Analysis Report for AP-070

Analysis of the WIPP-11R Pumping Test Conducted From 9/15/21 to 9/17/21

AP-070: Analysis Plan for Hydraulic-Test Interpretations

Task Number 4.4.2.3.1

Authors: _____ 10/11/22
Dale O. Bowman, II, 8882 Date
Repository Performance Department

Technical Review: _____ 10/11/22
Mahwa-Essa Akara, 8882 Date
Repository Performance Department

QA Review: _____ 10/11/22
Catrina Carrillo, 8880 Date
Edgewater, Inc

Management Review: _____ 10/11/22
Chammi Miller, 8882 Date
Repository Performance Department

4.4.2.3.1
WIPP:~~1.4.2.3~~:TD:QA-L:DPRP1:PKG# 539221
gg 12/1/22

Information Only

Contents

1. Introduction....4
2. Test and Analysis Procedures,....5
3. WIPP-11R Analysis Results....7
3.1. WIPP-11R....7
3.2. WIPP-11 to WIPP-11R Comparison....13
4. References....16
Appendix A – WIPP-1R Hydraulic Test – 9/15/22 to 9/22/22....17
Appendix B – nSIGHTS Listings....18
Appendix C – File Directories....26
Associated files can be found in the Solaris Directory -
/nfs/data/CVSLIB/WIPP_EXTERNAL/AP070. 26

Tables

Table 1. Culebra Transmissivity and Storativity Estimates....7

Figures

Figure 1. WIPP stratigraphy....4
Figure 2. Location of the WIPP-11R Culebra well located on the WIPP-11 wellpad. The WIPP-11R pumping well is designated by a blue star....6
Figure 3. WIPP-11R well configuration during testing....9
Figure 4. History, drawdown, and recovery period data for the WIPP-11R pumping test.....10
Figure 5. Pressure data and 336 model fits of the final Culebra pumping test in WIPP-11R.....10
Figure 6. Pressure data and 336 model fits of the observation response in well WQSP-2.....11
Figure 7. Estimates of radially varying transmissivity derived from the WIPP-11R perturbation analysis....11
Figure 8. Log-log plot showing 336 simulations of the WIPP-11R drawdown period pressure change and derivative response....12
Figure 9. Log-log plot showing 336 simulations of the WIPP-11R recovery period pressure change and derivative response....12
Figure 10. Semi-log plot showing the flow dimension diagnostic for the WIPP-11R pumping test....13
Figure 11. A comparison of the WIPP-11 flow dimension diagnostic, WIPP-11R flow dimension diagnostic, and WIPP-11R flow dimension simulations....14
Figure 12. A visual comparison of the diffusivity values used to model the WIPP-11 and WIPP-11R pumping tests....15

Information Only

Appendix B Figures

Figure B-1. X-Y scatter plot showing the skin conductivity parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values..... 24
Figure B-2. X-Y scatter plot showing the skin specific storage parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values..... 24
Figure B-3. X-Y scatter plot showing the skin thickness parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values..... 25
Figure B-4. X-Y scatter plot showing the tubing string radius parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values..... 25

Information Only

1. Introduction

This Analysis Report discusses the analyses results of a hydraulic test performed in the Culebra Member of the Rustler Formation (Figure 1) at the Waste Isolation Pilot Plant (WIPP) site at the WIPP-11 well pad (Figure 2). This analysis was performed in accordance with the Sandia National Laboratories (SNL) Analysis Plan for Hydraulic-Test Interpretations, AP-070, Revision 3 (Bowman, 2020). The computer code used for analysis was nSIGHTS (n-dimensional Statistical Inverse Graphical Hydraulic Test Simulator), version 2.50, a 64-bit SNL-developed upgrade from version 2.41a (Kuhlman 2011). The author of this Analysis Report is a qualified hydraulic-test analyst per AP-070, Rev 3. A detailed description of the approach followed in this analysis can be found in Beauheim et al. (1993, Appendix B) and Roberts et al. (1999, Chapter 6). With respect to the objectives outlined in AP-070, transmissivity and storativity were the focused hydraulic properties. Flow dimension was considered as an alternative model, but a model with changing transmissivity with respect to radius from the pumping well, $T(r)$, was used. Subsequently, its value was held as radial (n=2). Three observation wells were used (SNL-3, SNL-5, and WQSP-2) for initial fits to obtain an accurate representation of storage. Formation pre-test pressure is described as static formation pressure for the model. The history data prior to testing of the well allows for the value to be held as a constant. Double porosity effects were also not observed, so fracture-matrix storativity and interporosity flow did not apply to the model.

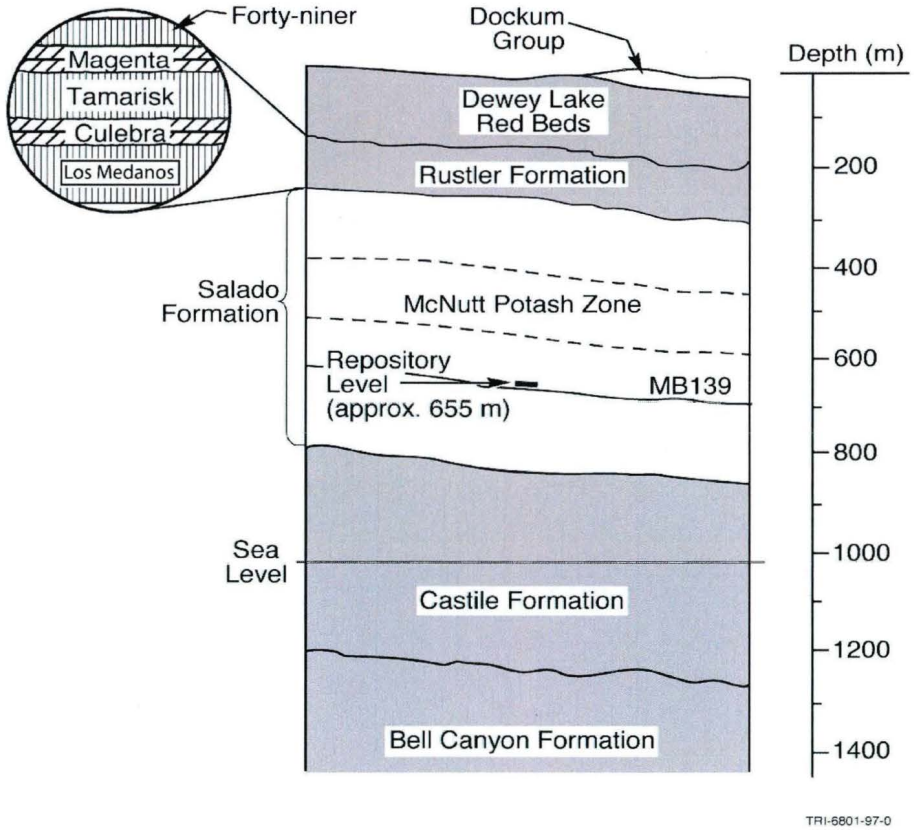


Figure 1. WIPP stratigraphy.

Information Only

2. Test and Analysis Procedures,

A purge test was conducted prior to testing to rid the well of remaining drilling mud and waters. Previously, well WIPP-11 was subject to a multi-pad, 3 acre-ft pumping test. This test was successfully modeled, though the diagnostic analysis of the well displayed a sinusoidal flow dimension diagnostic and a sinusoidal nature in the Bourdet derivative response. As WIPP-11R is a replacement well, confirmation of the aquifer parameters at the site were a driving motive for the well test but carried less weight than the initial discovery of aquifer parameters during the WIPP-11 testing, so an extensive test was not warranted. The challenge for this test was to produce an adequate pumping test that was similar to the original to verify the odd diagnostic responses while limiting the cost of produced water disposal. A compromise of two frac tanks of volume (42,000 gallons) was agreed upon. The main objectives of this analysis were to estimate transmissivity (T) and storativity (S) for subsequent use in T-field generation and WIPP performance assessment calculations, and to validate the construction of the Culebra replacement well on the WIPP-11 wellpad. The location of the WIPP-11R well in the WIPP well network is shown in Figure 2.

Pumping test analysis for the WIPP-11R pumping test data included the fitting of simulated well response with wellbore storage and skin in an infinite-acting radial flow system to Cartesian pressure data, pressure change, and pressure derivative (log-log diagnostic) as described by Bourdet (1989). We designate this first model as the "best fit". Obtaining the "best fit" involved finding the values of model fitting parameters that produced the best-simulated matches to the pressure data collected during the pumping test and subsequent recovery period. Observation well data for well WQSP-2 were simultaneously fit with the WIPP-11R pumping data in the modeling process. A simultaneous fit of the three observation wells was attempted, but given a radial model, was impossible. WQSP-2 was selected as the observation well to fit as it was the first well to respond and will give the most conservative estimate of aquifer parameters. All the nSIGHTS test simulations incorporated pre-test pressure records of various durations as "history" periods where the observed pressures were specified in the simulations.

The uncertainty quantification method applied to the analyses in this report is a process referred to as *perturbation analysis*. In this process, preliminary analyses are performed which result in a single set of "best fit" fitting-parameter values. These fitting-parameter values are considered the *baseline solution* set – a single value for each fitting parameter that provides a satisfactory fit to the data (*satisfactory* being a judgment call on the part of the hydraulic-test analyst). Perturbation analysis begins by assigning a plus/minus range corresponding to the parameter space of each baseline fitting-parameter values. These plus/minus fitting-parameter ranges for each fitting parameter are listed in Appendix B. Starting at the baseline value, the fitting parameters are randomly perturbed to fall somewhere within their assigned parameter space and are then optimized from these random starting points. The objective of perturbation analysis is to sample the parameter space adequately and locate all of the minima within the parameter space. By definition, the *global minimum* (assumed true solution) is the minimum that contains the smallest sum of squared error (SSE) values, while other minima are referred to as *local minima*. Local minima are effectively localized depressions in the parameter-space topography that can trap the inverse regression algorithm during its attempt to find the global minimum.

Information Only

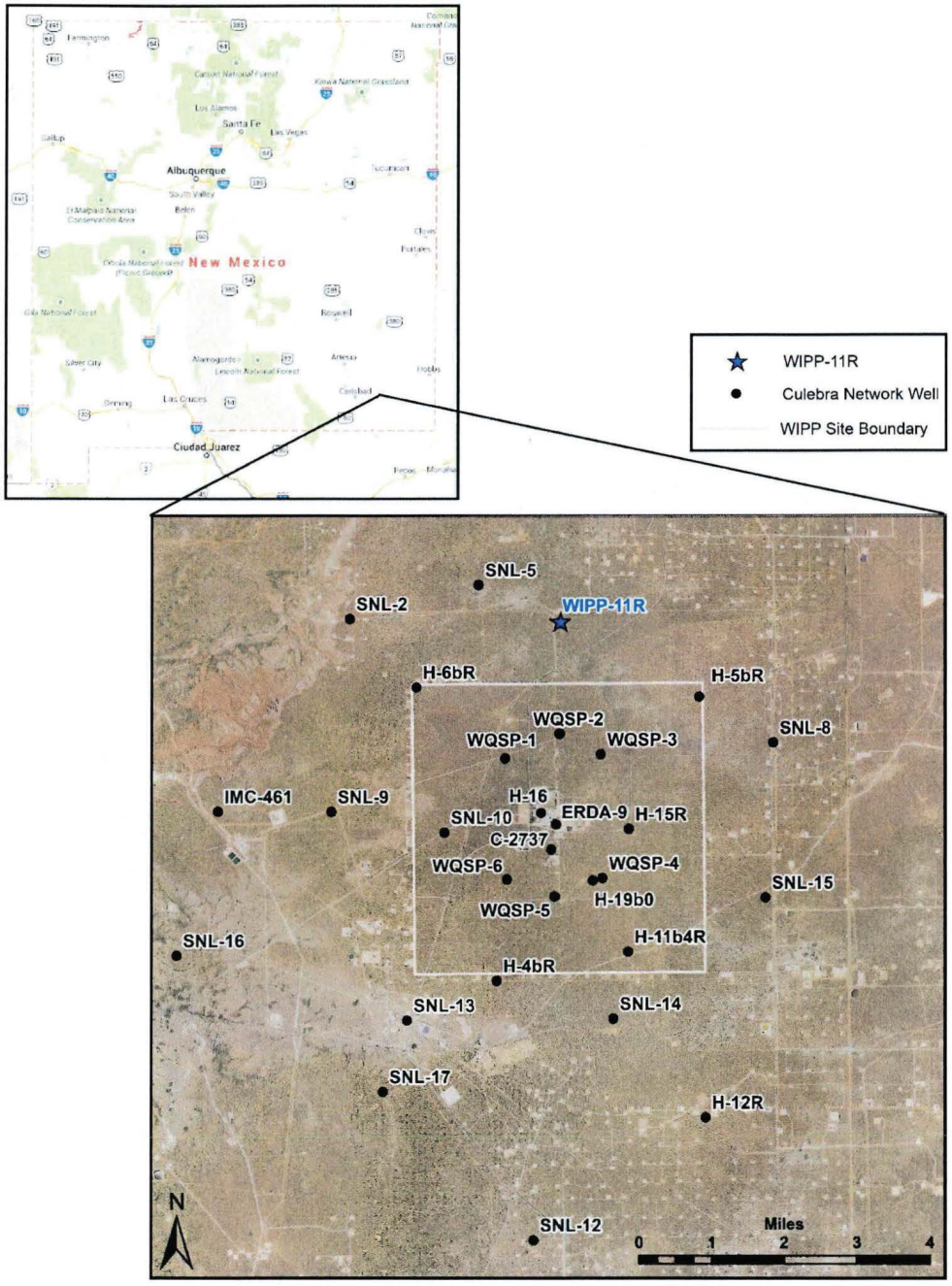


Figure 2. Location of the WIPP-11R Culebra well located on the WIPP-11 wellpad. The WIPP-11R pumping well is designated by a blue star.

Information Only

Five hundred perturbation/optimization runs of the simulated well response were performed per AP-070, Rev 3. A visual assessment of parameter-space plots for each fitting variable and a visual assessment of the fits themselves were all used to determine the value of the "fit discriminant". The fit discriminant is used to reduce the perturbations under consideration to only those within the best-fit minimum, and sufficiently close to be subjectively considered "acceptable" fits. All perturbation results for which the fit value was less than the fit discriminant were deemed acceptable solutions and are included in the final range of reported values for each fitting parameter. The final number of satisfactory perturbation results for each test is reported in the Section 3 figure captions.

3. WIPP-11R Analysis Results

Discussions of WIPP-11R and associated test analysis results are given below. A summary of the parameter estimates obtained from perturbation analysis is shown in Table 1. The full range of T values from which the statistics in Table 1 are derived is presented as a scatter plot in the sections below and a full listing is contained within the nPost configuration file for each analysis. Note that $T1$ denotes the closest of six modeled transmissivities ($T1$-$T6$) with respect to distance from the pumping well.

Table 1. Culebra Transmissivity and Storativity Estimates.

WIPP-11R Test	Mean S	Geo. Mean T (m^2/s)	Log Geo. Mean T (m^2/s)	Log Min. T (m^2/s)	Log Max. T (m^2/s)	Variance $(m^2/s)^2$
WIPP-11R Pumping Test ($T1$)	3.19E-06	7.59E-04	-3.12004	5.72E-04	1.36E-03	2.68E-10
WIPP-11 Pumping Test	6.40E-06	4.27E-04	-3.36957	8.34E-05	2.42E-03	4.59E-01

3.1. WIPP-11R

The Culebra interval of well WIPP-11R was drilled and completed on 9/23/19. The well was drilled to a depth of 895 ft with the Culebra interval screened from 839 ft to 860 ft. At the Culebra, the inner diameter (ID) of the well is 4.74-in and the pump is hanging on 1.4-in ID tubing. The siting and creation of the WIPP-11R well was based on the need to replace the previous WIPP-11 well in support of hydrologic testing and monitoring of the Culebra Dolomite north of the WIPP site. A physical description of the well is detailed in Figure 3.

A purge test was completed in the Culebra at WIPP-11R on 8/13/21. Stable water quality parameters were achieved during the purge, readying the well for a pumping test.

An approximately 42,000-gallon pumping test was conducted in the Culebra at WIPP-11R from 9/15/22 to 9/16/22. A pumping rate of approximately 30 gpm was used for the duration of the

Information Only

pumping test. The WIPP-11R nSIGHTS simulation consisted of three sequences: a history period prior to the initiation of pumping, a drawdown period, and a recovery period. The details of each sequence (start/end time, pressure, etc) are listed in Appendix B specified as the WIPP-11R_Pumping_cleanX.nPre file. The data acquired during the test are shown in Figure 4 for the pumping well and Figure 6 for the WQSP-2 observation well.

The specified WIPP-11R conceptual model was chosen as it was the simplest model that produced an acceptable fit to the data; acceptable by discretion of the modeler and was similar in structure and fashion as the original WIPP-11 conceptual model. The model used was an infinite-acting, radial system with a variable *T(r)*, wellbore storage, and negative skin. A gravel pack surrounding the screened portion of the well and localized fracturing likely account for the existence of negative skin. Model transmissivity varied by approximately three orders of magnitude over the full modeled radius of the well. One order of magnitude of that range is attributed to estimates of *T(r2)*. The inclusion of this transmissivity improved the fits of both Cartesian and diagnostic plots but is, oddly, not well constrained. The WIPP-11R model mean storativity and transmissivity are within a factor of 2 of the WIPP-11 pumping test model.

Information Only

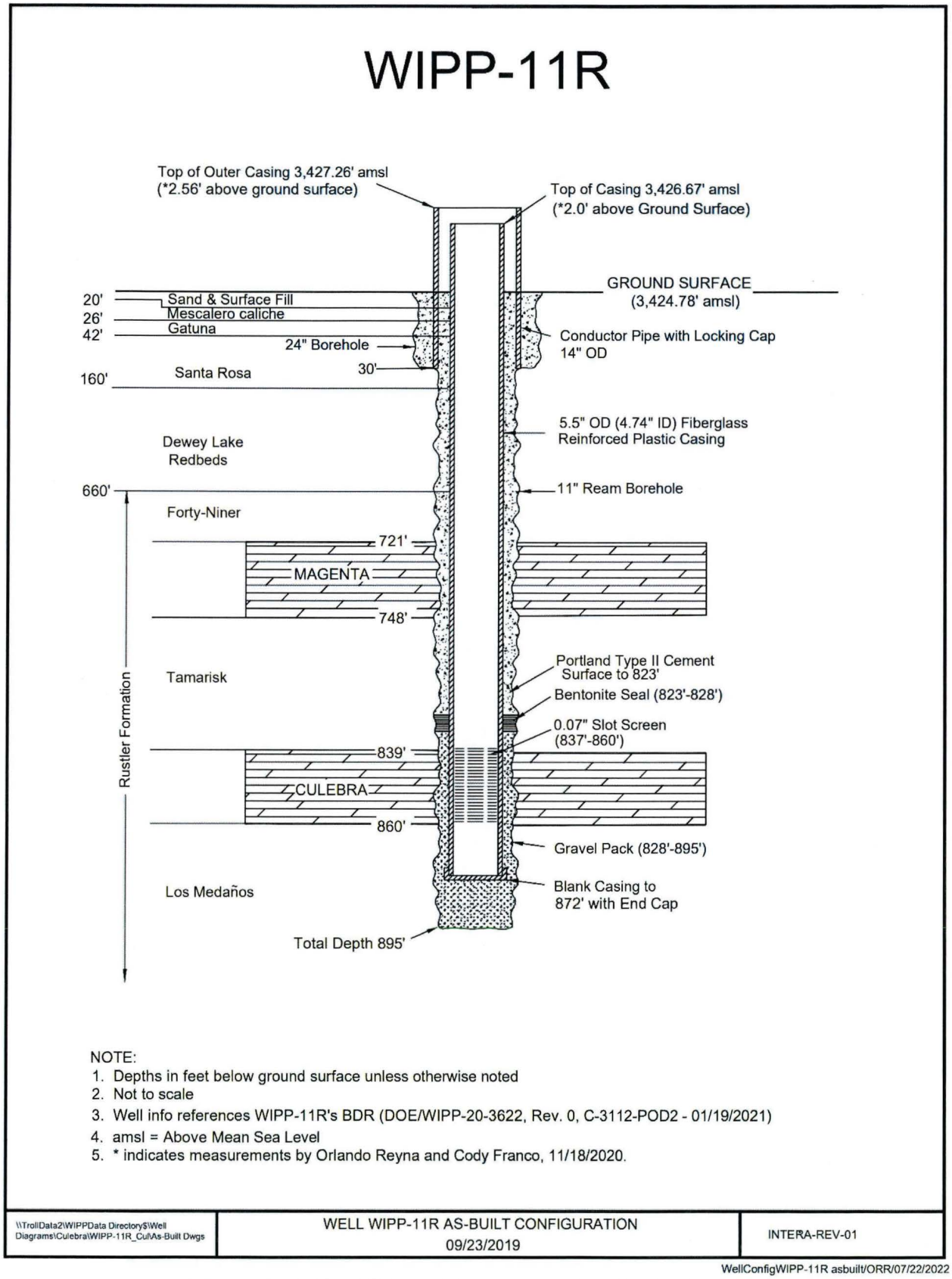


Figure 3. WIPP-11R well configuration during testing

Information Only

3.1.1 Pumping Test Analysis

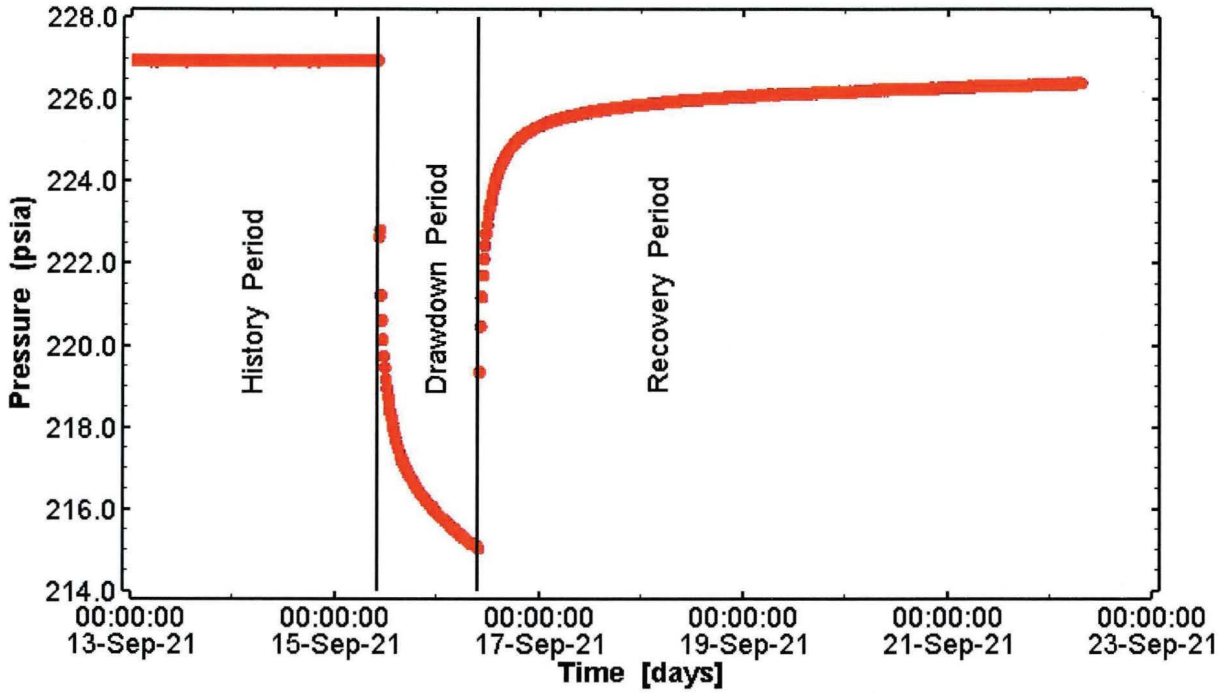


Figure 4. History, drawdown, and recovery period data for the WIPP-11R pumping test.

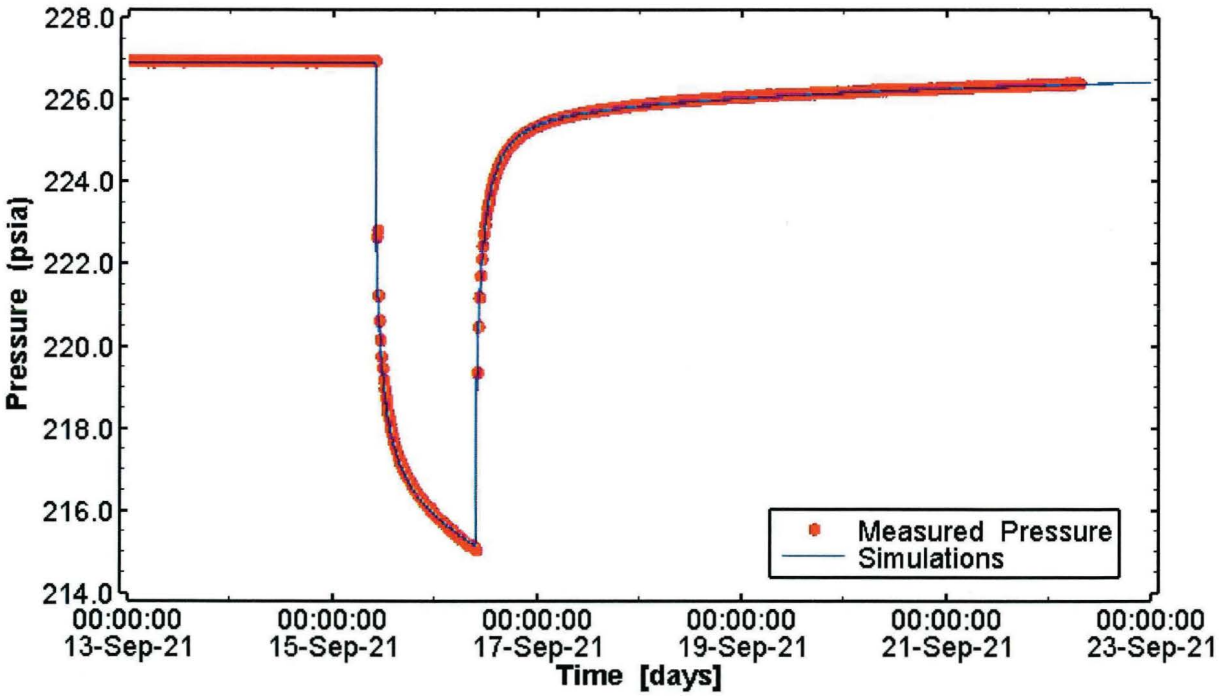


Figure 5. Pressure data and 336 model fits of the final Culebra pumping test in WIPP-11R.

Information Only

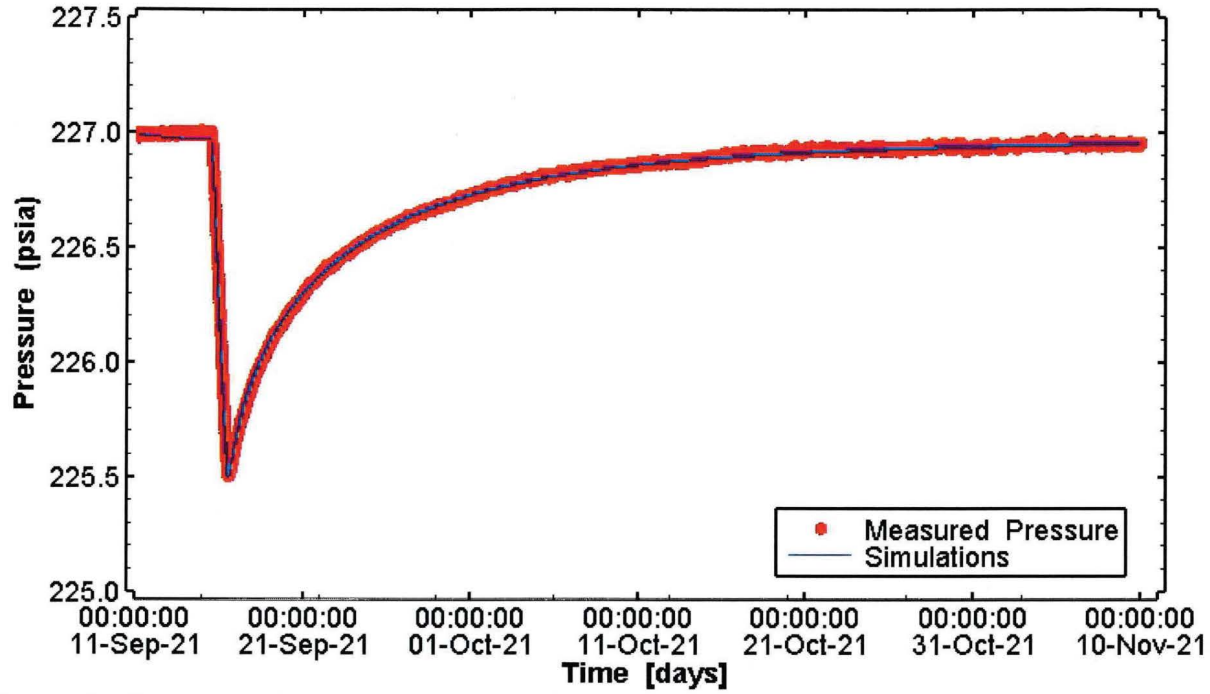


Figure 6. Pressure data and 336 model fits of the observation response in well WQSP-2.

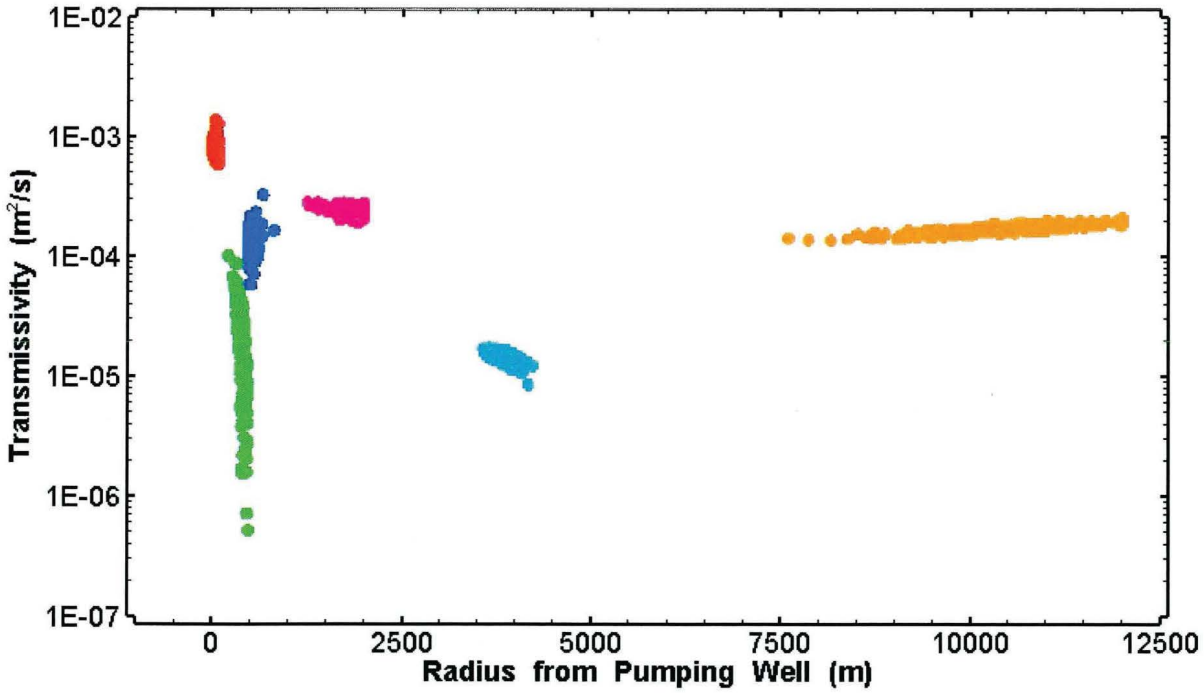


Figure 7. Estimates of radially varying transmissivity derived from the WIPP-11R perturbation analysis.

Information Only

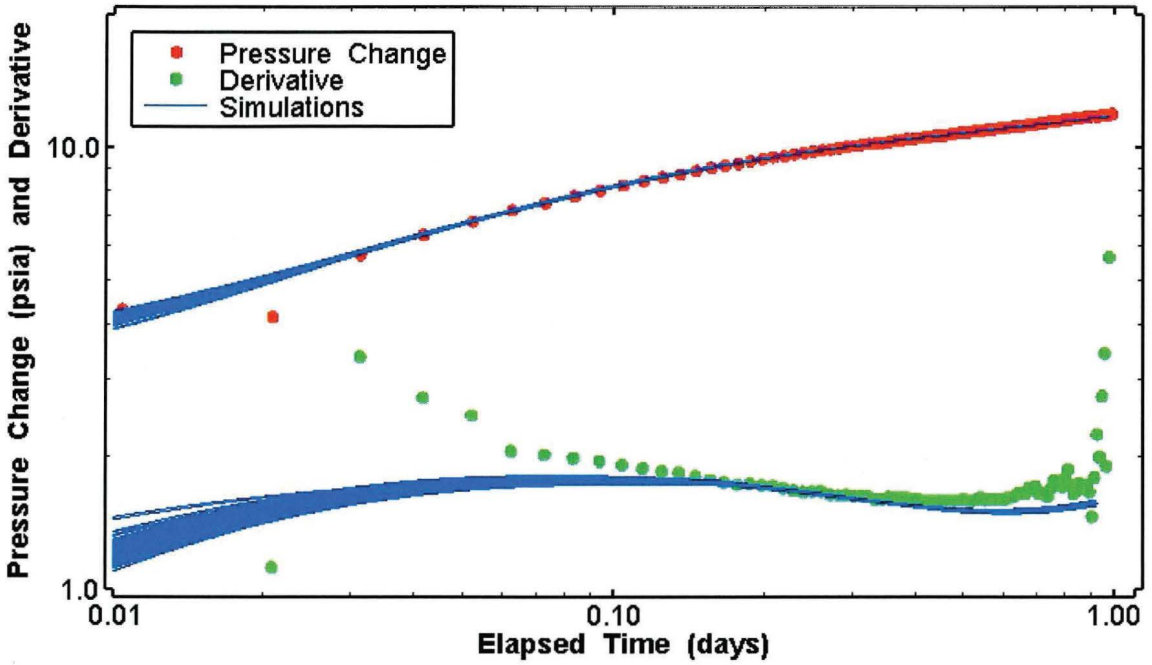


Figure 8. Log-log plot showing 336 simulations of the WIPP-11R drawdown period pressure change and derivative response.

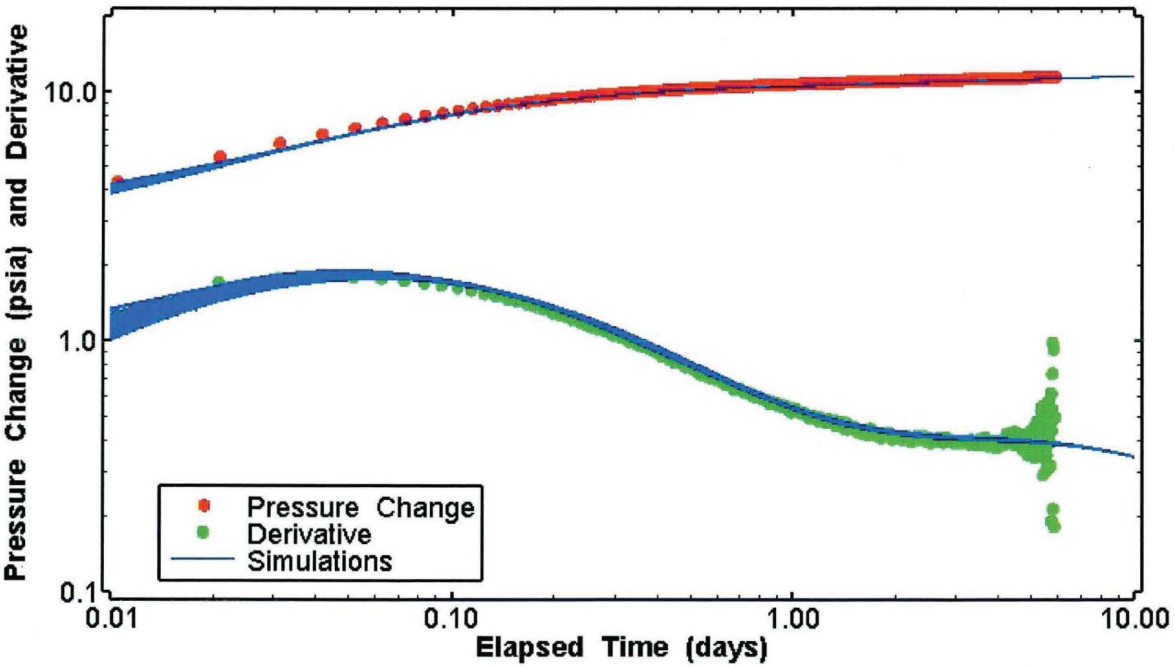


Figure 9. Log-log plot showing 336 simulations of the WIPP-11R recovery period pressure change and derivative response.

Information Only

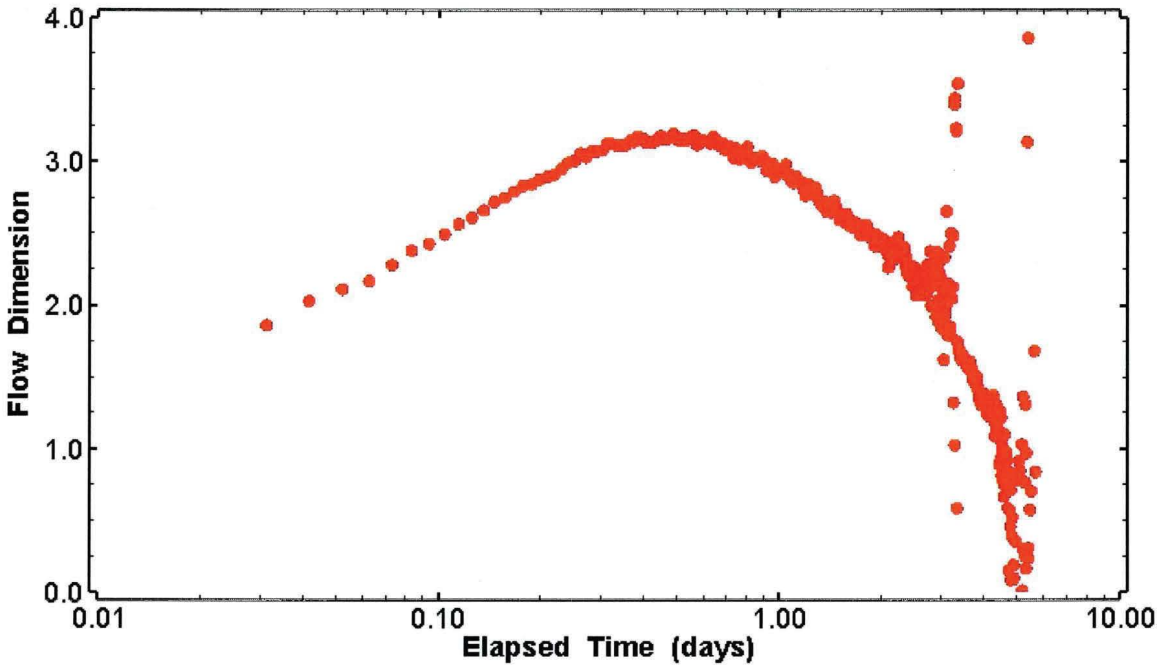


Figure 10. Semi-log plot showing the flow dimension diagnostic for the WIPP-11R pumping test.

3.2. WIPP-11 to WIPP-11R Comparison

Historically, the WIPP-11 pumping test was questioned due to the unusual patterns displayed in both its derivative and flow dimension diagnostics. Roberts (2006) produced a standard diagnostic that had a positive slope and sinusoidal signature. The positive slope of the pressure change and derivative diagnostic indicate possible sub-radial flow while the sinusoidal nature of the derivative was left to speculation. Considering the radial representation of the model a sinusoidal signature would indicate transmissivity that oscillated with respect to distance from the pumping well. Alternatively, spatial availability of water was questioned as the driver for the diagnostic changes, but barring a nest of testing wells on the WIPP-11 wellpad, there was no way to further evaluate these characteristics.

The WIPP-11R pumping test was confined to approximately 24 hours of testing (the WIPP-11 pumping test persisted for approximately 2 weeks), but still repeated some of the same spatial characteristics through the flow dimension diagnostic with respect to the WIPP-11 flow dimension diagnostic. Figure 11 illustrates the flow dimension diagnostics for the WIPP-11 and WIPP-11R tests with modeled WIPP-11R simulations. The repetition in sinusoidal pattern for the two independent wells validates that the unique signature seen originally in the WIPP-11 flow dimension diagnostic is sourced in the Culebra hydrogeology. An offset of approximately 6 hrs separates the peaks of central flow dimension diagnostic curves which is likely caused by a combination of the differential in pumping rate (5 gpm) between the two tests and the positional offset of the two pumping wells.

Information Only

Figure 12 illustrates a comparison of the diffusivity values used in the WIPP-11 and WIPP-11R models. Each model displays similarities in diffusivity values with respect to radius from their respective, but co-located, pumping wells. Their differing flow dimension diagnostics with similar diffusivity values indicate that spatial changes are likely affecting aquifer flow structure rather than varied transmissivities, exclusively. To further verify and validate flow structure, additional wells with longer pumping tests would be recommended.

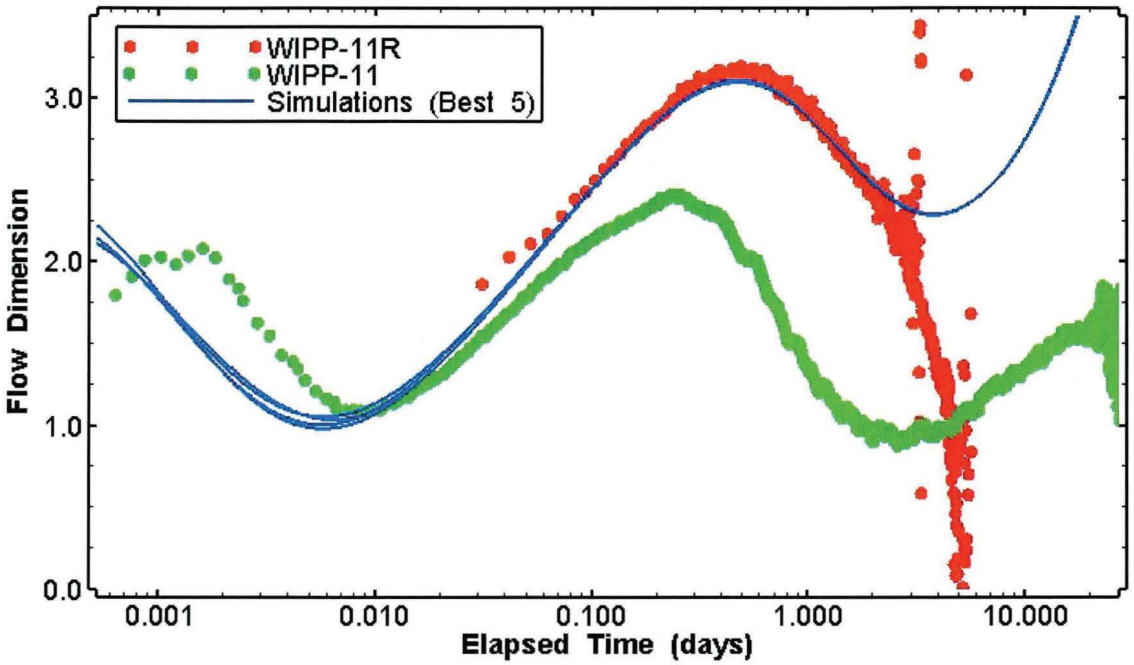


Figure 11. A comparison of the WIPP-11 flow dimension diagnostic, WIPP-11R flow dimension diagnostic, and WIPP-11R flow dimension simulations.

Information Only

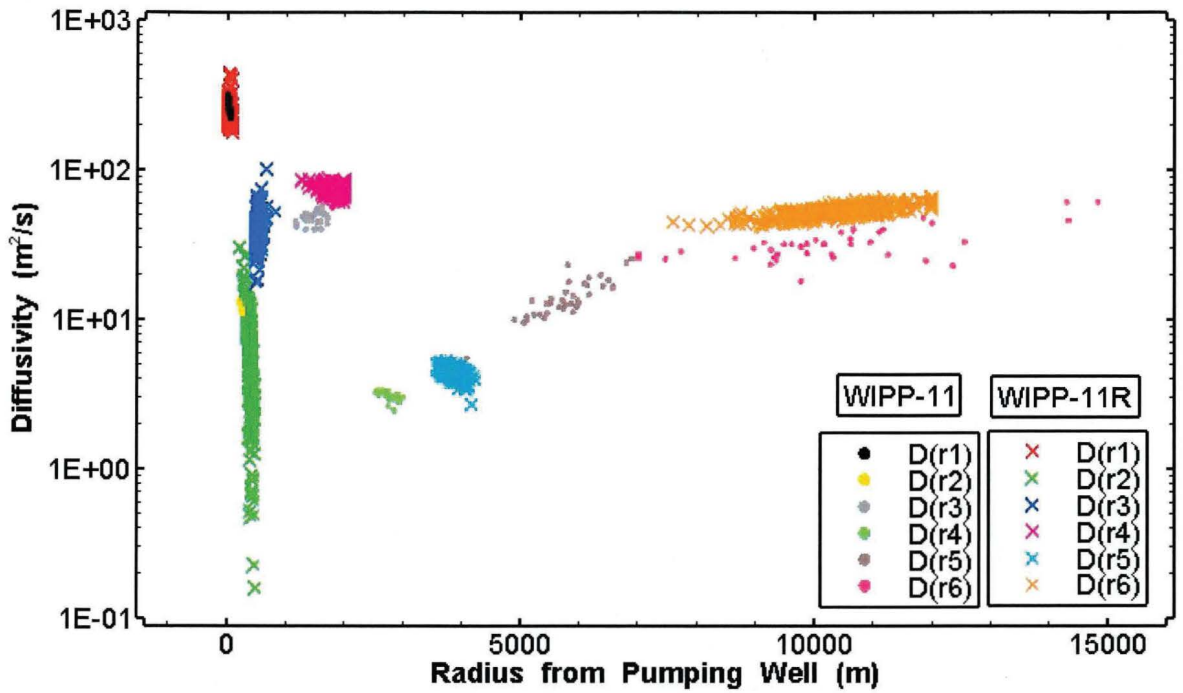


Figure 12. A visual comparison of the diffusivity values used to model the WIPP-11 and WIPP-11R pumping tests.

Information Only

4. References

Beauheim, R.L., R.M. Roberts, T.F. Dale, M.D. Fort, and W.A. Stensrud. 1993. *Hydraulic Testing of Salado Formation Evaporites at the Waste Isolation Pilot Plant Site: Second Interpretive Report*. SAND92-0533. Albuquerque, NM: Sandia National Laboratories.

Bourdet, D., J.A. Ayoub, and Y.M. Pirard. 1989. "Use of Pressure Derivative in Well-Test Interpretation," *SPE Formation Evaluation*, 4(2):293-302.

Bowman, D.O. 2020. Analysis Plan for Hydraulic-Test Interpretations, AP-070, Revision 3. ERMS# 574237. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

Lofton, O.W. 2022. WIPP Site Well Testing Notebook 20 (WSWT-20), ERMS #577092 Pkg #540244.

Kuhlman, K. 2011. User's Manual Criteria and User's Manual for nSIGHTS 2.41a, Document Version 2.41a. ERMS# 555653. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

Roberts, R.M. 2006. Analysis Report for AP-070, Analysis of Culebra Pumping Tests Performed Between December 2003 and August 2005. ERMS 543901.Carlsbad, NM: Sandia National Laboratories.

Roberts, R.M., R.L. Beauheim, and P.S. Domski. 1999. *Hydraulic Testing of Salado Formation Evaporites at the Waste Isolation Pilot Plant Site: Final Report*. SAND98-2537. Albuquerque, NM: Sandia National Laboratories.

Information Only

Appendix A – WIPP-11R Hydraulic Test – 9/15/22 to 9/17/22

Well	Date and Time Start DAS	Date and Time Stop DAS	Date and Time Start Test	Date and Time Stop Test	Borehole Diameter (in)
WIPP-11R	9/15/21 9:25	9/17/21 7:15	9/15/21 10:00	9/16/21 9:45	5.5

Inside Tubing or Casing Diameter (in)	Culebra Interval (ft bgs)	Fluid Density (g/cm^3)	Field Notebook	Data Source Report(s)
4.74	839-860 (21 ft)	1.032	WSWT-20	N/A

Information Only

Appendix B – nSIGHTS Listings

```
*************
nPre/32 2.41a
*************

Version date    1 April 2011
Listing date    13 Sep 2022
QA status       QA: Approved
Config file     C:\Users\dobowma\Desktop\Priority_Reports_AH\WIPP-11R\WIPP-
11R_Pumping_cleanX2.nPre
```

Control Settings

Main Settings

Simulation type	Optimization
Simulation subtype	Normal
Phase to simulate	Liquid
Skin zone ?	yes
External boundary	Fixed Pressure
Curve data source	Objects

Liquid Phase Settings

Aquifer type	Confined
Aquifer horizontal permeability	Isotropic
System porosity	Single
Compensate flow dimension geometry	yes
Leakage	None

Test Zone Settings

Test zone volume can vary	no	
Test zone compressibility can vary	no	
Test zone temperature can vary	no	
Default test-zone temperature	20.00	[C]
Solution variable	Pressure	
Allow negative head/pressure	yes	

Parameters

Formation

Formation thickness	21.000	[ft]
Flow dimension	2.0	[]
Static formation pressure	226.994	[psi]
External boundary radius	1000000	[m]
Formation conductivity	f(r) point	
Formation spec. storage	Optimization	
Minimum value	1.00000E-10	[1/m]
Maximum value	1.00000E-02	[1/m]

Information Only

Estimate value	5.21798E-07	[1/m]
Range type	Log	
Sigma	1.00000E+00	

Skin

Radial thickness of skin	Optimization	
Minimum value	0.001	[m]
Maximum value	5.0	[m]
Estimate value	3.5974897	[m]
Range type	Linear	
Sigma	1.00000E+00	
Skin zone conductivity	Optimization	
Minimum value	1.00000E-10	[m/sec]
Maximum value	1.00000E-02	[m/sec]
Estimate value	9.99841E-03	[m/sec]
Range type	Log	
Sigma	1.00000E+00	
Skin zone spec. storage	Optimization	
Minimum value	1.00000E-09	[1/m]
Maximum value	1.00000E-02	[1/m]
Estimate value	8.87853E-08	[1/m]
Range type	Log	
Sigma	1.00000E+00	

Fluid

Fluid density	1032.00	[kg/m^3]
Fluid thermal exp. coeff.	0.00000E+00	[1/C]

Test-Zone

Well radius	2.37	[in]
Tubing string radius	Optimization	
Minimum value	1.0	[in]
Maximum value	2.0	[in]
Estimate value	1.9996194	[in]
Range type	Linear	
Sigma	1.00000E+00	

Numeric

# of radial nodes	250	[]
# of skin nodes	50	[]
Pressure solution tolerance	1.45038E-11	[psi]
STP flow solution tolerance	1.58503E-11	[USgpm]

---

f(x) Points Parameters

Formation conductivity

Points type	f(r)	
Radius #1	Optimized	
Minimum	1.0	[m]
Estimat	45.0089479	[m]
Maximum	100.0	[m]

Information Only

Y value#1	Optimized	
Radius #2	Optimized	
Minimum	100.01	[m]
Estimat	409.1700237	[m]
Maximum	500.0	[m]
Y value#2	Optimized	
Radius #3	Optimized	
Minimum	500.01	[m]
Estimat	517.6981803	[m]
Maximum	1000	[m]
Y value#3	Optimized	
Radius #4	Optimized	
Minimum	1000.01	[m]
Estimat	1860.9918981	[m]
Maximum	2000	[m]
Y value#4	Optimized	
Radius #5	Optimized	
Minimum	2000.01	[m]
Estimat	3540.2689629	[m]
Maximum	5000	[m]
Y value#5	Optimized	
Radius #6	Optimized	
Minimum	5000.01	[m]
Estimat	10225.0045377	[m]
Maximum	12000	[m]
Y value#6	Optimized	
X opt range type	Linear	
X opt sigma	1.00000E+00	
Y opt minimum value	1.00000E-08	[m/sec]
Y opt maximum value	1.00000E-03	[m/sec]
Y opt range type	Log	
Y opt sigma	1.00000E+00	
Parameter curve type	Linear	

Calculated Parameters

Formation

Transmissivity	f(r)	
Storativity	min/max	
Minimum	6.40080E-10	[]
Maximum	6.40080E-02	[]
Diffusivity	f(r)	

Skin Zone

Transmissivity	min/max	
Minimum	6.40080E-10	[m^2/sec]
Maximum	6.40080E-02	[m^2/sec]
Storativity	min/max	
Minimum	6.40080E-09	[]
Maximum	6.40080E-02	[]

Information Only

Diffusivity	min/max	
Minimum	1.00000E-08	[m^2/sec]
Maximum	1.00000E+07	[m^2/sec]
Skin factor	f(r)	

Test Zone

Open hole well-bore storage	min/max	
Minimum	2.00279E-07	[m^3/Pa]
Maximum	8.01118E-07	[m^3/Pa]

Grid Properties

Grid increment delta	min/max	
Minimum	0.06127	[]
Maximum	0.08276	[]
First grid increment	min/max	
Minimum	3.20299E-01	[m]
Maximum	6.06944E-03	[m]
Skin grid increment delta	min/max	
Minimum	0.00029	[]
Maximum	0.08759	[]
Skin first grid increment	min/max	
Minimum	2.02654E-05	[m]
Maximum	6.34761E-03	[m]
Skin last grid increment	min/max	
Minimum	2.05516E-05	[m]
Maximum	4.25134E-01	[m]
Increment ratio	min/max	
Minimum	7.53409E-01	[]
Maximum	2.95326E+02	[]

Sequences

Sequence: H_01

Sequence type	History	
Start time	44450.000000	[day]
Duration	4.416670	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Curve	
Wellbore storage	Open	

Sequence: F_01

Sequence type	Flow	
Start time	44454.416670	[day]
Duration	0.989580	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Fixed	
Fixed value	-30.0	[USgpm]
Wellbore storage	Open	

Information Only

Sequence: F_02

Sequence type	Flow	
Start time	44455.406250	[day]
Duration	54.593750	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Fixed	
Fixed value	0.0	[USgpm]
Wellbore storage	Open	

Test Zone Curves

Curve object to use	P_Curve
Curve type	Pressure
Start sequence	H_01
End sequence	H_01
Curve time base	Test
Curve Y data units	[psi]
Curve Y data is log 10	no

Simulation Results Setup

Output ID	DAT	
Output type	Pressure	
Pressure capture type	Test Zone	
Output units	[psi]	
Output ID	DAT	
Output type	Flow Rate	
Flow rate output type	Well	
Output units	[USgpm]	
Output ID	WQSP-2	
Output type	Pressure	
Pressure capture type	Observation Well	
Observation well radius	2502	[m]
Output units	[psi]	

OutputFiles

XY Forward Output

Write file ?	yes
C:\Users\dobowma\Desktop\Priority_Reports_AH\WIPP-11R\Post\WIPP-11_Sim_Data2.nXYSim	
Run ID	Run#1
If file exists	Overwrite
Output data	AutoSimData

Optimization Output

Write file ?	yes

Information Only

C:\Users\dobowma\Desktop\Priority_Reports_AH\WIPP-11R\Post\WIPP-11R_Opt_Data2.nOpt	
Run ID	Run#1
If file exists	Overwrite
Write residuals ?	no
Write Jacobian ?	no
Write covariance matrices?	yes

Optimization Setup

Algorithm	Simplex
Simplex algorithm	NR
Calculate confidence limits ?	yes
Covariance matrix calculations	1st Order
Fixed derivative span ?	no
Fit tolerance	1.0000E-05
Parameter tolerance	not used
# of optimized variables	17
K_fm.R[01]	OK
K_fm.R[02]	OK
K_fm.R[03]	OK
K_fm.R[04]	OK
K_fm.R[05]	OK
K_fm.R[06]	OK
K_fm.V[01]	OK
K_fm.V[02]	OK
K_fm.V[03]	OK
K_fm.V[04]	OK
K_fm.V[05]	OK
K_fm.V[06]	OK
Skin zone conductivity	OK
Tubing string radius	OK
Formation spec. storage	OK
Skin zone spec. storage	OK
Radial thickness of skin	OK

Fits to Optimize

CompositeFit	OK

Calculated Parameters Included

# of calculated variables included	0

Suite/Range Setup

# of suite/range variables	0

Information Only

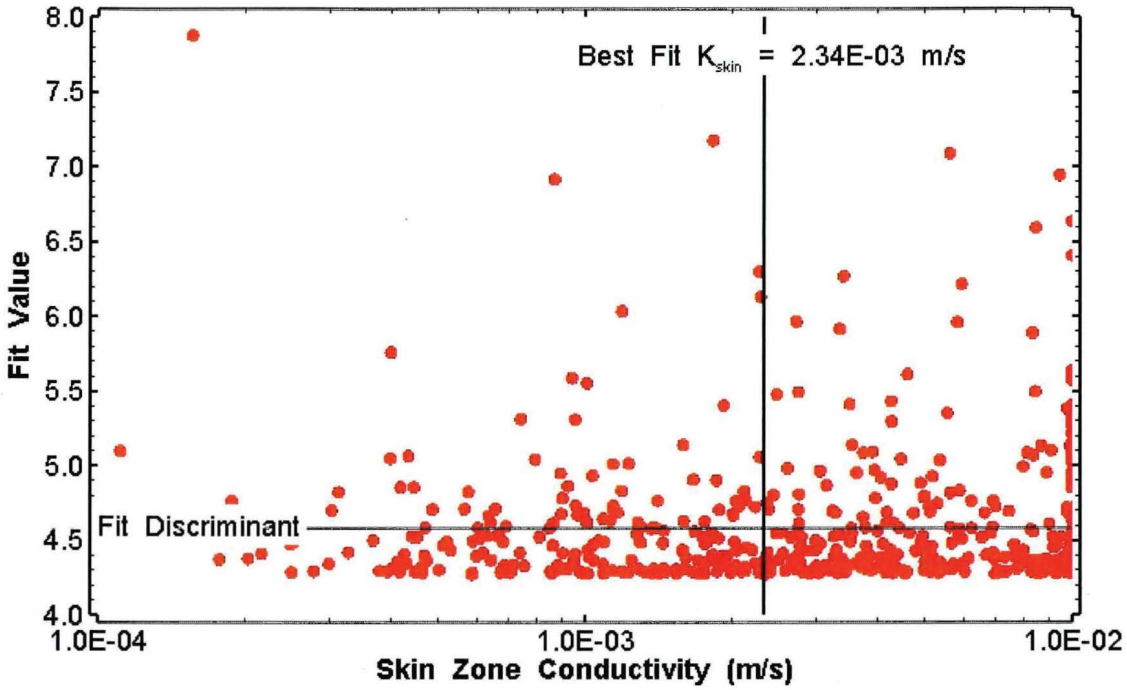


Figure B-1. X-Y scatter plot showing the skin conductivity parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values.

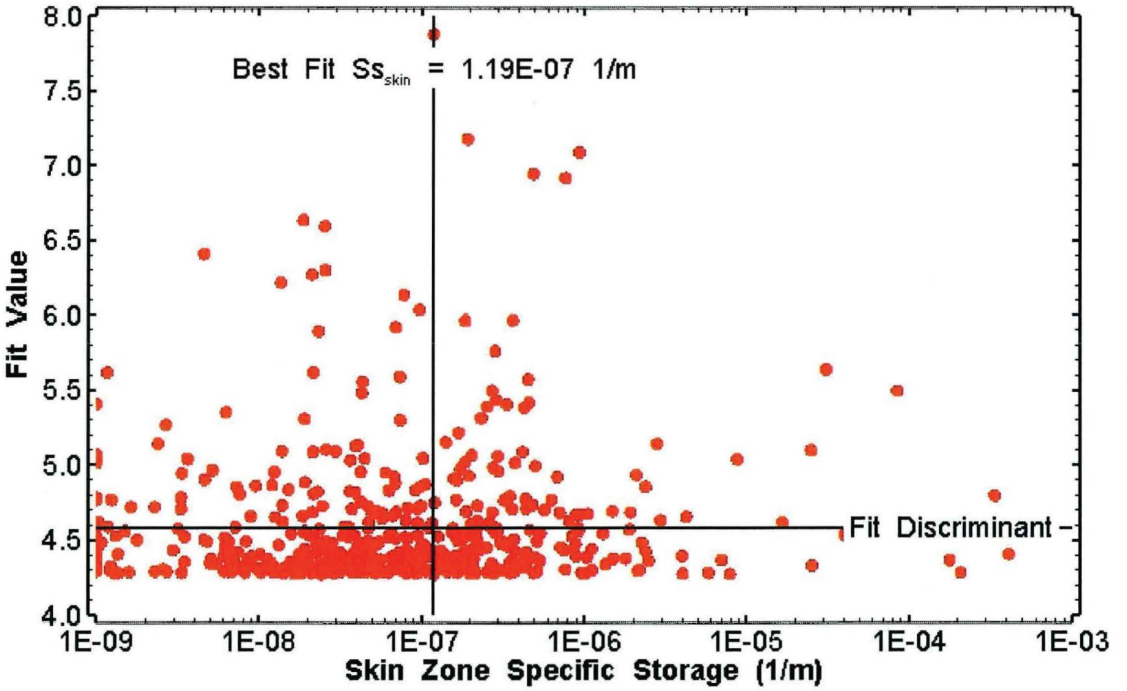


Figure B-2. X-Y scatter plot showing the skin specific storage parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values.

Information Only

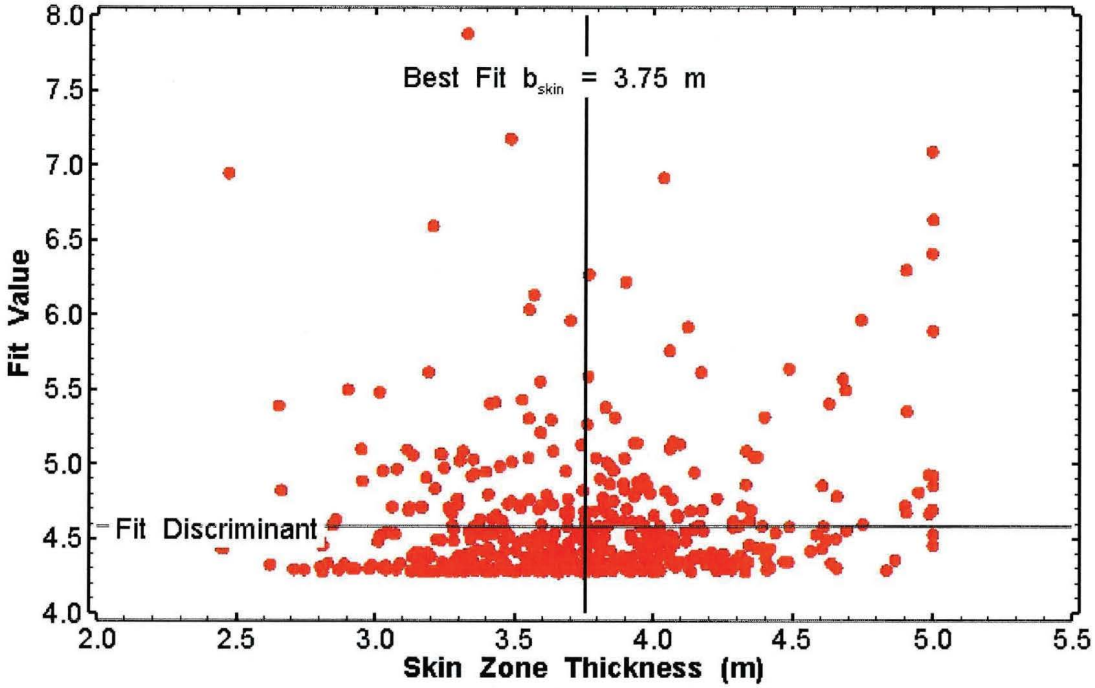


Figure B-3. X-Y scatter plot showing the skin thickness parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values.

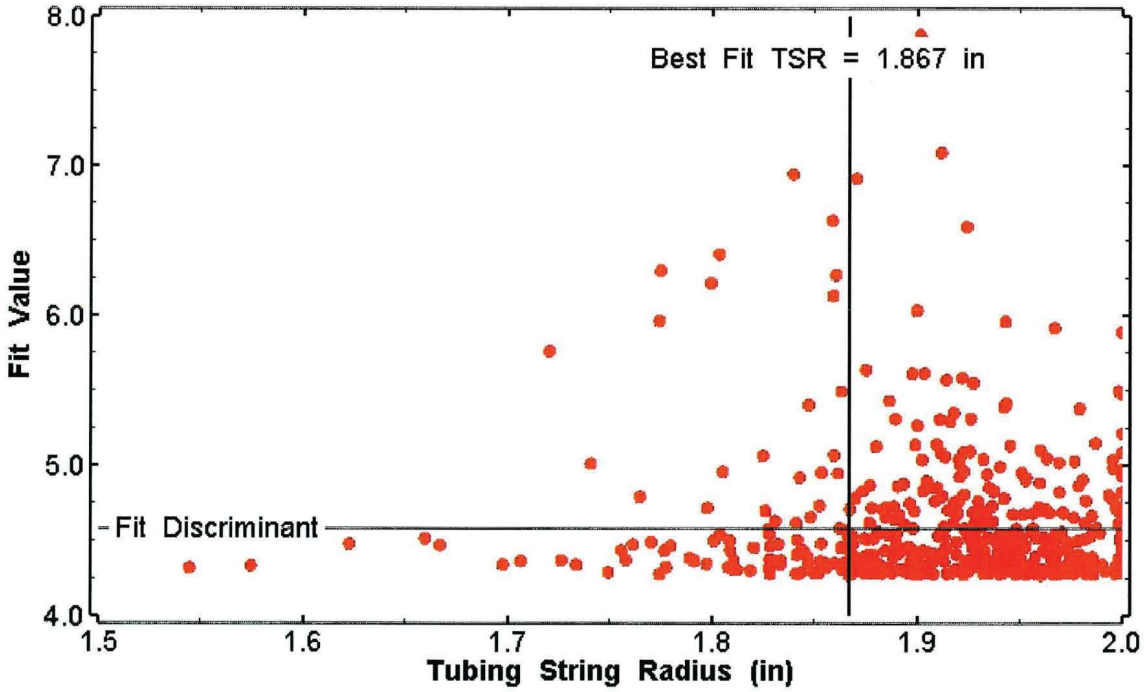


Figure B-4. X-Y scatter plot showing the tubing string radius parameter space for the WIPP-11R perturbation analysis with the fit discriminant and best fit values.

Information Only

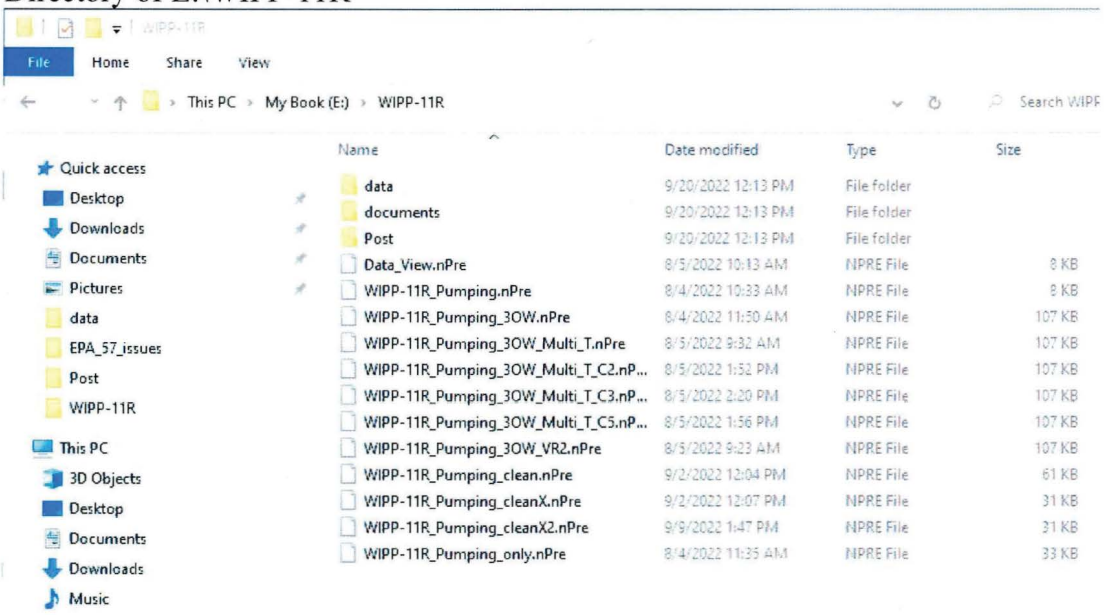
Appendix C – File Directories

Associated files will be archived in the following Directory - /nfs/data/CVSLIB/WIPP_EXTERNAL/AP070.

Table C-1. File descriptions.

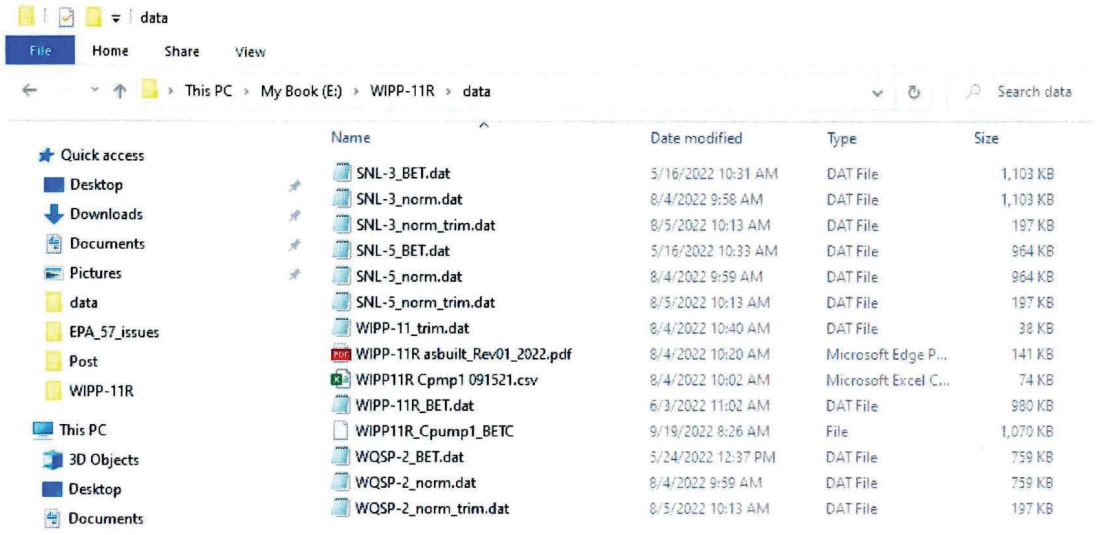
File Extension	Function/Use
<filename>.nPre	Files used for initial well test analysis.
<filename>X.nPre	Files used to generate perturbation analysis of .nPre results.
.nPost	Post-processing files used to visualize .nPre and perturbation analysis.
.nOpt	Optimization data used for post processing in .nPost files.
<filename>.nXYSim	Simulation data used for post processing in .nPost files.
<filename>FieldData.nXYSim	Field data used for post processing in .nPost files.
.jpg	Graphic output from .nPost files.
.csv,.xls, .dat	Data files used as input for .nPre files.

Directory of E:\WIPP-11R



Information Only

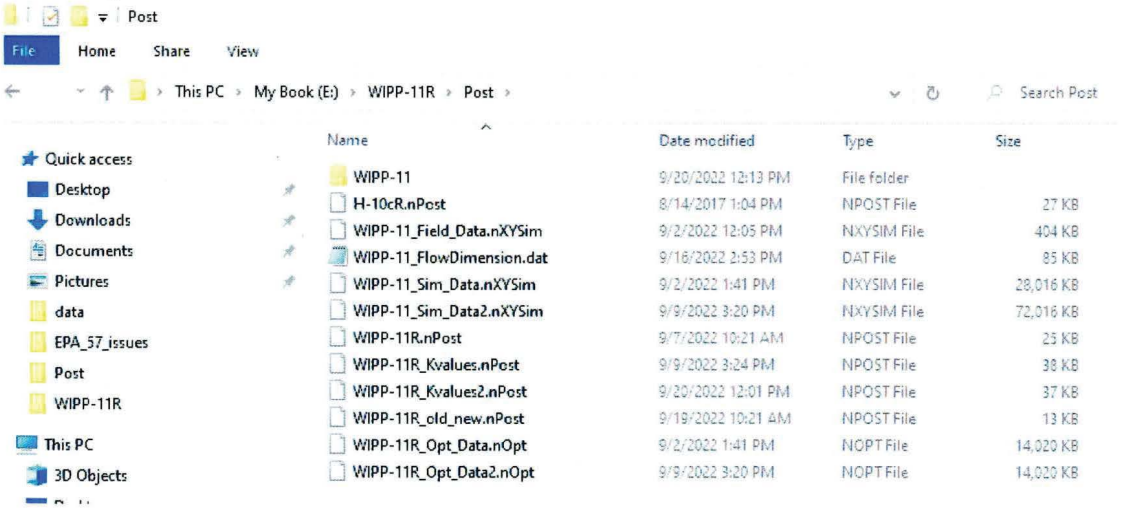
Directory of E:\WIPP-11R\data



Directory of E:\WIPP-11R\documents



Directory of E:\WIPP-11R\Post



Information Only

Directory of E:\WIPP-11R\Post\WIPP-11



Acknowledgements

The author of this report would like to acknowledge Orlando Reyna of Intera, Inc. for contributing the well configuration plot and Mike Farinacci of Intera, Inc. for contributing the well location map to this report.

Information Only