (2) 28-core Intel Xeon Platinum 8358 @ 2.60 GHz
GPU: NVIDIA Tesla T4 16 GB Video Card
256 GB of RAM

7. Operating System *(include version number)*:

Red Hat Enterprise Linux 9.5

8. Open Problem Report? ☐ Yes ☒ No PR/CR No.:

TEST CASE INFORMATION

9. Directory/Path:

[redacted]

10. Procedures:

CP-66777, MODFLOW and Related Codes Software Test Plan

11. Libraries:

N/A (static linking)

12. Input Files:

CP-66777, MODFLOW and Related Codes Software Test Plan

13. Output Files:

Found in installation test subdirectories

14. Test Cases:

SOFTWARE INSTALLATION AND CHECKOUT (Continued)
14. Test Cases: MF-ITC-1 (both standard and MST versions of MODFLOW); run double precision MT-ITC-1 run double precision, multiple solvers MF-USG-ITC-1 for MODFLOW-USG (two solvers) MF6-ITC-1 for MODFLOW 6
15. Test Case Results: Success
16. Test Performed By: Richard Lyons
17. Test Results: ☒ Satisfactory, Accepted for Use ☐ Unsatisfactory
18. Disposition *(include HISI update)*: Passed; testing and installation noted in HISI.

SOFTWARE INSTALLATION AND CHECKOUT (Continued)

19. Prepared By *(Software Owner)*:

Christopher Farrow	CHRISTOPHER FARROW (Affiliate) Digitally signed by CHRISTOPHER FARROW (Affiliate) Date: 2025.06.04 13:09:48 -05'00'
Print First and Last Name	*Signature / Date*

20. Test Personnel:

Title:

Richard Lyons	Richard Lyons Digitally signed by Richard Lyons Date: 2025.06.04 13:55:22 -06'00'
Print First and Last Name	*Signature / Date*

Title:

Print First and Last Name	*Signature / Date*

Title:

Print First and Last Name	*Signature / Date*

21. Approved By *(Software SQA)*:

Timothy Mar	Mar, Timothy S Digitally signed by Mar, Timothy S Date: 2025.06.04 13:20:56 -07'00'
Print First and Last Name	*Signature / Date*

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