SGW-46279
Revision 3

# Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model

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

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

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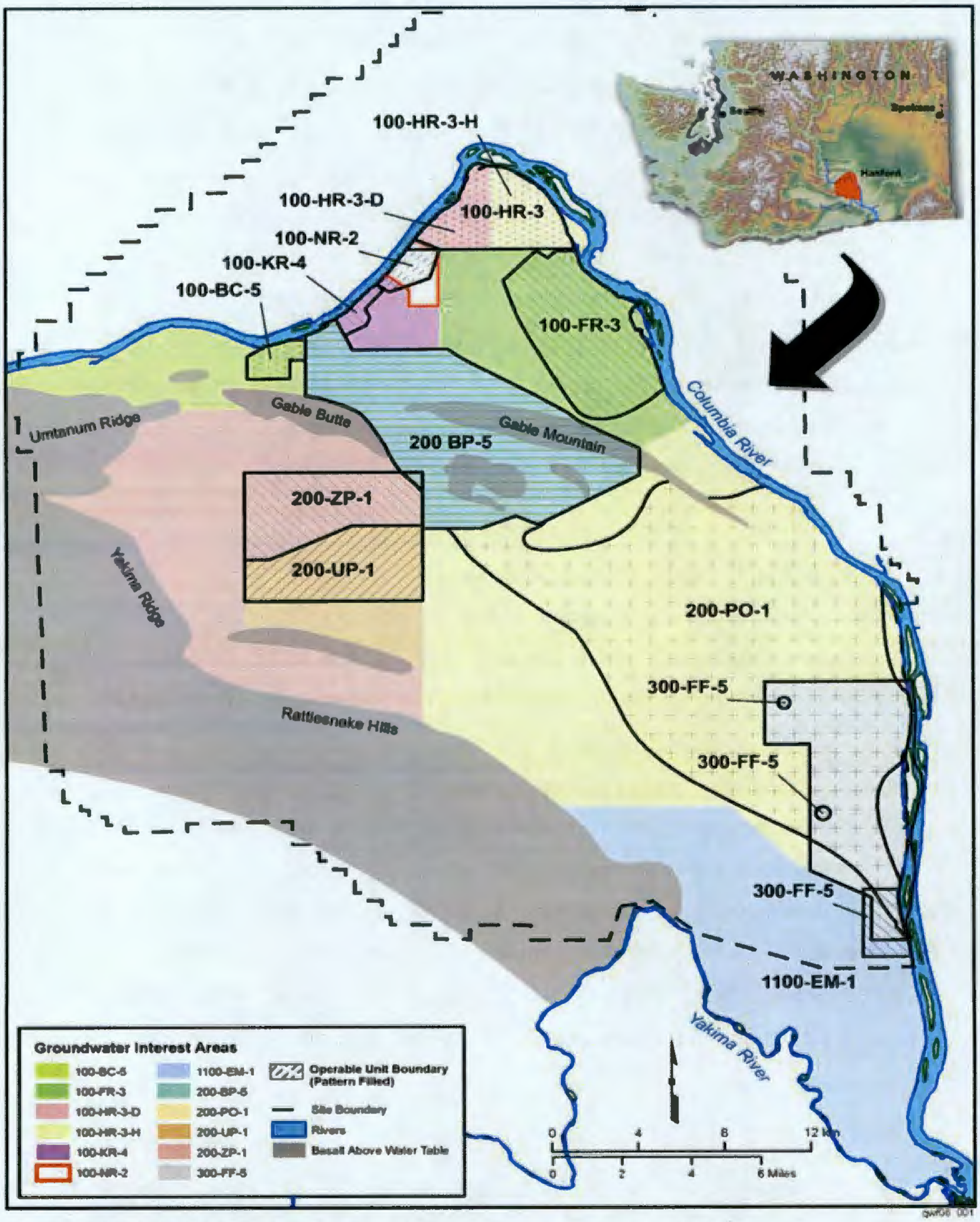
**APPROVED**
*By Julia Raymer at 10:35 am, May 19, 2016*

Release Approval          Date

## Executive Summary

This model documentation report presents data, analyses, and interpretations that are used to construct the conceptual model for the unsaturated and saturated aquifer within the Hanford 100 Areas (Figure ES-1). This report also documents development of the updated 100 Area Groundwater Model (100AGWM), a groundwater flow and contaminant fate and transport simulation model developed in support of remedial activities led by CH2M HILL Plateau Remediation Company (CHPRC) at the Hanford Site, Washington. The objective of this report is to concisely describe the conceptual model framework for the 100 Areas; the 100AGWM modeling objectives; and the model construction, calibration, deployment, and configuration control; as well as to summarize the assumptions and limitations of the 100AGWM.

The 100 Area groundwater operable units (OUs) (Figure ES-1) are located adjacent to the Columbia River in the northeastern corner of the Hanford Site. The 100 Area groundwater OUs encompass the operating areas of the former plutonium production reactors at the Hanford Site. The nine reactors (B, C, D, DR, F, H, KE, KW, and N Reactors) were built from 1943 through 1965. While the reactors were operational, large volumes of Columbia River water were treated with sodium dichromate (to inhibit corrosion of the reactor piping) and used as coolant for the reactors. In addition, numerous leaks and spills of concentrated sodium-dichromate stock solution occurred over the lifetime of reactor operations, locally introducing much higher concentrations of chromium contamination into the vadose zone and groundwater. While hexavalent chromium (Cr(VI)) is the primary contaminant of concern (COC) for 100-FR-3, 100-HR-3, 100-KR-4, and 100-BC-5 OUs (Figure ES-1), migration of other COCs are examined, including tritium, strontium-90, carbon-14, nitrate, and trichloroethylene.




Source: DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*.[1]

**Figure ES-1. Location of 100 Area Groundwater OUs in Relation to Other Hanford Site Groundwater OUs**

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[1] DOE/RL-2008-66, 2009, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0905131281.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0905131282.

The purpose of the 100AGWM is to provide the computational framework for groundwater flow and contaminant transport modeling for system performance evaluation, where an active remedy is in place; evaluation of migration patterns of contaminant plumes in each OU; and remedial process optimization (RPO) based on a final Record of Decision (ROD) for each OU. Intended and anticipated uses of the model include:

- Calculating groundwater levels, hydraulic gradients, and groundwater flows throughout the model domain, for use in subsequent calculations of the fate and transport of COCs.
- Estimating future groundwater concentrations of COCs to support the design and evaluation of remedial alternatives.
- Evaluating selected remedial alternatives, and optimizing final remedial designs in order to achieve specified remedial action objectives.

This report describes the 100 Areas conceptual model framework in terms of the existing features, events, and processes (FEPs) that are important to the various 100 Area OUs. The report focuses on the hydrogeology of each OU; the sources, patterns, and rates of groundwater recharge; and the groundwater response to fluctuations in the adjacent Columbia River and currently operating pump and treat (P&T) remedies. Structural (surface elevation) maps are presented to illustrate the geologic extent and aquifer conditions related to the Hanford/Ringold E Formation contact and the Ringold Formation Upper Mud unit (RUM) as well as transitional intervals of reworked Ringold (between the Hanford and Ringold E) and reworked RUM (between Ringold E and the RUM), identified in various areas across the River Corridor. Important features affecting unsaturated flow and transport for the 100 Areas, as well as available information on hydraulic properties for 100 Areas sediments, are summarized and aquifer properties derived from aquifer testing and well development data for the 100 Areas are tabulated.

The report details the numerical implementation of these FEPs as the 100AGWM, including the software employed, spatial and temporal discretization, aquifer properties, boundary conditions and recharge, and methods used to simulate pumping at wells in addition to model calibration and the methods used to complete simulations of contaminant transport. Assumptions and limitations that underlie the 100AGWM development and deployment are then summarized.

The 100AGWM represents the most recent incarnation of a model development process that commenced in fiscal year 2013 in support of remedy design/remedial action and remedial process optimization (RPO) activities at various OUs in the 100 Area. The model version history—summarized in this report—documents the major stages in the development of the 100AGWM. During 2009, CHPRC convened an external, technical peer review to assess the status of groundwater model development and implementation in support of RPO activities at the 100-HR-3 and 100-KR-4 OUs. That panel completed a detailed review of the 100 Areas groundwater model as it existed at that time, and provided recommendations for development to enhance the capabilities of the model. The majority of the peer review team recommendations were incorporated in a revised version published in 2012 (SGW-46279, Rev. 2).[2] A revised model, documented in this report, was developed and based on the following:

(a) Revised geologic interpretations across the River Corridor, including delineations of transitional geologic zones as part of a revised geological framework for the 100 Areas and a detailed representation of the land surface topography based on data collected using remote sensing technology

(b) Aquifer property data, based on refined interpretations of recent aquifer tests and existing well development data

(c) A more detailed representation of the aquifer interaction with the Columbia River, based on detailed river bathymetry data

In addition, the model domain was further extended to encompass the basalt subcrop west of the 100-B/C to better represent groundwater flow dynamics in that area.

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[2] SGW-46279, 2012, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*, Rev. 2, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087245.

# Contents

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## Terms

| | |
|---|---|
| 100AGWM | 100 Area groundwater model |
| 2D | two-dimensional |
| 3D | three-dimensional |
| AMSL | above mean sea level |
| AWLN | automated water level network |
| CHPRC | CH2M HILL Plateau Remediation Company |
| COC | contaminant of concern |
| Cr(VI) | hexavalent chromium |
| DOE | U.S. Department of Energy |
| ECF | environmental calculation brief |
| EMMA | environmental model management archive |
| FEP | features, events, and processes |
| GHB | general head boundary package |
| gpm | gallons per minute |
| HCOND | hydraulic conductivity |
| HEIS | Hanford Environmental Information System |
| HISI | Hanford Information Systems Inventory |
| $K_d$ | distribution coefficient |
| LiDAR | light detection and ranging |
| MNW2 | multi-node well package |
| OU | operable unit |
| P&T | pump and treat |
| PNNL | Pacific Northwest National Laboratory |
| POM | pumping optimization model |
| QAPjP | quality assurance project plan |
| RI/FS | remedial investigation/feasibility study |
| RPO | remedial process optimization |
| RUM | Ringold Upper Mud (unit) |
| SSP&A | S.S. Papadopulos & Associates, Inc. |

| | |
|---|---|
| USGS | U.S. Geological Survey |

# 1 Introduction

The 100 Area groundwater operable units (OUs) are located adjacent to the Columbia River in the northeastern corner of the Hanford Site in southeastern Washington State (Figure 1-1). The 100 Area OUs encompass the operating areas of the nine former plutonium production reactors (B, C, D, DR, F, H, KE, KW, and N Reactors), which were built from 1943 through 1965. While most of the reactors were single-pass reactors that operated only for plutonium production, the N Reactor was a dual-purpose reactor operated for plutonium production as well as electricity generation. As a legacy of the operation of these reactors, and related activities, the subsurface in the 100 Areas is affected by a variety of contaminants.

While the reactors were operational, large volumes of water pumped from the Columbia River were treated with sodium dichromate (to inhibit corrosion of the reactor piping) and used as coolant for the reactors. Leaks and spills of concentrated sodium-dichromate stock solution occurred over the lifetime of reactor operations, locally introducing high concentrations of chromium contamination into the vadose zone and groundwater. As a result, hexavalent chromium (Cr(VI)) is the principal contaminant of concern (COC) for the 100-HR-3 and 100-KR-4 OUs (Figure 1-1). Chromium contamination is also present in 100-BC-5, 100-NR-2 and 100-FR-3.

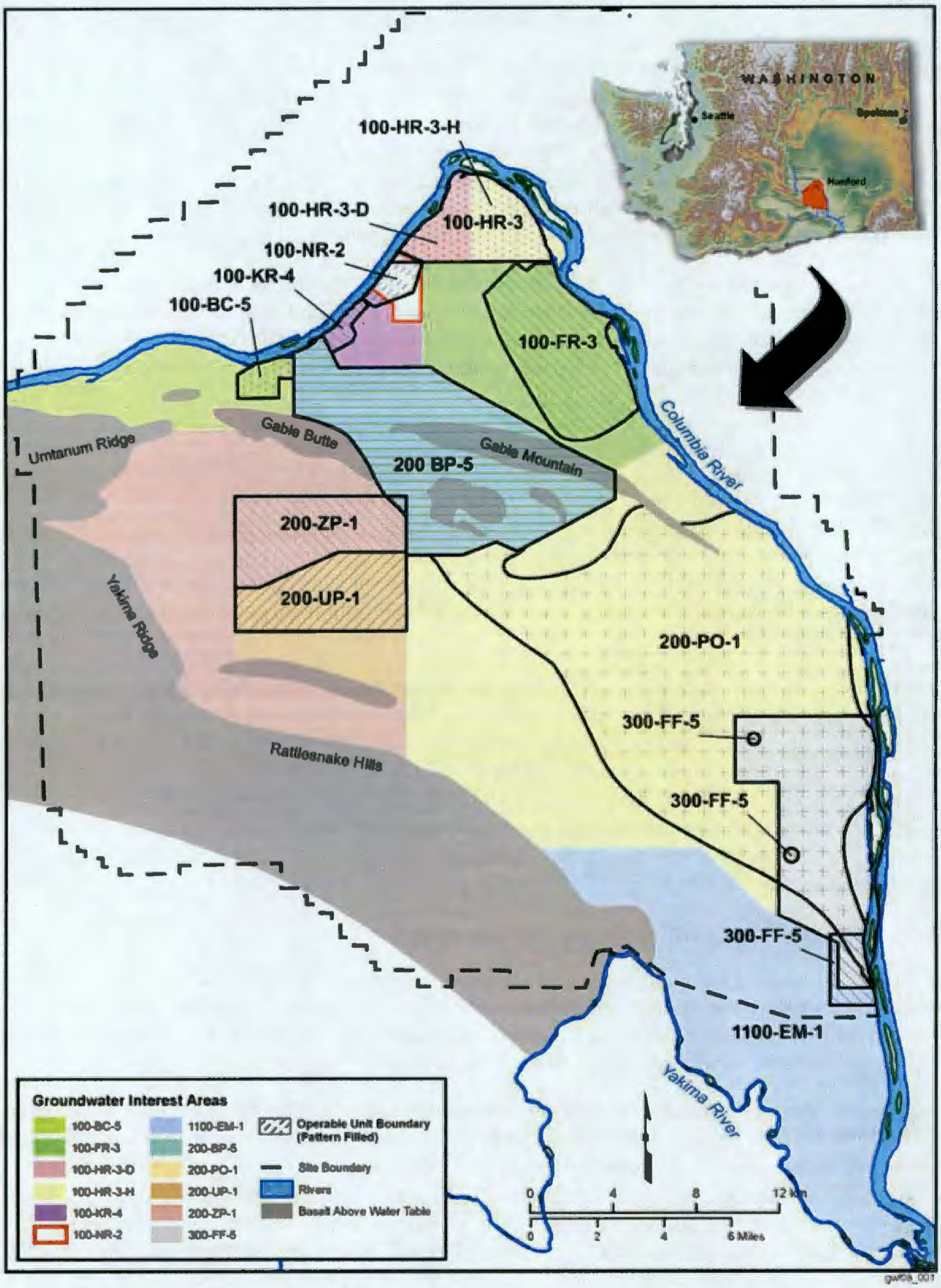
Although the primary COC identified in the 100 Areas is Cr(VI), additional COCs have been identified for the 100 Areas and their distribution, migration, and fate are subject to characterization and simulation. These COCs include tritium, strontium-90, carbon-14, nitrate, and trichloroethylene. Not all COCs are present in each OU. Details on the distribution and transport parameters for each of the various COCs are outside the scope of this report, but are provided in Hanford annual groundwater reports and application-specific calculation briefs (ECFs).

A groundwater flow and contaminant transport model, called the 100 Area Groundwater Model, or 100AGWM, has been developed to support evaluations of the migration and fate of identified COCs. The 100AGWM also designs and evaluates interim and final groundwater pump and treat (P&T) remedies as well as the actions taken to protect the Columbia River from COCs discharging to surface water. This report provides details on the development of the 100AGWM, including the conceptual framework, the assignment of parameter values, and the types and sources of information used to support model development, as well as the application of the model in designing and evaluating remedy expansion alternatives throughout the 100 Areas.

## 1.1 100 Areas Groundwater Modeling Objectives

Modeling of groundwater flow and contaminant transport is being conducted in the 100 Areas to support various efforts to reduce the risk posed to human health and the environment; control the migration of contaminants in groundwater close to the Columbia River shoreline; and shrink the contaminant footprint at the Hanford Site to a smaller geographic area.

The strategy developed for making decisions to complete cleanup along the River Corridor is described in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*. Addenda to the work plan outline the goals and strategy for data collection and analyses for each 100 Area OU to develop Remedial Investigation/Feasibility Study (RI/FS) documentation. The 100AGWM was developed to meet the RI/FS needs for each 100 Area OU; provide a tool for system performance evaluations in OUs with operational P&T systems in place as part of the annual reporting requirements; and support evaluations of remedial designs defined in OU-specific Records of Decision. The 100AGWM encompasses all 100 Area OUs and simulates saturated aquifer conditions and contaminant transport in three dimensions in the 100-BC-5, 100-KR-4, 100-HR-3, and 100-FR-3 OUs.




Source: DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008.*

**Figure 1-1. Location of 100 Area Groundwater OUs in Relation to Other Hanford Site Groundwater OUs**

## 1.2 Document Organization

This document is organized as follows:

- Chapter 1: Provides overarching modeling objectives.
- Chapter 2: Discusses the conceptual site models for the various OUs in the 100 Area. The discussion is presented in the context of features, events, and processes (FEPs). The nature and extent of contamination for individual OUs is also presented.
- Chapter 3: Discusses implementation of the OU-specific conceptual site models, the computer codes used, and the parameterization to construct the 100AGWM.
- Chapter 4: Discusses the 100AGWM flow model calibration.
- Chapter 5: Discusses the principal elements of the contaminant transport modeling methods employed with the 100AGWM.
- Chapter 6: Provides an overview of the 100AGWM assumptions and limitations.
- Chapter 7: Reviews aspects of model configuration management for the 100AGWM.
- Chapter 8: Lists the references cited in this report.

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# 2 Site Conceptual Model

## 2.1 FEPs

Conceptual models are evolving hypotheses that identify the important FEPs controlling fluid flow and contaminant transport at a specific field site and in the context of a specific problem. The conceptual model description provided in the report consists of a concise characterization of the following:

- Features: Such as site hydrogeology and media heterogeneity, as described by spatial variability of the physical properties, focusing particular attention on the hydrogeology of each OU.
- Events: Such as patterns and rates of natural and anthropogenic recharge.
- Processes: Such as stream/aquifer interaction and the groundwater response to fluctuations in the adjacent Columbia River, and to the currently operating P&T remedies.

The following subsections provide a brief description of the FEPs considered in the development of the 100AGWM.

## 2.2 Features

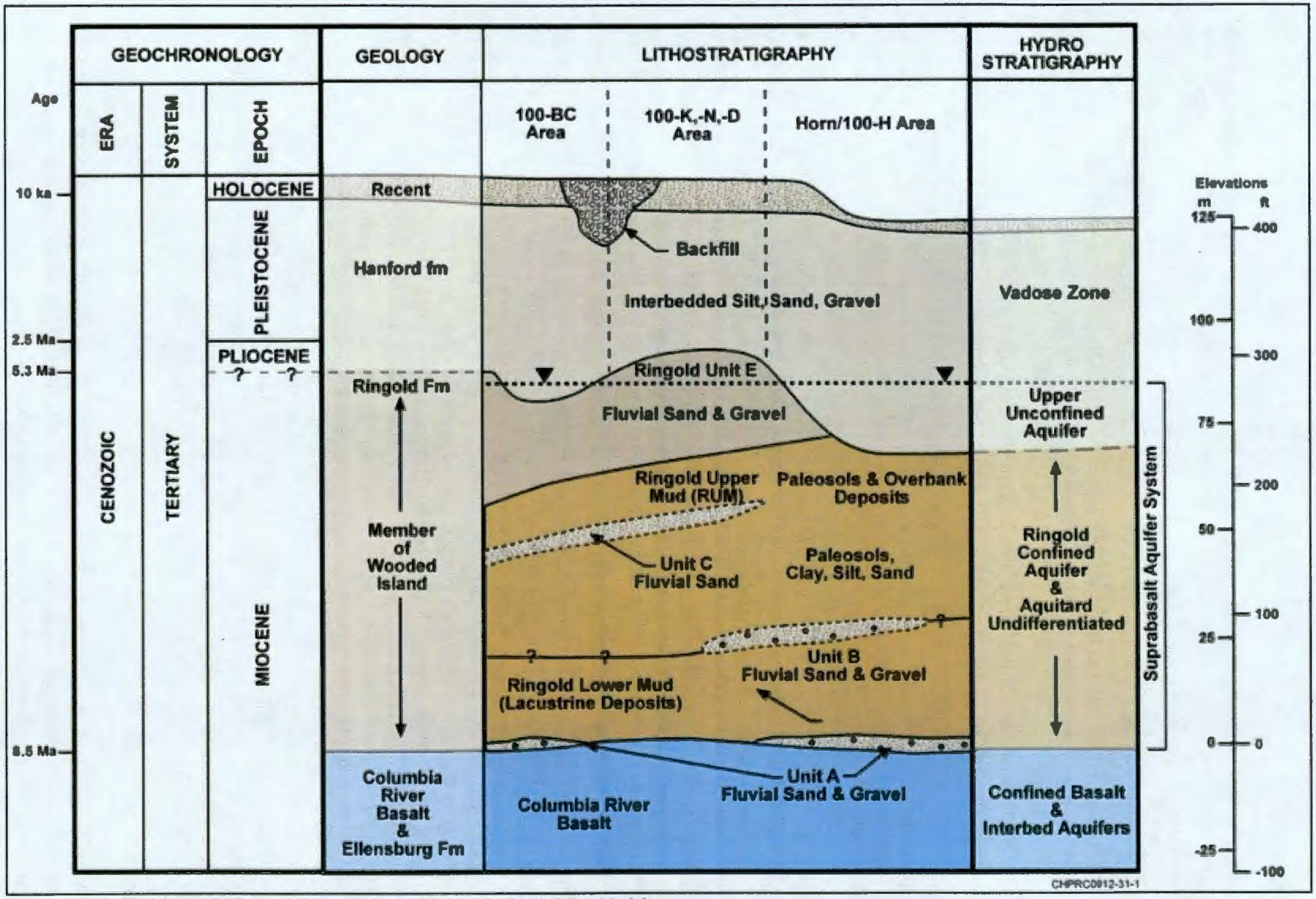
The generalized geology beneath the 100 Areas (Figure 2-1) comprises the Hanford formation, Ringold Formation, Columbia River Basalt Group, and the Columbia River Basalt Group sedimentary interbeds (Ellensburg Formation) (WHC-SD-EN-TI-132, *Geologic Setting of the 100-HR-3 Operable Unit, Hanford Site, South-Central Washington*; DOE/RL-93-43, *Limited Field Investigation Report for the 100-HR-3 Operable Unit*). The following descriptions are paraphrased from DOE/RL-2008-42, *Hydrogeological Summary Report for the 600 Area Between 100-D and 100-H for the 100-HR-3 Groundwater Operable Unit*. Figure 2-2 presents a schematic cross-section illustrating the regional character of the hydrogeology across the 100 Areas.

The uppermost-unconfined aquifer is contained within Ringold Formation and/or Hanford formation sediment and ranges in thickness from approximately 6 to 30 m (16.5 to 98 ft). Regionally, groundwater flows from areas of higher elevation upgradient (south) of the boundaries of the OUs near Gable Mountain and Gable Butte in a northerly direction, discharging to the Columbia River. The base of the unconfined aquifer is defined by the surface of the low-permeability Ringold Upper Mud (RUM), which underlies Ringold Unit E to the west (100-B/C to 100-D Area) and Hanford formation sediment to the east (100-H and 100-F Areas) (Figures 2-1 and 2-2). In addition, there are transitional intervals of reworked Ringold (between the Hanford and Ringold E) and Reworked RUM (primarily found between Ringold E and the RUM), identified in various areas across the River Corridor.

The geologic units that comprise the uppermost-unconfined aquifer (Figures 2-1 and 2-2) contain the bulk of the contaminants migrating beneath the 100 Area OUs. The description for geologic units begins with the youngest units at the surface that are within the overlying vadose zone, progressing into the older units, and then to the lower confining unit at the base of the unconfined aquifer. Additional information on the geology and its incorporation in the 100AGWM is presented in Section 3.4.2.

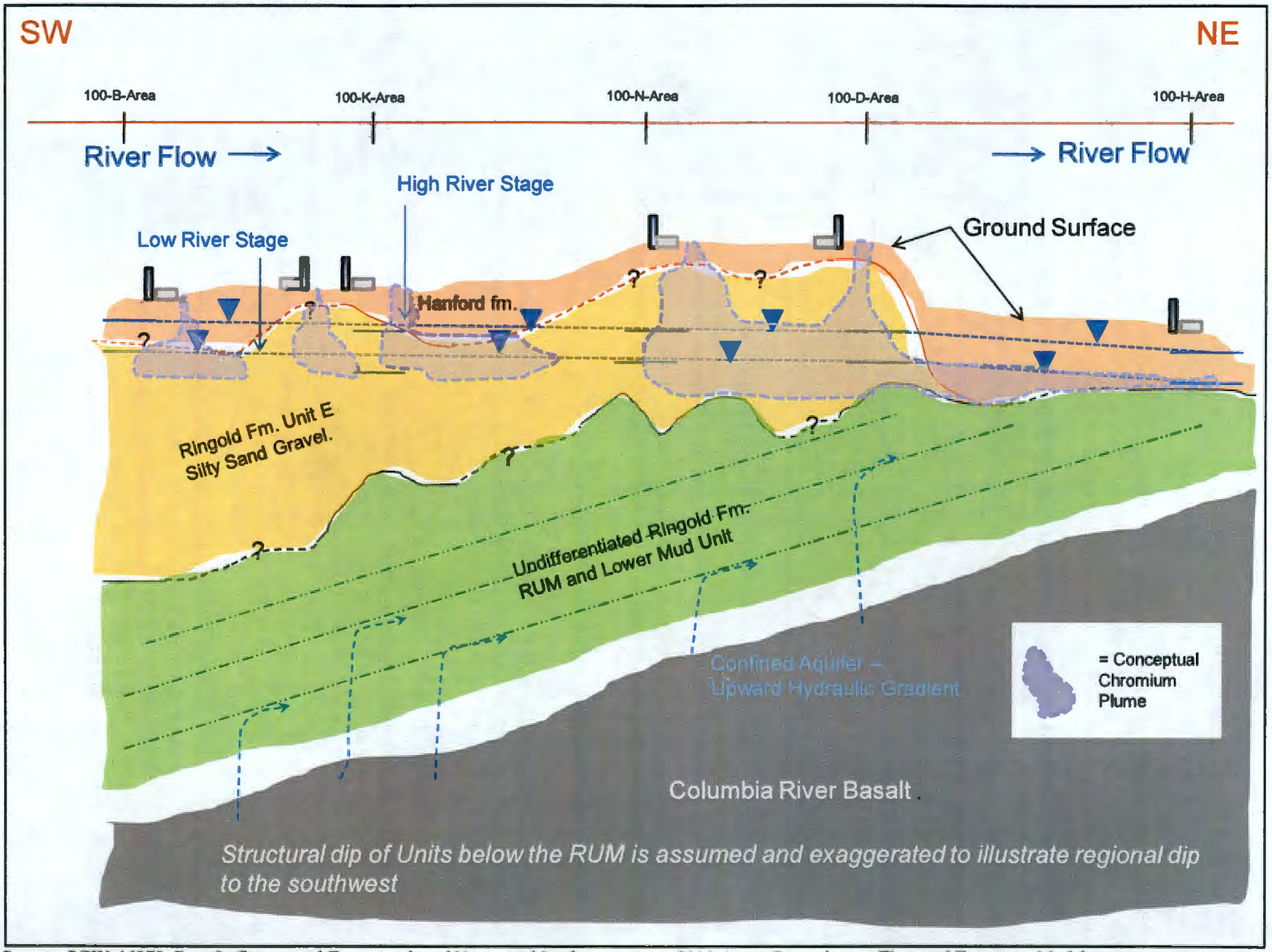
## 2.3 Events

Both natural and anthropogenic recharge events are summarized in the following subsections. The discussion of natural recharge is common to the entire 100 Areas whereas anthropogenic recharge considered in the development of the 100AGWM is reactor area-specific.




Source: SGW-44022, *Geohydrologic Data Package in Support of 100-BC-5 Modeling.*

**Figure 2-1. Generalized 100 Areas Hydrogeology**




Source: SGW-46279, Rev. 0, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model.*

**Figure 2-2. Schematic Hydrogeologic Conceptualization Along the Columbia River Reach**

### 2.3.1 Natural Recharge

The long-term, natural driving force for flow and transport through the vadose zone is precipitation that has infiltrated below the zone of evaporation and below the influence of plant roots. Such water eventually flows to the water table, carrying with it any dissolved contaminants. The actual fraction of precipitation that ultimately recharges the groundwater depends on the soil type and vegetation.

The estimated natural recharge for the soil type and the vegetation scenario prevalent in the 100 Areas is provided in PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*. Table 2-1 summarizes the estimated recharge rates for each soil type and area.

**Table 2-1. Estimated Natural Recharge Rates for the 100 Areas**

| Soil Type (Area) | Estimated Recharge Rate (mm/yr) | | | |
|---|---|---|---|---|
| | No Vegetation | Cheatgrass | Young Shrub-Steppe | Shrub-Steppe |
| Ephrata sandy loam (100-B/C) | 17 | 8.5 | 3.0 | 1.5 |
| Burbank loamy sand (100-B/C) | 53 | 26.5 | 6.0 | 3.0 |
| Ephrata sandy loam (100-K) | 17 | 8.5 | 3.0 | 1.5 |
| Ephrata sandy loam (100-D) | 17 | 8.5 | 3.0 | 1.5 |
| Ephrata stony loam (100-D) | 17 | 8.5 | 3.0 | 1.5 |
| Burbank loamy sand (100-H) | 53 | 26.0 | 6.0 | 3.0 |

Source: PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments.*

mm/yr = millimeters per year

Based on these recharge rates, a spatial distribution of natural recharge to the unconfined aquifer was developed by Pacific Northwest National Laboratories (PNNL) and was included in PNNL-14753, *Groundwater Data Package for Hanford Assessments.*

### 2.3.2 Anthropogenic Recharge

Raw water is used in large quantities (millions of gallons per day) at the Hanford Site for process water, fire control, dust suppression, and other non-potable uses. Water is pumped from the Columbia River to large-capacity reservoirs located in the 100 Areas using the export water system. These reservoirs supply a network of large-diameter (101 cm [3.5 ft]) pipelines to smaller pipelines traversing the 100 Areas and connecting to moderately sized distribution reservoirs located on the Central Plateau. A key component of this system is the 182-B reservoir capable of storing nearly 25 million gallons of water (DOE/RL-2001-16, *Historic American Engineering Record B Reactor (105-B Building) HAER No. WA-164*). It is the primary reservoir between the two remaining structures on the Hanford Site used to store large quantities of untreated water. The other reservoir (182-D) used for this purpose is located in the 100-D Area and is used as the backup facility (DOE/RL-2008-46-ADD3, *Integrated 100 Area Remedial Investigation Study/Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*). Leaks from these reservoirs provide additional recharge to the aquifer underneath.

## 2.4 Processes

### 2.4.1 River-Aquifer Interaction

Near the Columbia River, the groundwater flow system is influenced by the river in a mixing zone of groundwater and river interaction. The principal features and terminology associated with the zone of interaction are illustrated in Figure 2-3.

Physical, chemical, and biological processes occur within the zone of interaction that can potentially alter the characteristics of the approaching groundwater (PNNL-13674, *Zone of Interaction Between Hanford Site Groundwater and Adjacent Columbia River: Progress Report for the Groundwater/River Interface Task, Science and Technology Groundwater/Vadose Zone Integration Project*). Information to date suggests that physical processes are the dominant influence on contaminant concentrations and fluxes at locations of discharge into the free-flowing stream of the Columbia River. Physical processes include layering and mixing of groundwater and river water, which infiltrates the banks and riverbed sediments; and, varying hydraulic gradients caused by river stage fluctuations, controlled by daily releases of water at the Priest Rapids Dam located upstream of the Hanford Site. The hydraulic gradient is greatly increased near the river during periods of low flow. As the river stage increases, the gradient becomes less and reverses direction in response to the highest stages that occur. Chemical processes may change the characteristics of a contaminant in groundwater so it becomes less mobile (e.g., adsorbs to sediment or precipitates). Biological activity in the zone may immobilize or degrade them or it may introduce the contaminants to the food chain.

Discharge into the river environment occurs across two primary interfaces. The first is the region between the high and low river stages, generally corresponding with the riparian zone (Figure 2-3). Within this region, discharge from the zone of interaction appears as riverbank seepage during periods of low river stage. River water infiltrates the banks during periods of high river stage and forms either a layered system or a mixture during interaction with the approaching groundwater. As seepage continues to flow during the period of low river stage, the composition of the seepage may change from nearly pure river water to primarily groundwater (PNNL-13674).

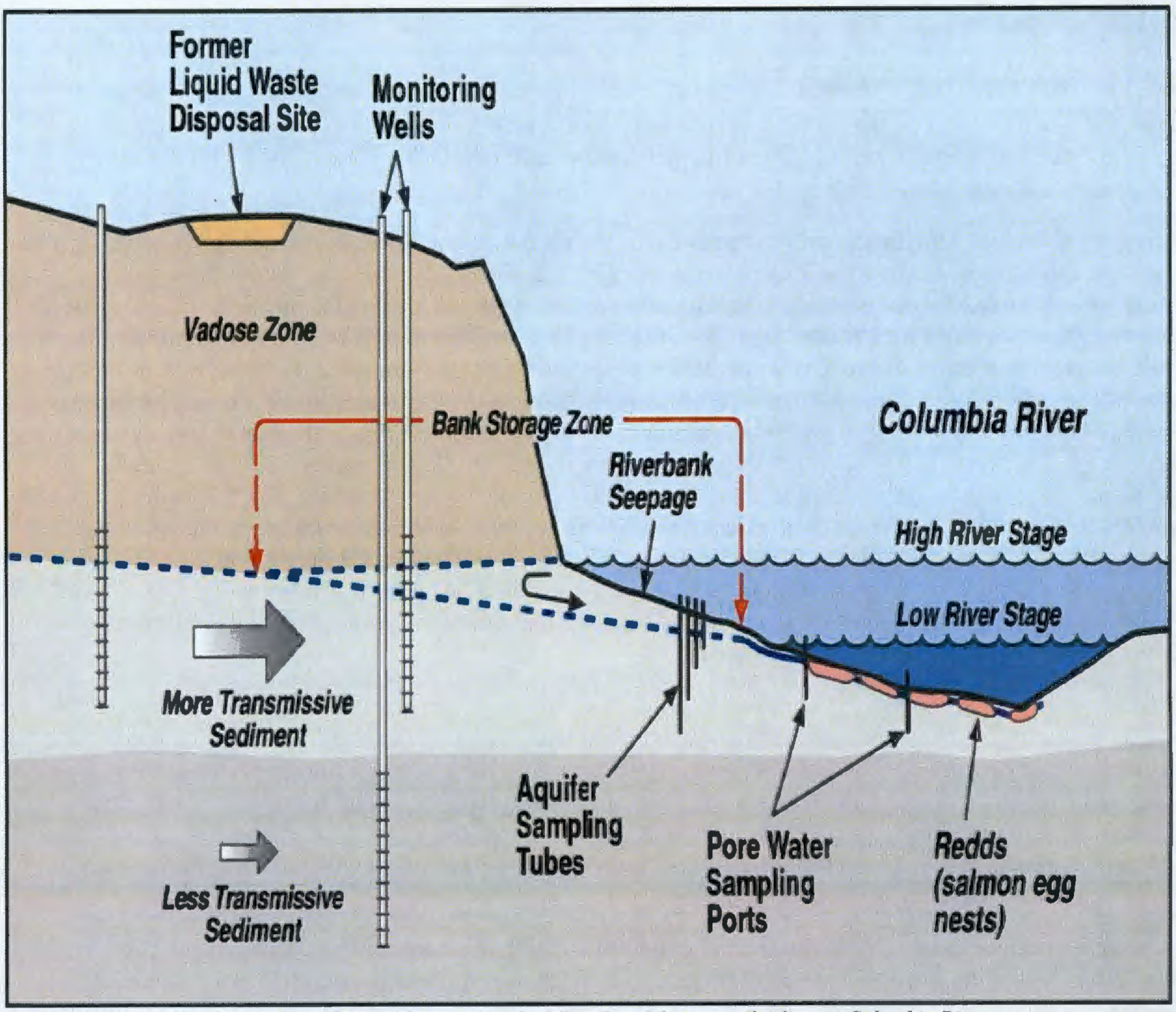
A second interface exists within the river channel substrate that is constantly submerged (i.e., at elevations below the lowest river stage) (Figure 2-3). This region contains sediment pore water that is influenced by the entrainment of Columbia River water and the gradual influx of groundwater upwelling from the underlying aquifer (PNNL-13674). The riverbed provides the spawning habitat for fall Chinook salmon.

### 2.4.2 Effect of Seasonal Fluctuations and P&T on Groundwater Conditions

As previously discussed, groundwater flow in the 100 Areas fluctuates in response to the river stage in the Columbia River, which is 2 to 3 m (6.6 to 9.8 ft) higher during high water level in the late spring and early summer versus the fall. As a result, the dynamics of groundwater flow near the river change seasonally. The aquifer response is most pronounced near the shoreline but extends inland of the shore.

Figure 2-3 illustrates the river/aquifer interaction in the 100-D Area (PNNL-13674). A comparison of fall and spring groundwater levels (Figure 2-3) suggests that the rise in the river stage due to the spring runoff causes changes in groundwater levels up to several hundred meters inland in the aquifer that attenuate further inland. However, most of the large-scale changes and actual reversals in flow direction are within several tens of meters of the Columbia River.

During low river stage in the fall and winter, groundwater flow is toward the river, whereas during high river stage in the spring and summer, flow is locally from the river inland. These observations suggest that the Columbia River is primarily a gaining reach during times of low flow and may temporarily become a losing reach during times of high flow.




Source: PNNL-13674, *Zone of Interaction Between Hanford Site Groundwater and Adjacent Columbia River.*

**Figure 2-3. Schematic of Principal Features and Monitoring Within the River/Aquifer/Vadose Zone**

Groundwater levels, hydraulic gradients, and the rates and directions of groundwater flow are also affected by extraction and re-injection as part of ongoing groundwater P&T remediation within the 100-HR-3 and 100-KR-4 areas. The effect of this extraction and re-injection is most evident in proximity to the extraction and injection wells and diminishes with increasing distance from those wells. However, the combined extraction and re-injection rates of these systems is such that they do affect water levels, gradients, and flow directions and rates for distances of up to several hundred meters away from some of the larger pumping centers. This is by design, as it is the intent of the P&T remedies to alter flow directions and rates in order to recover contaminated groundwater that extends over large areas in 100-HR-3 and 100-KR-4.

# 3 Model Implementation

## 3.1 Background

Local scale groundwater flow models have been used at the 100-KR-4 and 100-HR 3 Areas (DOE/RL-96-84, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*) to support design of P&T interim remedies and to evaluate the performance of the P&T systems. These groundwater flow models were constructed to simulate patterns of groundwater flow and other hydraulic features local to each OU and, as such, the domains of these models were of limited spatial extent. As modeling needs increased over time, efforts were undertaken to develop a groundwater model that unified the simulations for all 100 Area groundwater OUs. The 100AGWM was originally developed to simulate groundwater flow and the purely advective (i.e., non-dispersive and non-reactive) movement of water and contaminants in order to estimate the likely extent of hydraulic containment and ultimately "capture" developed by groundwater P&T remedies. The expansion of the model domain over time to encompass the 100 Area OUs occurred in several phases, as described in the following subsection.

### 3.1.1 Versions of the 100AGWM

First, because the size and influence of the 100 Area groundwater P&T remedies at 100-KR-4 and 100-HR-3 increased over time, a single, two-dimensional (2D) groundwater flow model was developed that encompassed the 100-KR-4, 100-NR-2, and 100-HR-3 Areas (DOE/RL-2006-75, *Supplement to the 100-HR-3 and 100-KR-4 Remedial Design Report and Remedial Action Workplan for the expansion of the 100-KR-4 Pump and Treat System*).

Second, P&T remedial process optimization (RPO) efforts led by the CH2M HILL Plateau Remediation Company (CHPRC) during Calendar Years 2008 and 2009 in 100-HR-3 and 100-KR-4 required contaminant transport simulations to develop projections of Cr(VI) distributions and evaluate plume migration patterns and attainment of river protection and aquifer cleanup goals. For that purpose, the 2D groundwater flow model was coupled with a contaminant transport model (SGW-46279, Rev. 0, *Conceptual Framework and Numerical Implementation of the 100 Areas Groundwater Flow and Transport Model*). The results of these RPO modeling efforts in 100-HR-3 are described in SGW-40044, *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum*. The strategy developed for making final decisions to complete cleanup along the River Corridor is described in DOE/RL-2008-46. A series of addenda to the work plan outlined the goals and strategy data collection and analyses for each 100 Area OU to develop the RI/FS studies.

Third, as data became available indicating that a three-dimensional (3D) model would be more suitable for representing the partial penetration of many pumped and monitoring wells, and vertical differences in contaminant distribution, the 2D (i.e., single layer) model was expanded to 3D, comprising four model layers. To meet the RI/FS needs for each 100 Area OU, this 3D groundwater model was expanded to include 100-B/C and 100-F (encompassing all 100 Area OUs). Thus, the model simulates groundwater flow as 3D to explicitly represent the saturated zone in the Hanford formation and Ringold Unit E Formation that comprise the unconfined aquifer across the 100 Areas. In addition, the model simulated contaminant transport in the unconfined aquifer, to support projections of fate and transport of several COCs and evaluations of alternative remedial designs as part of the RI/FS effort in River Corridor OUs. A detailed description of the resulting 100AGWM is provided in SGW-46279, Rev. 2, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*.

The fourth and fifth versions were developed by extending the model domain to the west of the 100-B/C area (to better represent groundwater flow dynamics in that region) and by providing parameter updates to improve the simulation of flow conditions in the 100-B/C and 100-F OUs. Additionally, they support the RI/FS evaluations of COC fate and transport in those OUs. The models used in these simulations are described in ECF-100BC5-11-0115, *Modeling of RI/FS Design Alternatives for 100-BC-5*, and ECF-100FR3-11-0116, *Modeling of RI/FS Design Alternatives for 100-FR-3*, respectively.

The 3D groundwater model has recently been further updated to incorporate revised geologic interpretations across the River Corridor, including delineations of transitional geologic zones as part of a revised geological framework for the 100 Areas and a detailed representation of the land surface topography based on data collected using remote sensing technology. The updates include aquifer property data based on refined interpretations of recent aquifer tests, existing well development data, and a more detailed representation of the aquifer interaction with the Columbia River, based on detailed river bathymetry data.

### 3.1.2 The Pumping Optimization Model

In recognition that the 3D 100AGWM can require lengthy run times to test alternative pumping configurations to optimize remediation and mass recovery, a 2D version of the model was created based on the 3D version, explicitly to support pumping optimization. This model is called the 100 Area Pumping Optimization Model (POM). The POM was initially used to support DOE/RL-2015-05, *Calendar Year 2014 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation.* A Plume Visualization Tool will be used principally to evaluate the relative performance of alternative well configurations. A description of the development of the POM, including calculation of equivalent parameterization from the 3D model, as well as comparison to the 3D model simulations and verification of model results, are presented in detail in Appendix G.

## 3.2 Software

The groundwater flow model is constructed using the U.S. Geological Survey (USGS) 3D modular groundwater flow model, MODFLOW (McDonald and Harbaugh, 1988, "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model;" Harbaugh and McDonald, 1996, *User's Documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model*; Harbaugh et al., 2000, *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model—User Guide to Modularization Concepts and the Ground-Water Flow Process*; Harbaugh, 2005, *MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model—the Ground-Water Flow Process*).

The MODFLOW code was selected because it has the necessary simulation capabilities, is relatively simple to use, and can be executed on a variety of computers and operating systems without modification. MODFLOW simulates groundwater flow using the block-centered, finite-difference approach (McDonald and Harbaugh, 1988). The finite-difference approach can simulate 2D groundwater flow using a single layer to represent the aquifer, or 3D groundwater flow using a series of model layers that may represent individual aquifers or aquitards or that may be used to provide vertical discretization detail within thick aquifers or aquitards. Layers can be simulated as unconfined (e.g., water table aquifers), confined, or as convertible between unconfined and confined conditions.

The following programs were used in addition to MODFLOW:

- **Contaminant transport:** MT3DMS Version 5.3 (Zheng, 2010, *MT3DMS v5.3: Supplemental User's Guide*). The second generation of the modular, 3D transport model MT3D, which is distributed with an expanded range of transport simulation capabilities, was used to simulate contaminant plume migration throughout the 100AGWM, simulate the effects of the operation of extraction and injection wells, and provide a basis for comparative remedy analyses in each OU as part of the RPO and RI/FS processes.

- **Calibration:** PEST (Doherty, 2010, *PEST Model-Independent Parameter Estimation User Manual: 5th Edition*) is a software package for model calibration, parameter estimation, and predictive uncertainty analysis that was used to assist in the groundwater flow model calibration. PEST Version 13 was used in this work.

- **GeoData Visualization:** ArcGIS (ESRI ArcMap 9.3), Surfer 12, and LeapFrog (Version 2.1, 64 bit) were used to visualize the spatial information included in the model.

### 3.2.1 Approved Software

The following software was used to perform calculations and was approved and compliant with PRC-PRO-IRM-309, *Controlled Software Management*. These softwares are managed under the following documents consistent with PRC-PRO-IRM-309:

- 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*

CHPRC-00258 distinguishes between safety software and support software based on whether the software managed calculates reportable results or provides run support, visualization, or other similar functions. Following are brief descriptions of the software.

### 3.2.2 Descriptions

#### *3.2.2.1 MODFLOW (Controlled Calculation Software)*

- **Software Title:** MODFLOW-2000 (Harbaugh et al., 2000); solves transient groundwater flow equations using the finite-difference discretization technique.

- **Software Version:** Version 1.19.01 modified by S.S. Papadopulos and Associates, Inc. (SSP&A) to address dry cell issues and to use the ORTHOMIN solver; approved as CHPRC Build 7 using the executable "mf2k-mst-chprc07dpv.exe" compiled to default double precision for real variables and optimized for speed. The MD5 Hash for this executable file is "4E7F29DD5496D2CBA7144ADACB13DAAD".

- **Hanford Information Systems Inventory (HISI) Identification Number:** 2517 (Safety Software, graded Level C).

  - Workstation type and property number (from which software is run): S.S. Papadopulos and Assoc, Inc., FE483.

#### *3.2.2.2 MT3DMS (Controlled Calculation Software)*

- **Software Title:** MT3DMS (Zheng and Wang, 1999, *MT3DMS: A Modular Three-dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*; Zheng, 2010)

- **Software Version:** Version 5.3 modified by SSP&A to address dry cell issues; approved as CHPRC Build 7 using the executable "mt3d-mst-chprc07dpv.exe" compiled to default double precision for real variables and optimized for speed. The MD5 Hash for this executable file is "A09EDC957F6B19A8CD3968EA901355CB"

- **HISI Identification Number:** 2518 (Safety Software, graded Level C)
  - Workstation type and property number (from which software is run): S.S. Papadopulos and Assoc, Inc., FE483.

### 3.2.3 Support Software

Support software and single-purpose software was used to manage and develop datasets to be used by the model as well as pre- and post-process model input/output files. Table 3-1 provides a list and description of the support software used for these purposes. Software with a trademark designation is commercial software. Software listed without a trademark has been developed internally and the resulting calculation products were approved through quality assurance and technical review. Electronic copies of all utilities are included in the 100AGWM archive in the *Environmental Model Management Archive* (EMMA), the model configuration management system required under CHPRC-00805, *Quality Assurance Project Plan for Modeling*.

Several python (https://www.python.org ) scripts were used to create model input files and post-process output files. All the scripts were executed with the freeware Anaconda Python distribution. Python Version *2.7.7*, *Anaconda 2.0.1 (64 bit)* was used in this work, with the software downloaded from the following location: https://store.continuum.io/cshop/anaconda.

**Table 3-1. Support Software**

| Purpose | Support Software | Description |
|---|---|---|
| MODFLOW Input/Output | MODFLOWUtils.py | Script to read and write MODFLOW inputs/outputs |
| DIS Package | calcelevs.exe | Calculation of model layer elevations from geological surfaces |
| LPF Package | *CreateZones3.py* | Script to create the hydraulic conductivity zones |
| | *ProcessHYWells.py* | Script to calculate the saturated well screen thicknesses and model layer elevations at well locations |
| | *Generate_CalcTinput.py* | Generate input files, template files and instruction files for PEST to estimate unit-wise HCOND |
| | *PEST* | Estimate unit-wise layer HCOND |
| | *CalcT.py* | Program called by PEST to calculate T at each location |
| | *CreateFieldgenInputFiles.py* | Create input files for Fieldgen based on PEST Estimates |
| | *Fieldgensrc.exe* | Hydraulic conductivity field generator to create hydraulic conductivity fields for each aquifer unit based on zonation, conditioning points and variograms |
| | *CreateHYFields.py* | Script to combine the hydraulic conductivity fields generated by FieldGensrc.exe |
| RIV Package | *ProcRiverStage_v9.py* | Script to generate first-cut MODFLOW RIV Package |
| | *FinalGapFill.py* | Script to generate the final MODFLOW RIV Package |
| MNW2 Package | *Allocateqwell.exe* | Development of MODFLOW MNW2 Package by processing well screen information and pumping data. |
| CHD Package | *Create_CHD_V6.exe* | Program to create the MODFLOW CHD Package |

**Table 3-1. Support Software**

| Purpose | Support Software | Description |
|---|---|---|
| GHB Package | *CalcRiverBasedGHB.exe* | Program to create the MODFLOW GHB Package using river stage data and interpolated aquifer hydraulic head data at the southeastern boundary. |
| | *checkghb.py* | Script checks GHB elevations against model layer elevations |
| General Use | Surfer(Version 12.5)™[3] | Data interpolation for visualization and model quality-assurance purposes. |
| General Use | *Groundwater Vistas (Version 6.65, Build 22)*™[4] | Data interpolation for visualization and model quality-assurance purposes. |
| General Use | *ArcGIS(Version 9.3)*™[5] | Data interpolation for visualization and model quality-assurance purposes. |
| Post-Processing Utilities | *readdble_writesngl.exe* | Convert double precision binary output files into single precision |
| | *Makehds.exe* | Append the model-calculated hydraulic head distribution at the end of the first stress period to the HDS MODFLOW output file. |
| | *Headtargs_s.exe* | Retrieve and interpolate simulated hydraulic heads at monitoring well locations and corresponding screened intervals, allowing for dry model cells. |
| | *CalcGradients.exe* | Calculate magnitude and direction of three-point hydraulic gradients. |
| | *CalculateMNW2.py* | Calculates simulated pumping rates at each multi-node pumping well and reports actual and simulated pumping rates by well and by treatment system |
| | *Plot_Obs_Vs_Sim.py* | Plot the observed and simulated water levels at each monitoring well |
| | *Shapefile.py* | Reads ESRI shapefiles |
| | *PrepGradients.py* | Prepares files for three-point gradient calculation |
| | *PlotGradients.py* | Plots simulated and observed three-point gradients |

Electronic copies of modeling software, model input/output files, input data, and pre-/post-processing utilities and other support software mentioned throughout this report are archived in EMMA.

### 3.2.4 Software Installation and Checkout

Safety Software (CHPRC Build 0007 of MODFLOW-2000-SSPA) is checked out in accordance with procedures specified in CHPRC-00258. Executables are obtained from the CHPRC software owner who maintains the configuration-managed copies in MKS Integrity™, installation tests identified in CHPRC-00259 are performed and successful installation confirmed, and Software Installation and Checkout Forms are required and must be approved for installations used to perform model runs.

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[3] Surfer is a trademark of Golden Software, Golden, Colorado.

[4] Groundwater Vistas (Rumbaugh and Rumbaugh, 2015) is a trademark of Environmental Simulations, Inc., Reinholds, Pennsylvania.

[5] ArcGIS is a trademark of ESRI, Inc., Redlands, California.

Approved Users are registered in HISI for safety software. A copy of the *Software Installation and Checkout* Form is provided in Appendix H.

### 3.2.5 Statement of Valid Software Application

- The software identified above was used consistent with intended use for CHPRC as identified in CHPRC-00257 and is a valid use of this software for the problem addressed in this application.
- The software was used within its limitations as identified in CHPRC-00257.
- Python has not been identified in CHPRC-00258 but is scheduled by the software owner to be included as support software in the next revision to that document. It is publically available, open-source freeware.

## 3.3 Model Domain

The 100AGWM groundwater model domain is shown in Figure 3-1. The 100 Areas are located within the portion of the Hanford Site between Gable Mountain and Gable Butte in the south and the Columbia River in the north and northeast. The domain is constricted by basalt sub-crops along the southern boundary. There are two gaps along the southern boundary between the basalt sub-crops—the Western Gap and the Gable Gap. Water generally flows through the gaps into the 100 Areas and discharges to the Columbia River. Low areal recharge contributes to the water budget across the model domain.

The conceptual model for the 100AGWM considers saturated porous flow through the unconfined aquifer, consisting of the Hanford formation and the Ringold E Formation, overlying the RUM where present and the top of the basalt where the RUM is absent. The unconfined aquifer also includes transitional zones between those units, as discussed in ECF-Hanford-13-0020, *Process for Constructing a Three-dimensional Geologic Framework Model of the Hanford Site 100 Area*. These transitional zones are identified as Reworked Ringold E and Reworked RUM, corresponding to sequences of coarser, unconsolidated deposits than the underlying Ringold E Formation and the RUM, respectively. These transitional zones are characterized by aquifer property values that generally range between the corresponding over- and underlying units.

The base of the model is assumed the top of the RUM, where present and the top of the basalt where the RUM is absent, which typically occurs in the southern portions of the model approaching Gable Butte. Throughout much of the western half of the modeled area (including 100-K and 100-D), the water table lies within the Ringold Unit E sands, whereas toward the east and north of the modeled area (including 100-H and 100-F), the water table lies within the Hanford formation sands and gravels. Near 100-B/C, the water table fluctuates between the two formations. Water enters the system through areal recharge and from the Columbia River. Additionally, water from the Central Plateau enters the 100 Areas through the Western Gap and the Gable Gap. Water exits the system primarily by discharge to the Columbia River.

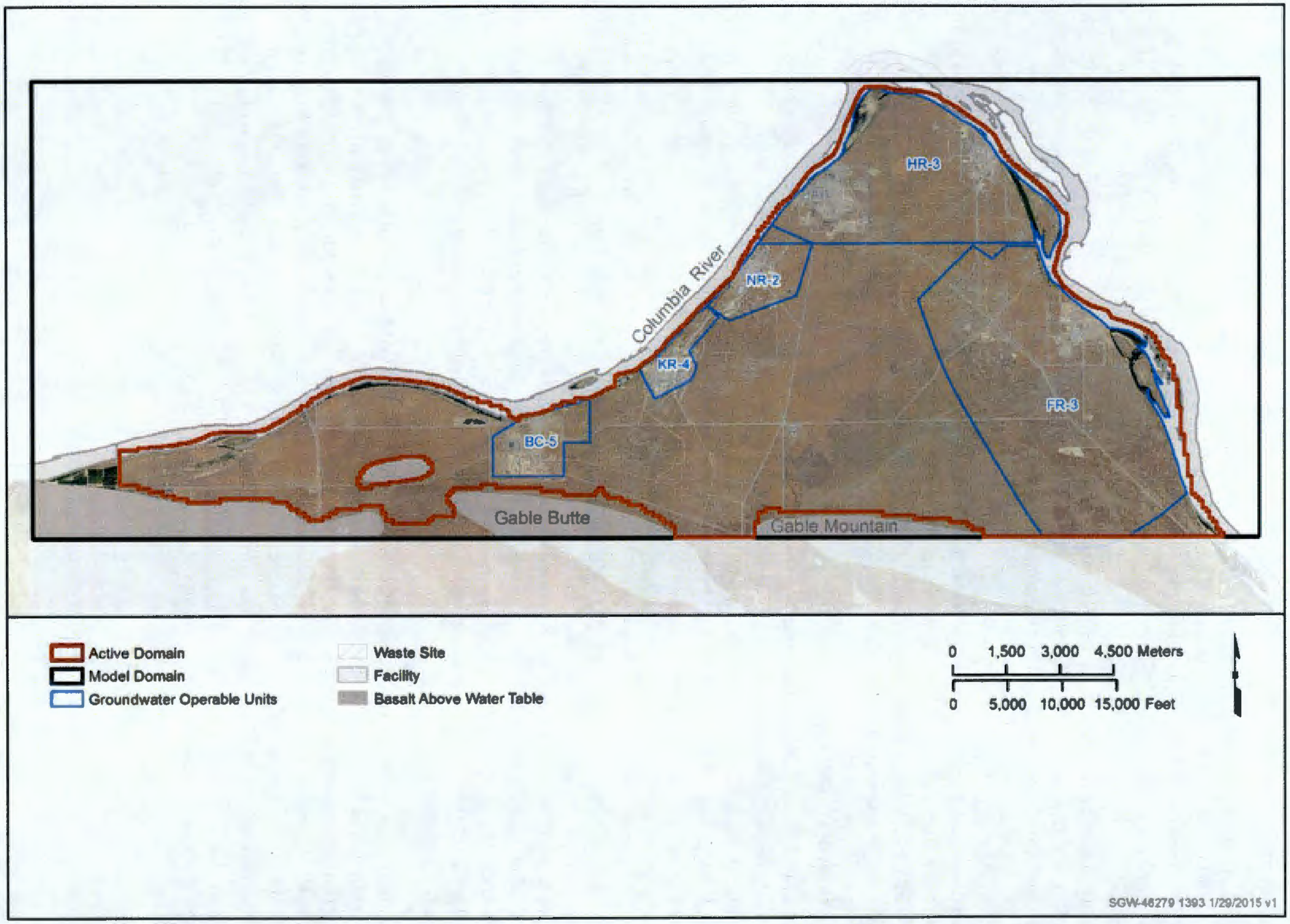



**Figure 3-1. Model Domain and Location of the 100 Area Groundwater OUs**

## 3.4 Spatial Discretization

### 3.4.1 Horizontal Discretization

Figure 3-1 illustrates the spatial extent of the 100AGWM and the locations of the 100-B/C, 100-K, 100-N, 100-D, 100-H, and 100-F Areas are shown. The 100-HR-3 OU encompasses the 100-D and 100-H Areas, which are treated as a single groundwater OU for the purposes of the remedy design. The model extends southward, toward Gable Butte and Gable Mountain. The model grid spacing is relatively coarse (100 m [328 ft]) throughout much of the model domain, but it is refined (15 m [49 ft]) in the area of the OUs in support of remedy evaluations. The model grid is shown in Figure 3-2. A detail of the model grid near 100-K is shown in Figure 3-3, illustrating the refinement in grid spacing in areas where detailed calculations of hydraulic head and contaminant transport are required.

The model domain has an approximate horizontal extent (rectangular region) of 12.8 km (8 mi) north-south and 34.3 km (21.3 mi) east-west. The lower left corner of the model domain is defined by the following coordinates in the Washington State Coordinate System:
(NAD_1983_StatePlane_Washington_South_FIPS_4602): Easting 551,225 m; Northing 141,970 m (NAD83, *North American Datum of 1983*).

### 3.4.2 Vertical Discretization

3D groundwater flow is simulated using four model layers. The model layers incorporate the geology reflected in recent delineations of the geologic units across the 100 Areas, as described in ECF-Hanford-13-0020, including, from top to bottom, the Hanford formation, Reworked Ringold E and Ringold E Formation, the Reworked RUM and the RUM, as well as the basalt bedrock. Appendix A includes a copy of ECF-Hanford-13-0020.

The source data for this geological model are available in the file *GeoContacts_100-Area_2013-12-19.xlsx*, maintained by Intera Inc. The method described in ECF-Hanford-13-0020 was used to construct a five-layer geological model (Personal Communication, Hammond, 2014). In addition to the Hanford, Ringold Unit E, and RUM formations, this method incorporated two additional units: Reworked Ringold E and Reworked RUM. The file *GeoContacts_100-Area_2014-04-07.New_Greenxlsx*, maintained by Intera Inc., contains the geologic contact data used in the development of the five-layer model. The methodology for mapping the geologic surfaces from the five-layer geologic to the four-layer groundwater model is explained in the subsequent paragraphs.

Interpolated surfaces for the top elevations of these units were derived from the 3D geologic framework developed in LeapFrog™, and extracted in mesh format for interpolation to the groundwater model grid (Personal Communication, Royer, 2014). The surfaces were mapped to the model grid using Groundwater Vistas™. Elevations of the Basalt surface, defining the lowermost boundary of the 100AGWM where the RUM is absent, were received from Intera, Inc. in an ASCII Grid format (filename "basalt ellensburg top_2010update m.ascii"). This dataset was converted into an ESRI shapefile and interpolated to the model grid. The interpolated surface was exported to a MODFLOW-compatible data array that allows the dataset to be easily processed with existing data processing utilities.

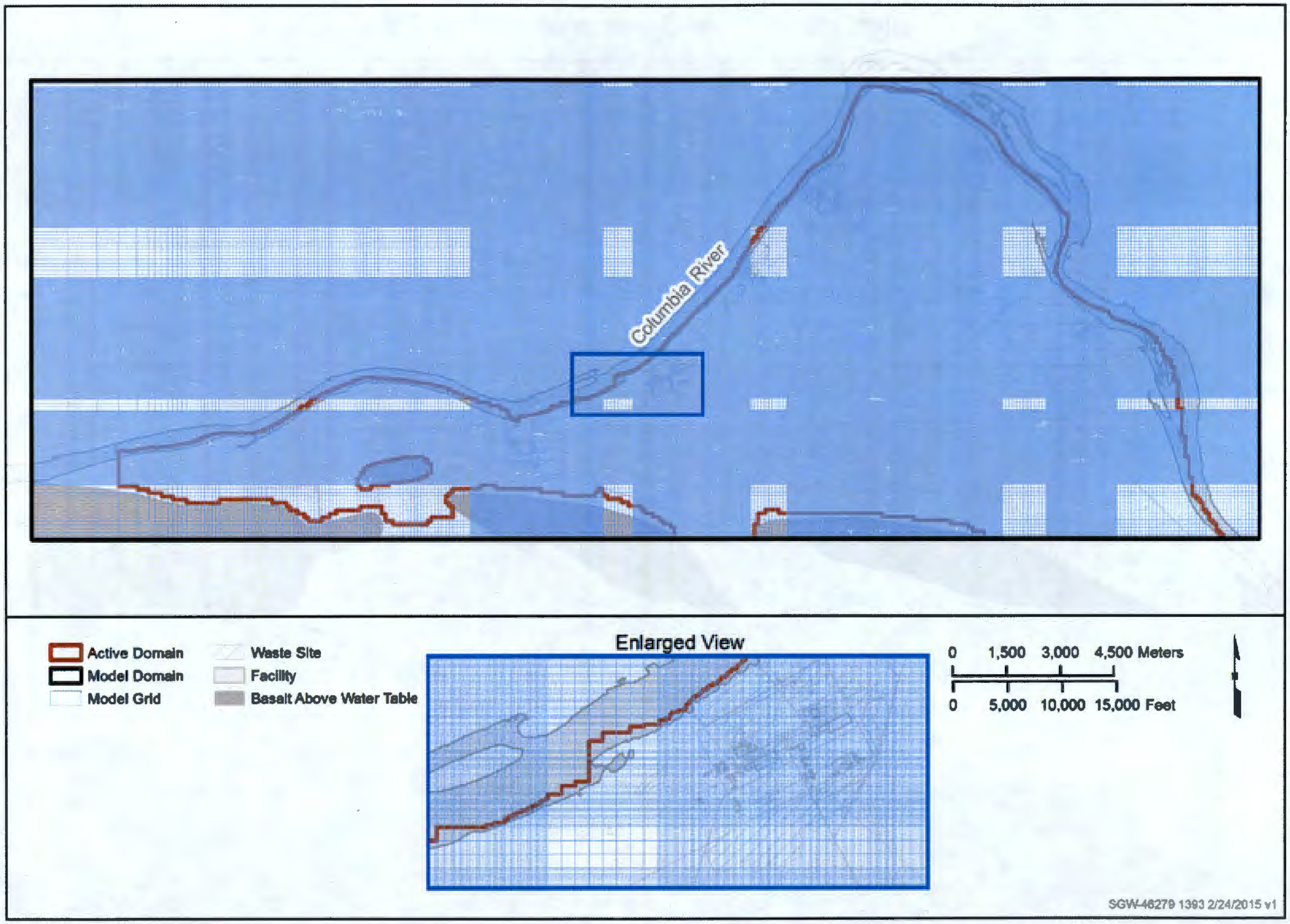



**Figure 3-2. 100AGWM Grid**

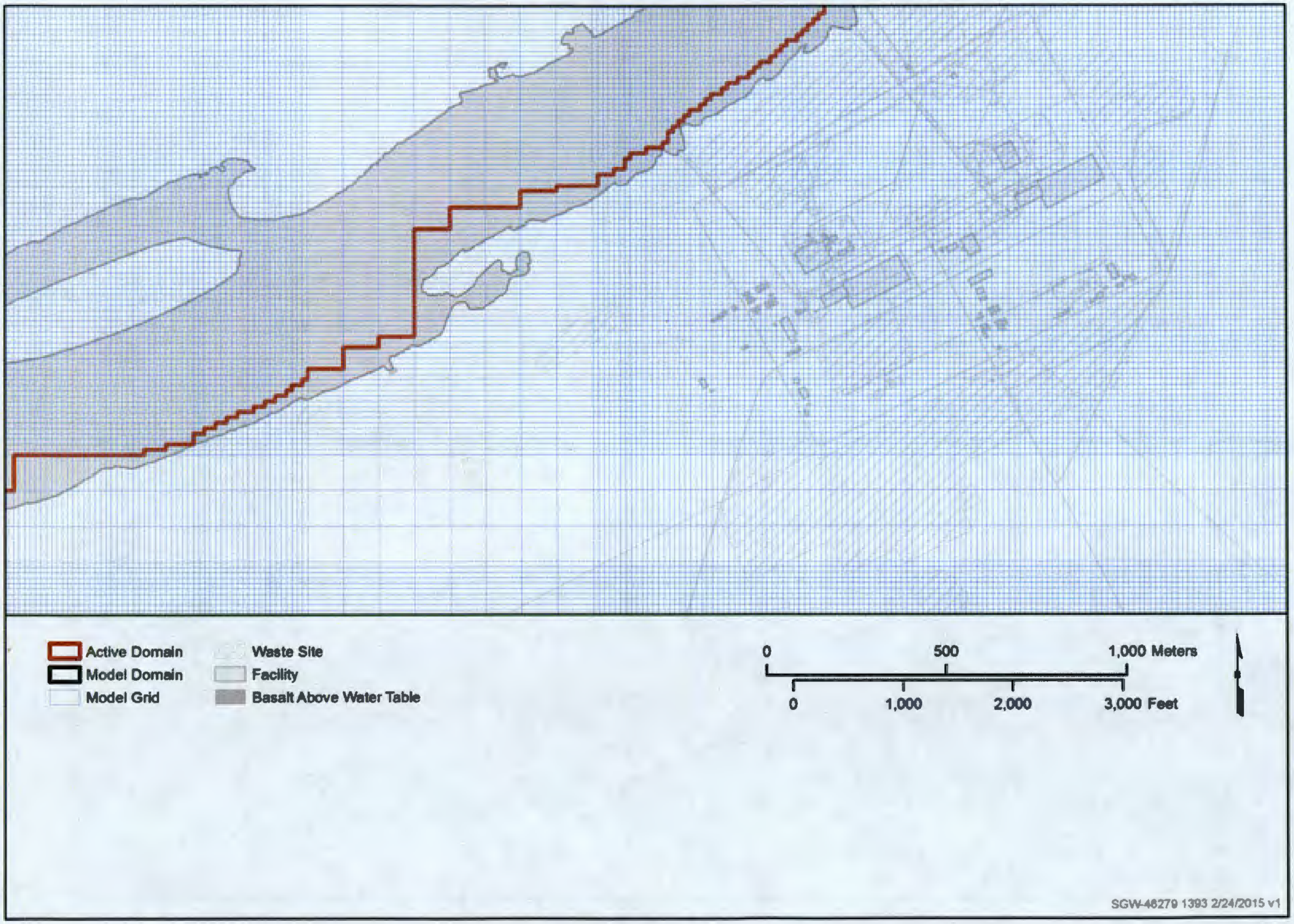



**Figure 3-3. 100AGWM Grid Refinement – Detail in 100-K**

The mapped surfaces for the top of the Hanford formation, Reworked Ringold E, Ringold E Formation, the Reworked RUM, the RUM, and the basalt are shown in Figures 3-4 through 3-9, respectively.

The top of the Hanford formation is set as the top elevation of the model (top of Layer 1). The model surface corresponding to the top of Layer 1 was developed using land surface topography based on light detection and ranging (LiDAR) elevation data for the 100 Areas south and west of the Columbia River; river bathymetry data for the 3D representation of the river geometry; and digital elevation model where LiDAR or bathymetry data were not available (ECF-Hanford-13-0020).

The base of the groundwater model is assumed the RUM or the basalt, where the RUM is absent. Typically, the basalt forms the model bottom in the southern portions of the model approaching Gable Butte.

An algorithm was developed to assign the appropriate geologic unit in each model cell based on the presence or absence of each geologic unit at the corresponding location. Based on this algorithm, in the presence of all geologic/aquifer units (i.e., Hanford formation, Reworked Ringold E and Ringold E Formation, and the Reworked RUM), model layers are configured as depicted schematically in Figure 3-10. When one or more geologic units are not present at a particular cell, vertical discretization follows the process of geologic unit assignment per model layer illustrated in Figures 3-11 through 3-17 for all combinations of geologic unit presence/absence.

In many instances, numerical interpolation in developing model layer elevations based on the geologic surfaces led to thin layers or layers with negative thicknesses. For that reason, minimum thickness constraints were developed. A nominal minimum aquifer thickness of 0.1 m (0.3 ft) was maintained at all times. Additionally, each individual model layer was required to be at least 0.025 m (0.08 ft) thick. If only the Hanford formation was present and the total aquifer thickness is at least 1.33 m (4.4 ft), the bottom three layers are each 0.333 m (1.1 ft) with a total thickness of 1 m (3.3 ft). If an underlying aquifer unit was found to have a higher elevation than an overlying unit, the underlying unit was lowered to satisfy minimum thickness constraints. The resulting calculated model layer elevations are shown in Figures 3-18 through 3-22.

All Layer 1 cells were assigned the properties of the Hanford formation with the exception of the cells that represent the Columbia River. The river cells in which the underlying aquifer units were higher than the Hanford formation were assigned the property of those underlying aquifer units.

## 3.5 Aquifer Properties

The development of aquifer property distributions for the groundwater model is described in the following subsections.

### 3.5.1 Hydraulic Conductivity

The principal aquifer property that is specified in the 100AGWM is the spatially varying hydraulic conductivity (HCOND). The horizontal HCOND distribution in the model was developed based on the following:

- Point estimates obtained from slug/aquifer pumping tests performed at various well locations, and data collected during well development
- Independent information on aquifer properties from prior modeling efforts and qualitative hydrostratigraphic interpretations

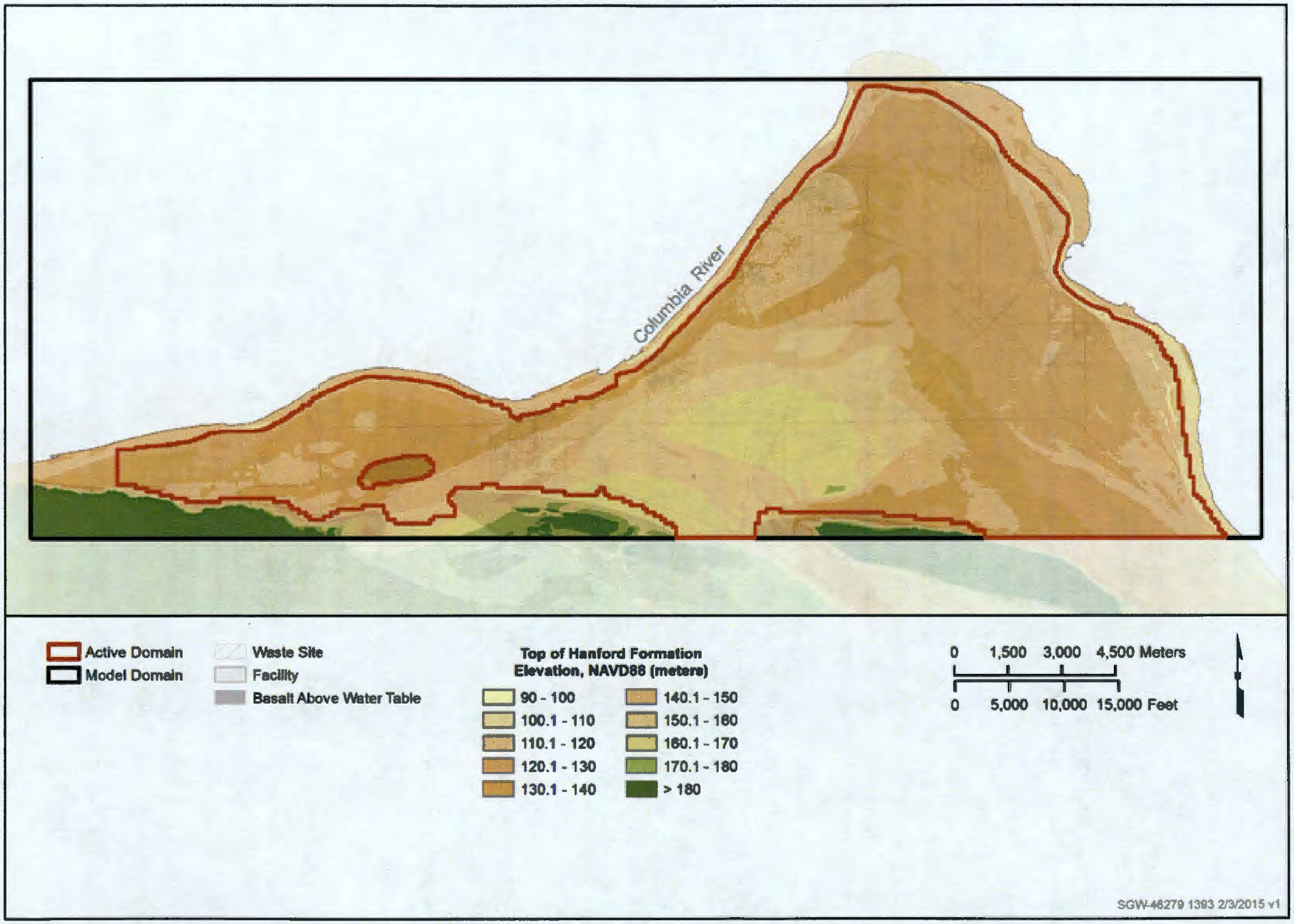



**Figure 3-4. Mapped Top of Hanford Elevations**

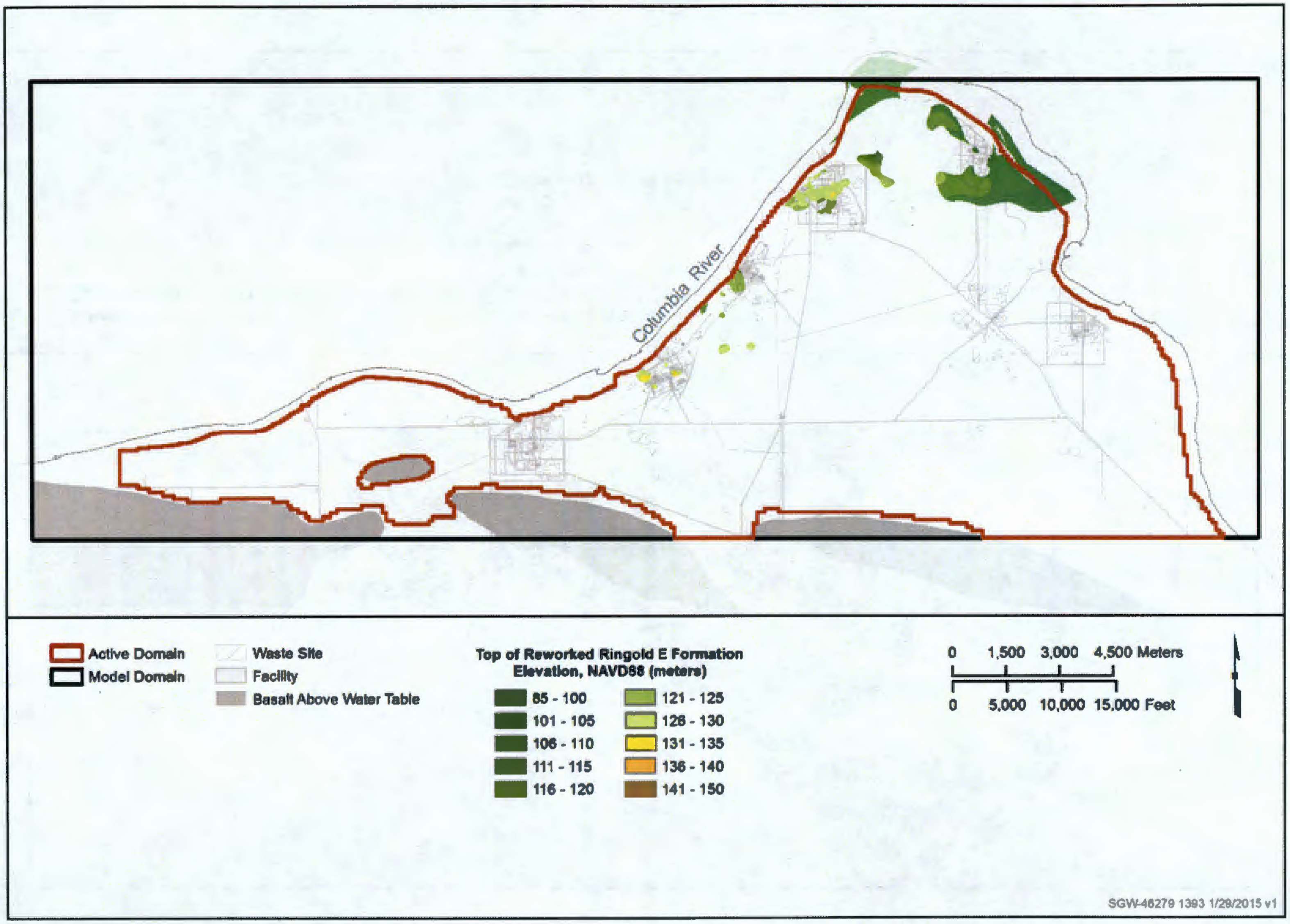



Figure 3-5. Mapped Top of Reworked Ringold E Elevations

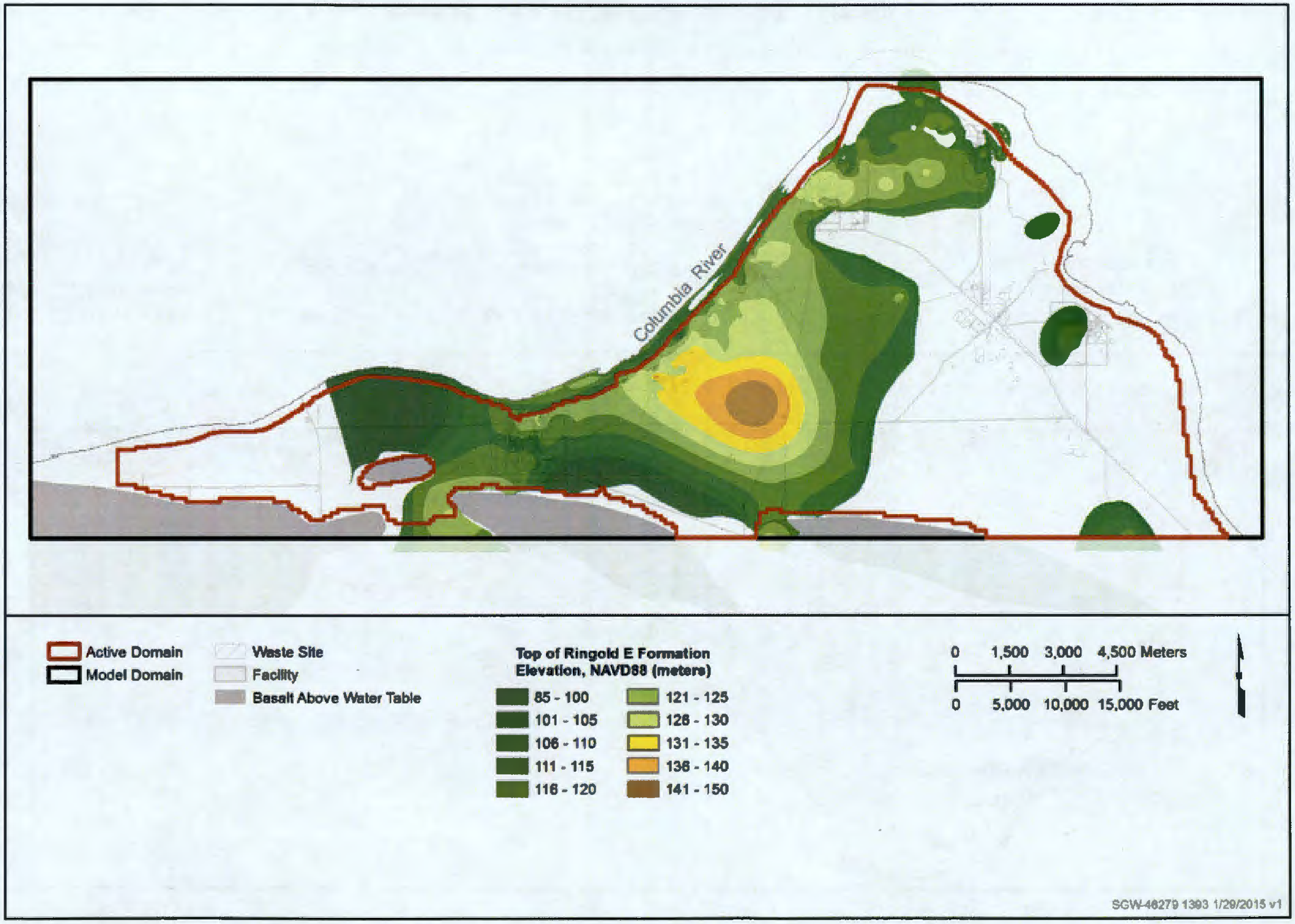



**Figure 3-6. Mapped Top of Ringold E Elevations**

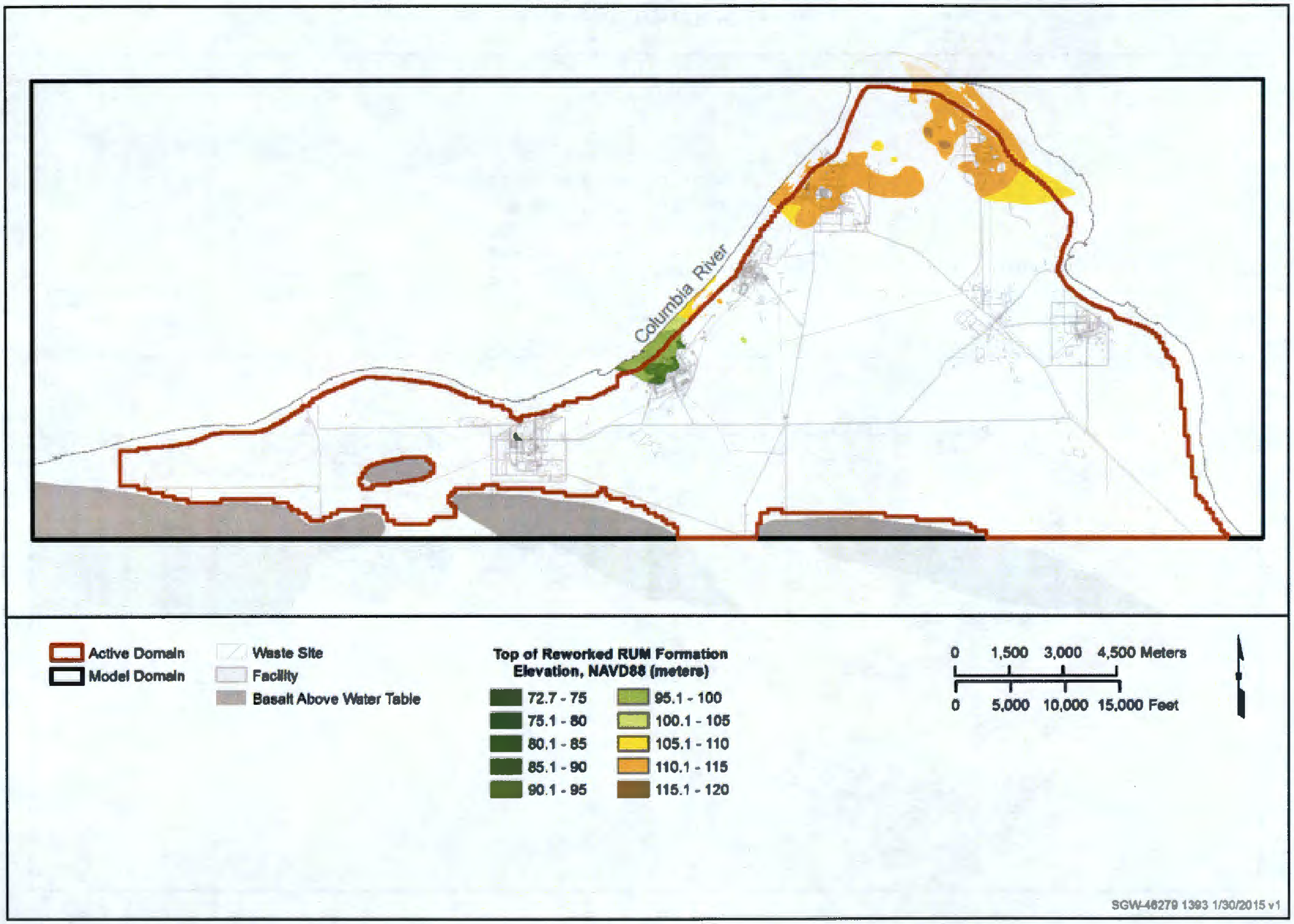



**Figure 3-7. Mapped Top of Reworked RUM Elevations**

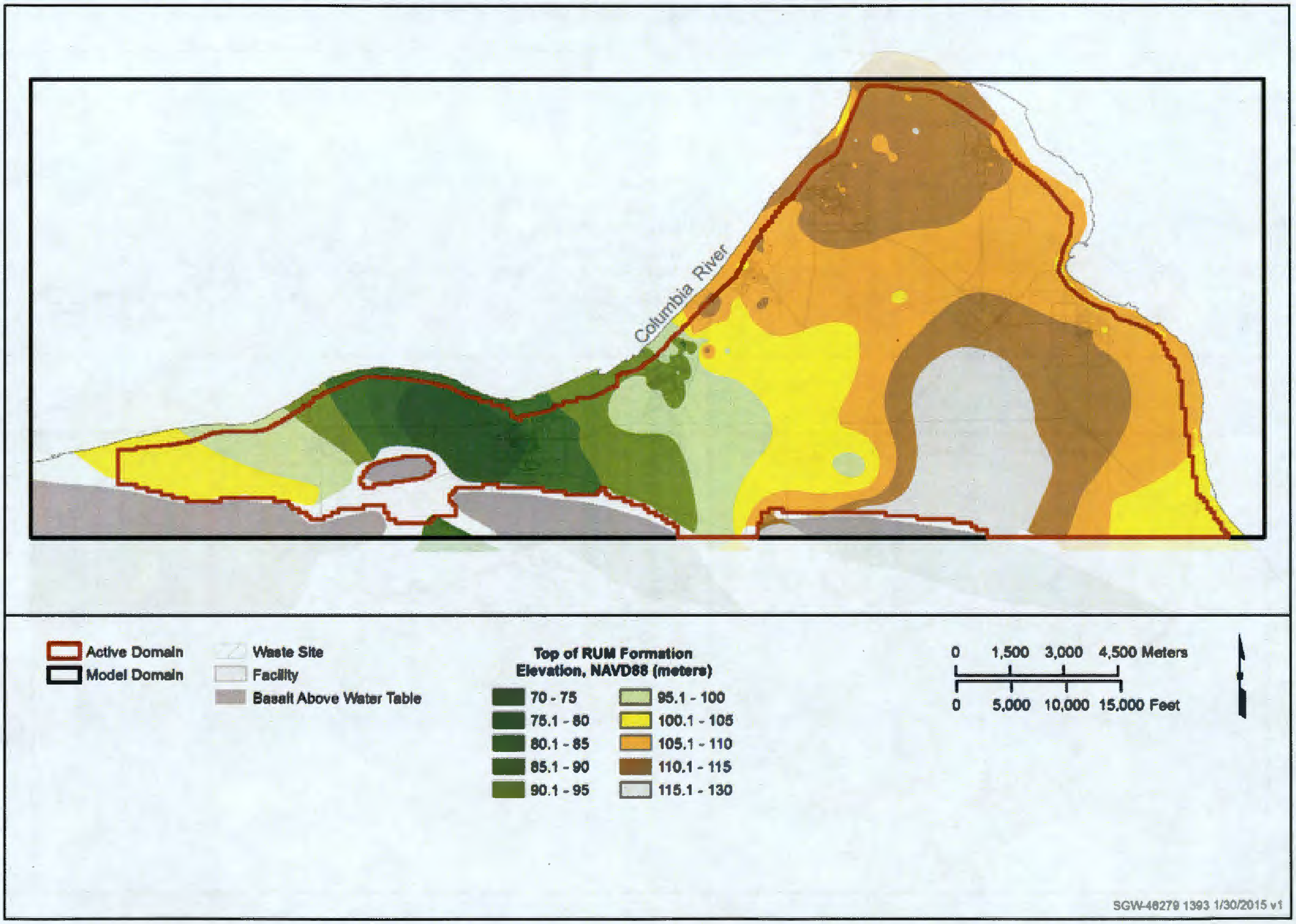



**Figure 3-8. Mapped Top of RUM Elevations**

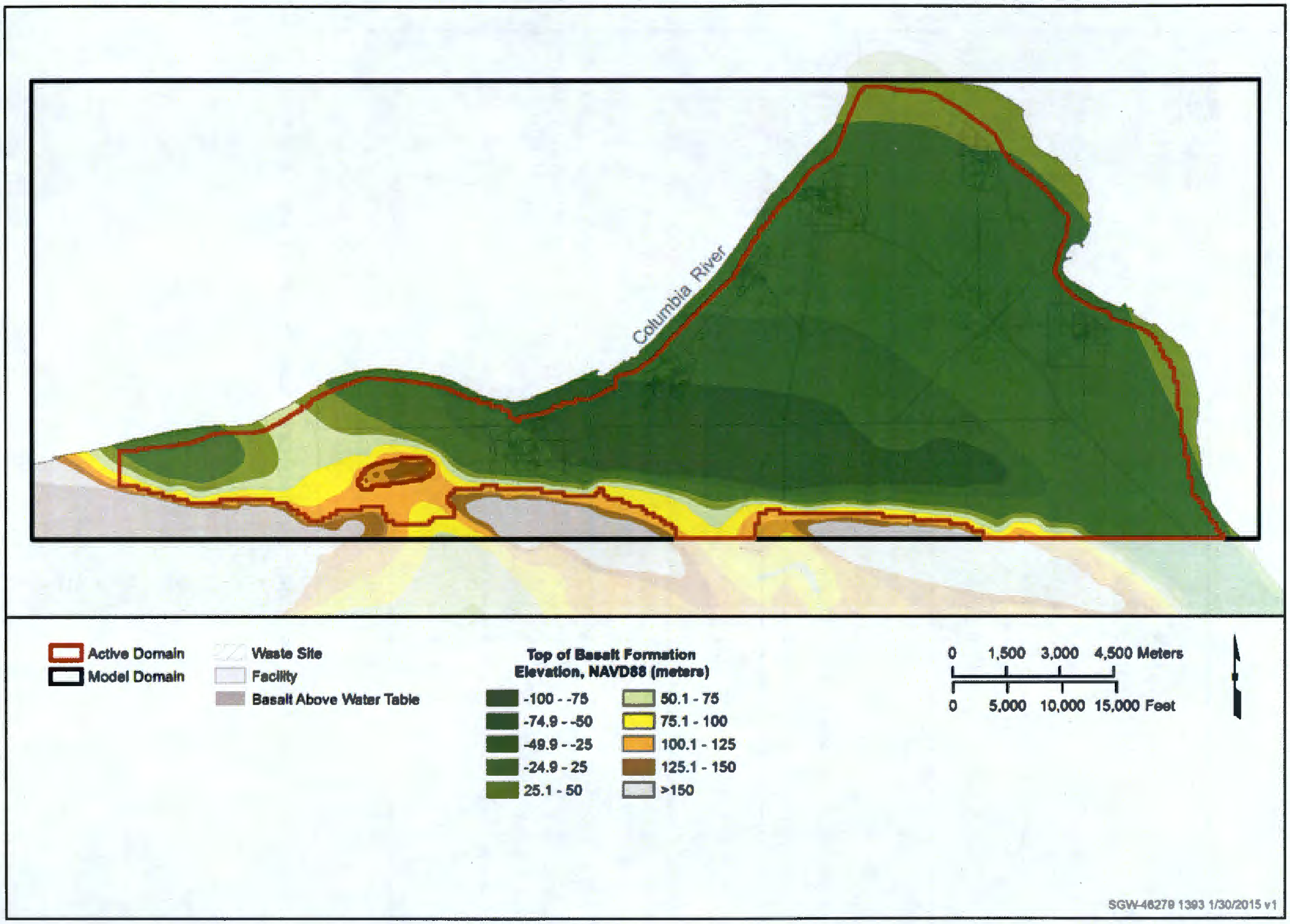



Figure 3-9. Mapped Top of Basalt Elevations

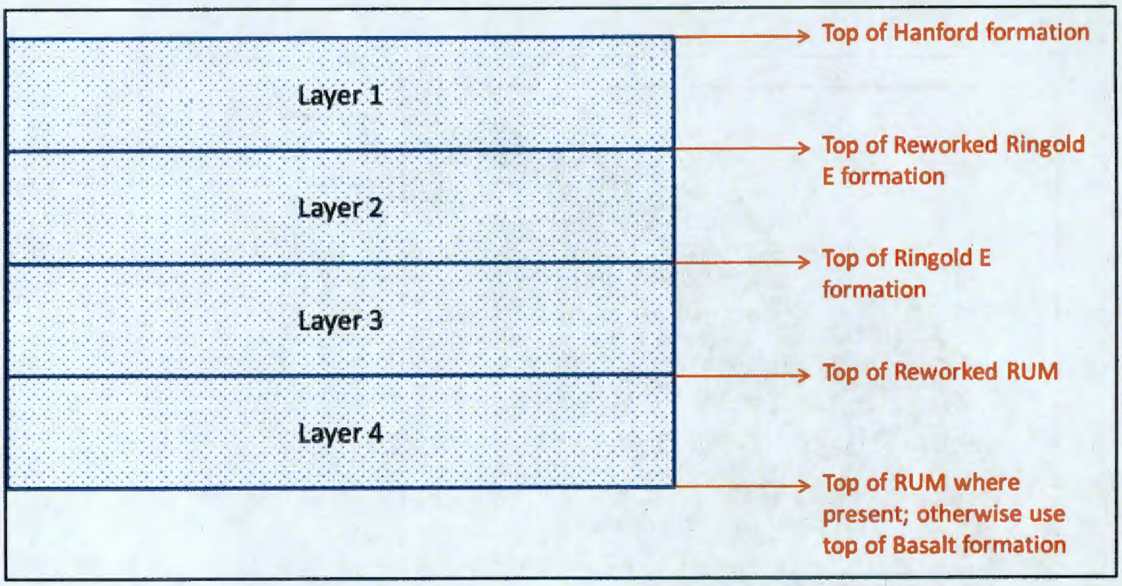



**Figure 3-10. Geologic Unit Assignment per Model Layer when All Geological Units are Present**

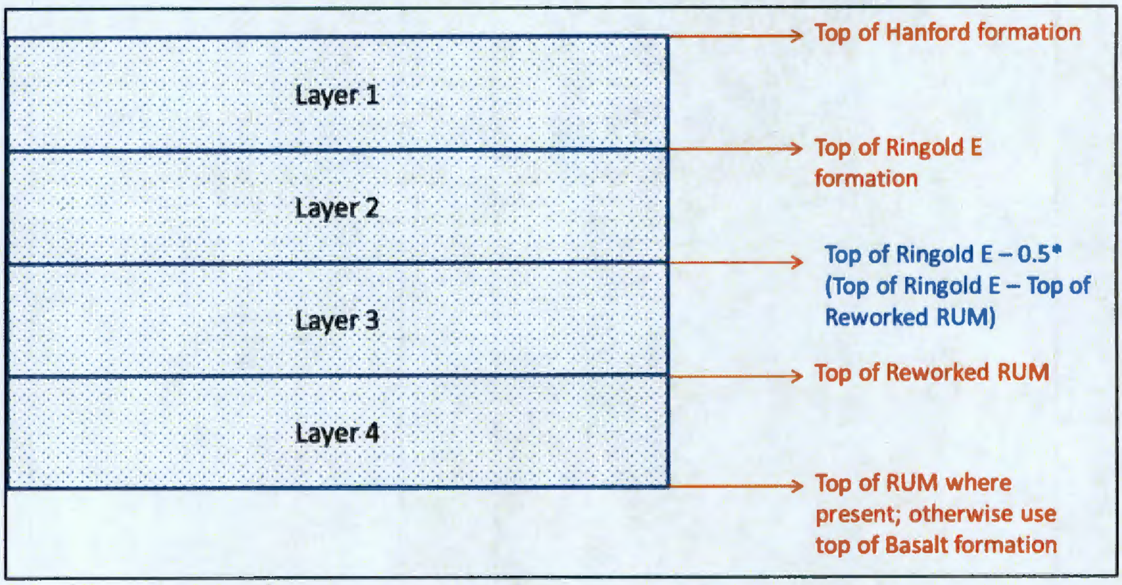



**Figure 3-11. Geologic Unit Assignment per Model Layer when Reworked Ringold E is Absent**

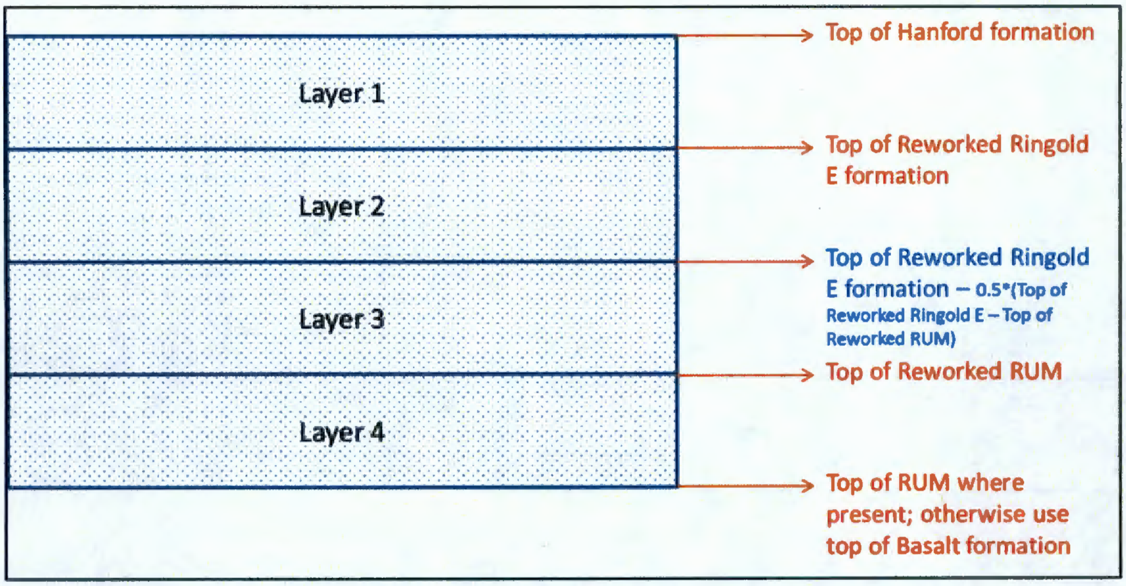



**Figure 3-12. Geologic Unit Assignment per Model Layer when Ringold E is Absent**

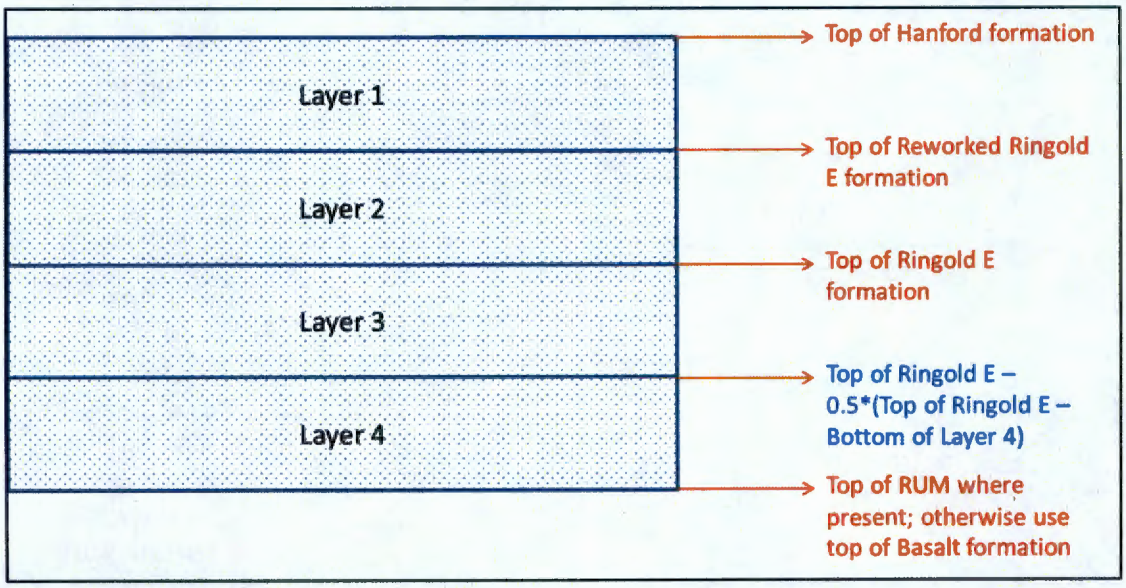



**Figure 3-13. Geologic Unit Assignment per Model Layer when Reworked RUM is Absent**

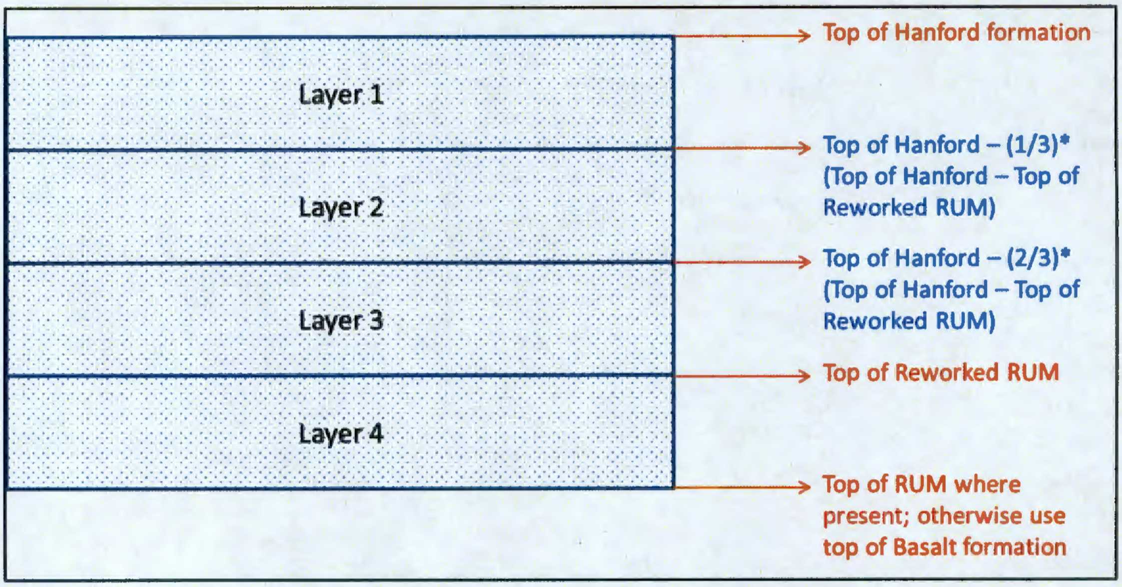



**Figure 3-14. Geologic Unit Assignment per Model Layer when Ringold E Units are Absent**

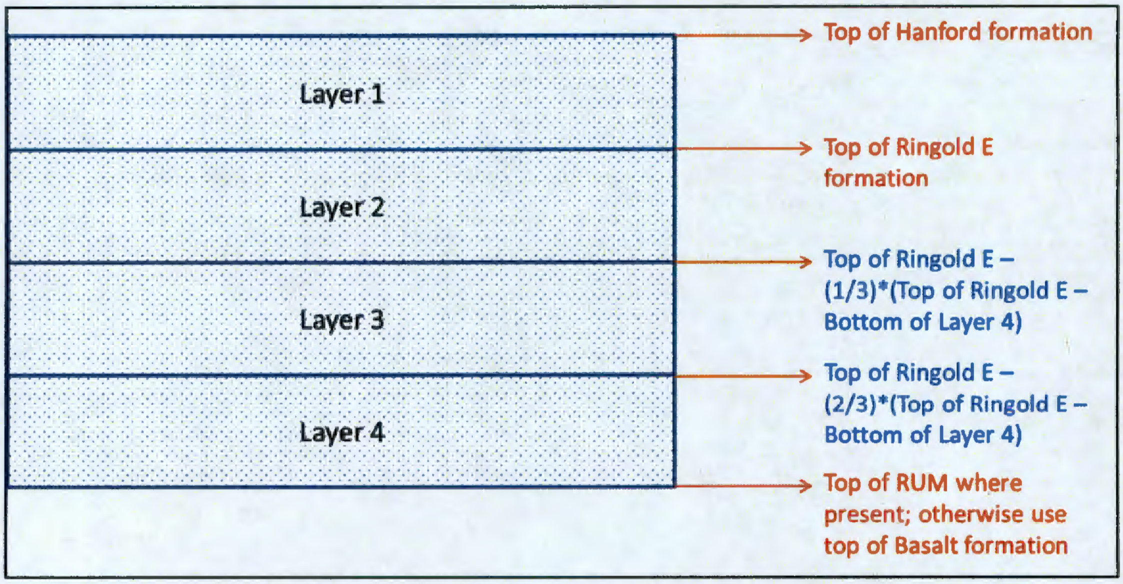



**Figure 3-15. Geologic Unit Assignment per Model Layer when Reworked Units are Absent**

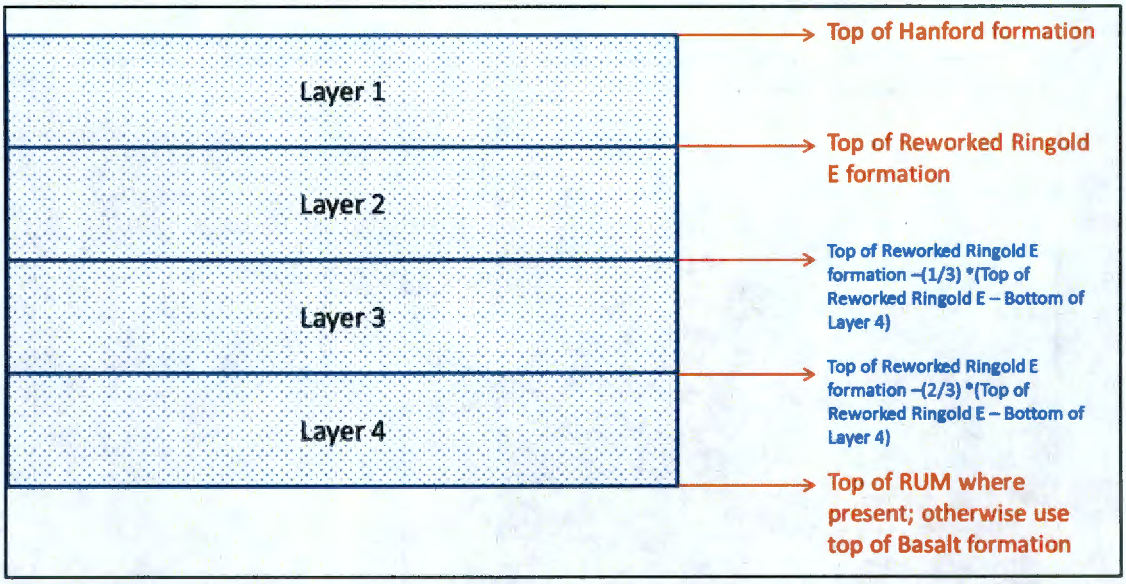



**Figure 3-16. Geologic Unit Assignment per Model Layer when Ringold E and Reworked RUM are Absent**

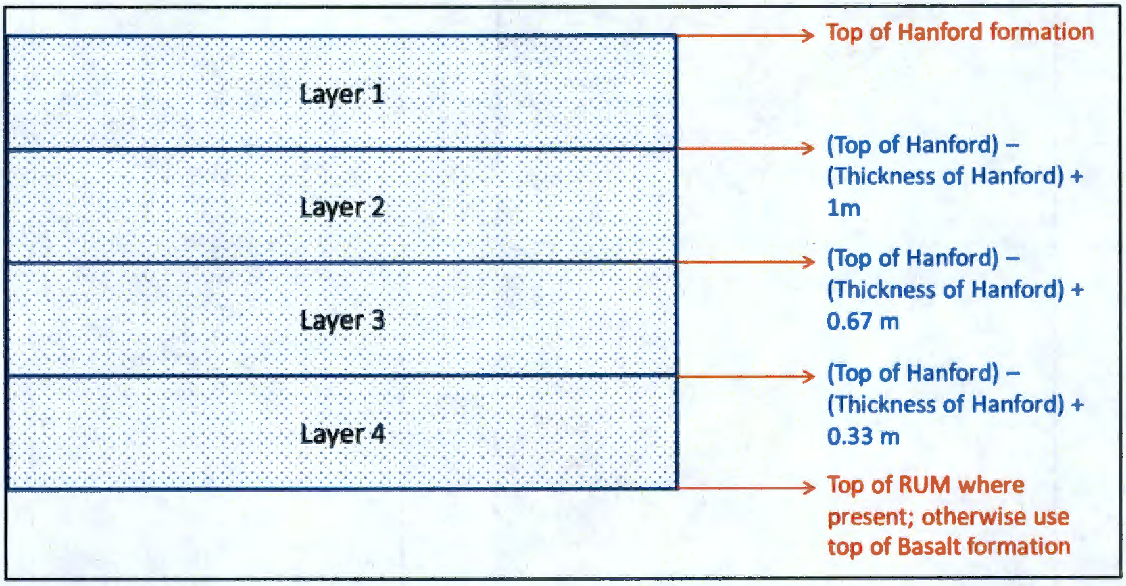



**Figure 3-17. Geologic Unit Assignment per Model Layer when Only Hanford is Present**

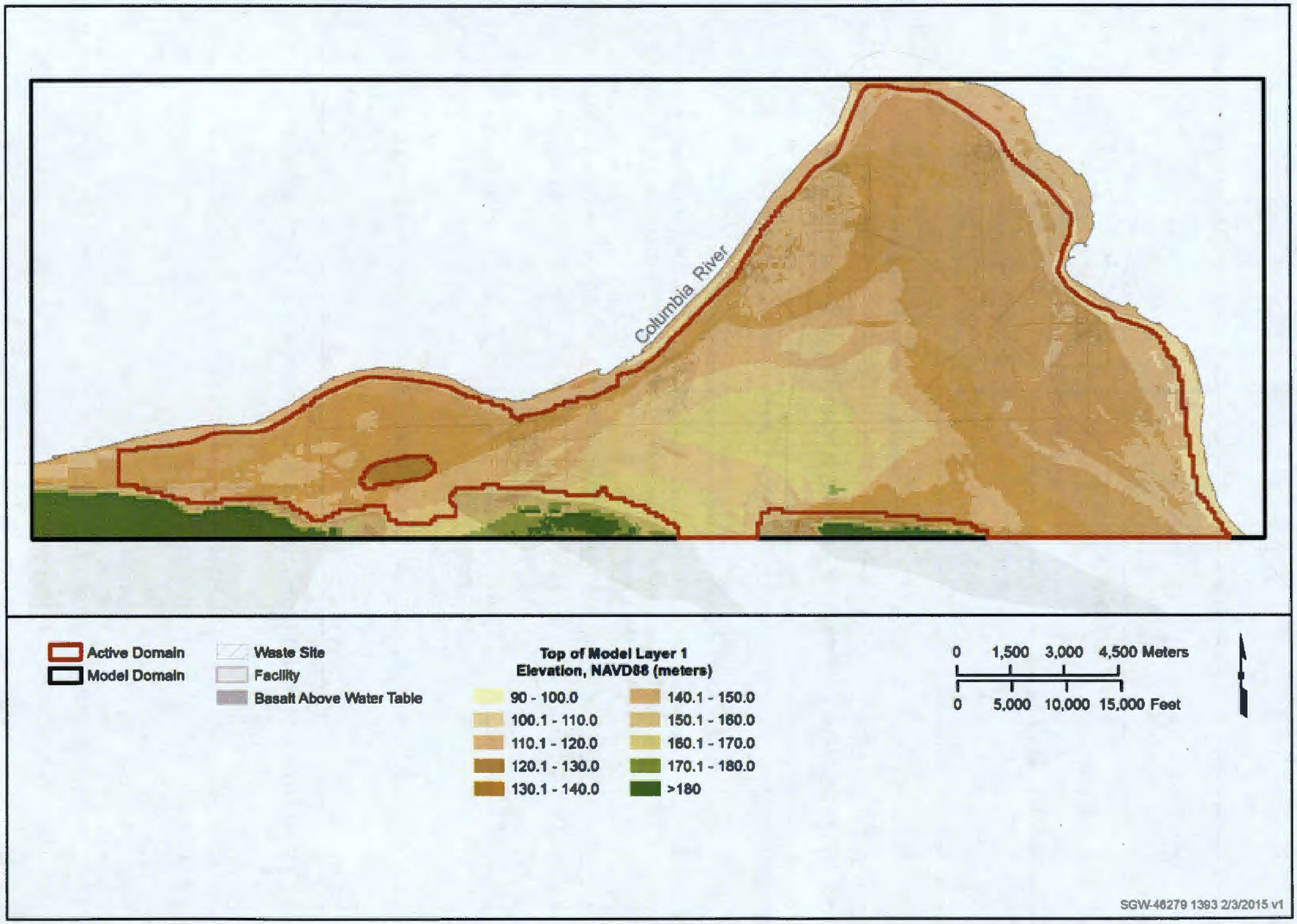



Figure 3-18. Calculated Elevation – Top of Model Layer 1

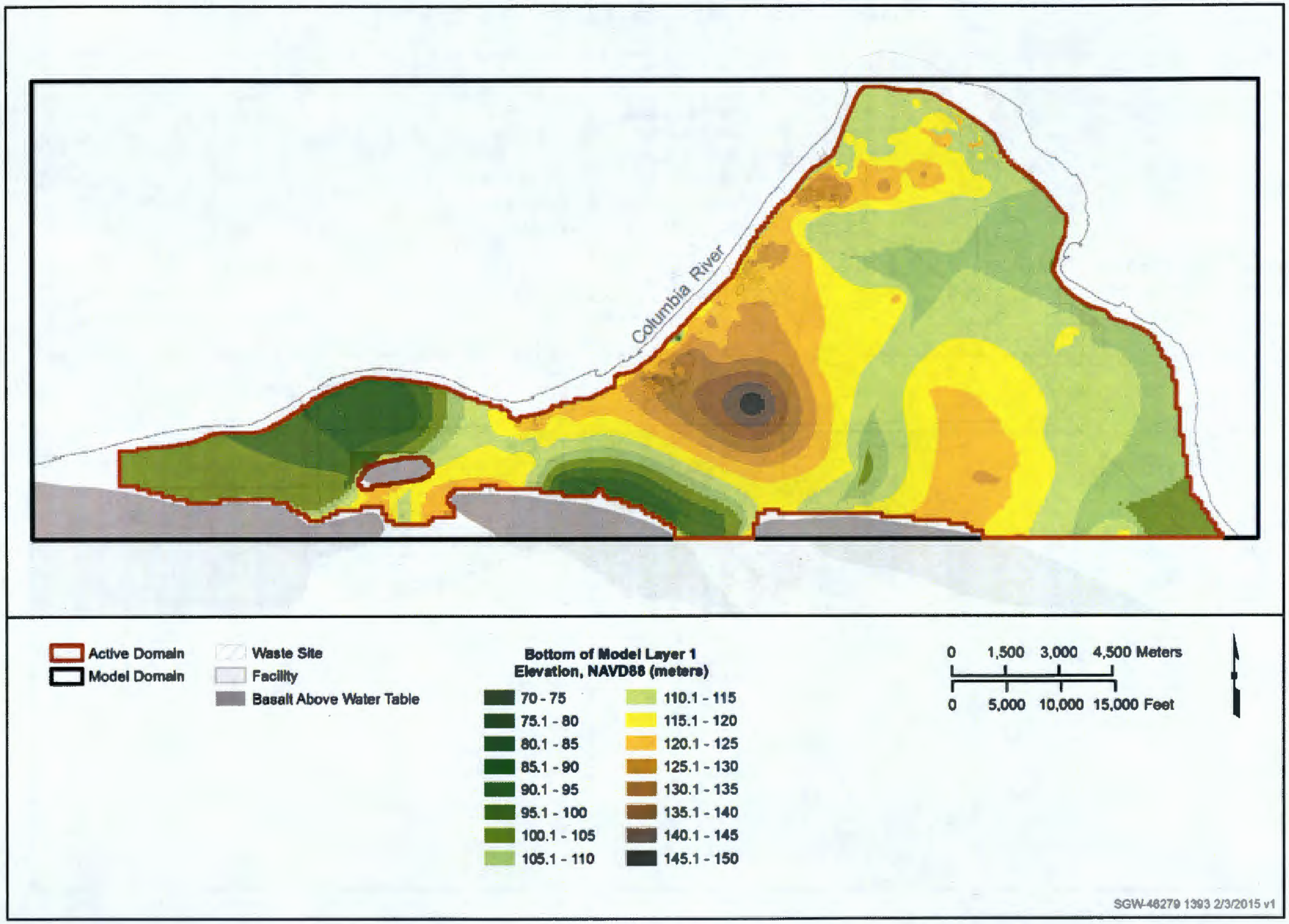



**Figure 3-19. Calculated Elevation – Bottom of Model Layer 1**

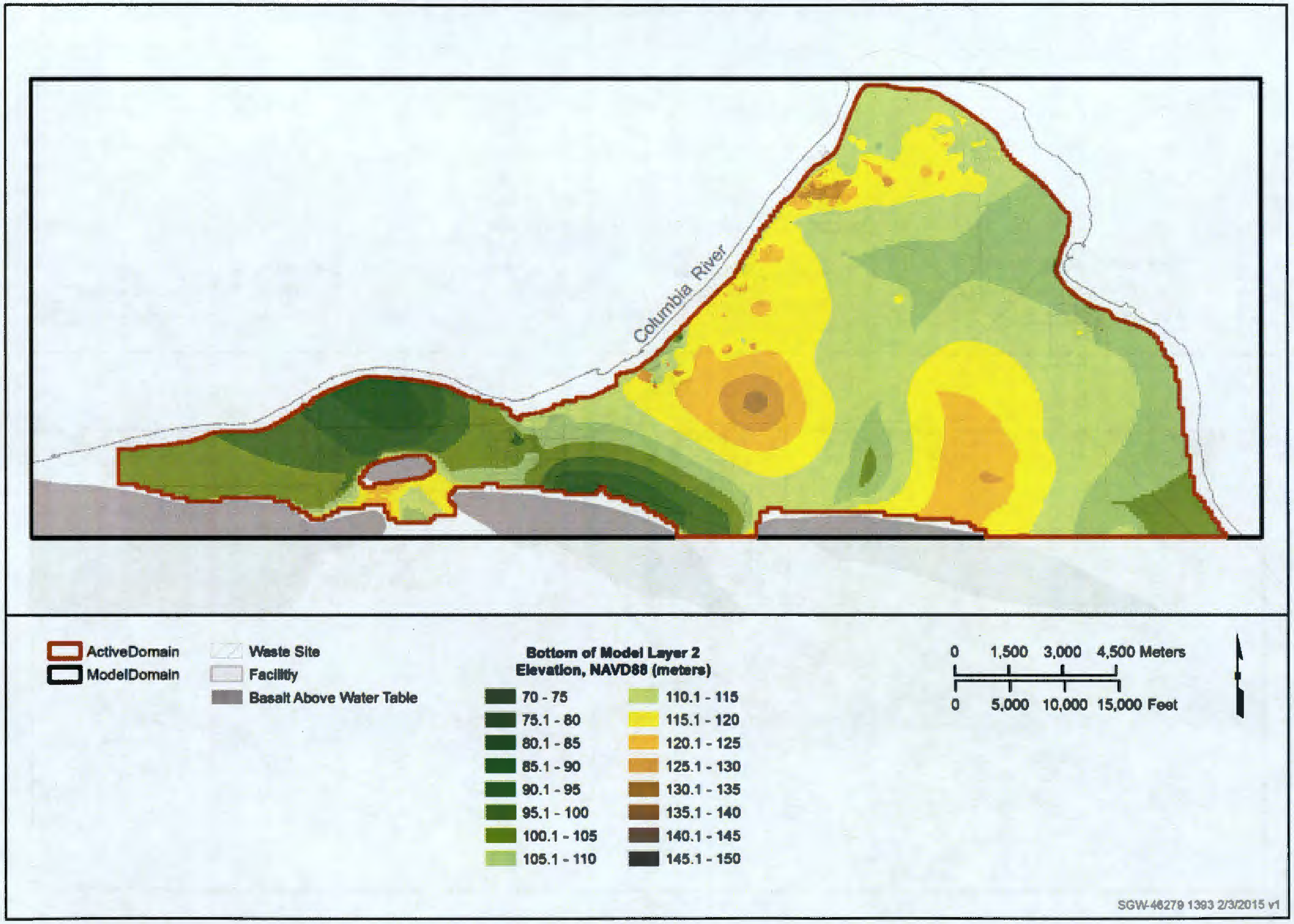



**Figure 3-20. Calculated Elevation – Bottom of Model Layer 2**

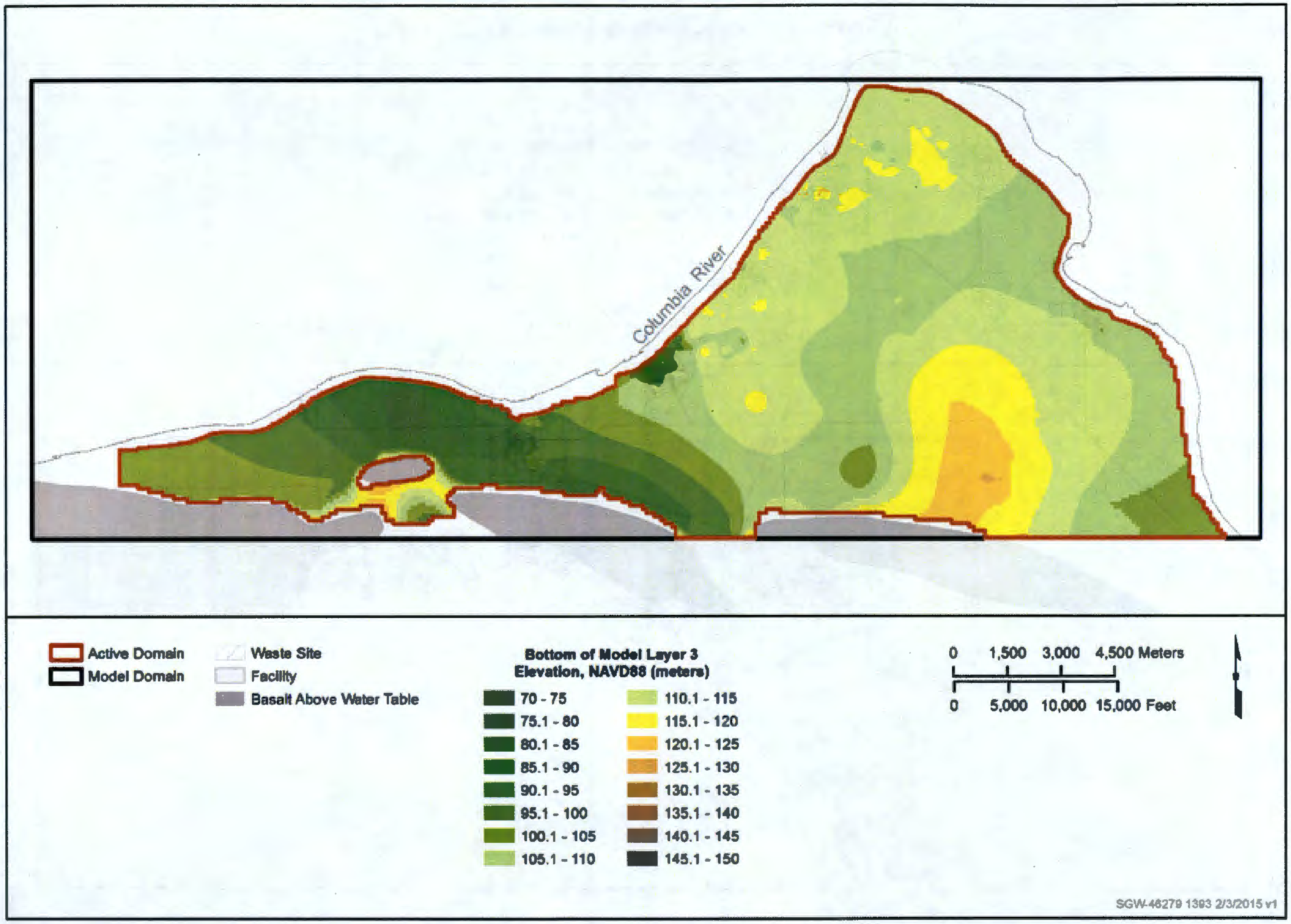



**Figure 3-21. Calculated Elevation – Bottom of Model Layer 3**

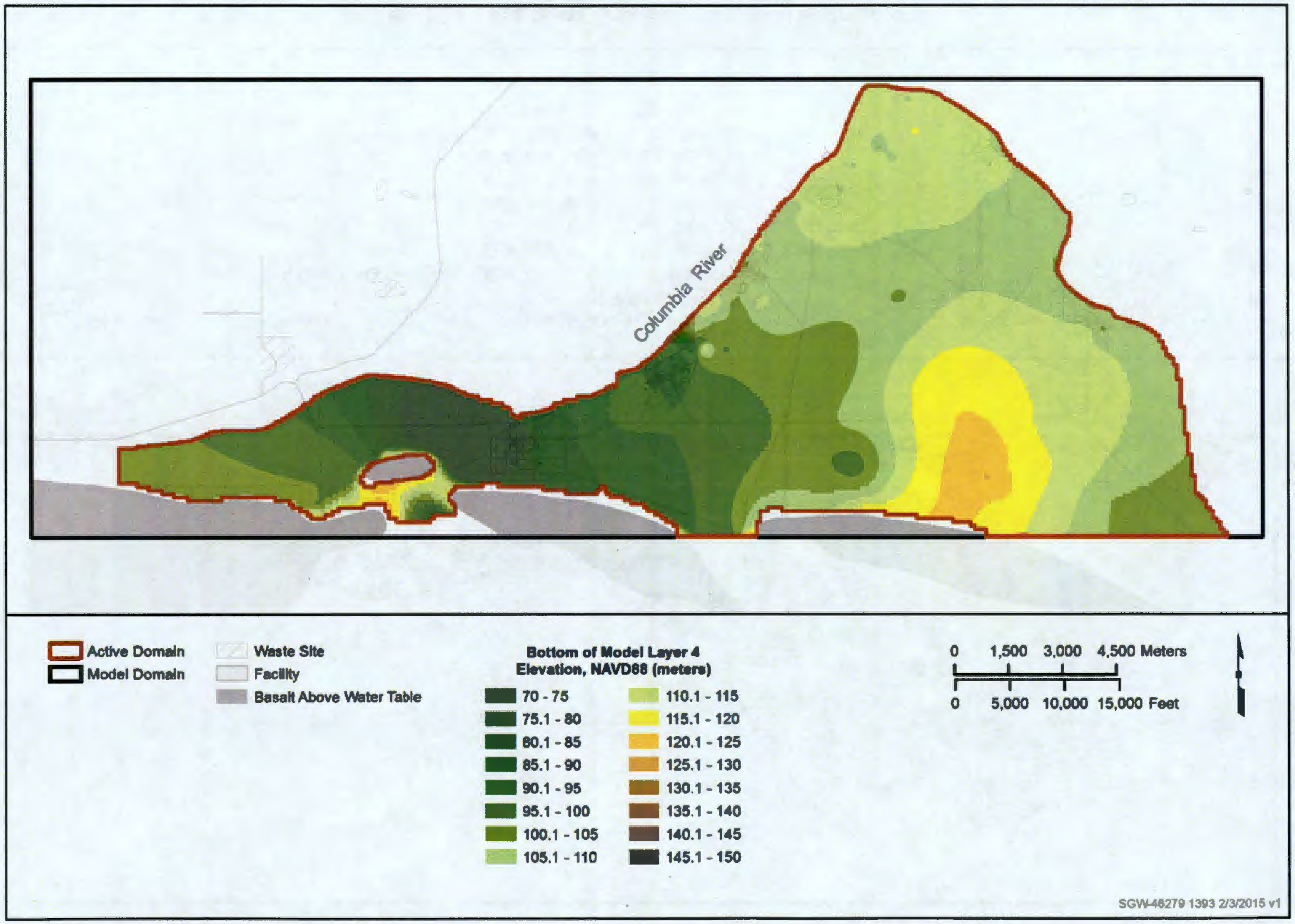



Figure 3-22. Calculated Elevation – Bottom of Model Layer 4

Data used for developing the initial HCOND distribution in the model are summarized in Appendix D. The final HCOND distribution was then updated via model calibration (parameter estimation).

The HCOND distribution was developed based on the following procedure:

- HCOND zones were delineated in each model layer, based on the presence of each geologic unit (Hanford, Reworked Ringold E, Ringold E, and Reworked RUM) in that layer and the extent of the geologic units as defined in the geological framework (ECF-Hanford-13-0020). Zone-wise mean values of HCOND in the Hanford and Ringold E units were set equal to the geometric mean of the HCOND values of the wells screened in those respective units. Mean HCOND values for the reworked units were adjusted during calibration. The mean HCOND values are tabulated in Table 3-2.

**Table 3-2. Mean Hydraulic Conductivity Values**

| OU | Geologic Unit | Hydraulic Conductivity (m/d) |
|---|---|---|
| All | Hanford | 88 |
| 100-K | Reworked Ringold E | 25 |
| 100-D and 100-H | | 35 |
| 100-B | Ringold E | 6.9 |
| 100-K | | 17.3 |
| 100-D, 100-H and 100-F | | 28.7 |
| 100-K | Reworked RUM | 2 |
| 100-D and 100-H | | 5 |
| 100-B | High conductivity Paleo-channel | 1,251 |

m/d = meters per day

RUM = Ringold Upper Mud (unit)

- Available point estimates of hydraulic conductivity/transmissivity from slug tests, aquifer tests, and well development data represent, in most cases, average hydraulic properties across multiple geologic units, depending on the screened interval of the well. Layer-based hydraulic conductivity values were developed based on the following procedure:
  - For each point estimate location, the saturated thickness was determined in the following manner: at each location with a point estimate of hydraulic conductivity, the saturated thickness was set to the value reported in the corresponding test data based on which the hydraulic conductivity value was estimated. If that value of saturated thickness was not available, it was set equal to the saturated thickness calculated from the initial hydraulic head distribution in the model at that location.
  - Transmissivity values at each location were considered:
    - At each location with a point estimate of hydraulic conductivity, the transmissivity of the saturated portion of the unconfined aquifer (potentially across multiple geologic units) was

calculated based on the reported hydraulic conductivity and the saturated thickness determined earlier.

- At locations with published transmissivity estimates, the published estimate was used.

– For each well, screen data and corresponding saturated thickness were used for determining the length of screened interval per model layer.

– Layer-based hydraulic conductivity variables were assigned at each location ($K_{ij}$, where $i$ is the location index and $j$ is the layer index). PEST was used to calculate each $K_{ij}$ considering the following set of equations and prior information:

- At each location, the sum of the products of hydraulic conductivity and thickness for each model layer should be equal to the total transmissivity at that location

$$T_i = \sum_{j=1}^{n} K_{ij} \times b_{ij}$$

Where:

$T$ is the total transmissivity at location $i$, $b$ is the saturated thickness at location $i$ and layer $j$, and $n$ is the number of layers the well penetrates and saturated flow occurs.

- Layer-based hydraulic conductivity $K_{ij}$ should honor the mean hydraulic conductivity of the zone of location $i$, which is the type of prior information used by PEST.

- For all locations where the well penetrates multiple geologic units, the ratio of hydraulic conductivities per layer should be equal to the ratio of the mean hydraulic conductivity value of the corresponding zones in each layer.

– Once point estimates of hydraulic conductivity were developed at each location and for each layer using PEST, they were grouped by hydraulic conductivity zone, delineated as described earlier. A spatial HCOND distribution was then calculated for each zone in each aquifer unit by using an appropriate variogram, whose properties were adjusted during calibration. This calculation was made using the FIELDGEN utility of PEST.

– The locations of the point estimates for each aquifer unit are shown in Figures 3-23 through 3-39. The modeled horizontal hydraulic conductivity distributions are presented in Figures 3-40 through 3-43. Vertical hydraulic conductivity was assumed to be 10 percent of the horizontal hydraulic conductivity.

The following example illustrates the process to determine the prior information and constraints for the calculation of the hydraulic conductivity per layer at a particular well: well 199-F7-1 is screened in the Hanford and Ringold E formations. PEST is used for estimating the HCOND values in the Hanford and Ringold E units to match the total transmissivity at the well. PEST calculates HCOND per layer while attempting to honor the mean hydraulic conductivity of the Hanford formation and the mean hydraulic conductivity of the Ringold E Formation, and maintain the user-specified ratio between the HCOND values of the two units.

Equation 3-1 describes that the preferred value for HCOND of the Hanford formation at well 199-F7-1 (K1199-F7-1) is $10^{1.944}$ m/d or 88 m/d.

$$1.0 * \log(K1199\text{-}F7\text{-}1) = 1.944 \quad \text{3-1}$$

Equation 3-2 describes that the preferred value for the Ringold E Formation at well 199-F7-1, (K3199-F7-1), is $10^{1.458}$ m/d or 28.7 m/d.

$$1.0 * \log(K3199\text{-}F7\text{-}1) = 1.458 \quad \text{3-2}$$

Equation 3-3 describes that the preferred value for the ratios of the Hanford formation and Ringold E Formation at well 199-F7-1 is (88/28.7) or $10^{0.486}$.

$$1.0 * \log(K1199\text{-}F7\text{-}1) - 1.0 * \log(K3199\text{-}F7\text{-}1) = 0.486 \quad \text{3-3}$$

The workflow and associated utilities for developing the hydraulic conductivity distribution are shown in Table 3-3.

**Table 3-3. Hydraulic Conductivity Estimation Workflow**

| Sequence | Program | Function |
|---|---|---|
| 1 | CreateZones3.py | Create zones for each aquifer unit |
| 2 | ProcessHYWells.py | Collate aquifer test estimates and screen intervals; calculate saturated layer thicknesses |
| 3 | Generate_CalcTinput.py | Generate input files, template files and instruction files for PEST to estimate unit-wise HCOND |
| 4 | PEST | Estimate unit-wise layer HCOND |
| 5 | CalcT.py | Program called by PEST to calculate T at each location |
| 6 | CreateFieldgenInputFiles.py | Create input files for Fieldgen containing layer-wise HCOND point estimates |
| 7 | CreateHYFields.py | Run Fieldgen to create model-wide HCOND distributions |

HCOND = hydraulic conductivity

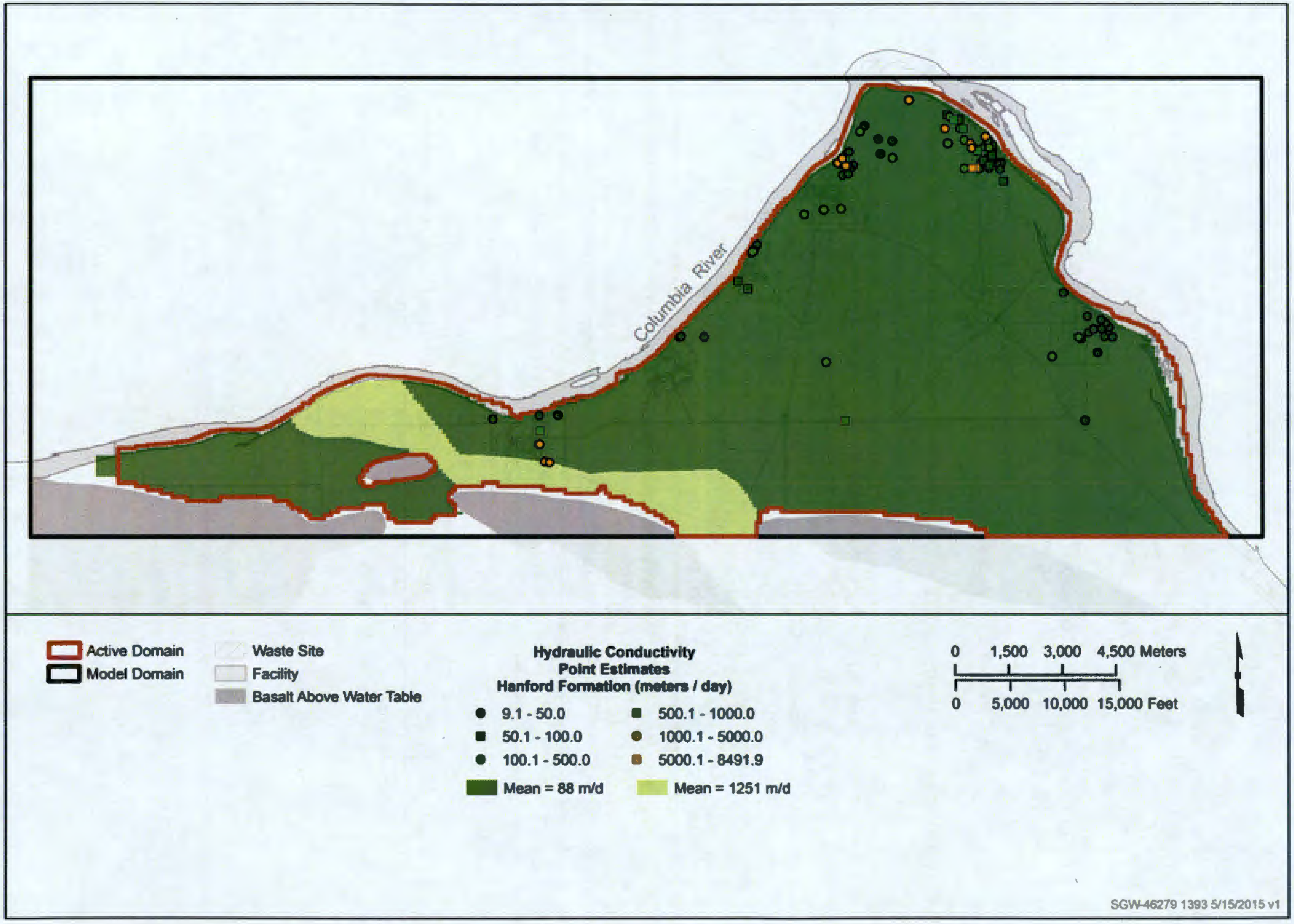



Figure 3-23. Hydraulic Conductivity Point Estimates (entire 100 Area) in the Hanford Formation

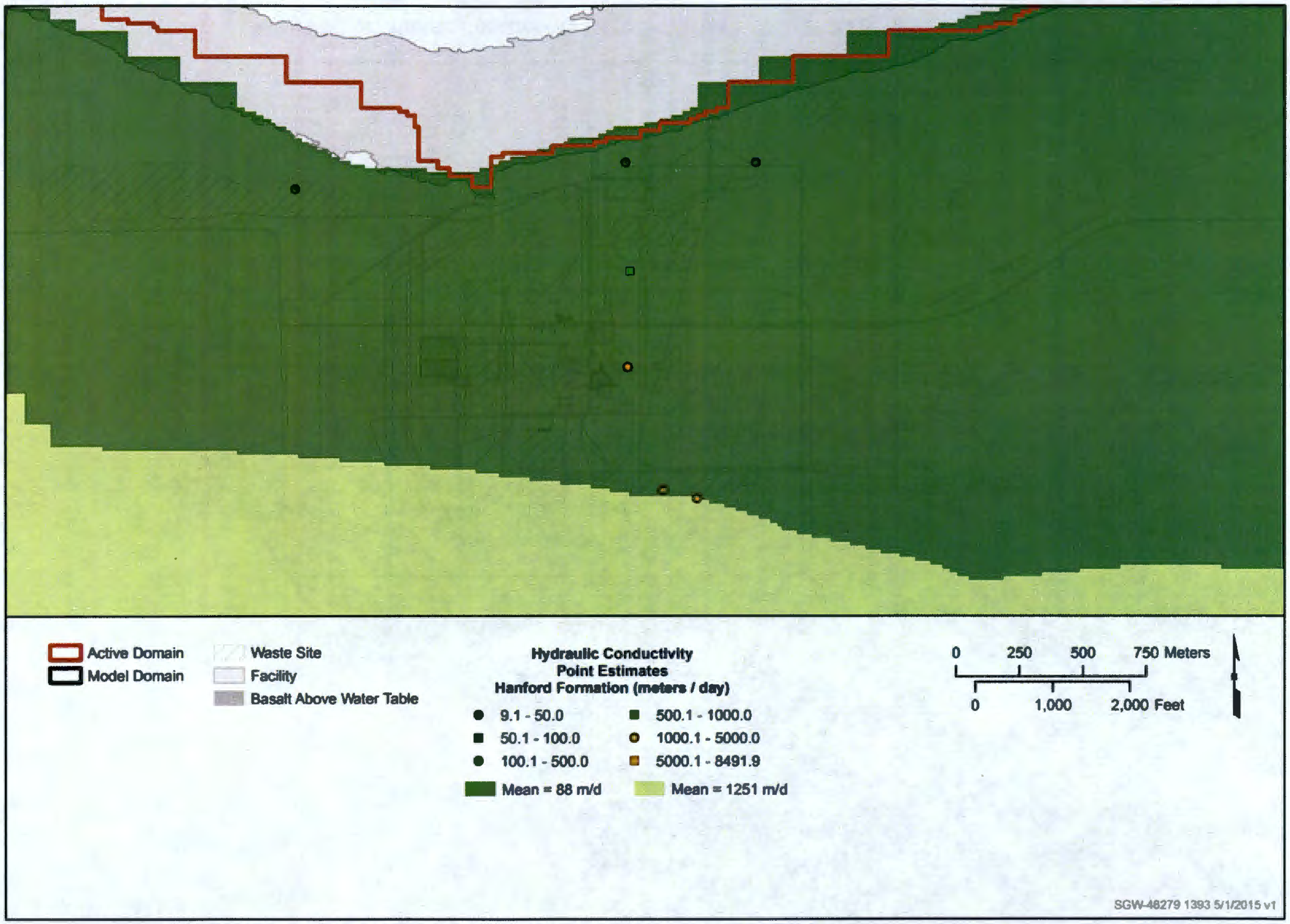



Figure 3-24. Hydraulic Conductivity Point Estimates (100-B) in the Hanford Formation

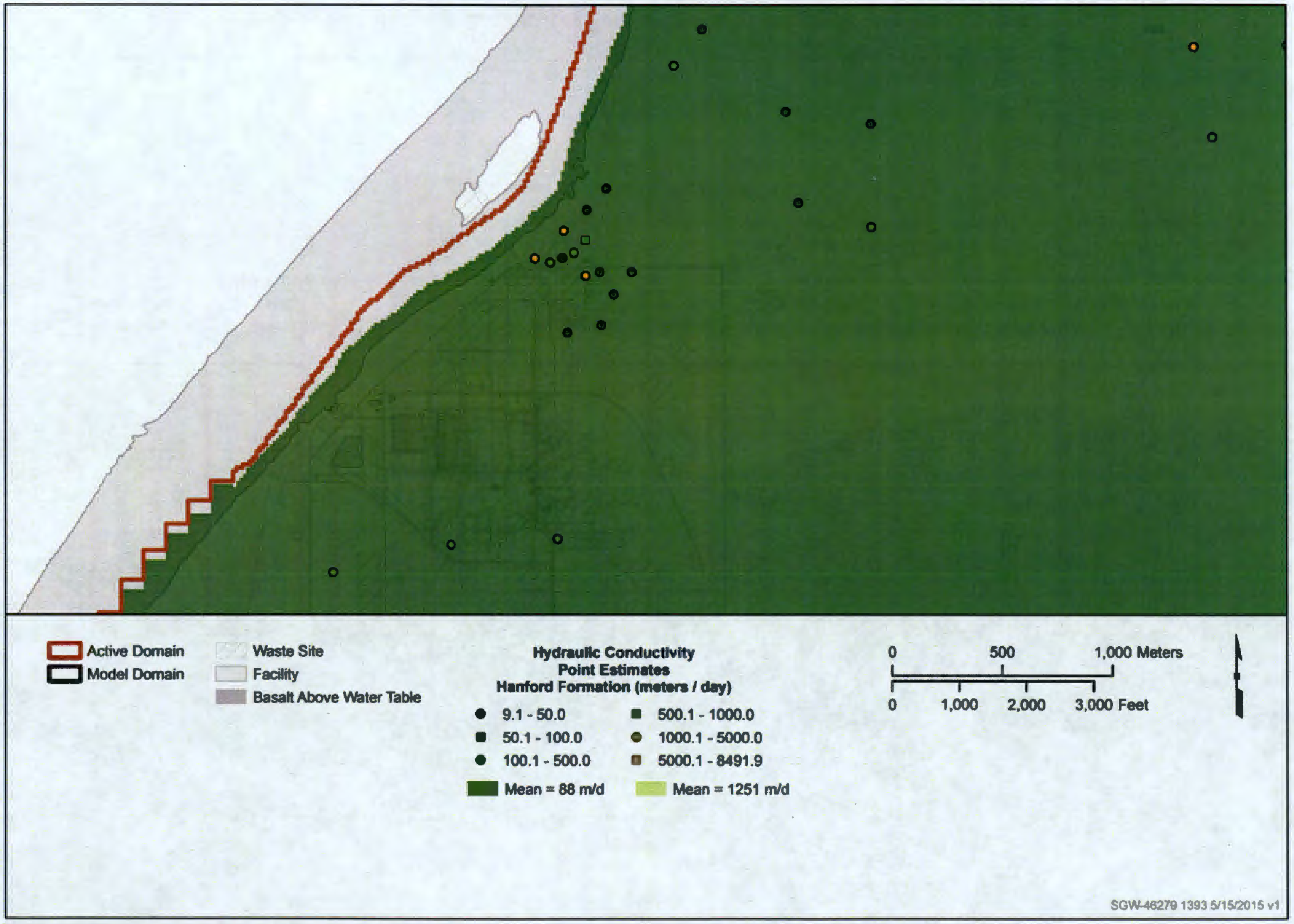



**Figure 3-25. Hydraulic Conductivity Point Estimates (100-D) in the Hanford Formation**

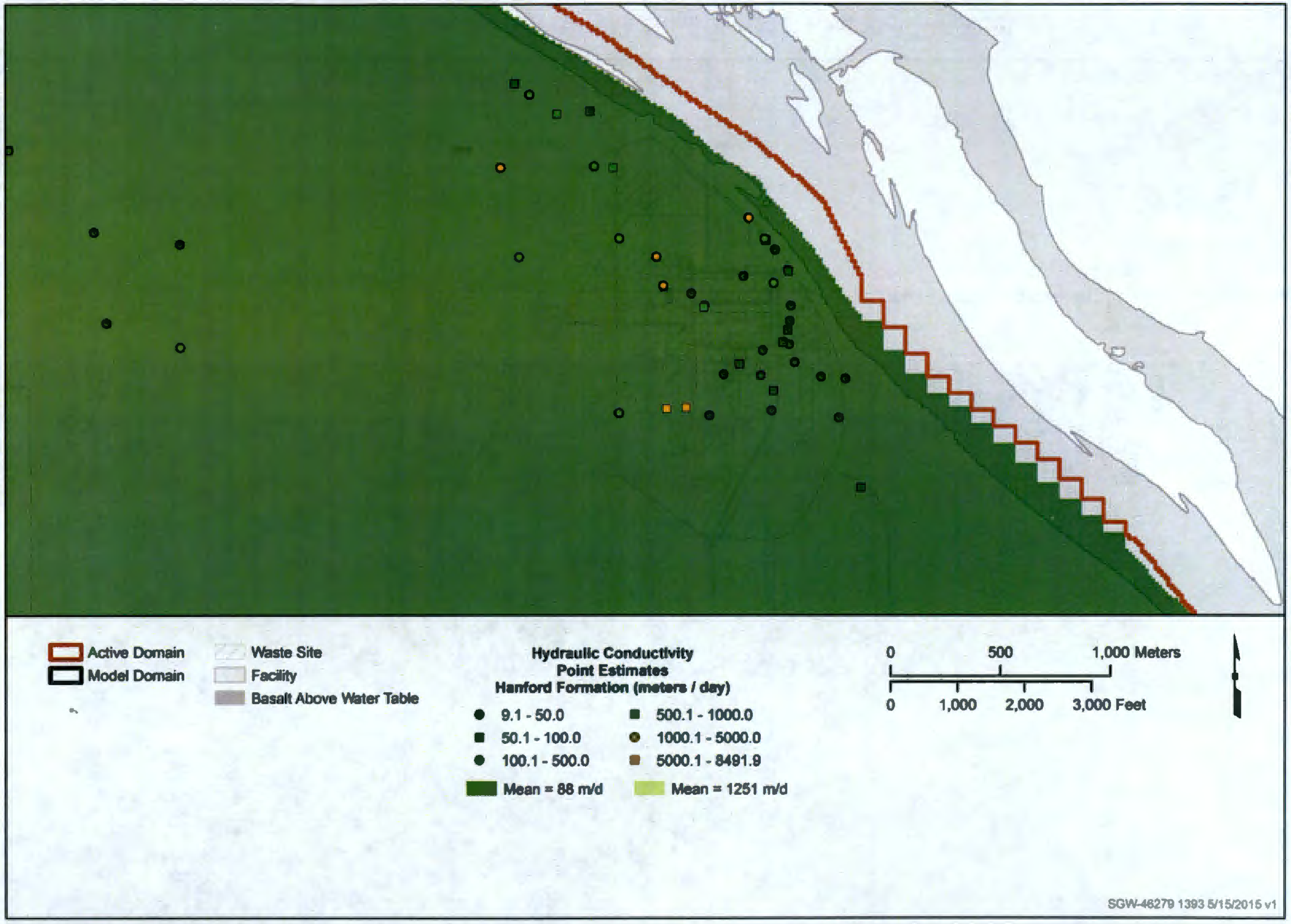



**Figure 3-26. Hydraulic Conductivity Point Estimates (100-H) in the Hanford Formation**

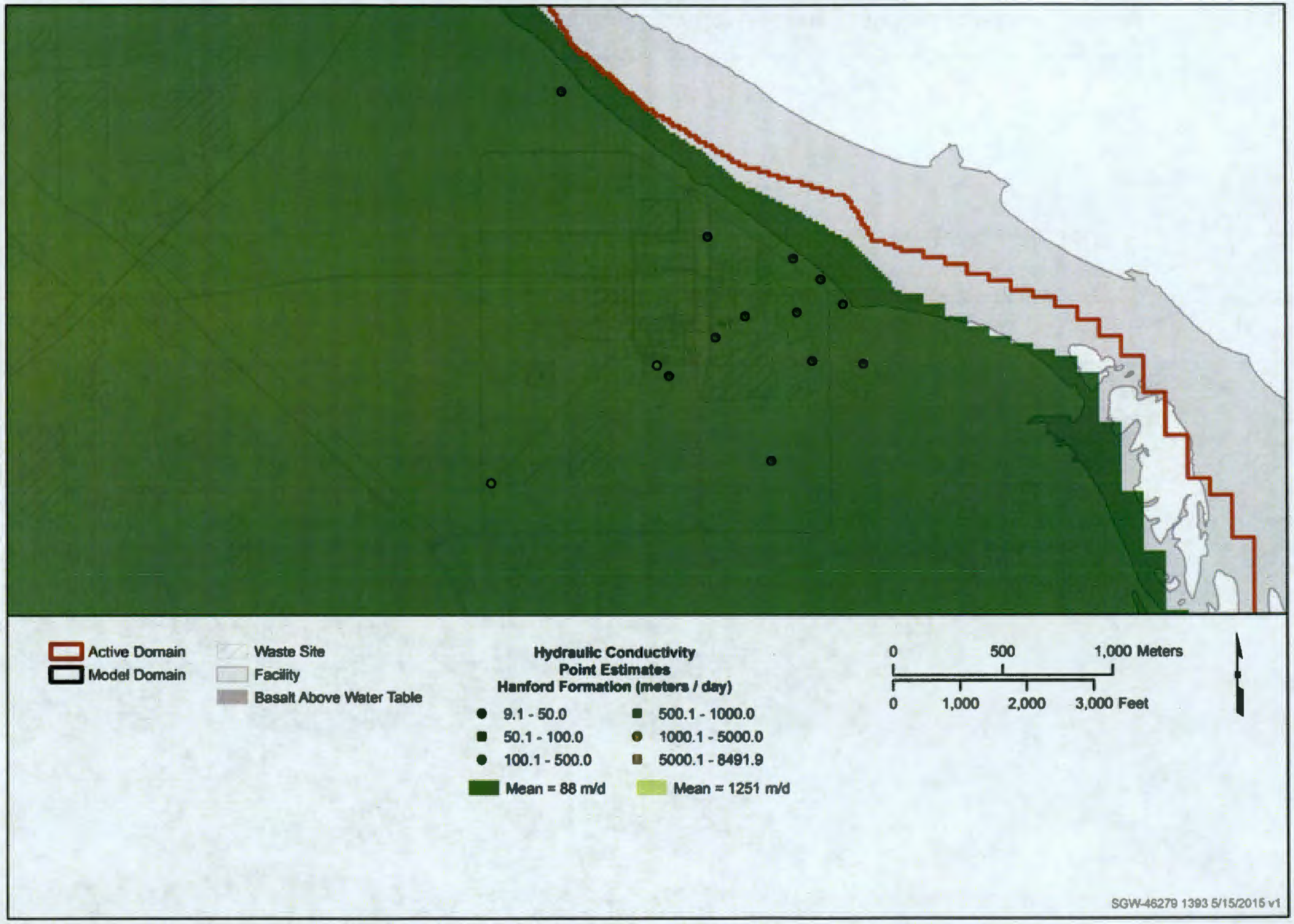



Figure 3-27. Hydraulic Conductivity Point Estimates (100-F) in the Hanford Formation

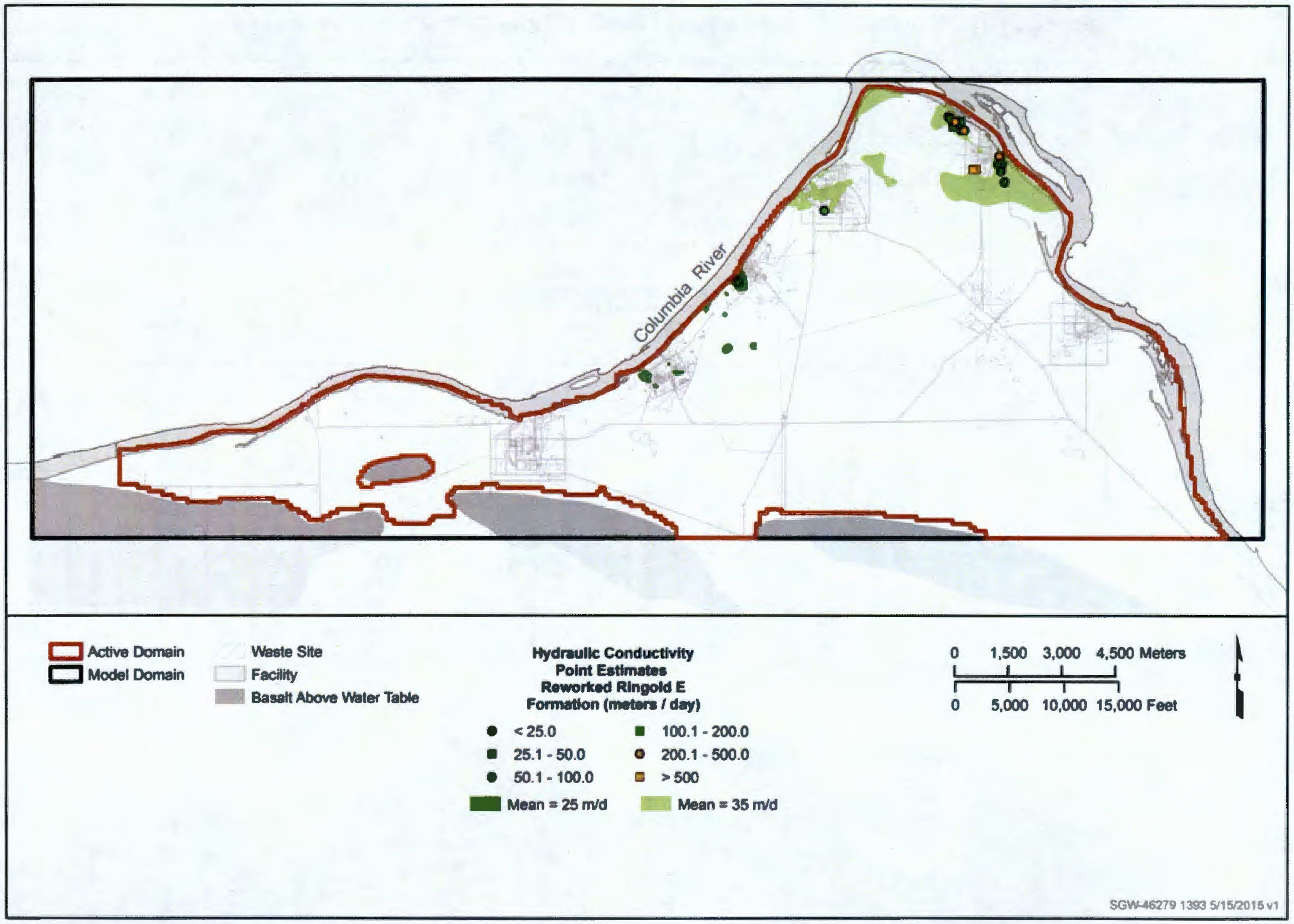



Figure 3-28. Hydraulic Conductivity Point Estimates in the Reworked Ringold E Formation

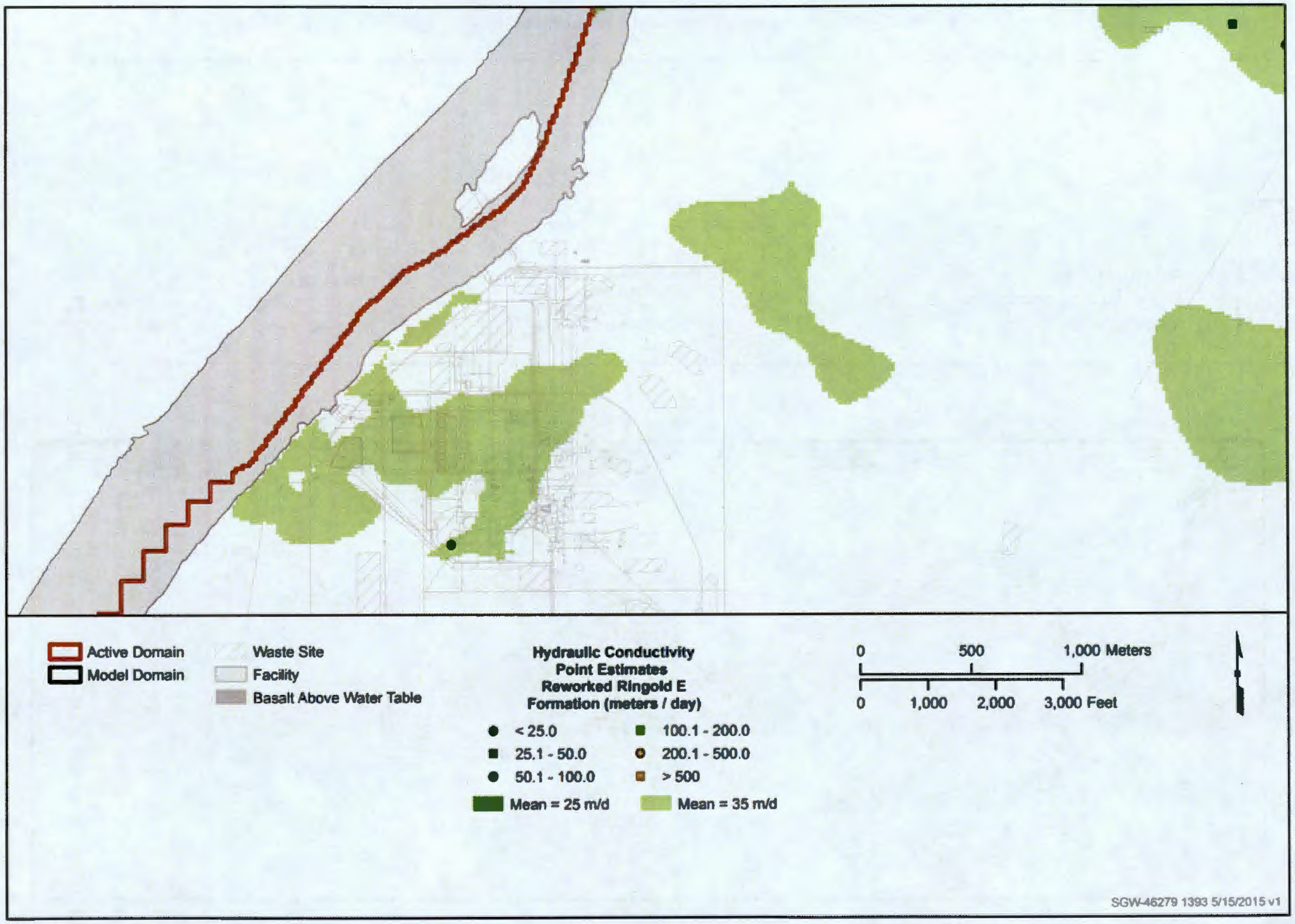



**Figure 3-29. Hydraulic Conductivity Point Estimates (100-D) in the Reworked Ringold E Formation**

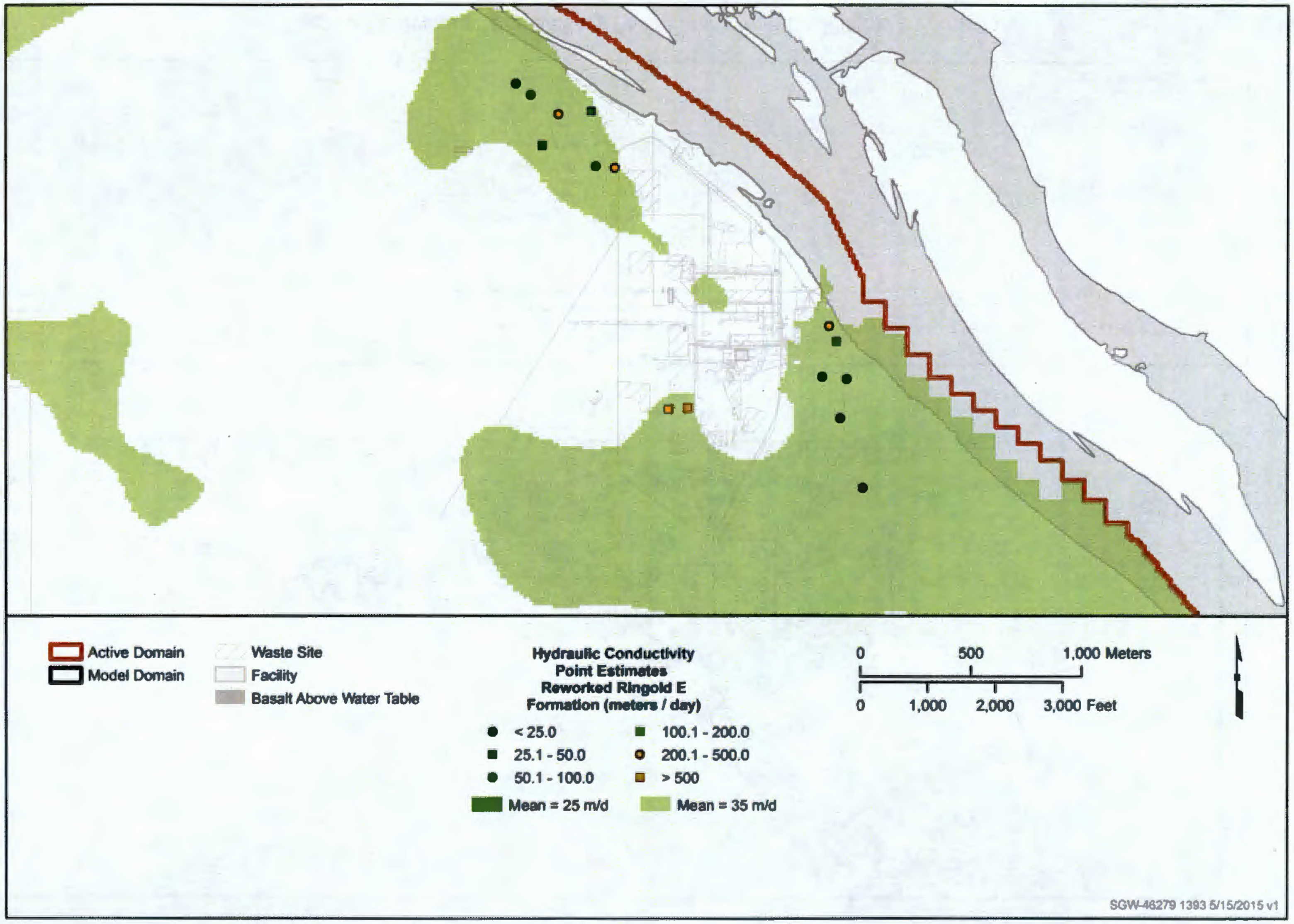



Figure 3-30. Hydraulic Conductivity Point Estimates (100-H) in the Reworked Ringold E Formation

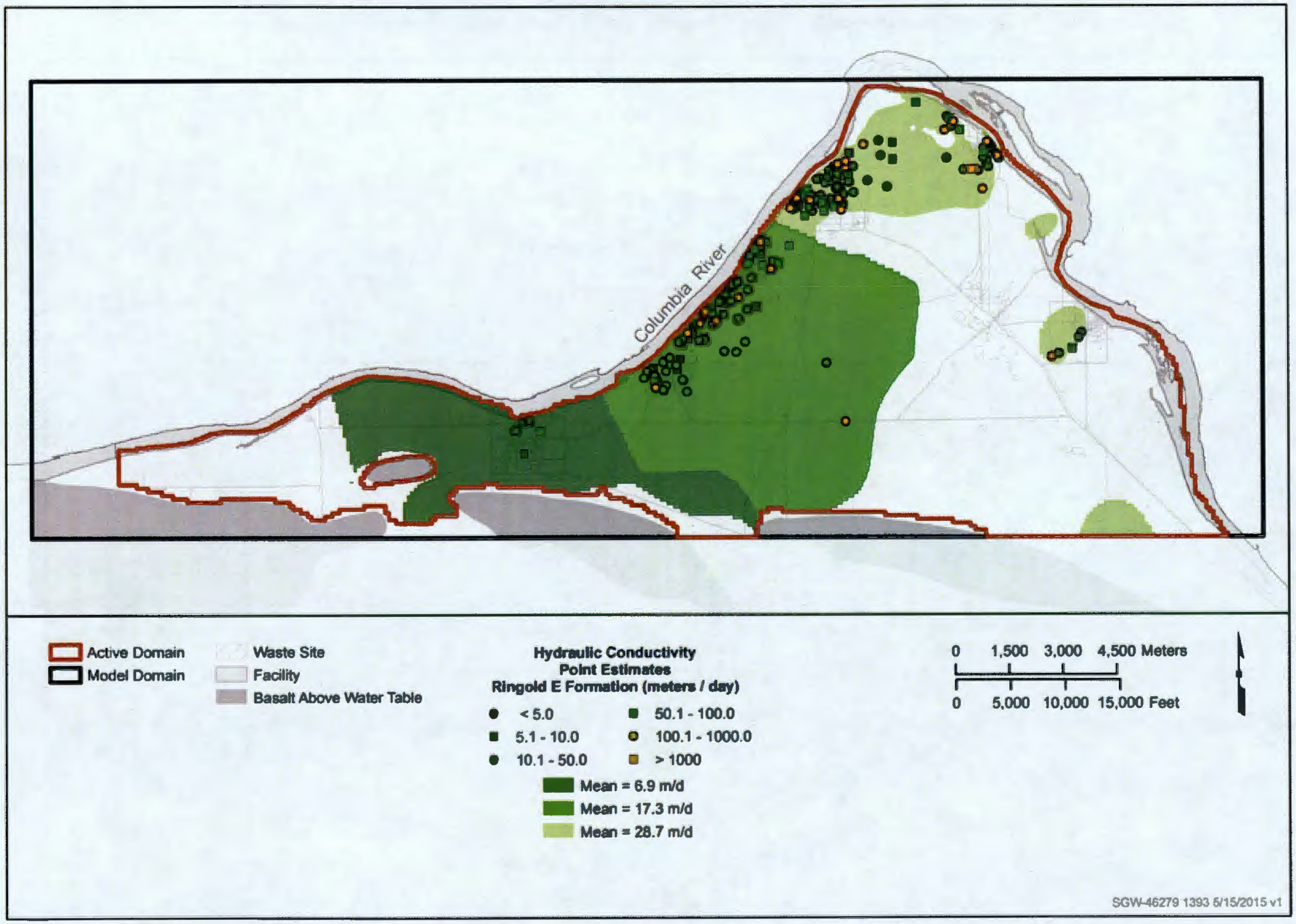



**Figure 3-31. Hydraulic Conductivity Point Estimates in the Ringold E Formation**

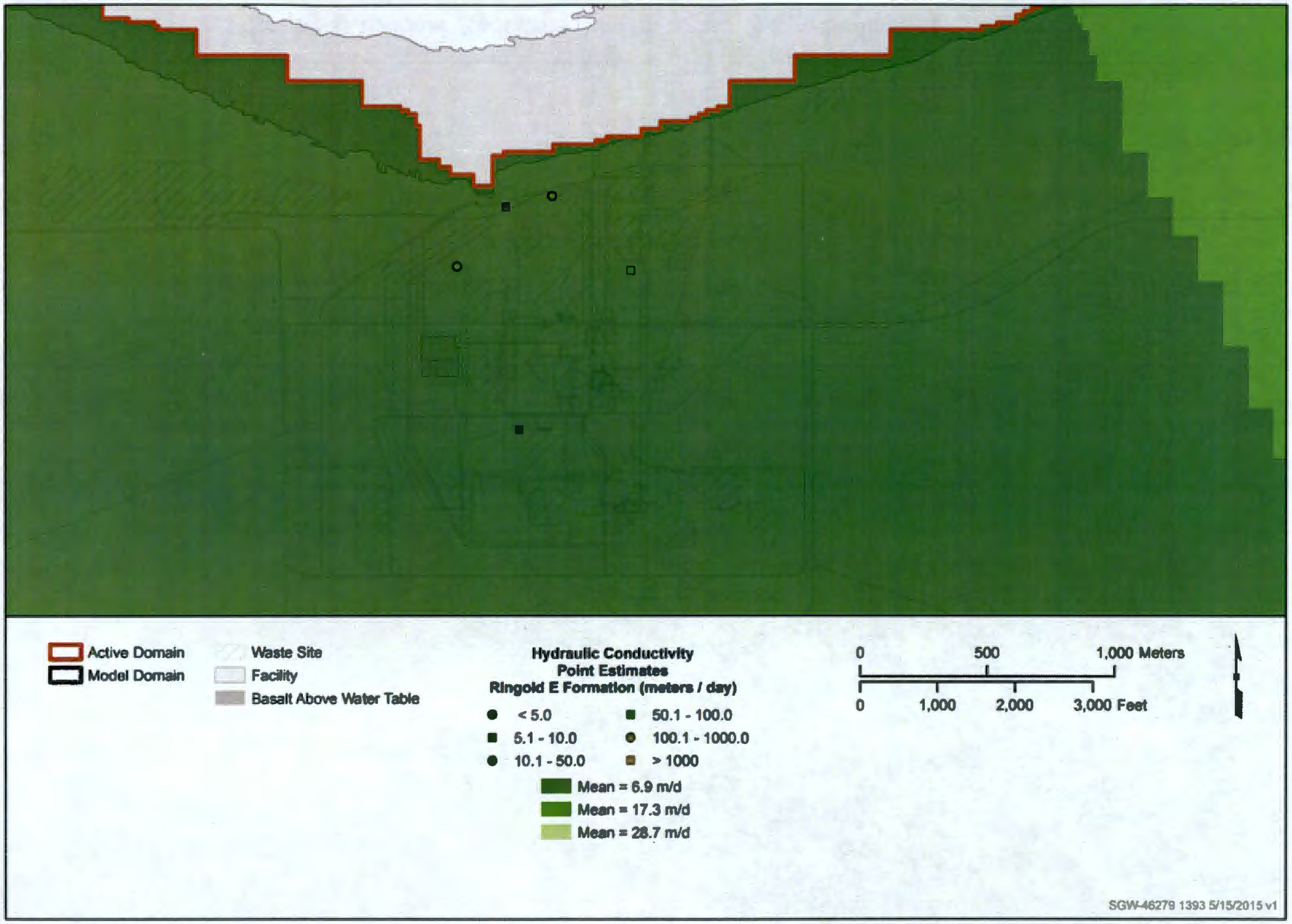



**Figure 3-32. Hydraulic Conductivity Point Estimates (100-B) in the Ringold E Formation**

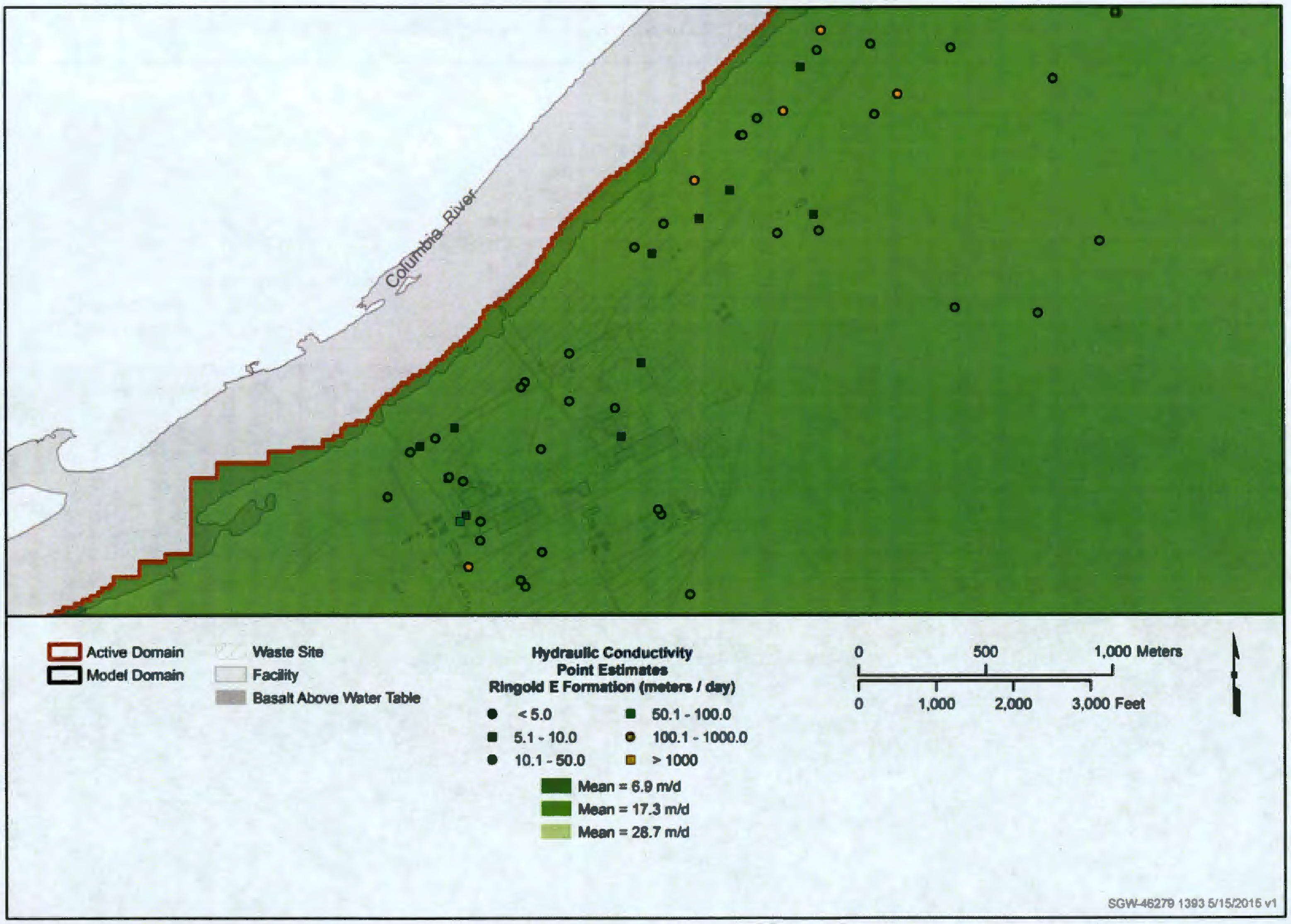



**Figure 3-33. Hydraulic Conductivity Point Estimates (100-K) in the Ringold E Formation**

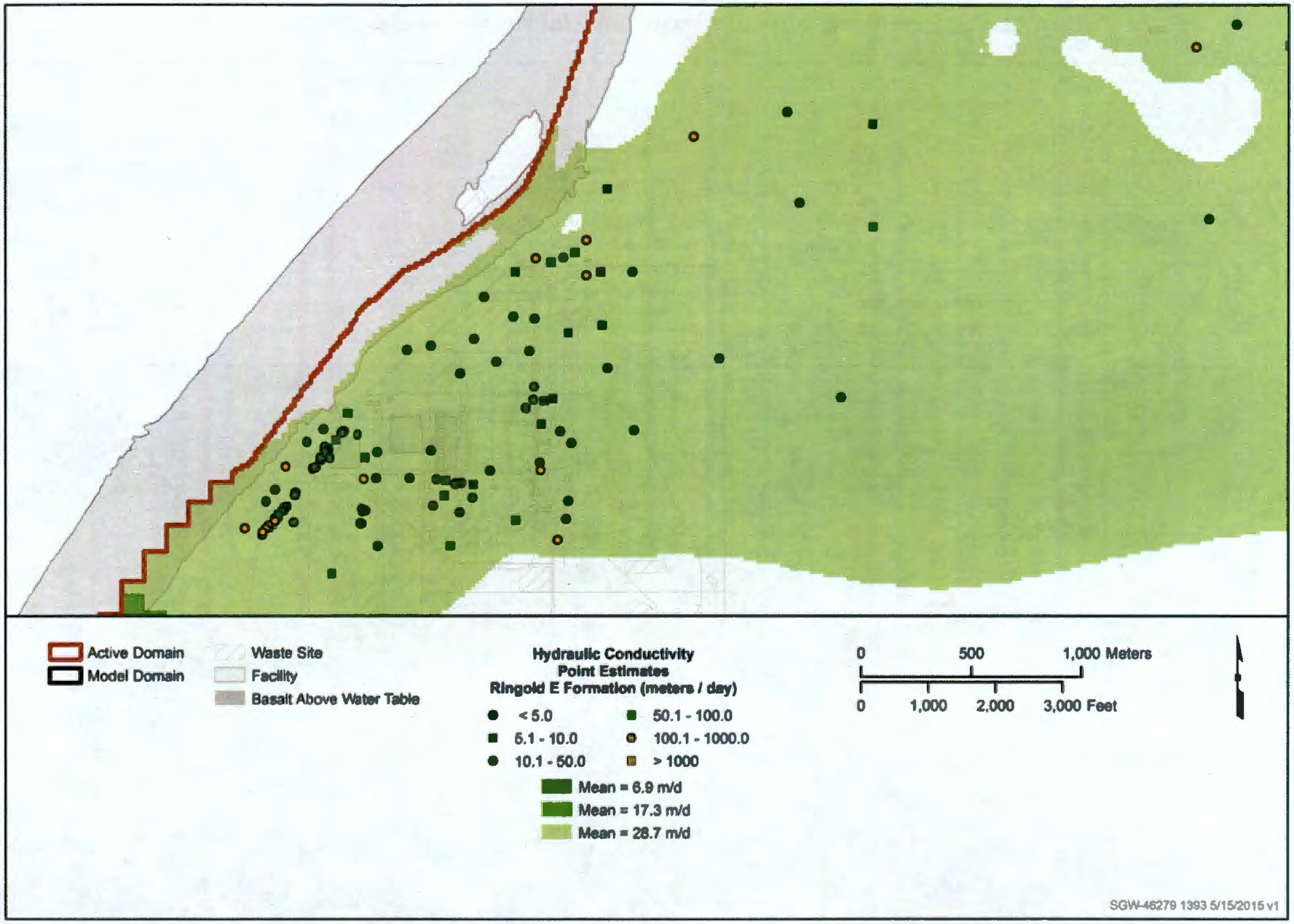



Figure 3-34. Hydraulic Conductivity Point Estimates (100-D) in the Ringold E Formation

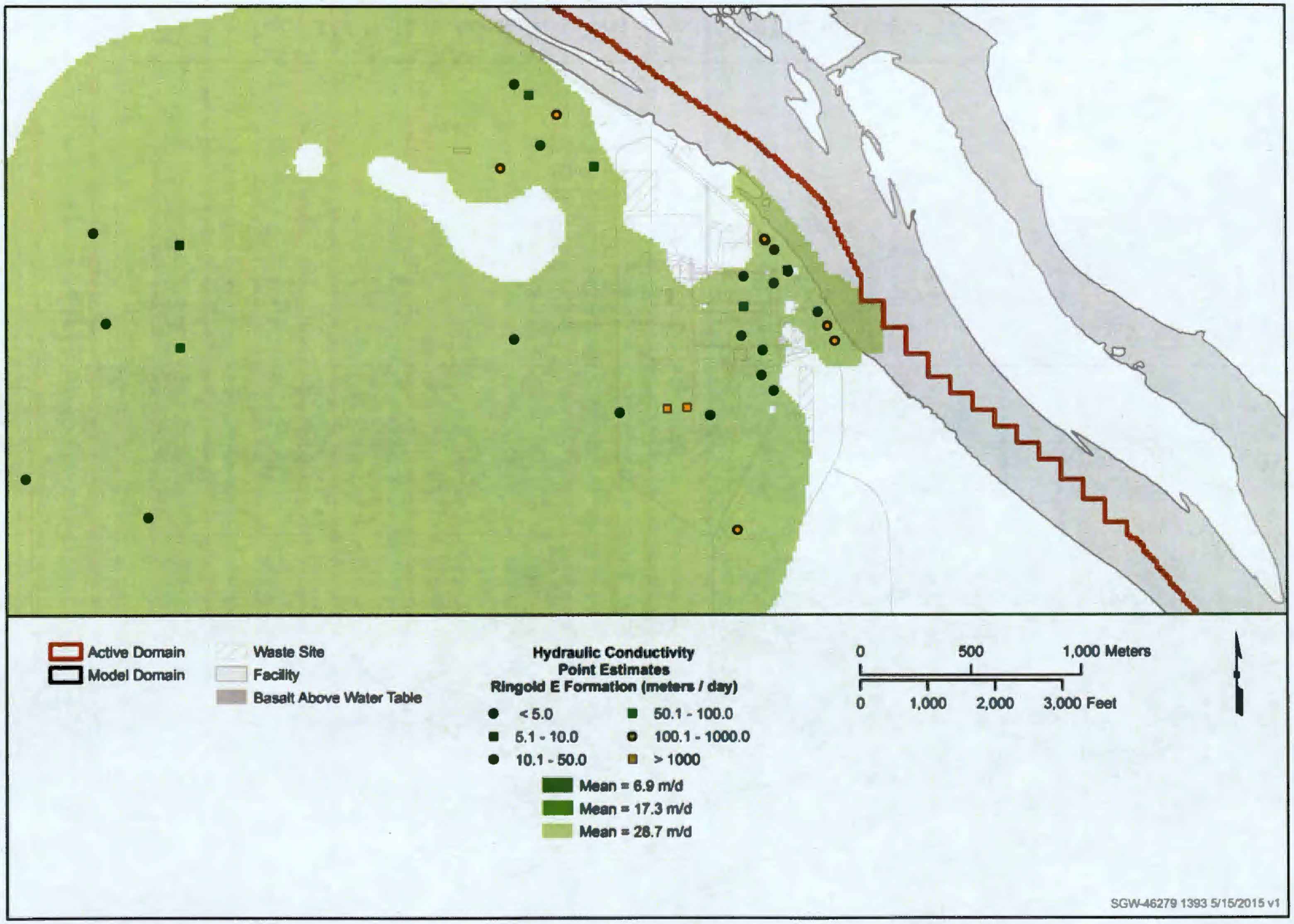



**Figure 3-35. Hydraulic Conductivity Point Estimates (100-H) in the Ringold E Formation**

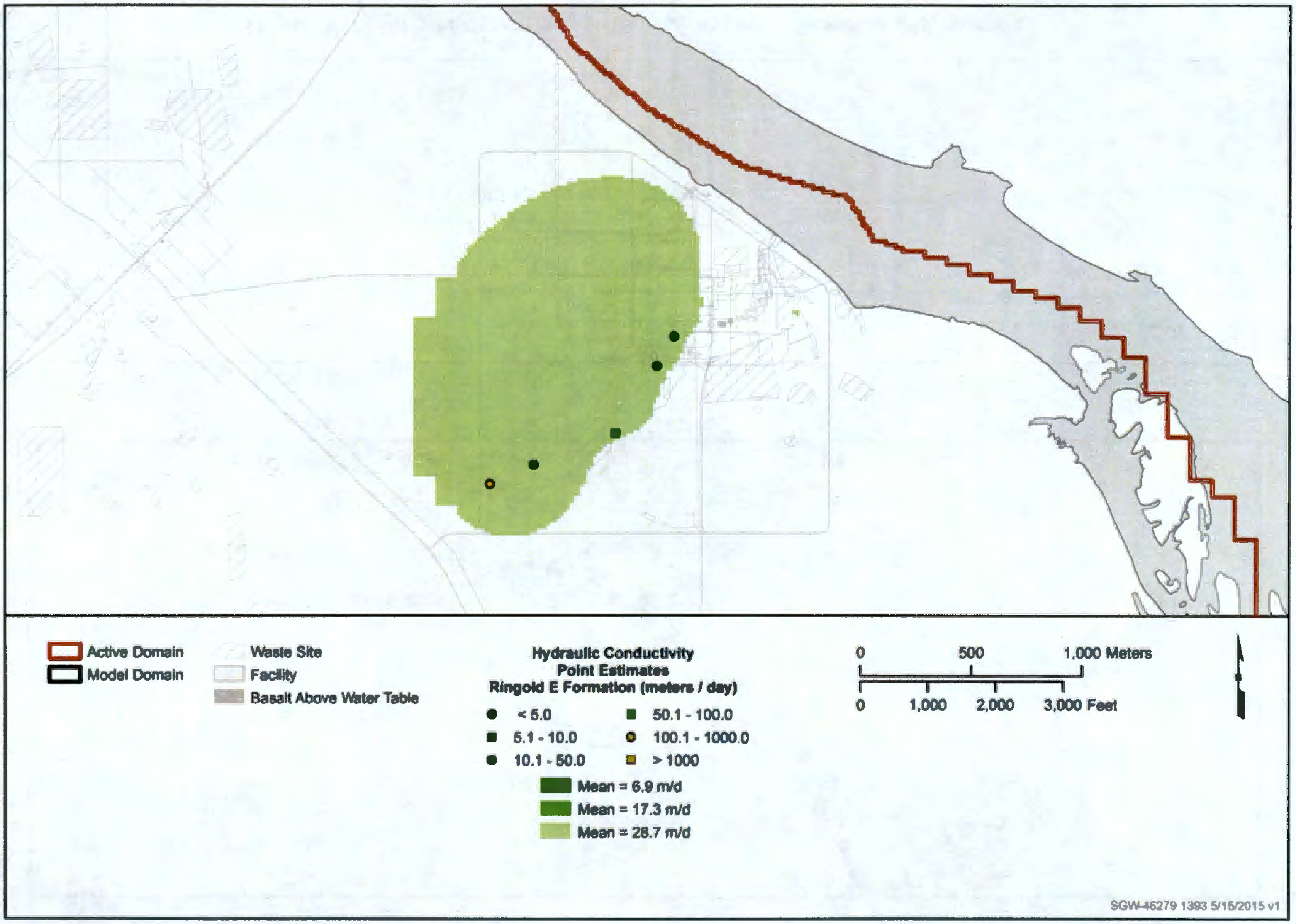



Figure 3-36. Hydraulic Conductivity Point Estimates (100-F) in the Ringold E Formation

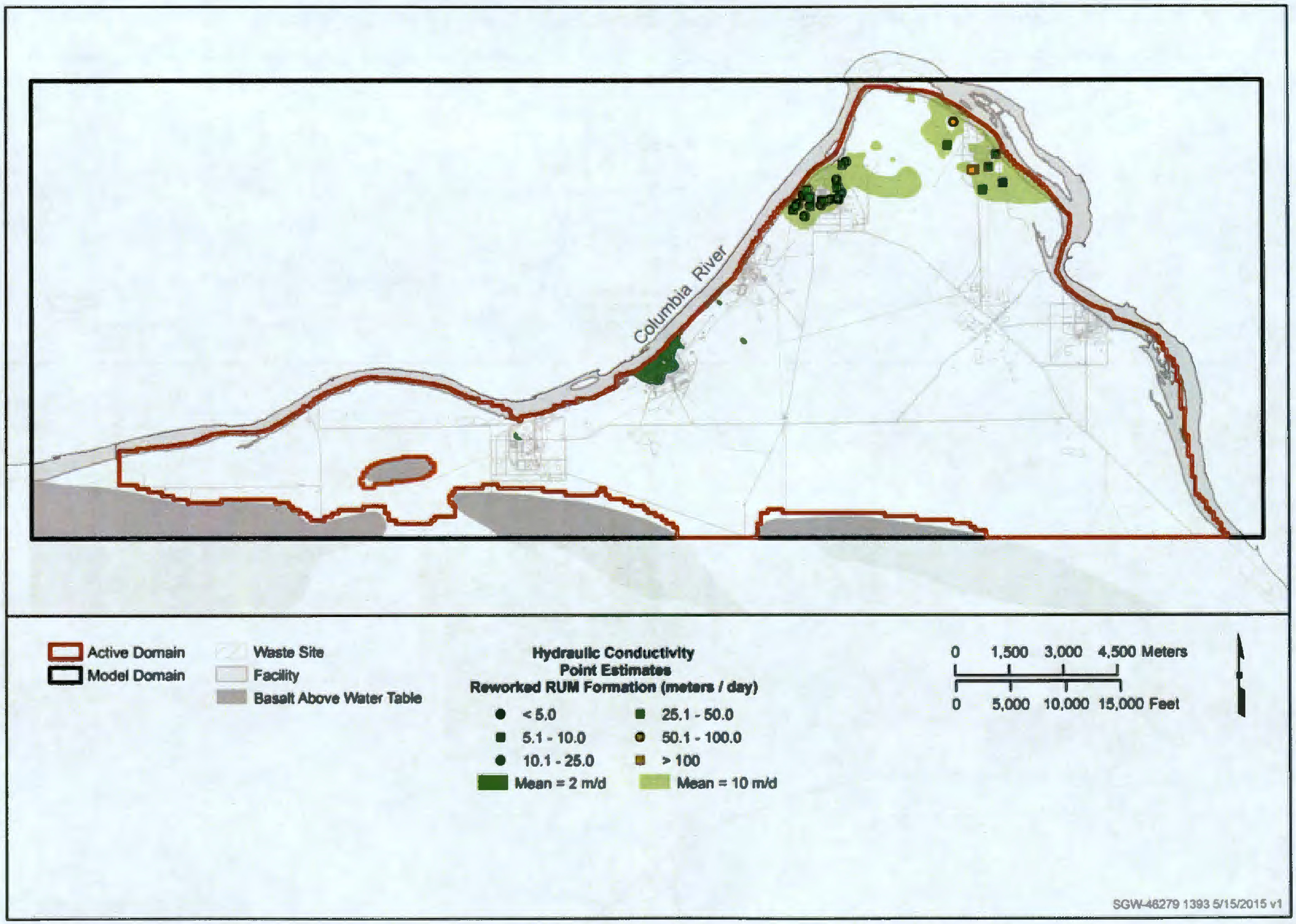



Figure 3-37. Hydraulic Conductivity Point Estimates in the Reworked RUM Formation

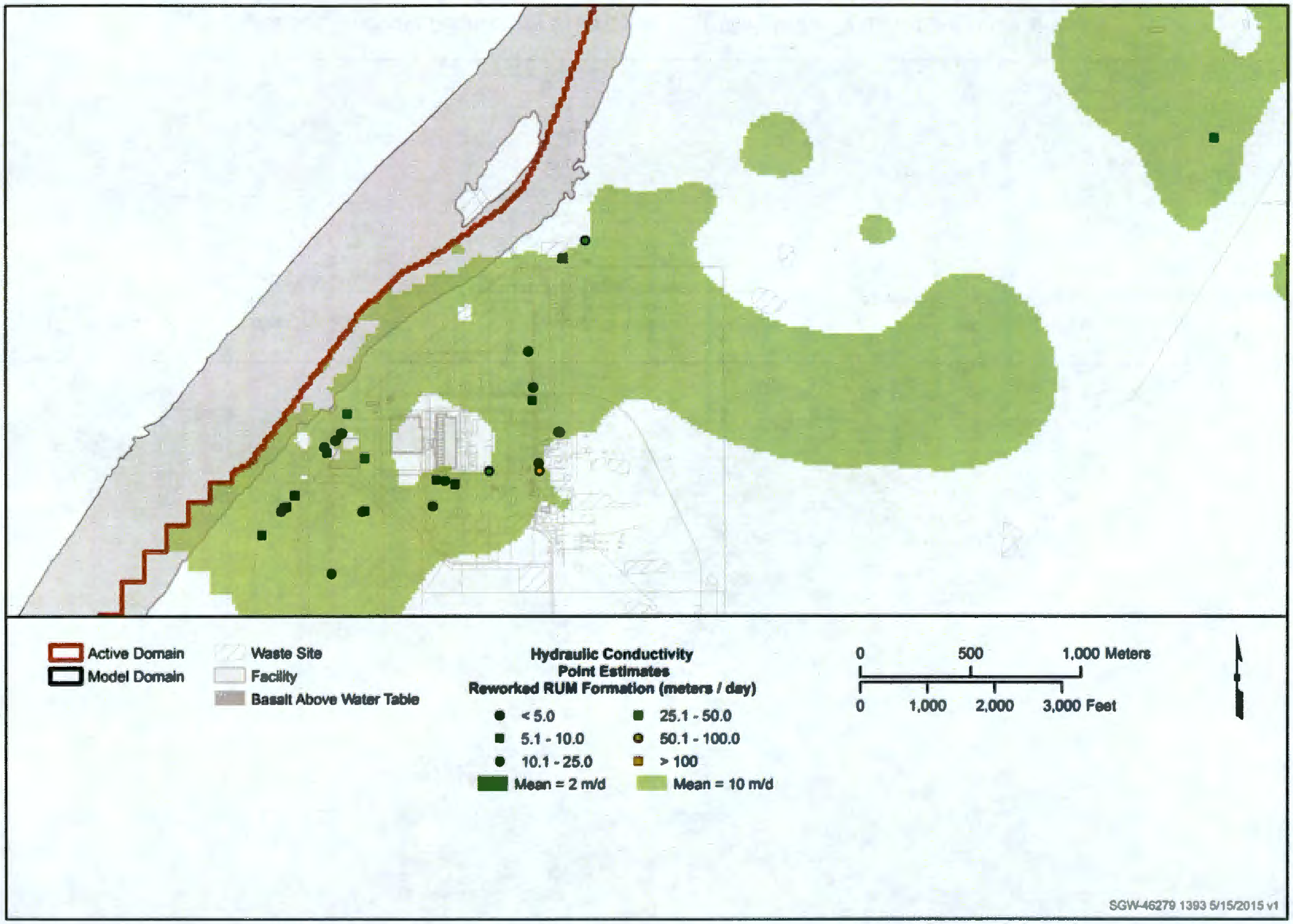



Figure 3-38. Hydraulic Conductivity Point Estimates (100-D) in the Reworked RUM Formation

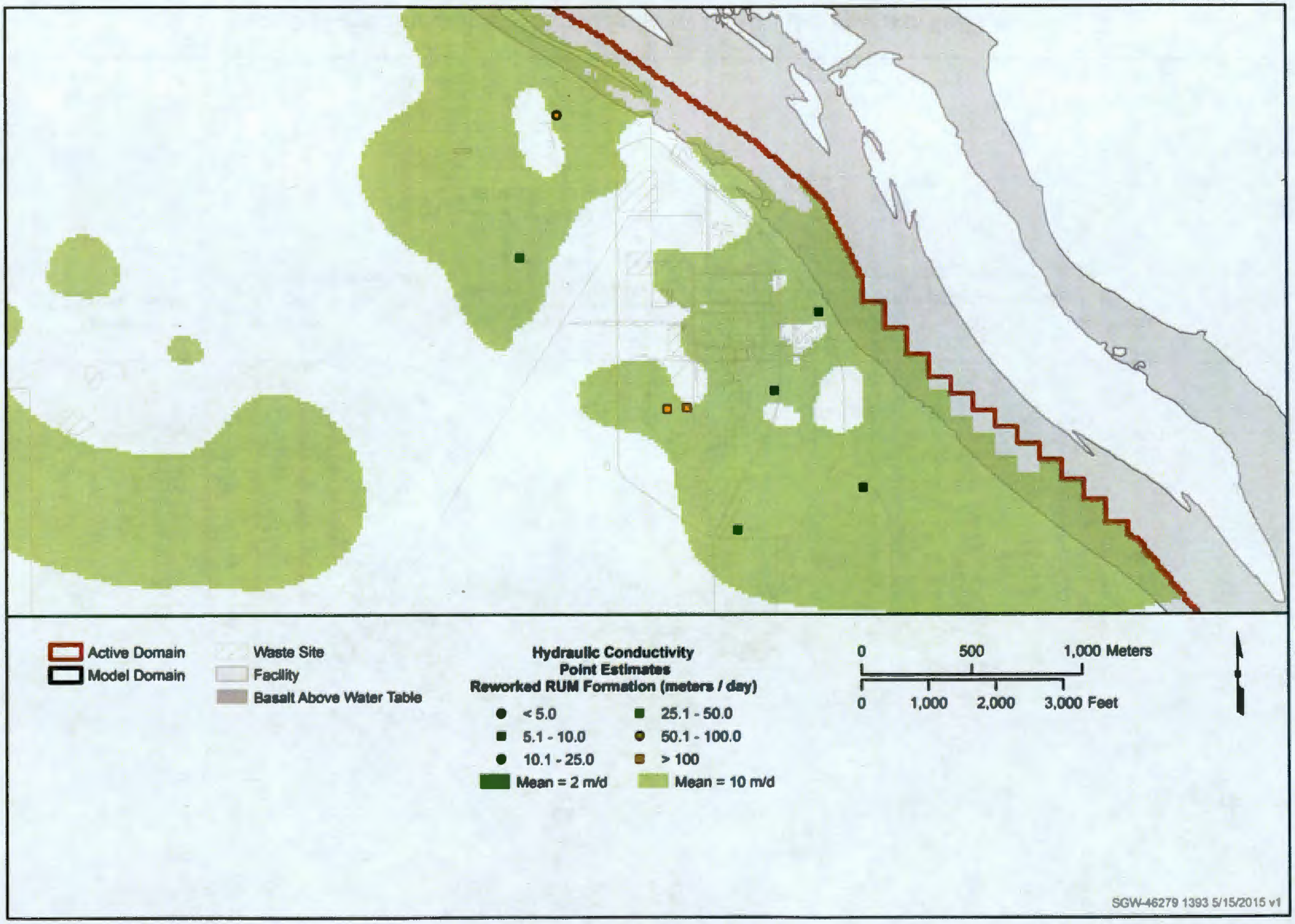



**Figure 3-39. Hydraulic Conductivity Point Estimates (100-H) in the Reworked RUM Formation**

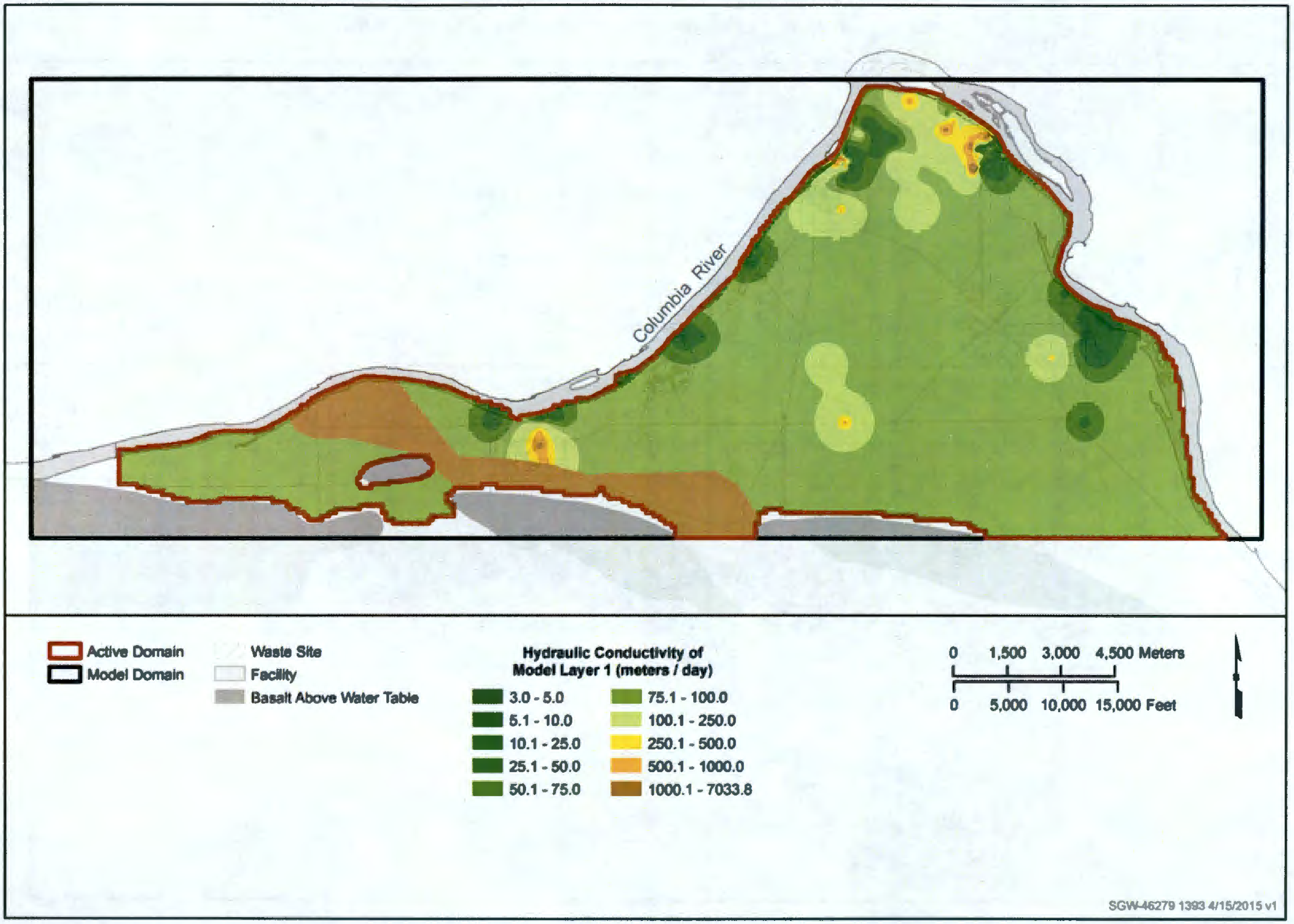



**Figure 3-40. Horizontal Hydraulic Conductivity Distribution in Layer 1**

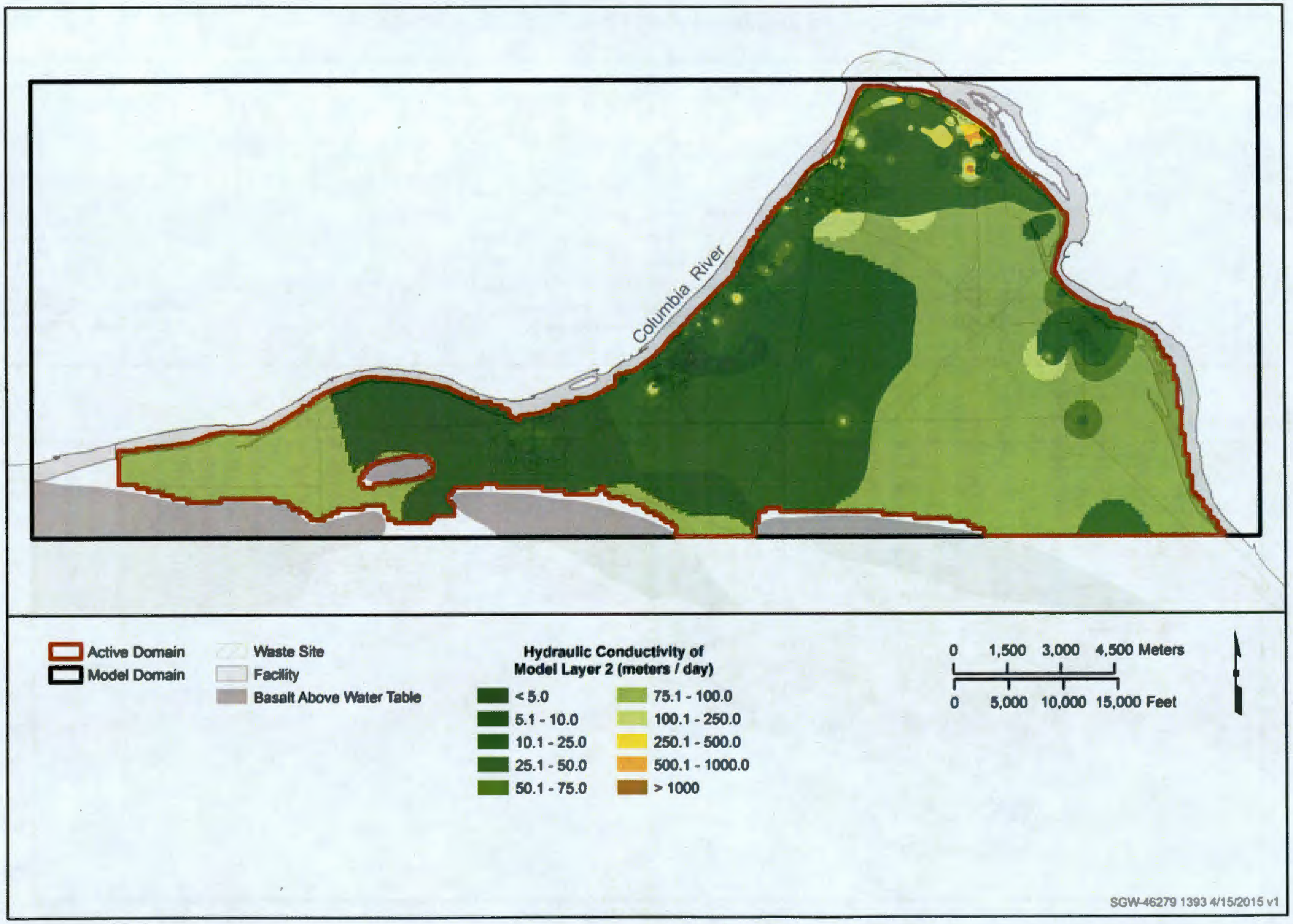



**Figure 3-41. Horizontal Hydraulic Conductivity Distribution in Layer 2**

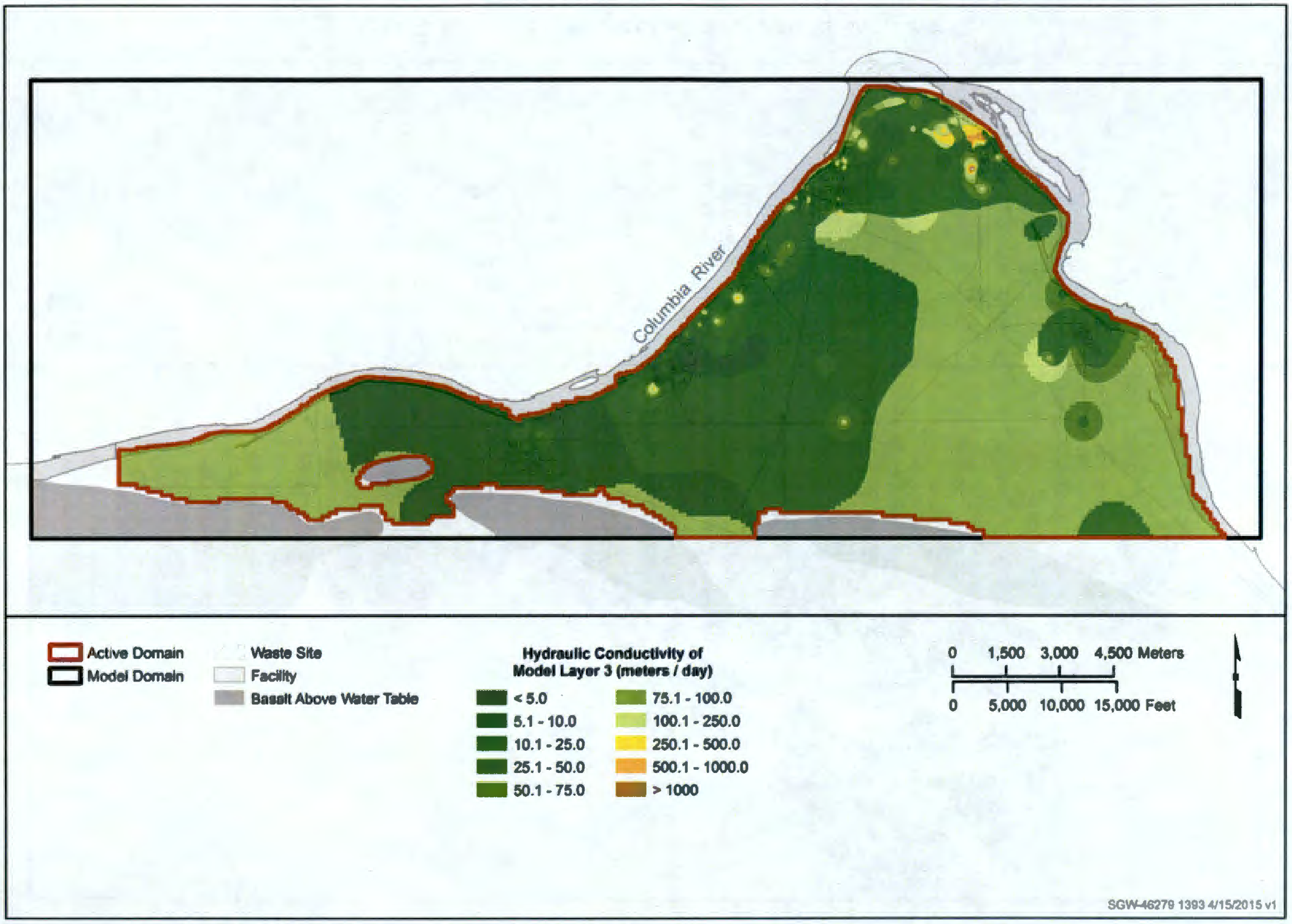



**Figure 3-42. Horizontal Hydraulic Conductivity Distribution in Layer 3**

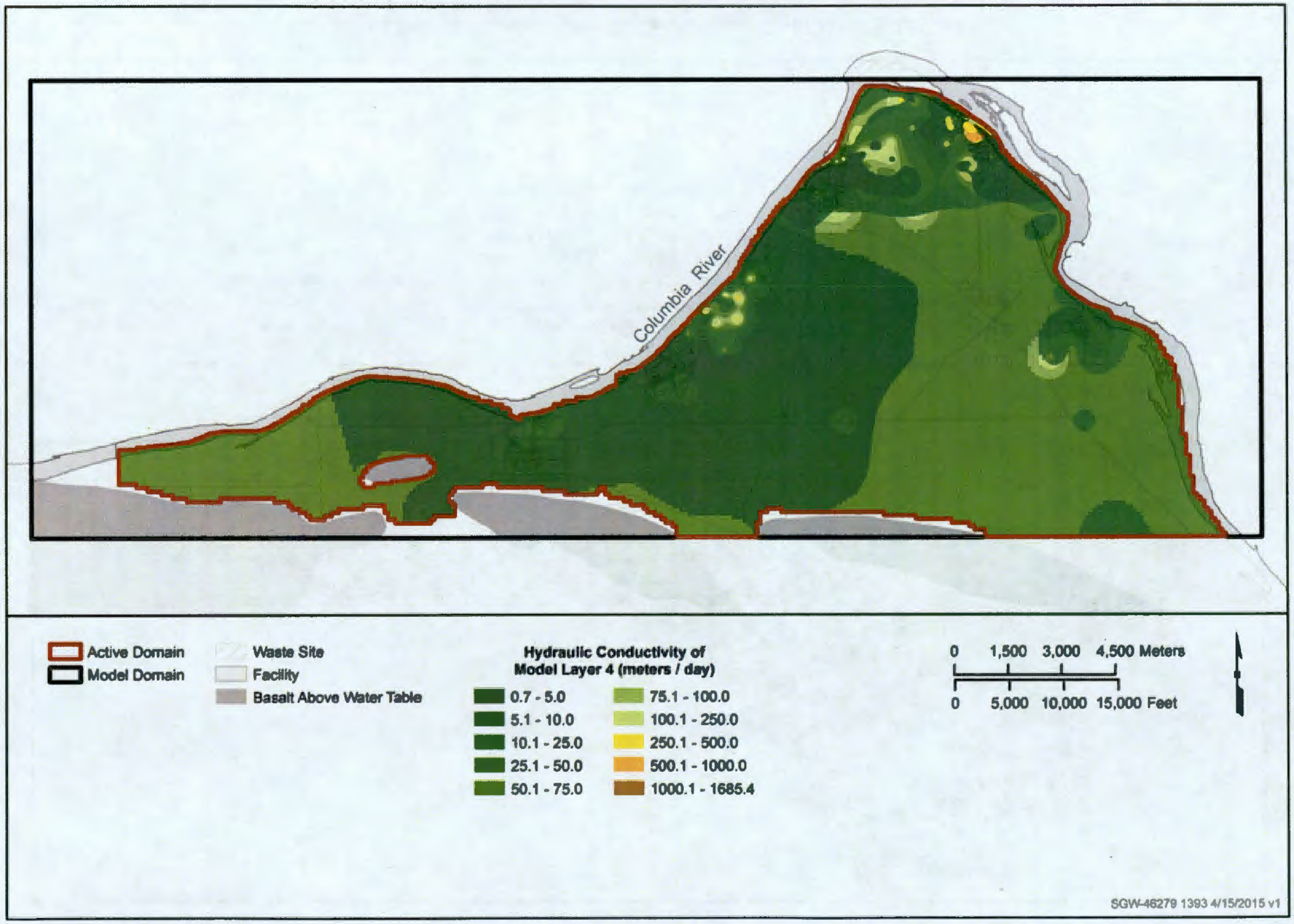



Figure 3-43. Horizontal Hydraulic Conductivity Distribution in Layer 4

### 3.5.2 Porosity and Storage

Effective porosity and specific yield values for the saturated aquifer were determined from model calibration and are equal to 0.18 and 0.10, respectively. Both values are within the range of values (0.04-0.37) documented in previous investigations for the Hanford Site (PNL-10886, *Development of a Three-Dimensional Ground-Water Model of the Hanford Site Unconfined Aquifer System: FY 1995 Status Report*; PNNL-14753). The specific yield value of 0.10 results in a satisfactory simulated groundwater response to changes in the Columbia River stage but is lower than the expected field value of specific yield. This results from the preponderance of short oscillations in the Columbia River stage, the duration of which does not elicit the full value of the specific yield. A similar phenomenon has been noted in aquifer tests conducted in the Central Plateau (PNNL-19695, *Large-Scale Pumping Test Recommendations for the 200-ZP-1 Operable Unit*), which suggested that many weeks of sustained head change might be required before the bulk of the water table drainage occurs. Although use of 0.10 for specific yield in the historical model results in an improved calibration versus the use of higher values, the use of this value in predictive simulations may result in more rapid simulated stabilization of the aquifer in response to groundwater extraction than will be measured in the field.

A specific storage value of $5 \times 10^{-6}$ day$^{-1}$ was assumed for the entire model. The resultant storage coefficient typically varies between $1 \times 10^{-6}$ and $2 \times 10^{-4}$ across the model domain. This value lies within the range of values in the literature for similar geologic data and it is within the range of values ($3 \times 10^{-5}$ to 0.01) documented in previous investigations for the Hanford Site (PNL-10886).

## 3.6 Simulation Period

The model simulates transient-state (i.e., time-varying) conditions in the aquifer that reflect water level changes due to river stage variations over time and changing pumping patterns corresponding to P&T operations at each OU. The historical model simulation timeframe spans the period January 2006 through December 2014, consisting of monthly stress periods with one time step per stress period for a total of 108 stress periods. These stress periods correspond to monthly average river stages, representing the time-varying river stage during that period. The first stress period is simulated as steady state (i.e., not time varying, but an effective *average* condition) to produce meaningful initial conditions for the transient stress periods that follow. The head contours from the steady-state simulation are shown in Figure 3-44 and are consistent with the published fiscal year 2006 groundwater head distribution (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*).

## 3.7 Boundary Conditions

The MODFLOW model domain comprises active cells where the flow of groundwater is simulated and inactive cells where the flow of groundwater is not simulated. In general, the inactive cells are located beyond the shores of the Columbia River that form the lateral extents of the model to the northwest and northeast, and in the area of Gable Mountain and Gable Butte to the south.

The MODFLOW simulation code comprises a main program that provides the basic requirements for simulating groundwater flow, as well as a series of packages that provide the capability to simulate particular features of the groundwater system. The 100AGWM MODFLOW model uses packages that simulate the following:

- Flow of water to and from major surface water bodies (river package [RIV])

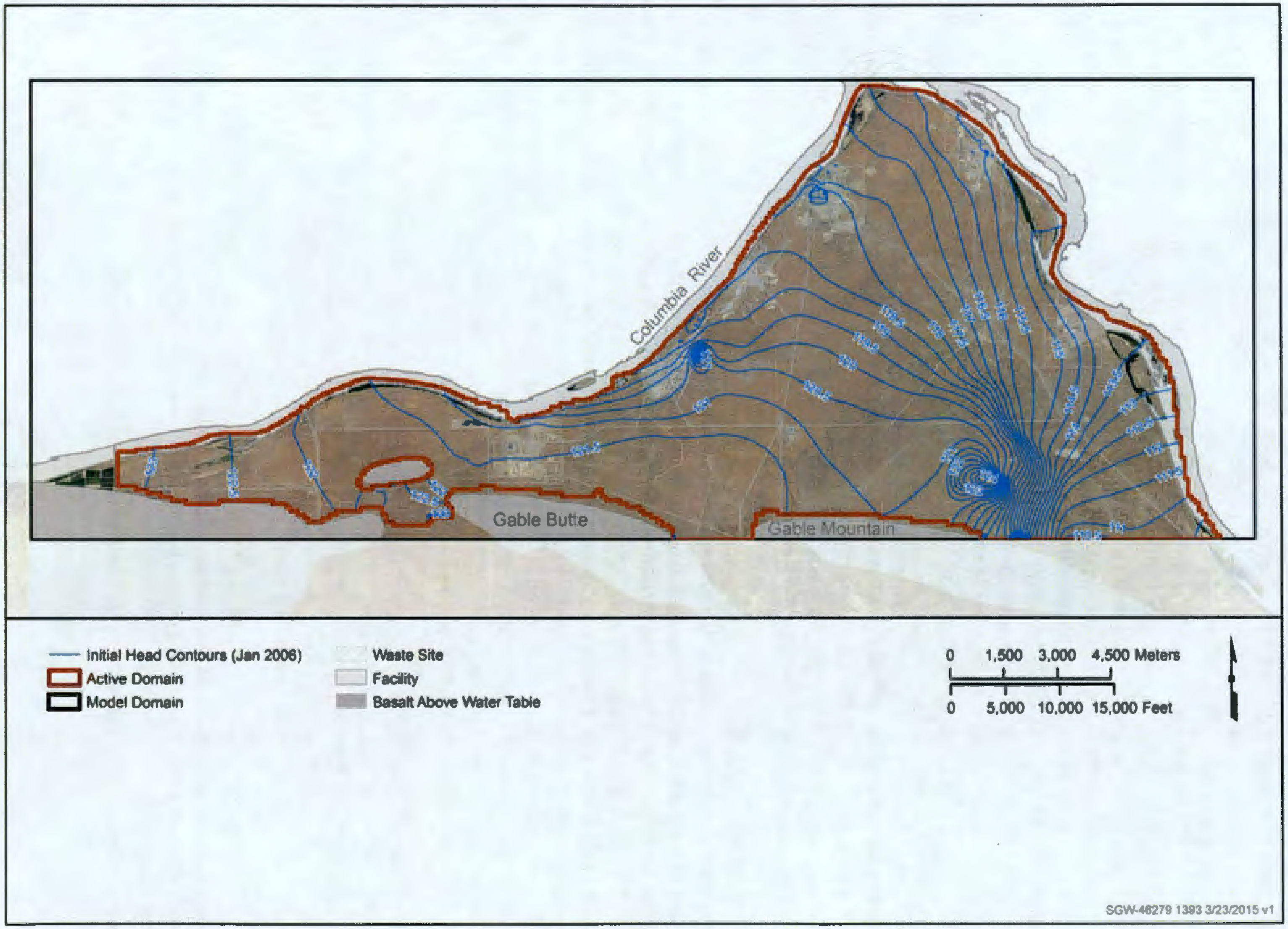



**Figure 3-44. Steady-State Head Contours at the End of the First Stress Period**

- Lateral flow into and out of the model domain based on information about the aquifer transmissivity and hydraulic gradient (general head boundary package [GHB])
- Lateral flow into and out of the model domain based on a prescribed hydraulic head at particular cells (constant head boundary package [CHD])
- Areal recharge (recharge package [RCH])
- Flow of water to and from wells (multi-node well package [MNW2])

Figure 3-45 illustrates the distribution of active and inactive model cells, and the location of lateral boundaries specified for the 100AGWM MODFLOW model.

### 3.7.1 River Boundary

The river package (RIV) was used to represent the flow of water to and from the Columbia River. Due to the diurnal and seasonal fluctuations of the Columbia River stage, a varying number of model cells in each layer was identified as river cells during each stress period, to represent the varying river stage and associated spatial extent of inundation. River stage and riverbed conductance were calculated for each stress period, reflecting monthly average conditions as discussed in the following text.

River stage data at the USGS gauge 12472800 (located below Priest Rapids Dam) was processed and summarized for the period January 2006 through December 2014. Data gaps were filled by linearly interpolating between the closest two known points. Stages at the K, N, D, and 300 gauges were estimated using regression equations developed in ECF-Hanford-13-0028, *Columbia River Correlation for the Hanford Area*. Similar regression equations for the B and F gauges were developed to aid in the analysis. It is noted that the gauges were not monitored for the entire duration of the simulation period. Additionally, there were documented gauge shifts (Personal Communication, Sage, 2011). As a result, the period for which regression equations were developed does not extend to the duration of the simulation period. The regression equations are presented in Table 3-4 and the locations of gauges are shown in Figure 3-46. Due to the long distance between the F and 300 gauges and knowledge of the slope of the bed of the Columbia River obtained from available bathymetric data, linear interpolation of the stage between these two gauges was not deemed appropriate. Hence, two additional interpolation points (F1 and F2) were included in the analysis to replicate the change in bed slope south of F (Figure 3-47).

Monthly average river stage values were calculated at each gauge location in the 100 Area and at the location of the two control points. In order to accurately represent the transient river boundary geometry, cross-sections of the river bathymetry extending inland were developed in ArcGIS. These cross-sections were developed along the river centerline at 15 m (49.2 ft) intervals, using river bathymetry and LiDAR data (Personal Communication, Royer, 2014). Along each cross-section, the river extent and corresponding cell inundation laterally inland from the river centerline, and the associated wetted perimeter, were calculated for river stage elevations varying between 105 m (344.5 ft) and 130 m (426.5 ft), at 0.25 m (0.8 ft) intervals. This information was stored in a SQL Server Database. The 3D transient River Package was created by running the Python Script *ProcRiverStage_v9.py* followed by *FinalGapFill.py*. River boundary cells were created for each of the 108 months in the simulation period and associated hydraulic properties were calculated based the following sequence of steps:

- River stage elevations were calculated at each cross-section by linearly interpolating the calculated river stage elevations between upstream and downstream river gauges.

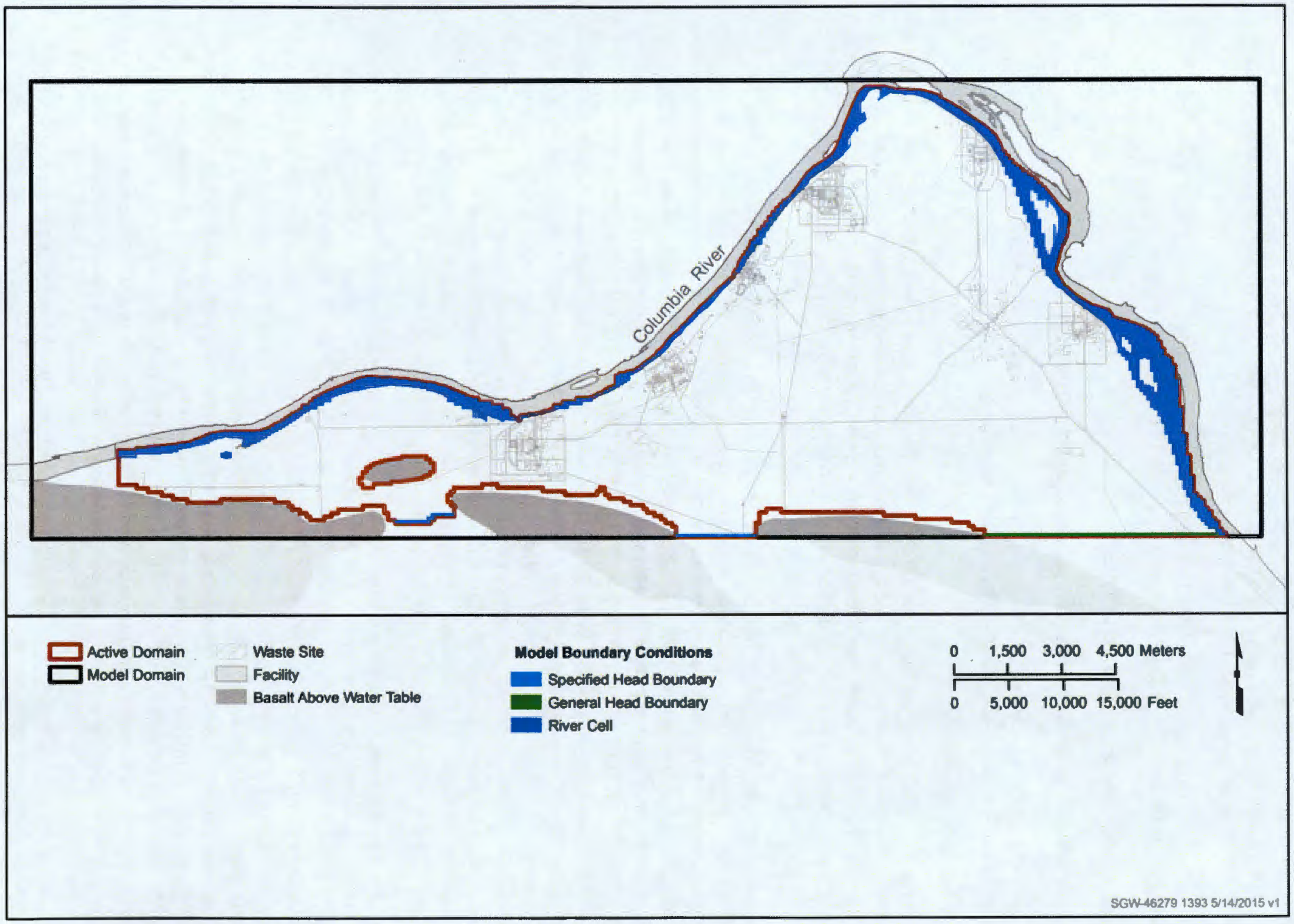



**Figure 3-45. Location of Active and Inactive Model Cells and Lateral Boundary Conditions**

**Table 3-4. Hanford Area River Stage Locations and Regression Analysis Results**

| Location Name | Transducer Location[a] | | | River Stage Regression Equation[d] | Regression Equation $R^2$ Value | River Stage Lag Time (hour) | Source |
|---|---|---|---|---|---|---|---|
| | Easting[b] | Northing[b] | USGS River Mile[c] | | | | |
| USGS Station 12472800 | 548730.63 | 144197.48 | 394.5 | n/a | n/a | n/a | ECF-Hanford-13-0028 |
| 100-B River Gauge | 564832.29 | 145242.19 | 384.1 | y = 0.8315x + 17.040 | 0.98 | 1.00 | Appendix B |
| 100-K River Gauge | 568758.16 | 147084.25 | 381.5 | y = 0.8406x + 14.113 | 0.97 | 1.50 | ECF-Hanford-13-0028 |
| 100-N River Gauge | 570988.731 | 149457.1 | 379.5 | y = 0.7866x + 20.457 | 0.96 | 1.75 | ECF-Hanford-13-0028 |
| 100-D River Gauge | 572778.4 | 151738.44 | 377.7 | y = 0.6492x + 37.056 | 0.94 | 1.75 | ECF-Hanford-13-0028 |
| 100-H River Gauge | 577547.54 | 153492.956 | 372.9 | y = 0.7318x + 24.305 | 0.98 | 2.50 | ECF-Hanford-13-0028 |
| 100-F River Gauge | 580977.00 | 148139.84 | 368.4 | y = 0.7765x + 17.199 | 0.97 | 3.00 | Appendix B |
| Location F1 | 582928.45 | 146556.25 | 364.0 | y = 0.94*F_stage + 0.06*300_stage | n/a | n/a | |
| Location F2 | 584712.81 | 141947.83 | 356.0 | y = 0.55*F_stage + 0.45*300_stage | n/a | n/a | |
| 300 Area River Gauge | 594582.109 | 115779.646 | 344.2 | y = 0.4039x + 55.012 | 0.78 | 8.50 | ECF-Hanford-13-0028 |

**Table 3-4. Hanford Area River Stage Locations and Regression Analysis Results**

| Location Name | Transducer Location[a] | | | River Stage Regression Equation[d] | Regression Equation $R^2$ Value | River Stage Lag Time (hour) | Source |
|---|---|---|---|---|---|---|---|
| | Easting[b] | Northing[b] | USGS River Mile[c] | | | | |

a. The transducer location specifies the location along the Columbia River where the regression equations, $R^2$ values, and lag times apply. If regression equations are applied at locations other than those specified, the calculated river stage will decrease in accuracy as the distance from the specific location increases.

b. Easting and Northing columns show the State Plane Coordinates (SPC) for Zone 4602 for each transducer. For USGS Station 12472800, location information was converted from NAD83, *North American Datum of 1983*, Latitude/Longitude to SPC using the National Geodetic Survey's conversion tool located at http://www.ngs.noaa.gov/cgi-bin/spc_getpc.prl. 100-K, 100-N, 100-D, and 100-H SPC are reported in the automated water level network (AWLN). At the time of this report, 300-River Gauge SPC reported in the AWLN appeared incorrect and were in the process of being rectified. As a result, SPC based on a survey conducted by PNNL in 2004 were used for the 300 Area river gauge in lieu of SPC found in the AWLN.

c. USGS river mile refers to the distance (to the nearest tenth of a mile) from the mouth of the Columbia River to the river gauge. The USGS river mile for Station 12472800 was reported on the USGS website listed in the inputs and references section. USGS river mile for each Hanford Area transducer was determined using ArcGIS 10.1 by first measuring the distance from the location specified by the SPC to the nearest USGS river mile and then adding/subtracting this distance, as appropriate, to/from the nearest USGS river mile.

*y* = Columbia River elevation above mean sea level (AMSL) in meters relative to NAVD88, *North American Vertical Datum of 1988*, at the specified Hanford Area location

x = Columbia River elevation AMSL in meters relative to NAVD88 at USGS Station 12472800. Time series data measured at Priest Rapids Dam must be corrected for lag time prior to substituting into the regression equation.

R2 = coefficient of determination

USGS = U.S. Geological Survey

- At each cross-section, the extents of the river, the inundated river cells, and the wetted perimeter were determined by finding the closest match to the calculated stage in the SQL database. A limited number of river cells were used to represent the river in the model at each cross-section, determined such that a sufficient minimum number of cells would always be present to define the river during both low and high river stage periods.
- The river was connected to Layer 1 of the model as long as the stage was above the cell bottom elevation. At certain locations, the model cells below Layer 1 have the nominal thickness discussed in Section 3.4. In such cases, the river was connected to those layers as long as the stage is above their cell bottom elevations. This is illustrated in Figure 3-48 for the case of the river penetrating two model layers.
- The conductance of the cross-section was calculated using equation 3-4. The calculated conductance was distributed among those river cells being used in the model to represent the river. A factor of 0.5 is used in the equation because it was assumed that aquifer recharge/discharge from/to the river occurs equally between the 100 Areas and the areas north and east of the river. The wetted perimeter is determined based on the length of wet riverbed calculated from the number of wet river cells, and the vertical hydraulic conductivity in each of the river cells as the mean zonal value from the HCOND distribution used in the model. A riverbed thickness of 0.3 m (0.98 ft) was used based on the information presented in PNNL-14824, *River Data Package for the 2004 Composite Analysis*.

$$conductance = 0.5 * \frac{Wetted\ Perimeter * Vertical\ Hydraulic\ Conductivity}{River\ Bed\ Thickness} \qquad 3\text{-}4$$

The location of the river gauges, and the river boundary cells during extreme high and low river stage events (June 2011 and September 2007, respectively) are shown in Figure 3-46. The riverbed profile downstream of the F gauge is shown in Figure 3-47. The calculated monthly average river stage elevations are shown in Figure 3-49. Examples of river cell definition per model layer are illustrated in Figures 3-50 and 3-51 for low and high river stage conditions, respectively.

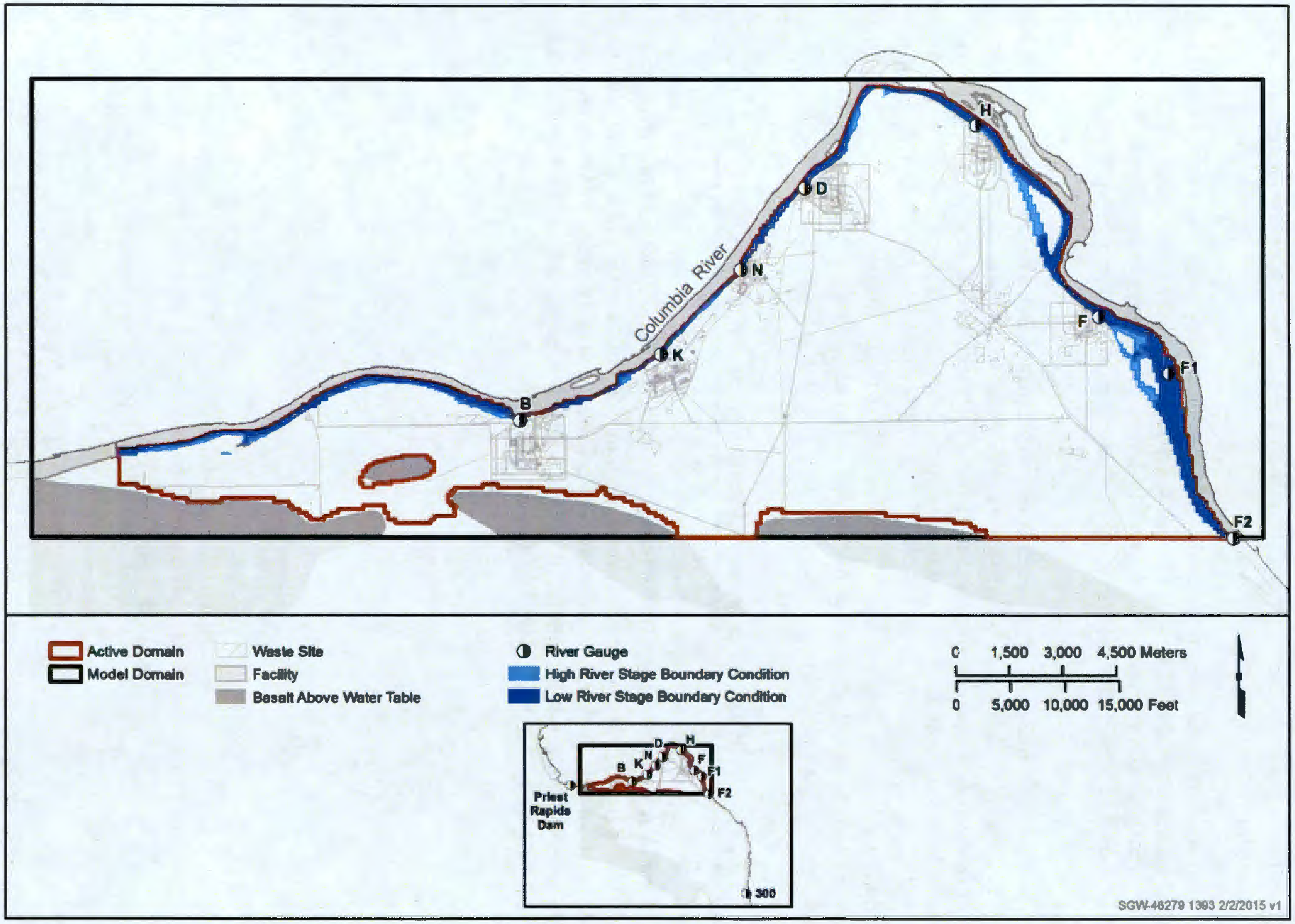



Figure 3-46. Location of River Gauges and High/Low River Stage Boundary Cells

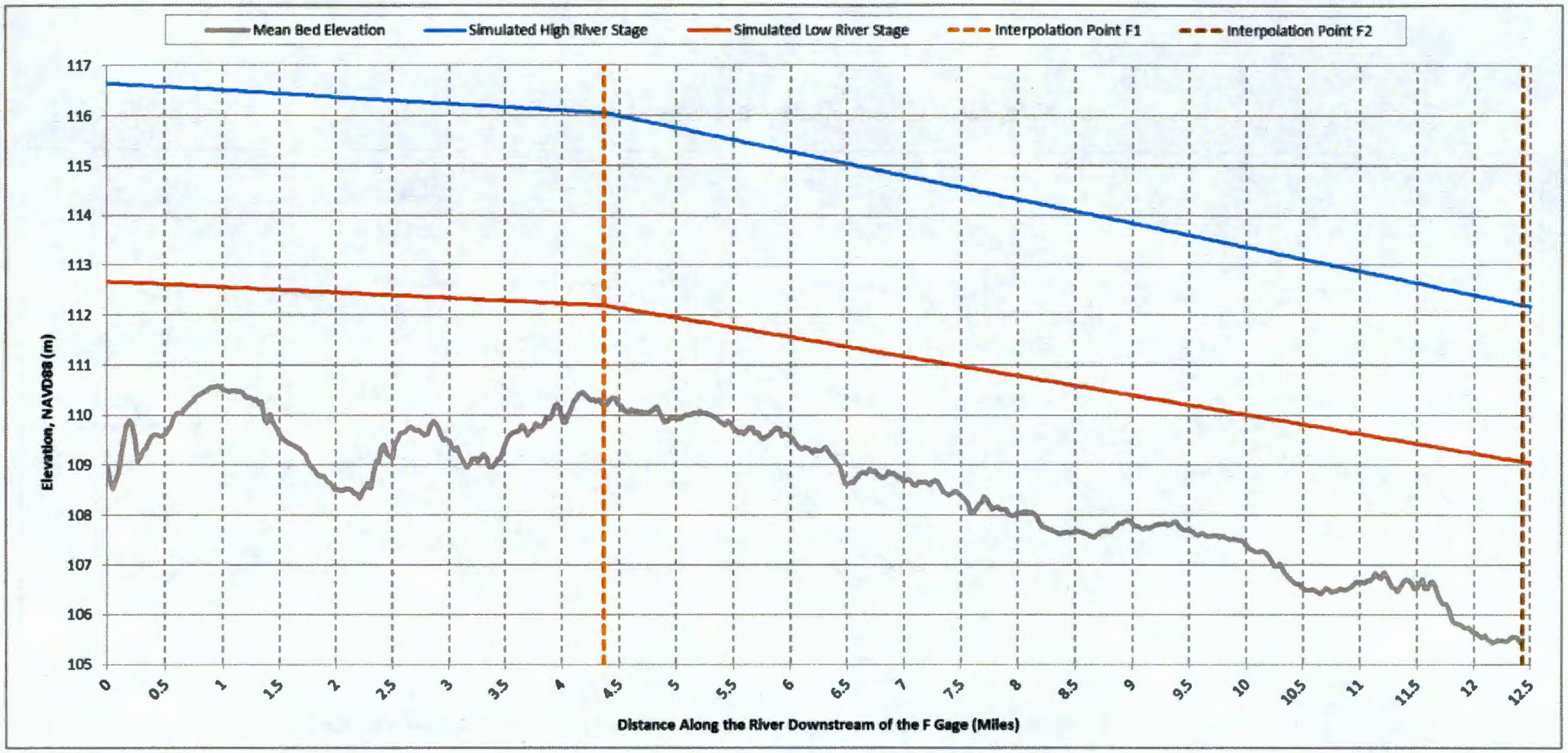



**Figure 3-47. Riverbed Profile Downstream of the F River Gauge**

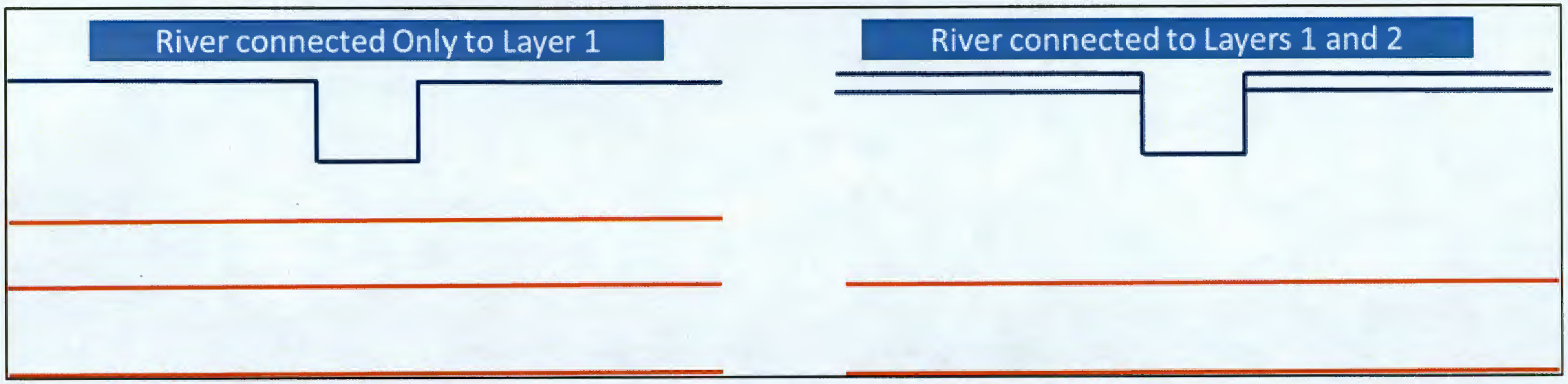



**Figure 3-48. Schematic Example of Vertical Connection Between River and Aquifer Cells for Layers 1 and 2**

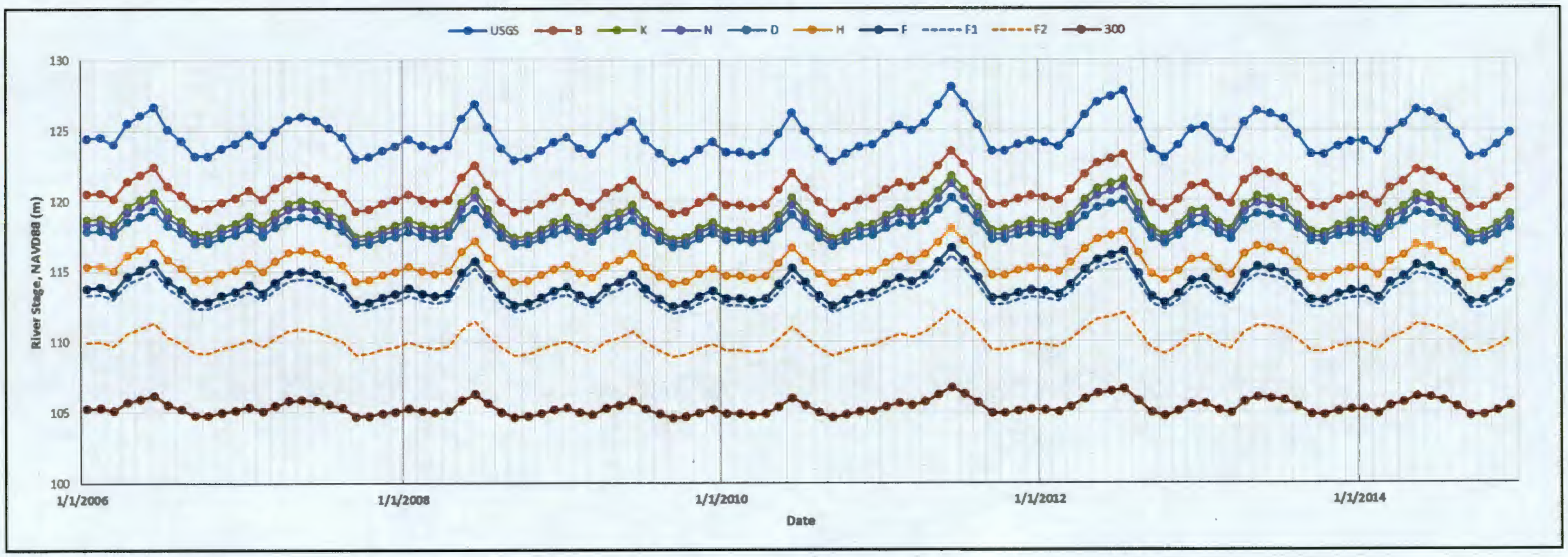



**Figure 3-49. Calculated Monthly Average River Stage**

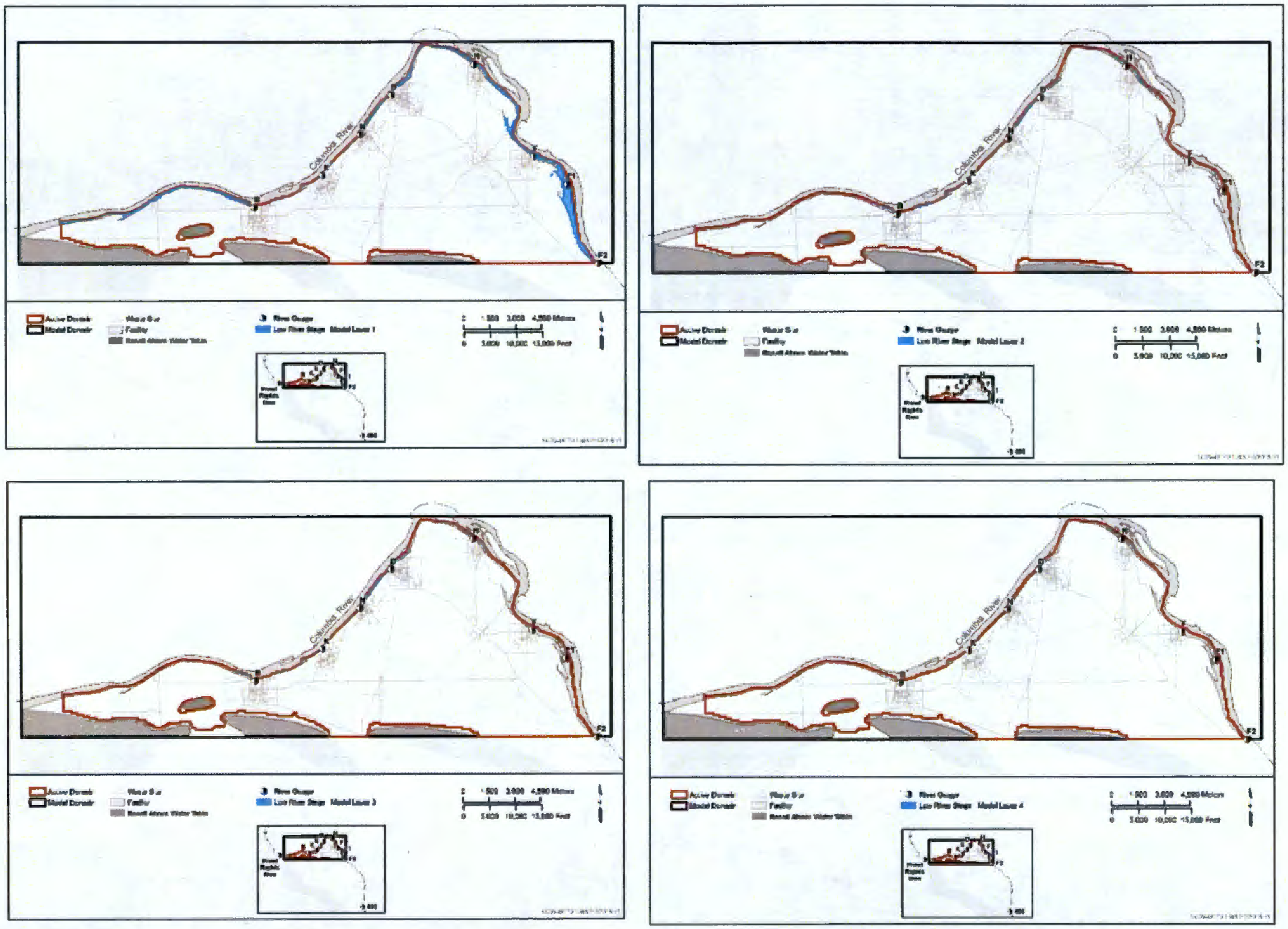


**Figure 3-50. River Cells per Model Layer for Low River Stage Conditions (September 2007)**

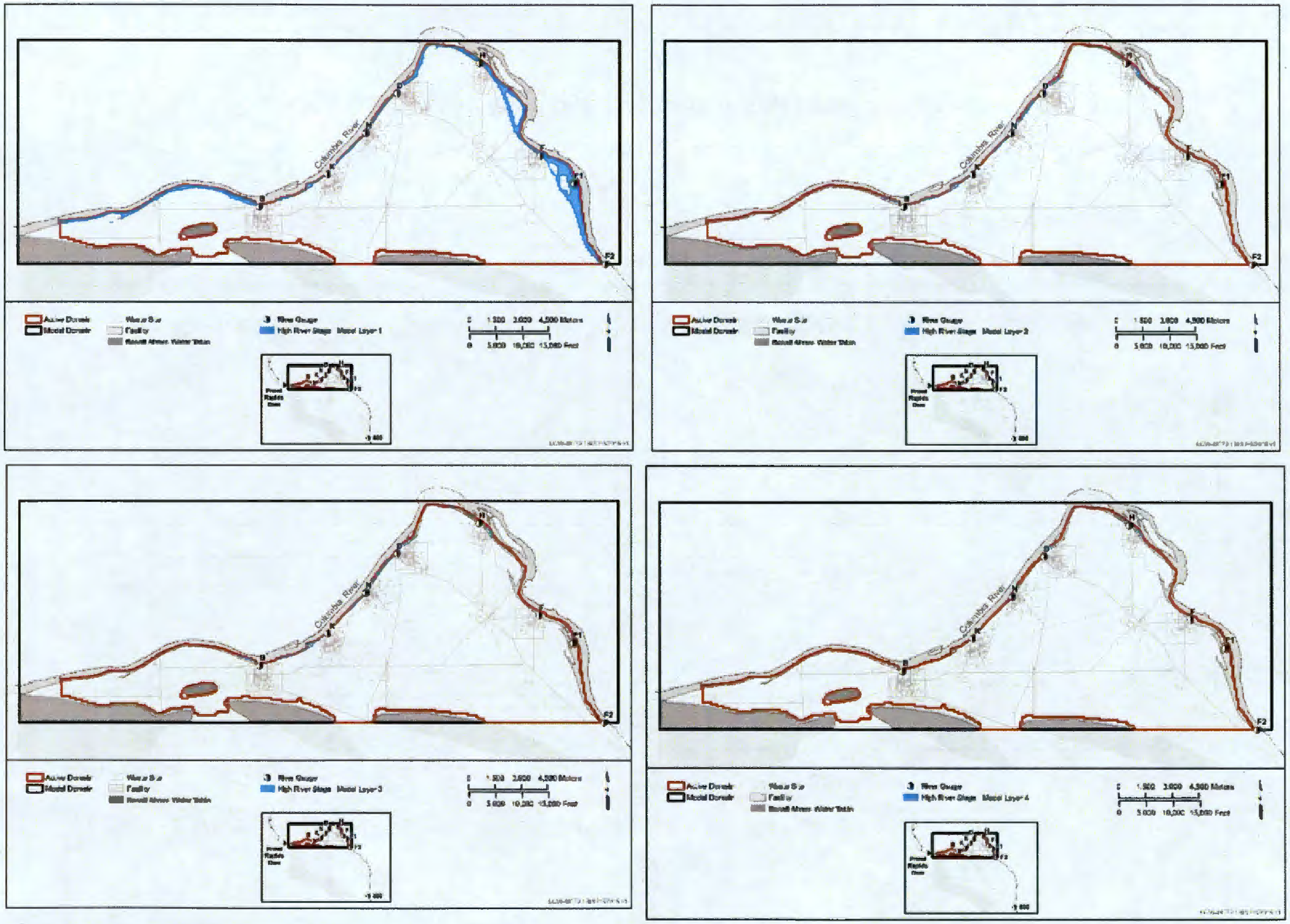


Figure 3-51. River Cells per Model Layer for High River Stage Conditions (June 2011)

### 3.7.2 General Head Boundary

The GHB package was used to represent the flow into and out of the model domain along the southeast model boundary between the Gable Mountain and the Columbia River. The model cells with GHB cells assigned are shown in Figure 3-45. The hydraulic head specified at these GHB cells was equal to the river stage elevation at the southern-most river cell (Row 663, Column 1153) in the model. A conductance value of 5.0 $m^2day^{-1}$ was estimated during model calibration. The GHB head was varied with the river stage, as defined in the river package (RIV). In any given stress period and of all GHB cells along that boundary, cells were assigned GHB properties if the bottom elevation of the cell was below the calculated GHB head. The variation of the GHB head over the simulation period is shown in Figure 3-52. The GHB package was created using the utilities *CalcRiverBasedGHB.exe* and *checkghb.py.*

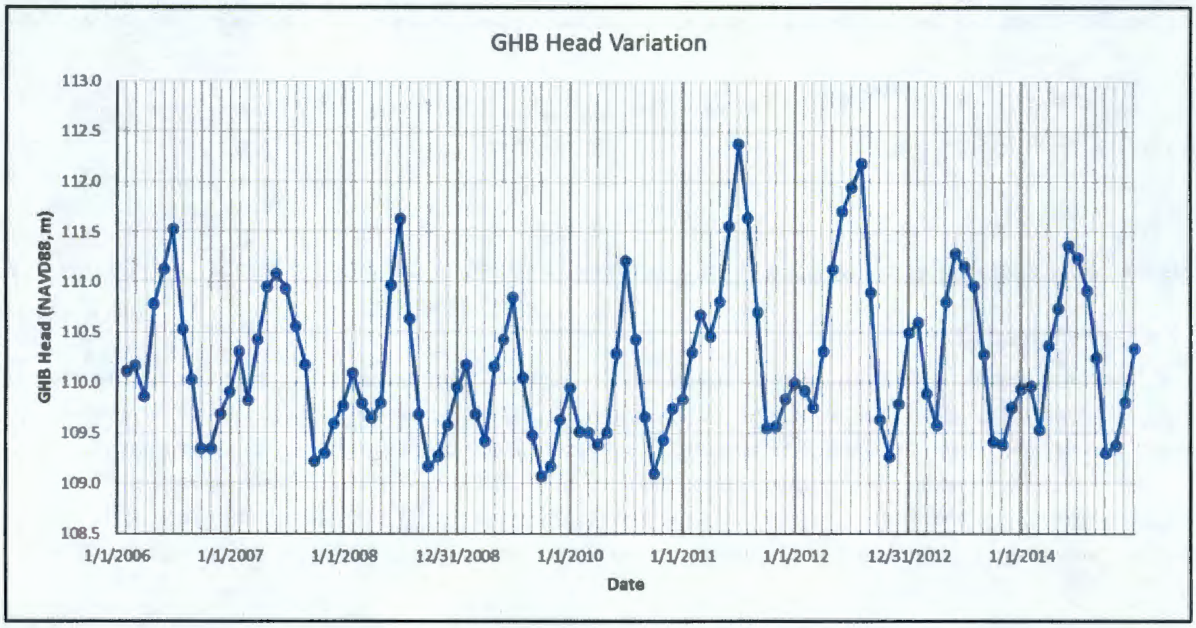



**Figure 3-52. Hydraulic Head Time Series for General Head Boundary Condition Between Gable Mountain and the Columbia River**

### 3.7.3 Constant Head Boundary

Time-varying specified heads, implemented via the constant head boundary package (CHD) package, were used to represent the hydraulic head distribution along model cells representing the Western Gap and the Gable Gap, between the Gable Butte and the Gable Mountain. The constant head boundary cells are shown in Figure 3-45. The prescribed hydraulic head at those boundary cells is consistent with hydraulic heads calculated by the Central Plateau model described in CP-47631, *Model Package Report: Central Plateau Groundwater Model Version 6.3.3*, at the same locations. The specified hydraulic heads are shown in Figure 3-53.

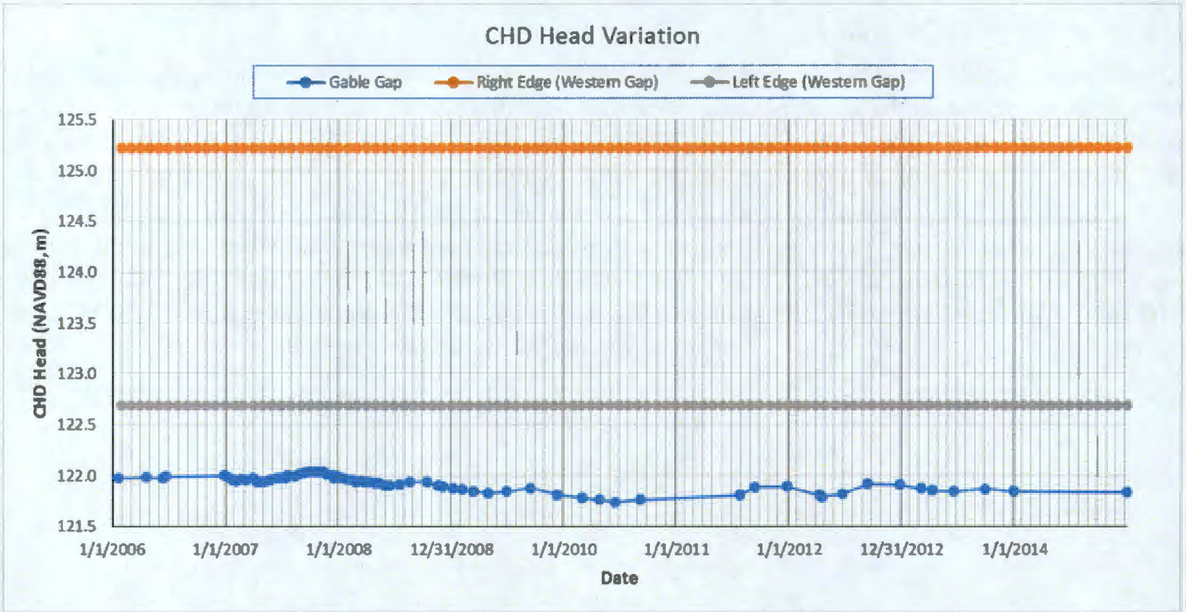



**Figure 3-53. Hydraulic Head Time Series for Constant Head Boundary Condition at Western and Gable Gaps**

### 3.7.4 Areal Recharge

Areal recharge from precipitation was assessed by PNNL, which developed a recharge distribution that was included in PNNL-14753. An electronic version of the recharge package developed in the PNNL report was obtained, and the data were spatially distributed to the model grid cells. Based on the results of manual model calibration, the recharge value specified in the 100AGWM domain was then uniformly scaled to provide improved fit to measured groundwater elevations. This resulted in a typical value for groundwater recharge equal to 12 mm/yr throughout the model domain except for the storage reservoirs in the 100-B and 100-D Areas.

Locally, additional areal recharge is considered in 100-B/C and 100-D Areas, representing leakage from the corresponding water reservoirs. The 182-D reservoir remains in use as one of two sources of untreated raw water (i.e., non-potable water) to supply the Hanford Site. Results of water level monitoring at the 182-D reservoir indicate that approximately 31 million L (8.2 million gal) of water leaked to the ground between November 2005 and March 2006. Three distinct leakage events that were identified are summarized in SGW-38338, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document*:

- November 5 through December 15, 2005: Approximately 22 million L (5.8 million gal)
- January 1 through February 3, 2006: Approximately 4.9 million L (1.3 million gal)
- February 23 through March 13, 2006: Approximately 4.5 million L (1.1 million gal)

Leakage rates were 386 L/min, 100 L/min, and 163 L/min (102 gallons per minute [gpm], 26 gpm, and 43 gpm), respectively, for the three events. The water table below the reservoir rose temporarily in response to the first and third leakage events. Based on these documented events, the reservoir was assumed to leak at the average rate of 50 gpm. Since leakage information for 182-B was not available, it was assumed that the reservoir would leak at the same rate as 182-D. At the 182-D reservoir, this resulted in a recharge rate of 5 m/yr over an area of 19,800 $m^2$. At the 182-B reservoir, a recharge rate of 4.4 m/yr over an area of 22,500 $m^2$ was calculated.

In some instances, focused recharge might occur over prolonged periods at various areas as part of ongoing deactivation and decommissioning activities. The amount of water discharged during such occasions has not typically been reported or monitored and any infiltration occurring as a result of these activities is difficult to estimate. This type of recharge is not considered in the model and impacts of such recharge to the water levels near these areas will not be reflected in model results.

### 3.7.5 Well Pumping

Well pumping rates, screened intervals, and operational periods are specified using the multi-node well package (MNW2). Eight P&T systems for treating extracted water were operational at various periods between January 2006 and December 2014 in the 100 Area OUs. The operational periods and the number of extraction/injection wells for each P&T system are shown in Table 3-5.

**Table 3-5. Pumping Treatment System Information**

| Treatment System | System ID in MNW2 Package | Number of Extraction Wells | Number of Injection Wells | System Start Date | System End Date |
|---|---|---|---|---|---|
| DR-5 | 6 | 5 | 2 | 9/6/2005 | 4/20/2011 |
| DX | 1 | 41 | 14 | 12/17/2010 | (ongoing) |
| HR3 | 2 | 16 | 7 | 6/23/1997 | 5/4/2011 |
| HX | 7 | 32 | 15 | 10/1/2011 | (ongoing) |
| KR4 | 3 | 17 | 6 | 9/1/1997 | (ongoing) |
| KW | 4 | 10 | 6 | 1/29/2007 | (ongoing) |
| KX | 5 | 18 | 10 | 2/3/2009 | (ongoing) |
| NR2 | N/A | 4 | 2 | 9/1/1995 | 3/19/2006 |

Extraction and injection rates for 100 Area P&T wells for the period January 2006 through December 2014 are documented in Appendix C and are archived in EMMA. Wells H3-2C and H4-12C were excluded from the model because these wells are screened in the RUM, which is not part of the model domain. The NR2 treatment system was operational only for the first three months of the simulation period. Since the focus of this model is on the fate and transport of contaminants in the later part of the simulations period, these wells were not included in the model.

Well screen elevations were obtained from the Hanford Environmental Information System (HEIS) (DOE/RL-93-24-1, *Hanford Environmental Information System (HEIS) Volume 1 User's Guide*) and from spreadsheets with corrected and/or updated information ("Well Construction Data" spreadsheets, Personal Communication, Ivarson, 2013). Well screen elevations are documented in Appendix C. For wells with multiple screens, the elevations of the top of the highest and the bottom of the lowest screened interval were used.

The MNW2 package was created by executing the program *AllocateQwell.exe*. A unique identifier consisting of the well name, type (injection/extraction system), and P&T system name was used to designate each well in the MNW2 package. The locations of the extraction/injection wells operational at any time during the simulation period from January 2006 to December 2014 for the 100-K and 100-HR-3 areas are shown in Figures 3-54 and 3-55, respectively.

In future model applications, an energy balance assessment of the P&T conveyance system will be performed as part of a systematic evaluation of design flow rates and associated losses due to system components that include, but are not limited to, pipe size and length, elevation, filter type, and fittings. Head losses across the P&T conveyance system can also be related to pump capacity curves to estimate limits on extraction rates, thereby ensuring that P&T configurations and flow rates are designed considering inherent limitation to system performance that are not directly related to aquifer properties.

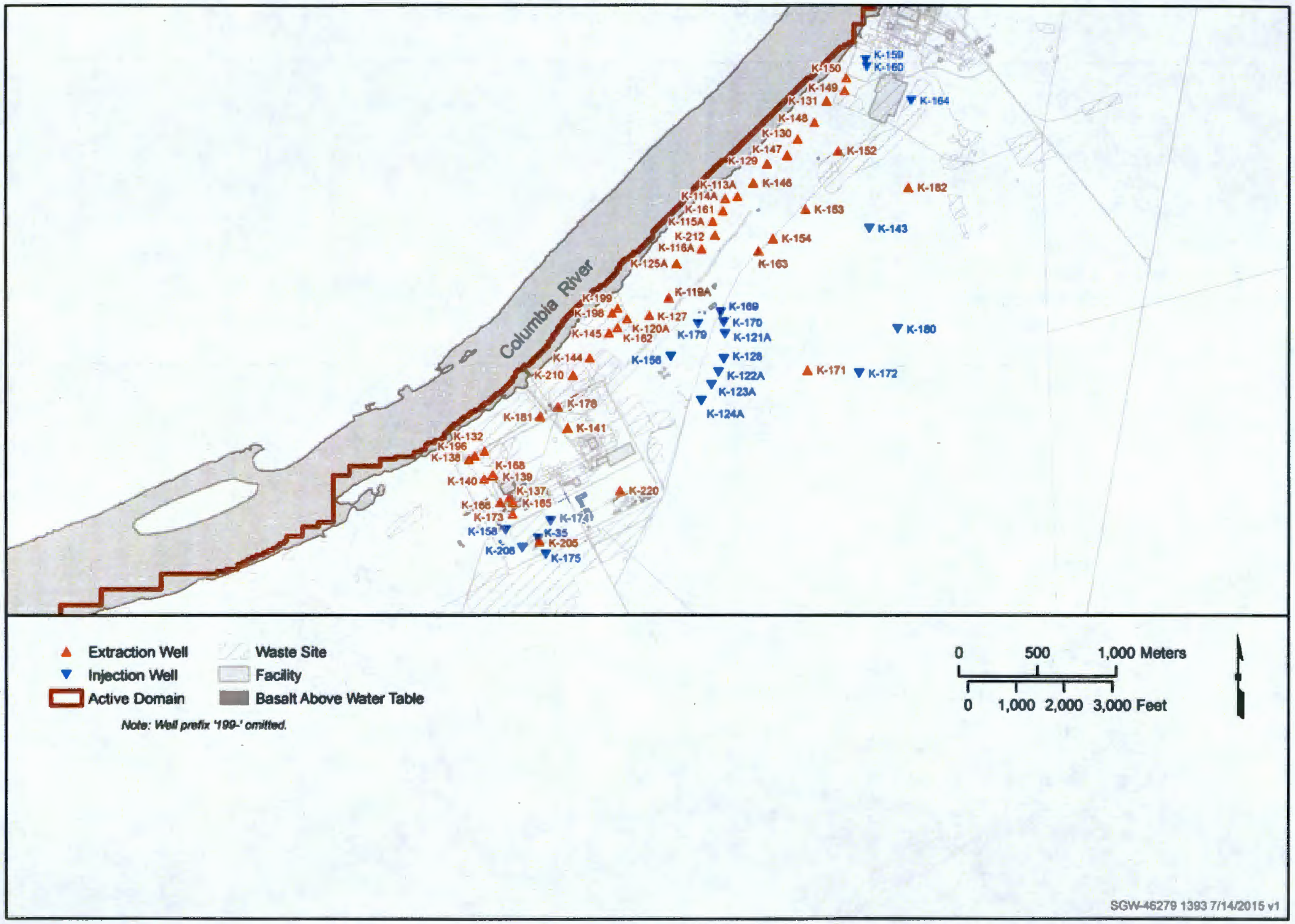



Figure 3-54. Extraction/Injection Wells in 100-K

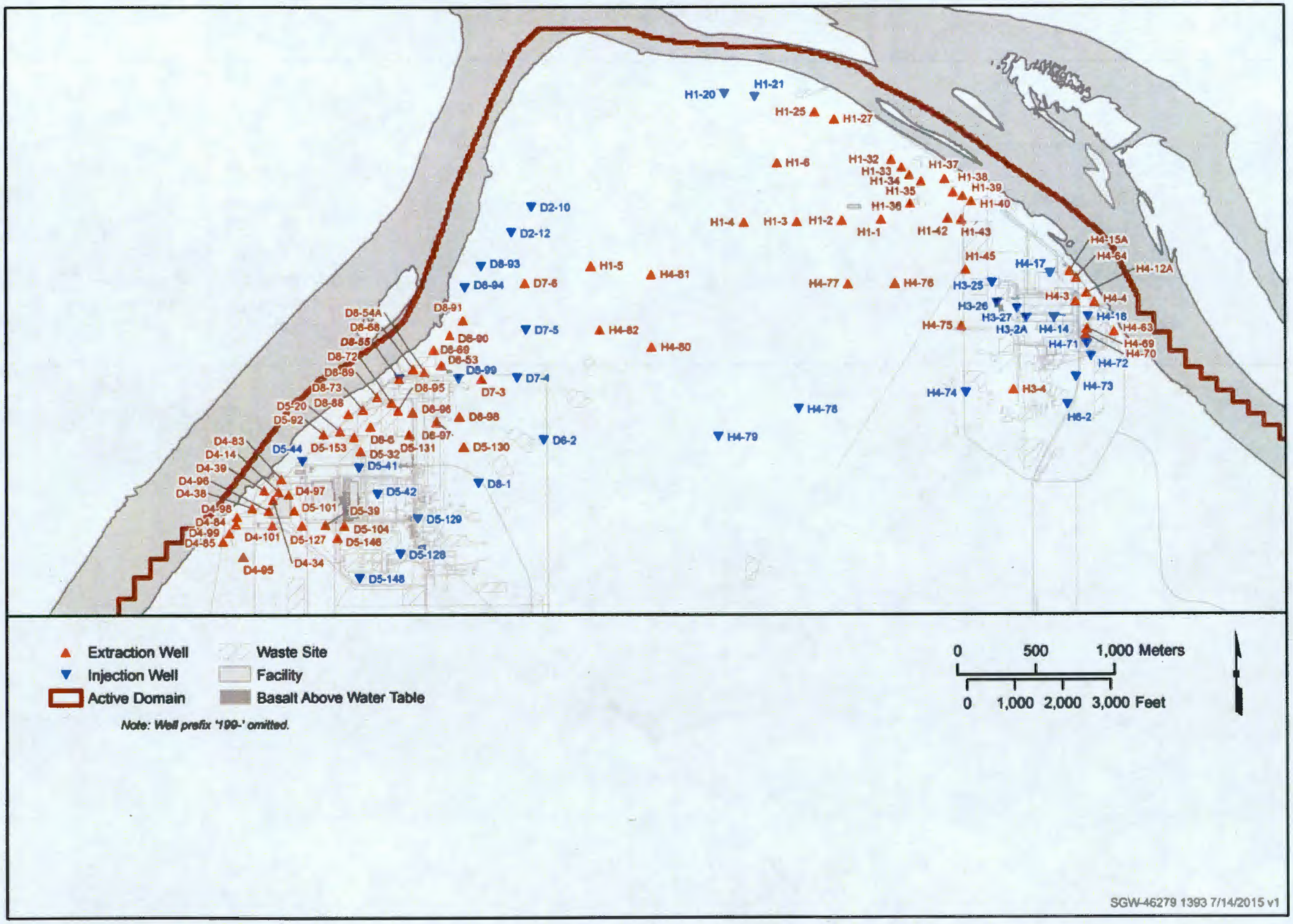



**Figure 3-55. Extraction/Injection Wells in 100-HR-3**

# 4 Flow Model Calibration

The groundwater flow component of the 100AGWM was calibrated to groundwater level data, using as a starting-point the information on likely parameter values included in the model data packages.

Values for some of the boundary conditions and aquifer parameters that are described in the preceding sections were estimated through a manual (trial-and-error) and automated calibration process. The model calibration process was facilitated in part, by the use of the automated calibration tool PEST (Doherty, 2010), with post-processing programs that were developed to calculate simulated groundwater responses to stresses such as pumping and river stage changes. Due to the relatively long historical model simulation run times, calibration was expedited by a combined qualitative and quantitative (automated) adjustment of parameter values. The model was calibrated to data from the period January 2006 to December 2013. The model calibration process focused on the following:

- Simulating the transient response of groundwater levels to changing stresses and how these compare to measured responses at monitoring locations in the 100-K, 100-D, 100-H, 100-B, and 100-F Areas.
- Simulating the direction and magnitude of hydraulic gradients near each reactor area and across the 100 Areas, in general. This was accomplished by directly comparing simulated and measured hydraulic gradients calculated from model outputs and from measured water levels using the three-point gradient technique (Silliman and Frost, 1998, "Monitoring Hydraulic Gradient Using Three-Point Estimator").
- Simulating the transient groundwater pumping rates at remedy wells in 100-K, 100-D, and 100-H and assessing how these compare to the measured pumping rates at the same wells.

## 4.1 Compilation and Disposition of Hydraulic Head Data

Transducer data recording hourly groundwater levels at monitoring wells in the 100 Areas were compiled for the period January 2006 through December 2013. Daily averages were calculated from these automated data and were supplemented with manually recorded groundwater level measurements. These datasets were downloaded from the HEIS database in August 2014. The complete dataset is archived in EMMA.

## 4.2 Compilation and Disposition of Well Screen Data

Well screen data were obtained from HEIS through queries to retrieve this information. These data were reviewed together with corrections and additions provided by CHPRC for some wells. For wells without screen elevations in HEIS, screen elevations were obtained from well construction spreadsheets (provided by CHPRC), if available. If no screen information was available, the well was assumed to be fully penetrating.

## 4.3 Calibration

### 4.3.1 Calibration to Hydraulic Heads

Model parameters were determined based on calibration. This technique comprises a combination of the following:

- Parameterizing the aquifer hydraulic conductivity using point estimates distributed throughout the model domain in broad zones that exhibit relatively consistent mean values, but for which there is evidence of variability. The parameterization is accomplished using the PEST FIELDGEN utility

(Doherty, 2014, *Groundwater Data Utilities*; Khambhammettu et al., 2011, *FIELDGEN_D – A Modified 2D Field Generator for Deterministic and Stochastic Groundwater Modeling*).

- More simplistic parameterization of aquifer storage properties (Specific Yield and Specific Storage) using model-wide average values.

Parameter value adjustments were based on qualitative evaluation of the estimated aquifer parameter values, prior independent information on these values, and the correspondence between simulated and measured groundwater levels and hydraulic gradients and pumping rates.

As a result of this approach to calibration, estimated parameters included the following:

- The mean HCOND for each defined zone
- Variogram parameters (nugget, sill, and range) to define the HCOND distribution in each area
- Conductance of the GHB
- Specific Yield and Specific Storage

Calibrated values of the estimated parameters are summarized in Table 4-1, and variogram parameters for the HCOND distributions are summarized in Table 4-2.

The model was calibrated to water level data from 330 monitoring wells (not pumping wells) for the period January 2006 to December 2013. These monitoring wells are in addition to the pumping wells described in Section 3.7.5. A total of 172,376 water level measurements were tabulated for the calibration process by combining manually measured water levels with daily averages of automated water level network (AWLN) data (Section 4.1). Only 169,107 measurements were used in the calibration because, upon inspection of the data, 3,269 measurements were considered as outliers and were assigned zero-weights in the calibration.

The simulated outputs were compared to the measured data obtained from each monitoring well, for each time that a measured value is available. These comparisons were compiled into various statistical and graphical forms, including scatter diagrams, time series plots, and residual statistics, to evaluate the performance of the model and guide adjustments to model parameters. Table 4-3 includes statistical metrics that are routinely used to evaluate model calibration progress. They are reported for the 100AGWM and for each of the OU areas. In summary for the 100AGWM, the Mean Error (ME, equivalent to the average residual) is 0.11 m (0.36 ft) and the Mean Square Error (MSE, also known as the Variance) is 0.17 $m^2$ (1.82 $ft^2$). The Root Mean Square Error (RMSE, also known as the Standard Deviation) is 0.41 m (1.35 ft). The coefficient of determination ($R^2$) is close to 1.0, suggesting that measured and simulated water levels are highly correlated. The small positive average residual (observed minus simulated) indicates a slight positive bias in the model (i.e., the model slightly under-predicts measured water levels). The low RMSE value suggests a reasonable fit between the measured and simulated water levels. The average residuals over the duration of the simulation period at each monitoring well in the model domain are shown in Figure 4-1. The residuals at monitoring wells within each OU are shown in Figures 4-2 through 4-6. Scatter plots and residual percentile plots for each OU are shown in Figures 4-7 through 4-18.

The head contours at the beginning and the end of the simulation are shown in Figure 4-19. The largest differences between the two head distributions occur in the 100-K, 100-D, and 100-H OUs as a result of continued injection and extraction. In 100-K, the injection mound is more pronounced at the end of the simulation. Likewise, areas with high extraction in the three OUs have lower water levels compared to the beginning of the simulation. Away from the pumping wells, the differences between the two head distributions are diminished and the same head patterns can be seen. The head contours during low and high river stage are shown in Figure 4-20 to illustrate the gradient shift between the two periods. The low river stage months (typically in September and October) are typically characterized by high gradients toward the Columbia River in all the OUs. At high river stage (typically in May and June), the gradients toward the river decrease and gradients are inland.

Currently, the model under-predicts water levels in the 100-B and 100-K OUs, which could be attributed to aquifer conditions that are not captured by the current conceptual model and resulting parameterization of the hydraulic properties. Although there is evidence of the presence of a highly transmissive paleo-channel to the south of 100-B, the extent and hydraulic properties of that channel have not been fully investigated. Within the 100-N, 100-D, and 100-H OUs, the average residual is about zero (i.e., the model does not under-predict or over-predict water levels in an average sense). In the 100-F OU, the model over-predicts water levels on the average, which could also be attributed to uncertainty in the delineation of geologic units under the current geological framework, as few borelogs are available for an accurate area-wise interpretation of geologic conditions and hydraulic properties. Ongoing efforts to collect more data and provide additional detail to the geological framework will provide improved definition of the geology and associated hydraulic properties.

**Table 4-1. Model Calibration: Estimated Parameters**

| Parameter | Value |
|---|---|
| Mean hydraulic conductivity of Hanford formation | 88 m/d |
| Mean hydraulic conductivity of channel in 100-B | 1,251 m/d |
| Mean hydraulic conductivity of Reworked Ringold E Formation in 100-K and 100-N | 25 m/d |
| Mean hydraulic conductivity of Reworked Ringold E Formation to the east of 100-D | 35 m/d |
| Mean hydraulic conductivity of Ringold E Formation in 100-B | 6.9 m/d |
| Mean hydraulic conductivity of Ringold E Formation in 100-K | 17.3 m/d |
| Mean hydraulic conductivity of Ringold E Formation to the east of 100-D | 28.7 m/d |
| Mean hydraulic conductivity of Reworked RUM formation to the west of 100-D | 2 m/d |
| Mean hydraulic conductivity of Reworked RUM formation to the east of 100-D | 5 m/d |
| Specific storage | $5 \times 10^{-6}$/m |
| Specific yield | 0.1 |
| Conductance of the general head boundary to the south of 100-F | 5.0 $m^2$/d |

m = meter
m/d = meters per day
m2/d = square meters per day
RUM = Ringold Upper Mud

**Table 4-2. Model Calibration: Variogram Parameters for Hydraulic Conductivity Distribution**

| Area | Aquifer Unit | Data Transformation | Type | Range (meters) | Sill | Nugget | Bearing | Anisotropy |
|---|---|---|---|---|---|---|---|---|
| 100-B, 100-K and 100-D | Hanford, Ringold E | Log | Exponential | 300 | 1.2 | 0.0 | 0.0 | 1.0 |
| 100-H and 100-F | Hanford, Ringold E | Log | Exponential | 300 | 2.2 | 0.0 | 0.0 | 1.0 |
| Channel in 100-B | Hanford | Log | Exponential | 300 | 0.1 | 0.0 | 0.0 | 1.0 |
| All | Reworked Ringold E | Log | Exponential | 200 | 0.5 | 0.0 | 0.0 | 1.0 |
| All | Reworked RUM | Log | Exponential | 100 | 0.5 | 0.0 | 0.0 | 1.0 |

RUM = Ringold Upper Mud

**Table 4-3. Model Calibration Statistics**

| Metric | All | B | K | N | D | H | F |
|---|---|---|---|---|---|---|---|
| Coefficient of Correlation | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 0.91 |
| Coefficient of Determination ($R^2$) | 1.00 | 0.77 | 1.00 | 1.00 | 1.00 | 1.00 | 0.82 |
| Average Residual (m) | 0.11 | 0.18 | 0.22 | 0.19 | 0.00 | 0.19 | -0.44 |
| Maximum Residual (m) | 2.89 | 1.93 | 2.13 | 2.89 | 2.01 | 1.82 | 1.89 |
| Minimum Residual (m) | -1.70 | -1.37 | -1.70 | -1.58 | -1.56 | -1.23 | -1.32 |
| Sum of Squared Errors ($m^2$) | 28,953 | 1,561 | 8,662 | 5,651 | 6,235 | 5,246 | 1,597 |
| Mean Squared Error ($m^2$) | 0.17 | 0.22 | 0.26 | 0.17 | 0.10 | 0.15 | 0.36 |
| Root Mean Squared Error (m) | 0.41 | 0.47 | 0.51 | 0.41 | 0.32 | 0.39 | 0.60 |
| Observed Range (m) | 13.39 | 4.55 | 5.28 | 6.12 | 5.80 | 5.19 | 11.00 |
| Root Mean Squared Error/Observed Range | 0.031 | 0.102 | 0.097 | 0.067 | 0.056 | 0.074 | 0.054 |

m = meter
$m^2$ = square meter

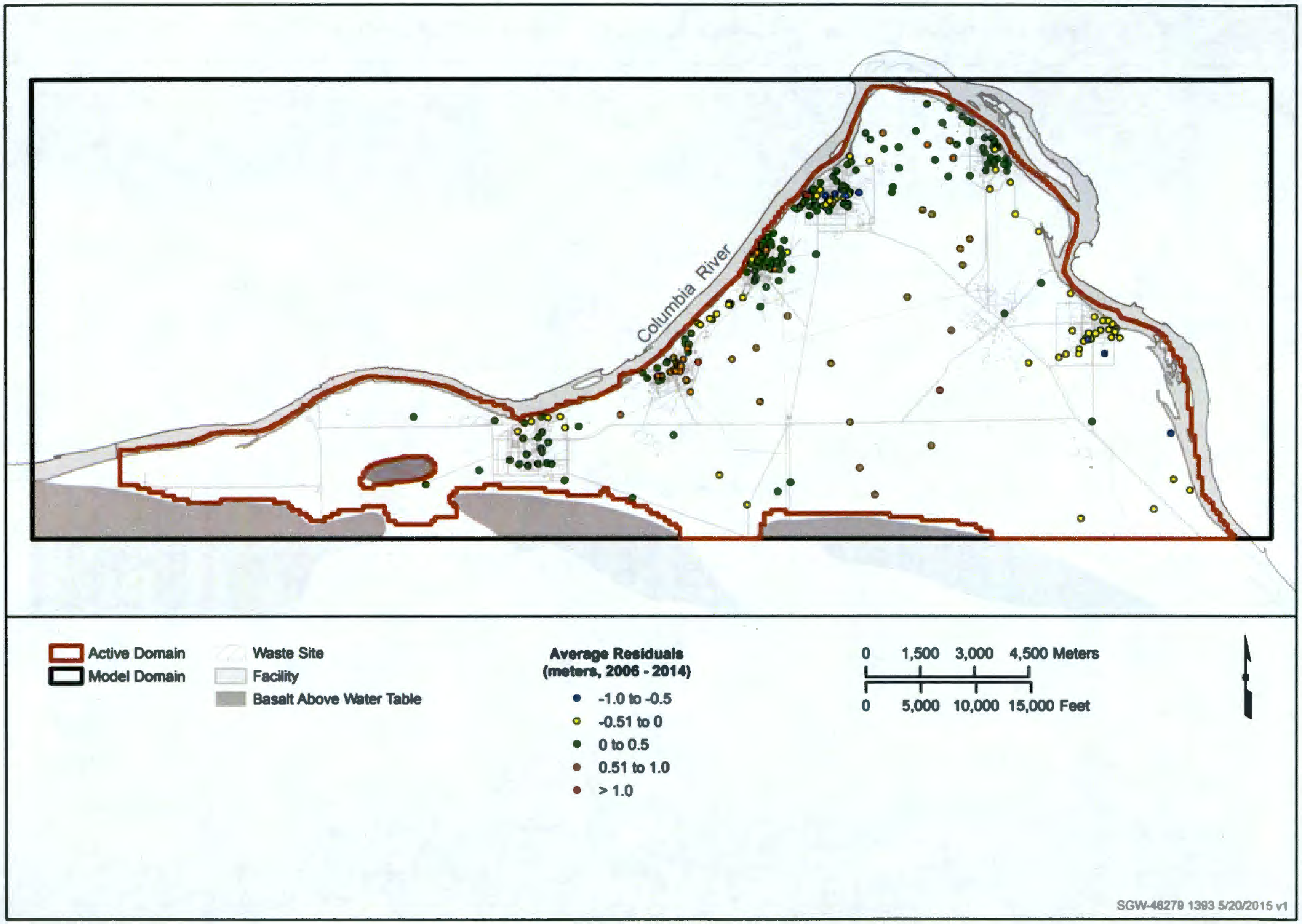



Figure 4-1. Average Residuals (meters, 2006–2013) at Monitoring Wells in the 100 Area

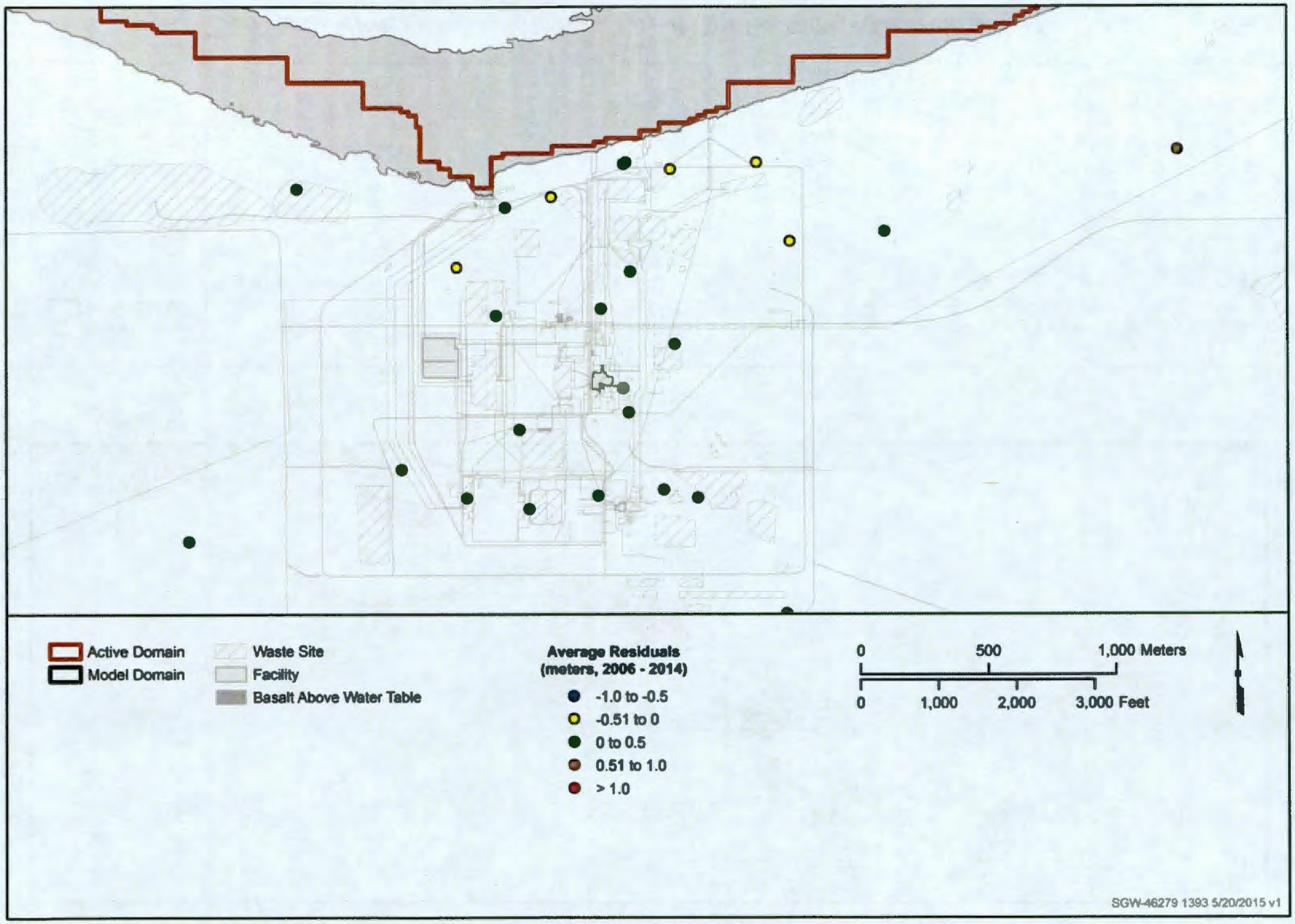



**Figure 4-2. Average Residuals (meters, 2006–2013) at Monitoring Wells in the Vicinity of 100-B**

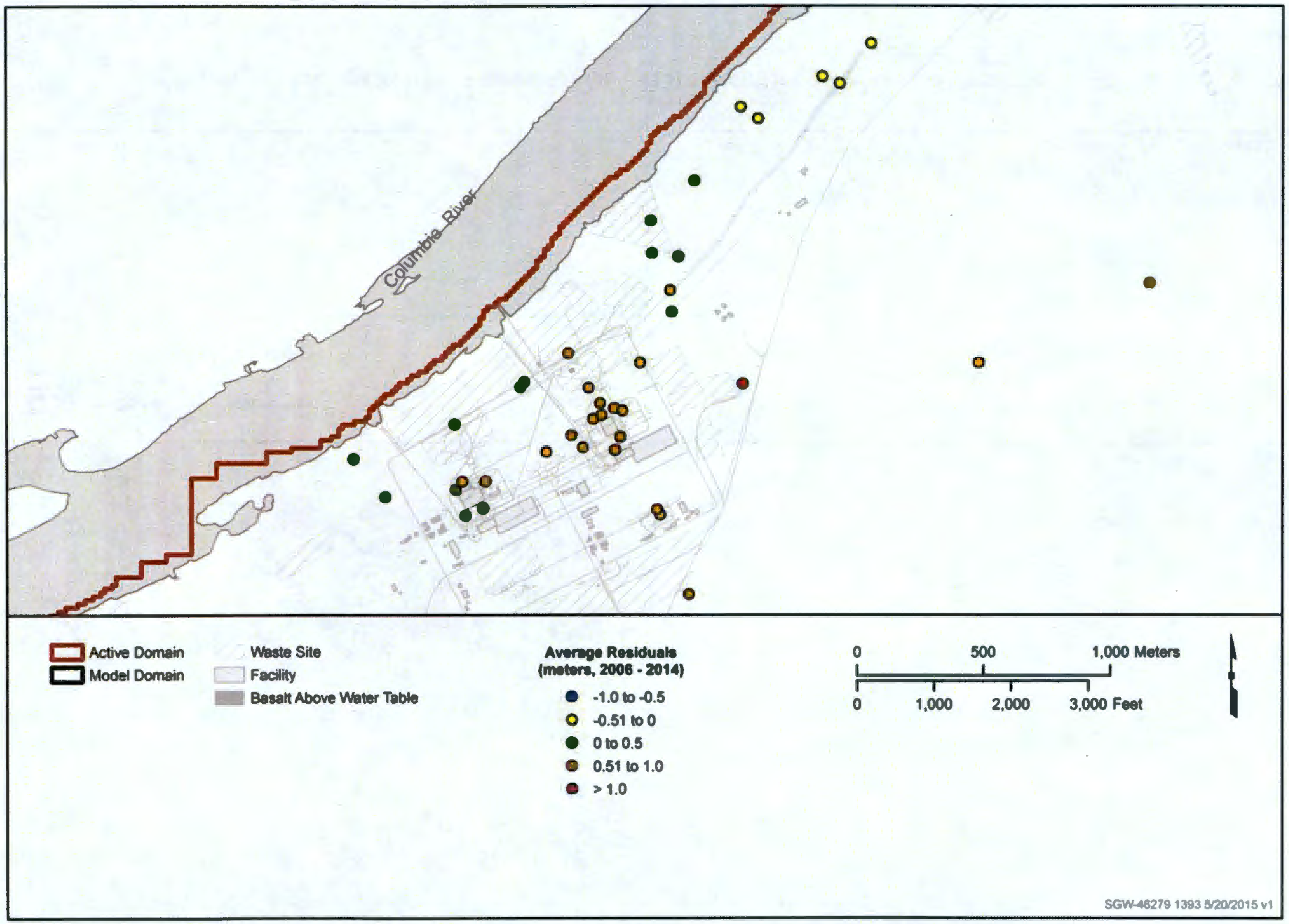



**Figure 4-3. Average Residuals (meters, 2006–2013) at Monitoring Wells in the Vicinity of 100-K**

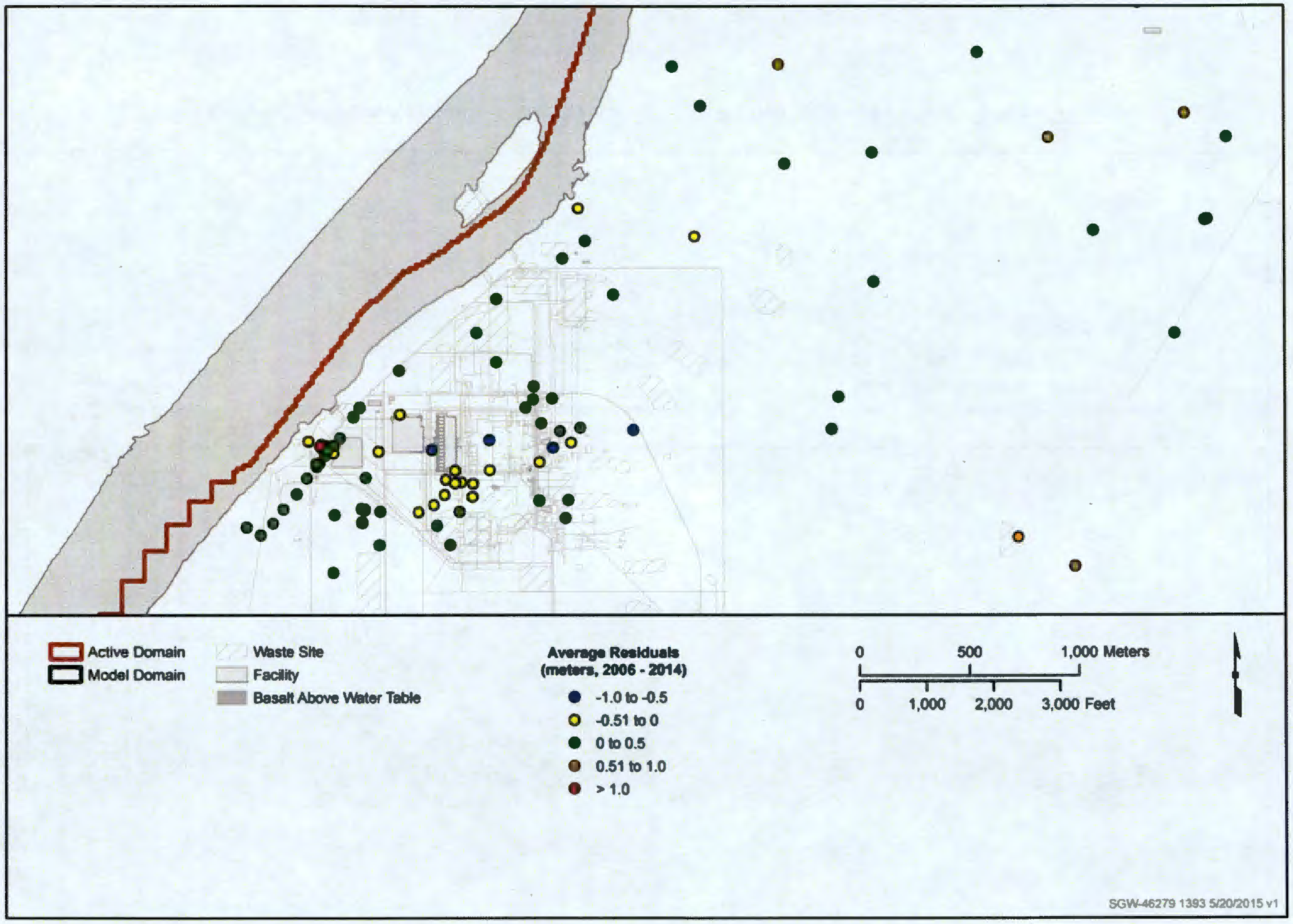



**Figure 4-4. Average Residuals (meters, 2006–2013) at Monitoring Wells in the Vicinity of 100-D**

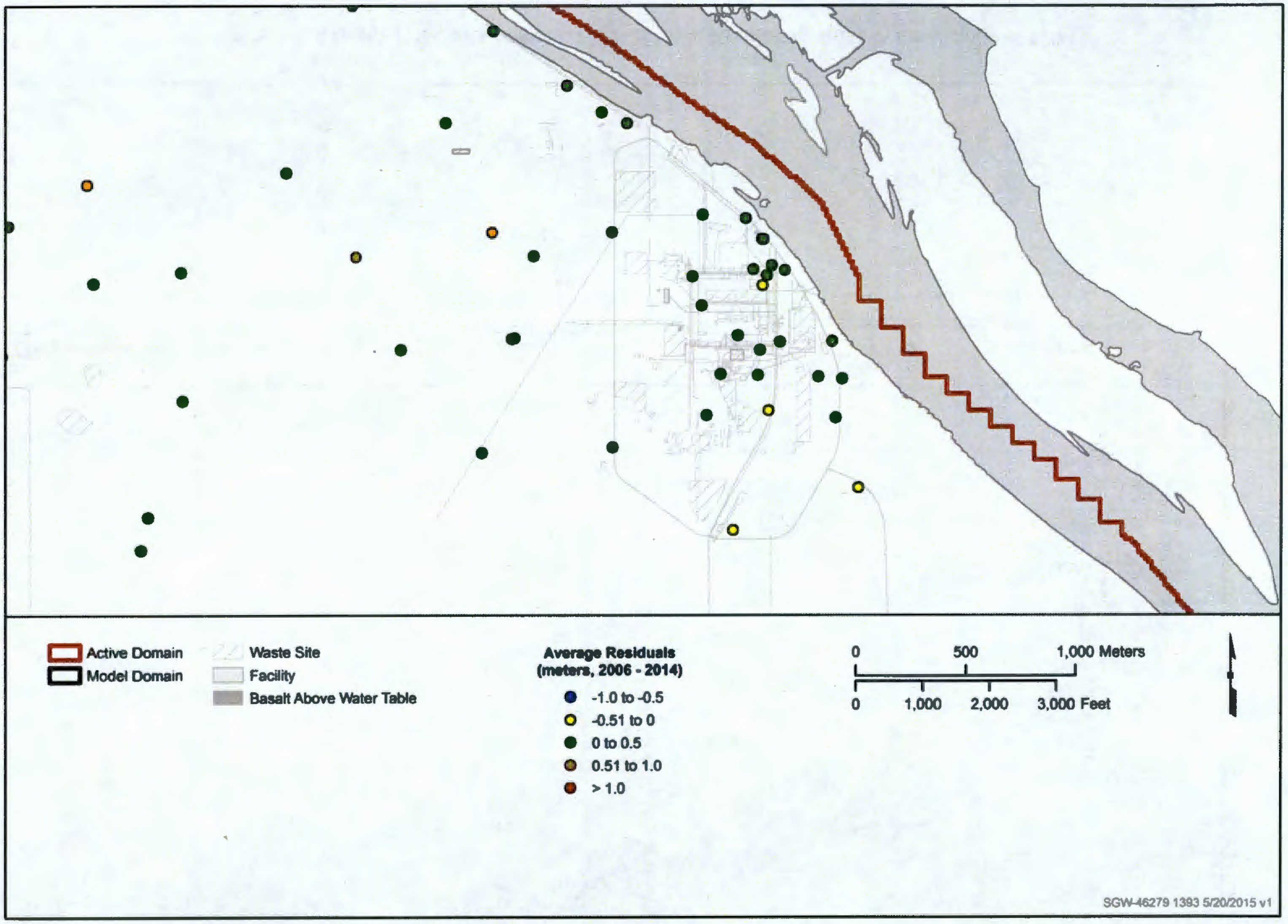



**Figure 4-5. Average Residuals (meters, 2006–2013) at Monitoring Wells in the Vicinity of 100-H**

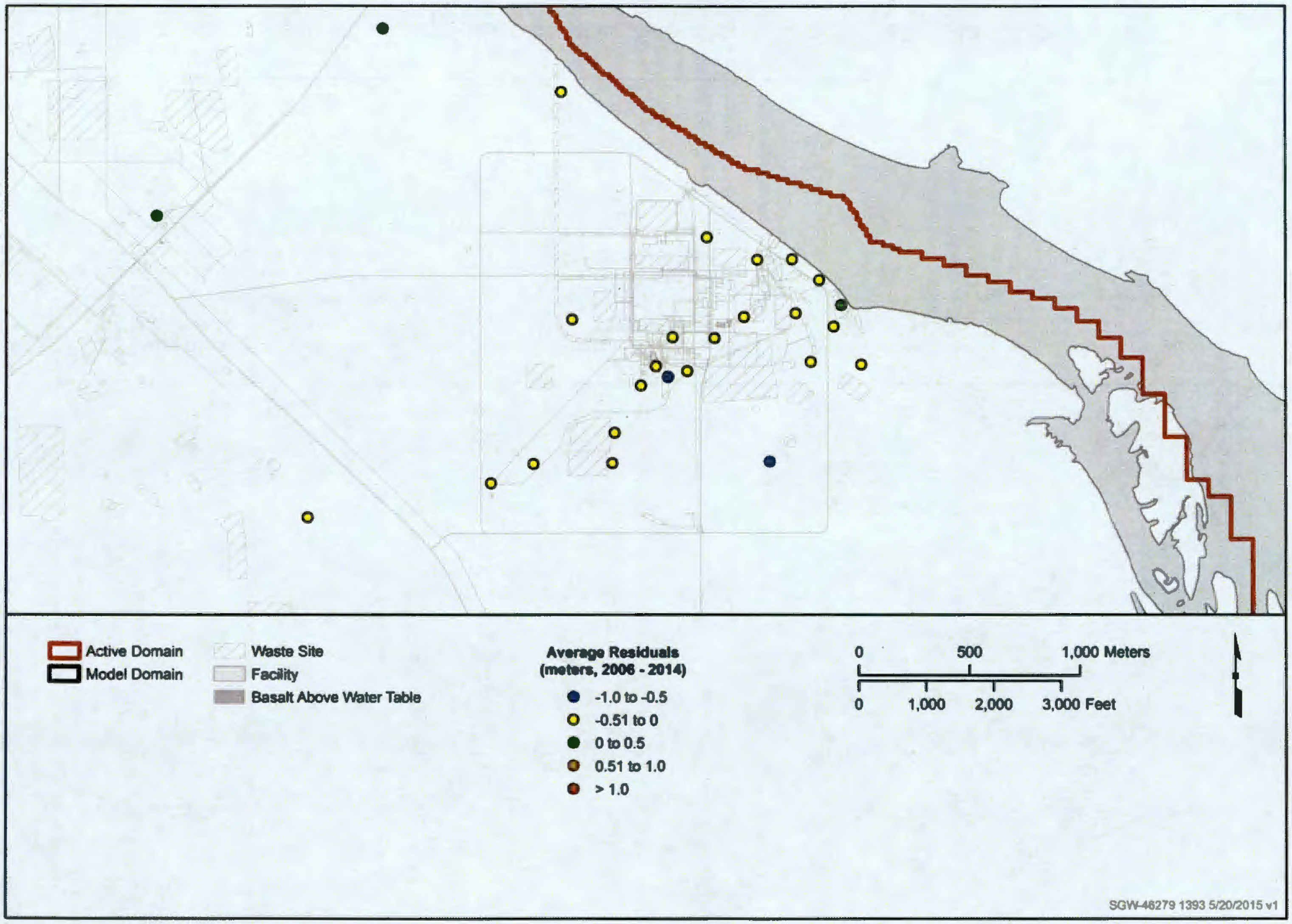



**Figure 4-6. Average Residuals (meters, 2006–2013) at Monitoring Wells in the Vicinity of 100-F**

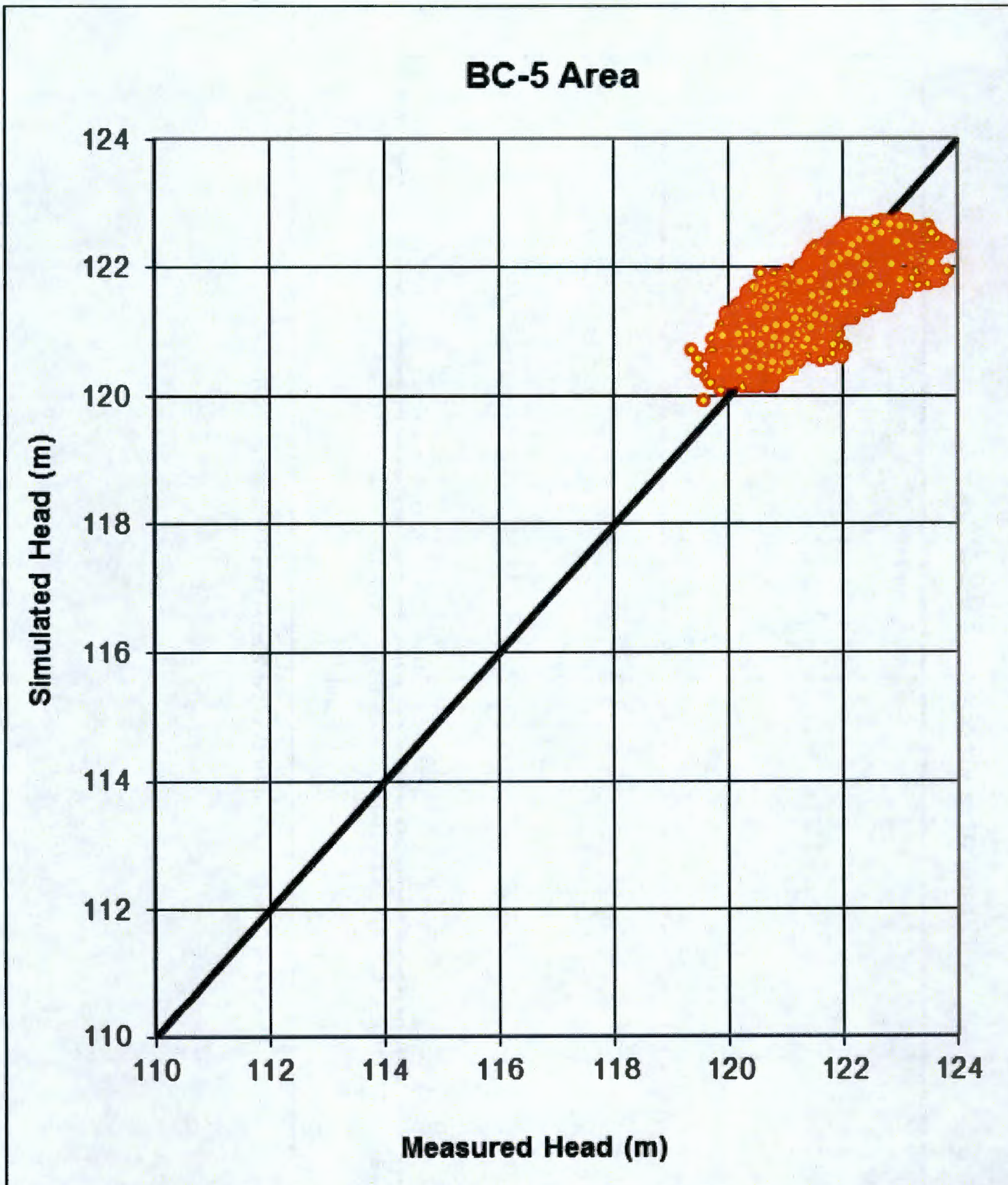



Figure 4-7. Measured Versus Simulated Water Levels in 100-B

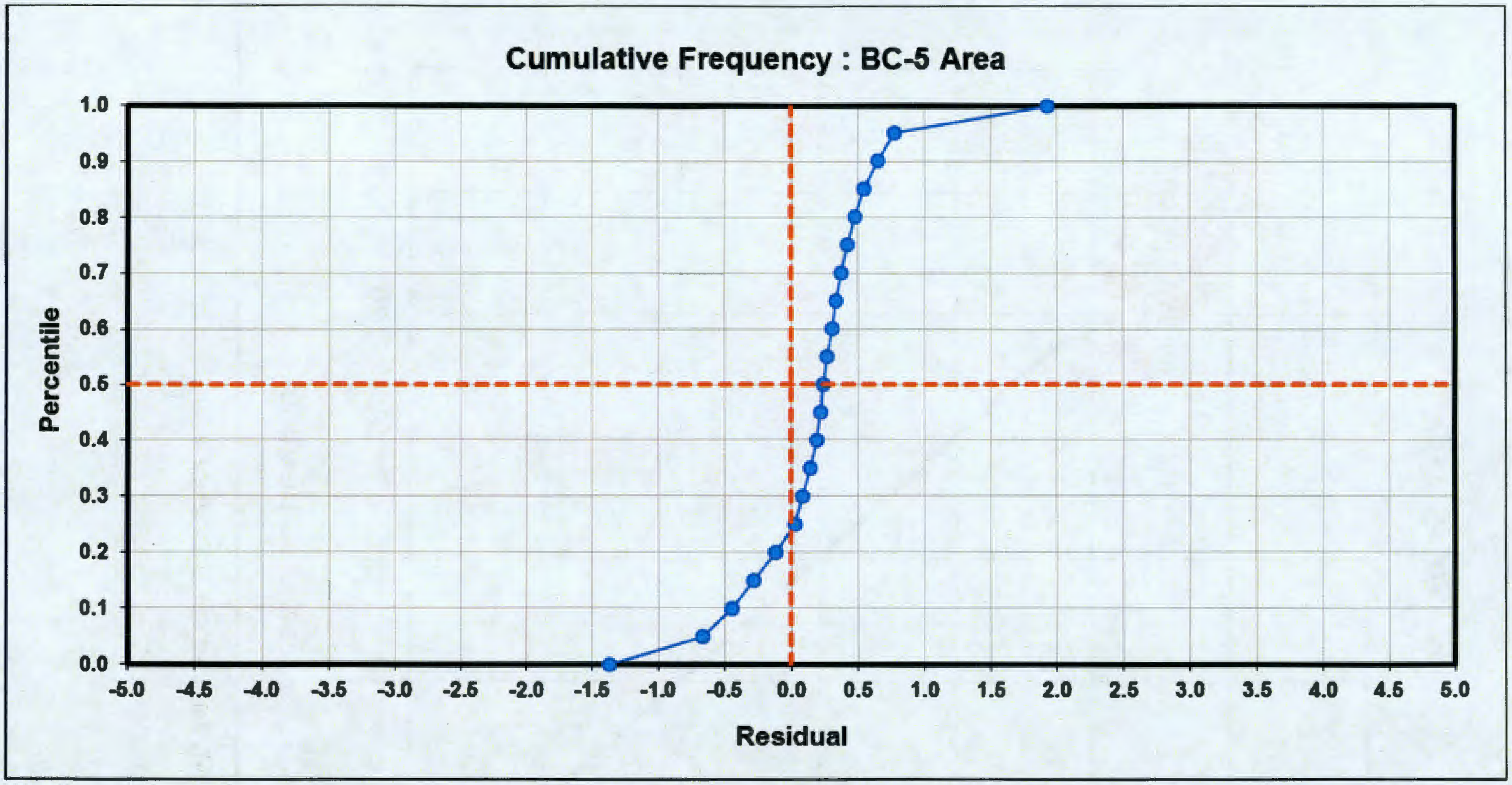



Figure 4-8. Cumulative Frequency of the Water Level Residuals in 100-B

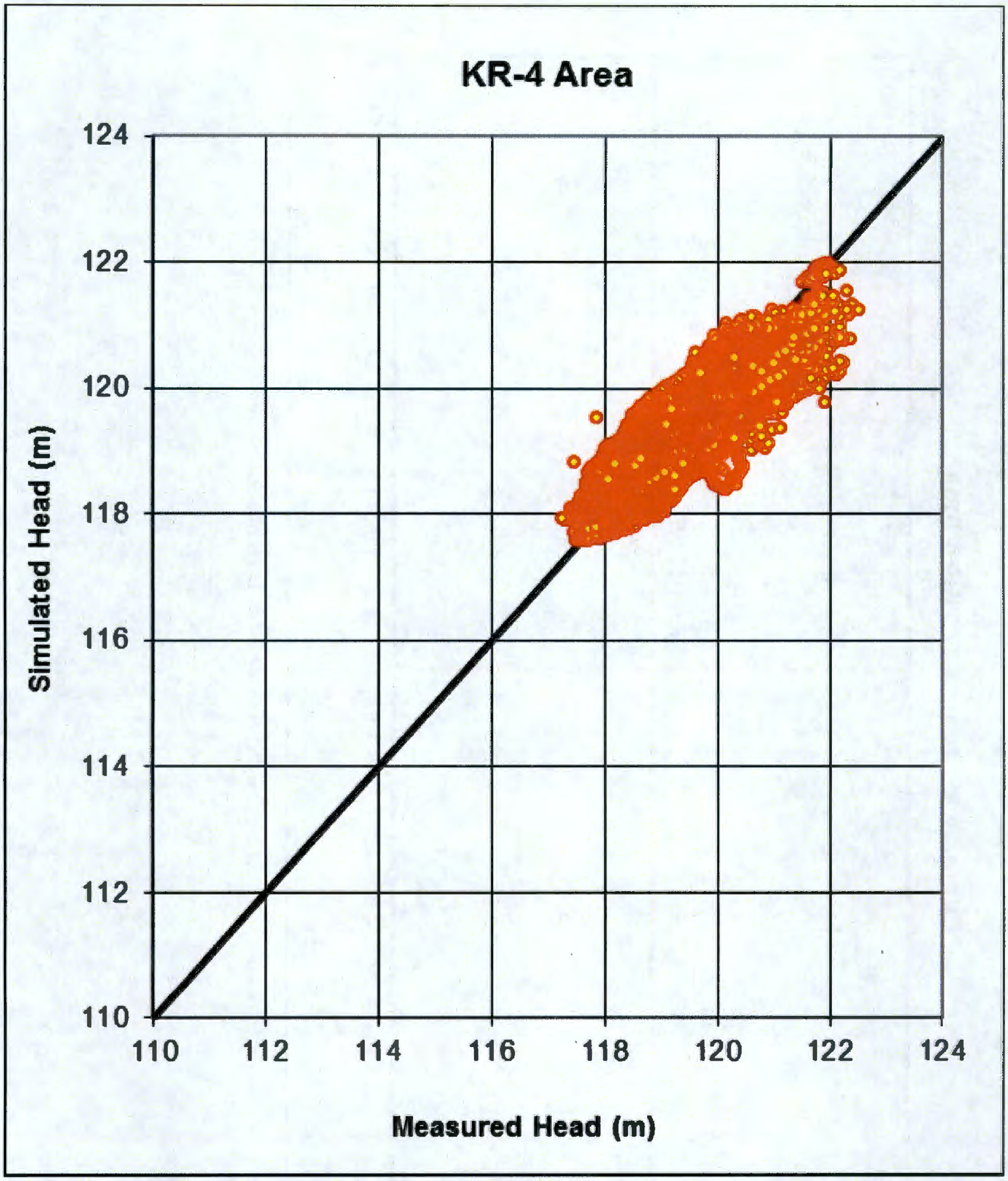



Figure 4-9. Measured Versus Simulated Water Levels in 100-K

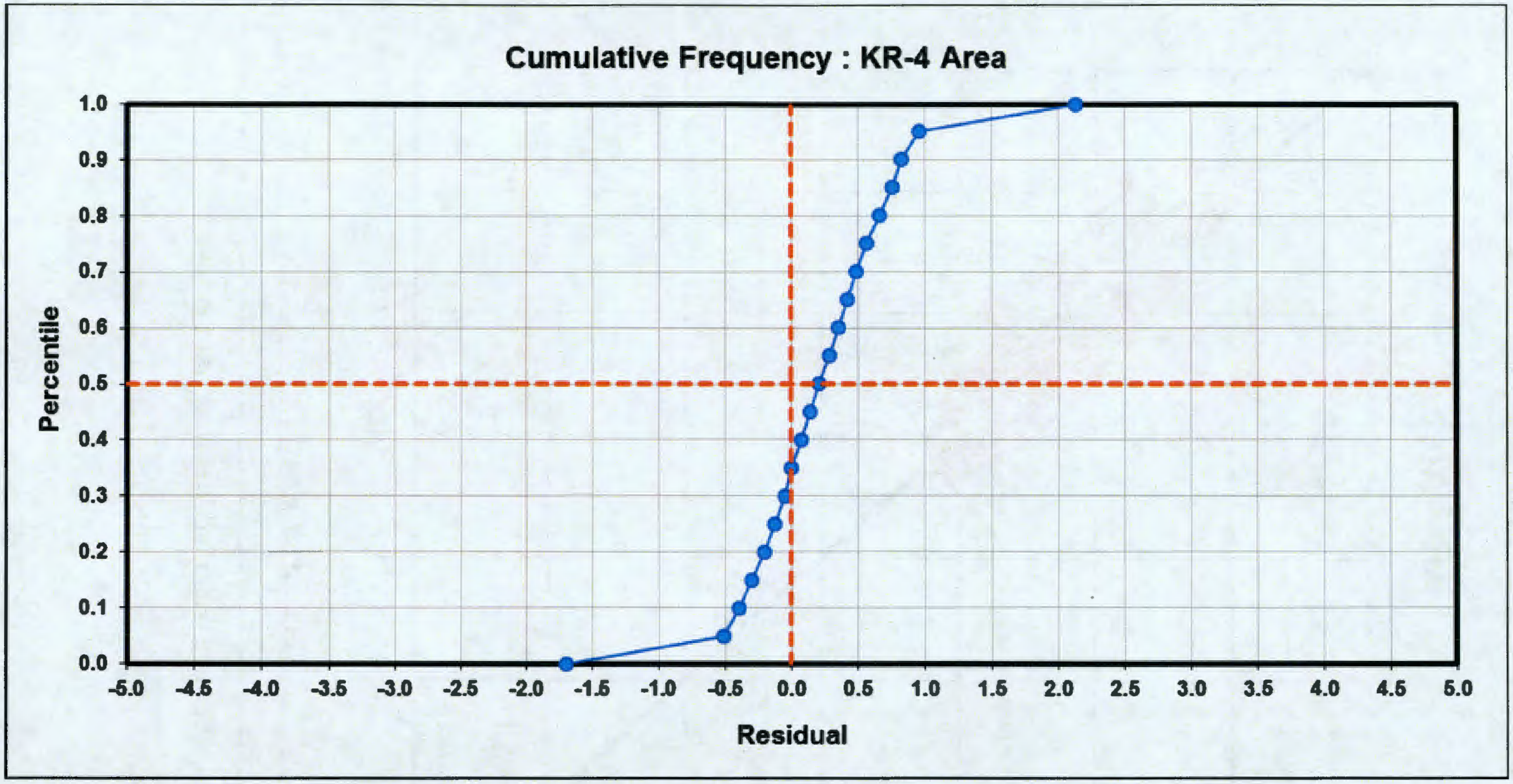



Figure 4-10. Cumulative Frequency of the Water Level Residuals in 100-K

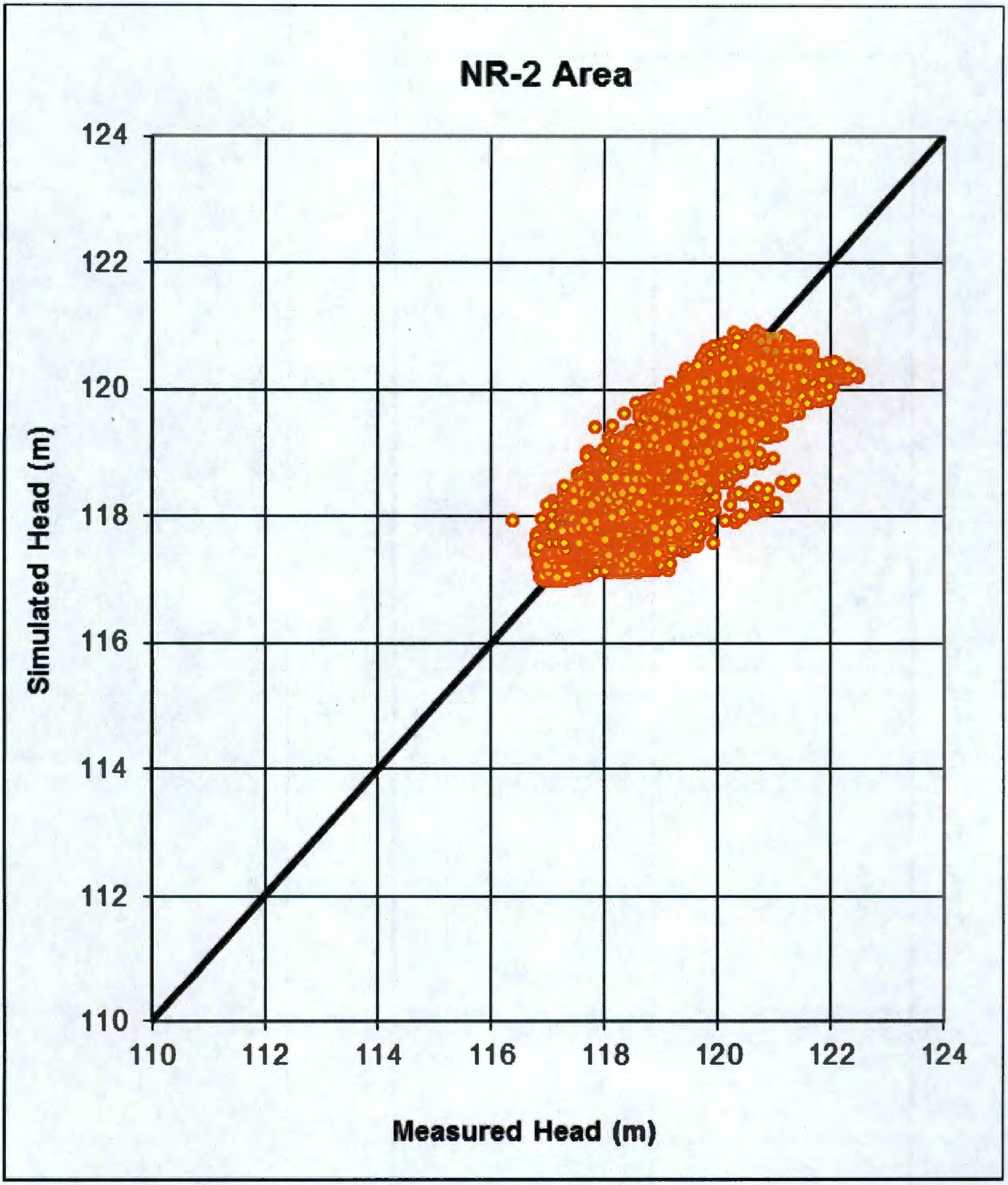



**Figure 4-11. Measured Versus Simulated Water Levels in 100-N**

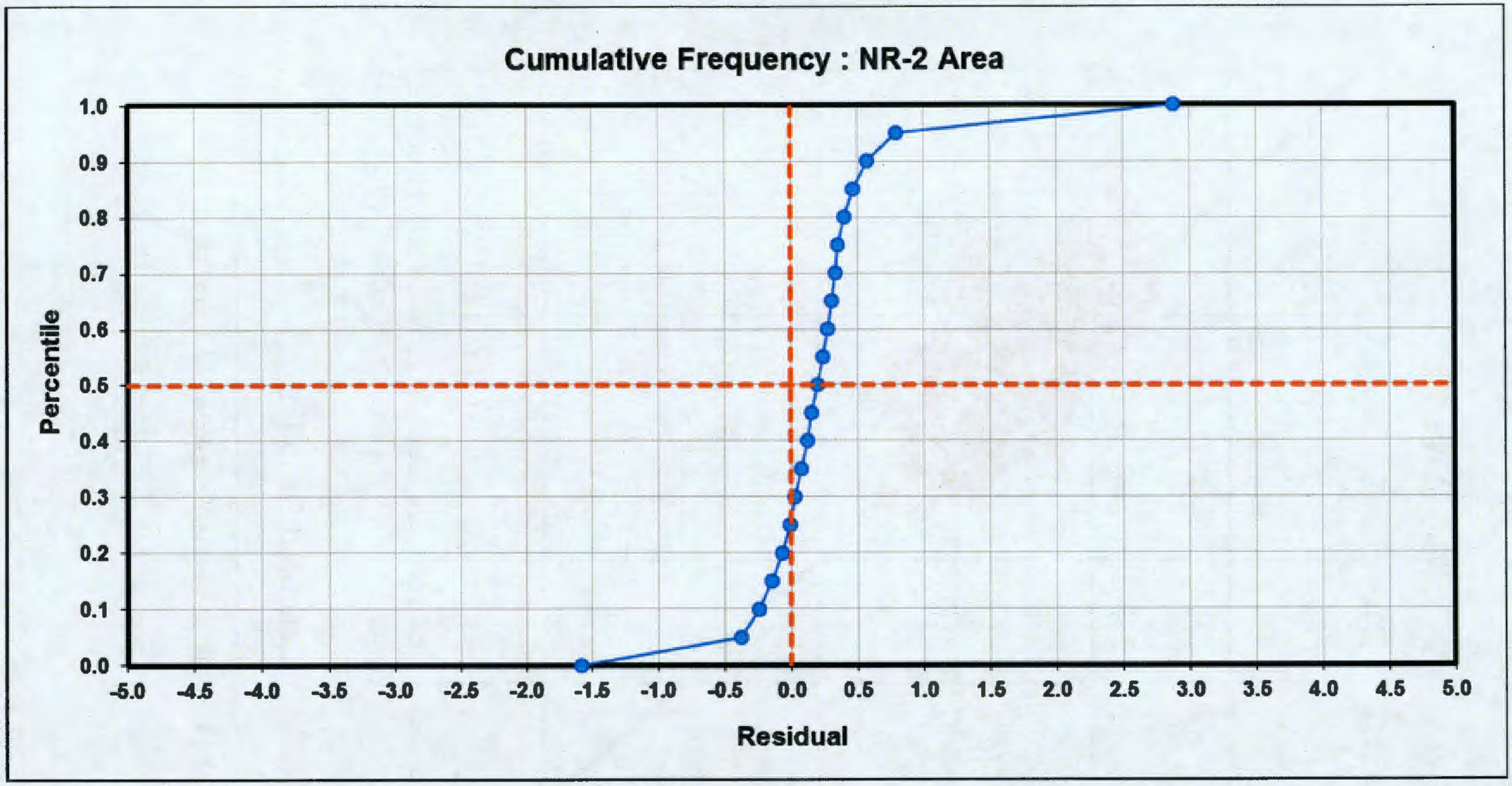



**Figure 4-12. Cumulative Frequency of the Water Level Residuals in 100-N**

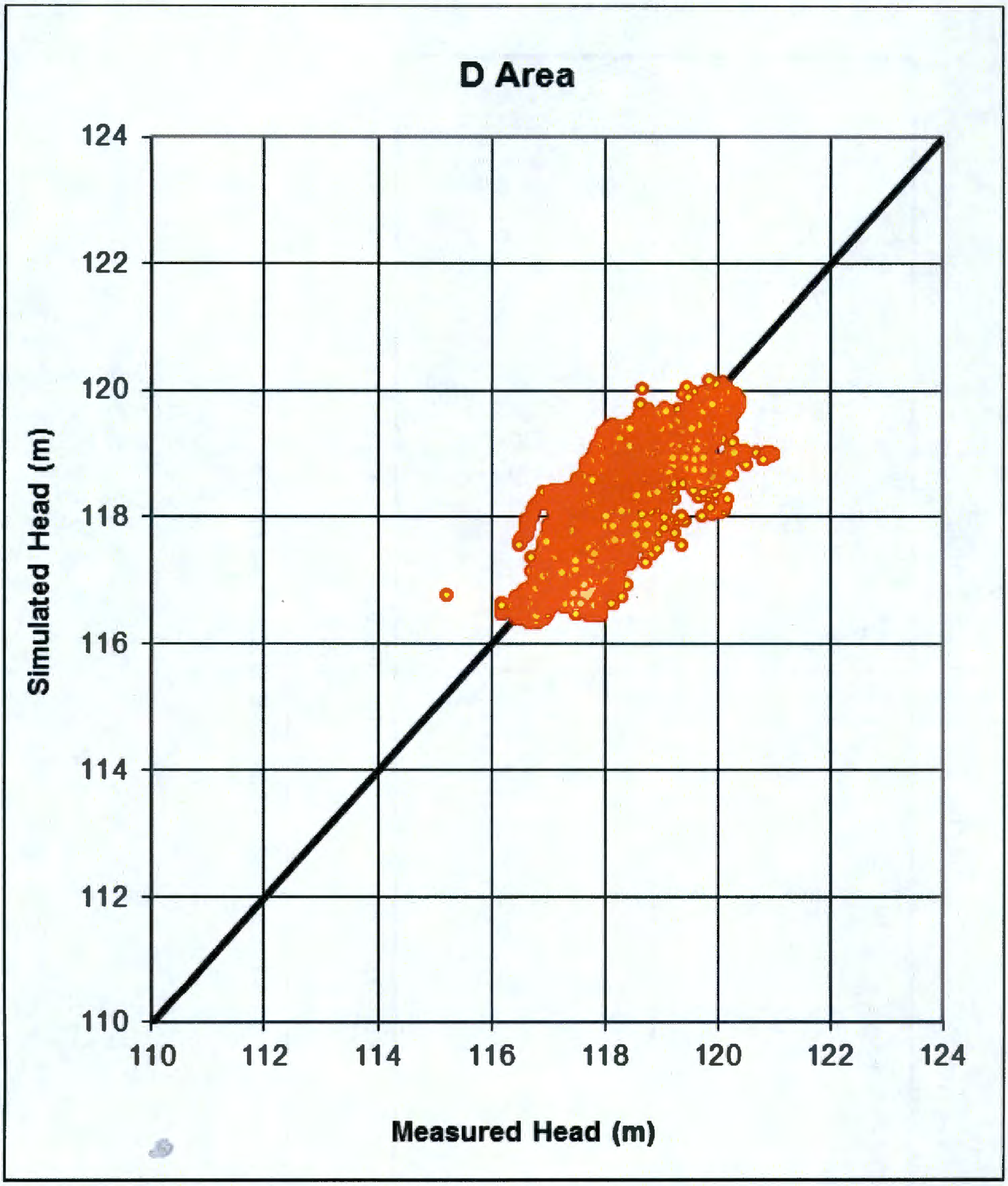



Figure 4-13. Measured Versus Simulated Water Levels in 100-D

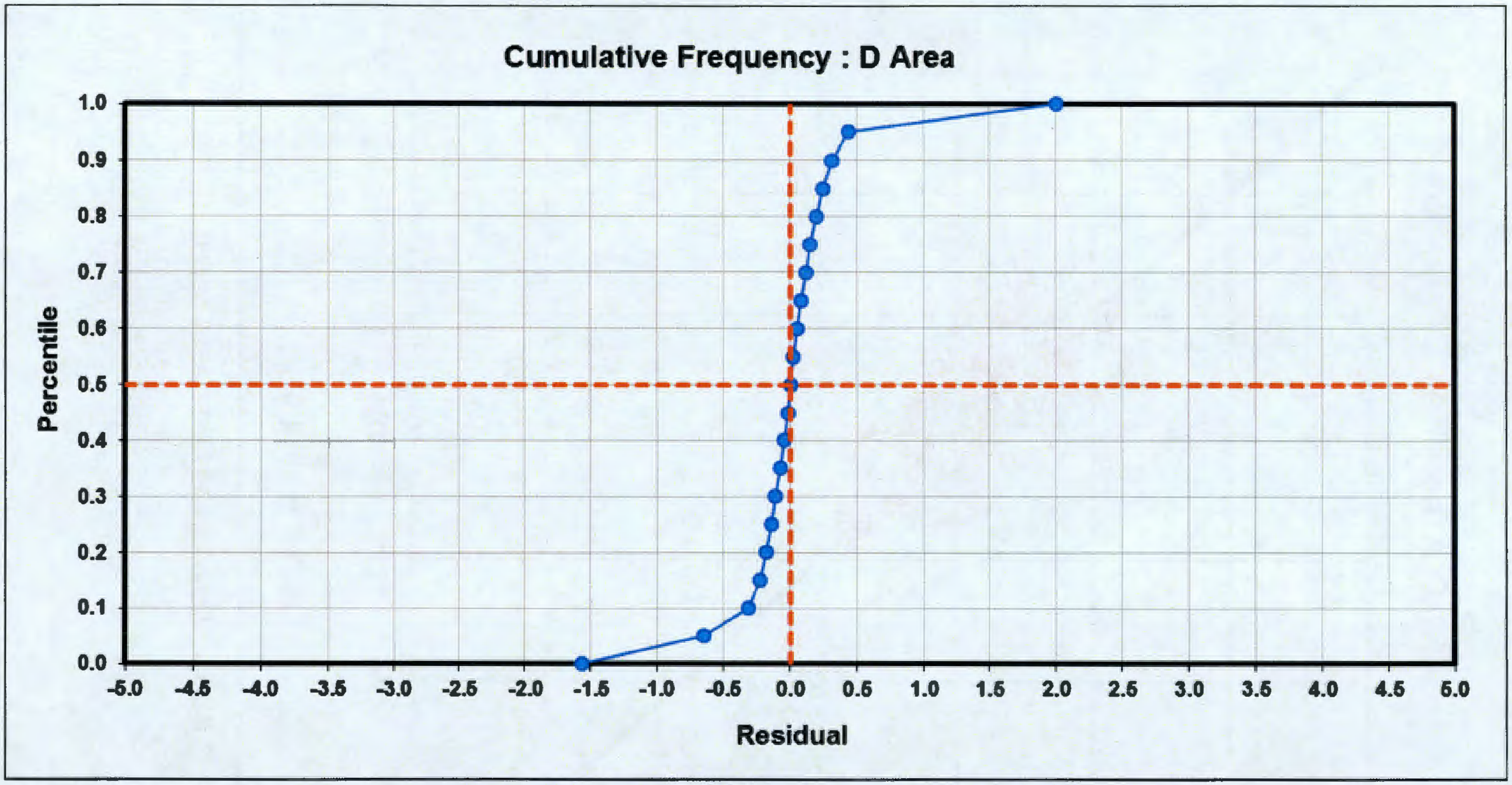



**Figure 4-14. Cumulative Frequency of the Water Level Residuals in 100-D**

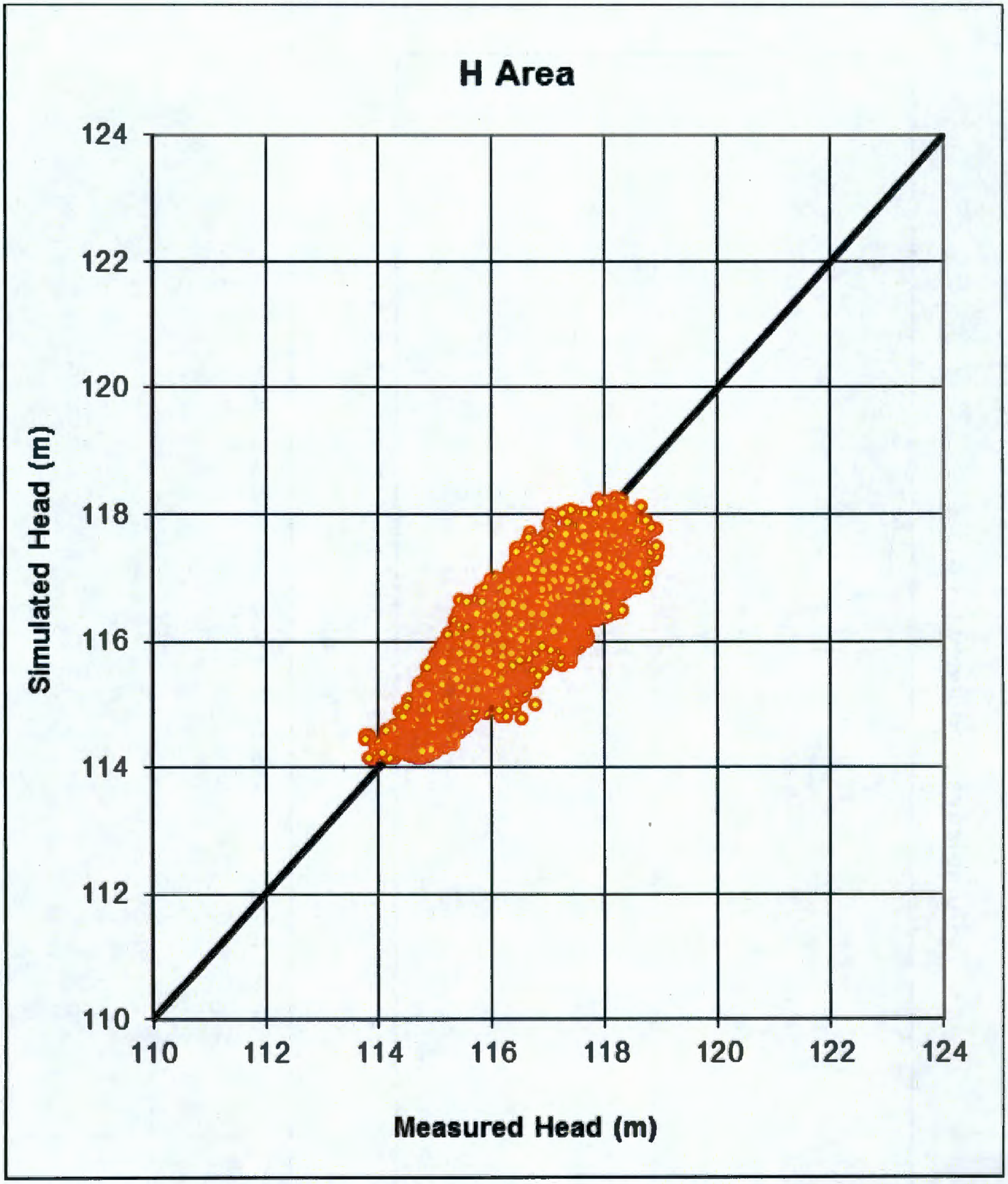



Figure 4-15. Measured Versus Simulated Water Levels in 100-H

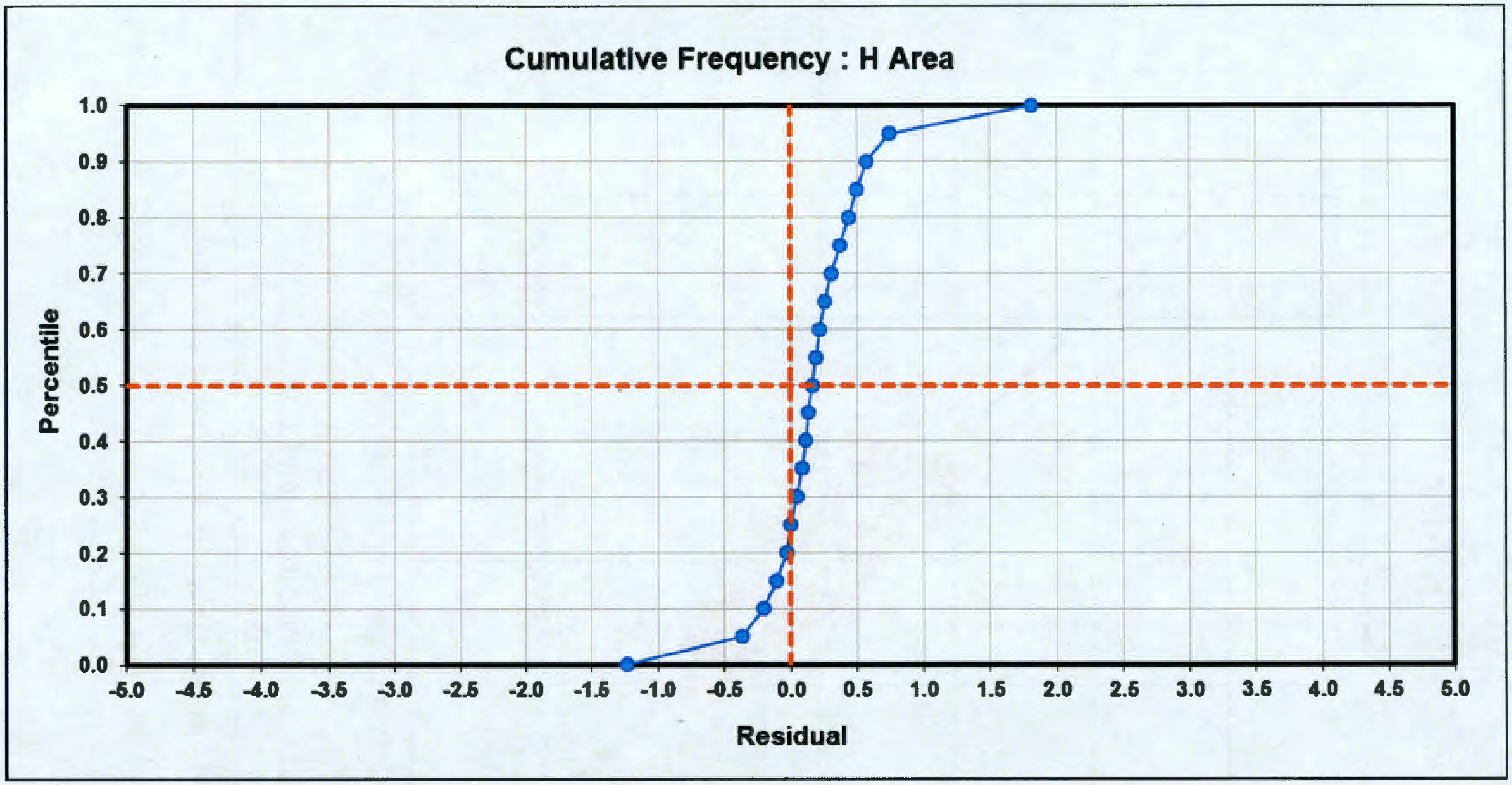



**Figure 4-16. Cumulative Frequency of the Water Level Residuals in 100-H**

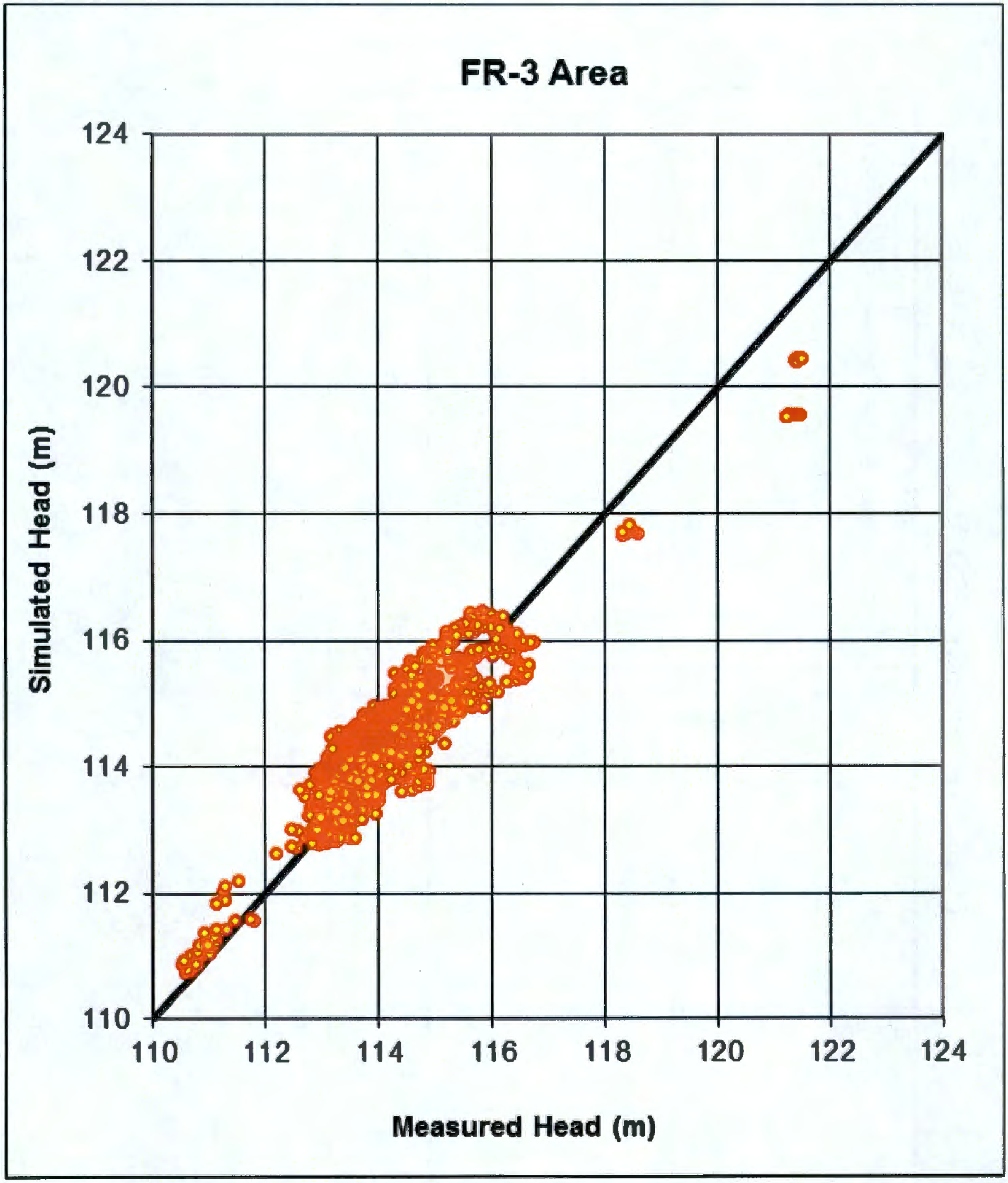



Figure 4-17. Measured Versus Simulated Water Levels in 100-F

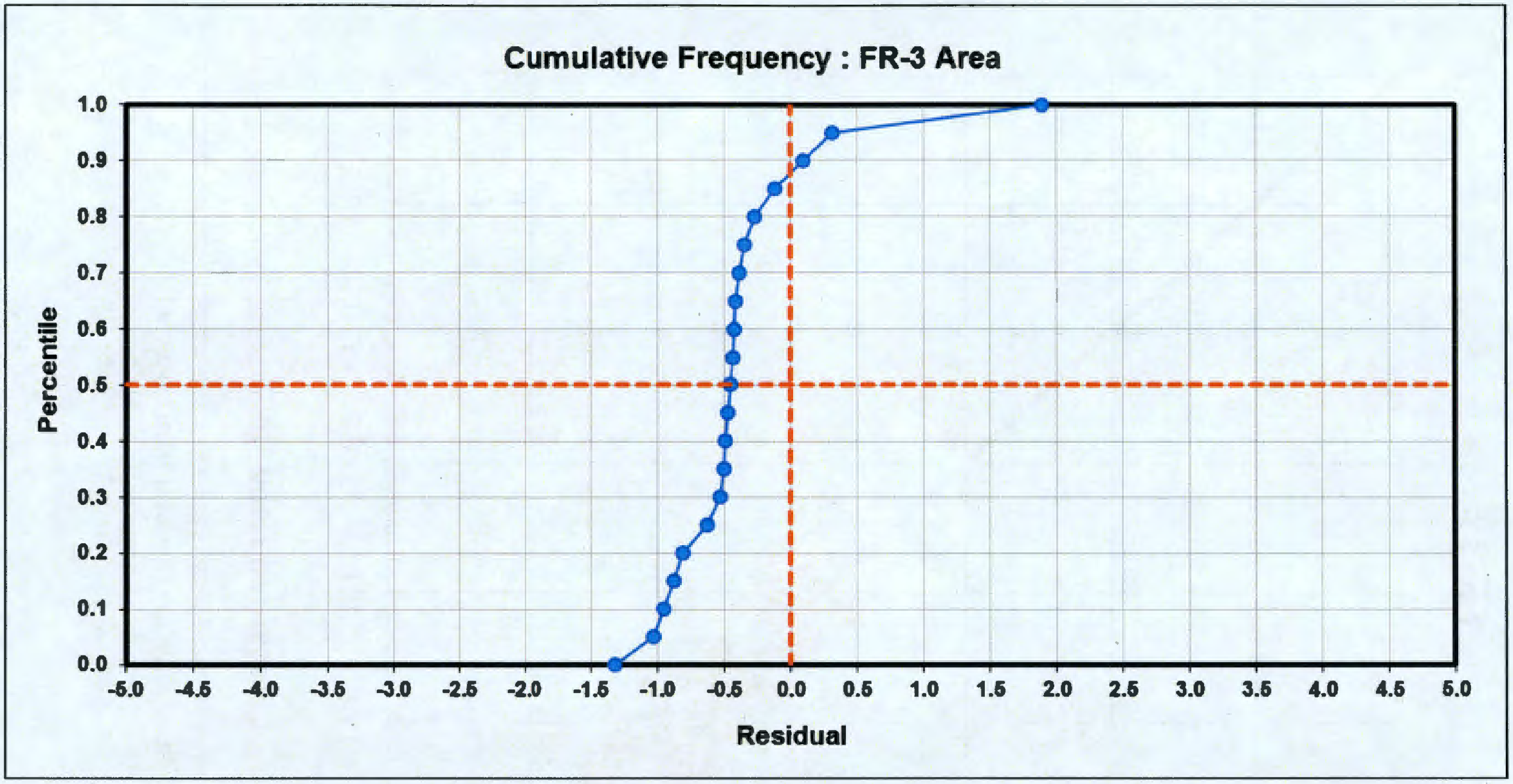
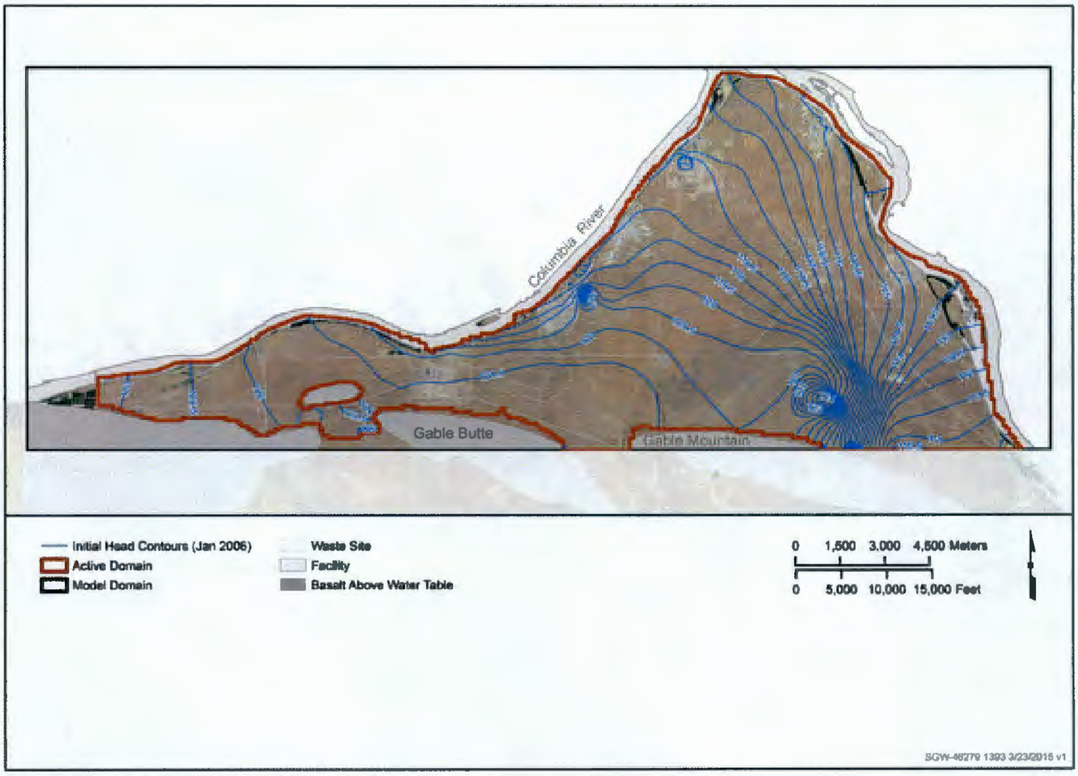



**Figure 4-18. Cumulative Frequency of the Water Level Residuals in 100-F**



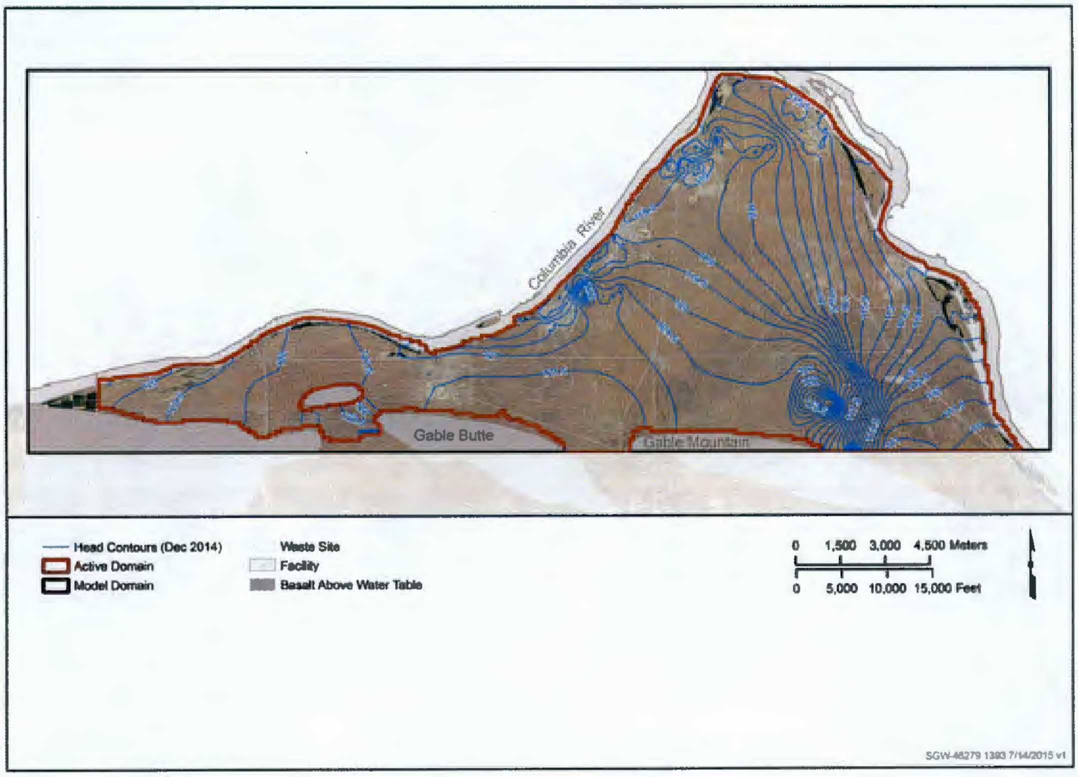




**Figure 4-19. Initial and Final Head Contours in the 100AGWM**

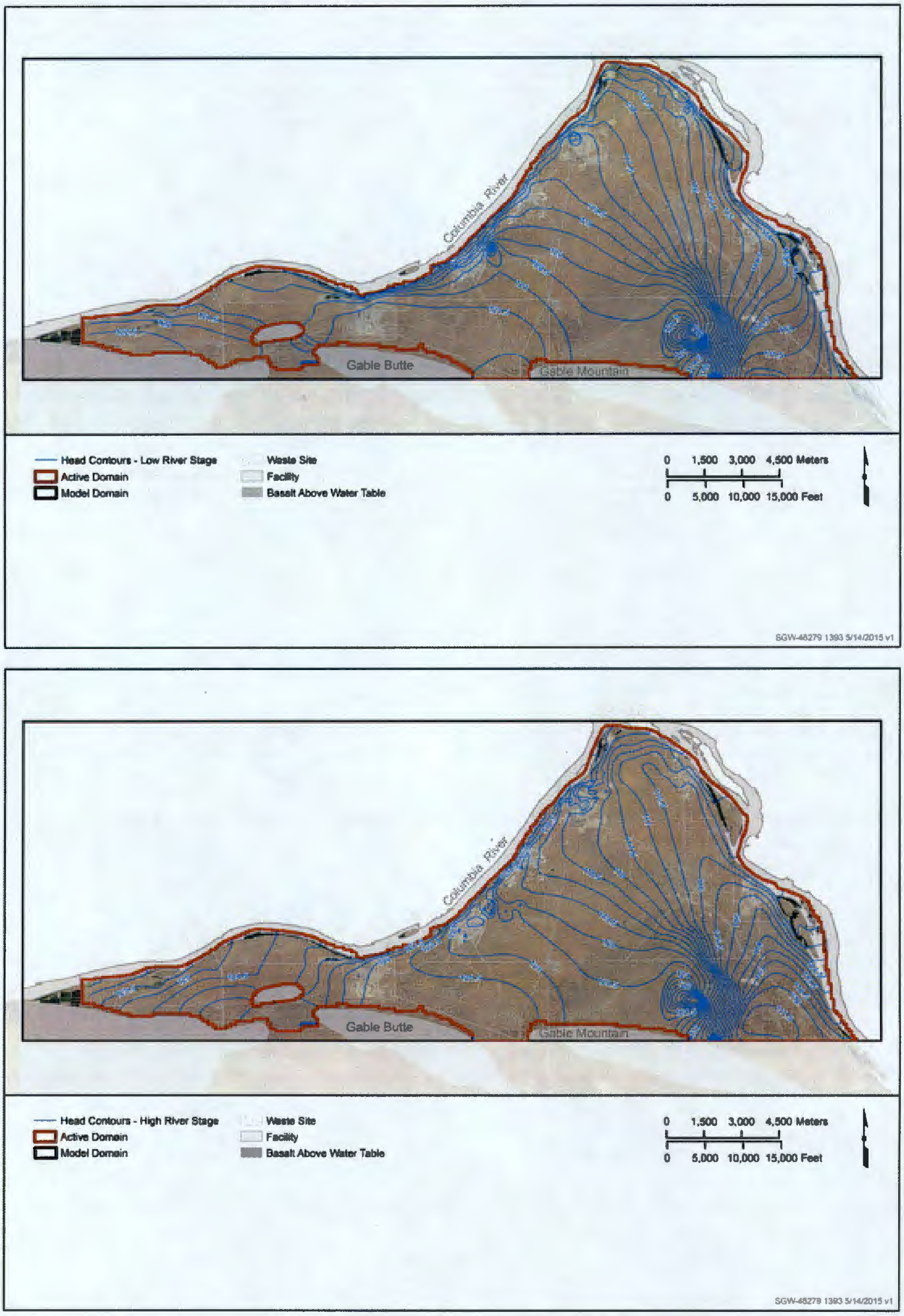



**Figure 4-20. Head Contours in 100AGWM during Low River Stage (Top) and High River Stage (Bottom)**

### 4.3.2 Calibration to Hydraulic Gradients

In addition to simulating groundwater level responses, the model was calibrated to the observed magnitude and direction of hydraulic gradients. Doing so is important for both the model calibration process and use of the model for groundwater remedy design, since the direction and magnitude of hydraulic gradients is a first-order determinant in the direction and rates of contamination migration. To calculate observed gradients, triangular elements were developed based on the location of monitoring wells in each OU. The triangle locations were selected such that they overlap the primary areas of interest in each OU. Additionally, the monitoring wells that define the three vertices of the triangle needed to be monitored around the same time. For each of these triangular elements, monthly average groundwater levels were used to calculate the direction and magnitude of the hydraulic gradient each month: 82 triangular elements were used to assess the model performance in this regard. The triangles used for gradient calculations considered in the 100AGWM calibration process are shown in Figures 4-21 through 4-25 and the comparison between measured and simulated gradient magnitude/direction are depicted on rose diagrams in Appendix E. In each diagram, the location of the triangle is shown on the left. The direction and magnitudes of the measured and simulated gradients are shown in the right. The number of data points and statistics on the gradients are shown in a table at the bottom.

It should be noted that some of the triangular elements used for hydraulic gradient evaluation are eccentric; that is, they are not close to equilateral, and that this can undermine conclusions regarding simulated or observed hydraulic gradients and their correspondence. In general, the gradients compare well near the shoreline but comparison is poorer for the inland eccentric elements that are often near pumping wells. Gradients in the elements to the south of 100-F compare well, suggesting that the GHB boundary on the southeastern portion of the model is reasonable.

Finally, since the 100AGWM uses monthly stress periods to represent time-varying boundary conditions, including the Columbia River and groundwater extraction and re-injection, higher-frequency variations in groundwater levels and hydraulic gradients cannot typically be reproduced in simulations conducted using the 100AGWM. Previous tests conducted with the 100AGWM using boundary conditions that varied on a daily basis have suggested that while the model representation of high-frequency variations in groundwater levels and hydraulic gradients is improved by higher-frequency boundary conditions, the effect on the simulated net migration of groundwater over periods of interest (i.e., months to years) was minimal.

The calibration results presented in this report are the result of a continuous and ongoing process of development, and calibration of the 100AGWM that will continue following collation and incorporation of new data or updated interpretations of the hydrogeologic conceptual framework.

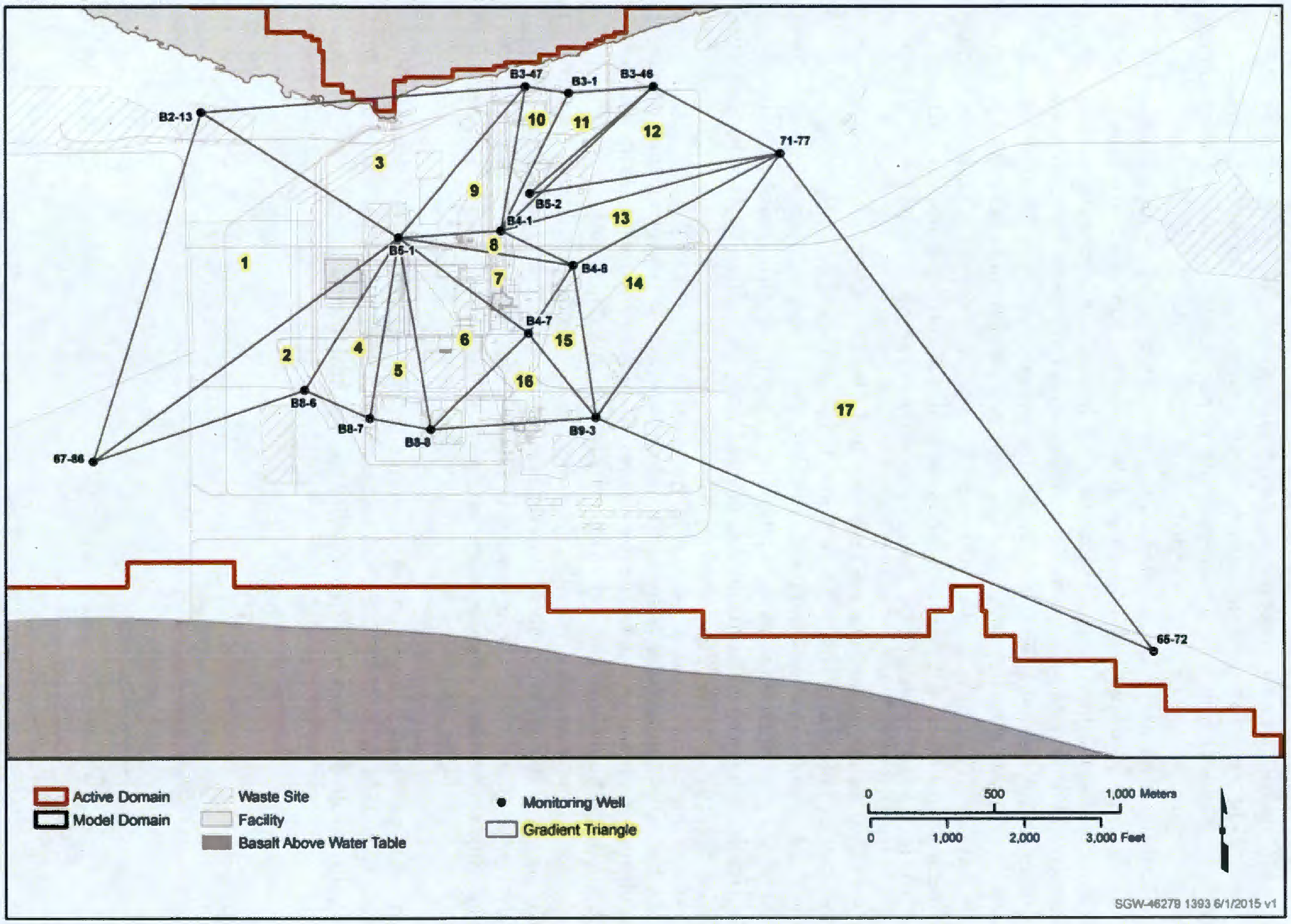



**Figure 4-21. Gradient Triangles in 100-B**

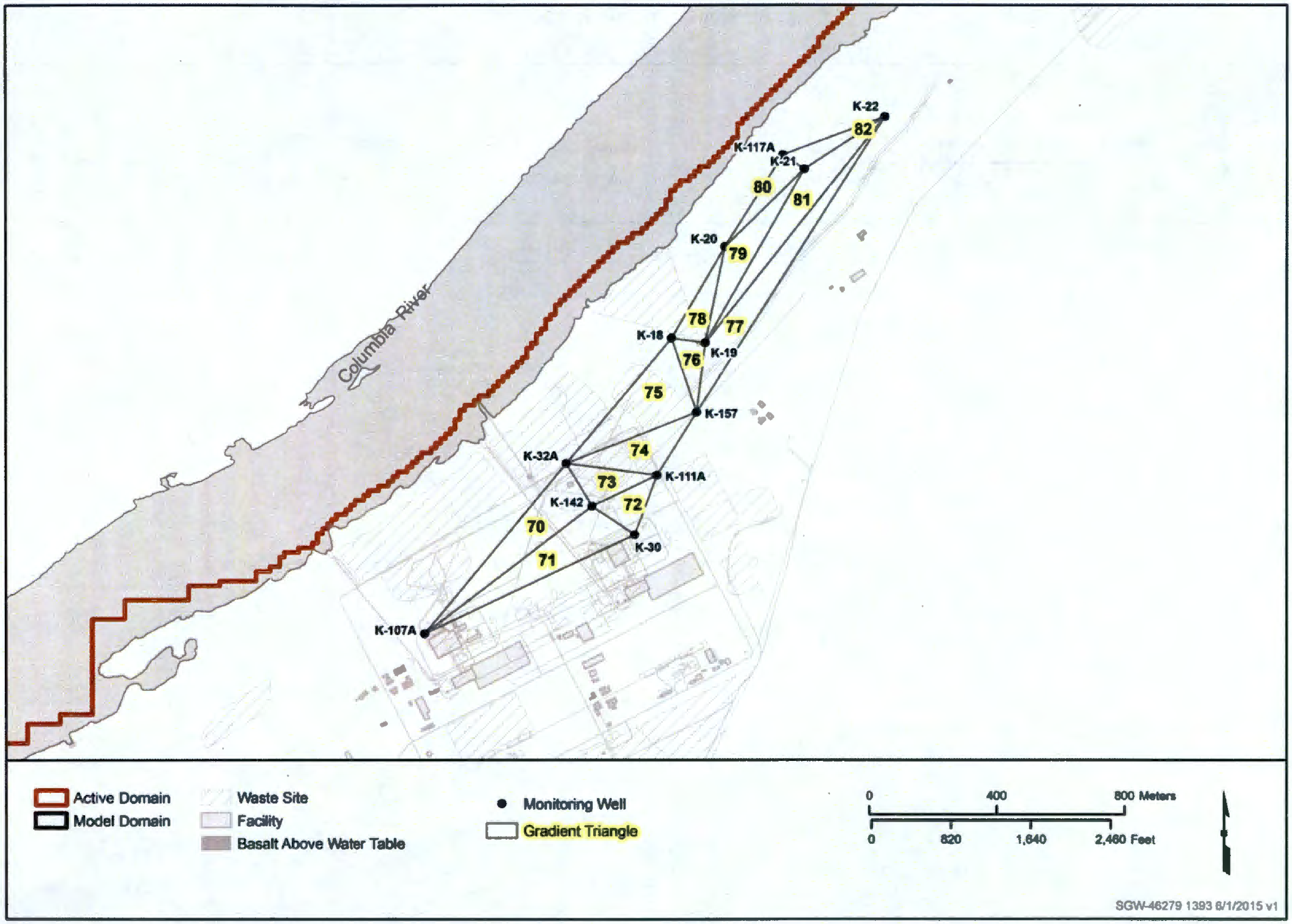



Figure 4-22. Gradient Triangles in 100-K

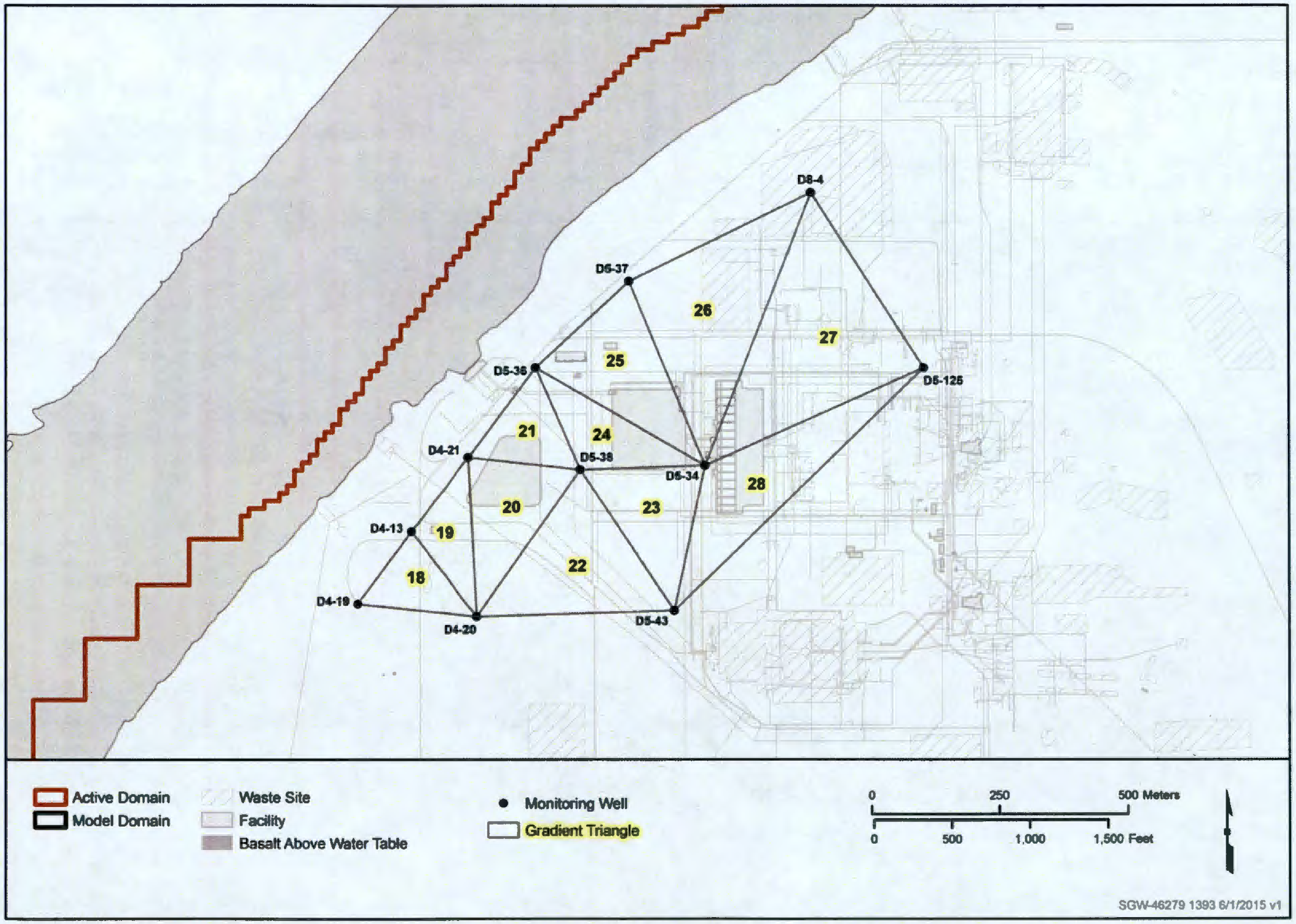



**Figure 4-23. Gradient Triangles in 100-D**

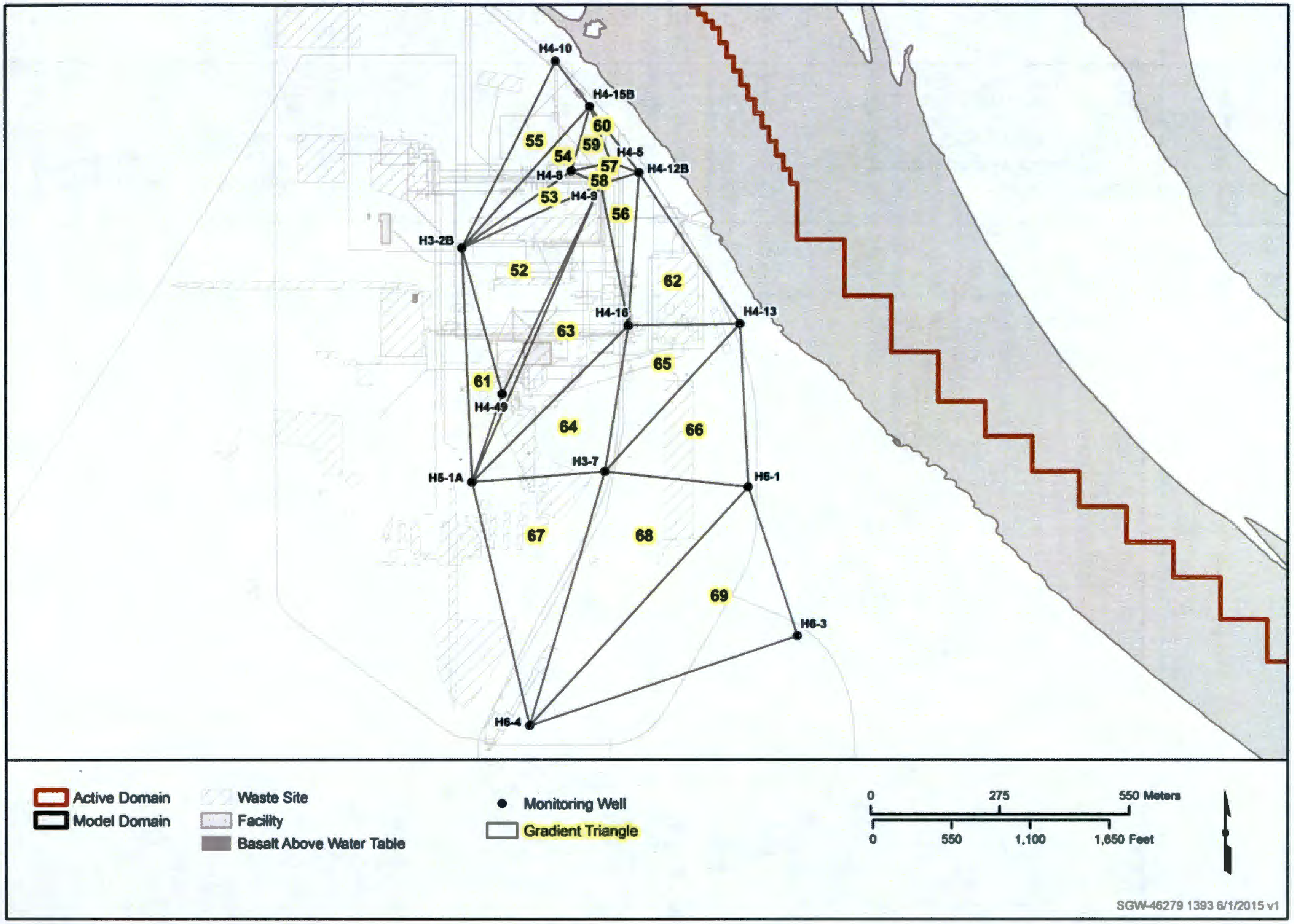



**Figure 4-24. Gradient Triangles in 100-H**

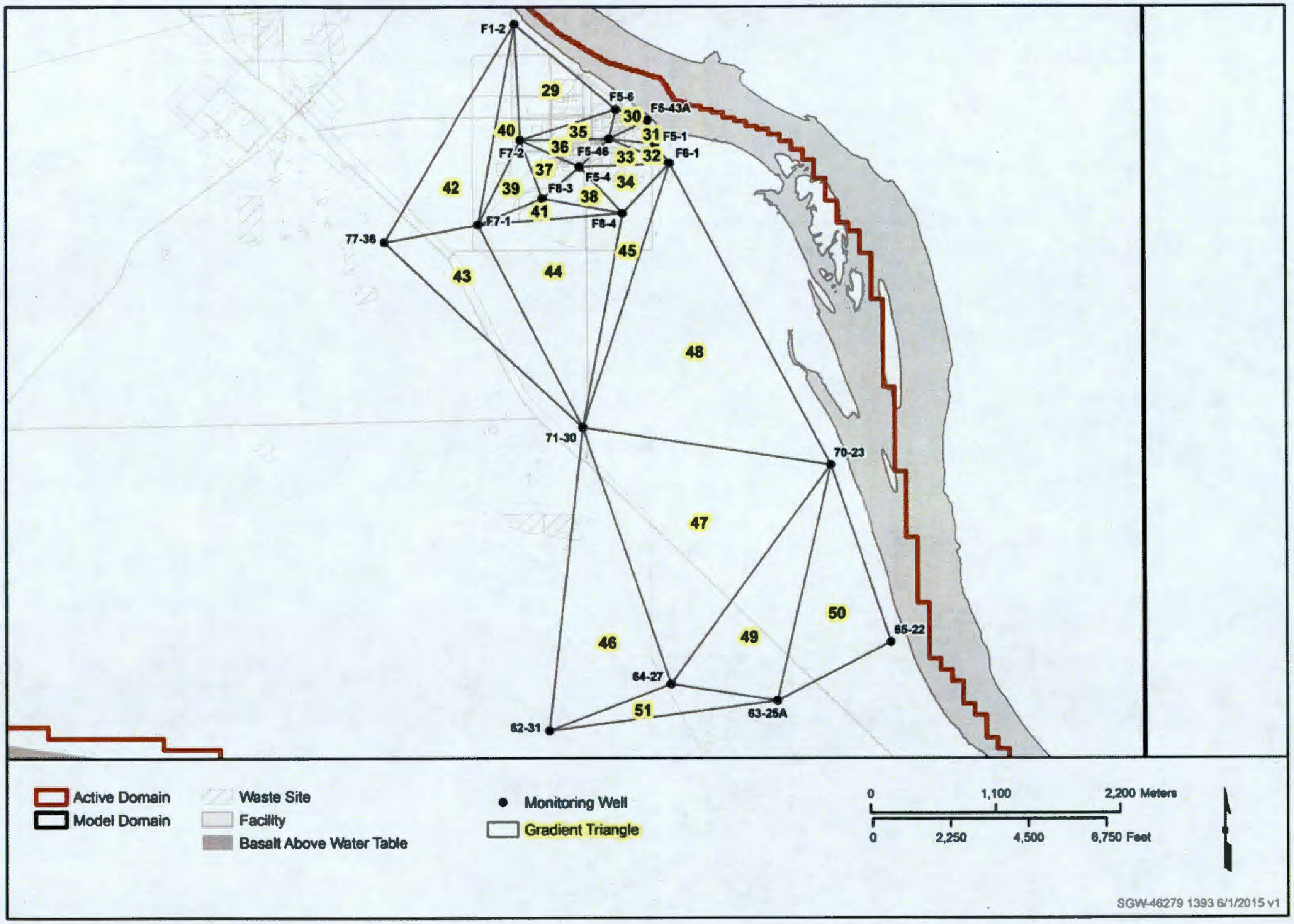


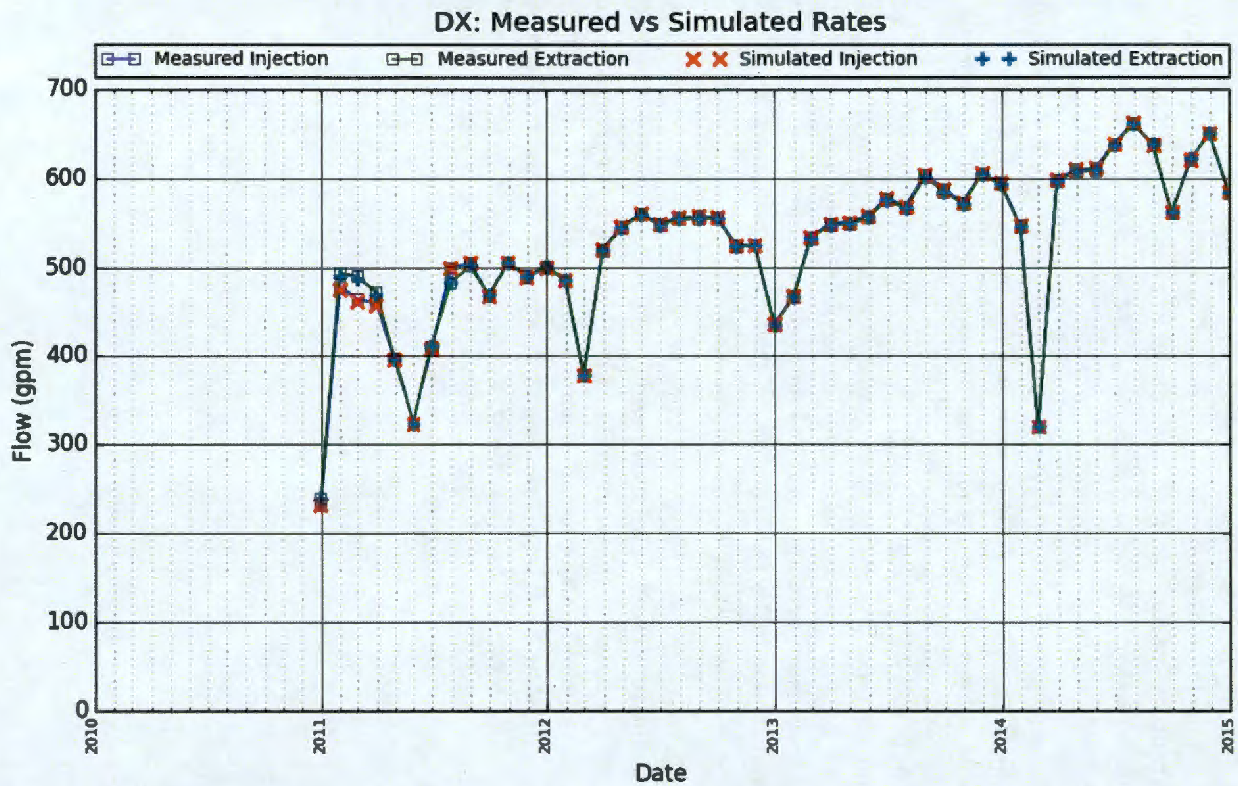

Figure 4-25. Gradient Triangles in 100-F

## 4.4 Comparison of Measured and Simulated Pumping Rates

The pumping operations of the extraction and injection wells in the 100-K, 100-D, and 100-H Areas are simulated using the MNW2 Package, with pumping wells grouped by P&T system. Even though the measured pumping rates are prescribed in the model input file, simulated net flow rates are determined by the model based on the available saturated thickness at each model time step. If saturated thickness is not sufficient, the model reduces the prescribed extraction rate so that a nominal saturated thickness is maintained at the well (Konikow et al., 2010, *Revised Multi-Node Well (MNW2) Package for MODFLOW Ground-Water Flow Model*). The pumping rates at all injection wells in the corresponding P&T system are also automatically proportionately decreased to account for the reduced extraction (CHPRC-00261). Therefore, a comparison of the measured and simulated pumping rates is essential to ensure that the model accurately simulated the measured flow rates.

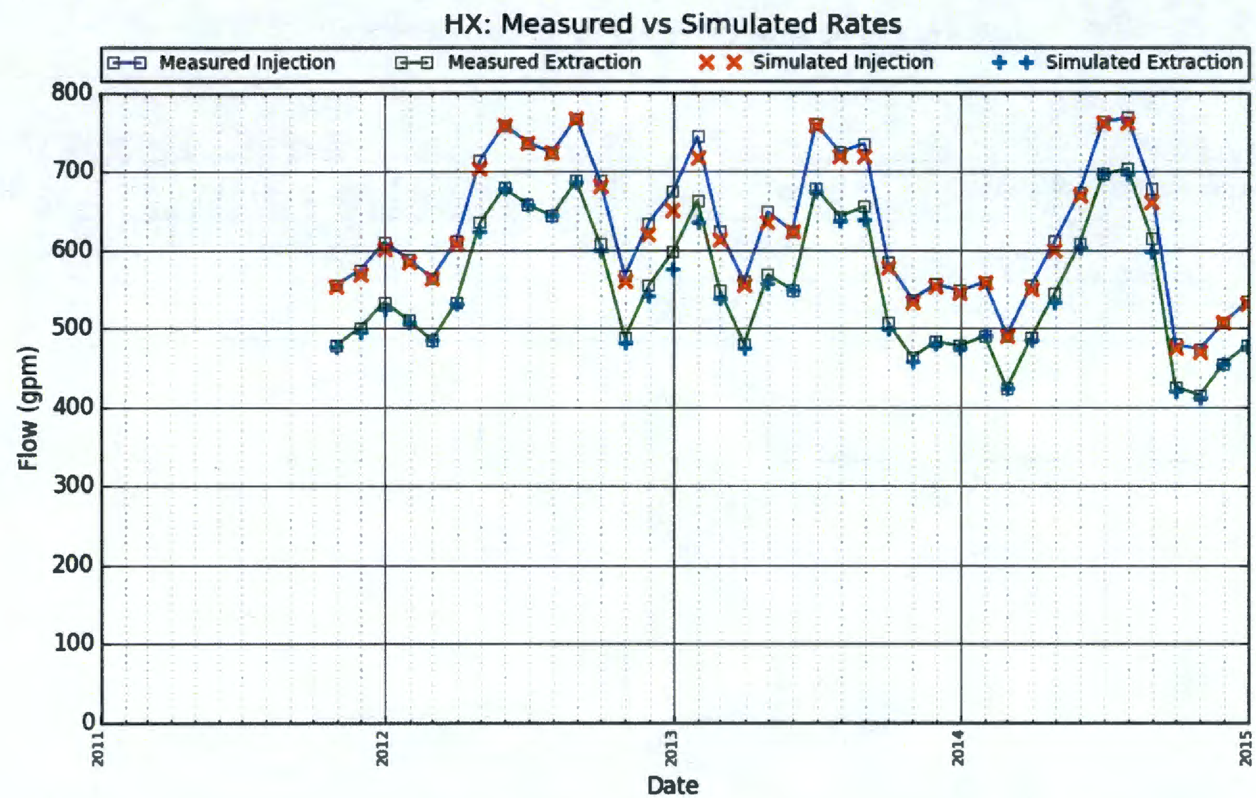
The measured and simulated rates for each individual P&T system (described in Section 3.7.5) are shown in Figures 4-26 through 4-32. Since the NR2 system was active for only a few months during the simulation period, it was not simulated in the model and, hence, the corresponding plots are not provided. The plots for the HX and HR3 systems show an imbalance between the injection and extraction rates. This is because the extraction rates from two RUM wells (199-H3-2C and 199-H4-12C) are not included in the model; the model does not simulate groundwater flow in the RUM. However, the simulated injection rates include the contribution from these two wells, creating an artificial imbalance.
The maximum error (discrepancy) between measured and simulated flow rates in each system, tabulated in the figures, suggest that such discrepancies are negligible and should primarily be attributed to conditions near the well that could not be accurately represented in the model.

Plots of measured versus simulated flow rates per well are included in Appendix F. The naming convention adopted in the appendix conveys the well name, well type (injection/extraction), and the P&T system to which the well is connected. For example, injection well 199-D4-10 in the DX system is named as "199-D4-10_I_DX" and extraction well 199-K-220 in the KX system is named as "199-K-220_E_KX". Except for a few wells in the HX system, the discrepancy between the measured and simulated pumping rates is minimal, suggesting that the modeled saturated thicknesses are reasonable or represent a reasonable lower-bound value that sustains historical pumping rates. The two RUM wells in HX do not have a significant impact on the overall system-wide pumping totals.



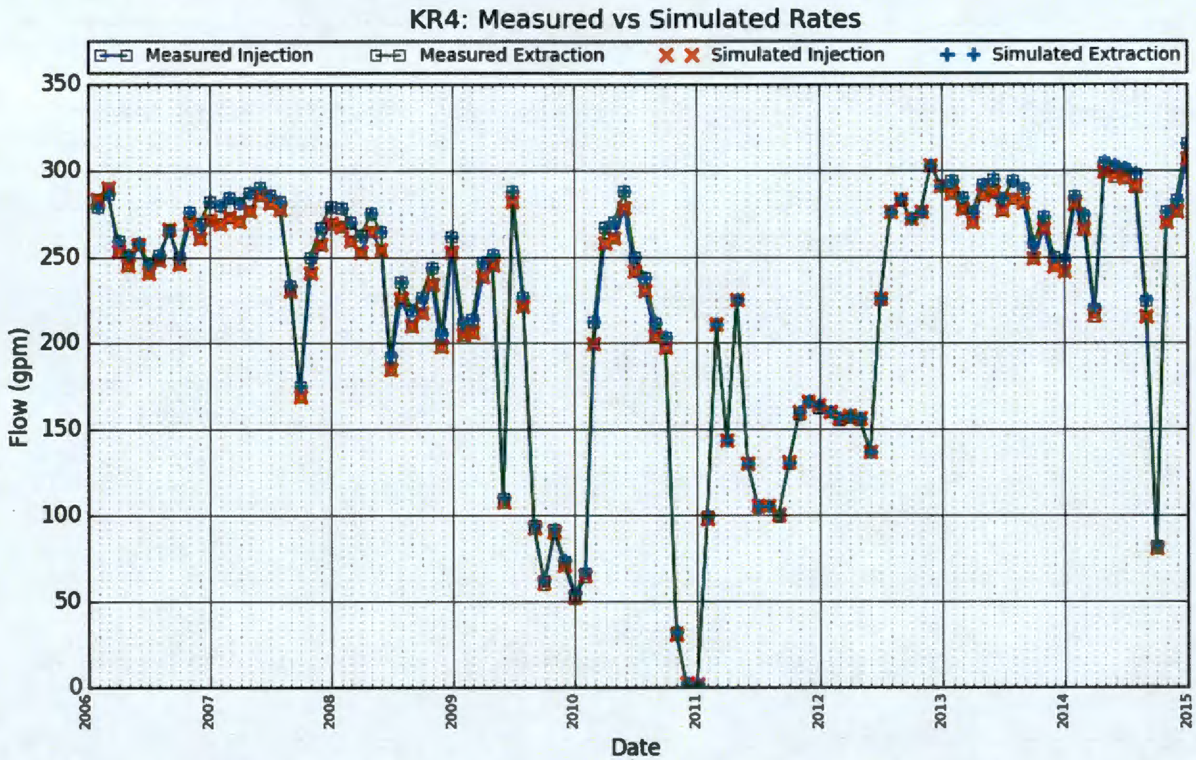

| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | February, 2011 | -490.5 | -487.6 | 2.89 | 0.6% |
| Maximum % error | February, 2011 | -490.5 | -487.6 | 2.89 | 0.6% |

**Figure 4-26. Measured Versus Simulated Rates for the DX P&T System**



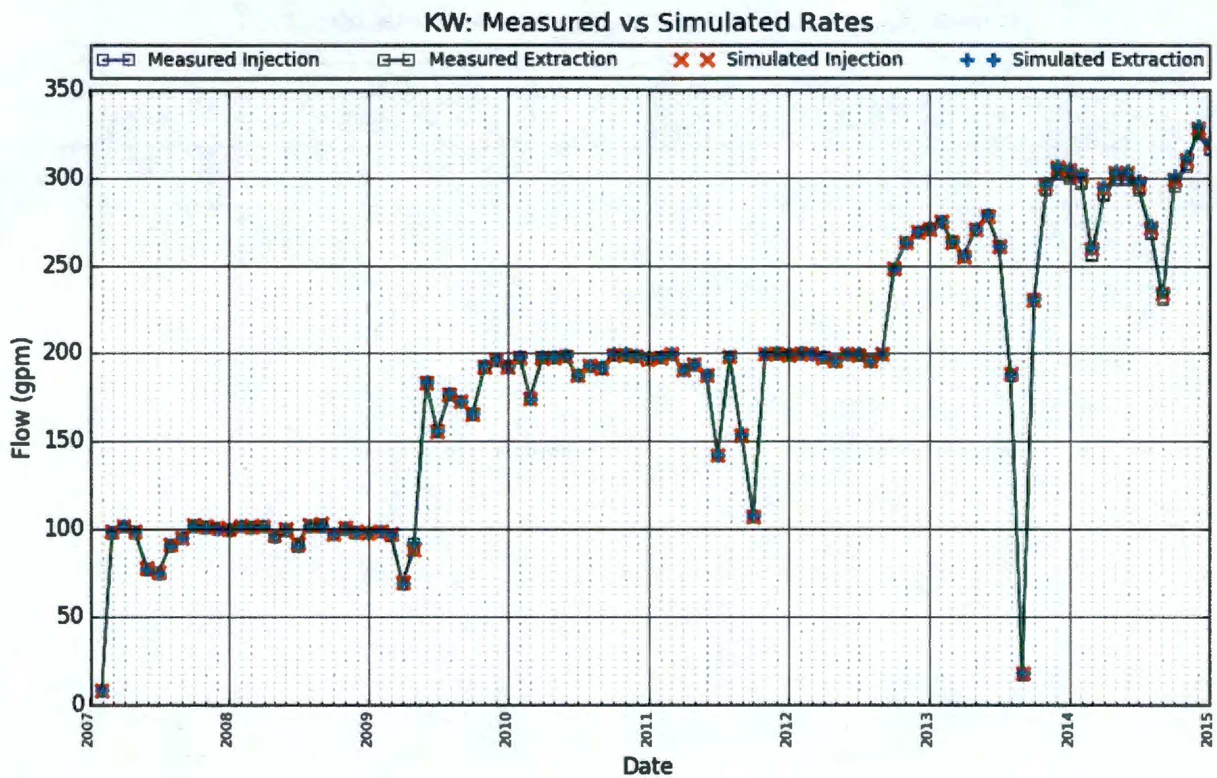

| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | January, 2013 | -662.8 | -636.4 | 26.43 | 4.0% |
| Maximum % error | January, 2013 | -662.8 | -636.4 | 26.43 | 4.0% |

**Figure 4-27. Measured Versus Simulated Rates for the HX P&T System**



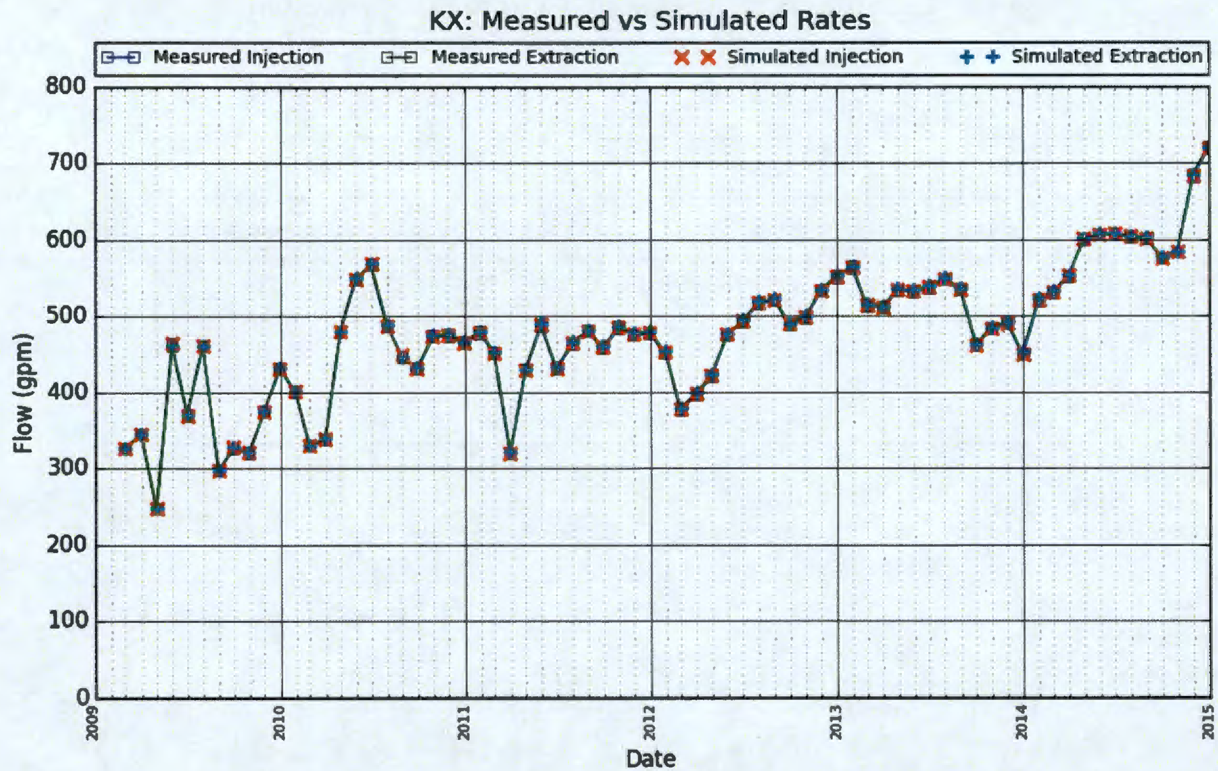

| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | December, 2011 | -162.2 | -163.6 | 1.45 | 0.9% |
| Maximum % error | September, 2009 | -61.4 | -62.1 | 0.70 | 1.1% |

**Figure 4-28. Measured Versus Simulated Rates for the KR4 P&T System**



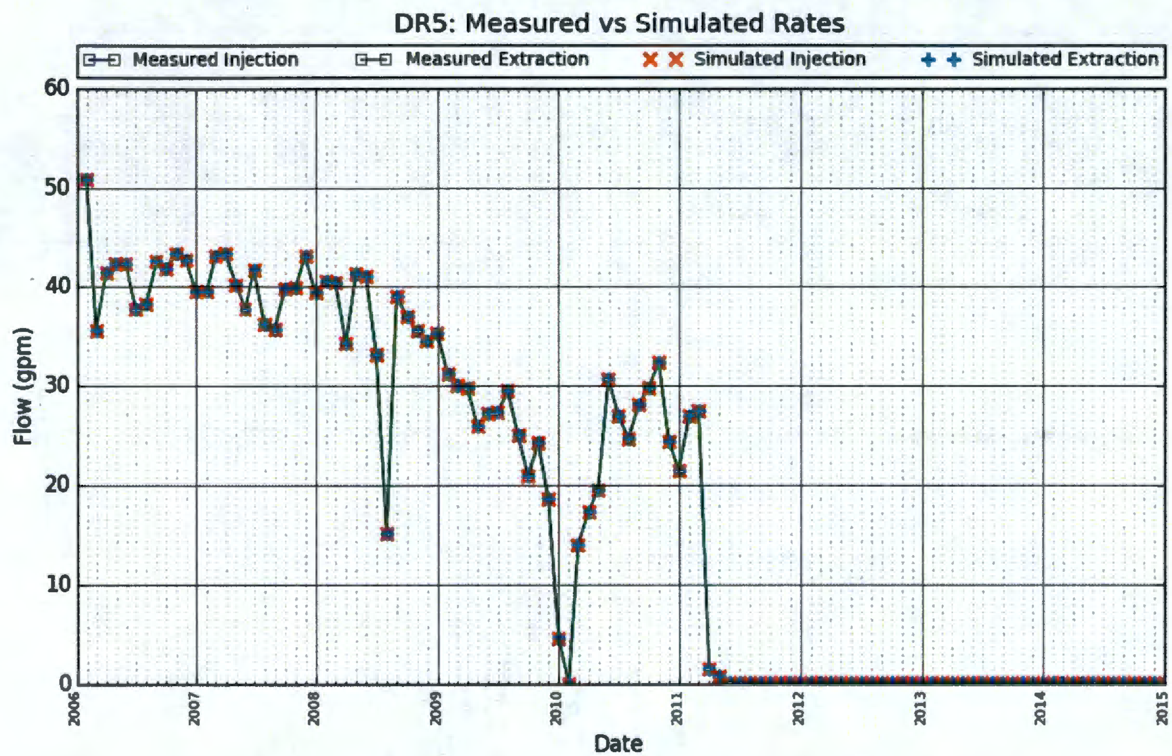

| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | December, 2013 | -301.2 | -305.2 | 4.00 | 1.3% |
| Maximum % error | August, 2013 | -17.1 | -17.4 | 0.31 | 1.8% |

**Figure 4-29. Measured Versus Simulated Rates for the KW P&T System**



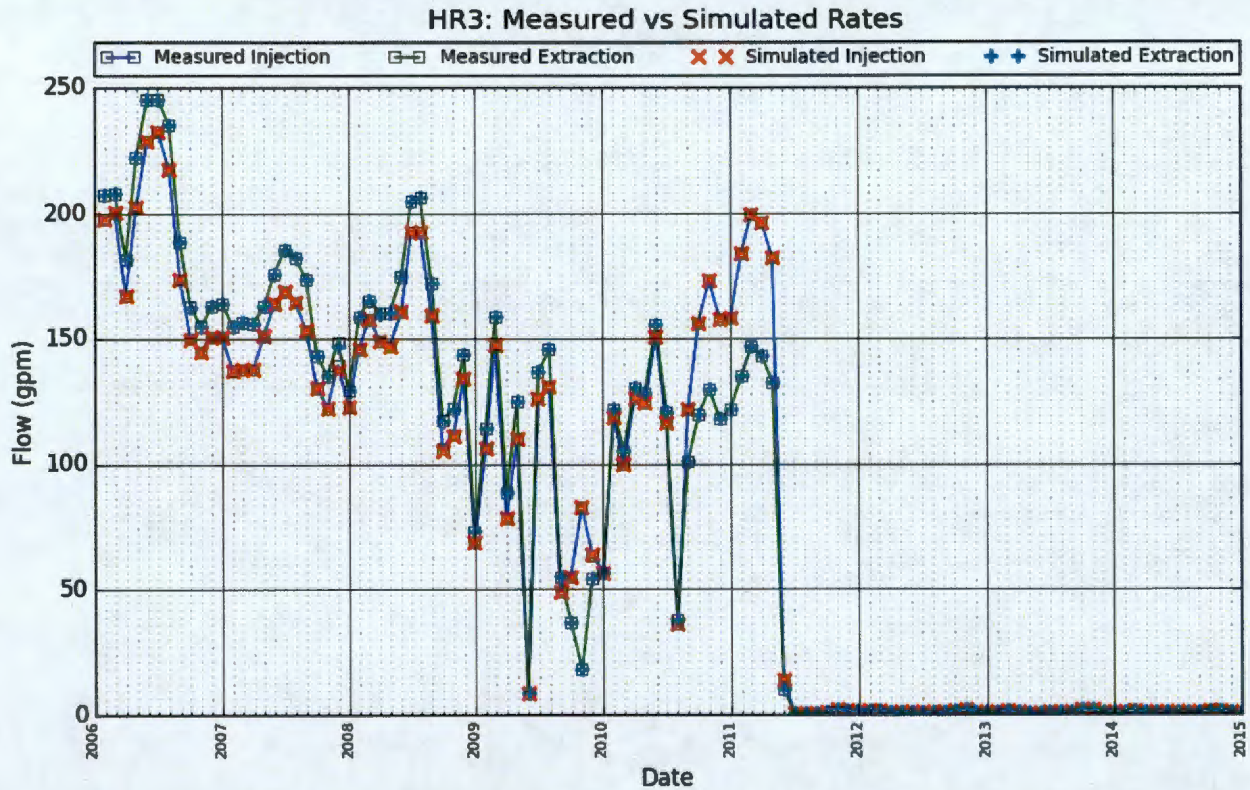

| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | July, 2012 | -517.7 | -519.3 | 1.64 | 0.3% |
| Maximum % error | September, 2011 | -459.2 | -460.8 | 1.58 | 0.3% |

**Figure 4-30. Measured Versus Simulated Rates for the KX P&T System**




| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | April, 2011 | -0.7 | -0.7 | 0.00 | 0.0% |
| Maximum % error | April, 2011 | -0.7 | -0.7 | 0.00 | 0.0% |

**Figure 4-31. Measured Versus Simulated Rates for the DR5 P&T System**




| | Date | Measured Extraction (gpm) | Simulated Extraction (gpm) | Error (gpm) | Error (% of Measured) |
|---|---|---|---|---|---|
| Maximum Error | November, 2007 | -148.6 | -146.8 | 1.82 | 1.2% |
| Maximum % error | November, 2007 | -148.6 | -146.8 | 1.82 | 1.2% |

**Figure 4-32. Measured Versus Simulated Rates for the HR3 P&T System**

# 5 Contaminant Transport Modeling

This section describes those aspects of the transport of contaminants dissolved in groundwater that can be simulated using the current version of the 100AGWM, and the general procedures used to assign parameter values describing transport characteristics for COCs and other indicator parameters in the 100 Areas. Detailed, application-specific explanations of contaminant transport properties (parameters) and simulations will be provided in application-specific ECFs on any occasion that the 100AGWM is employed to make a specific calculation. Simulation of the transport of contaminants is accomplished using a version of the multi-species reactive-transport simulator MT3DMS, modified specifically for use at the Hanford Site.

Steady-state and transient transport simulations are based upon groundwater flow fields calculated by the flow component of the 100AGWM. The 100AGWM was originally developed to simulate groundwater flow and purely advective (i.e., non-dispersive and non-reactive) movement of water and contaminants in order to estimate the likely extent of hydraulic containment and ultimately "capture" developed by groundwater P&T remedies. As the development of remedy alternatives progressed, however, it became necessary to simulate the fate of contaminants, commencing with Cr(VI), and later incorporating other COCs and indicator parameters, using mass conservative reactive-transport methods. These capabilities were required in order to simulate the following:

- Concentrations at point locations (for example, corresponding to wells) and integrated over broad areas (such as plumes) and other quantities such as plume masses and volumes, over time.
- Influent concentrations at extraction wells.
- Aboveground mixing, including "blending" or combining influent streams from multiple extraction wells, and treatment of contaminants by existing and/or proposed aboveground treatment systems.
- Transformations and reactions that some contaminants undergo under either natural or anthropogenic (enhanced) conditions; for example, to evaluate the likely impact and effectiveness of in situ biodegradation as a remedy component.

Although the subsurface migration and fate of many contaminants at Hanford is dominated by advection, that is, the movement of dissolved contaminants in the subsurface with, and in the general direction of, groundwater flow, contaminants do undergo processes of dispersion, adsorption-desorption, transformations (such as radioactive decay), and degradation. Indeed, PNNL studies (PNNL-17674, *Geochemical Characterization of Chromate Contamination in the 100 Area Vadose Zone at the Hanford Site*) suggest that although advection is the primary transport mechanism, contaminant transport cannot be adequately simulated with advection alone since advection only effectively simulates the highly mobile mass that is already dissolved in the actively moving groundwater. In addition to simple advection, contaminants undergo reactions and contaminant mass can be retained within heterogeneous parts of the aquifer of low hydraulic conductivity or poorly connected pore spaces. Where these conditions occur above the seasonal low water table and below the seasonal high water table, this relatively less mobile mass can constitute a continuing source of contaminants to the permanently saturated aquifer below, facilitated by mass transfer between these domains (i.e., secondary sources within the periodically rewetted zone). Where these conditions occur within the saturated aquifer, these processes can cause tailing in breakthrough curves that is not always adequately explained using standard advection-dispersion simulations.[6]

Based on these observations, and on previous simulations conducted at Hanford, the following features of the transport of contaminants in the 100 Areas are available through the MT3DMS simulation code for inclusion in saturated transport simulations using the 100AGWM (note that not all capabilities need be included in all simulations):

- **Advection.** On most occasions, this is represented using the implicit finite-difference technique for computational expediency. Advection is not discussed further in this report.
- **Dispersion.** The contribution of mechanical dispersion and molecular diffusion to the migration of contaminants is available via MT3DMS but is typically not included in simulations because the use of simulated dispersion often results in the "spreading" and lowering of predicted concentrations, which can lead to overly optimistic projections of cleanup times and natural attenuation. For this reason, dispersion (and diffusion) are not discussed further in this report. Several studies (e.g., Feehley et al., 2000; Flach et al., 2004; Liu et al., 2007, "Evaluation of the applicability of the dual-domain mass transfer model in porous media containing connected high-conductivity channels;" Guan et al., 2008, "Behavior of the mass transfer coefficient during the MADE-2 experiment: New insights;" Liu and Kitanidis, 2012; Molz, 2015, "Advection, Dispersion and Confusion") have suggested that within transient flow fields, such as that present in the 100 Areas, the dual-domain formulation (described below) may more effectively reproduce the patterns exhibited by field data, including tailing of breakthrough curves, although appropriately defining site-specific parameters for the formulation can be difficult (Flach, 2012, "Relationship Between Dual-Domain Parameters and Practical Characterization Data").
- **Radioactive decay.** Where applicable, this is simulated using published half-lives for each corresponding radionuclide. Half-lives used in specific applications will be listed in the corresponding application-specific ECF(s). Radioactive decay is discussed in Section 5.3.
- **Reversible sorption.** When included in simulations, this is typically simulated using a linear isotherm (i.e., instantaneously reversible [de-]sorption using a distribution coefficient: $K_d$). Distribution coefficients ($K_d$s) used in specific applications will be listed in the corresponding application-specific ECF(s). However, some considerations for the selection of appropriate $K_d$ values in transport simulations are given in the subsections that follow within this report.
- **Dual-domain (dual-porosity) transport.** When included in simulations, this is typically used to represent the effect of heterogeneity that is present at the sub-grid scale (i.e., within the model cells). This is detailed further in Section 5.1.
- **(Bio) degradation under natural and artificially augmented (mediated) conditions.** This is detailed further in Section 5.2.
- **Treatment system processes.** This includes the blending, treatment, and recirculation of dissolved contaminants and indicator parameters that are extracted by pumped wells and returned to the aquifer via injection wells (or other means). This is detailed further in Section 5.4.

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[6] Feehley et al., 2000, "A dual-domain mass transfer approach for modeling solute transport in heterogeneous aquifers: Application to the Macrodispersion Experiment [MADE] site;" Flach et al., 2004, "Comparison of Single-Domain and Dual-Domain Subsurface Transport Models;" Liu and Kitanidis, 2012, "Applicability of the Dual-Domain Model to Nonaggregated Porous Media"

The sections that follow detail the implementation of dual-domain (dual-porosity) transport, biodegradation, radioactive decay, and treatment system processes for selective use within transport simulations completed using the 100AGWM. The final subsection describes how initial conditions are typically developed for saturated aquifer transport simulations using the 100AGWM. The following discussions describe the method(s) used to implement certain contaminant transport processes using MT3DMS as the transport simulator for the 100AGWM: the application-specific parameterization of each transport process will be described in application-specific ECFs, and will depend on the contaminant(s) simulated and other features of the specific application.

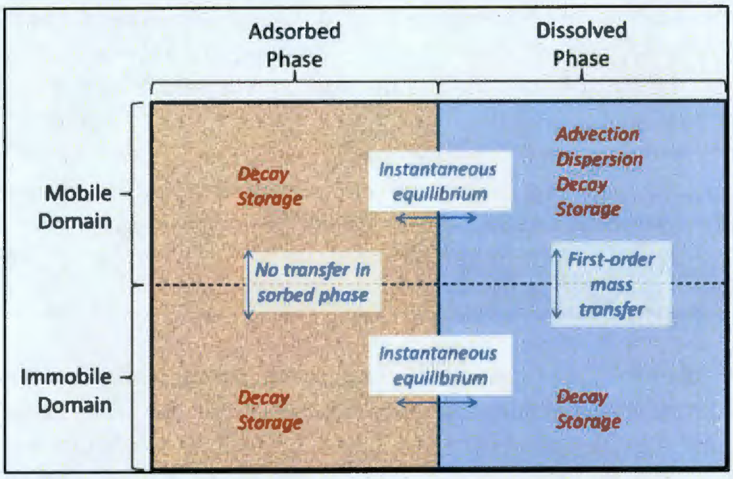
## 5.1 Dual-Domain Transport

Numerous studies have identified that asymmetric breakthrough curves, which depict rapid first-arrival of contamination followed by long-term tailing (persistence), observed in field data are often not adequately reproduced using standard advection-dispersion simulation methods. This is in part because the asymmetric tailing appears related to processes that occur at the sub-grid scale (Flach et al., 2004) that cannot easily be explicitly characterized or simulated. This finding is consistent with PNNL studies (PNNL-17674), which suggest that contaminant mass can reside within, and slowly be released from, low hydraulic conductivity regions and poorly connected pore spaces of the heterogeneous aquifer, and that this mass can continue to contaminate the moving groundwater that are not necessarily explicitly represented by patterns of regional heterogeneity that can be discretized in transport simulations (PNNL-17674). Studies conducted at many sites, including Borden, Savannah River, and the MADE[7] sites have identified that a "dual-domain" formulation often performs better than the classical advection-dispersion formulation in reproducing observed breakthrough curves for relatively homogeneous porous media that do not contain distinct "dual domains" but rather exhibit smaller-scale heterogeneity that can be explicitly simulated (Feehley et al., 2000; Flach et al., 2004; Guan et al., 2008; Luo et al., 2008, "Effective reaction parameters for mixing controlled reactions in heterogeneous media;" Liu et al., 2007; Ronayne et al., 2010, "Geological modeling of submeter scale heterogeneity and its influence on tracer transport in a fluvial aquifer;" Liu and Kitanidis, 2012).

Although the "mobile" versus "immobile" domain literature terminology is unfortunate and misleading, this dual-domain transport capability has been demonstrated to provide improved correspondence between simulated and observed breakthrough curves. For that reason, the 100AGWM enables the migration of dissolved contaminants at the 100 Areas to be simulated using the dual-domain (dual-porosity) approach, effectively dividing the saturated aquifer into two "domains" that exhibit contrasting transport characteristics. The dual-domain simulation approach assumes that the movement of contaminants dissolved in groundwater is dominated by advection that occurs predominantly within the coarser connected fraction of the aquifer, which is referred to in the literature as the "mobile" domain. Mass can transfer between this region of highly advective transport and a region of the aquifer that exhibits slower migration due to small-scale heterogeneity, sorption, and surface-complexation processes, referred to in the literature as the "immobile" domain.

In simulations completed using the 100AGWM, mass transfer is simulated as a simple linear function of the dissolved concentration gradient between these two domains. Figure 5-1 schematically depicts the dual-domain processes that the 100AGWM can simulate. It is typically assumed that sorption occurs only within the "immobile" domain so that the partitioning coefficient $K_d$ in the mobile domain is zero. This specification is consistent with studies and publications that conceptualize the mobile domain as comprising sub-grid scale connected "preferential pathways" where advection dominates.

[7] Macrodispersion Experiment, Columbus, Mississippi




Note: Blue font represents mass transfer between various phases/domains; red font represents simulated transport processes.

**Figure 5-1. Conceptual R of Dual-Domain (Dual-Porosity) Simulation**

To help develop initial parameters for the MT3DMS dual-domain formulation, benchmark calculations evaluating migration in a soil under single- and dual-domain conditions were performed using MPNE1D (Neville, 2004, *MPNE1D A General Analytical Solution for One-Dimensional Solute Transport with Multiprocess Nonequilibrium*). The analytical solution describes the following transport processes: advection, dispersion, dual-porosity, mobile-immobile mass transfer, combined equilibrium and kinetic sorption, and first-order transformation reactions. The following are the principal assumptions that underlie the use of the MPNE1D code to provide initial parameters for use together with the MT3DMS dual-domain formulation with the 100AGWM:

- The domain is represented as a dual-porosity continuum, with mass movement between the mobile and immobile domains modeled as first-order mass transfer.
- Sorption (within the immobile domain only) occurs at equilibrium and/or rate-limited sites.
- The material (aquifer) properties are spatially uniform and temporally constant.
- The initial concentrations in each domain are specified and assumed in equilibrium.

The conceptual model developed to help provide initial parameters for the 100 Areas dual-domain simulations consisted of a one-dimensional soil column of 50 cm (19.7 in.) in length. Uniform hydraulic and transport parameters were assumed throughout the soil column. A steady-state flow field is assumed with a Darcy flux of 1.319 cm/day (0.519 in./day) under confined conditions. Contaminant transport is simulated for a period of 40 days for a conservative solute with no dispersion or decay. The initial concentration in the soil column is assumed equal to zero. The boundary condition at the top of the soil column represents a contaminant flux of 1 g/cc from the start of simulation to 17.6 days. From 17.6 days to 40 days, the influx of mass drops to zero and no additional mass is introduced into the system. Breakthrough curves are calculated at a distance of 30 cm (11.8 in.) from the top of the soil column. The parameters used in the problem are shown in Table 5-1. Numerical simulation of the conditions described in the conceptual model using the same parameter values were performed using MT3DMS, and the results were compared to the analytical solution.

**Table 5-1. Parameter Values for the Simulation of Plume Migration in a Soil Column**

| Parameter | Value |
|---|---|
| Bulk density, ρb (g/cm$^3$) | 1.72 |
| Mobile water content, θm (cm$^3$/cm$^3$) | 0.18 |
| Immobile water content, θim (cm$^3$/cm$^3$) | 0.045 |
| Total water content, θ (cm$^3$/cm$^3$) | 0.225 |
| Fraction of mobile water content, f (-) | 0.8 |
| Darcy flux, q (cm/day) | 1.319 |
| Immobile Soil-water distribution coefficient, $K_d$ (cm$^3$/g) | 0.3 |

cm/day = centimeter per day

cm$^3$/cm3 = cubic centimeter per cubic centimeter

cm3/g = cubic centimeter per gram

g/cm3 = gram per cubic centimeter

A single-domain model that simulates the movement of a conservative plume through a soil column was developed first to provide an initial basis for comparison to assess and understand the effect of each individual process that influences the movement of contaminants under dual-domain conditions. Figure 5-2 shows breakthrough curves for a single-domain simulation using the analytical solution and the numerical model, assuming a mobile porosity of 18 percent and no consideration of an immobile domain or of adsorption in either domain (i.e., a single domain with porosity 18 percent). The breakthrough curves suggest excellent agreement between the analytical and numerical solutions, indicating that the MT3DMS dual-domain formulation when simulating a single-domain case properly reflects the results obtained with the analytical solution provided by MPNE1D.

Dual-domain simulations were then performed assuming 20 percent immobile water fraction, which results in an immobile water content of 4.5 percent and mobile water content of 18 percent, for a total water content of 22.5 percent. The value of 20 percent used for the immobile fraction was based upon qualitative review of stratigraphic logs from drilling that has occurred in the 100 Areas over time, which identified that the finer sediment fraction, within which most mineral surface area would exist and most surface-based reactions might reasonably be assumed to occur, was typically of this order. More recent work completed by PNNL as part of investigations within the 100-D area identified within a number of cores that finer-fraction (in this particular case, <4 mm diameter grains) percentages ranged between 20 percent and 100 percent (SGW-58416, *Persistent Source Investigation at 100-D Area*).

Adsorption was also simulated in the form of instantaneous linear adsorption in the immobile domain. A value of 0.3 cc/g, was used for the $K_d$. Two cases were examined, for different values of the first-order mass transfer coefficient α: α equal to zero, reducing the system to a single domain; and α equal to 0.01 day$^{-1}$, representing a dual-domain system.

When the mass transfer coefficient α is set to 0.01 day$^{-1}$, solute mass is able to enter and leave the immobile domain generating a characteristic "tailing" of the contaminant plume migration. When compared to the single-domain simulation, lower solute concentrations are initially observed in the mobile phase. This can be attributed to mass transfer from the mobile domain into the immobile domain when the immobile dissolved concentration is lower than the mobile domain concentration. Subsequently, mass in the immobile domain is slowly released into the mobile domain as the mobile domain concentrations decrease.

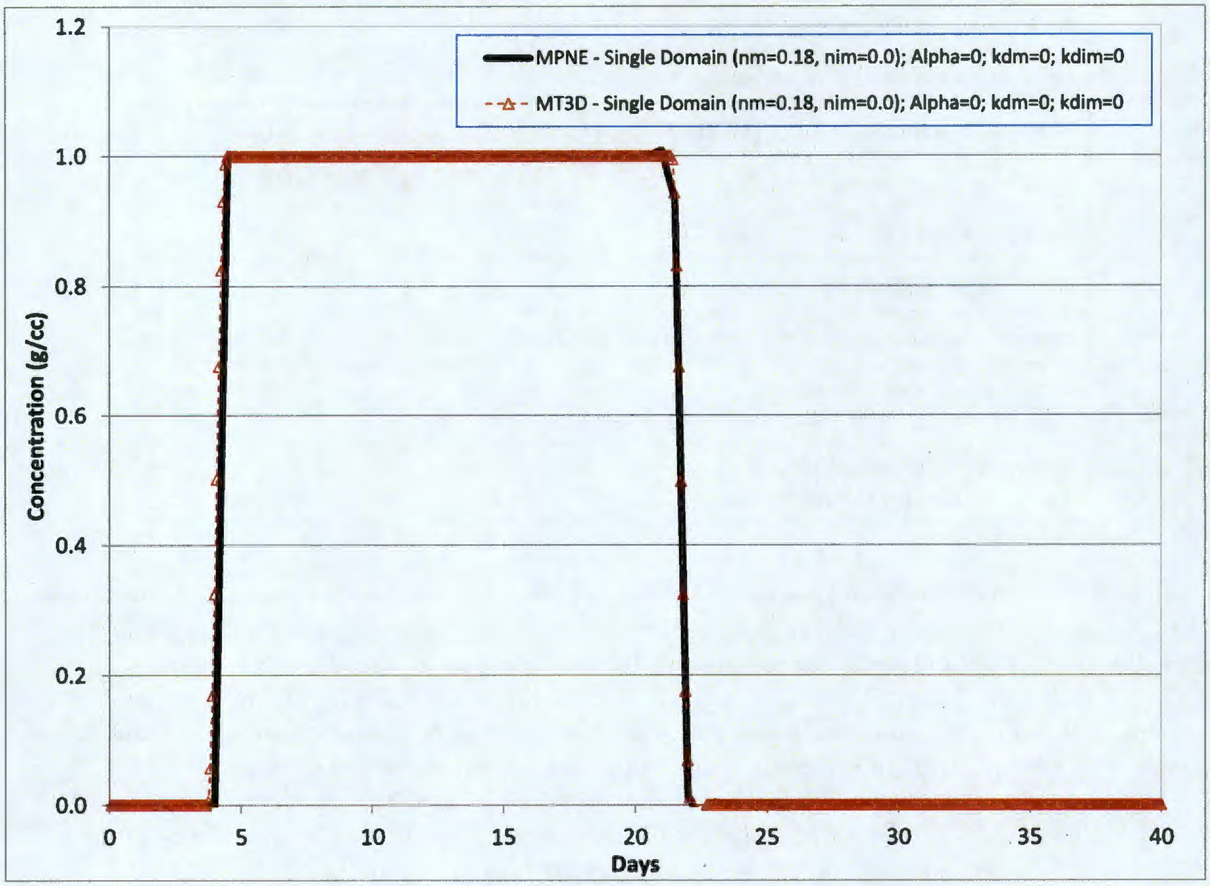



**Figure 5-2. Breakthrough Curves – Single Domain**

Figures 5-3 and 5-4 show the breakthrough curves for a dual-domain case obtained by the analytical solution and the numerical model, respectively. The breakthrough curves indicate additional retardation of the plume migration due to adsorption.

Table 5-2 shows the solute mass introduced to, recovered from, and remaining in the system at the end of the simulation timeframe under single-domain conditions, dual-domain conditions, and dual-domain conditions with absorption considered. Although the entire solute mass was flushed from the system within the 40-day simulation period for the single-domain case and the dual-domain case with no transfer between domains, on the order of 6 percent of the mass introduced into the system remains in the column under dual-domain conditions that include adsorption and transfer between the mobile and immobile domains.

The results of the simulations undertaken using MPNE1D to benchmark the dual-domain implementation within MT3DMS supports the presumption that the dual-domain formulation can represent the effect of small-scale heterogeneities in the aquifer that sequester and slowly release contaminant mass, thereby prolonging the time required to achieve aquifer cleanup levels in groundwater. The parameterization of the dual-domain system described previously (i.e., a total porosity of 22.5 percent, comprising a mobile porosity of 80 percent [0.18] of the total porosity, and an immobile porosity of 20 percent [0.045] of the total porosity, with a rate-transfer coefficient of 0.01 day$^{-1}$ between the two domains) was retained for the simulation of COCs using the 100AGWM. This does not, however, indicate that these initial parameters ascribed to the dual-domain formulation are the most suitable or representative for use in simulations completed using the 100AGWM. The most suitable parameterization of the dual domain for simulations conducted using the 100AGWM would be achieved through calibration to historical groundwater concentration data, ideally under conditions of relatively limited complexity where the release history of the target solutes is well known (e.g., Flach, 2012). The benefit of rigorous assessment of mass-transfer coefficients has been demonstrated in both packed column studies and field applications (e.g., Maraqa, 2001, “Prediction of mass-transfer coefficient for solute transport in porous media”).

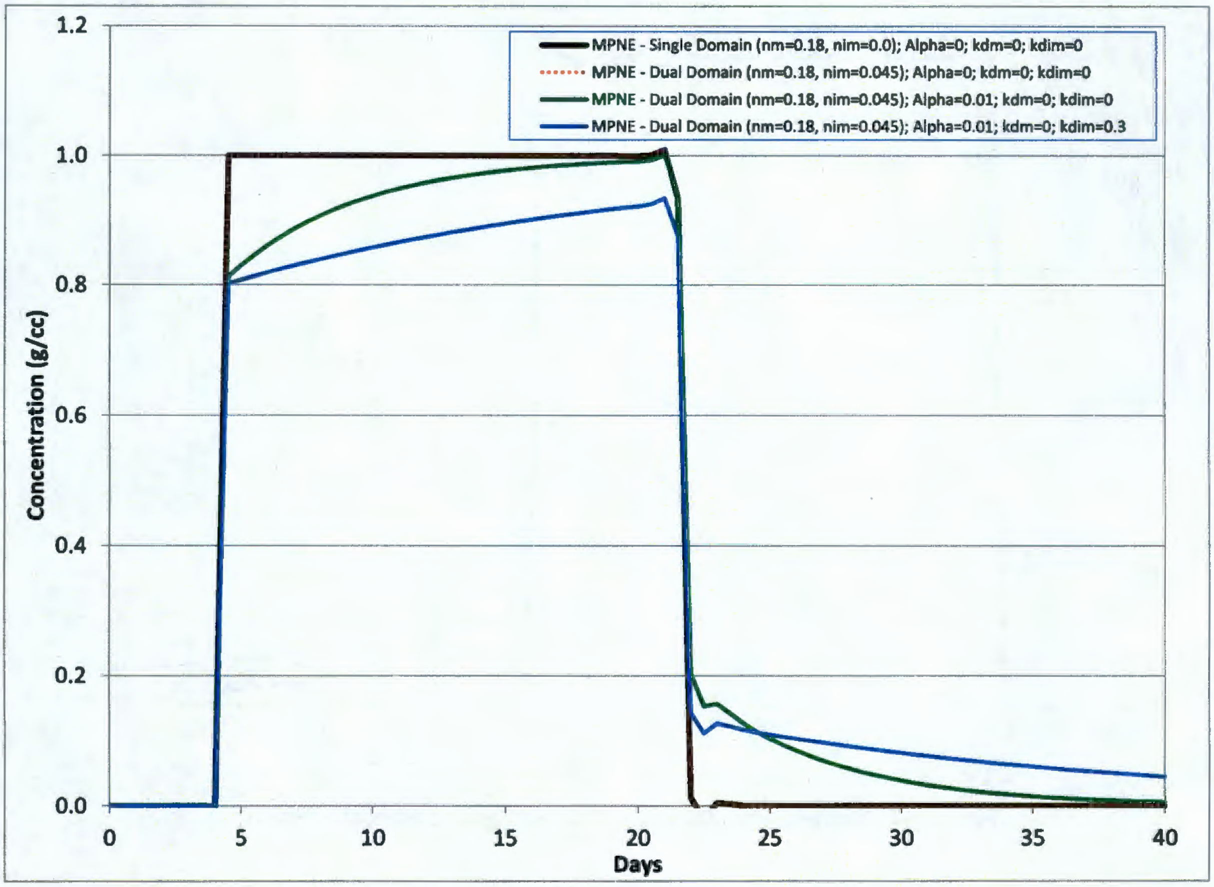



**Figure 5-3. Breakthrough Curves – Dual Domain, Analytical Solution**

Using this apportionment of the mobile and immobile domains, contaminant-specific parameters for the $K_d$ within the immobile domain are required. These are described within each application-specific calculation brief, together with supporting information. Nonetheless, it is expected that the dual-domain parameterization may vary, depending on the simulated contaminant and the objective of the simulation. For example, the distribution coefficient of 0.3 cc/g described previously has been used for simulations of Cr(VI) using the 100AGWM. Work described in ECF-HANFORD-11-0165, *Evaluation of Hexavalent Chromium Leach Test Data Conducted on Vadose Zone Sediment Samples from the 100-Area*, suggests that a higher-valued $K_d$ of 0.8 cc/g may be appropriate as a conservative lower limit when representing residual Cr(VI) that is present in fine sediment after several pore-volume flushes of contaminated sediments have occurred. Still more recent work completed by PNNL suggests that within waste sites characterized by low-pH releases of concentrated sodium di-chromate, the inhibition of Cr(VI) release from soils may be dictated by rate-limited dissolution of chromate co-precipitated with calcite. Future revisions of the groundwater fate and transport models will consider all new information in parameterizing the representation of the transport of Cr(VI) and other contaminants in the 100AGWM. As these data become available, the transport model parameters will be corroborated through calibration to observed conditions and comparison with the mapped movement of Cr(VI) plumes across the River Corridor.

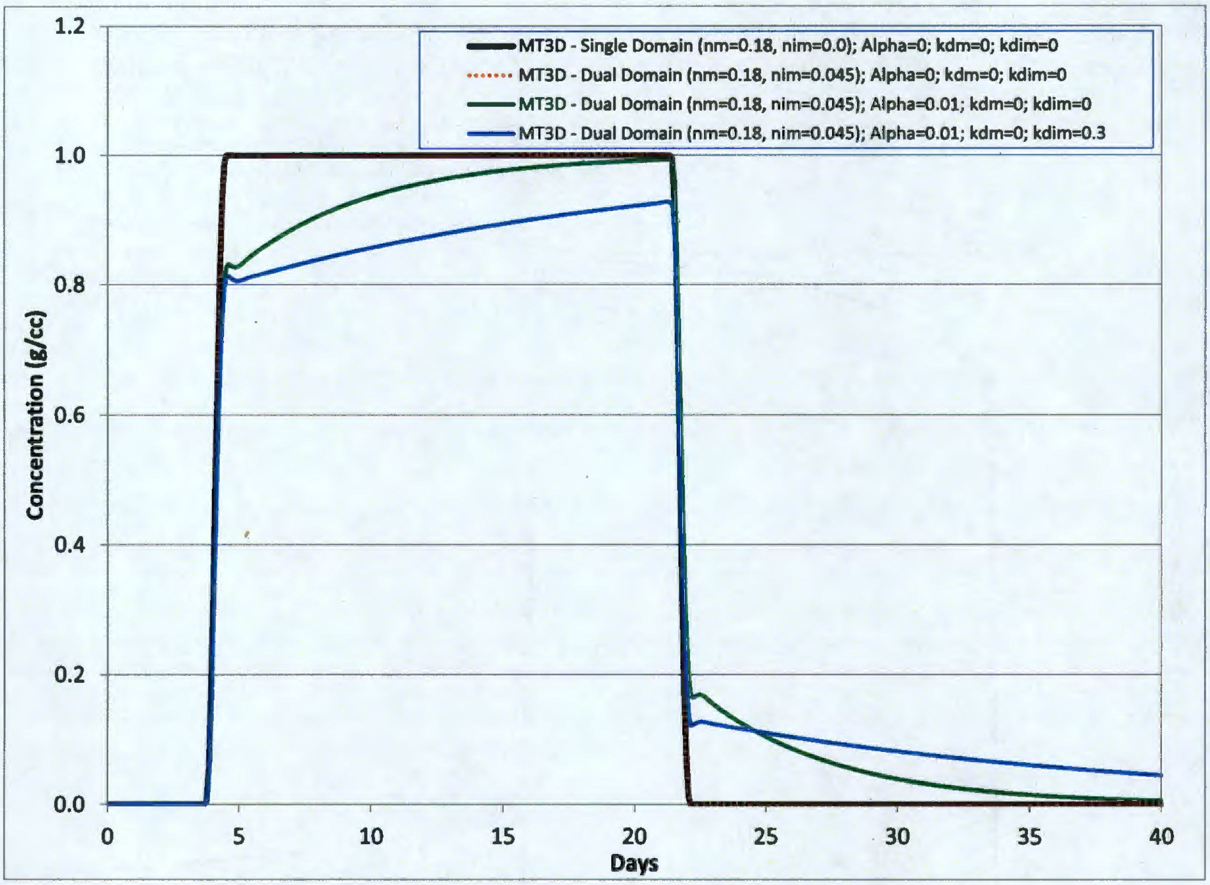



**Figure 5-4. Breakthrough Curves – Dual Domain, Numerical Simulation**

**Table 5-2. Mass-Balance of Solute for Each Scenario After 40 Days**

| Scenario | Total In (g) | Mass Remaining (g) | Total Out (g) |
|---|---|---|---|
| Base case, single domain | 23.264 | 0.000 | 23.264 |
| Dual-domain, no sorption | 23.264 | 0.118 | 23.147 |
| Dual-domain, sorption in immobile phase | 23.264 | 1.395 | 21.870 |

## 5.2 Bioremediation

The majority of flow and transport simulations conducted using the 100AGWM to date focus on the fate of groundwater and contaminants under "ambient" and under remediation conditions, with the principal groundwater remedy typically groundwater P&T. However, the 100AGWM has also been used to evaluate the efficacy of in situ bioremediation, either as an augmentation to groundwater P&T remedies, or as a stand-alone remedial alternative. To accomplish this, the 100AGWM has been used to make predictive simulations of the effect of injecting water amended with a suitable substrate for remediation of one (or potentially more) target contaminants. The discussion in this subsection provides the general approach to completing these bioremediation simulations: the case of the bioremediation of Cr(VI) using a source of carbon as the substrate is used as an example to illustrate details of the implementation.

To date, the 100AGWM has been used to simulate the bioremediation of a single contaminant, using a single injected species (substrate). That is, simulations consider the transport and interaction of two species: the first species being the COC and the second species being the injected substrate. The substrate injection is simulated as an injection concentration that enters the groundwater system through an injection well using the Source Sink Mixing (SSM) package of MT3DMS. An instantaneous reaction is simulated, with a specified stoichiometry. In other words, a specified ratio of the substrate that is required to reduce/consume/transform the COC such that under most conditions, absent transport of the species, either the substrate completely and instantaneously reduces/consumes/transforms the contaminant in the model cell or the substrate is entirely consumed and reduces/consumes/transforms the corresponding amount of contaminant. This reaction between the two species assumes instantaneous and complete mixing within each model cell, and is represented explicitly in the model. The rate of the reaction, (i.e. the amount of contaminant that is reduced/consumed/transformed by the injected substrate) is calculated directly based on the specific reaction stoichiometry for the two corresponding species.

The foregoing approach to simulating degradation can, in theory, be used to represent direct reduction (or oxidation) and/or biodegradation/biotransformation. The approach does not explicitly consider the growth of organisms in the case of bioremediation. In many cases, the reaction stoichiometry will be semi-empirical, based in part upon equations that describe the oxidation-reduction system, including the target contaminant, but also considering field experience with similar remediation technologies.

For example, if ethanol ($C_2H_6O$) is used as a carbon source to reduce Cr(VI) to trivalent chromium, the following equation describes the chemical reaction that is involved in the bioremediation process:

$$C_2H_6O + 4CrO_4^{\ 2-} + 8H^+ \rightarrow 2CO_2 + 4Cr(OH)_3 + H_2O$$

This equation assumes that chromium is present at the Hanford Site in the hexavalent form. Using this equation, stoichiometric calculations suggest that every gram of ethanol reduces 4.5 grams of Cr(VI). If, however, chromium is present in the form of $CrO_4^{2-}$, then 10.07 grams of $CrO_4^{2-}$ are reduced per gram ethanol oxidized. As written, this equation does not consider the demand that is placed on the ethanol from other electron acceptors residing in the aquifer. In reality, before the substrate reacts with the chromium, it is consumed by two processes:

1. Bioactivity of the microbes that diminishes the substrate concentration
2. Competitive reaction with other compounds present in the system

Since neither bioactivity of microbes nor the reaction of the substrate with secondary compounds is explicitly simulated in the 100AGWM, the MT3DMS reactive-transport simulator developed for use with the 100AGWM enables a first-order decay term to be applied to the substrate that can approximate the consumption of the substrate over time due to these two processes. Typically, the half-life of this first-order decay term will be empirically based, derived from field observations of pilot scale studies and other field-scale applications. In the case of Cr(VI) reduction to trivalent chromium though injection of ethanol, a first-order decay rate for the substrate is provided that assumes that the substrate has a half-life of 20 days as a result of competing demands. In this context, "half-life" refers to the surrogate representation of the consumption of the substrate by a variety of processes that are collectively represented as a first-order decay process.

As for the dual-domain simulations, the specific parameters used to describe a bioremediation scenario will be described in the corresponding application-specific environmental calculation brief.

## 5.3 Radioactive Decay

Decay of radionuclide contaminants is simulated as a first-order decay process, consistent with the physics of the decay process. Although radioactive decay is often described in terms of a "half-life" ($t_{½}$), equating to the time required for the activity to decline to half of its initial value, MT3DMS provides the capability for simulating first-order decay by specifying a decay rate, λ, calculated as follows:

$$t_{½} = \frac{\ln(2)}{\lambda}$$

$$\lambda = \frac{\ln(2)}{t½}$$

As for the dual-domain simulations, the specific parameters used to describe radioactive decay will be described in the corresponding application-specific environmental calculation brief.

## 5.4 P&T System Circulation

When groundwater is extracted for aboveground treatment, the treatment technology is generally selected to be effective in removing (by one process or another) one or more targeted COCs. Certain technologies are effective for certain COCs, potentially removing all of the contaminant from the water, whereas, certain technologies may not completely remove a COC but may remove sufficient of the COC that the treatment effluent meets discharge requirements. Finally, some contaminants are difficult, or technically impracticable, to remove from pumped groundwater. An example of the latter is tritium, which is an isotope of hydrogen and, as such, when combined with oxygen, has essentially the same properties as water.

In order to represent the effect of aboveground treatment systems on the quality of extracted (and re-injected) groundwater, the MODFLOW and MT3DMS simulators that are used to execute the 100AGWM are able to simulate the circulation and treatment of extracted COCs within a P&T system comprising a network of extraction and injection wells. While the primary COCs are actively treated to a level (efficiency or effectiveness) that is specified by the user, secondary contaminants simply pass untreated from the extraction wells, through the treatment system, and are returned to the groundwater domain via injection wells. Blending of the extracted water can occur (as occurs within aboveground treatment systems), which will alter blended concentration so that the effluent concentration is generally lower (more dilute) than the highest influent concentration for untreated contaminants. This movement of contaminants through a P&T system is simulated using the contaminant treatment system package implemented in MT3DMS (Bedekar et al., 2011, *Implementation of a Contaminant Treatment System (CTS) module in MT3DMS*).

## 5.5 Development of Initial Plumes for Transport Modeling

To complete a predictive (forward-in-time) simulation of the fate of contaminants that are currently presenting in groundwater, a depiction of the current extent and concentration of each COC is required. This is referred to as the contaminant transport "initial condition," or the "initial plume." This initial plume is a depiction of the spatially varying concentration of a COC, typically prepared based on measured concentration data obtained by sampling wells. Initial plumes can represent these concentrations in 2D or 3D, depending on the availability and location of the sample data, and the discretization of the numerical model.

Unless decided otherwise, initial COC distributions are developed following the procedure implemented annually for the purposes of the Hanford Site Groundwater Monitoring Report (e.g., DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*). Maps of the extent of contamination, referred to as contaminant plume maps, are typically developed by interpolating concentration data at wells and aquifer tubes to a grid using ordinary kriging in 2D. The approach to develop COC piece-wise continuous distributions implements an integrated procedure of compiling and aggregating datasets in a comprehensive database; developing input files; and executing batch processes using the open-source statistical computing/programming language R (The R Development Core Team, 2013, *The R Project for Statistical Computing*). Details on the development and implementation of this procedure are provided in ECF-Hanford-14-0035, *Description of Groundwater Calculations and Assessments for the Calendar Year 2013 (CY2013) 100 Areas Pump-and-Treat Report*.

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# 6 Model Assumptions and Limitations

The following describe principal assumptions and limitations of the modeling effort:

- Fluid flow in the vadose zone above the saturated aquifer (i.e., above the water table) is not simulated.
- The RUM, where present, is considered a vertical no-flow boundary. However, sensitivity analysis should be performed to examine the effects, if any, of possible flow across the bottom of the model domain on results obtained using the 100AGWM, including plume migration and the effectiveness of proposed groundwater remedies.
- River-aquifer interaction and river stage variation, in particular, represent an important mechanism for water level changes near the shoreline and at some distance inland. In the absence of continuous river gauge data, representation of the river stage temporal variation in the model was based on regression-based estimates using the USGS gauge data below Priests Dam. These estimated values can lead to misrepresented river stage variations, affecting the simulated water level distributions.
- With respect to the contaminant transport processes described in this report, the effect of small-scale (i.e., sub-grid scale) heterogeneity and transport processes on contaminant transport are incorporated in the model through a dual-domain formulation. However, the parameters that describe mass transfer between the mobile and immobile phases are calculated based on limited information from soil column experiments and, to date, have not been corroborated through calibration to field data. Actual field-scale values could vary significantly and should be evaluated through model calibration when remedy mass recovery data are collected.
- The 100AGWM transport simulations do not include continuing sources in the vadose zone, periodically rewetted zone, or RUM. However, recent investigations at the Hanford Site revealed a source of Cr(VI) to groundwater within the 100-D groundwater OU. Partial excavation of the source area was completed, and soil samples obtained from the excavation were subjected to sequential column leach studies and electron microscopic analysis. The column studies revealed that Cr(VI) leaching extended far longer than would be expected if the Cr(VI) on soils were readily ("instantaneously") soluble and exhibited characteristic 'rebound' following stop-flow periods, which demonstrated empirically that asymptotic reductions in effluent Cr(VI) concentrations could not be interpreted as asymptotic removal of Cr(VI) from source soils. This was confirmed by the mass-balance at the conclusion of the column studies, which revealed that substantial extractable Cr(VI) remained in the sediment after dozens of pore flushes. These findings indicate that where continuing sources that exhibit these characteristics are present, such sources could significantly prolong aquifer cleanup times for groundwater remedies simulated using the 100AGWM.

As a result of the above, and consistent with recommendations made throughout the development of the 100AGWM in support of remedy design and evaluation, simulated COC distributions in the future are best interpreted as estimates and not as absolute predictions. Important simulation results should be verified using field data where possible. Numerical transport modeling over long timeframes is most appropriately used for comparative remedy analysis (i.e., to identify the likely benefits of one remedy versus another) through qualitative assessments of long-term plume migration patterns, rather than to accurately calculate point concentration time series at future locations and times.

Monitoring data should continue to be compiled and analyzed to further improve estimation of the parameters associated with the simulations undertaken using the 100AGWM, and the model should be updated accordingly to provide improved predictions over time.

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# 7 Model Configuration Management and Version History

The model described in this report is uniquely designated as the 100AGWM Version 6. For purposes of archival in EMMA, model version and simulation run numbers are assigned to the model to enable complete identification and traceability based on the guidelines of the Quality Assurance Project Plan (QAPjP) for Modeling (CHPRC-00189, *CH2M Hill Plateau Remediation Company Environmental Quality Assurance Program Plan*). Based on these guidelines, the convention for naming model versions and designating simulations includes six entries in the form:

Model Name, Version (N1), Simulation G(N2)_B(N3)_I(N4)_TC.CC_CN_iter

Where:

Model Name: a descriptive character string to uniquely identify the model

N1: Major version number (for readily identifiable distinct model)

N2: Model grid; entry is an index number

N3: Flow boundary conditions; entry is an index number

N4: Initial conditions; entry is an index number

F/TC: Flow or Transport code ("p" for particle tracking or "c" for contaminant transport)

CC: Constituent code

CN: Computer Name

iter: Iteration; a sequential number to distinguish between multiple runs (note that it is not necessary to save and archive all successive iterations)

Although this is Version 6 of the 100AGWM, it is the second model version to be archived in EMMA. For that purpose and based on the QAPjP naming convention, the current version of the model is named:

100Area_Historic_N6_G3_B7_I6_F_00_FE483_1, for the flow simulation

100Area_Historic_N6_G3_B7_I6_TC.*COCname*_00_FE483_1, for the transport simulation

## 7.1 Model Version History

Version 1 of the 100AGWM was a 2D steady-state model first developed to evaluate the system performance as part of the 100-KR-4 P&T expansion (DOE/RL-2006-75). MODFLOW was used to simulate flow and MODPATH was used to simulate particle tracking and evaluate capture zone development and system performance for the expanded P&T system in 100-KR-4. The single model layer represented the unconfined aquifer above the RUM with the HCOND distribution reflecting the corresponding formation where the water table was located. The model boundary conditions consisted of river cells representing the Columbia River and GHB cells everywhere else along the perimeter of the active model domain.

Version 2 of the model was developed for the purposes of P&T system RPO in the 100-HR-3 OU, which required contaminant transport simulations to develop projections of Cr(VI) distributions and evaluate plume migration patterns and attainment of river protection and aquifer cleanup goals. For that purpose, the groundwater flow model was converted to transient-state and coupled with a contaminant transport model using MT3DMS (SGW-46279, Rev. 0). The model grid was further refined near each OU so that transport processes were sufficiently represented in the model. A transient river stage was adopted with monthly stress periods to reflect the water level variations in the aquifer and better reproduce hydraulic gradient reversals during high and low river stage periods. Contaminant transport was considered and a dual-domain approach was introduced to simulate the tailing effects of the Cr(VI) migration. The model was used to support the calculation of appropriate pumping rates for 100-HR-3 OU injection and extraction wells to achieve RPO objectives by 2012 and 2020 (SGW-40044).

Version 3 was developed as described in SGW-46279 (Rev. 2) to support the RI/FS for the 100-HR-3 and 100-KR-4 OUs. The groundwater model was expanded to encompass all 100 Area OUs, simulating groundwater flow as 3D to explicitly represent the Hanford formation and Ringold Unit E Formation that comprise the unconfined aquifer across the 100 Areas; and contaminant transport for various COCs in each OU. This version of the model is implemented using a newer version of MODFLOW-2000 with the inclusion of the ORTHOMIN solver and capabilities to address dry cell problems.

Versions 4 and 5 were developed based on Version 3, with the model domain further extended to the west of the 100-B/C area to better represent the groundwater flow dynamics in that area, and minor calibration updates to improve the simulation of flow conditions in 100-B/C and 100-F OUs and support RI/FS evaluations of COC plume fate and transport in these OUs. The models used in these simulations are briefly described in ECF-100BC5-11-0115 and ECF-100FR3-11-0116, respectively.

Version 6, documented in this report, was developed by incorporating revised geologic interpretations (ECF-Hanford-130020) and hydraulic property estimates from additional aquifer tests, and includes a more detailed representation of the aquifer interaction with the Columbia River. Additionally, the model simulation period was extended to the end of CY 2014 to support calculations to support the CY 2014 P&T evaluations described in ECF-Hanford-15-0001, *Description of Groundwater Calculations and Assessments for the Calendar Year 2014 (CY2014) 100 Areas Pump-and-Treat Report.*

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# Appendix A

## Reprint of ECF-Hanford-13-0020, *Process for Constructing a Three-dimensional Geological Framework Model of the Hanford Site 100 Area*, Rev. 1, published July 2014

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ECF-Hanford-13-0020
Revision 1

# Process for Constructing a Three-dimensional Geological Framework Model of the Hanford Site 100 Area

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

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ECF-Hanford-13-0020
Revision 1

# Process for Constructing a Three-dimensional Geological Framework Model of the Hanford Site 100 Area

Document Type: ENV Program/Project: EP&SP

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INTERA

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**APPROVED**
*By Lee Ann Snyder at 7:47 am, Aug 20, 2014*

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# ENVIRONMENTAL CALCULATION COVER PAGE

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Software User Qualification checked 08/28/2013 WEN- confirmed that approved Leapfrog Hydro® installation available and software training requirements completed.

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# Environmental Calculation File

# Process for Constructing a Three-dimensional Geological Framework Model of the Hanford Site 100 Area

## Contents



## Attachments

# Figures



# Tables

# Terms

| | |
|---|---|
| 3D | three-dimensional |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| ECF | environmental calculation file |
| GIS | geographic information system |
| HEIS | Hanford Environmental Information System (database) |
| Hf | Hanford formation (undifferentiated) |
| Re | Ringold Formation unit E |
| RUM | Ringold Formation upper mud unit |
| NAVD88 | North American Vertical Datum 1988 |
| LiDAR | Laser Imaging Detection Ranging |
| NAIP | National Agriculture Imagery Program |
| ODBC | Open Database Connectivity |

# 1 Purpose

This environmental calculation file (ECF) provides background and details for the process used in constructing a three-dimensional (3D) geological framework model of the River Corridor (100 Area) at the Hanford Site. Leapfrog Hydro®[1] (versions 1-7 thru 2.0, ARANZ Geo Limited, LLC, 2013) is a powerful 3D geological modeling tool that utilizes existing geologic and hydrogeologic data to provide a 3D spatial representation of the subsurface. It is used as a visual tool that can be manipulated by the end user to illustrate and explore hydrogeologic features that control and constrain groundwater, and groundwater contaminant movement in the subsurface. These 3D model interpretations can be used during many stages of project development requiring hydrogeologic evaluations, to enhance and improve site characterization, conceptual model development, inputs to other modeling efforts, remedial process evaluations, and remedial action decisions. In addition, the portability of the models and associated viewer software allow visual presentations of complex hydrogeologic-to-contaminant relationships/ issues to be easily presented, and greatly improve communications and interactions with regulators and the public.

The objective of this modeling effort is to provide an accurate representation of the subsurface hydrogeologic environment beneath contaminated waste disposal facilities to support other modeling needs (i.e., contaminant fate and transport), to make informed remedial action decisions, and as an educational tool for presenting complex hydrogeologic concepts and associations to the public. The model is constructed based on consistent and defensible 3D interpretations of the Hanford Site's extensive hydrogeologic database.

# 2 Background

Leapfrog Hydro® (version 2.0, ARANZ Geo Limited, LLC, 2013) utilizes radial basis functions to construct 3D interpolations based on borehole lithological contact elevations to create continuous surfaces representing geologic lithostratigraphy.

If the user is so inclined to create these surfaces with a different geo-statistical function (i.e., ordinary kriging, inverse distance weighting), then surfaces can be created using any geographic information system (GIS) tool to generate a continuous gridded surface, and theses surfaces can be imported into Leapfrog. However, given the Leapfrog workflow paradigm, it is much more practical, and time effective to use the proprietary interpolation function (radial basis function), and manage the model consistently within Leapfrog software. The Hanford Environmental Information System (HEIS) and the 100-Area GeoContacts datasets provide the borehole and lithology data used with the Leapfrog proprietary interpolation function to generate the models.

The 3D hydrogeologic solid model is updated periodically as borehole, or lithology datasets are updated or as interpretations change. Data inputs and configuration files will be available concurrently with each release of the model, however, there is additional qualitative information used in each model version. The process of creating the 3D solids model will be repeatable to a certain extent based solely on using the same input data provided with each version.

Additionally, underlying data from boreholes, such as location, surface elevation, casing, and depth to geologic units, can be dynamically linked to an underlying data base using Open Database Connectivity (ODBC). And consequently, changes to the model can be made concurrently with changes to the database, as opposed to uploading new flat files. Supporting data is also imported and uploaded to the model to

[1] Leapfrog Hydro® is a registered trademark of ARANZ, Christchurch, New Zealand.

provide improved spatial representation and orientation for the end-user. This includes, for example, Laser Imaging Detection Ranging (LiDAR) based ground surface layers, river bathymetry, and facility location information. In addition, user-specified layers can be imported to support multiple projects, i.e., water table surfaces, contaminant plume interpretations, etc.

# 3 Methodology

The leapfrog workflow overview for creating the Hanford Site 3D geo-framework solids models (hydrogeologic model) follows a generalized and consistent workflow structure that is used in the construction of the 100-Area 3D model. In summary, interpreted lithology from borehole data is used to define geologic contact points as subsurface elevations (ECF-100NPL-11-0070, Rev. 3). These data inputs are interpolated within the Leapfrog Hydro® framework to provide geological model surfaces that form the upper (e.g., surface elevation) and lower bounding surface constraints of the geologic intervals that, combined together, represent the solid model. The basic methodology for development and construction of a 3D solids model is as follows:

a. Define the model boundary and gather the site-specific descriptions and hydrogeologic data for constructing the geologic layers of the model.

b. Run the model to generate the surface interpolations needed to assemble the geologic surface/layer components of the solid model. Subtract from the top down, or add from the bottom up, the interpolated surfaces to generate the volume and spatial orientation of each geologic unit. Apply additional control points as necessary to constrain known hydrogeologic features (e.g., pinch-outs, faults, etc.) within the model volume.

c. Save the new model as a unique 3D geologic model 'scene' for visual exploration and graphic presentations. Retain copies and records of all data used in the model in user accessible folders on PRC-Spatial.

Figure 1 depicts the lateral boundaries used to define the 100-Area model construction. For the 100 Area model, the Columbia River boundary forms the northern and eastern boundary and the Gable Mountain-Gable Butte basalt subcrop and uplift above ground surface forms the southern boundary. The western boundary is defined by the north-to-south transect located just upgradient of the westernmost 100-Area operational area (100-B/C Operable Unit). The basalt sub-crops and exposures are assumed to be impermeable boundaries and form the basement rock underlying the entire Hanford Site. The surface of the basalt represents the bottom layer of Leapfrog Hydro® model.

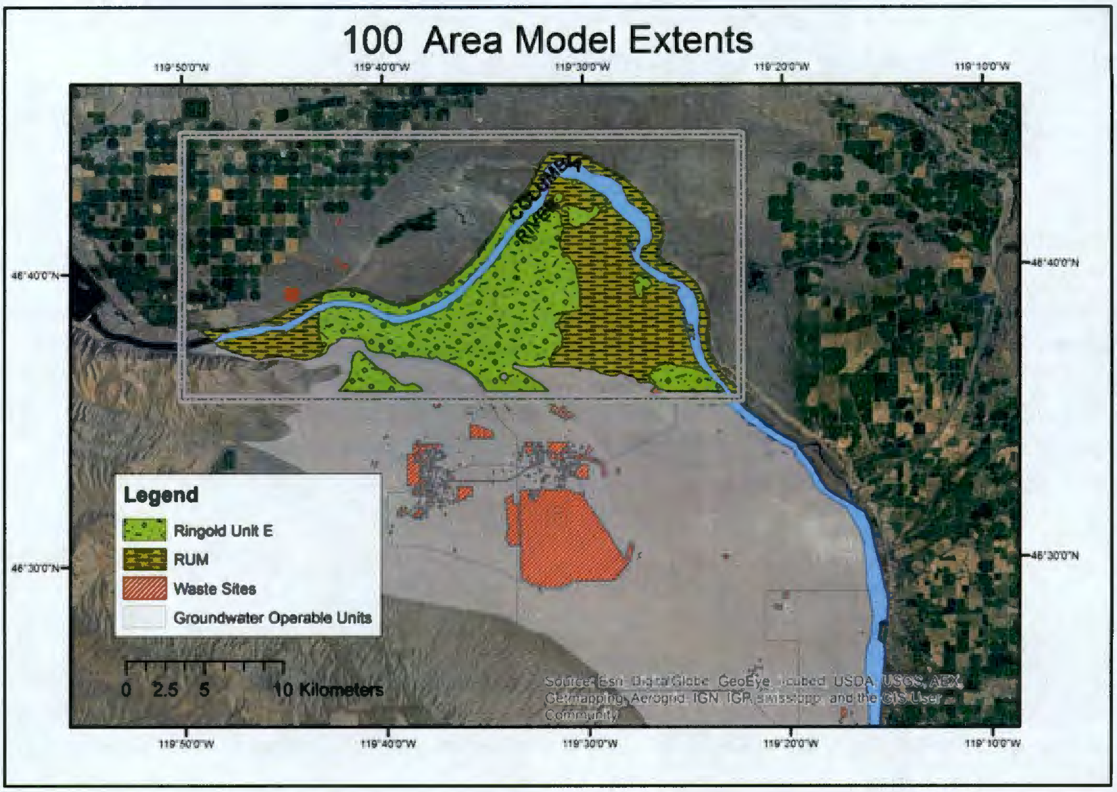


**Figure 1. 100 Area Model Boundary and Extents of Ringold Formation Unit E and RUM Hydrogeologic Units**

## 3.1 Defining Model Construction Boundaries - Topography and Basalt Surfaces, and Importing Borehole Data

The first step in creating a model is to define the topography, which represents the ground surface or top of the model and all data associated with it. The complete surface layer for this model required combining land surface topography (2008 Aero-Metric LiDAR) with the Columbia River bathymetry (PNNL-19878). This surface was created using a continuous (grid) interpolated from 0.5 m resolution LiDAR for land surface, integrated with continuous (grid) 0.2 m bathymetry data to represent the bottom surface of the Columbia River. The 2 grids (LiDAR & Bathymetry) were combined to create one continuous surface using a mosaic spatial analysis function in ArcMap®[2] 10.1 (ESRI 2011. ArcGIS Desktop, Release 10.1. Redlands, CA. Environmental Systems Research Institute.).

The bottom of the model is defined by the surface of the basalt bedrock that underlies the Hanford Site. The 100 Area model lower surface constraints are defined by the top of basalt. The top of basalt was interpolated into a 10-m grid from contours based on published interpretations of the top of basalt surface (i.e., PNNL-14753, Rev. 1) using the contours spatial analysis function in ArcMap® 10.0. Further refinements were made to the basalt surface using the Topo-to-Raster function in ArcMap® 10.0 which can use point data, contour data, boundary data and drain enforcement to create a hydrological correct surface with/or without sinks or drains.

The next step in the modeling workflow, after the upper (topography) and lower (top of basalt surface) boundaries of the model are defined, is to construct the spatial representation of the hydrogeologic unit

[2] ArcMap® is a registered trademark of ESRI, Inc., Redlands, California, in the United States and other countries.

surfaces that can be constrained within the model boundaries; information for defining the top of each surface is acquired from HEIS and the Hanford geological contacts databases. The process for selecting boreholes, defining contact elevations from borehole logs, and quality assurance for borehole contacts is described in detail in *100 Area Stratigraphic Database Development* (ECF-100NPL-11-0070 Rev. 3). The required borehole spatial location information, i.e., surface horizontal and vertical elevation coordinates, along with other optional well construction information are obtained from records maintained in HEIS.

The following steps describe the borehole data used and the essential format, and fields required to develop the Leapfrog models:

1. Import selected borehole collars containing borehole horizontal location coordinates and ground surface elevations using the "Borehole Data" folder directory in the Leapfrog project tree (abbreviated example shown in Table 1). Attachment A, Table A-1 contains the entire population of well and borehole surface information used to identify and locate the boreholes within the model.
2. Import borehole lithology data (elevations of geologic contact tops; Attachment A, Table A-2) associated with each borehole (example in Table 2, and Figure 1). This data import is a subset of the borehole collar data set imported into Table 1 and contains available subsurface geologic information that is not defined for all wells defined in the model. The 100-Area model domain is divided into three hydrogeologic units that are based on area specific geologic interpretations and publications.
    a. The three hydrogeologic units are:
        i. Hanford formation (undifferentiated).
        ii. Ringold Formation unit E (also known as the Ringold unit 5).
        iii. Ringold Formation upper mud unit (also known as the RUM).
3. Import well construction information (i.e., total borehole depth, screen top and bottom information) associated with each borehole (see example in Table 3). This data import is a subset of the borehole collar data set imported into Table 1 and contains available well construction information that is not defined for all wells defined in the model.

The completed Leapfrog Hydro® model is termed a 'scene' (Figure 2). Each scene is unique, composed of the top and bottom boundaries of the model as defined above, and the data inputs (pre-defined) from the tables above. Each model scene (or version) including the supporting tables used in the construction of the model are archived as a complete model data package to support future recreation of the model. Note: Each Leapfrog Hydro® scene available for use will also contain wells that were not used in the geological framework construction, but whose existence and location are of specific interest to scientists and project managers. Examples of these include decommissioned wells, aquifer tubes, and other wells that do not have information and details essential to hydrogeologic model construction.

**Table 1. Example of Leapfrog Borehole Collars Table**

| Well Name | xcoord[a] | ycoord[a] | Elevation(m) | TD(m) | Well_id |
|---|---|---|---|---|---|
| 199-B2-12 | 565368.44 | 145363.68 | 133.93 | 54.4 | A4550 |
| 199-B2-14 | 564969.25 | 144313.98 | 144.39 | 45.5 | C7786 |
| 199-B5-1 | 565439.68 | 144551.98 | 139.04 | 46.02 | A4561 |
| 199-B5-2 | 565405.43 | 144939.70 | 139.8 | 22.86 | A4562 |
| 199-B5-6 | 564967.7 | 144316.44 | 144.97 | 59.59 | C7507 |

a. Coordinates system in NAD 1983 HARN State Plane Washington South FIPS 4602

**Table 2. Example of Leapfrog Borehole Lithology Table**

| Well Name | From (m)[a] | To (m)[b] | Lithology |
|---|---|---|---|
| 199-B2-12 | 0 | 3.8 | Hanford |
| 199-B2-12 | 3.8 | 45.6 | Ringold E |
| 199-B2-12 | 45.6 | 50.1 | RUM |
| 199-B2-14 | 0 | 10.1 | Hanford |
| 199-B2-14 | 10.1 | 43.8 | Ringold E |

Notes:

a. Depth in meters below ground surface of the contact surface elevation.

b. Depth in meters below ground surface of the lower constraint of the contact elevation, and the beginning of the next contact elevation.

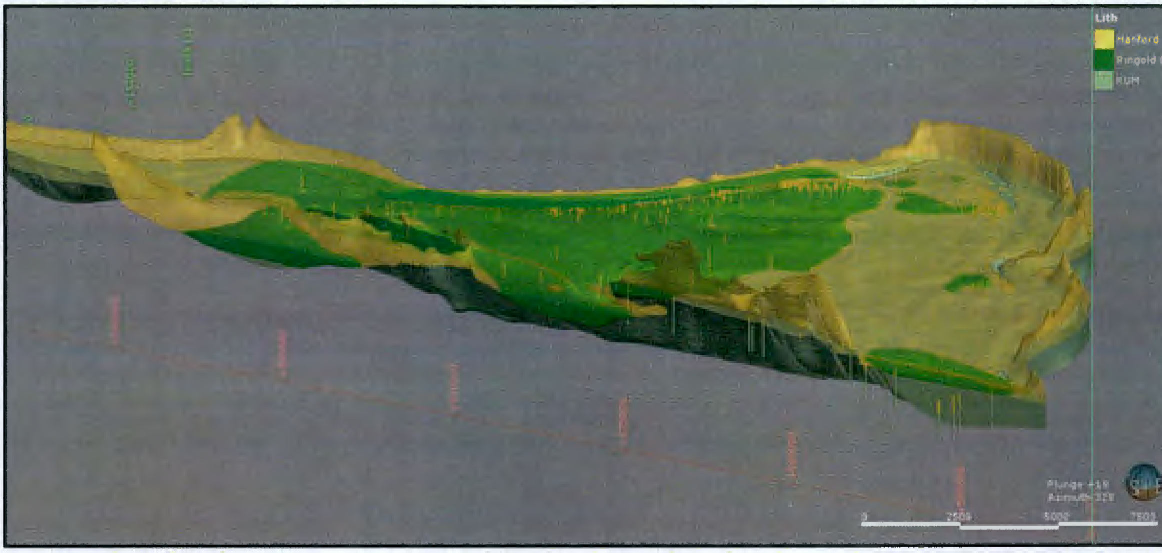

**Figure 2. Three-dimensional View of the Leapfrog Hydro® Model show Hydrogeologic Boundaries and Borehole Locations**

**Table 3. Example of Leapfrog Well Screens Table**

| Well Name | From (m)[a] | To (m)[b] | Well type | status | Screen type |
|---|---|---|---|---|---|
| 199-B2-14 | 12.77 | 20.39 | Groundwater | IN-USE | perforation |
| 199-B2-15 | 48.13 | 51.38 | Groundwater | IN-USE | screen |
| 199-B3-1 | 6.1 | 18.29 | Groundwater | IN-USE | screen |
| 199-B3-50 | 21.09 | 27.19 | Groundwater | IN-USE | screen |
| 199-D2-10 | 3.01 | 7.58 | Groundwater | IN-USE | Screen |

Notes:

a. Depth in meters below ground surface of the top of open interval (screen or perforations).

b. Depth in meters below ground surface of the bottom of the open interval (screen or perforations).

## 3.2 Building a Geological Model

A geological model is the fundamental method for describing and ordering lithological units in Leapfrog Hydro®. Building the geological model in Leapfrog Hydro® is a process of successive refinements made up of defining the models boundary extents and building the internal structures. The geological model consists of a number of non-intersecting volumes that fit together to exactly fill a 3D boundary defined by the model top and bottom extents. The geological model is usually built from oldest to youngest or from youngest to oldest. At Hanford, the model boundary extents default to the topographic and top of basalt layers, but different lateral extents can be made, if desired.

Two-dimensional lithological columns constructed from imported borehole lithologic contact data (Table 2) are used as the basis to form the internal structure of the model, and the 3D model is created in the following sequence:

a) Define surfaces from linked lithology columns in chronological order from oldest to youngest (i.e., RUM, Re, Hf).

b) Build geological model volumes from oldest to youngest as sequential new deposits from the lithology contacts.

c) Leapfrog generates a new surface for each sequential lithologic entry using radial basis function

As mentioned previously, users may desire a different approach to interpolating from borehole data. This can be accomplished by applying an interpolation scheme in 2D to create a continuous surface, and then importing the grid directly in to the Leapfrog model, and transform it to a 3D surface. The disadvantage of this approach is maintaining and managing the 3D model. If model surfaces are interpolated using the proprietary Leapfrog interpolation co-radial base function scheme, then the model automatically updates if boreholes are updated. Conversely, if gridded surfaces are first created with a 3rd party program and then imported into the model, then each time there is an update to the borehole data, each surface will have to be re-created, and imported into the 3D model.

## 3.3 Refine Geological Surfaces and Spatial Resolution

Model surfaces in the 100 Area model are refined by adding control points to geologic surfaces. The control point data includes x-coordinate, y-coordinate, and an elevation of the unit it represents (i.e., Hf, Re, RUM). The logic for placement of control points is based on an underlying understanding of the geologic framework, which is developed by professionally trained and experienced hydrogeologic practitioners, and is necessary in areas where the interpolated surface deviates from empirical information that is not represented by borehole contacts (e.g., geologic truncations, faults, etc.). It also may be useful in areas where borehole data is sparse but well-defined structural patterns or trends are known. The tables containing the control points that are associated with each scene or revision are also uploaded and archived concurrently with each model release.

The 100 Area model is considered a regional model and provides hydrogeologic detail appropriate for the scale of this model. Refined models consisting of smaller extents are often required for supporting project specific work scope in more localized areas typically defined by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Operable Unit boundaries. To meet the specific needs of scientists and project managers, we have created smaller models ("sub models") with greater spatial detail and higher resolution in select areas of interest within the larger boundary. To maintain model consistency and transparency, the smaller models are created by making a copy of the larger model in the same workspace and changing/trimming the model extents to cover a smaller area. Spatial detail and resolution are increased during this process. Currently smaller, project specific models are available for the 100-K, 100-N, and 100-D/H Areas. For user access purposes, the smaller domain models are maintained with the larger models used to create them.

## 3.4 Add Feature Data

Additional feature data is added to the geological models as reference points, and attributes of interest, particularly important are the sources and information for wells. The following feature data was added to the 100-Area Leapfrog scenes for view enhancement:

a) 1-m resolution Aerial photographs – National Agriculture Imagery Program (NAIP, 2012)

b) Groundwater Area Operable Unit boundaries

c) Waste sites boundaries

d) Well names, and color-indicators, by category, of the well information provided at that location. Information may include well screen information, geologic information, or well status, i.e., well decommissioned

e) Published 2-dimensional groundwater plume extents for all major contaminants of concern

f) Published interpretations of the water table

Additional feature data can be added to any scene at the request of project staff. The feature data sets are captured and archived with the completed scene data package.

## 3.5 Step-by-Step Instructions for Reproducing the 100 Area Leapfrog Solids Model

In the previous sections of the methodology, we have endeavored to provide the overall workflow and logic we employed to create our model. The section below provides the exact sequence of steps that must be followed, and the input files referred to in each step, in order for the user to construct the exact same model *(note: variation from this sequence of steps will produce a slightly different model output)*:

a) Open Leapfrog Software and create a new project

b) Import borehole data by right clicking on the folder titled "Borehole" data and navigating to the comma separated value (csv) table entitled "100 Area Leapfrog Collars.csv". In the "import data dialogue box" there will also be a section to import well intervals. In this area, browse to the coma separated value table entitled "100 Area Lithology.csv".

c) Follow the prompts in the Leapfrog Borehole Data dialogue box entering the well name column from the csv file as (Hole ID) , the x-coordinates column from the table as (X) data, the y-coordinates as (Y) data, the elevation as (Z) and the constructed depth as (MAX DEPTH) in the Leap frog dialogue boxes respectively.

d) To add the upper surface of the model right click on the folder entitled "Topography", then "New Topography", then "Import Elevation Grid". Browse to the Lidar tif file, and import it. (*Note: Leapfrog will not accept the native 0.5 resolution due to the size of the file. Input 40 for the grid spacing)*

e) To add the lower surface of the model boundary and the northern clipping boundary, right click on the "Meshes" folder, and "import elevation grid", and navigate to stwdtob.tif, and 100_Area Trim.tif, and import both files.

f) To create a new geological model we define a region that encompasses the boundary coordinates of the model. Right click on the folder entitled "Geological Model", and click "New geological model". In the Base Lithology dropdown, navigate to the lithology (which should appear by default). Set the X minimum and maximum to 551,000 and 587,000 respectively, and set the Y minimum and maximum to 141,000 and 156000 respectively. Set the surface resolution to 100, and click OK.

g) Expand the new Geological model and right click "Surface Chronology", then drop down to "New Deposit from Base Lithology." Drop down to Ringold E. Click the radio button "Contacts

Below" and check the RUM. Click OK. This will add the Ringold solids model geometry to the existing model.

h) Again, right click on "Surface Chronology", but this time drop down to "New Erosion", and "From Base Lithology", and choose the Hanford, and choose the RUM and Ringold for contacts below.

i) Next, right click on the folder "Locations" and import the control contact data files (3) entitled; Ringold Control Points 7 2012.csv, Ringold Control Points 1 2012.csv, and Hanford Control Points 7 2012.csv.

j) Add the two sets of Ringold control points to the Ringold by expanding the "Surface Chronology" tab, right clicking on Ringold E Contacts, and adding the two sets of control points. Likewise, add the Hanford control points to the Hanford by right clicking on Hanford Contacts, and adding Hanford control points.

k) To change the base of the model to the top of basalt, expand the geological model. Under "Boundaries", drop down to New Base, From Surface, and add the top of basalt that was previously added to the mesh ("stwtob").

l) To trim the Northern extent of the model boundary so it clips at the river, right click "Boundary" again, then Add New Lateral Extent, from surface, and select the 100 Area trim surface that was added to the mesh folder.

# 4 Assumptions and Inputs

## 4.1 100-Area Model Domain

The model domain is comprised of a rectangular region:

- approximately 15.0 km north-south
- approximately 35.5 km east-west
- coordinates:
  - Washington State Coordinate System: NAD_1983_StatePlane_Washington_South_FIPS_4602
  - lower left corner: Easting 550980 m, Northing 141125 m
  - upper right corner: Easting 589183 m, Northing 156327

### 4.1.1 Hydrogeology of the 100-Area Model

The interior of the 100-Area model domain is divided into three vertically stacked hydrogeologic unit layers. The hydrogeologic naming convention is not consistent with the nomenclature used to define other models outside of the 100 Area domain (e.g., the Central Plateau model) because these regions were investigated following separate paths and corresponding and transecting stratigraphic correlations have not been made for the regions beyond the 100 Area.

The three hydrogeologic units are, from youngest to oldest:

1) Hanford formation (undifferentiated)

2) Ringold Formation unit E (this may also be labeled Ringold unit E or Ringold unit 5)
3) The Ringold Formation upper mud unit (also known as RUM)

# 5 Software Applications

Software used for this calculation is applicable in accordance with PRC-PRO-IRM-309, *Controlled Software Management.*

## 5.1 Approved Software

The following software was used to perform the calculations and was approved and compliant with PRC-PRO-IRM-309. This software is managed under the following documents consistent with the procedure:

## 5.2 Descriptions

Required software descriptions are provided in the subsections that follow.

### 5.2.1 Leapfrog Hydro® (Controlled Calculation Software)

- Software Title: Leapfrog Hydro®
- Software Version: Version 2.0
- Hanford Information Systems Inventory (HISI) Identification Number: 2874 (Safety Software, graded Level C)
- Workstation type and property number (from which software is run): Dell Laptop (non-HLAN), Dell Service Tag #14610748609

### 5.2.2 pgAdmin PostGresSQL tools (Utility Software)

pgAdmin PostGresSQL tools were used to store and query data in a spatially-enabled relational database and perform calculations as necessary.

- Software Title: pgAdmin PostGresSQL tools
- Software Version: Version 1.16
- Hanford Information Systems Inventory (HISI) Identification Number: (unregistered)
- Workstation type and property number (from which software is run): Dell Laptop (non-HLAN), Dell Service Tag #14610748609

### 5.2.3 ArcMap® (Utility Software)

ArcMap® was used for grid math and interpolations using the spatial analyst tool and 3D analyst tools.

- Software Title: ArcMap®
- Software Version: Version 10.0
- Hanford Information Systems Inventory (HISI) Identification Number: (unregistered)
- Workstation type and property number (from which software is run): Dell Laptop (non-HLAN), Dell Service Tag #14610748609

## 5.3 Statement of Valid Software Application

- Leapfrog Hydro® software identified was used consistent with intended use for CHPRC as identified in CHPRC-01753 and is a valid use of this software for the problem addressed in this application. This software was used within the limitations defined in CHPRC-01753 for CHPRC applications. A copy of the *Software Installation and Checkout* form for this software is provided in Attachment B.
- Utility software was used for limited purposes to support the use of Leapfrog Hydro® and this use was consistent with the purposes of these commercial, off-the-shelf software packages.

# 6 Results/Conclusions

The Leapfrog Hydro® model is a 3D geological model builder. The model scenes are outputs representing the models which can be easily viewed and explored using a free Leapfrog Hydro® Viewer (Leapfrog Hydro Viewer® version 4.0, ARANZ Geo Limited, LLC, 2013) The available models may be accessed (with permission) for viewing at the following link maintained by CHPRC: \\hanford\data\sitedata\PRC-Spatial\Visualization. The Leapfrog Hydro Viewer® (version 4.0 or latest version) can be downloaded from the following link: http://www.rl.gov/softdist/.

The model scenes are maintained and regularly updated to remain consistent with the most recent borehole data and other relevant information. Update intervals vary depending on the availability of new information and/or project specific requirements. New and revised model scenes are generated periodically as new borehole and site information become available. New models and revisions and the supporting data sets used in their construction are stored together in folders that are identified and linked by date (e.g., 100-Areas_2013-04-12).

The calculation results presented in Chapter 4 are evaluated with respect to the data source uncertainty. Uncertainty is not quantified in the ECF but is discussed qualitatively.

## 6.1 Uncertainty in Hydrogeologic Surface Interpolation

The representation of the hydrogeologic surface is affected by the following uncertainties:

- Uncertainties in interpreting geologic contacts
- Errors in reported depth measurements
- Method used to define control points may add bias and is subjective
- Representativeness of individual contact data points with respect to the region surrounding the data point
- Biases and variability introduced by the interpolating algorithm
- Limited number of deep geologic contact data measurements.

Developing geologic surface configurations from a limited spatial dataset also leads to uncertainty in the shape of that surface away from areas of dense well control. The kriging based interpolation routine (radial basis functions for the 3D hydrogeologic layers) was introduced to reduce this uncertainty. The issue is how far a geologic data point can be extrapolated away from the wellbore or model cell containing the wellbore. Kriging and radial basis functions have a diminishing influence with distance as defined by the exponential variogram structure. Kriging reduces but cannot eliminate uncertainty due to sparse data as it does not represent the physics of the processes that deposited the surface. It is instead an interpolation algorithm that is symmetric with respect to the measurement point. One of the reasons for using control points was to reduce the influence of this modeling limitation. Control points allow the imposition of the subjective bias by the hydrogeologist into the interpolation. Control points were used to define geologic surface extents that have been inferred by limited measurements and knowledge of distributions or process knowledge. Control points introduce bias and uncertainty because their placement and the interpretation of their influence are subjective. They are mainly used to apply professional judgment where insufficient data exist to fully describe site conditions. The net effect of control points is to reduce bias and uncertainty while defining geologic surface configurations that are consistent with published or interpreted hydrogeologic results.

The uncertainties listed above provide a listing of some common uncertainties encountered during any hydrogeologic investigation. These uncertainties are minimized, where possible, through accurate collection and recording of the raw data that is used to interpret the results, and by utilizing consistent interpretation techniques, and maintenance/archival of the related databases, and hydrogeologic publications that provide the basis for the interpretations.

# 7 References

Aero-Metric LiDAR, 2008, *RCCC-Hanford Battelle/PNNL/DOE, Digital Orthophotography & LiDAR Surveys Photogrammetric Report*, prepared by Aero-metric, Seattle, Washington.

CERCLA, *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq.

ECF-100NPL-11-0070, 2014, *100 Area Stratigraphic Database Development*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington.

PNNL-19878, 2010, *Development of a High-Resolution Bathymetry Dataset for the Columbia River Through the Hanford Reach*, Pacific Northwest National Laboratory for the USDOE. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19878.pdf.

PRC-PRO-IRM-309, 2009, *Controlled Software Management*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington.

# Attachment A

# Well Information and Geologic Contacts Data Tables

The data contained in Tables A-1 and A-2 represent the most accurate and currently available well location and interpreted geologic contact depths available. Table A-1 presents the format used for well location and elevation information (i.e. ground surface, top of casing, brass cap, etc.) used in Leapfrog Hydro. The information in Table A-1 is best estimate at the time of drilling and is derived from GeoContacts_100-Area_2013-12-19.xlsx. Table A-2 presents the geologic contact information derived from GeoContacts_100-Area_2013-12-19.xlsx used to generate geologic unit surfaces and interpolated volumes in the Leapfrog geologic framework model. Table A-2 is formatted for use in Leapfrog Hydro.

**Table A-1. Well Names, Locations, Maximum Drill Depths, and Surface Elevations Used in the Model**

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-B2-12 | 565368.4 | 145363.7 | 133.93 | 55.5 |
| 199-B2-13 | 565926.9 | 145364.6 | 127.69 | 13.19 |
| 199-B2-14 | 565096 | 145232.3 | 134.3 | 47.42 |
| 199-B2-15 | 565092.3 | 145230.5 | 134.27 | 60.07 |
| 199-B2-16 | 564915 | 145190.7 | 133.37 | 48.3 |
| 199-B3-1 | 565561.5 | 145342.1 | 134.58 | 20.2 |
| 199-B3-2 | 565847.6 | 145326.1 | 135.43 | 241.79 |
| 199-B3-46 | 565899.6 | 145369 | 134.73 | 21.35 |
| 199-B3-47 | 565388.7 | 145369 | 133.85 | 19.59 |
| 199-B3-50 | 566028.9 | 145058.2 | 143.02 | 56.87 |
| 199-B3-51 | 565379.3 | 145362.4 | 134.04 | 48.61 |
| 199-B3-52 | 565391 | 145115 | 134.66 | 19.29 |
| 199-B4-1 | 565289.8 | 144791.5 | 141.2 | 28.43 |
| 199-B4-2 | 565283.8 | 144770.9 | 141.35 | 28.43 |
| 199-B4-3 | 565295.6 | 144771.1 | 141.31 | 28.74 |
| 199-B4-4 | 565377.1 | 144479.7 | 144.63 | 33 |
| 199-B4-5 | 565390.5 | 144349.2 | 147.06 | 30.62 |
| 199-B4-6 | 565388.9 | 144383 | 147.02 | 30.69 |
| 199-B4-7 | 565396.9 | 144382.9 | 147.07 | 30.42 |
| 199-B4-8 | 565578.5 | 144653.8 | 144.46 | 28.55 |
| 199-B4-9 | 565395.6 | 144563.9 | 143.81 | 29.29 |
| 199-B4-10 | 565396.6 | 144516.4 | 144.69 | 8.16 |
| 199-B4-14 | 564969.3 | 144314 | 144.97 | 30.2 |
| 199-B4-15 | 565439.7 | 144552 | 144.26 | 26.69 |
| 199-B5-1 | 564878.2 | 144764.9 | 139.04 | 47.02 |
| 199-B5-2 | 565405.4 | 144939.7 | 139.8 | 23.86 |
| 199-B5-5 | 564723.2 | 144955.2 | 135.42 | 66.47 |
| 199-B5-6 | 564967.7 | 144316.4 | 144.97 | 60.59 |
| 199-B5-8 | 566014 | 143587.7 | 153.93 | 71.29 |
| 199-B8-6 | 564498.8 | 144157.8 | 145.02 | 28.74 |
| 199-B8-9 | 565276.4 | 144054.5 | 150.99 | 67.9 |
| 199-B9-1 | 565502 | 144029.7 | 151.37 | 36.66 |
| 199-B9-2 | 565534.8 | 144078.1 | 151.73 | 36.97 |
| 199-B9-3 | 565667.4 | 144046.7 | 150.41 | 34.22 |
| 199-D2-5 | 573812.3 | 151148.2 | 140.51 | 29.96 |
| 199-D2-6 | 573000.2 | 151119.9 | 143.36 | 34.74 |
| 199-D2-8 | 573263.6 | 151208.6 | 143.61 | 31.75 |
| 199-D2-10 | 574470.7 | 153465.2 | 120.3 | 10.45 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-D2-11 | 573328.2 | 151120.7 | 143.45 | 35.75 |
| 199-D2-12 | 574343.4 | 153300.8 | 120.57 | 11.36 |
| 199-D3-3 | 572482.5 | 151187 | 143.2 | 35.75 |
| 199-D3-4 | 572468.2 | 151171 | 143.25 | 35.81 |
| 199-D3-5 | 572788.1 | 150990.7 | 144.05 | 35.2 |
| 199-D4-1 | 572752.9 | 151558.9 | 143.25 | 33 |
| 199-D4-2 | 572768.4 | 151544 | 143.75 | 31.48 |
| 199-D4-3 | 572766.1 | 151546.1 | 143.67 | 32.09 |
| 199-D4-4 | 572754.6 | 151571.6 | 143.42 | 33.31 |
| 199-D4-5 | 572740.5 | 151556.5 | 143.31 | 31.78 |
| 199-D4-6 | 572733.3 | 151577.9 | 143.28 | 31.78 |
| 199-D4-8 | 572763.3 | 151552.7 | 143.34 | 31.18 |
| 199-D4-9 | 572758.2 | 151543.3 | 143.6 | 30.72 |
| 199-D4-10 | 572750.3 | 151540.4 | 143.44 | 30.84 |
| 199-D4-11 | 572768.9 | 151554.1 | 143.38 | 30.6 |
| 199-D4-12 | 572771.6 | 151562.1 | 143.5 | 31.08 |
| 199-D4-13 | 572665.9 | 151424.5 | 142.94 | 31.78 |
| 199-D4-14 | 572839.8 | 151641.6 | 143.47 | 32.06 |
| 199-D4-15 | 572936.6 | 151424.9 | 143.66 | 33 |
| 199-D4-16 | 572756.7 | 151555.3 | 143.43 | 32 |
| 199-D4-17 | 572738.1 | 151558.4 | 143.37 | 32.36 |
| 199-D4-18 | 572726.3 | 151570.9 | 142.98 | 32.06 |
| 199-D4-19 | 572559.4 | 151282 | 143.12 | 34.68 |
| 199-D4-20 | 572794 | 151257.5 | 143.56 | 33.77 |
| 199-D4-21 | 572778.9 | 151569.8 | 143.65 | 31.18 |
| 199-D4-22 | 572788.5 | 151539.3 | 144.03 | 31.78 |
| 199-D4-23 | 572672.5 | 151592.9 | 140.39 | 27.82 |
| 199-D4-24 | 572699.9 | 151471.4 | 143.2 | 31.78 |
| 199-D4-25 | 572711.4 | 151476.2 | 143.51 | 33.31 |
| 199-D4-26 | 572712.3 | 151488.9 | 143.46 | 33 |
| 199-D4-27 | 572724.2 | 151493.5 | 143.63 | 33 |
| 199-D4-28 | 572725.1 | 151506.1 | 143.52 | 32.09 |
| 199-D4-29 | 572736.9 | 151510.7 | 143.81 | 32.09 |
| 199-D4-30 | 572737.4 | 151523.2 | 143.82 | 30.57 |
| 199-D4-31 | 572749.5 | 151528 | 143.88 | 30.87 |
| 199-D4-32 | 572790.9 | 151573.8 | 143.68 | 31.78 |
| 199-D4-33 | 572792.6 | 151585.9 | 143.71 | 32.39 |
| 199-D4-34 | 572804.6 | 151590 | 143.58 | 32.7 |
| 199-D4-35 | 572806.3 | 151602.3 | 143.52 | 32.09 |
| 199-D4-36 | 572818.2 | 151606.2 | 143.52 | 32.09 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-D4-37 | 572820.3 | 151618.6 | 143.52 | 32.09 |
| 199-D4-38 | 572671.3 | 151537.9 | 142.81 | 32.09 |
| 199-D4-39 | 572747.5 | 151650.8 | 143.19 | 32.09 |
| 199-D4-40 | 572832.4 | 151622.6 | 143.57 | 31.66 |
| 199-D4-41 | 572834.1 | 151634.7 | 143.48 | 31.78 |
| 199-D4-42 | 572847.1 | 151642.4 | 143.51 | 32.95 |
| 199-D4-43 | 572849.7 | 151656.2 | 143.46 | 32.09 |
| 199-D4-44 | 572856.1 | 151665.6 | 143.34 | 32.39 |
| 199-D4-45 | 572868 | 151671.8 | 143.28 | 33.31 |
| 199-D4-46 | 572868.9 | 151684.9 | 143.17 | 32.7 |
| 199-D4-47 | 572880.5 | 151690.1 | 143.16 | 32.15 |
| 199-D4-48 | 572881.3 | 151703.5 | 143 | 33.92 |
| 199-D4-49 | 572699.1 | 151458.7 | 143.24 | 31.51 |
| 199-D4-50 | 572687.3 | 151454 | 143.12 | 30.9 |
| 199-D4-51 | 572686.6 | 151441.4 | 143.15 | 31.39 |
| 199-D4-52 | 572674.9 | 151436.7 | 143.17 | 31.39 |
| 199-D4-53 | 572674.1 | 151424.6 | 143.14 | 30.66 |
| 199-D4-54 | 572662.4 | 151419.7 | 143.17 | 30.96 |
| 199-D4-55 | 572659 | 151414.6 | 143.19 | 31.33 |
| 199-D4-56 | 572657.7 | 151402.3 | 143.1 | 30.72 |
| 199-D4-57 | 572645.9 | 151397.9 | 143.16 | 30.92 |
| 199-D4-58 | 572644.8 | 151385.4 | 143.34 | 33.52 |
| 199-D4-59 | 572633.3 | 151380.8 | 143.22 | 32.15 |
| 199-D4-60 | 572632.4 | 151368.3 | 143.18 | 31.78 |
| 199-D4-61 | 572620.7 | 151363.7 | 143.1 | 32.09 |
| 199-D4-62 | 572619.5 | 151351.1 | 143.19 | 34.44 |
| 199-D4-63 | 572607.6 | 151346.8 | 143.29 | 34.89 |
| 199-D4-64 | 572607 | 151333.9 | 143.32 | 34.83 |
| 199-D4-65 | 572594.8 | 151329.7 | 143.32 | 35.14 |
| 199-D4-66 | 572594.3 | 151316.9 | 143.33 | 34.59 |
| 199-D4-67 | 572581.9 | 151312.8 | 143.28 | 34.83 |
| 199-D4-68 | 572581.3 | 151299.8 | 143.07 | 34.7 |
| 199-D4-69 | 572569 | 151295.7 | 143.08 | 33.99 |
| 199-D4-70 | 572568.8 | 151282.7 | 143.13 | 33.59 |
| 199-D4-71 | 572556.3 | 151278.5 | 143.12 | 34.35 |
| 199-D4-72 | 572554.4 | 151265.8 | 143 | 34.51 |
| 199-D4-73 | 572542.2 | 151262.7 | 143.15 | 34.68 |
| 199-D4-74 | 572539.8 | 151249.8 | 142.9 | 34.81 |
| 199-D4-75 | 572527.8 | 151247 | 143.07 | 35.05 |
| 199-D4-76 | 572526.1 | 151234.2 | 142.97 | 34.88 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-D4-77 | 572513.3 | 151231 | 142.93 | 34.53 |
| 199-D4-78 | 572511.3 | 151218.3 | 142.98 | 35.44 |
| 199-D4-79 | 572498.2 | 151214 | 143.63 | 36.08 |
| 199-D4-80 | 572496.9 | 151202.6 | 143.43 | 35.44 |
| 199-D4-81 | 572484.4 | 151199.6 | 143.33 | 35.38 |
| 199-D4-82 | 572470.3 | 151183.9 | 143.23 | 36.05 |
| 199-D4-83 | 572859.4 | 151723.4 | 142.89 | 30.87 |
| 199-D4-84 | 572568 | 151433.5 | 143.63 | 32.55 |
| 199-D4-85 | 572486.2 | 151324.2 | 143.31 | 36.05 |
| 199-D4-86 | 572389.1 | 151202.1 | 142.6 | 35.29 |
| 199-D4-87 | 572757.1 | 151550 | 143.44 | 28.29 |
| 199-D4-89 | 572760.9 | 151549.3 | 143.53 | 30.08 |
| 199-D4-94 | 572712.9 | 151496.1 | 143.33 | 32.3 |
| 199-D4-95 | 572613 | 151227 | 143.37 | 38 |
| 199-D4-96 | 572777 | 151520 | 144.2 | 33.46 |
| 199-D4-97 | 572906.5 | 151624.9 | 143.87 | 34.53 |
| 199-D4-98 | 572606.3 | 151486 | 143.1 | 34.83 |
| 199-D4-99 | 572526.5 | 151376.6 | 143.2 | 36.42 |
| 199-D4-101 | 572800.3 | 151425.8 | 143.61 | 34.5 |
| 199-D5-12 | 573839.6 | 151557.2 | 143.74 | 28.74 |
| 199-D5-15 | 573738.6 | 151673.8 | 143.9 | 32.03 |
| 199-D5-17 | 573730.5 | 151322.8 | 143.26 | 36.05 |
| 199-D5-18 | 573861.7 | 151325.2 | 142.58 | 31.63 |
| 199-D5-19 | 573849.1 | 151243.2 | 141.99 | 29.96 |
| 199-D5-20 | 573240 | 152030.2 | 142.97 | 32.49 |
| 199-D5-32 | 573372 | 151903.4 | 143.14 | 33.24 |
| 199-D5-33 | 573095 | 151714.5 | 143.41 | 32.75 |
| 199-D5-34 | 573240.4 | 151554.1 | 144.52 | 33.75 |
| 199-D5-36 | 572909.8 | 151746.3 | 143.12 | 32.39 |
| 199-D5-37 | 573092.2 | 151916.4 | 143.07 | 31.33 |
| 199-D5-38 | 572996.8 | 151545.6 | 143.96 | 34.53 |
| 199-D5-39 | 573142.9 | 151428.4 | 143.98 | 33.92 |
| 199-D5-40 | 573003.3 | 151272 | 143.98 | 34.38 |
| 199-D5-41 | 573358.2 | 151792.2 | 143.43 | 34.38 |
| 199-D5-42 | 573479.8 | 151622.7 | 143.85 | 34.38 |
| 199-D5-43 | 573180 | 151269.4 | 143.84 | 35.29 |
| 199-D5-44 | 572993.6 | 151835.7 | 142.66 | 31.48 |
| 199-D5-92 | 573131.9 | 152009.8 | 142.48 | 31.21 |
| 199-D5-93 | 573350.2 | 151459.6 | 143.61 | 34.22 |
| 199-D5-97 | 573250.1 | 151302.5 | 143.72 | 35.59 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-D5-98 | 573369.6 | 151272.4 | 142.97 | 35.56 |
| 199-D5-99 | 573349.6 | 151402 | 143.99 | 36.05 |
| 199-D5-100 | 573182 | 151223.8 | 143.47 | 9.72 |
| 199-D5-101 | 572942.8 | 151521.3 | 143.83 | 35.84 |
| 199-D5-102 | 573428.2 | 151340.2 | 143.81 | 35.59 |
| 199-D5-103 | 573505.9 | 151460.9 | 143.61 | 36.66 |
| 199-D5-104 | 573265.5 | 151422.4 | 144.05 | 36.36 |
| 199-D5-106 | 573503.7 | 151598 | 143.67 | 33.67 |
| 199-D5-107 | 572932.4 | 151283.1 | 144.09 | 32.7 |
| 199-D5-108 | 572923.3 | 151222.9 | 144.38 | 33.31 |
| 199-D5-109 | 572917.4 | 151285.6 | 144.02 | 32.73 |
| 199-D5-110 | 572931.6 | 151277.6 | 144.12 | 32.24 |
| 199-D5-111 | 572943.2 | 151281.5 | 144.11 | 32 |
| 199-D5-112 | 572929.1 | 151289.9 | 143.99 | 29.61 |
| 199-D5-113 | 572927 | 151288.5 | 143.99 | 32.09 |
| 199-D5-114 | 572918 | 151223.8 | 144.36 | 32.79 |
| 199-D5-115 | 572923.2 | 151221.1 | 144.39 | 33 |
| 199-D5-116 | 572926.9 | 151222.4 | 144.42 | 32.85 |
| 199-D5-117 | 572922.9 | 151225.4 | 144.39 | 28.92 |
| 199-D5-118 | 572921 | 151224.5 | 144.37 | 32.85 |
| 199-D5-119 | 573306.2 | 151418 | 144.01 | 35.63 |
| 199-D5-120 | 573377.2 | 151406.8 | 143.66 | 35.26 |
| 199-D5-121 | 573430.2 | 151399.3 | 143.77 | 35.08 |
| 199-D5-122 | 573300.3 | 151349.3 | 143.67 | 35.23 |
| 199-D5-125 | 573667.4 | 151746.2 | 143.99 | 35.08 |
| 199-D5-127 | 572992.9 | 151428.7 | 143.83 | 34.22 |
| 199-D5-128 | 573622 | 151237.1 | 143.15 | 33.49 |
| 199-D5-129 | 573728.4 | 151443.2 | 143.34 | 35.59 |
| 199-D5-130 | 574039.4 | 151928.2 | 142.4 | 31.91 |
| 199-D5-131 | 573684.3 | 152007 | 143.75 | 36.48 |
| 199-D5-132 | 573988.4 | 151641.7 | 144.36 | 35.14 |
| 199-D5-133 | 573729.5 | 151496.7 | 143.44 | 35.14 |
| 199-D5-134 | 573675.3 | 151862.5 | 143.68 | 83.3 |
| 199-D5-140 | 573753.3 | 151781.3 | 143.95 | 35.41 |
| 199-D5-141 | 573243.4 | 151424.5 | 144.21 | 97.53 |
| 199-D5-142 | 573791.9 | 151563.3 | 143.16 | 28.37 |
| 199-D5-143 | 573701.5 | 151784.3 | 143.71 | 36.97 |
| 199-D6-1 | 574129.6 | 151691.5 | 144.22 | 33.61 |
| 199-D6-2 | 574545.2 | 151970.6 | 133.72 | 25.51 |
| 199-D6-3 | 574158.3 | 151643.2 | 143.93 | 34.68 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-D7-3 | 574151.4 | 152364.1 | 135.38 | 28.22 |
| 199-D7-4 | 574377 | 152369.5 | 133.76 | 24.62 |
| 199-D7-5 | 574434.2 | 152678.6 | 131.43 | 20.35 |
| 199-D7-6 | 574428.6 | 152980.2 | 125.01 | 14.35 |
| 199-D8-4 | 573447.2 | 152090.2 | 143.22 | 32.52 |
| 199-D8-5 | 573537.2 | 152243.5 | 138.17 | 27.58 |
| 199-D8-53 | 573889.9 | 152452.3 | 132.89 | 22.17 |
| 199-D8-54A | 573781.2 | 152408 | 134.93 | 24.77 |
| 199-D8-54B | 573768.2 | 152398.7 | 134.92 | 44.89 |
| 199-D8-55 | 573621 | 152364.4 | 135.6 | 23.56 |
| 199-D8-68 | 573711.7 | 152427.1 | 134.82 | 25.38 |
| 199-D8-69 | 573843.6 | 152552.2 | 130.53 | 19.9 |
| 199-D8-70 | 573942.1 | 152508.7 | 131.95 | 23.56 |
| 199-D8-71 | 573837.1 | 152429.4 | 133.72 | 25.69 |
| 199-D8-72 | 573570.5 | 152211.8 | 140.75 | 29.96 |
| 199-D8-73 | 573388.7 | 152167.4 | 141.79 | 29.23 |
| 199-D8-88 | 573292.3 | 152141.3 | 141.1 | 30.83 |
| 199-D8-89 | 573468.1 | 152246.4 | 138.09 | 26.85 |
| 199-D8-90 | 573948.8 | 152646.2 | 125.96 | 18.19 |
| 199-D8-91 | 574037.2 | 152741.3 | 123.74 | 15.17 |
| 199-D8-93 | 574191.2 | 153067.3 | 120.4 | 7.4 |
| 199-D8-94 | 574082.3 | 152920.2 | 120.29 | 10.54 |
| 199-D8-95 | 573611.8 | 152160.8 | 141.81 | 32.82 |
| 199-D8-96 | 573705.9 | 152152.6 | 140.48 | 31.94 |
| 199-D8-97 | 573859.6 | 152087.6 | 140.85 | 32.79 |
| 199-D8-98 | 574012.5 | 152122.7 | 138.03 | 28.86 |
| 199-D8-99 | 574006.3 | 152364 | 136.54 | 28.1 |
| 199-D8-101 | 574069.5 | 152262.4 | 136.38 | 22.95 |
| 199-F1-2 | 580011 | 148805.3 | 121.47 | 12.43 |
| 199-F2-3 | 580496.2 | 148497.8 | 121.84 | 15.63 |
| 199-F5-1 | 581250.1 | 147736.9 | 124.27 | 21.42 |
| 199-F5-2 | 581076.3 | 147799.5 | 126.47 | 31.48 |
| 199-F5-3 | 581177 | 147754 | 125.13 | 28.43 |
| 199-F5-4 | 580583.2 | 147533.7 | 126.47 | 36.05 |
| 199-F5-5 | 580971.3 | 147935.1 | 125.88 | 31.48 |
| 199-F5-6 | 580901.7 | 148042 | 126.55 | 59.52 |
| 199-F5-43A | 581183.9 | 147948.1 | 120.61 | 16.15 |
| 199-F5-43B | 581170.9 | 147960.4 | 120.43 | 58.91 |
| 199-F5-45 | 580706.9 | 147683.9 | 126.37 | 17.03 |
| 199-F5-46 | 580841.3 | 147781.5 | 127.19 | 18.37 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-F5-47 | 580495.5 | 147508.5 | 127.84 | 20.35 |
| 199-F5-48 | 580517.6 | 147690.1 | 127.29 | 17.76 |
| 199-F5-52 | 580672.8 | 148143.8 | 127.62 | 23.49 |
| 199-F5-53 | 580978.5 | 148042.5 | 125.11 | 36.36 |
| 199-F5-54 | 581145.5 | 147576.4 | 126.62 | 24.59 |
| 199-F5-55 | 581076.1 | 147797.6 | 126.81 | 16.24 |
| 199-F5-56 | 580440.6 | 147556.4 | 127.22 | 16.51 |
| 199-F6-1 | 581375.9 | 147564.5 | 123.6 | 17.15 |
| 199-F7-1 | 579687.2 | 147022.4 | 118.66 | 46.72 |
| 199-F7-3 | 579884.7 | 147112.5 | 120.49 | 11.06 |
| 199-F8-1 | 580335.3 | 147430.5 | 124.06 | 18.37 |
| 199-F8-2 | 580373.9 | 147468.5 | 125.45 | 17.76 |
| 199-F8-3 | 580254 | 147253.4 | 121.95 | 11.36 |
| 199-F8-4 | 580958.5 | 147123.5 | 125.37 | 15.48 |
| 199-F8-7 | 580242.9 | 147116.7 | 123.17 | 11.67 |
| 199-H1-1 | 576702.3 | 153384.5 | 123.52 | 13.53 |
| 199-H1-2 | 576451.1 | 153378.3 | 128.13 | 17.61 |
| 199-H1-3 | 576147.9 | 153371.3 | 128.56 | 15.78 |
| 199-H1-4 | 575826.8 | 153366.9 | 127.88 | 15.78 |
| 199-H1-5 | 574846.1 | 153090.8 | 123.99 | 15.17 |
| 199-H1-6 | 576037.8 | 153745.7 | 125.44 | 15.33 |
| 199-H1-7 | 577750.7 | 153211.8 | 124.8 | 12.28 |
| 199-H1-20 | 575705.7 | 154184.4 | 121.11 | 18.59 |
| 199-H1-21 | 575896.6 | 154163.2 | 121.38 | 13.13 |
| 199-H1-25 | 576279.2 | 154069.9 | 122.96 | 13.04 |
| 199-H1-27 | 576403.9 | 154024.2 | 123.57 | 13.56 |
| 199-H1-32 | 576767 | 153766 | 127.46 | 16.67 |
| 199-H1-33 | 576833 | 153716 | 126.09 | 14.72 |
| 199-H1-34 | 576883 | 153667 | 125.36 | 14.69 |
| 199-H1-35 | 576958.6 | 153627.6 | 125.57 | 15.63 |
| 199-H1-36 | 576885.2 | 153486.8 | 125.46 | 15.17 |
| 199-H1-37 | 577107 | 153642 | 126.05 | 15.14 |
| 199-H1-38 | 577159.3 | 153562.1 | 126.24 | 15.48 |
| 199-H1-39 | 577224 | 153533 | 125.57 | 14.41 |
| 199-H1-40 | 577279.4 | 153499.8 | 125.95 | 14.53 |
| 199-H1-42 | 577127.2 | 153391.7 | 124.62 | 14.41 |
| 199-H1-43 | 577213.7 | 153384.3 | 125.35 | 15.94 |
| 199-H1-45 | 577239.4 | 153062.6 | 127.9 | 19.62 |
| 199-H2-1 | 577750.4 | 153237.5 | 123.35 | 58.61 |
| 199-H3-1 | 577645 | 152437.9 | 129.13 | 23.86 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-H3-2A | 577624.6 | 152750.1 | 128.05 | 18.07 |
| 199-H3-2B | 577628.3 | 152757.2 | 128.01 | 18.68 |
| 199-H3-2C | 577632.1 | 152750.3 | 128.02 | 48.24 |
| 199-H3-3 | 577562.1 | 152363.2 | 128.05 | 17.34 |
| 199-H3-4 | 577544.3 | 152293.2 | 126.46 | 15.94 |
| 199-H3-5 | 577454.7 | 152287.5 | 126.29 | 16.21 |
| 199-H3-6 | 578265.2 | 152424 | 128.53 | 19.78 |
| 199-H3-7 | 577935.5 | 152279.2 | 129.07 | 18.98 |
| 199-H3-9 | 578035.9 | 152915 | 126.36 | 67.48 |
| 199-H3-10 | 577545.1 | 152723.5 | 128.25 | 71.35 |
| 199-H3-11 | 577786.8 | 152490.4 | 130.21 | 17.64 |
| 199-H3-25 | 577408.5 | 152989.7 | 127.79 | 19.68 |
| 199-H3-26 | 577440.8 | 152846.5 | 127.3 | 18.16 |
| 199-H3-27 | 577566.8 | 152810.8 | 128.36 | 19.87 |
| 199-H4-1 | 578148.5 | 152657.7 | 128.48 | 23.86 |
| 199-H4-2 | 578093.6 | 152501.5 | 128.21 | 118.65 |
| 199-H4-3 | 577940.5 | 152858.5 | 128.48 | 18.59 |
| 199-H4-5 | 577944.9 | 152939.8 | 127.33 | 19.29 |
| 199-H4-6 | 577585.3 | 152888.4 | 128.67 | 17.76 |
| 199-H4-7 | 577804.1 | 152890.9 | 128.76 | 17.76 |
| 199-H4-8 | 577860.7 | 152921.7 | 128.6 | 17.76 |
| 199-H4-10 | 577827.2 | 153155.8 | 123.7 | 12.58 |
| 199-H4-11 | 578141.9 | 152728.4 | 127.68 | 17.15 |
| 199-H4-12A | 578009.2 | 152912.7 | 126.47 | 15.63 |
| 199-H4-12B | 578004.4 | 152918.5 | 126.46 | 16.54 |
| 199-H4-12C | 578011.8 | 152919.8 | 126.34 | 68.06 |
| 199-H4-13 | 578219.3 | 152595.3 | 127.98 | 19.59 |
| 199-H4-14 | 577803.8 | 152752.4 | 128.61 | 17.15 |
| 199-H4-15A | 577904.3 | 153053.4 | 124.63 | 15.02 |
| 199-H4-15B | 577899.6 | 153059.6 | 124.54 | 14.41 |
| 199-H4-15C | 577907.7 | 153060 | 124.64 | 101.58 |
| 199-H4-16 | 577981.9 | 152591.6 | 129.82 | 19.59 |
| 199-H4-17 | 577779.2 | 153037.6 | 128.34 | 13.65 |
| 199-H4-18 | 578018.3 | 152756.5 | 129.1 | 16.54 |
| 199-H4-46 | 577883.9 | 152439.9 | 129.38 | 19.75 |
| 199-H4-48 | 577792.7 | 152620.2 | 129.97 | 19.9 |
| 199-H4-49 | 577713.8 | 152445.2 | 129.62 | 19.29 |
| 199-H4-63 | 578185.8 | 152665.5 | 127.6 | 20.48 |
| 199-H4-64 | 577946.1 | 153010.6 | 125.29 | 18.22 |
| 199-H4-65 | 577998.3 | 152787.3 | 128.82 | 17.15 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-H4-69 | 578011 | 152686.5 | 129.39 | 20.46 |
| 199-H4-70 | 578004.7 | 152646.5 | 129.6 | 19.71 |
| 199-H4-71 | 578010.6 | 152581.5 | 129.78 | 22.64 |
| 199-H4-72 | 578036.3 | 152500.1 | 128.39 | 19.67 |
| 199-H4-73 | 577940.6 | 152370 | 129.31 | 22.64 |
| 199-H4-74 | 577239.1 | 152268.8 | 125.36 | 15.02 |
| 199-H4-75 | 577212.4 | 152704.6 | 128.54 | 19.04 |
| 199-H4-76 | 576787.3 | 152976.9 | 129.66 | 18.19 |
| 199-H4-77 | 576487.8 | 152975.4 | 127.89 | 16.54 |
| 199-H4-78 | 576168.2 | 152166.1 | 129.54 | 20.54 |
| 199-H4-79 | 575659.1 | 151989.3 | 131.3 | 20.81 |
| 199-H4-80 | 575239.4 | 152568.2 | 129.34 | 23.65 |
| 199-H4-81 | 575234.2 | 153035.2 | 124.79 | 14.53 |
| 199-H4-82 | 574861.1 | 152684.4 | 129.6 | 19.01 |
| 199-H4-83 | 578135 | 152634 | 126.48 | 15.81 |
| 199-H4-84 | 577902.6 | 152848.7 | 128.66 | 13.89 |
| 199-H4-9 | 577923.2 | 152893.9 | 128.28 | 16.54 |
| 199-H5-1A | 577650.1 | 152257.7 | 128.17 | 18.37 |
| 199-H6-2 | 577886.2 | 152193.2 | 129.02 | 19.5 |
| 199-H6-3 | 578340.6 | 151929.1 | 128.4 | 21.54 |
| 199-H6-4 | 577772.2 | 151736.9 | 127.46 | 20.2 |
| 199-K-10 | 568912.8 | 146628.1 | 142.63 | 53.12 |
| 199-K-11 | 568938 | 146617.8 | 142.71 | 52.82 |
| 199-K-21 | 569769.9 | 147932.1 | 129.07 | 16.24 |
| 199-K-22 | 570023.7 | 148097.4 | 129.55 | 16.24 |
| 199-K-25 | 569140.4 | 147238.2 | 144.07 | 24.16 |
| 199-K-27 | 569156 | 146763.8 | 142.6 | 28.43 |
| 199-K-28 | 569171.7 | 146772.8 | 142.33 | 28.43 |
| 199-K-29 | 569205.1 | 146790.1 | 142.52 | 28.43 |
| 199-K-30 | 569238.1 | 146781 | 142.34 | 28.43 |
| 199-K-32A | 569024.2 | 147006.7 | 135.47 | 22.03 |
| 199-K-32B | 569012.4 | 147004.8 | 135.84 | 54.64 |
| 199-K-33 | 568573.7 | 146713.3 | 135.33 | 21.3 |
| 199-K-34 | 568605.8 | 146501.9 | 142.75 | 28.61 |
| 199-K-35 | 568832.3 | 146110.7 | 150.84 | 36.66 |
| 199-K-36 | 569373.8 | 146390.7 | 150.79 | 28.61 |
| 199-K-37 | 570216.2 | 148226.5 | 134.76 | 22.12 |
| 199-K-106A | 568697.4 | 146502.4 | 142.55 | 58.91 |
| 199-K-107A | 568579.9 | 146468.8 | 142.63 | 30.02 |
| 199-K-108A | 568687.2 | 146396.1 | 142.77 | 29.5 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-K-109A | 569122.2 | 146748.5 | 142.81 | 51.57 |
| 199-K-110A | 569230 | 146677.9 | 142.97 | 29.38 |
| 199-K-111A | 569308.2 | 146968.9 | 140.97 | 57.39 |
| 199-K-112A | 570278.6 | 148503.4 | 126.49 | 17.46 |
| 199-K-113A | 570098.1 | 148294.5 | 125.94 | 15.63 |
| 199-K-114A | 570020.3 | 148280.6 | 125.73 | 16.54 |
| 199-K-115A | 569940 | 148135.4 | 126.58 | 19.59 |
| 199-K-116A | 569871.2 | 147960.5 | 129.94 | 29.22 |
| 199-K-117A | 569702.6 | 147977 | 127.08 | 23.25 |
| 199-K-118A | 569703.1 | 147865.9 | 130.06 | 25.69 |
| 199-K-119A | 569661.8 | 147649.7 | 132.57 | 29.04 |
| 199-K-120A | 569399.6 | 147518.5 | 125.21 | 31.78 |
| 199-K-121A | 570017.2 | 147418.3 | 142.15 | 31.07 |
| 199-K-122A | 569975.1 | 147172.9 | 142.43 | 31.78 |
| 199-K-123A | 569931.1 | 147090.2 | 142.84 | 30.87 |
| 199-K-124A | 569867.9 | 146991.7 | 143.02 | 31.76 |
| 199-K-125A | 569712.9 | 147866 | 130.17 | 24.77 |
| 199-K-126 | 570574.7 | 148509.7 | 139.73 | 28.43 |
| 199-K-127 | 569539.2 | 147539 | 132.17 | 32.39 |
| 199-K-128 | 570009.5 | 147257.5 | 143.6 | 29.47 |
| 199-K-129 | 570283.7 | 148503.1 | 126.59 | 16.09 |
| 199-K-130 | 570479 | 148661.2 | 133.66 | 25.05 |
| 199-K-132 | 568495.1 | 146670.8 | 135.96 | 27.82 |
| 199-K-133 | 570560.1 | 148536.3 | 139.54 | 31.18 |
| 199-K-134 | 570600.1 | 148525.3 | 140.17 | 31.18 |
| 199-K-135 | 570589.3 | 148484.1 | 140.09 | 35.56 |
| 199-K-136 | 570549 | 148495 | 139.74 | 32.7 |
| 199-K-137 | 568653.4 | 146374.5 | 142.4 | 33.9 |
| 199-K-138 | 568395.2 | 146616.6 | 134.22 | 30.87 |
| 199-K-139 | 568551.4 | 146518.4 | 142.81 | 34.04 |
| 199-K-140 | 568493.1 | 146493.7 | 142.56 | 33.92 |
| 199-K-141 | 569024.2 | 146818.5 | 141.57 | 35.69 |
| 199-K-142 | 569104.3 | 146870.9 | 141.79 | 36.27 |
| 199-K-143 | 570934.4 | 148088.3 | 135.74 | 29.96 |
| 199-K-144 | 569163.3 | 147266 | 126.4 | 33.64 |
| 199-K-145 | 569284.6 | 147425.7 | 125.51 | 38.7 |
| 199-K-146 | 570197.6 | 148379.8 | 128.42 | 18.65 |
| 199-K-147 | 570411.6 | 148558.1 | 135.07 | 26.63 |
| 199-K-148 | 570584.7 | 148767.9 | 138.12 | 34.16 |
| 199-K-150 | 570787.7 | 149051.9 | 139.38 | 36.81 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-K-151 | 570941.3 | 148686.4 | 139.81 | 37.21 |
| 199-K-152 | 570736.3 | 148585.9 | 140.25 | 37.15 |
| 199-K-153 | 570530 | 148210.1 | 137.41 | 32.88 |
| 199-K-154 | 570320.7 | 148027.7 | 137.2 | 33.89 |
| 199-K-156 | 569674 | 147270.9 | 140.48 | 53.49 |
| 199-K-157 | 569432.2 | 147167.9 | 138.84 | 44.68 |
| 199-K-158 | 568630.5 | 146163.4 | 145.5 | 36.2 |
| 199-K-159 | 570911.7 | 149159.6 | 138.95 | 36.66 |
| 199-K-160 | 570919.6 | 149116 | 139.22 | 36.97 |
| 199-K-161 | 570004.4 | 148202.1 | 126.48 | 18.22 |
| 199-K-162 | 569340 | 147460 | 125.42 | 41.72 |
| 199-K-163 | 570230.7 | 147947.9 | 137.95 | 35.66 |
| 199-K-164 | 571202.2 | 148903.7 | 141.34 | 37.27 |
| 199-K-165 | 568675 | 146342.4 | 145.46 | 55.92 |
| 199-K-166 | 568594.6 | 146343 | 144.54 | 53.01 |
| 199-K-167 | 568675.8 | 146267.6 | 145.47 | 12.28 |
| 199-K-168 | 568544.4 | 146513.6 | 142.59 | 51.84 |
| 199-K-169 | 569989 | 147555 | 141.86 | 44.28 |
| 199-K-170 | 570009 | 147491.4 | 142.03 | 47.02 |
| 199-K-171 | 570544 | 147187.9 | 144.22 | 47.82 |
| 199-K-172 | 570871.7 | 147166.4 | 144.26 | 43.67 |
| 199-K-173 | 568674.1 | 146266.9 | 145.63 | 56.17 |
| 199-K-174 | 568915.4 | 146222.5 | 148.19 | 41.39 |
| 199-K-175 | 568882.7 | 146008.8 | 153.25 | 46.26 |
| 199-K-178 | 568963 | 146954.4 | 136.4 | 41.72 |
| 199-K-179 | 569847.3 | 147481.9 | 140.24 | 45.5 |
| 199-K-180 | 571116.1 | 147449.1 | 146.98 | 48.09 |
| 199-K-181 | 568849.8 | 146892.8 | 135.98 | 42.45 |
| 199-K-182 | 571185.3 | 148350.2 | 142.45 | 39.71 |
| 199-K-183 | 568302.6 | 146439.6 | 140.33 | 47.48 |
| 199-K-184 | 568619.3 | 146366.1 | 142.84 | 66.87 |
| 199-K-185 | 568573.4 | 146728.2 | 134.62 | 43.21 |
| 199-K-186 | 569209.3 | 146625.3 | 145.45 | 51.9 |
| 199-K-187 | 569497.6 | 146052.1 | 155.38 | 62.69 |
| 199-K-188 | 569387.4 | 146370.4 | 151.07 | 72.63 |
| 199-K-189 | 569150.7 | 146809.4 | 142.23 | 49.46 |
| 199-K-190 | 568835.4 | 146873.3 | 135.39 | 43.06 |
| 199-K-191 | 569710.8 | 146886 | 143.86 | 49.16 |
| 199-K-192 | 569394 | 147292.6 | 134.06 | 59.8 |
| 199-K-193 | 570642.8 | 146969.1 | 144.88 | 51.6 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-K-194 | 571388.9 | 147289.2 | 146.48 | 45.9 |
| 199-K-195 | 568849 | 146085 | 146.87 | 71.26 |
| 199-K-198 | 569305.7 | 147552.2 | 123.93 | 31.94 |
| 199-K-199 | 569339.7 | 147584.4 | 124.94 | 32.42 |
| 199-K-200 | 569426.1 | 147253.6 | 135.91 | 19.07 |
| 199-K-201 | 570092.1 | 148069.1 | 133.36 | 19.41 |
| 199-N-2 | 571476.2 | 149859.4 | 140.55 | 39.1 |
| 199-N-5 | 571405.9 | 149675.2 | 139.37 | 39.1 |
| 199-N-54 | 571363.8 | 149633.7 | 139.77 | 23.25 |
| 199-N-61 | 571355.9 | 149156.7 | 141.3 | 21.57 |
| 199-N-62 | 571725.6 | 149483.1 | 141.82 | 24.93 |
| 199-N-66 | 571636.9 | 149684.1 | 142.42 | 25.38 |
| 199-N-69 | 571483.9 | 149804.8 | 140.61 | 32.7 |
| 199-N-70 | 572042 | 149878 | 138.91 | 32.82 |
| 199-N-71 | 571588.8 | 148982.2 | 141.23 | 27.52 |
| 199-N-77 | 571309.8 | 149243.1 | 139.94 | 32.39 |
| 199-N-80 | 571477.6 | 149950.9 | 139.61 | 39.25 |
| 199-N-8P | 571326.9 | 149924.2 | 124.46 | 31.48 |
| 199-N-91A | 571730 | 150500 | 122.55 | 18.98 |
| 199-N-92A | 571647.4 | 150383.5 | 122.1 | 15.63 |
| 199-N-93A | 571560 | 150260 | 120.79 | 14.11 |
| 199-N-94A | 571466.1 | 150154.2 | 121.6 | 11.06 |
| 199-N-95A | 571360 | 149970 | 121.61 | 15.94 |
| 199-N-96A | 571213.5 | 149800.8 | 123.64 | 22.64 |
| 199-N-103A | 571424.8 | 149903.7 | 140.32 | 33 |
| 199-N-104A | 571778.3 | 149542.6 | 141.34 | 28.89 |
| 199-N-105A | 571602.3 | 150025 | 139.62 | 30.87 |
| 199-N-106A | 571737.6 | 150150.9 | 144.63 | 37.88 |
| 199-N-107A | 571462.4 | 149685.1 | 141.26 | 24.16 |
| 199-N-121 | 571368.3 | 149973.3 | 122.38 | 13.95 |
| 199-N-122 | 571318.5 | 149928.8 | 122.33 | 15.63 |
| 199-N-123 | 571282.9 | 149889.4 | 123.1 | 17.46 |
| 199-N-136 | 571337.2 | 149940.7 | 122.06 | 8.86 |
| 199-N-137 | 571344.4 | 149946.3 | 122 | 8.86 |
| 199-N-142 | 571310.2 | 149916.2 | 122.2 | 8.77 |
| 199-N-143 | 571316.5 | 149923 | 122.26 | 8.86 |
| 199-N-144 | 571322.8 | 149935.1 | 122.25 | 8.83 |
| 199-N-145 | 571329.9 | 149935.1 | 122.08 | 8.92 |
| 199-N-160 | 571333.4 | 149938 | 122.08 | 8.92 |
| 199-N-161 | 571326.5 | 149932.4 | 122.13 | 8.68 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-N-162 | 571319.7 | 149926.6 | 122.24 | 8.92 |
| 199-N-163 | 571313.3 | 149919.7 | 122.22 | 8.92 |
| 199-N-164 | 571307.1 | 149913.1 | 122.18 | 8.74 |
| 199-N-167 | 571296.8 | 149698.3 | 140.7 | 26.3 |
| 199-N-169 | 571294 | 149705.4 | 140.76 | 26.3 |
| 199-N-170 | 571288.5 | 149714.8 | 140.79 | 26.45 |
| 199-N-171 | 571296.7 | 149740.1 | 140.96 | 26.6 |
| 199-N-172 | 571263.3 | 149738.5 | 140.56 | 25.99 |
| 199-N-173 | 571193 | 149759.7 | 123.46 | 14.78 |
| 199-N-174 | 571346.8 | 149955.3 | 122.07 | 7.34 |
| 199-N-176 | 571349.2 | 149953.3 | 121.96 | 6.67 |
| 199-N-177 | 571350.4 | 149952.4 | 121.91 | 6.61 |
| 199-N-178 | 571348.7 | 149957.6 | 122.07 | 6.7 |
| 199-N-179 | 571349.8 | 149956.7 | 122.03 | 7.1 |
| 199-N-180 | 571350.9 | 149955.7 | 122 | 6.73 |
| 199-N-181 | 571352.3 | 149954.8 | 121.95 | 6.88 |
| 199-N-200 | 571196.3 | 149755.6 | 123.44 | 6.49 |
| 199-N-201 | 571198.6 | 149759.5 | 123.48 | 9.06 |
| 199-N-202 | 571200.9 | 149763.4 | 123.51 | 6.21 |
| 199-N-203 | 571203.1 | 149767.4 | 123.5 | 9.26 |
| 199-N-204 | 571205.3 | 149771.4 | 123.49 | 5.89 |
| 199-N-205 | 571207.5 | 149775.5 | 123.44 | 8.99 |
| 199-N-206 | 571209.6 | 149779.5 | 123.38 | 6.36 |
| 199-N-207 | 571211.7 | 149783.5 | 123.37 | 9.23 |
| 199-N-208 | 571231.9 | 149787.6 | 123.42 | 5.94 |
| 199-N-209 | 571216.1 | 149791.6 | 123.44 | 9.02 |
| 199-N-210 | 571218.3 | 149795.5 | 123.46 | 6.03 |
| 199-N-211 | 571221.3 | 149799.1 | 123.47 | 8.99 |
| 199-N-212 | 571224.2 | 149802.5 | 123.44 | 5.88 |
| 199-N-213 | 571227.1 | 149806.1 | 123.4 | 8.99 |
| 199-N-214 | 571229.9 | 149809.7 | 123.32 | 5.88 |
| 199-N-215 | 571232.7 | 149813.2 | 123.25 | 9.29 |
| 199-N-216 | 571235.6 | 149816.8 | 123.23 | 5.97 |
| 199-N-217 | 571238.5 | 149820.4 | 123.14 | 9.14 |
| 199-N-218 | 571241.3 | 149824 | 123.16 | 6.21 |
| 199-N-219 | 571244.2 | 149827.6 | 123.25 | 9.38 |
| 199-N-220 | 571247.1 | 149831.2 | 123.23 | 8.99 |
| 199-N-221 | 571249.9 | 149834.8 | 123.3 | 9.2 |
| 199-N-222 | 571252.7 | 149838.5 | 123.13 | 6.3 |
| 199-N-223 | 571255.3 | 149842.2 | 123.17 | 9.14 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-N-224 | 571257.9 | 149846 | 123.26 | 6.33 |
| 199-N-225 | 571260.5 | 149849.7 | 123.4 | 9.17 |
| 199-N-226 | 571236.1 | 149853.5 | 123.35 | 5.88 |
| 199-N-227 | 571266 | 149857.1 | 123.31 | 9.38 |
| 199-N-228 | 571268.7 | 149860.7 | 123.23 | 5.91 |
| 199-N-229 | 571271.5 | 149864.4 | 123.21 | 9.08 |
| 199-N-230 | 571274.5 | 149868 | 123.17 | 5.82 |
| 199-N-231 | 571277.2 | 149871.6 | 123.09 | 8.99 |
| 199-N-232 | 571280.1 | 149875.2 | 123.07 | 5.97 |
| 199-N-233 | 571283.3 | 149878.5 | 123.12 | 9.32 |
| 199-N-234 | 571285.5 | 149883.4 | 123.21 | 6.12 |
| 199-N-235 | 571348.4 | 149951 | 121.94 | 5.94 |
| 199-N-236 | 571351.2 | 149954.5 | 121.97 | 9.11 |
| 199-N-237 | 571354.1 | 149958.1 | 122.07 | 6.12 |
| 199-N-238 | 571356.9 | 149961.7 | 122.12 | 9.14 |
| 199-N-239 | 571359.1 | 149965.7 | 122.17 | 6.15 |
| 199-N-240 | 571361.5 | 149969.7 | 122.22 | 9.05 |
| 199-N-241 | 571364.4 | 149973.2 | 122.25 | 6 |
| 199-N-242 | 571367.2 | 149976.7 | 122.24 | 5.43 |
| 199-N-243 | 571371.3 | 149978.8 | 122.28 | 6.15 |
| 199-N-244 | 571374 | 149982.5 | 122.28 | 8.99 |
| 199-N-245 | 571376.7 | 149986.2 | 122.27 | 6.27 |
| 199-N-246 | 571379.2 | 149990 | 122.28 | 9.23 |
| 199-N-247 | 571382.1 | 149993.6 | 122.26 | 6.49 |
| 199-N-248 | 571384.8 | 149997.3 | 122.22 | 9.17 |
| 199-N-249 | 571387.2 | 150001.2 | 122.17 | 6.21 |
| 199-N-250 | 571389.7 | 150005 | 122.14 | 9.23 |
| 199-N-251 | 571392.2 | 150008.8 | 122.11 | 6.18 |
| 199-N-252 | 571394.6 | 150012.7 | 122.08 | 9.08 |
| 199-N-253 | 571397.2 | 150016.5 | 122.03 | 6.24 |
| 199-N-254 | 571399.5 | 150020.4 | 121.93 | 9.08 |
| 199-N-255 | 571402.1 | 150024.2 | 121.9 | 6.24 |
| 199-N-256 | 571404.5 | 150028 | 121.84 | 9.26 |
| 199-N-257 | 571406.8 | 150032 | 121.82 | 6.18 |
| 199-N-258 | 571409.2 | 150035.8 | 121.78 | 9.11 |
| 199-N-259 | 571411.6 | 150039.6 | 121.82 | 6.24 |
| 199-N-260 | 571414.1 | 150043.5 | 121.82 | 9.05 |
| 199-N-261 | 571416.6 | 150047.3 | 121.86 | 6.39 |
| 199-N-262 | 571419.2 | 150051.1 | 121.88 | 9.02 |
| 199-N-263 | 571421.6 | 150054.9 | 121.88 | 6.39 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-N-264 | 571424.1 | 150058.8 | 121.86 | 9.11 |
| 199-N-265 | 571426.4 | 150062.8 | 121.87 | 6.27 |
| 199-N-266 | 571429.1 | 150066.6 | 121.87 | 9.2 |
| 199-N-267 | 571431.4 | 150070.5 | 121.86 | 6.21 |
| 199-N-268 | 571433.7 | 150074.4 | 121.87 | 9.2 |
| 199-N-269 | 571436.2 | 150078.3 | 121.84 | 6.33 |
| 199-N-270 | 571438.7 | 150082.1 | 121.81 | 9.08 |
| 199-N-271 | 571441.1 | 150085.9 | 121.85 | 6.49 |
| 199-N-272 | 571443.5 | 150089.8 | 121.9 | 9.17 |
| 199-N-273 | 571445.9 | 150093.7 | 121.93 | 6.39 |
| 199-N-274 | 571447.8 | 150097.9 | 121.94 | 8.92 |
| 199-N-275 | 571449.6 | 150102 | 121.95 | 6.33 |
| 199-N-276 | 571451.4 | 150106.2 | 121.93 | 9.02 |
| 199-N-277 | 571452.9 | 150110.5 | 121.83 | 6.46 |
| 199-N-278 | 571454.7 | 150114.7 | 121.76 | 9.05 |
| 199-N-279 | 571456.3 | 150119 | 121.73 | 6.39 |
| 199-N-280 | 571458.1 | 150123.2 | 121.69 | 9.23 |
| 199-N-281 | 571459.9 | 150127.4 | 121.66 | 6.52 |
| 199-N-282 | 571461.6 | 150131.6 | 121.67 | 9.17 |
| 199-N-283 | 571463.4 | 150135.8 | 121.62 | 6.39 |
| 199-N-284 | 571465.1 | 150140.1 | 121.61 | 8.89 |
| 199-N-285 | 571467 | 150144.3 | 121.65 | 6.39 |
| 199-N-286 | 571468.7 | 150148.4 | 121.68 | 9.35 |
| 199-N-287 | 571470.7 | 150152.6 | 121.65 | 6.36 |
| 199-N-288 | 571474.1 | 150155.7 | 121.67 | 9.26 |
| 199-N-289 | 571477.7 | 150158.7 | 121.74 | 6.18 |
| 199-N-290 | 571481.2 | 150161.8 | 121.79 | 9.38 |
| 199-N-291 | 571484.6 | 150164.7 | 121.77 | 6.27 |
| 199-N-292 | 571488.2 | 150167.6 | 121.81 | 9.38 |
| 199-N-293 | 571491.9 | 150170.4 | 121.8 | 6.36 |
| 199-N-294 | 571495.1 | 150173.6 | 121.86 | 9.26 |
| 199-N-295 | 571498.4 | 150176.8 | 121.92 | 6.46 |
| 199-N-296 | 571501.8 | 150179.7 | 121.93 | 9.29 |
| 199-N-297 | 571504.9 | 150183 | 121.95 | 6.46 |
| 199-N-298 | 571508 | 150186.3 | 121.97 | 9.35 |
| 199-N-299 | 571511.3 | 150189.7 | 121.97 | 6.49 |
| 199-N-300 | 571514.3 | 150193 | 121.96 | 9.29 |
| 199-N-301 | 571517.4 | 150196.4 | 121.98 | 6.33 |
| 199-N-302 | 571520.3 | 150199.9 | 121.99 | 9.26 |
| 199-N-303 | 571523.2 | 150203.4 | 122 | 6.15 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-N-304 | 571526.2 | 150206.9 | 121.98 | 9.5 |
| 199-N-305 | 571529 | 150210.5 | 121.99 | 6.46 |
| 199-N-306 | 571531.9 | 150214 | 121.95 | 9.41 |
| 199-N-307 | 571534.6 | 150217.6 | 121.95 | 6.21 |
| 199-N-308 | 571537.5 | 150221.2 | 121.97 | 9.2 |
| 199-N-309 | 571540.1 | 150224.9 | 122 | 6.43 |
| 199-N-310 | 571542.9 | 150228.5 | 121.99 | 9.38 |
| 199-N-311 | 571545.8 | 150232.1 | 121.94 | 6.36 |
| 199-N-312 | 571548.3 | 150235.9 | 121.89 | 9.53 |
| 199-N-313 | 571551 | 150239.6 | 121.85 | 6.24 |
| 199-N-314 | 571553.6 | 150243.4 | 121.87 | 9.14 |
| 199-N-315 | 571556.2 | 150247.2 | 121.89 | 6.33 |
| 199-N-316 | 571558.8 | 150251 | 121.91 | 9.41 |
| 199-N-317 | 571561.3 | 150254.8 | 121.87 | 6.33 |
| 199-N-318 | 571563.7 | 150258.8 | 121.88 | 9.17 |
| 199-N-319 | 571566.2 | 150262.6 | 121.88 | 6.15 |
| 199-N-320 | 571568.6 | 150266.5 | 121.88 | 9.32 |
| 199-N-321 | 571571 | 150270.3 | 121.91 | 6.46 |
| 199-N-322 | 571573.4 | 150274.2 | 121.91 | 9.11 |
| 199-N-323 | 571575.7 | 150278.2 | 122.02 | 6.24 |
| 199-N-324 | 571578.2 | 150282.1 | 122.08 | 9.17 |
| 199-N-325 | 571580.5 | 150286 | 122.07 | 6.52 |
| 199-N-326 | 571582.7 | 150290 | 122.09 | 9.08 |
| 199-N-327 | 571584.9 | 150294 | 122.09 | 6.46 |
| 199-N-328 | 571587.1 | 150298 | 122.1 | 8.92 |
| 199-N-329 | 571589.2 | 150302 | 122.12 | 6.12 |
| 199-N-330 | 571591.3 | 150306.1 | 122.09 | 8.89 |
| 199-N-331 | 571593.5 | 150310.1 | 122.09 | 6.67 |
| 199-N-332 | 571595.8 | 150314.1 | 122.14 | 9.02 |
| 199-N-333 | 571598.1 | 150318.1 | 122.16 | 6.27 |
| 199-N-334 | 571600.4 | 150322 | 122.15 | 9.02 |
| 199-N-335 | 571603 | 150325.8 | 122.13 | 6.27 |
| 199-N-336 | 571605.8 | 150329.5 | 122.14 | 9.17 |
| 199-N-337 | 571608.8 | 150333 | 122.13 | 6.3 |
| 199-N-338 | 571612.1 | 150336.2 | 122.1 | 9.23 |
| 199-N-339 | 571615.2 | 150339.5 | 122.1 | 6.3 |
| 199-N-340 | 571618.4 | 150342.7 | 122.08 | 8.89 |
| 199-N-341 | 571624.5 | 150346.1 | 122.15 | 6.21 |
| 199-N-342 | 571627.5 | 150349.6 | 122.2 | 9.66 |
| 199-N-343 | 571630.3 | 150353.2 | 122.25 | 6.3 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-N-344 | 571632.9 | 150356.8 | 122.27 | 9.35 |
| 199-N-345 | 571266.8 | 150360.6 | 122.21 | 6.52 |
| 199-N-346 | 571203.4 | 149780.4 | 123.61 | 9.17 |
| 199-N-347 | 571230.9 | 149822.8 | 123.13 | 9.17 |
| 199-N-348 | 571248.2 | 149845 | 123.19 | 9.08 |
| 199-N-349 | 571266.8 | 149886.1 | 123.17 | 9.14 |
| 199-N-350 | 571356.3 | 149966.5 | 122.16 | 9.2 |
| 199-N-351 | 571373.2 | 149987.3 | 122.3 | 9.2 |
| 199-N-352 | 571388.7 | 150009 | 122.18 | 9.23 |
| 199-N-353 | 571403.5 | 150031.5 | 121.92 | 9.05 |
| 199-N-354 | 571417.8 | 150054.2 | 121.93 | 9.2 |
| 199-N-355 | 571431.5 | 150077.1 | 121.96 | 9.11 |
| 199-N-356 | 571445.1 | 150100.1 | 122 | 8.8 |
| 199-N-357 | 571455.2 | 150125 | 121.83 | 9.17 |
| 199-N-358 | 571465.9 | 150149.5 | 121.73 | 9.08 |
| 199-N-359 | 571484.2 | 150169.2 | 121.93 | 9.2 |
| 199-N-360 | 571503.8 | 150187.4 | 122.09 | 9.08 |
| 199-N-361 | 571521.7 | 150207.4 | 122.08 | 9.23 |
| 199-N-362 | 571538.5 | 150228.3 | 122.11 | 9.26 |
| 199-N-363 | 571554.2 | 150250.1 | 121.99 | 9.2 |
| 199-N-364 | 571568.8 | 150272.7 | 121.91 | 8.92 |
| 199-N-365 | 571582.6 | 150295.7 | 122.1 | 9.05 |
| 199-N-366 | 571595.2 | 150319.4 | 122.17 | 8.77 |
| 199-N-367 | 571611 | 150341 | 122.21 | 9.26 |
| 199-N-368 | 571345.4 | 149947.5 | 122.07 | 8.99 |
| 199-N-369 | 571341.8 | 149947.9 | 122.13 | 8.99 |
| 199-N-370 | 571340 | 149945.5 | 122.14 | 8.99 |
| 699-52-17 | 584666.4 | 139410.5 | 122.23 | 116.82 |
| 699-52-18A | 584261.8 | 139367.3 | 125.49 | 28.43 |
| 699-52-18C | 584270.8 | 139299.9 | 125.42 | 33.61 |
| 699-54-18C | 584471.5 | 139998.6 | 123.56 | 109.2 |
| 699-54-18E | 584297.4 | 139984.5 | 121.22 | 28.43 |
| 699-57-16 | 584953.5 | 140807.6 | 117.29 | 13.5 |
| 699-57-25B | 582109.4 | 140801.5 | 126.79 | 25.69 |
| 699-59-32 | 580010.3 | 141607.4 | 129.64 | 23.86 |
| 699-60-32 | 580115.1 | 141902 | 129.67 | 26.91 |
| 699-60-57 | 572623.5 | 141870.3 | 143.44 | 48.24 |
| 699-60-60 | 571588.6 | 141763.9 | 156.36 | 40.01 |
| 699-61-26A | 581874.9 | 142105 | 125.12 | 111.64 |
| 699-61-37 | 578587.2 | 141964.3 | 135.06 | 24.16 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 699-61-41 | 577344.6 | 142188.4 | 130.82 | 16.85 |
| 699-61-62 | 570914.9 | 141921.7 | 151.76 | 58.3 |
| 699-61-66 | 569787.6 | 142008 | 159.68 | 69.58 |
| 699-62-31 | 580302.6 | 142532.5 | 132.42 | 26.6 |
| 699-62-43A | 576809.6 | 142363.9 | 132.2 | 24.77 |
| 699-62-43F | 576858.1 | 142481.1 | 129.31 | 25.69 |
| 699-63-25A | 582315.5 | 142798 | 121.23 | 34.53 |
| 699-63-51 | 574446.8 | 142553.7 | 129.48 | 11.97 |
| 699-63-55 | 573094.4 | 142562.3 | 130.19 | 39.1 |
| 699-63-58 | 572262.7 | 142583.1 | 150.1 | 41.54 |
| 699-63-89 | 562902.1 | 142577 | 156.24 | 68.06 |
| 699-63-90 | 562367.2 | 142612.4 | 156.28 | 78.11 |
| 699-63-92 | 561559.7 | 142637.4 | 151.84 | 57.69 |
| 699-63-95 | 560914.6 | 142650.8 | 148.33 | 216.49 |
| 699-64-27 | 581375.5 | 142946.1 | 127.04 | 26.6 |
| 699-65-50 | 574590.8 | 143187.9 | 142.57 | 179.31 |
| 699-65-72 | 567883.7 | 143107.9 | 164.97 | 66.84 |
| 699-65-83 | 564590.5 | 143249.1 | 148.1 | 37.88 |
| 699-66-23 | 582864.8 | 143617.2 | 119.03 | 31.48 |
| 699-66-38 | 578294 | 143607.7 | 133.3 | 46.72 |
| 699-66-58 | 572266.7 | 143532.7 | 153.44 | 35.29 |
| 699-66-39 | 577847.2 | 143636.3 | 138.47 | 28.43 |
| 699-66-64 | 570290.7 | 143734.1 | 154.31 | 36.97 |
| 699-66-91 | 562174.8 | 143476.8 | 142.62 | 58.91 |
| 699-67-51 | 574178.9 | 143933.2 | 160.21 | 77.2 |
| 699-67-86 | 563661.7 | 143873.1 | 144.47 | 143.34 |
| 699-67-98 | 559944 | 143714.7 | 139.17 | 57.39 |
| 699-68-105 | 557803.4 | 144206.1 | 138.93 | 29.65 |
| 699-69-45 | 576157.4 | 144556.3 | 148.66 | 92.44 |
| 699-71-30 | 580603.4 | 145226.9 | 122.67 | 46.72 |
| 699-71-52 | 573907.9 | 145214.8 | 159.94 | 65.01 |
| 699-71-77 | 566402 | 145098.6 | 144.23 | 92.44 |
| 699-72-73 | 567551.5 | 145418.8 | 147.55 | 61.96 |
| 699-72-92 | 561839.4 | 145359.8 | 137.51 | 61.96 |
| 699-73-61 | 571420.8 | 145781.5 | 162.5 | 46.72 |
| 699-74-23 | 582756.4 | 146203.2 | 114.9 | 16.24 |
| 699-74-44 | 576393.1 | 146098.8 | 136.28 | 46.72 |
| 699-74-48 | 575237.7 | 146037.7 | 148.88 | 46.72 |
| 699-75-23A | 582750.3 | 146233.7 | 115.69 | 11.67 |
| 699-77-36 | 578847.2 | 146868.9 | 126.09 | 46.72 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 699-77-54 | 573386 | 146854.8 | 146.92 | 46.72 |
| 699-78-62 | 570877.3 | 147166.2 | 143.62 | 46.72 |
| 699-80-39B | 578418.4 | 147763.3 | 123.87 | 17.15 |
| 699-80-43P | 576703.9 | 147729.9 | 126.68 | 138.16 |
| 699-80-43Q | 576703.2 | 147745 | 126.41 | 71.71 |
| 699-80-43R | 576702.5 | 147760.3 | 126.45 | 43.67 |
| 699-81-38 | 578172.4 | 148241.6 | 124.76 | 11.79 |
| 699-81-58 | 572185.4 | 148173.4 | 134.5 | 46.72 |
| 699-81-62 | 570943 | 148103.1 | 134.86 | 309.15 |
| 699-81-64B | 570385.8 | 148163.8 | 136.64 | 12.58 |
| 699-83-47 | 575492 | 148705.3 | 133.16 | 46.72 |
| 699-84-59 | 571758 | 149179.8 | 140.61 | 306.1 |
| 699-86-60 | 571625.7 | 149600.8 | 138.41 | 162.85 |
| 699-87-55 | 572969.8 | 149904 | 140.33 | 29.65 |
| 699-89-35 | 579121.7 | 150543.5 | 121.77 | 23.86 |
| 699-93-48A | 575094.1 | 151795.3 | 133.54 | 26.3 |
| 699-94-41 | 577223.1 | 152111.7 | 124.96 | 13.23 |
| 699-94-43 | 576625.6 | 152087.9 | 129.81 | 19.5 |
| 699-95-45 | 576257 | 152556.3 | 128.54 | 16.36 |
| 699-95-48 | 575253.4 | 152323.1 | 130.69 | 20.62 |
| 699-95-51 | 574439.5 | 152528.6 | 132.29 | 22.73 |
| 699-96-43 | 576761.5 | 152605.3 | 128.71 | 17.18 |
| 699-96-49 | 574851.3 | 152858.1 | 128.26 | 31.48 |
| 699-96-52B | 573910.2 | 152656.2 | 123.56 | 15.02 |
| 699-97-41 | 577217.5 | 153090.4 | 127.59 | 18.89 |
| 699-97-43 | 576671.9 | 153090.3 | 129.08 | 31.48 |
| 699-97-43B | 576859.8 | 152981.3 | 129.34 | 17.28 |
| 699-97-43C | 576857.3 | 152980.7 | 129.41 | 39.4 |
| 699-97-45 | 576051.7 | 152979 | 126.03 | 14.93 |
| 699-97-45B | 576049.3 | 152979.4 | 125.99 | 37.7 |
| 699-97-48B | 575247.6 | 152900.8 | 129.02 | 19.05 |
| 699-97-48C | 575245.4 | 152909.7 | 129.07 | 38.49 |
| 699-98-43 | 576862.1 | 153369.9 | 122.44 | 13.04 |
| 699-98-46 | 575726.9 | 153365.6 | 127.37 | 14.9 |
| 699-98-51 | 574339.3 | 153302.7 | 120.4 | 10.17 |
| 699-99-41 | 577284 | 153590.7 | 125.63 | 14.9 |
| 699-99-42B | 577010.2 | 153761 | 127.12 | 16.73 |
| 699-99-44 | 576458.8 | 153592.4 | 124.16 | 12.43 |
| 699-100-43B | 576675.9 | 154008.7 | 122.18 | 11.7 |
| 699-101-45 | 576032.4 | 154124.2 | 121.81 | 10.39 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 699-101-48C | 575222.9 | 154411 | 119.42 | 24.47 |
| 199-N-108A | 571541.5 | 149812.5 | 140.25 | 23.1 |
| B2539 | 571898.2 | 149630.6 | 138.34 | 20.66 |
| C7842 | 565391.9 | 145327.4 | 133.42 | 17.76 |
| C7844 | 565290.2 | 144761.3 | 141.36 | 23.28 |
| C7845 | 565355.9 | 144638.9 | 143.1 | 25.05 |
| C7847 | 565340.9 | 144511.8 | 144.1 | 5.08 |
| C7849 | 565397.3 | 144027 | 151.81 | 33.83 |
| C7850 | 573888.9 | 152315.3 | 136.39 | 23.04 |
| C7851 | 573701.8 | 152307 | 135.88 | 22.03 |
| C7855 | 573841.7 | 151608.2 | 144.13 | 28.8 |
| C7862 | 577708.9 | 152479.4 | 129.61 | 16.97 |
| C7864 | 578090.1 | 152428 | 128.74 | 16.48 |
| C7883 | 564812.4 | 144161.1 | 145.49 | 28.34 |
| C7884 | 565331.7 | 144527.6 | 145.38 | 28.77 |
| C7971 | 580158.6 | 147192.8 | 122.14 | 11.21 |
| C8239 | 565331.7 | 144527.6 | 144.04 | 26.09 |
| 199-N-182 | 571428.7 | 149819.9 | 140.52 | 47.94 |
| 199-N-183 | 571269.7 | 149756 | 140.24 | 36.78 |
| 199-N-184 | 571430.7 | 149817.8 | 140.53 | 33.92 |
| 199-N-185 | 571546.3 | 150238 | 122.07 | 29.19 |
| 199-N-186 | 571480.9 | 149715.1 | 141.39 | 30.66 |
| 199-N-187 | 571565.9 | 149898 | 141.25 | 29.8 |
| 199-N-188 | 571906.9 | 149581.5 | 139.31 | 28.43 |
| 199-N-189 | 571431.7 | 148430.5 | 143.64 | 36.75 |
| 199-N-75 | 571523.6 | 150060.7 | 139.33 | 28.31 |
| 199-N-52 | 572302.9 | 149466.2 | 141.9 | 24.16 |
| 699-58-24 | 582308.8 | 141345.9 | 127.75 | 19.29 |
| 699-66-103 | 558538.8 | 143553.3 | 142.04 | 40.01 |
| 199-N-50 | 572090.9 | 150298.8 | 141.75 | 27.21 |
| 199-N-43 | 572366.2 | 150140 | 137.13 | 24.77 |
| 699-65-95 | 560815.4 | 143192.9 | 137.91 | 33.31 |
| 199-D5-123 | 573824.2 | 151639.4 | 144.17 | 38.7 |
| 199-D5-16 | 573917.4 | 151652.5 | 144.45 | 30.87 |
| 199-K-131 | 570662 | 148903.8 | 134.41 | 31.27 |
| 199-K-196 | 568433.3 | 146639.3 | 133.96 | 43.61 |
| 199-K-197 | 569348.8 | 147528.8 | 125.14 | 34.01 |
| 199-N-97A | 571140 | 149650 | 120.85 | 15.02 |
| 699-75-23B | 582744.1 | 146264.2 | 115.98 | 11.97 |
| 199-D4-7 | 572760.9 | 151551.3 | 143.36 | 30.26 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-D4-88 | 572758.7 | 151553.2 | 143.4 | 30.87 |
| 199-D4-90 | 572823.2 | 151616.1 | 143.45 | 31.94 |
| 199-D4-91 | 572817.6 | 151621.1 | 143.45 | 31.39 |
| 199-D4-92 | 572714.1 | 151486.3 | 143.52 | 33.49 |
| 199-D4-93 | 572710.4 | 151491.2 | 143.33 | 33.08 |
| 199-D5-126 | 573705.7 | 151843.3 | 143.63 | 35.78 |
| 199-D5-13 | 573535.5 | 151955.2 | 143.65 | 30.66 |
| 199-D5-14 | 573789.6 | 151788 | 143.85 | 31.78 |
| 199-D5-144 | 573352 | 151404.8 | 143.77 | 36.23 |
| 199-K-149 | 570778.3 | 148970.7 | 139.98 | 35.5 |
| 199-N-41 | 572182.3 | 149965.3 | 139.9 | 24.77 |
| 199-N-57 | 571413.2 | 149542.1 | 140.06 | 24.16 |
| 699-57-29B | 581138.3 | 140904 | 127.27 | 25.69 |
| 699-91-46A | 575910.9 | 151156.6 | 127.26 | 14.87 |
| 199-F5-49 | 581133.2 | 147705 | 126.42 | 11.88 |
| 199-K-155 | 570230 | 147950 | 137.84 | 10.94 |
| 699-80-43S | 576701.9 | 147774.7 | 125.28 | 16.24 |
| 699-96-41 | 576770.6 | 152607.6 | 129.18 | 19.96 |
| 699-96-42 | 576773.2 | 152612.6 | 129.21 | 16.85 |
| 699-96-44 | 576773.1 | 152608.2 | 129.24 | 19.17 |
| 699-96-45 | 576768.2 | 152607 | 129.19 | 19.26 |
| C6446 | 573592 | 151559.5 | 139.71 | 17.76 |
| C6447 | 573593.1 | 151531.2 | 139.85 | 13.19 |
| C6449 | 573590.4 | 151525.6 | 140.05 | 17.46 |
| C6450 | 573579.9 | 151524.1 | 138.61 | 16.24 |
| C8205 | 569405.1 | 146619.8 | 144.32 | 57.81 |
| control_1 | 573314.4 | 154147.4 | 121.01 | 101 |
| control_2 | 573763.9 | 154399.2 | 126.61 | 101 |
| control_3 | 573764.2 | 155458 | 192.24 | 101 |
| control_4 | 574318.8 | 155752 | 195.62 | 101 |
| control_5 | 575156.4 | 155729.9 | 203.26 | 101 |
| control_6 | 575685.5 | 155688.3 | 208.94 | 101 |
| control_7 | 576352 | 155586.3 | 204.51 | 101 |
| control_8 | 576940.3 | 155286.6 | 200.76 | 101 |
| control_9 | 577647.8 | 155044.8 | 193.5 | 101 |
| control_10 | 578207.1 | 154782.4 | 198.79 | 101 |
| control_11 | 578624.8 | 154534.8 | 200.85 | 101 |
| control_12 | 579021.7 | 154247.5 | 203.18 | 101 |
| control_13 | 579341.8 | 153651.1 | 156.98 | 101 |
| 199-H4-85 | 577980 | 152880.8 | 128.029 | 16.96 |

| Well Name | X-coord | Y-coord | Elevation | Drill Depth* |
|---|---|---|---|---|
| 199-H4-86 | 577704.6 | 152745.7 | 129.101 | 21.0944 |
| 199-D5-145 | 573215.6 | 151396.3 | 144.209 | 37.1152 |
| 199-D5-146 | 573219.8 | 151345.6 | 144.036 | 36.4768 |
| 199-D5-147 | 572993.1 | 151380.8 | 143.846 | 33.9232 |
| 199-D5-148 | 573361.5 | 151083.5 | 143.024 | 36.0512 |
| 199-K-202 | 569101.6 | 146792.8 | 141.3 | 49.6704 |
| 199-K-205 | 568845.6 | 146090.5 | 147.8 | 57.544 |
| 199-K-206 | 568734.2 | 146049.8 | 149.9 | 56.6016 |
| 199-H4-90 | 577922.8 | 152592.4 | 129.8 | 30.488 |
| 199-H4-91 | 578126.4 | 152524.6 | 127.9 | 29.728 |
| 199-D5-153 | 573329.7 | 151992.9 | 142.6 | 34.136 |
| 199-D5-154 | 573632.1 | 151830.9 | 143.2 | 35.8688 |

* = Maximum drill depth is approximately ± 1 m of actual borehole total drill depth to facilitate model visualization.

**Table A-2. Current Lithologic Unit Selections from GeoContacts_100-Area_2013-12-19.xlsx for Wells used in the Model (See Table A-1 for well locations and depths)**

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-B2-12 | 0 | 3.8 | Hanford |
| 199-B2-12 | 3.8 | 45.6 | Ringold E |
| 199-B2-12 | 45.6 | 54.5 | RUM |
| 199-B2-14 | 0 | 10.1 | Hanford |
| 199-B2-14 | 10.1 | 43.8 | Ringold E |
| 199-B2-14 | 43.8 | 46.42 | RUM |
| 199-B2-15 | 0 | 9.1 | Hanford |
| 199-B2-15 | 9.1 | 43.8 | Ringold E |
| 199-B2-15 | 43.8 | 59.07 | RUM |
| 199-B2-16 | 0 | 9.8 | Hanford |
| 199-B2-16 | 9.8 | 44.8 | Ringold E |
| 199-B2-16 | 44.8 | 47.3 | RUM |
| 199-B3-2 | 0 | 46.6 | Hanford |
| 199-B3-2 | 46.6 | 240.79 | RUM |
| 199-B3-46 | 0 | 15.2 | Hanford |
| 199-B3-46 | 15.2 | 20.4 | Ringold E |
| 199-B3-50 | 0 | 27.7 | Hanford |
| 199-B3-50 | 27.7 | 53.9 | Ringold E |
| 199-B3-50 | 53.9 | 55.87 | RUM |
| 199-B3-51 | 0 | 4 | Hanford |
| 199-B3-51 | 4 | 45.6 | Ringold E |
| 199-B3-51 | 45.6 | 47.61 | RUM |
| 199-B3-52 | 8.2 | 18.3 | Ringold E |
| 199-B4-8 | 0 | 26.8 | Hanford |
| 199-B4-8 | 26.8 | 27.6 | Ringold E |
| 199-B5-5 | 0 | 16.2 | Hanford |
| 199-B5-5 | 16.2 | 62.5 | Ringold E |
| 199-B5-5 | 62.5 | 65.47 | RUM |
| 199-B5-6 | 0 | 28.3 | Hanford |
| 199-B5-6 | 28.3 | 58.2 | Ringold E |
| 199-B5-6 | 58.2 | 59.59 | RUM |
| 199-B5-8 | 0 | 59.7 | Hanford |
| 199-B5-8 | 59.7 | 67.8 | Ringold E |
| 199-B5-8 | 67.8 | 70.29 | RUM |
| 199-B8-6 | 0 | 27.7 | Hanford |
| 199-B8-9 | 0 | 35.1 | Hanford |
| 199-B8-9 | 35.1 | 64.5 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-B8-9 | 64.5 | 66.9 | RUM |
| 199-B9-2 | 0 | 36 | Hanford |
| 199-B9-3 | 0 | 33.2 | Hanford |
| 199-D2-10 | 0 | 7.9 | Hanford |
| 199-D2-10 | 7.9 | 9.45 | RUM |
| 199-D2-11 | 0 | 27.5 | Hanford |
| 199-D2-11 | 27.5 | 33.5 | Ringold E |
| 199-D2-11 | 33.5 | 34.75 | RUM |
| 199-D2-12 | 0 | 8.6 | Hanford |
| 199-D2-5 | 0 | 27.4 | Hanford |
| 199-D2-5 | 27.4 | 28.96 | RUM |
| 199-D2-6 | 0 | 22.9 | Hanford |
| 199-D2-6 | 22.9 | 31.4 | Ringold E |
| 199-D2-6 | 31.4 | 33.74 | RUM |
| 199-D2-8 | 0 | 15.4 | Hanford |
| 199-D2-8 | 15.4 | 30.8 | Ringold E |
| 199-D3-3 | 0 | 19.5 | Hanford |
| 199-D3-3 | 19.5 | 34.6 | Ringold E |
| 199-D3-3 | 34.6 | 34.75 | RUM |
| 199-D3-4 | 0 | 20.6 | Hanford |
| 199-D3-4 | 20.6 | 34.4 | Ringold E |
| 199-D3-4 | 34.4 | 34.81 | RUM |
| 199-D3-5 | 0 | 26.5 | Hanford |
| 199-D3-5 | 26.5 | 31.7 | Ringold E |
| 199-D3-5 | 31.7 | 34.2 | RUM |
| 199-D4-1 | 0 | 16.8 | Hanford |
| 199-D4-1 | 16.8 | 29.9 | Ringold E |
| 199-D4-1 | 29.9 | 32 | RUM |
| 199-D4-10 | 0 | 16.5 | Hanford |
| 199-D4-10 | 16.5 | 29.6 | Ringold E |
| 199-D4-10 | 29.6 | 29.84 | RUM |
| 199-D4-101 | 0 | 19.2 | Hanford |
| 199-D4-101 | 19.2 | 32 | Ringold E |
| 199-D4-101 | 32 | 33.5 | RUM |
| 199-D4-11 | 0 | 17.1 | Hanford |
| 199-D4-11 | 17.1 | 29.1 | Ringold E |
| 199-D4-11 | 29.1 | 29.6 | RUM |
| 199-D4-12 | 0 | 18.3 | Hanford |
| 199-D4-12 | 18.3 | 29.6 | Ringold E |
| 199-D4-12 | 29.6 | 30.08 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-13 | 0 | 15.5 | Hanford |
| 199-D4-13 | 15.5 | 27.7 | Ringold E |
| 199-D4-13 | 27.7 | 30.78 | RUM |
| 199-D4-14 | 0 | 13.1 | Hanford |
| 199-D4-14 | 13.1 | 29.6 | Ringold E |
| 199-D4-14 | 29.6 | 31.06 | RUM |
| 199-D4-15 | 0 | 15.2 | Hanford |
| 199-D4-15 | 15.2 | 30.5 | Ringold E |
| 199-D4-15 | 30.5 | 32 | RUM |
| 199-D4-16 | 0 | 17.1 | Hanford |
| 199-D4-16 | 17.1 | 29.8 | Ringold E |
| 199-D4-16 | 29.8 | 31 | RUM |
| 199-D4-17 | 0 | 17.7 | Hanford |
| 199-D4-17 | 17.7 | 29.6 | Ringold E |
| 199-D4-17 | 29.6 | 31.36 | RUM |
| 199-D4-18 | 0 | 4.6 | Hanford |
| 199-D4-18 | 4.6 | 29.1 | Ringold E |
| 199-D4-18 | 29.1 | 31.06 | RUM |
| 199-D4-19 | 0 | 18.7 | Hanford |
| 199-D4-19 | 18.7 | 33.5 | Ringold E |
| 199-D4-19 | 33.5 | 33.68 | RUM |
| 199-D4-2 | 0 | 29.7 | Hanford |
| 199-D4-2 | 0 | 29.7 | Hanford |
| 199-D4-2 | 29.7 | 30.48 | RUM |
| 199-D4-20 | 0 | 19.2 | Hanford |
| 199-D4-20 | 19.2 | 32 | Ringold E |
| 199-D4-20 | 32 | 32.77 | RUM |
| 199-D4-21 | 0 | 14.9 | Hanford |
| 199-D4-21 | 14.9 | 29.7 | Ringold E |
| 199-D4-21 | 29.7 | 30.18 | RUM |
| 199-D4-22 | 0 | 17.7 | Hanford |
| 199-D4-22 | 17.7 | 29.9 | Ringold E |
| 199-D4-22 | 29.9 | 30.78 | RUM |
| 199-D4-23 | 0 | 13.7 | Hanford |
| 199-D4-23 | 13.7 | 25.3 | Ringold E |
| 199-D4-23 | 25.3 | 26.82 | RUM |
| 199-D4-24 | 0 | 13.4 | Hanford |
| 199-D4-24 | 13.4 | 30 | Ringold E |
| 199-D4-24 | 30 | 30.78 | RUM |
| 199-D4-25 | 0 | 15.7 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-25 | 15.7 | 30.9 | Ringold E |
| 199-D4-25 | 30.9 | 32.31 | RUM |
| 199-D4-26 | 0 | 18 | Hanford |
| 199-D4-26 | 18 | 30.8 | Ringold E |
| 199-D4-26 | 30.8 | 32 | RUM |
| 199-D4-27 | 0 | 17.1 | Hanford |
| 199-D4-27 | 17.1 | 30.8 | Ringold E |
| 199-D4-27 | 30.8 | 32 | RUM |
| 199-D4-28 | 0 | 17.1 | Hanford |
| 199-D4-28 | 17.1 | 30 | Ringold E |
| 199-D4-28 | 30 | 31.09 | RUM |
| 199-D4-29 | 0 | 17.7 | Hanford |
| 199-D4-29 | 17.7 | 29.9 | Ringold E |
| 199-D4-29 | 29.9 | 31.09 | RUM |
| 199-D4-3 | 0 | 17.4 | Hanford |
| 199-D4-3 | 17.4 | 29.9 | Ringold E |
| 199-D4-3 | 29.9 | 31.09 | RUM |
| 199-D4-30 | 0 | 16.5 | Hanford |
| 199-D4-30 | 16.5 | 29.6 | Ringold E |
| 199-D4-30 | 29.6 | 29.57 | RUM |
| 199-D4-31 | 0 | 16.5 | Hanford |
| 199-D4-31 | 16.5 | 29.6 | Ringold E |
| 199-D4-31 | 29.6 | 29.87 | RUM |
| 199-D4-32 | 0 | 15.8 | Hanford |
| 199-D4-32 | 15.8 | 29.9 | Ringold E |
| 199-D4-32 | 29.9 | 30.78 | RUM |
| 199-D4-33 | 0 | 15.2 | Hanford |
| 199-D4-33 | 15.2 | 30.3 | Ringold E |
| 199-D4-33 | 30.3 | 31.39 | RUM |
| 199-D4-34 | 0 | 17.1 | Hanford |
| 199-D4-34 | 17.1 | 30.3 | Ringold E |
| 199-D4-34 | 30.3 | 31.7 | RUM |
| 199-D4-35 | 0 | 17.7 | Hanford |
| 199-D4-35 | 17.7 | 29.6 | Ringold E |
| 199-D4-35 | 29.6 | 31.09 | RUM |
| 199-D4-36 | 0 | 14.3 | Hanford |
| 199-D4-36 | 14.3 | 29.9 | Ringold E |
| 199-D4-36 | 29.9 | 31.09 | RUM |
| 199-D4-37 | 0 | 16.8 | Hanford |
| 199-D4-37 | 16.8 | 29.9 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-37 | 29.9 | 31.09 | RUM |
| 199-D4-38 | 0 | 16.6 | Hanford |
| 199-D4-38 | 16.6 | 29.9 | Ringold E |
| 199-D4-38 | 29.9 | 31.09 | RUM |
| 199-D4-39 | 0 | 15.2 | Hanford |
| 199-D4-39 | 15.2 | 29.7 | Ringold E |
| 199-D4-39 | 29.7 | 31.09 | RUM |
| 199-D4-4 | 0 | 17.3 | Hanford |
| 199-D4-4 | 17.3 | 29.7 | Ringold E |
| 199-D4-4 | 29.7 | 32.31 | RUM |
| 199-D4-40 | 0 | 16.5 | Hanford |
| 199-D4-40 | 16.5 | 29.9 | Ringold E |
| 199-D4-40 | 29.9 | 30.66 | RUM |
| 199-D4-41 | 0 | 16.5 | Hanford |
| 199-D4-41 | 16.5 | 30.1 | Ringold E |
| 199-D4-41 | 30.1 | 30.78 | RUM |
| 199-D4-42 | 0 | 14.3 | Hanford |
| 199-D4-42 | 14.3 | 30.6 | Ringold E |
| 199-D4-42 | 30.6 | 31.95 | RUM |
| 199-D4-43 | 0 | 16.5 | Hanford |
| 199-D4-43 | 16.5 | 30.5 | Ringold E |
| 199-D4-43 | 30.5 | 31.09 | RUM |
| 199-D4-44 | 0 | 17.1 | Hanford |
| 199-D4-44 | 17.1 | 30.6 | Ringold E |
| 199-D4-44 | 30.6 | 31.39 | RUM |
| 199-D4-45 | 0 | 16.8 | Hanford |
| 199-D4-45 | 16.8 | 29.6 | Ringold E |
| 199-D4-45 | 29.6 | 32.31 | RUM |
| 199-D4-46 | 0 | 16.2 | Hanford |
| 199-D4-46 | 16.2 | 30.8 | Ringold E |
| 199-D4-46 | 30.8 | 31.7 | RUM |
| 199-D4-47 | 0 | 17.1 | Hanford |
| 199-D4-47 | 17.1 | 29.9 | Ringold E |
| 199-D4-47 | 29.9 | 31.15 | RUM |
| 199-D4-48 | 0 | 17.4 | Hanford |
| 199-D4-48 | 17.4 | 31.7 | Ringold E |
| 199-D4-48 | 31.7 | 32.92 | RUM |
| 199-D4-49 | 0 | 17.7 | Hanford |
| 199-D4-49 | 17.7 | 29.9 | Ringold E |
| 199-D4-49 | 29.9 | 30.51 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-5 | 0 | 17.4 | Hanford |
| 199-D4-5 | 17.4 | 29.3 | Ringold E |
| 199-D4-5 | 29.3 | 30.78 | RUM |
| 199-D4-50 | 0 | 17.4 | Hanford |
| 199-D4-50 | 17.4 | 29.7 | Ringold E |
| 199-D4-50 | 29.7 | 29.9 | RUM |
| 199-D4-51 | 0 | 18.3 | Hanford |
| 199-D4-51 | 18.3 | 29.9 | Ringold E |
| 199-D4-51 | 29.9 | 30.39 | RUM |
| 199-D4-52 | 0 | 18.1 | Hanford |
| 199-D4-52 | 18.1 | 29.9 | Ringold E |
| 199-D4-52 | 29.9 | 30.39 | RUM |
| 199-D4-53 | 0 | 16.5 | Hanford |
| 199-D4-53 | 16.5 | 29.6 | Ringold E |
| 199-D4-53 | 29.6 | 29.66 | RUM |
| 199-D4-54 | 0 | 18 | Hanford |
| 199-D4-54 | 18 | 29.7 | Ringold E |
| 199-D4-54 | 29.7 | 29.96 | RUM |
| 199-D4-55 | 0 | 18.6 | Hanford |
| 199-D4-55 | 18.6 | 29.9 | Ringold E |
| 199-D4-55 | 29.9 | 30.33 | RUM |
| 199-D4-56 | 0 | 16.2 | Hanford |
| 199-D4-56 | 16.2 | 29.6 | Ringold E |
| 199-D4-56 | 29.6 | 29.72 | RUM |
| 199-D4-57 | 0 | 29.9 | Hanford |
| 199-D4-57 | 29.9 | 29.92 | RUM |
| 199-D4-58 | 0 | 31.3 | Hanford |
| 199-D4-58 | 31.3 | 32.52 | RUM |
| 199-D4-59 | 0 | 30.5 | Hanford |
| 199-D4-59 | 30.5 | 31.15 | RUM |
| 199-D4-6 | 0 | 16.3 | Hanford |
| 199-D4-6 | 16.3 | 29.3 | Ringold E |
| 199-D4-6 | 29.3 | 30.78 | RUM |
| 199-D4-60 | 0 | 18.9 | Hanford |
| 199-D4-60 | 18.9 | 30.8 | Ringold E |
| 199-D4-60 | 30.8 | 30.78 | RUM |
| 199-D4-61 | 0 | 18.9 | Hanford |
| 199-D4-61 | 18.9 | 31.1 | Ringold E |
| 199-D4-61 | 31.1 | 31.09 | RUM |
| 199-D4-62 | 0 | 18.6 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-62 | 18.6 | 33.2 | Ringold E |
| 199-D4-62 | 33.2 | 33.44 | RUM |
| 199-D4-63 | 0 | 18.6 | Hanford |
| 199-D4-63 | 18.6 | 33.5 | Ringold E |
| 199-D4-63 | 33.5 | 33.89 | RUM |
| 199-D4-64 | 0 | 19.8 | Hanford |
| 199-D4-64 | 19.8 | 33.7 | Ringold E |
| 199-D4-64 | 33.7 | 33.83 | RUM |
| 199-D4-65 | 0 | 18.9 | Hanford |
| 199-D4-65 | 18.9 | 33.8 | Ringold E |
| 199-D4-65 | 33.8 | 34.14 | RUM |
| 199-D4-66 | 0 | 19.1 | Hanford |
| 199-D4-66 | 19.1 | 33.7 | Ringold E |
| 199-D4-66 | 33.7 | 33.59 | RUM |
| 199-D4-67 | 0 | 18.6 | Hanford |
| 199-D4-67 | 18.6 | 33.8 | Ringold E |
| 199-D4-67 | 33.8 | 33.83 | RUM |
| 199-D4-68 | 0 | 18.3 | Hanford |
| 199-D4-68 | 18.3 | 34.1 | Ringold E |
| 199-D4-68 | 34.1 | 33.7 | RUM |
| 199-D4-69 | 0 | 18 | Hanford |
| 199-D4-69 | 18 | 33.5 | Ringold E |
| 199-D4-69 | 33.5 | 32.99 | RUM |
| 199-D4-70 | 0 | 18.6 | Hanford |
| 199-D4-70 | 18.6 | 33.7 | Ringold E |
| 199-D4-70 | 33.7 | 32.59 | RUM |
| 199-D4-71 | 0 | 18.3 | Hanford |
| 199-D4-71 | 18.3 | 33.7 | Ringold E |
| 199-D4-71 | 33.7 | 33.35 | RUM |
| 199-D4-72 | 0 | 18 | Hanford |
| 199-D4-72 | 18 | 33.8 | Ringold E |
| 199-D4-72 | 33.8 | 33.51 | RUM |
| 199-D4-73 | 0 | 18.4 | Hanford |
| 199-D4-73 | 18.4 | 34 | Ringold E |
| 199-D4-73 | 34 | 33.68 | RUM |
| 199-D4-74 | 0 | 18.3 | Hanford |
| 199-D4-74 | 18.3 | 34 | Ringold E |
| 199-D4-74 | 34 | 33.81 | RUM |
| 199-D4-75 | 0 | 18.1 | Hanford |
| 199-D4-75 | 18.1 | 34.6 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-75 | 34.6 | 34.05 | RUM |
| 199-D4-76 | 0 | 18.4 | Hanford |
| 199-D4-76 | 18.4 | 34.3 | Ringold E |
| 199-D4-76 | 34.3 | 33.88 | RUM |
| 199-D4-77 | 0 | 18.4 | Hanford |
| 199-D4-77 | 18.4 | 33.8 | Ringold E |
| 199-D4-77 | 33.8 | 33.53 | RUM |
| 199-D4-78 | 0 | 18.6 | Hanford |
| 199-D4-78 | 18.6 | 34.1 | Ringold E |
| 199-D4-78 | 34.1 | 34.44 | RUM |
| 199-D4-79 | 0 | 19.2 | Hanford |
| 199-D4-79 | 19.2 | 34.4 | Ringold E |
| 199-D4-79 | 34.4 | 35.08 | RUM |
| 199-D4-8 | 0 | 16.9 | Hanford |
| 199-D4-8 | 16.9 | 29.3 | Ringold E |
| 199-D4-8 | 29.3 | 30.18 | RUM |
| 199-D4-80 | 0 | 18.6 | Hanford |
| 199-D4-80 | 18.6 | 34.4 | Ringold E |
| 199-D4-80 | 34.4 | 34.44 | RUM |
| 199-D4-81 | 0 | 18.7 | Hanford |
| 199-D4-81 | 18.7 | 34.3 | Ringold E |
| 199-D4-81 | 34.3 | 34.38 | RUM |
| 199-D4-82 | 0 | 19.8 | Hanford |
| 199-D4-82 | 19.8 | 34.6 | Ringold E |
| 199-D4-82 | 34.6 | 35.05 | RUM |
| 199-D4-83 | 0 | 29.6 | Hanford |
| 199-D4-83 | 29.6 | 29.87 | RUM |
| 199-D4-84 | 0 | 17.7 | Hanford |
| 199-D4-84 | 17.7 | 30.9 | Ringold E |
| 199-D4-84 | 30.9 | 31.55 | RUM |
| 199-D4-85 | 0 | 33.8 | Hanford |
| 199-D4-85 | 33.8 | 35.05 | RUM |
| 199-D4-86 | 0 | 29.6 | Hanford |
| 199-D4-86 | 29.6 | 33.5 | Ringold E |
| 199-D4-86 | 33.5 | 34.29 | RUM |
| 199-D4-87 | 0 | 29.6 | Hanford |
| 199-D4-87 | 29.6 | 27.29 | RUM |
| 199-D4-89 | 0 | 19.8 | Hanford |
| 199-D4-89 | 19.8 | 29.6 | Ringold E |
| 199-D4-89 | 29.6 | 29.08 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D4-9 | 0 | 17.4 | Hanford |
| 199-D4-9 | 17.4 | 29.4 | Ringold E |
| 199-D4-9 | 29.4 | 29.72 | RUM |
| 199-D4-94 | 0 | 17.4 | Hanford |
| 199-D4-94 | 17.4 | 30 | Ringold E |
| 199-D4-94 | 30 | 31.3 | RUM |
| 199-D4-95 | 0 | 20.4 | Hanford |
| 199-D4-95 | 20.4 | 35.2 | Ringold E |
| 199-D4-95 | 35.2 | 37 | RUM |
| 199-D4-96 | 0 | 18 | Hanford |
| 199-D4-96 | 18 | 30.5 | Ringold E |
| 199-D4-96 | 30.5 | 32.46 | RUM |
| 199-D4-97 | 0 | 18.3 | Hanford |
| 199-D4-97 | 18.3 | 31.9 | Ringold E |
| 199-D4-97 | 31.9 | 33.53 | RUM |
| 199-D4-98 | 0 | 18 | Hanford |
| 199-D4-98 | 18 | 31.3 | Ringold E |
| 199-D4-98 | 31.3 | 33.83 | RUM |
| 199-D4-99 | 0 | 18.6 | Hanford |
| 199-D4-99 | 18.6 | 33.4 | Ringold E |
| 199-D4-99 | 33.4 | 35.42 | RUM |
| 199-D5-101 | 0 | 32.9 | Hanford |
| 199-D5-101 | 32.9 | 34.84 | RUM |
| 199-D5-102 | 0 | 14.8 | Hanford |
| 199-D5-102 | 14.8 | 32.9 | Ringold E |
| 199-D5-102 | 32.9 | 34.59 | RUM |
| 199-D5-103 | 0 | 18.3 | Hanford |
| 199-D5-103 | 18.3 | 33.7 | Ringold E |
| 199-D5-103 | 33.7 | 35.66 | RUM |
| 199-D5-104 | 0 | 33.6 | Hanford |
| 199-D5-104 | 33.6 | 35.36 | RUM |
| 199-D5-106 | 0 | 15.2 | Hanford |
| 199-D5-106 | 15.2 | 32.7 | Ringold E |
| 199-D5-107 | 0 | 30.8 | Hanford |
| 199-D5-107 | 30.8 | 31.7 | RUM |
| 199-D5-108 | 0 | 22.9 | Hanford |
| 199-D5-108 | 22.9 | 31.4 | Ringold E |
| 199-D5-108 | 31.4 | 32.31 | RUM |
| 199-D5-109 | 0 | 22.3 | Hanford |
| 199-D5-109 | 22.3 | 31.7 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D5-109 | 31.7 | 31.73 | RUM |
| 199-D5-110 | 0 | 20.7 | Hanford |
| 199-D5-110 | 20.7 | 30.6 | Ringold E |
| 199-D5-110 | 30.6 | 31.24 | RUM |
| 199-D5-111 | 0 | 21.3 | Hanford |
| 199-D5-111 | 21.3 | 30.5 | Ringold E |
| 199-D5-111 | 30.5 | 31 | RUM |
| 199-D5-112 | 0 | 20.7 | Hanford |
| 199-D5-112 | 20.7 | 28.6 | Ringold E |
| 199-D5-113 | 0 | 20.7 | Hanford |
| 199-D5-113 | 20.7 | 30.6 | Ringold E |
| 199-D5-113 | 30.6 | 31.09 | RUM |
| 199-D5-114 | 0 | 22.3 | Hanford |
| 199-D5-114 | 22.3 | 31.8 | Ringold E |
| 199-D5-114 | 31.8 | 31.79 | RUM |
| 199-D5-115 | 0 | 22.3 | Hanford |
| 199-D5-115 | 22.3 | 31.7 | Ringold E |
| 199-D5-115 | 31.7 | 32 | RUM |
| 199-D5-116 | 0 | 22.6 | Hanford |
| 199-D5-116 | 22.6 | 31.7 | Ringold E |
| 199-D5-116 | 31.7 | 31.85 | RUM |
| 199-D5-117 | 0 | 22.4 | Hanford |
| 199-D5-117 | 22.4 | 27.9 | Ringold E |
| 199-D5-118 | 0 | 22.4 | Hanford |
| 199-D5-118 | 22.4 | 31.7 | Ringold E |
| 199-D5-118 | 31.7 | 31.85 | RUM |
| 199-D5-119 | 0 | 22.6 | Hanford |
| 199-D5-119 | 22.6 | 33.5 | Ringold E |
| 199-D5-119 | 33.5 | 34.63 | RUM |
| 199-D5-12 | 0 | 14.6 | Hanford |
| 199-D5-12 | 14.6 | 27.1 | Ringold E |
| 199-D5-12 | 27.1 | 27.74 | RUM |
| 199-D5-120 | 0 | 16.2 | Hanford |
| 199-D5-120 | 16.2 | 32.9 | Ringold E |
| 199-D5-120 | 32.9 | 34.26 | RUM |
| 199-D5-121 | 0 | 19.2 | Hanford |
| 199-D5-121 | 19.2 | 32.6 | Ringold E |
| 199-D5-121 | 32.6 | 34.08 | RUM |
| 199-D5-122 | 0 | 22.6 | Hanford |
| 199-D5-122 | 22.6 | 32.8 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D5-122 | 32.8 | 34.23 | RUM |
| 199-D5-123 | 0 | 36.6 | Hanford |
| 199-D5-125 | 0 | 22.9 | Hanford |
| 199-D5-125 | 22.9 | 32.6 | Ringold E |
| 199-D5-125 | 32.6 | 34.08 | RUM |
| 199-D5-126 | 0 | 33.5 | Hanford |
| 199-D5-127 | 0 | 19.5 | Hanford |
| 199-D5-127 | 19.5 | 32.3 | Ringold E |
| 199-D5-127 | 32.3 | 33.22 | RUM |
| 199-D5-128 | 0 | 18.9 | Hanford |
| 199-D5-128 | 18.9 | 30.2 | Ringold E |
| 199-D5-128 | 30.2 | 32.49 | RUM |
| 199-D5-129 | 0 | 18.3 | Hanford |
| 199-D5-129 | 18.3 | 32.2 | Ringold E |
| 199-D5-129 | 32.2 | 34.59 | RUM |
| 199-D5-130 | 0 | 14.6 | Hanford |
| 199-D5-130 | 14.6 | 29 | Ringold E |
| 199-D5-130 | 29 | 30.91 | RUM |
| 199-D5-131 | 0 | 16.8 | Hanford |
| 199-D5-131 | 16.8 | 33.2 | Ringold E |
| 199-D5-131 | 33.2 | 35.48 | RUM |
| 199-D5-132 | 0 | 15.5 | Hanford |
| 199-D5-132 | 15.5 | 32.3 | Ringold E |
| 199-D5-132 | 32.3 | 34.14 | RUM |
| 199-D5-133 | 0 | 16.2 | Hanford |
| 199-D5-133 | 16.2 | 31.7 | Ringold E |
| 199-D5-133 | 31.7 | 34.14 | RUM |
| 199-D5-134 | 0 | 16.2 | Hanford |
| 199-D5-134 | 16.2 | 33.1 | Ringold E |
| 199-D5-134 | 33.1 | 82.3 | RUM |
| 199-D5-140 | 0 | 14.6 | Hanford |
| 199-D5-140 | 14.6 | 32.9 | Ringold E |
| 199-D5-140 | 32.9 | 34.41 | RUM |
| 199-D5-141 | 0 | 18 | Hanford |
| 199-D5-141 | 18 | 34.1 | Ringold E |
| 199-D5-141 | 34.1 | 96.53 | RUM |
| 199-D5-142 | 0 | 13.7 | Hanford |
| 199-D5-142 | 13.7 | 27.4 | Ringold E |
| 199-D5-143 | 0 | 17.4 | Hanford |
| 199-D5-143 | 17.4 | 32 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D5-143 | 32 | 35.97 | RUM |
| 199-D5-144 | 0 | 22.8 | Hanford |
| 199-D5-144 | 22.8 | 32.98 | Ringold E |
| 199-D5-144 | 32.98 | 35.23 | |
| 199-D5-145 | 0 | 16.72 | Hanford |
| 199-D5-145 | 16.72 | 34.5 | Ringold E |
| 199-D5-145 | 34.5 | 36.1152 | RUM |
| 199-D5-146 | 0 | 22.19 | Hanford |
| 199-D5-146 | 22.19 | 33.77 | Ringold E |
| 199-D5-146 | 33.77 | 35.4768 | RUM |
| 199-D5-147 | 0 | 16.87 | Hanford |
| 199-D5-147 | 16.87 | 31.31 | Ringold E |
| 199-D5-147 | 31.31 | 32.9232 | RUM |
| 199-D5-148 | 0 | 16.72 | Hanford |
| 199-D5-148 | 16.72 | 32.53 | Ringold E |
| 199-D5-148 | 32.53 | 35.0512 | RUM |
| 199-D5-15 | 0 | 14 | Hanford |
| 199-D5-15 | 14 | 30.8 | Ringold E |
| 199-D5-15 | 30.8 | 31.03 | RUM |
| 199-D5-153 | 0 | 14.59 | Hanford |
| 199-D5-153 | 14.59 | 31.16 | Ringold E |
| 199-D5-153 | 31.16 | 33.136 | RUM |
| 199-D5-154 | 0 | 15.2 | Hanford |
| 199-D5-154 | 15.2 | 32.07 | Ringold E |
| 199-D5-154 | 32.07 | 34.8688 | RUM |
| 199-D5-17 | 0 | 31.5 | Hanford |
| 199-D5-17 | 31.5 | 35.05 | RUM |
| 199-D5-18 | 0 | 30.2 | Hanford |
| 199-D5-18 | 30.2 | 30.63 | RUM |
| 199-D5-19 | 0 | 15.2 | Hanford |
| 199-D5-19 | 15.2 | 28.8 | Ringold E |
| 199-D5-19 | 28.8 | 28.96 | RUM |
| 199-D5-20 | 0 | 30.8 | Hanford |
| 199-D5-20 | 30.8 | 31.49 | RUM |
| 199-D5-32 | 0 | 32 | Hanford |
| 199-D5-32 | 32 | 32.24 | RUM |
| 199-D5-33 | 0 | 16.8 | Hanford |
| 199-D5-33 | 16.8 | 31.4 | Ringold E |
| 199-D5-33 | 31.4 | 31.75 | RUM |
| 199-D5-34 | 0 | 16.5 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D5-34 | 16.5 | 32 | Ringold E |
| 199-D5-34 | 32 | 32.75 | RUM |
| 199-D5-36 | 0 | 14.3 | Hanford |
| 199-D5-36 | 14.3 | 29.9 | Ringold E |
| 199-D5-36 | 29.9 | 31.39 | RUM |
| 199-D5-37 | 0 | 14 | Hanford |
| 199-D5-37 | 14 | 28.8 | Ringold E |
| 199-D5-37 | 28.8 | 30.33 | RUM |
| 199-D5-38 | 0 | 16.5 | Hanford |
| 199-D5-38 | 16.5 | 32 | Ringold E |
| 199-D5-38 | 32 | 33.53 | RUM |
| 199-D5-39 | 0 | 15.2 | Hanford |
| 199-D5-39 | 15.2 | 31.4 | Ringold E |
| 199-D5-39 | 31.4 | 32.92 | RUM |
| 199-D5-40 | 0 | 22.6 | Hanford |
| 199-D5-40 | 22.6 | 32.3 | Ringold E |
| 199-D5-40 | 32.3 | 33.38 | RUM |
| 199-D5-41 | 0 | 15.2 | Hanford |
| 199-D5-41 | 15.2 | 31.9 | Ringold E |
| 199-D5-41 | 31.9 | 33.38 | RUM |
| 199-D5-42 | 0 | 14.6 | Hanford |
| 199-D5-42 | 14.6 | 32.3 | Ringold E |
| 199-D5-42 | 32.3 | 33.38 | RUM |
| 199-D5-43 | 0 | 20.1 | Hanford |
| 199-D5-43 | 20.1 | 32.6 | Ringold E |
| 199-D5-43 | 32.6 | 34.29 | RUM |
| 199-D5-44 | 0 | 14.5 | Hanford |
| 199-D5-44 | 14.5 | 29 | Ringold E |
| 199-D5-44 | 29 | 30.48 | RUM |
| 199-D5-92 | 0 | 16.8 | Hanford |
| 199-D5-92 | 16.8 | 29.9 | Ringold E |
| 199-D5-92 | 29.9 | 30.21 | RUM |
| 199-D5-93 | 0 | 33.2 | Hanford |
| 199-D5-93 | 33.2 | 33.22 | RUM |
| 199-D5-97 | 0 | 33.2 | Hanford |
| 199-D5-97 | 33.2 | 34.59 | RUM |
| 199-D5-98 | 0 | 17.4 | Hanford |
| 199-D5-98 | 17.4 | 32.9 | Ringold E |
| 199-D5-98 | 32.9 | 34.56 | RUM |
| 199-D5-99 | 0 | 33.4 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D5-99 | 33.4 | 35.05 | RUM |
| 199-D6-1 | 0 | 18.9 | Hanford |
| 199-D6-1 | 18.9 | 30.8 | Ringold E |
| 199-D6-1 | 30.8 | 32.61 | RUM |
| 199-D6-2 | 0 | 13.4 | Hanford |
| 199-D6-2 | 13.4 | 23.5 | Ringold E |
| 199-D6-2 | 23.5 | 24.51 | RUM |
| 199-D6-3 | 0 | 18.3 | Hanford |
| 199-D6-3 | 18.3 | 31 | Ringold E |
| 199-D6-3 | 31 | 33.68 | RUM |
| 199-D7-3 | 0 | 25.6 | Hanford |
| 199-D7-3 | 25.6 | 27.22 | RUM |
| 199-D7-4 | 0 | 13.4 | Hanford |
| 199-D7-4 | 13.4 | 22.6 | Ringold E |
| 199-D7-4 | 22.6 | 23.62 | RUM |
| 199-D7-5 | 0 | 16.5 | Hanford |
| 199-D7-5 | 16.5 | 19.35 | RUM |
| 199-D7-6 | 0 | 9.1 | Hanford |
| 199-D7-6 | 9.1 | 11.1 | Ringold E |
| 199-D7-6 | 11.1 | 13.35 | RUM |
| 199-D8-4 | 0 | 31.5 | Hanford |
| 199-D8-4 | 31.5 | 31.52 | RUM |
| 199-D8-5 | 0 | 13.5 | Hanford |
| 199-D8-5 | 13.5 | 25.3 | Ringold E |
| 199-D8-5 | 25.3 | 26.58 | RUM |
| 199-D8-53 | 0 | 12.2 | Hanford |
| 199-D8-53 | 12.2 | 21 | Ringold E |
| 199-D8-53 | 21 | 21.17 | RUM |
| 199-D8-54A | 0 | 19.8 | Hanford |
| 199-D8-54A | 19.8 | 23.2 | Ringold E |
| 199-D8-54A | 23.2 | 23.77 | RUM |
| 199-D8-54B | 0 | 10.7 | Hanford |
| 199-D8-54B | 10.7 | 23.2 | Ringold E |
| 199-D8-54B | 23.2 | 43.89 | RUM |
| 199-D8-55 | 0 | 10.7 | Hanford |
| 199-D8-55 | 10.7 | 21 | Ringold E |
| 199-D8-55 | 21 | 22.56 | RUM |
| 199-D8-68 | 0 | 22.9 | Hanford |
| 199-D8-68 | 22.9 | 24.38 | RUM |
| 199-D8-69 | 0 | 17.5 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-D8-69 | 17.5 | 18.9 | RUM |
| 199-D8-70 | 0 | 21.6 | Hanford |
| 199-D8-70 | 21.6 | 22.56 | RUM |
| 199-D8-71 | 0 | 23.5 | Hanford |
| 199-D8-71 | 23.5 | 24.69 | RUM |
| 199-D8-72 | 0 | 15.7 | Hanford |
| 199-D8-72 | 15.7 | 28.5 | Ringold E |
| 199-D8-72 | 28.5 | 28.96 | RUM |
| 199-D8-73 | 0 | 16 | Hanford |
| 199-D8-73 | 16 | 27.3 | Ringold E |
| 199-D8-73 | 27.3 | 28.23 | RUM |
| 199-D8-88 | 0 | 15.8 | Hanford |
| 199-D8-88 | 15.8 | 29.3 | Ringold E |
| 199-D8-88 | 29.3 | 29.83 | RUM |
| 199-D8-89 | 0 | 15.8 | Hanford |
| 199-D8-89 | 15.8 | 23.8 | Ringold E |
| 199-D8-89 | 23.8 | 25.85 | RUM |
| 199-D8-90 | 0 | 15.5 | Hanford |
| 199-D8-90 | 15.5 | 17.19 | RUM |
| 199-D8-91 | 0 | 12.8 | Hanford |
| 199-D8-91 | 12.8 | 14.17 | RUM |
| 199-D8-93 | 0 | 4.9 | Hanford |
| 199-D8-93 | 4.9 | 6.4 | RUM |
| 199-D8-94 | 0 | 8 | Hanford |
| 199-D8-94 | 8 | 9.54 | RUM |
| 199-D8-95 | 0 | 17.7 | Hanford |
| 199-D8-95 | 17.7 | 29.6 | Ringold E |
| 199-D8-95 | 29.6 | 31.82 | RUM |
| 199-D8-96 | 0 | 19.8 | Hanford |
| 199-D8-96 | 19.8 | 29.6 | Ringold E |
| 199-D8-96 | 29.6 | 30.94 | RUM |
| 199-D8-97 | 0 | 28.2 | Hanford |
| 199-D8-97 | 28.2 | 31.79 | RUM |
| 199-D8-98 | 0 | 25.9 | Hanford |
| 199-D8-98 | 25.9 | 27.86 | RUM |
| 199-D8-99 | 0 | 17.4 | Hanford |
| 199-D8-99 | 17.4 | 25.6 | Ringold E |
| 199-D8-99 | 25.6 | 27.1 | RUM |
| 199-F1-2 | 0 | 10.7 | Hanford |
| 199-F1-2 | 10.7 | 11.43 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-F2-3 | 0 | 14.2 | Hanford |
| 199-F2-3 | 14.2 | 14.63 | RUM |
| 199-F5-1 | 0 | 18.9 | Hanford |
| 199-F5-1 | 18.9 | 20.42 | RUM |
| 199-F5-2 | 0 | 23.2 | Hanford |
| 199-F5-2 | 23.2 | 30.48 | RUM |
| 199-F5-3 | 0 | 19.8 | Hanford |
| 199-F5-3 | 19.8 | 27.43 | RUM |
| 199-F5-4 | 0 | 15.2 | Hanford |
| 199-F5-4 | 15.2 | 35.05 | RUM |
| 199-F5-43A | 0 | 14.5 | Hanford |
| 199-F5-43A | 14.5 | 15.15 | RUM |
| 199-F5-43B | 0 | 13.1 | Hanford |
| 199-F5-43B | 13.1 | 57.91 | RUM |
| 199-F5-45 | 0 | 15.7 | Hanford |
| 199-F5-45 | 15.7 | 16.03 | RUM |
| 199-F5-46 | 0 | 17.2 | Hanford |
| 199-F5-46 | 17.2 | 17.37 | RUM |
| 199-F5-47 | 0 | 19.1 | Hanford |
| 199-F5-47 | 19.1 | 19.35 | RUM |
| 199-F5-48 | 0 | 5.5 | Hanford |
| 199-F5-48 | 5.5 | 15.8 | Ringold E |
| 199-F5-48 | 15.8 | 16.76 | RUM |
| 199-F5-5 | 0 | 21.9 | Hanford |
| 199-F5-5 | 21.9 | 30.48 | RUM |
| 199-F5-52 | 0 | 20.1 | Hanford |
| 199-F5-52 | 20.1 | 22.49 | RUM |
| 199-F5-53 | 0 | 16.6 | Hanford |
| 199-F5-53 | 16.6 | 35.36 | RUM |
| 199-F5-54 | 0 | 21.3 | Hanford |
| 199-F5-54 | 21.3 | 23.59 | RUM |
| 199-F5-6 | 0 | 21 | Hanford |
| 199-F5-6 | 21 | 58.52 | RUM |
| 199-F6-1 | 0 | 15.2 | Hanford |
| 199-F6-1 | 15.2 | 16.15 | RUM |
| 199-F7-1 | 0 | 9.1 | Hanford |
| 199-F7-1 | 9.1 | 45.72 | RUM |
| 199-F7-3 | 0 | 5.2 | Hanford |
| 199-F7-3 | 5.2 | 8.8 | Ringold E |
| 199-F7-3 | 8.8 | 10.06 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-F8-1 | 0 | 13.7 | Hanford |
| 199-F8-1 | 13.7 | 17.37 | RUM |
| 199-F8-2 | 0 | 16.5 | Hanford |
| 199-F8-2 | 16.5 | 16.76 | RUM |
| 199-F8-3 | 0 | 9.1 | Hanford |
| 199-F8-3 | 9.1 | 10.36 | RUM |
| 199-F8-4 | 0 | 14.2 | Hanford |
| 199-F8-4 | 14.2 | 14.48 | RUM |
| 199-F8-7 | 0 | 9.8 | Hanford |
| 199-F8-7 | 0 | 9.8 | Hanford |
| 199-F8-7 | 9.8 | 10.67 | RUM |
| 199-H1-1 | 0 | 10.3 | Hanford |
| 199-H1-1 | 10.3 | 12.53 | RUM |
| 199-H1-2 | 0 | 13.9 | Hanford |
| 199-H1-2 | 13.9 | 16.61 | RUM |
| 199-H1-20 | 11.6 | 17.59 | RUM |
| 199-H1-21 | 0 | 4.9 | Hanford |
| 199-H1-21 | 4.9 | 10.1 | Ringold E |
| 199-H1-21 | 10.1 | 12.13 | RUM |
| 199-H1-25 | 0 | 9.8 | Hanford |
| 199-H1-25 | 9.8 | 12.04 | RUM |
| 199-H1-27 | 0 | 10.7 | Hanford |
| 199-H1-27 | 10.7 | 12.56 | RUM |
| 199-H1-3 | 0 | 12.8 | Hanford |
| 199-H1-3 | 12.8 | 14.78 | RUM |
| 199-H1-32 | 0 | 13.1 | Hanford |
| 199-H1-32 | 13.1 | 15.67 | RUM |
| 199-H1-33 | 0 | 11.9 | Hanford |
| 199-H1-33 | 11.9 | 13.72 | RUM |
| 199-H1-34 | 0 | 11.6 | Hanford |
| 199-H1-34 | 11.6 | 13.69 | RUM |
| 199-H1-35 | 0 | 12.5 | Hanford |
| 199-H1-35 | 12.5 | 14.63 | RUM |
| 199-H1-36 | 0 | 11.9 | Hanford |
| 199-H1-36 | 11.9 | 14.17 | RUM |
| 199-H1-37 | 0 | 14.1 | Hanford |
| 199-H1-37 | 14.1 | 14.14 | RUM |
| 199-H1-38 | 0 | 12.8 | Hanford |
| 199-H1-38 | 12.8 | 14.48 | RUM |
| 199-H1-39 | 0 | 11.6 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-H1-39 | 11.6 | 13.41 | RUM |
| 199-H1-4 | 0 | 12.5 | Hanford |
| 199-H1-4 | 12.5 | 14.78 | RUM |
| 199-H1-40 | 0 | 12 | Hanford |
| 199-H1-40 | 12 | 13.53 | RUM |
| 199-H1-42 | 0 | 12.5 | Hanford |
| 199-H1-42 | 12.5 | 13.41 | RUM |
| 199-H1-43 | 0 | 13.1 | Hanford |
| 199-H1-43 | 13.1 | 14.94 | RUM |
| 199-H1-45 | 0 | 17.1 | Hanford |
| 199-H1-45 | 0 | 17.1 | Hanford |
| 199-H1-45 | 17.1 | 18.62 | RUM |
| 199-H1-5 | 0 | 4.6 | Hanford |
| 199-H1-5 | 4.6 | 13 | Ringold E |
| 199-H1-5 | 13 | 14.17 | RUM |
| 199-H1-6 | 0 | 11.1 | Hanford |
| 199-H1-6 | 11.1 | 14.33 | RUM |
| 199-H1-7 | 0 | 9.6 | Hanford |
| 199-H1-7 | 9.6 | 11.28 | RUM |
| 199-H2-1 | 0 | 10.7 | Hanford |
| 199-H2-1 | 10.7 | 57.61 | RUM |
| 199-H3-1 | 0 | 17.1 | Hanford |
| 199-H3-1 | 17.1 | 22.86 | RUM |
| 199-H3-10 | 0 | 16.8 | Hanford |
| 199-H3-10 | 16.8 | 70.35 | RUM |
| 199-H3-25 | 0 | 17.1 | Hanford |
| 199-H3-25 | 17.1 | 18.68 | RUM |
| 199-H3-27 | 0 | 17.4 | Hanford |
| 199-H3-27 | 17.4 | 18.87 | RUM |
| 199-H3-2A | 0 | 16.5 | Hanford |
| 199-H3-2A | 16.5 | 17.07 | RUM |
| 199-H3-2B | 0 | 17.4 | Hanford |
| 199-H3-2B | 17.4 | 17.68 | RUM |
| 199-H3-2C | 0 | 16.8 | Hanford |
| 199-H3-2C | 16.8 | 47.24 | RUM |
| 199-H3-3 | 0 | 14.9 | Hanford |
| 199-H3-3 | 14.9 | 16.34 | RUM |
| 199-H3-4 | 0 | 13.7 | Hanford |
| 199-H3-4 | 13.7 | 14.94 | RUM |
| 199-H3-5 | 0 | 13.9 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-H3-5 | 13.9 | 15.21 | RUM |
| 199-H3-6 | 0 | 16.6 | Hanford |
| 199-H3-6 | 16.6 | 18.78 | RUM |
| 199-H3-7 | 0 | 16 | Hanford |
| 199-H3-7 | 16 | 17.98 | RUM |
| 199-H3-9 | 0 | 15.2 | Hanford |
| 199-H3-9 | 15.2 | 66.48 | RUM |
| 199-H4-1 | 0 | 16.8 | Hanford |
| 199-H4-1 | 16.8 | 22.86 | RUM |
| 199-H4-10 | 0 | 11.6 | Hanford |
| 199-H4-10 | 11.6 | 11.58 | RUM |
| 199-H4-11 | 0 | 18 | Hanford |
| 199-H4-11 | 18 | 16.15 | RUM |
| 199-H4-12A | 0 | 15.5 | Hanford |
| 199-H4-12A | 15.5 | 14.63 | RUM |
| 199-H4-12B | 0 | 15.4 | Hanford |
| 199-H4-12B | 15.4 | 15.54 | RUM |
| 199-H4-12C | 0 | 15.2 | Hanford |
| 199-H4-12C | 15.2 | 67.06 | RUM |
| 199-H4-13 | 0 | 18 | Hanford |
| 199-H4-13 | 18 | 18.59 | RUM |
| 199-H4-14 | 0 | 18 | Hanford |
| 199-H4-14 | 18 | 16.15 | RUM |
| 199-H4-15A | 0 | 13.4 | Hanford |
| 199-H4-15A | 13.4 | 14.02 | RUM |
| 199-H4-15B | 0 | 13.1 | Hanford |
| 199-H4-15B | 13.1 | 13.41 | RUM |
| 199-H4-15C | 0 | 14 | Hanford |
| 199-H4-15C | 14 | 100.58 | RUM |
| 199-H4-16 | 0 | 18 | Hanford |
| 199-H4-16 | 18 | 18.59 | RUM |
| 199-H4-17 | 0 | 13.7 | Hanford |
| 199-H4-18 | 0 | 15.2 | Hanford |
| 199-H4-18 | 15.2 | 15.54 | RUM |
| 199-H4-2 | 0 | 19.8 | Hanford |
| 199-H4-2 | 19.8 | 117.65 | RUM |
| 199-H4-3 | 0 | 15.2 | Hanford |
| 199-H4-3 | 15.2 | 17.6 | Ringold E |
| 199-H4-46 | 0 | 18.6 | Hanford |
| 199-H4-46 | 18.6 | 18.75 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-H4-48 | 0 | 12.2 | Hanford |
| 199-H4-48 | 12.2 | 18.9 | Ringold E |
| 199-H4-49 | 0 | 16.8 | Hanford |
| 199-H4-49 | 16.8 | 18.29 | RUM |
| 199-H4-5 | 0 | 14.6 | Hanford |
| 199-H4-5 | 14.6 | 18.29 | RUM |
| 199-H4-63 | 0 | 17.4 | Hanford |
| 199-H4-63 | 17.4 | 19.48 | RUM |
| 199-H4-64 | 0 | 10.7 | Hanford |
| 199-H4-64 | 10.7 | 14.6 | Ringold E |
| 199-H4-65 | 0 | 15.2 | Hanford |
| 199-H4-65 | 15.2 | 16.15 | RUM |
| 199-H4-69 | 0 | 18.3 | Hanford |
| 199-H4-69 | 18.3 | 19.46 | RUM |
| 199-H4-7 | 0 | 16.5 | Hanford |
| 199-H4-7 | 16.5 | 16.76 | RUM |
| 199-H4-70 | 0 | 17.1 | Hanford |
| 199-H4-70 | 17.1 | 18.71 | RUM |
| 199-H4-71 | 0 | 18.9 | Hanford |
| 199-H4-71 | 18.9 | 21.64 | RUM |
| 199-H4-72 | 0 | 17.1 | Hanford |
| 199-H4-72 | 17.1 | 18.67 | RUM |
| 199-H4-73 | 0 | 19.7 | Hanford |
| 199-H4-73 | 19.7 | 21.64 | RUM |
| 199-H4-74 | 0 | 9.1 | Hanford |
| 199-H4-74 | 9.1 | 11.6 | Ringold E |
| 199-H4-74 | 11.6 | 14.02 | RUM |
| 199-H4-75 | 0 | 12.2 | Hanford |
| 199-H4-75 | 12.2 | 15.2 | Ringold E |
| 199-H4-75 | 15.2 | 18.04 | RUM |
| 199-H4-76 | 0 | 14.5 | Hanford |
| 199-H4-76 | 14.5 | 17.19 | RUM |
| 199-H4-77 | 0 | 13 | Hanford |
| 199-H4-77 | 13 | 15.54 | RUM |
| 199-H4-78 | 0 | 2.6 | Hanford |
| 199-H4-78 | 2.6 | 18.1 | Ringold E |
| 199-H4-78 | 18.1 | 19.54 | RUM |
| 199-H4-79 | 0 | 14.6 | Hanford |
| 199-H4-79 | 14.6 | 18.1 | Ringold E |
| 199-H4-79 | 18.1 | 19.81 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-H4-8 | 0 | 14.6 | Hanford |
| 199-H4-8 | 0 | 14.6 | Hanford |
| 199-H4-8 | 14.6 | 16.76 | RUM |
| 199-H4-80 | 0 | 12.2 | Hanford |
| 199-H4-80 | 12.2 | 20.4 | Ringold E |
| 199-H4-80 | 20.4 | 22.65 | RUM |
| 199-H4-81 | 0 | 11.9 | Hanford |
| 199-H4-81 | 11.9 | 13.53 | RUM |
| 199-H4-82 | 0 | 16.2 | Hanford |
| 199-H4-82 | 16.2 | 18.01 | RUM |
| 199-H4-85 | 0 | 10.64 | Hanford |
| 199-H4-85 | 10.64 | 14.44 | Ringold E |
| 199-H4-85 | 14.44 | 15.96 | RUM |
| 199-H4-86 | 0 | 12.92 | Hanford |
| 199-H4-86 | 12.92 | 18.39 | Ringold E |
| 199-H4-86 | 18.39 | 20.0944 | RUM |
| 199-H4-9 | 0 | 14.2 | Hanford |
| 199-H4-9 | 14.2 | 15.54 | RUM |
| 199-H4-90 | 0 | 19.15 | Hanford |
| 199-H4-90 | 19.15 | 29.488 | RUM |
| 199-H4-91 | 0 | 17.18 | Hanford |
| 199-H4-91 | 18.18 | 28.728 | RUM |
| 199-H5-1A | 0 | 15.8 | Hanford |
| 199-H5-1A | 15.8 | 17.37 | RUM |
| 199-H6-2 | 0 | 15.2 | Hanford |
| 199-H6-2 | 15.2 | 18.5 | RUM |
| 199-H6-3 | 0 | 18.3 | Hanford |
| 199-H6-3 | 18.3 | 20.54 | RUM |
| 199-H6-4 | 0 | 16.9 | Hanford |
| 199-H6-4 | 16.9 | 19.2 | RUM |
| 199-K-10 | 0 | 50 | Hanford |
| 199-K-10 | 50 | 52.12 | RUM |
| 199-K-106A | 0 | 6.4 | Hanford |
| 199-K-106A | 6.4 | 49.5 | Ringold E |
| 199-K-106A | 49.5 | 57.91 | RUM |
| 199-K-107A | 0 | 5.8 | Hanford |
| 199-K-107A | 5.8 | 29 | Ringold E |
| 199-K-108A | 0 | 9.1 | Hanford |
| 199-K-108A | 9.1 | 28.5 | Ringold E |
| 199-K-109A | 0 | 11.7 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-109A | 11.7 | 47.2 | Ringold E |
| 199-K-109A | 47.2 | 50.57 | RUM |
| 199-K-11 | 0 | 13.7 | Hanford |
| 199-K-11 | 13.7 | 50.3 | Ringold E |
| 199-K-11 | 50.3 | 51.82 | RUM |
| 199-K-110A | 0 | 12.2 | Hanford |
| 199-K-110A | 12.2 | 28.4 | Ringold E |
| 199-K-111A | 0 | 7.9 | Hanford |
| 199-K-111A | 7.9 | 47.3 | Ringold E |
| 199-K-111A | 47.3 | 56.39 | RUM |
| 199-K-112A | 0 | 3.7 | Hanford |
| 199-K-112A | 3.7 | 14.6 | Ringold E |
| 199-K-112A | 14.6 | 16.46 | RUM |
| 199-K-113A | 0 | 6.7 | Hanford |
| 199-K-113A | 6.7 | 12.5 | Ringold E |
| 199-K-113A | 12.5 | 14.63 | RUM |
| 199-K-114A | 0 | 7.3 | Hanford |
| 199-K-114A | 7.3 | 12.5 | Ringold E |
| 199-K-114A | 12.5 | 15.54 | RUM |
| 199-K-115A | 0 | 4.9 | Hanford |
| 199-K-115A | 4.9 | 16.5 | Ringold E |
| 199-K-115A | 16.5 | 18.59 | RUM |
| 199-K-116A | 0 | 4.3 | Hanford |
| 199-K-116A | 4.3 | 26.5 | Ringold E |
| 199-K-116A | 26.5 | 28.22 | RUM |
| 199-K-117A | 0 | 4.3 | Hanford |
| 199-K-117A | 4.3 | 20.7 | Ringold E |
| 199-K-117A | 20.7 | 22.25 | RUM |
| 199-K-118A | 0 | 5.8 | Hanford |
| 199-K-118A | 5.8 | 23 | Ringold E |
| 199-K-118A | 23 | 24.69 | RUM |
| 199-K-119A | 0 | 4.9 | Hanford |
| 199-K-119A | 4.9 | 27.1 | Ringold E |
| 199-K-119A | 27.1 | 28.04 | RUM |
| 199-K-120A | 0 | 0.9 | Hanford |
| 199-K-120A | 0.9 | 29.3 | Ringold E |
| 199-K-120A | 29.3 | 30.78 | RUM |
| 199-K-121A | 0 | 16.5 | Hanford |
| 199-K-121A | 16.5 | 29.3 | Ringold E |
| 199-K-121A | 29.3 | 30.07 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-122A | 0 | 11.9 | Hanford |
| 199-K-122A | 11.9 | 30.5 | Ringold E |
| 199-K-122A | 30.5 | 30.78 | RUM |
| 199-K-123A | 0 | 11.6 | Hanford |
| 199-K-123A | 11.6 | 29.9 | Ringold E |
| 199-K-124A | 0 | 19.8 | Hanford |
| 199-K-124A | 19.8 | 30.8 | Ringold E |
| 199-K-125A | 0 | 8.8 | Hanford |
| 199-K-125A | 8.8 | 22.9 | Ringold E |
| 199-K-125A | 22.9 | 23.77 | RUM |
| 199-K-126 | 0 | 15.8 | Hanford |
| 199-K-126 | 15.8 | 27.4 | Ringold E |
| 199-K-127 | 0 | 4.6 | Hanford |
| 199-K-127 | 4.6 | 31.4 | Ringold E |
| 199-K-128 | 0 | 13.7 | Hanford |
| 199-K-128 | 13.7 | 29.8 | Ringold E |
| 199-K-128 | 29.8 | 28.47 | RUM |
| 199-K-129 | 0 | 7.3 | Hanford |
| 199-K-129 | 7.3 | 14.6 | Ringold E |
| 199-K-129 | 14.6 | 15.09 | RUM |
| 199-K-130 | 0 | 8.5 | Hanford |
| 199-K-130 | 8.5 | 24 | Ringold E |
| 199-K-131 | 0 | 9.1 | Hanford |
| 199-K-131 | 9.1 | 29.9 | Ringold E |
| 199-K-132 | 0 | 8.2 | Hanford |
| 199-K-132 | 8.2 | 26.8 | Ringold E |
| 199-K-133 | 0 | 15.7 | Hanford |
| 199-K-133 | 15.7 | 30.2 | Ringold E |
| 199-K-134 | 0 | 18.3 | Hanford |
| 199-K-134 | 18.3 | 30.2 | Ringold E |
| 199-K-135 | 0 | 15.2 | Hanford |
| 199-K-135 | 15.2 | 34.6 | Ringold E |
| 199-K-135 | 34.6 | 34.56 | RUM |
| 199-K-136 | 0 | 15.2 | Hanford |
| 199-K-136 | 15.2 | 31.7 | Ringold E |
| 199-K-137 | 0 | 7 | Hanford |
| 199-K-137 | 7 | 32.9 | Ringold E |
| 199-K-138 | 0 | 9.1 | Hanford |
| 199-K-138 | 9.1 | 29.9 | Ringold E |
| 199-K-139 | 0 | 13.1 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-139 | 13.1 | 33 | Ringold E |
| 199-K-140 | 0 | 12.2 | Hanford |
| 199-K-140 | 12.2 | 32.9 | Ringold E |
| 199-K-141 | 0 | 12.2 | Hanford |
| 199-K-141 | 12.2 | 34.7 | Ringold E |
| 199-K-142 | 0 | 11.6 | Hanford |
| 199-K-142 | 11.6 | 35.3 | Ringold E |
| 199-K-143 | 0 | 15.2 | Hanford |
| 199-K-143 | 15.2 | 29 | Ringold E |
| 199-K-144 | 0 | 3.4 | Hanford |
| 199-K-144 | 3.4 | 29.6 | Ringold E |
| 199-K-144 | 29.6 | 32.64 | RUM |
| 199-K-145 | 0 | 1.2 | Hanford |
| 199-K-145 | 1.2 | 36 | Ringold E |
| 199-K-145 | 36 | 37.7 | RUM |
| 199-K-146 | 0 | 5.2 | Hanford |
| 199-K-146 | 5.2 | 16.2 | Ringold E |
| 199-K-146 | 16.2 | 17.65 | RUM |
| 199-K-147 | 0 | 8.2 | Hanford |
| 199-K-147 | 8.2 | 24.1 | Ringold E |
| 199-K-147 | 24.1 | 25.63 | RUM |
| 199-K-148 | 0 | 15.2 | Hanford |
| 199-K-148 | 15.2 | 30.5 | Ringold E |
| 199-K-148 | 30.5 | 33.16 | RUM |
| 199-K-149 | 0 | 32.3 | Hanford |
| 199-K-149 | 0 | 32.3 | Hanford |
| 199-K-150 | 0 | 16.5 | Hanford |
| 199-K-150 | 16.5 | 34.1 | Ringold E |
| 199-K-150 | 34.1 | 35.81 | RUM |
| 199-K-151 | 0 | 16.8 | Hanford |
| 199-K-151 | 16.8 | 35.1 | Ringold E |
| 199-K-151 | 35.1 | 36.21 | RUM |
| 199-K-152 | 0 | 13.7 | Hanford |
| 199-K-152 | 13.7 | 35.4 | Ringold E |
| 199-K-152 | 35.4 | 36.15 | RUM |
| 199-K-153 | 0 | 12.2 | Hanford |
| 199-K-153 | 12.2 | 30.5 | Ringold E |
| 199-K-153 | 30.5 | 31.88 | RUM |
| 199-K-154 | 0 | 12.2 | Hanford |
| 199-K-154 | 12.2 | 31.1 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-154 | 31.1 | 32.89 | RUM |
| 199-K-156 | 0 | 9.1 | Hanford |
| 199-K-156 | 9.1 | 50.6 | Ringold E |
| 199-K-156 | 50.6 | 52.49 | RUM |
| 199-K-157 | 0 | 9.1 | Hanford |
| 199-K-157 | 9.1 | 42.4 | Ringold E |
| 199-K-157 | 42.4 | 43.68 | RUM |
| 199-K-158 | 0 | 12.5 | Hanford |
| 199-K-158 | 12.5 | 35.2 | Ringold E |
| 199-K-159 | 0 | 18.3 | Hanford |
| 199-K-159 | 18.3 | 33.5 | Ringold E |
| 199-K-159 | 33.5 | 35.66 | RUM |
| 199-K-160 | 0 | 16.8 | Hanford |
| 199-K-160 | 16.8 | 34.4 | Ringold E |
| 199-K-160 | 34.4 | 35.97 | RUM |
| 199-K-161 | 0 | 8.5 | Hanford |
| 199-K-161 | 8.5 | 15.5 | Ringold E |
| 199-K-161 | 15.5 | 17.22 | RUM |
| 199-K-162 | 0 | 3 | Hanford |
| 199-K-162 | 3 | 39 | Ringold E |
| 199-K-162 | 39 | 40.72 | RUM |
| 199-K-163 | 0 | 12.2 | Hanford |
| 199-K-163 | 12.2 | 33.5 | Ringold E |
| 199-K-163 | 33.5 | 34.66 | RUM |
| 199-K-164 | 0 | 11.9 | Hanford |
| 199-K-164 | 11.9 | 34.1 | Ringold E |
| 199-K-164 | 34.1 | 36.27 | RUM |
| 199-K-165 | 0 | 8.8 | Hanford |
| 199-K-165 | 8.8 | 53.6 | Ringold E |
| 199-K-165 | 53.6 | 54.92 | RUM |
| 199-K-166 | 0 | 8.2 | Hanford |
| 199-K-166 | 8.2 | 51.3 | Ringold E |
| 199-K-166 | 51.3 | 52.01 | RUM |
| 199-K-168 | 0 | 13.1 | Hanford |
| 199-K-168 | 13.1 | 48.8 | Ringold E |
| 199-K-168 | 48.8 | 50.84 | RUM |
| 199-K-169 | 0 | 21.3 | Hanford |
| 199-K-169 | 21.3 | 40.2 | Ringold E |
| 199-K-169 | 40.2 | 43.28 | RUM |
| 199-K-170 | 0 | 13.7 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-170 | 13.7 | 45.4 | Ringold E |
| 199-K-170 | 45.4 | 46.02 | RUM |
| 199-K-171 | 0 | 18.3 | Hanford |
| 199-K-171 | 18.3 | 45.1 | Ringold E |
| 199-K-171 | 45.1 | 46.82 | RUM |
| 199-K-172 | 0 | 18.3 | Hanford |
| 199-K-172 | 18.3 | 40.2 | Ringold E |
| 199-K-172 | 40.2 | 42.67 | RUM |
| 199-K-173 | 0 | 10.7 | Hanford |
| 199-K-173 | 10.7 | 53.2 | Ringold E |
| 199-K-173 | 53.2 | 55.17 | RUM |
| 199-K-174 | 0 | 15.2 | Hanford |
| 199-K-174 | 15.2 | 40.4 | Ringold E |
| 199-K-175 | 0 | 18.3 | Hanford |
| 199-K-175 | 18.3 | 45.3 | Ringold E |
| 199-K-178 | 0 | 9.1 | Hanford |
| 199-K-178 | 9.1 | 39.3 | Ringold E |
| 199-K-178 | 39.3 | 40.72 | RUM |
| 199-K-179 | 0 | 12.2 | Hanford |
| 199-K-179 | 12.2 | 43 | Ringold E |
| 199-K-179 | 43 | 44.5 | RUM |
| 199-K-180 | 0 | 19.8 | Hanford |
| 199-K-180 | 19.8 | 46.3 | Ringold E |
| 199-K-180 | 46.3 | 47.09 | RUM |
| 199-K-181 | 0 | 6.1 | Hanford |
| 199-K-181 | 6.1 | 39.9 | Ringold E |
| 199-K-181 | 39.9 | 41.45 | RUM |
| 199-K-182 | 0 | 15.2 | Hanford |
| 199-K-182 | 15.2 | 37.5 | Ringold E |
| 199-K-182 | 37.5 | 38.71 | RUM |
| 199-K-183 | 0 | 6.4 | Hanford |
| 199-K-183 | 6.4 | 45 | Ringold E |
| 199-K-183 | 45 | 46.48 | RUM |
| 199-K-184 | 0 | 16.8 | Hanford |
| 199-K-184 | 16.8 | 49.6 | Ringold E |
| 199-K-184 | 49.6 | 65.87 | RUM |
| 199-K-185 | 0 | 8.2 | Hanford |
| 199-K-185 | 8.2 | 40.7 | Ringold E |
| 199-K-185 | 40.7 | 42.21 | RUM |
| 199-K-186 | 0 | 14.2 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-186 | 14.2 | 49.4 | Ringold E |
| 199-K-186 | 49.4 | 50.9 | RUM |
| 199-K-187 | 0 | 20.9 | Hanford |
| 199-K-187 | 20.9 | 60.2 | Ringold E |
| 199-K-187 | 60.2 | 61.69 | RUM |
| 199-K-188 | 0 | 18.3 | Hanford |
| 199-K-188 | 18.3 | 55.8 | Ringold E |
| 199-K-188 | 55.8 | 71.63 | RUM |
| 199-K-189 | 0 | 11.3 | Hanford |
| 199-K-189 | 11.3 | 46.9 | Ringold E |
| 199-K-189 | 46.9 | 48.46 | RUM |
| 199-K-190 | 0 | 10.1 | Hanford |
| 199-K-190 | 10.1 | 40.5 | Ringold E |
| 199-K-190 | 40.5 | 42.06 | RUM |
| 199-K-191 | 0 | 12.2 | Hanford |
| 199-K-191 | 12.2 | 46.7 | Ringold E |
| 199-K-191 | 46.7 | 48.16 | RUM |
| 199-K-192 | 0 | 6.7 | Hanford |
| 199-K-192 | 6.7 | 43.3 | Ringold E |
| 199-K-192 | 43.3 | 58.8 | RUM |
| 199-K-193 | 0 | 14 | Hanford |
| 199-K-193 | 14 | 49.1 | Ringold E |
| 199-K-193 | 49.1 | 50.6 | RUM |
| 199-K-194 | 0 | 19.8 | Hanford |
| 199-K-194 | 19.8 | 43.1 | Ringold E |
| 199-K-194 | 43.1 | 44.9 | RUM |
| 199-K-195 | 0 | 14.6 | Hanford |
| 199-K-195 | 14.6 | 54.3 | Ringold E |
| 199-K-195 | 54.3 | 70.26 | RUM |
| 199-K-196 | 0 | 6.08 | Hanford |
| 199-K-196 | 6.08 | 40.28 | Ringold E |
| 199-k-196 | 40.28 | 42.61 | RUM |
| 199-K-197 | 0 | 1 | Hanford |
| 199-K-197 | 1 | 30.8 | Ringold E |
| 199-K-197 | 30.8 | 33.01 | RUM |
| 199-K-198 | 0 | 28.5 | Hanford |
| 199-K-198 | 28.5 | 30.94 | RUM |
| 199-K-199 | 0 | 29.36 | Hanford |
| 199-K-199 | 29.36 | 31.42 | RUM |
| 199-K-200 | 0 | 8.2 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-K-200 | 8.2 | 18.1 | Ringold E |
| 199-K-201 | 0 | 7.9 | Hanford |
| 199-K-201 | 7.9 | 18.4 | Ringold E |
| 199-K-202 | 0 | 12.77 | Hanford |
| 199-K-202 | 12.77 | 46.51 | Ringold E |
| 199-K-202 | 46.51 | 48.6704 | RUM |
| 199-K-205 | 0 | 15.5 | Hanford |
| 199-K-205 | 15.5 | 55.02 | Ringold E |
| 199-K-205 | 55.02 | 56.544 | RUM |
| 199-K-206 | 0 | 18.54 | Hanford |
| 199-K-206 | 18.54 | 53.4 | Ringold E |
| 199-K-206 | 53.4 | 55.6016 | RUM |
| 199-K-21 | 0 | 7.6 | Hanford |
| 199-K-21 | 7.6 | 15.2 | Ringold E |
| 199-K-22 | 0 | 7 | Hanford |
| 199-K-22 | 7 | 15.2 | Ringold E |
| 199-K-25 | 0 | 7.6 | Hanford |
| 199-K-25 | 7.6 | 23.2 | Ringold E |
| 199-K-27 | 0 | 20.4 | Hanford |
| 199-K-27 | 20.4 | 27.4 | Ringold E |
| 199-K-28 | 0 | 19.8 | Hanford |
| 199-K-28 | 19.8 | 27.4 | Ringold E |
| 199-K-29 | 0 | 12.2 | Hanford |
| 199-K-29 | 12.2 | 27.4 | Ringold E |
| 199-K-30 | 0 | 12.2 | Hanford |
| 199-K-30 | 12.2 | 27.4 | Ringold E |
| 199-K-32A | 0 | 8.2 | Hanford |
| 199-K-32A | 8.2 | 21 | Ringold E |
| 199-K-32B | 0 | 11 | Hanford |
| 199-K-32B | 11 | 41.5 | Ringold E |
| 199-K-32B | 41.5 | 53.64 | RUM |
| 199-K-34 | 0 | 6.7 | Hanford |
| 199-K-34 | 6.7 | 27.6 | Ringold E |
| 199-K-35 | 0 | 13.7 | Hanford |
| 199-K-35 | 13.7 | 35.7 | Ringold E |
| 199-K-36 | 0 | 18.9 | Hanford |
| 199-K-36 | 18.9 | 27.6 | Ringold E |
| 199-K-37 | 0 | 9.3 | Hanford |
| 199-K-37 | 9.3 | 21.1 | Ringold E |
| 199-N-103A | 0 | 18 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-103A | 18 | 31.1 | Ringold E |
| 199-N-103A | 31.1 | 32 | RUM |
| 199-N-104A | 0 | 17.4 | Hanford |
| 199-N-104A | 17.4 | 27.9 | Ringold E |
| 199-N-105A | 0 | 13.1 | Hanford |
| 199-N-105A | 13.1 | 29.3 | Ringold E |
| 199-N-105A | 29.3 | 29.87 | RUM |
| 199-N-106A | 0 | 17.7 | Hanford |
| 199-N-106A | 17.7 | 36.3 | Ringold E |
| 199-N-106A | 36.3 | 36.88 | RUM |
| 199-N-107A | 0 | 13.4 | Hanford |
| 199-N-107A | 13.4 | 23.2 | Ringold E |
| 199-N-108A | 0 | 11.85 | Hanford |
| 199-N-108A | 11.85 | 11.9 | Ringold E |
| 199-N-121 | 0 | 2.4 | Hanford |
| 199-N-121 | 2.4 | 12.5 | Ringold E |
| 199-N-121 | 12.5 | 12.95 | RUM |
| 199-N-122 | 0 | 4.3 | Hanford |
| 199-N-122 | 4.3 | 13.6 | Ringold E |
| 199-N-122 | 13.6 | 14.63 | RUM |
| 199-N-123 | 0 | 3.5 | Hanford |
| 199-N-123 | 3.5 | 16.1 | Ringold E |
| 199-N-123 | 16.1 | 16.46 | RUM |
| 199-N-136 | 0 | 3.7 | Hanford |
| 199-N-136 | 3.7 | 7.9 | Ringold E |
| 199-N-137 | 0 | 4.9 | Hanford |
| 199-N-137 | 4.9 | 7.9 | Ringold E |
| 199-N-142 | 0 | 4.3 | Hanford |
| 199-N-142 | 4.3 | 7.8 | Ringold E |
| 199-N-143 | 0 | 4.3 | Hanford |
| 199-N-143 | 4.3 | 7.9 | Ringold E |
| 199-N-144 | 0 | 4.3 | Hanford |
| 199-N-144 | 4.3 | 7.8 | Ringold E |
| 199-N-145 | 0 | 3 | Hanford |
| 199-N-145 | 3 | 7.9 | Ringold E |
| 199-N-160 | 0 | 4.6 | Hanford |
| 199-N-160 | 4.6 | 7.9 | Ringold E |
| 199-N-161 | 0 | 3.7 | Hanford |
| 199-N-161 | 3.7 | 7.7 | Ringold E |
| 199-N-162 | 0 | 3.4 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-162 | 3.4 | 7.9 | Ringold E |
| 199-N-163 | 0 | 4.3 | Hanford |
| 199-N-163 | 4.3 | 7.9 | Ringold E |
| 199-N-164 | 0 | 4 | Hanford |
| 199-N-164 | 4 | 7.7 | Ringold E |
| 199-N-167 | 0 | 14.9 | Hanford |
| 199-N-167 | 14.9 | 25.3 | Ringold E |
| 199-N-169 | 0 | 13.1 | Hanford |
| 199-N-169 | 13.1 | 25.3 | Ringold E |
| 199-N-170 | 0 | 12.8 | Hanford |
| 199-N-170 | 12.8 | 25.5 | Ringold E |
| 199-N-171 | 0 | 15.4 | Hanford |
| 199-N-171 | 15.4 | 25.6 | Ringold E |
| 199-N-172 | 0 | 13.4 | Hanford |
| 199-N-172 | 13.4 | 25 | Ringold E |
| 199-N-173 | 0 | 2.7 | Hanford |
| 199-N-173 | 2.7 | 13.7 | Ringold E |
| 199-N-173 | 13.7 | 13.78 | RUM |
| 199-N-174 | 0 | 4.3 | Hanford |
| 199-N-174 | 4.3 | 6.3 | Ringold E |
| 199-N-176 | 0 | 4.9 | Hanford |
| 199-N-176 | 4.9 | 5.7 | Ringold E |
| 199-N-177 | 0 | 4.4 | Hanford |
| 199-N-177 | 4.4 | 5.6 | Ringold E |
| 199-N-178 | 0 | 4.9 | Hanford |
| 199-N-178 | 4.9 | 5.7 | Ringold E |
| 199-N-180 | 0 | 4.7 | Hanford |
| 199-N-180 | 4.7 | 5.7 | Ringold E |
| 199-N-181 | 0 | 4.6 | Hanford |
| 199-N-181 | 4.6 | 5.9 | Ringold E |
| 199-N-182 | 0 | 13.98 | Hanford |
| 199-N-182 | 13.98 | 31 | Ringold E |
| 199-N-182 | 31 | 46.94 | RUM |
| 199-N-183 | 0 | 17.4 | Hanford |
| 199-N-183 | 17.4 | 33.2 | Ringold E |
| 199-N-183 | 33.2 | 35.78 | RUM |
| 199-N-184 | 0 | 18.4 | Hanford |
| 199-N-184 | 18.4 | 30.4 | Ringold E |
| 199-N-184 | 30.4 | 32.92 | RUM |
| 199-N-185 | 0 | 7 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-185 | 7 | 12.46 | Ringold E |
| 199-N-185 | 12.46 | 28.19 | RUM |
| 199-N-186 | 0 | 16.26 | Hanford |
| 199-N-186 | 16.26 | 28.8 | Ringold E |
| 199-N-186 | 28.8 | 29.66 | RUM |
| 199-N-187 | 0 | 12.2 | Hanford |
| 199-N-187 | 12.2 | 28.8 | Ringold E |
| 199-N-188 | 0 | 9.12 | Hanford |
| 199-N-188 | 9.15 | 27.4 | Ringold E |
| 199-N-189 | 0 | 18 | Hanford |
| 199-N-189 | 18 | 31.92 | Ringold E |
| 199-N-189 | 31.92 | 35.75 | RUM |
| 199-N-2 | 0 | 32 | Hanford |
| 199-N-2 | 32 | 38.1 | RUM |
| 199-N-200 | 0 | 0.2 | Hanford |
| 199-N-200 | 0.2 | 5.5 | Ringold E |
| 199-N-203 | 0 | 3 | Hanford |
| 199-N-203 | 3 | 8.3 | Ringold E |
| 199-N-205 | 0 | 2.3 | Hanford |
| 199-N-205 | 2.3 | 8 | Ringold E |
| 199-N-206 | 0 | 2.1 | Hanford |
| 199-N-206 | 2.1 | 5.4 | Ringold E |
| 199-N-207 | 0 | 0.2 | Hanford |
| 199-N-207 | 0.2 | 8.2 | Ringold E |
| 199-N-208 | 0 | 2.4 | Hanford |
| 199-N-208 | 2.4 | 4.9 | Ringold E |
| 199-N-209 | 0 | 2.6 | Hanford |
| 199-N-209 | 2.6 | 8 | Ringold E |
| 199-N-210 | 0 | 0.6 | Hanford |
| 199-N-210 | 0.6 | 5 | Ringold E |
| 199-N-211 | 0 | 1.8 | Hanford |
| 199-N-211 | 1.8 | 8 | Ringold E |
| 199-N-212 | 0 | 2.1 | Hanford |
| 199-N-212 | 2.1 | 4.9 | Ringold E |
| 199-N-213 | 0 | 3 | Hanford |
| 199-N-213 | 3 | 8 | Ringold E |
| 199-N-215 | 0 | 0.3 | Hanford |
| 199-N-215 | 0.3 | 8.3 | Ringold E |
| 199-N-216 | 0 | 3.7 | Hanford |
| 199-N-216 | 3.7 | 5 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-217 | 0 | 4.9 | Hanford |
| 199-N-217 | 4.9 | 8.1 | Ringold E |
| 199-N-221 | 0 | 3.7 | Hanford |
| 199-N-221 | 3.7 | 8.2 | Ringold E |
| 199-N-223 | 0 | 4.3 | Hanford |
| 199-N-223 | 4.3 | 8.1 | Ringold E |
| 199-N-224 | 0 | 1.8 | Hanford |
| 199-N-224 | 1.8 | 5.3 | Ringold E |
| 199-N-225 | 0 | 1.8 | Hanford |
| 199-N-225 | 1.8 | 8.2 | Ringold E |
| 199-N-226 | 0 | 4.9 | Ringold E |
| 199-N-227 | 0 | 0.6 | Hanford |
| 199-N-227 | 0.6 | 8.4 | Ringold E |
| 199-N-228 | 0 | 2.7 | Hanford |
| 199-N-228 | 2.7 | 4.9 | Ringold E |
| 199-N-231 | 0 | 1.8 | Hanford |
| 199-N-231 | 1.8 | 8 | Ringold E |
| 199-N-232 | 0 | 3 | Hanford |
| 199-N-232 | 3 | 5 | Ringold E |
| 199-N-234 | 0 | 2.4 | Hanford |
| 199-N-234 | 2.4 | 5.1 | Ringold E |
| 199-N-235 | 0 | 2.7 | Hanford |
| 199-N-235 | 2.7 | 4.9 | Ringold E |
| 199-N-236 | 0 | 4 | Hanford |
| 199-N-236 | 4 | 8.1 | Ringold E |
| 199-N-238 | 0 | 4.9 | Hanford |
| 199-N-238 | 4.9 | 8.1 | Ringold E |
| 199-N-239 | 0 | 3 | Hanford |
| 199-N-239 | 3 | 5.2 | Ringold E |
| 199-N-240 | 0 | 0.6 | Hanford |
| 199-N-240 | 0.6 | 8 | Ringold E |
| 199-N-242 | 0 | 0.9 | Hanford |
| 199-N-242 | 0.9 | 4.4 | Ringold E |
| 199-N-244 | 0 | 1.2 | Hanford |
| 199-N-244 | 1.2 | 8 | Ringold E |
| 199-N-245 | 0 | 0.9 | Hanford |
| 199-N-245 | 0.9 | 5.3 | Ringold E |
| 199-N-246 | 0 | 3 | Hanford |
| 199-N-246 | 3 | 8.2 | Ringold E |
| 199-N-247 | 0 | 1.5 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-247 | 1.5 | 5.5 | Ringold E |
| 199-N-248 | 0 | 1.8 | Hanford |
| 199-N-248 | 1.8 | 8.2 | Ringold E |
| 199-N-249 | 0 | 0.6 | Hanford |
| 199-N-249 | 0.6 | 5.2 | Ringold E |
| 199-N-250 | 0 | 0.6 | Hanford |
| 199-N-250 | 0.6 | 8.2 | Ringold E |
| 199-N-251 | 0 | 5.2 | Ringold E |
| 199-N-252 | 0 | 1.8 | Hanford |
| 199-N-252 | 1.8 | 8.1 | Ringold E |
| 199-N-253 | 0 | 5.2 | Ringold E |
| 199-N-254 | 0 | 0.6 | Hanford |
| 199-N-254 | 0.6 | 8.1 | Ringold E |
| 199-N-255 | 0 | 0.6 | Hanford |
| 199-N-255 | 0.6 | 5.2 | Ringold E |
| 199-N-256 | 0 | 0.6 | Hanford |
| 199-N-256 | 0.6 | 8.3 | Ringold E |
| 199-N-257 | 0 | 5.2 | Ringold E |
| 199-N-258 | 0 | 8.1 | Ringold E |
| 199-N-259 | 0 | 5.2 | Ringold E |
| 199-N-260 | 0 | 0.6 | Hanford |
| 199-N-260 | 0.6 | 8 | Ringold E |
| 199-N-261 | 0 | 5.4 | Ringold E |
| 199-N-262 | 0 | 0.6 | Hanford |
| 199-N-262 | 0.6 | 8 | Ringold E |
| 199-N-263 | 0 | 0.6 | Hanford |
| 199-N-263 | 0.6 | 5.4 | Ringold E |
| 199-N-264 | 0 | 0.6 | Hanford |
| 199-N-264 | 0.6 | 8.1 | Ringold E |
| 199-N-265 | 0 | 5.3 | Ringold E |
| 199-N-266 | 0 | 0.3 | Hanford |
| 199-N-266 | 0.3 | 8.2 | Ringold E |
| 199-N-267 | 0 | 0.3 | Hanford |
| 199-N-267 | 0.3 | 5.2 | Ringold E |
| 199-N-268 | 0 | 0.6 | Hanford |
| 199-N-268 | 0.6 | 8.2 | Ringold E |
| 199-N-269 | 0 | 5.3 | Ringold E |
| 199-N-270 | 0 | 8.1 | Ringold E |
| 199-N-271 | 0 | 5.5 | Ringold E |
| 199-N-272 | 0 | 8.2 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-273 | 0 | 0.6 | Hanford |
| 199-N-273 | 0.6 | 5.4 | Ringold E |
| 199-N-275 | 0 | 0.9 | Hanford |
| 199-N-275 | 0.9 | 5.3 | Ringold E |
| 199-N-277 | 0 | 0.6 | Hanford |
| 199-N-277 | 0.6 | 5.5 | Ringold E |
| 199-N-278 | 0 | 0.6 | Hanford |
| 199-N-278 | 0.6 | 8 | Ringold E |
| 199-N-279 | 0 | 0.3 | Hanford |
| 199-N-279 | 0.3 | 5.4 | Ringold E |
| 199-N-281 | 0 | 1.2 | Hanford |
| 199-N-281 | 1.2 | 5.5 | Ringold E |
| 199-N-282 | 0 | 1.2 | Hanford |
| 199-N-282 | 1.2 | 8.2 | Ringold E |
| 199-N-283 | 0 | 1.4 | Hanford |
| 199-N-283 | 1.4 | 5.4 | Ringold E |
| 199-N-284 | 0 | 1.2 | Hanford |
| 199-N-284 | 1.2 | 7.9 | Ringold E |
| 199-N-285 | 0 | 0.9 | Hanford |
| 199-N-285 | 0.9 | 5.4 | Ringold E |
| 199-N-286 | 0 | 1.5 | Hanford |
| 199-N-286 | 1.5 | 8.4 | Ringold E |
| 199-N-287 | 0 | 1.2 | Hanford |
| 199-N-287 | 1.2 | 5.4 | Ringold E |
| 199-N-288 | 0 | 1.4 | Hanford |
| 199-N-288 | 1.4 | 8.3 | Ringold E |
| 199-N-289 | 0 | 0.9 | Hanford |
| 199-N-289 | 0.9 | 5.2 | Ringold E |
| 199-N-290 | 0 | 0.6 | Hanford |
| 199-N-290 | 0.6 | 8.4 | Ringold E |
| 199-N-291 | 0 | 5.3 | Ringold E |
| 199-N-292 | 0 | 1.2 | Hanford |
| 199-N-292 | 1.2 | 8.4 | Ringold E |
| 199-N-293 | 0 | 1.5 | Hanford |
| 199-N-293 | 1.5 | 5.4 | Ringold E |
| 199-N-294 | 0 | 1.8 | Hanford |
| 199-N-294 | 1.8 | 8.3 | Ringold E |
| 199-N-295 | 0 | 1.8 | Hanford |
| 199-N-295 | 1.8 | 5.5 | Ringold E |
| 199-N-296 | 0 | 4.9 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-296 | 4.9 | 8.3 | Ringold E |
| 199-N-297 | 0 | 2.1 | Hanford |
| 199-N-297 | 2.1 | 5.5 | Ringold E |
| 199-N-298 | 0 | 1.5 | Hanford |
| 199-N-298 | 1.5 | 8.4 | Ringold E |
| 199-N-299 | 0 | 1.8 | Hanford |
| 199-N-299 | 1.8 | 5.5 | Ringold E |
| 199-N-300 | 0 | 4.9 | Hanford |
| 199-N-300 | 4.9 | 8.3 | Ringold E |
| 199-N-302 | 0 | 5.5 | Hanford |
| 199-N-302 | 5.5 | 8.3 | Ringold E |
| 199-N-303 | 0 | 0.9 | Hanford |
| 199-N-303 | 0.9 | 5.2 | Ringold E |
| 199-N-305 | 0 | 1.8 | Hanford |
| 199-N-305 | 1.8 | 5.5 | Ringold E |
| 199-N-306 | 0 | 1.5 | Hanford |
| 199-N-306 | 1.5 | 8.4 | Ringold E |
| 199-N-307 | 0 | 0.9 | Hanford |
| 199-N-307 | 0.9 | 5.2 | Ringold E |
| 199-N-308 | 0 | 0.9 | Hanford |
| 199-N-308 | 0.9 | 8.2 | Ringold E |
| 199-N-309 | 0 | 0.6 | Hanford |
| 199-N-309 | 0.6 | 5.4 | Ringold E |
| 199-N-310 | 0 | 3 | Hanford |
| 199-N-310 | 3 | 8.4 | Ringold E |
| 199-N-311 | 0 | 0.9 | Hanford |
| 199-N-311 | 0.9 | 5.4 | Ringold E |
| 199-N-312 | 0 | 1.8 | Hanford |
| 199-N-312 | 1.8 | 8.5 | Ringold E |
| 199-N-313 | 0 | 0.6 | Hanford |
| 199-N-313 | 0.6 | 5.2 | Ringold E |
| 199-N-314 | 0 | 1.2 | Hanford |
| 199-N-314 | 1.2 | 8.1 | Ringold E |
| 199-N-315 | 0 | 0.9 | Hanford |
| 199-N-315 | 0.9 | 5.3 | Ringold E |
| 199-N-318 | 0 | 0.6 | Hanford |
| 199-N-318 | 0.6 | 8.2 | Ringold E |
| 199-N-319 | 0 | 0.6 | Hanford |
| 199-N-319 | 0.6 | 5.2 | Ringold E |
| 199-N-320 | 0 | 0.9 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-320 | 0.9 | 8.3 | Ringold E |
| 199-N-321 | 0 | 0.9 | Hanford |
| 199-N-321 | 0.9 | 5.5 | Ringold E |
| 199-N-322 | 0 | 1.2 | Hanford |
| 199-N-322 | 1.2 | 8.1 | Ringold E |
| 199-N-323 | 0 | 0.6 | Hanford |
| 199-N-323 | 0.6 | 5.2 | Ringold E |
| 199-N-324 | 0 | 0.6 | Hanford |
| 199-N-324 | 0.6 | 8.2 | Ringold E |
| 199-N-325 | 0 | 0.9 | Hanford |
| 199-N-325 | 0.9 | 5.5 | Ringold E |
| 199-N-326 | 0 | 0.6 | Hanford |
| 199-N-326 | 0.6 | 8.1 | Ringold E |
| 199-N-327 | 0 | 0.6 | Hanford |
| 199-N-327 | 0.6 | 5.5 | Ringold E |
| 199-N-328 | 0 | 0.9 | Hanford |
| 199-N-328 | 0.9 | 7.9 | Ringold E |
| 199-N-329 | 0 | 0.9 | Hanford |
| 199-N-329 | 0.9 | 5.1 | Ringold E |
| 199-N-330 | 0 | 0.9 | Hanford |
| 199-N-330 | 0.9 | 7.9 | Ringold E |
| 199-N-331 | 0 | 1.1 | Hanford |
| 199-N-331 | 1.1 | 5.7 | Ringold E |
| 199-N-332 | 0 | 8 | Ringold E |
| 199-N-333 | 0 | 0.6 | Hanford |
| 199-N-333 | 0.6 | 5.3 | Ringold E |
| 199-N-334 | 0 | 0.6 | Hanford |
| 199-N-334 | 0.6 | 8 | Ringold E |
| 199-N-335 | 0 | 0.9 | Hanford |
| 199-N-335 | 0.9 | 5.3 | Ringold E |
| 199-N-336 | 0 | 1.2 | Hanford |
| 199-N-336 | 1.2 | 8.2 | Ringold E |
| 199-N-337 | 0 | 0.9 | Hanford |
| 199-N-337 | 0.9 | 5.3 | Ringold E |
| 199-N-338 | 0 | 0.9 | Hanford |
| 199-N-338 | 0.9 | 8.2 | Ringold E |
| 199-N-339 | 0 | 1.8 | Hanford |
| 199-N-339 | 1.8 | 5.3 | Ringold E |
| 199-N-340 | 0 | 1.8 | Hanford |
| 199-N-340 | 1.8 | 7.9 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-341 | 0 | 0.9 | Hanford |
| 199-N-341 | 0.9 | 5.2 | Ringold E |
| 199-N-343 | 0 | 0.9 | Hanford |
| 199-N-343 | 0.9 | 5.3 | Ringold E |
| 199-N-344 | 0 | 0.6 | Hanford |
| 199-N-344 | 0.6 | 8.4 | Ringold E |
| 199-N-345 | 0 | 0.9 | Hanford |
| 199-N-345 | 0.9 | 5.5 | Ringold E |
| 199-N-346 | 0 | 2.1 | Hanford |
| 199-N-346 | 2.1 | 8.2 | Ringold E |
| 199-N-347 | 0 | 2.1 | Hanford |
| 199-N-347 | 2.1 | 8.2 | Ringold E |
| 199-N-348 | 0 | 0.6 | Hanford |
| 199-N-348 | 0.6 | 8.1 | Ringold E |
| 199-N-349 | 0 | 2.7 | Hanford |
| 199-N-349 | 2.7 | 8.1 | Ringold E |
| 199-N-350 | 0 | 3.5 | Hanford |
| 199-N-350 | 3.5 | 8.2 | Ringold E |
| 199-N-351 | 0 | 1.8 | Hanford |
| 199-N-351 | 1.8 | 8.2 | Ringold E |
| 199-N-352 | 0 | 1.2 | Hanford |
| 199-N-352 | 1.2 | 8.2 | Ringold E |
| 199-N-353 | 0 | 8 | Ringold E |
| 199-N-354 | 0 | 0.9 | Hanford |
| 199-N-354 | 0.9 | 8.2 | Ringold E |
| 199-N-355 | 0 | 0.3 | Hanford |
| 199-N-355 | 0.3 | 8.1 | Ringold E |
| 199-N-356 | 0 | 7.8 | Ringold E |
| 199-N-359 | 0 | 3 | Hanford |
| 199-N-359 | 3 | 8.2 | Ringold E |
| 199-N-360 | 0 | 3 | Hanford |
| 199-N-360 | 3 | 8.1 | Ringold E |
| 199-N-361 | 0 | 1.8 | Hanford |
| 199-N-361 | 1.8 | 8.2 | Ringold E |
| 199-N-362 | 0 | 1.2 | Hanford |
| 199-N-362 | 1.2 | 8.3 | Ringold E |
| 199-N-363 | 0 | 1.2 | Hanford |
| 199-N-363 | 1.2 | 8.2 | Ringold E |
| 199-N-364 | 0 | 1.2 | Hanford |
| 199-N-364 | 1.2 | 7.9 | Ringold E |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-365 | 0 | 0.6 | Hanford |
| 199-N-365 | 0.6 | 8 | Ringold E |
| 199-N-366 | 0 | 1.2 | Hanford |
| 199-N-366 | 1.2 | 7.8 | Ringold E |
| 199-N-367 | 0 | 0.9 | Hanford |
| 199-N-367 | 0.9 | 8.3 | Ringold E |
| 199-N-368 | 0 | 4.4 | Hanford |
| 199-N-368 | 4.4 | 8 | Ringold E |
| 199-N-41 | 0 | 13.7 | Hanford |
| 199-N-43 | 0 | 11.6 | Hanford |
| 199-N-43 | 11.6 | 23.8 | Ringold E |
| 199-N-5 | 0 | 35 | Hanford |
| 199-N-5 | 35.1 | 38.1 | RUM |
| 199-N-50 | 0 | 18 | Hanford |
| 199-N-52 | 0 | 18.9 | Hanford |
| 199-N-54 | 0 | 14.9 | Hanford |
| 199-N-54 | 14.9 | 22.3 | Ringold E |
| 199-N-57 | 0 | 17.4 | Hanford |
| 199-N-61 | 0 | 18 | Hanford |
| 199-N-61 | 18 | 20.6 | Ringold E |
| 199-N-62 | 0 | 19.5 | Hanford |
| 199-N-62 | 19.5 | 23.9 | Ringold E |
| 199-N-66 | 0 | 16.2 | Hanford |
| 199-N-66 | 16.2 | 24.4 | Ringold E |
| 199-N-69 | 0 | 12.8 | Hanford |
| 199-N-69 | 12.8 | 30.8 | Ringold E |
| 199-N-69 | 30.8 | 31.7 | RUM |
| 199-N-70 | 0 | 11.3 | Hanford |
| 199-N-70 | 11.3 | 31.7 | Ringold E |
| 199-N-70 | 31.7 | 31.82 | RUM |
| 199-N-71 | 0 | 16.8 | Hanford |
| 199-N-71 | 16.8 | 26.5 | Ringold E |
| 199-N-75 | 0 | 13.7 | Hanford |
| 199-N-77 | 0 | 29.6 | Hanford |
| 199-N-77 | 29.6 | 31.39 | RUM |
| 199-N-80 | 0 | 14.9 | Hanford |
| 199-N-80 | 14.9 | 29.9 | Ringold E |
| 199-N-80 | 29.9 | 38.25 | RUM |
| 199-N-8P | 0 | 15.9 | Hanford |
| 199-N-91A | 0 | 0.6 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 199-N-91A | 0.6 | 13.4 | Ringold E |
| 199-N-91A | 13.4 | 17.98 | RUM |
| 199-N-92A | 0 | 12.8 | Hanford |
| 199-N-92A | 12.8 | 14.63 | RUM |
| 199-N-93A | 0 | 10.1 | Hanford |
| 199-N-93A | 10.1 | 13.11 | RUM |
| 199-N-94A | 0 | 11.1 | Hanford |
| 199-N-94A | 11.1 | 10.06 | RUM |
| 199-N-95A | 0 | 4.3 | Hanford |
| 199-N-95A | 4.3 | 11.7 | Ringold E |
| 199-N-95A | 11.7 | 14.94 | RUM |
| 199-N-96A | 0 | 18.3 | Hanford |
| 199-N-96A | 18.3 | 21.64 | RUM |
| 199-N-97A | 0 | 1.4 | Hanford |
| 199-N-97A | 1.4 | 18.3 | Ringold E |
| 699-100-43B | 0 | 9 | Hanford |
| 699-100-43B | 9 | 10.7 | RUM |
| 699-101-45 | 0 | 7.8 | Hanford |
| 699-101-45 | 7.8 | 9.39 | RUM |
| 699-101-48C | 0 | 14.9 | Hanford |
| 699-101-48C | 0 | 14.9 | Hanford |
| 699-101-48C | 14.9 | 23.47 | RUM |
| 699-52-17 | 0 | 27.4 | Hanford |
| 699-52-17 | 0 | 27.4 | Hanford |
| 699-52-17 | 27.4 | 115.82 | RUM |
| 699-52-18A | 0 | 26.8 | Hanford |
| 699-52-18A | 0 | 26.8 | Hanford |
| 699-52-18A | 26.8 | 27.43 | RUM |
| 699-52-18C | 0 | 30.5 | Hanford |
| 699-52-18C | 0 | 30.5 | Hanford |
| 699-52-18C | 30.5 | 32.61 | RUM |
| 699-54-18C | 0 | 22.9 | Hanford |
| 699-54-18C | 0 | 22.9 | Hanford |
| 699-54-18C | 22.9 | 108.2 | RUM |
| 699-54-18E | 0 | 24.1 | Hanford |
| 699-54-18E | 0 | 24.1 | Hanford |
| 699-54-18E | 24.1 | 27.43 | RUM |
| 699-57-16 | 0 | 11.6 | Hanford |
| 699-57-16 | 0 | 11.6 | Hanford |
| 699-57-16 | 11.6 | 12.5 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 699-57-25B | 0 | 24.1 | Hanford |
| 699-57-25B | 24.1 | 24.69 | RUM |
| 699-57-29B | 0 | 24.7 | Hanford |
| 699-57-29B | 24.7 | 24.69 | RUM |
| 699-59-32 | 0 | 22.86 | Hanford |
| 699-59-32 | 22.86 | 22.86 | RUM |
| 699-60-32 | 0 | 19.8 | Hanford |
| 699-60-32 | 19.8 | 25.91 | RUM |
| 699-60-57 | 29.3 | 100 | Ringold E |
| 699-60-57 | 0 | 29.3 | Hanford |
| 699-60-60 | 0 | 29.9 | Hanford |
| 699-61-26A | 0 | 7.3 | Hanford |
| 699-61-26A | 7.3 | 22.6 | Ringold E |
| 699-61-26A | 22.6 | 110.64 | RUM |
| 699-61-37 | 0 | 23.16 | Hanford |
| 699-61-37 | 23.16 | 23.16 | RUM |
| 699-61-41 | 0 | 12.2 | Hanford |
| 699-61-41 | 12.2 | 15.85 | RUM |
| 699-61-62 | 0 | 35.1 | Hanford |
| 699-61-62 | 35.1 | 57.3 | Ringold E |
| 699-61-66 | 0 | 50.3 | Hanford |
| 699-61-66 | 50.3 | 68.6 | Ringold E |
| 699-62-31 | 0 | 22.9 | Hanford |
| 699-62-31 | 22.9 | 25.6 | RUM |
| 699-62-43A | 0 | 20.1 | Hanford |
| 699-62-43A | 0 | 20.1 | Hanford |
| 699-62-43A | 20.1 | 23.77 | RUM |
| 699-62-43F | 0 | 21.3 | Hanford |
| 699-62-43F | 0 | 21.3 | Hanford |
| 699-62-43F | 21.3 | 24.69 | RUM |
| 699-63-25A | 0 | 18.9 | Hanford |
| 699-63-25A | 0 | 18.9 | Hanford |
| 699-63-25A | 18.9 | 33.53 | RUM |
| 699-63-51 | 0 | 7.6 | Hanford |
| 699-63-51 | 0 | 7.6 | Hanford |
| 699-63-51 | 7.6 | 10.97 | RUM |
| 699-63-55 | 0 | 19.8 | Hanford |
| 699-63-55 | 19.8 | 25 | Ringold E |
| 699-63-55 | 25 | 38.1 | RUM |
| 699-63-58 | 0 | 40.5 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 699-63-89 | 0 | 30.5 | Hanford |
| 699-63-89 | 30.5 | 67 | Ringold E |
| 699-63-90 | 0 | 32 | Hanford |
| 699-63-92 | 0 | 56.7 | Hanford |
| 699-63-95 | 0 | 24 | Hanford |
| 699-64-27 | 0 | 22.6 | Hanford |
| 699-64-27 | 0 | 22.6 | Hanford |
| 699-64-27 | 22.6 | 25.6 | RUM |
| 699-65-50 | 0 | 35.1 | Hanford |
| 699-65-50 | 0 | 35.1 | Hanford |
| 699-65-50 | 35.1 | 178.31 | RUM |
| 699-65-83 | 0 | 25.9 | Hanford |
| 699-65-83 | 25.9 | 36.9 | Ringold E |
| 699-66-23 | 0 | 16.8 | Hanford |
| 699-66-23 | 0 | 16.8 | Hanford |
| 699-66-23 | 16.8 | 30.48 | RUM |
| 699-66-38 | 0 | 8.2 | Hanford |
| 699-66-38 | 0 | 8.2 | Hanford |
| 699-66-38 | 8.2 | 45.72 | RUM |
| 699-66-39 | 0 | 12.8 | Hanford |
| 699-66-39 | 0 | 12.8 | Hanford |
| 699-66-39 | 12.8 | 27.43 | RUM |
| 699-66-64 | 0 | 35.9 | Hanford |
| 699-66-91 | 0 | 23.8 | Hanford |
| 699-66-91 | 23.8 | 57.9 | Ringold E |
| 699-67-51 | 0 | 44.2 | Hanford |
| 699-67-51 | 44.2 | 64 | Ringold E |
| 699-67-51 | 64 | 76.2 | RUM |
| 699-67-86 | 0 | 75.3 | Hanford |
| 699-67-86 | 0 | 75.3 | Hanford |
| 699-67-86 | 75.3 | 142.34 | RUM |
| 699-67-98 | 0 | 39.3 | Hanford |
| 699-67-98 | 0 | 39.3 | Hanford |
| 699-67-98 | 39.3 | 56.39 | RUM |
| 699-69-45 | 0 | 41.1 | Hanford |
| 699-69-45 | 0 | 41.1 | Hanford |
| 699-69-45 | 41.1 | 91.44 | RUM |
| 699-71-30 | 0 | 11.3 | Hanford |
| 699-71-30 | 0 | 11.3 | Hanford |
| 699-71-30 | 11.3 | 45.72 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 699-71-52 | 0 | 53.3 | Hanford |
| 699-71-52 | 53.3 | 64.01 | RUM |
| 699-71-77 | 0 | 24.4 | Hanford |
| 699-71-77 | 24.4 | 54.9 | Ringold E |
| 699-71-77 | 54.9 | 91.44 | RUM |
| 699-72-73 | 0 | 27.4 | Hanford |
| 699-72-73 | 27.4 | 50.9 | Ringold E |
| 699-72-73 | 50.9 | 60.96 | RUM |
| 699-72-92 | 0 | 47.2 | Hanford |
| 699-72-92 | 47.2 | 61 | Ringold E |
| 699-74-23 | 0 | 7.6 | Hanford |
| 699-74-23 | 0 | 7.6 | Hanford |
| 699-74-23 | 7.6 | 15.24 | RUM |
| 699-74-44 | 0 | 16.8 | Hanford |
| 699-74-44 | 16.8 | 45.72 | RUM |
| 699-74-48 | 0 | 37.8 | Hanford |
| 699-74-48 | 37.8 | 45.72 | RUM |
| 699-75-23A | 0 | 10.7 | Hanford |
| 699-75-23A | 0 | 10.7 | Hanford |
| 699-75-23A | 10.7 | 10.67 | RUM |
| 699-75-23B | 0 | 11 | Hanford |
| 699-75-23B | 11 | 10.97 | RUM |
| 699-77-36 | 0 | 15.2 | Hanford |
| 699-77-36 | 0 | 15.2 | Hanford |
| 699-77-36 | 15.2 | 45.72 | RUM |
| 699-77-54 | 0 | 29 | Hanford |
| 699-77-54 | 29 | 46.3 | Ringold E |
| 699-77-54 | 46.3 | 45.72 | RUM |
| 699-78-62 | 0 | 39.6 | Hanford |
| 699-78-62 | 39.6 | 45.72 | RUM |
| 699-80-39B | 0 | 13.1 | Hanford |
| 699-80-39B | 0 | 13.1 | Hanford |
| 699-80-39B | 13.1 | 16.15 | RUM |
| 699-80-43P | 0 | 14 | Hanford |
| 699-80-43P | 0 | 14 | Hanford |
| 699-80-43P | 14 | 137.16 | RUM |
| 699-80-43Q | 0 | 13.7 | Hanford |
| 699-80-43Q | 0 | 13.7 | Hanford |
| 699-80-43Q | 13.7 | 70.71 | RUM |
| 699-80-43R | 0 | 13.7 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 699-80-43R | 0 | 13.7 | Hanford |
| 699-80-43R | 13.7 | 42.67 | RUM |
| 699-80-43S | 0 | 12.18 | Hanford |
| 699-80-43S | 12.18 | 15.24 | RUM |
| 699-81-58 | 0 | 29 | Hanford |
| 699-81-58 | 0 | 29 | Hanford |
| 699-81-58 | 29 | 45.72 | RUM |
| 699-81-62 | 0 | 13.7 | Hanford |
| 699-81-62 | 13.7 | 32 | Ringold E |
| 699-81-62 | 32 | 308.15 | RUM |
| 699-83-47 | 0 | 10.7 | Hanford |
| 699-83-47 | 10.7 | 29 | Ringold E |
| 699-83-47 | 29 | 45.72 | RUM |
| 699-84-59 | 0 | 15.8 | Hanford |
| 699-86-60 | 0 | 16.8 | Hanford |
| 699-86-60 | 16.8 | 29.3 | Ringold E |
| 699-86-60 | 29.3 | 161.85 | RUM |
| 699-87-55 | 0 | 18.6 | Hanford |
| 699-87-55 | 18.6 | 28.7 | Ringold E |
| 699-89-35 | 0 | 16.8 | Hanford |
| 699-89-35 | 0 | 16.8 | Hanford |
| 699-89-35 | 16.8 | 22.86 | RUM |
| 699-93-48A | 0 | 22.3 | Hanford |
| 699-93-48A | 22.3 | 25.3 | RUM |
| 699-94-41 | 0 | 10.8 | Hanford |
| 699-94-41 | 10.8 | 12.23 | RUM |
| 699-94-43 | 0 | 13.7 | Hanford |
| 699-94-43 | 13.7 | 16.9 | Ringold E |
| 699-94-43 | 16.9 | 18.5 | RUM |
| 699-95-45 | 0 | 13.8 | Hanford |
| 699-95-45 | 0 | 13.8 | Hanford |
| 699-95-45 | 13.8 | 15.36 | RUM |
| 699-95-48 | 0 | 18 | Hanford |
| 699-95-48 | 18 | 19.62 | RUM |
| 699-95-51 | 0 | 20.1 | Hanford |
| 699-95-51 | 0 | 20.1 | Hanford |
| 699-95-51 | 20.1 | 21.73 | RUM |
| 699-96-41 | 0 | 14.18 | Hanford |
| 699-96-41 | 14.18 | 18.96 | RUM |
| 699-96-42 | 0 | 14.61 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| 699-96-42 | 14.61 | 15.85 | RUM |
| 699-96-43 | 13.7 | 16.18 | RUM |
| 699-96-44 | 0 | 14.34 | Hanford |
| 699-96-44 | 14.34 | 18.17 | RUM |
| 699-96-45 | 0 | 14.39 | Hanford |
| 699-96-45 | 14.39 | 18.26 | RUM |
| 699-96-49 | 0 | 18.6 | Hanford |
| 699-96-49 | 18.6 | 30.48 | RUM |
| 699-96-52B | 0 | 12.2 | Hanford |
| 699-96-52B | 12.2 | 14.02 | RUM |
| 699-97-41 | 0 | 16.5 | Hanford |
| 699-97-41 | 16.5 | 17.89 | RUM |
| 699-97-43 | 0 | 16.8 | Hanford |
| 699-97-43 | 0 | 16.8 | Hanford |
| 699-97-43 | 16.8 | 30.48 | RUM |
| 699-97-43B | 0 | 14.6 | Hanford |
| 699-97-43B | 14.6 | 16.28 | RUM |
| 699-97-43C | 0 | 15.4 | Hanford |
| 699-97-43C | 15.4 | 38.4 | RUM |
| 699-97-45 | 0 | 12.2 | Hanford |
| 699-97-45 | 0 | 12.2 | Hanford |
| 699-97-45 | 12.2 | 13.93 | RUM |
| 699-97-45B | 0 | 12.1 | Hanford |
| 699-97-45B | 12.1 | 36.7 | RUM |
| 699-97-48B | 0 | 16.5 | Hanford |
| 699-97-48B | 16.5 | 18.05 | RUM |
| 699-97-48C | 0 | 16.8 | Hanford |
| 699-97-48C | 16.8 | 37.49 | RUM |
| 699-98-43 | 0 | 10.4 | Hanford |
| 699-98-43 | 10.4 | 12.04 | RUM |
| 699-98-46 | 0 | 12.3 | Hanford |
| 699-98-46 | 12.3 | 13.9 | RUM |
| 699-98-51 | 0 | 7.6 | Hanford |
| 699-98-51 | 7.6 | 9.17 | RUM |
| 699-99-41 | 0 | 12.2 | Hanford |
| 699-99-41 | 12.2 | 13.9 | RUM |
| 699-99-42B | 0 | 13.9 | Hanford |
| 699-99-42B | 13.9 | 15.73 | RUM |
| 699-99-44 | 0 | 9.9 | Hanford |
| 699-99-44 | 9.9 | 11.43 | RUM |

| Well Name | From | To | Lithology |
|---|---|---|---|
| B2539 | 0 | 13.4 | Hanford |
| B2539 | 13.4 | 19.7 | Ringold E |
| C6446 | 0 | 15.21 | Hanford |
| C6446 | 15.21 | 16.8 | Ringold E |
| C6449 | 0 | 11.55 | Hanford |
| C6449 | 11.55 | 16.5 | Ringold E |
| C6450 | 0 | 14.01 | Hanford |
| C6450 | 14.01 | 15.2 | Ringold E |
| C7850 | 0 | 15.5 | Hanford |
| C7850 | 15.5 | 22 | Ringold E |
| C7855 | 0 | 15.2 | Hanford |
| C7855 | 15.2 | 27.8 | Ringold E |
| C7971 | 0 | 8.8 | Hanford |
| C7971 | 8.8 | 10.21 | RUM |
| C8205 | 0 | 7.02 | Hanford |
| C8205 | 7.02 | 51.82 | Ringold E |
| C8205 | 51.82 | 56.81 | RUM |
| control_1 | 0 | 8.8 | Hanford |
| control_1 | 8.8 | 100 | RUM |
| control_10 | 0 | 86.5 | Hanford |
| control_10 | 86.5 | 100 | RUM |
| control_11 | 0 | 88.5 | Hanford |
| control_11 | 88.5 | 100 | RUM |
| control_12 | 0 | 91.67 | Hanford |
| control_12 | 91.67 | 100 | RUM |
| control_13 | 0 | 45.97 | Hanford |
| control_13 | 45.97 | 100 | RUM |
| control_2 | 0 | 15.6 | Hanford |
| control_2 | 15.6 | 100 | RUM |
| control_3 | 0 | 85.24 | Hanford |
| control_3 | 85.24 | 100 | RUM |
| control_4 | 0 | 89.61 | Hanford |
| control_4 | 89.61 | 100 | RUM |
| control_5 | 0 | 97.25 | Hanford |
| control_5 | 97.25 | 100 | RUM |
| control_6 | 0 | 100 | Hanford |
| control_6 | 100 | 130 | RUM |
| control_7 | 0 | 93.5 | Hanford |
| control_7 | 93.5 | 100 | RUM |
| control_8 | 0 | 87.75 | Hanford |

| Well Name | From | To | Lithology |
|---|---|---|---|
| control_8 | 87.75 | 100 | RUM |
| control_9 | 0 | 80.5 | Hanford |
| control_9 | 80.5 | 100 | RUM |

# Attachment B

## Software Installation and Checkout Form for Leapfrog Hydro®

## 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: Leapfrog Hydro  Software Version No.: 2.0

**EXECUTABLE INFORMATION:**

2. Executable Name (include path):
   c:\aranzgeo\leapfrog2.0\bin\hydro.exe
3. Executable Size (bytes): 3.7MB

**COMPILATION INFORMATION:**

4. Hardware System (i.e., property number or ID):
   Vendor supplied
5. Operating System (include version number):
   Vendor supplied

**INSTALLATION AND CHECKOUT INFORMATION:**

6. Hardware System (i.e., property number or ID):
   Dell Inspiron Laptop, Dell Express Service #14610748609
7. Operating System (include version number):
   Windows 7 Professional Edition
8. Open Problem Report? (◉) No ( ) Yes  PR/CR No.

**TEST CASE INFORMATION:**

9. Directory/Path:
   c:\test\leapfrog\
10. Procedure(s):
   CHPRC-01754 Rev. 0, Leapfrog Hydro Software Test Plan
11. Libraries:
   N/A
12. Input Files:
   Per CHPRC-01754
13. Output Files:
   Per CHPRC-01754
14. Test Cases:
   Vendor installation package; TC-1, TC-2, TC-3, TC-4
15. Test Case Results:
   Pass
16. Test Performed By: Patrick Royer (INTERA)
17. Test Results: (◉) Satisfactory, Accepted for Use ( ) Unsatisfactory
18. Disposition (include HISI update):
   Accepted

**CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)**

1. Software Name: Leapfrog Hydro — Software Version No.: 2.0

**Prepared By:**

| | Signature | Print | Date |
|---|---|---|---|
| 19. Software Owner (Signature) | [signature] | William E Nichols | 27 AUG 2013 |
| 20. Test Personnel: Sign | [signature] | Patrick Royer | 8/27/2013 |
| Sign | | | |
| Sign | | | |

**Approved By:**

| | Signature | Print | Date |
|---|---|---|---|
| 21. Software SME (Signature) | | (Not required per SMP) | |

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# Appendix B

# Columbia River Stage Calculations

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# Contents



# Figures



# Table

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# B1 Introduction

This appendix presents regression equations used to estimate the stage of the Columbia River at the location of the 100-B and 100-F groundwater operable units. The river stage at these locations is estimated from measurements of the stage of the river downstream of Priest Rapids Dam, for which piece-wise continuous measurements are available as documented in ECF-Hanford-13-0028, *Columbia River Stage Correlation for the Hanford Area*. For consistency, since the river boundary for the 100 Area groundwater model (100AGWM) as documented in this report is defined using results of the application of regression equations to estimate the stage of the Columbia River at 100-D, 100-H, 100-K, and 100-N, the linear regression approach used here to estimate the river stage at 100-B and 100-F mimics the technique presented in ECF-Hanford-13-0028. It is noted, however, that ECF-Hanford-13-0028 is currently being revised and expanded in the following ways, and that subsequent releases of the 100AGWM will incorporate these updates in the definition of the river boundary:

- Incorporate and document calculations for estimation of river stage at all 100 Area groundwater operable units in addition to the 300 Area, within a single calculation file.
- Correct some input data sets for daylight savings time adjustments.
- Improve the estimate of the lag-times at each gauge, using 15 minute data.
- Implement a non-linear regression incorporating both lag-time estimation and a simple diffusive-wave approximation to both lag and dampen stage-changes at river gauges with increasing distance from Priest Rapids Dam.
- Incorporate data recording the stage of the lake formed by the downstream McNary Dam in the estimation of river stage at the 300 Area.

### *River Stage Regression for 100-B*

The following charts and tables illustrate the river-stage regression analysis for the 100-B Area. The automated water level network gauge river stage data at 100-B was plotted against the stage at Priest Rapids Dam lagged by an hour (Figure B-1). A linear trend line was fitted to the data to develop the regression equation for the 100-B Area. The quality of the regression is presented in subsequent plots and tables.

Summary statistics for the residuals, evaluated by subtracting the regression-calculated values from the measured values, are presented in Table B-1. The measured and calculated residuals are plotted against each other in Figure B-2. A time-series plot of the measured and calculated river stages is presented in Figure B-3. A histogram of the residuals is shown in Figure B-4. The data suggest that there is higher variability at low river stage than high river stage. The regression plot in Figure B-1 shows that the coefficient of determination ($R^2$) is high. The mean and median residuals are close to zero, indicating the lack of bias in the regression.

### *River Stage Regression for 100-F*

The following charts and tables illustrate the river-stage regression analysis for the 100-F Area. The automated water level network gauge river stage data at 100-F was plotted against the stage at Priest Rapids Dam lagged by three hours (Figure B-5). A linear trend line was fitted to the data to develop the regression equation for the 100-F Area. The quality of the regression is presented in subsequent plots and tables.

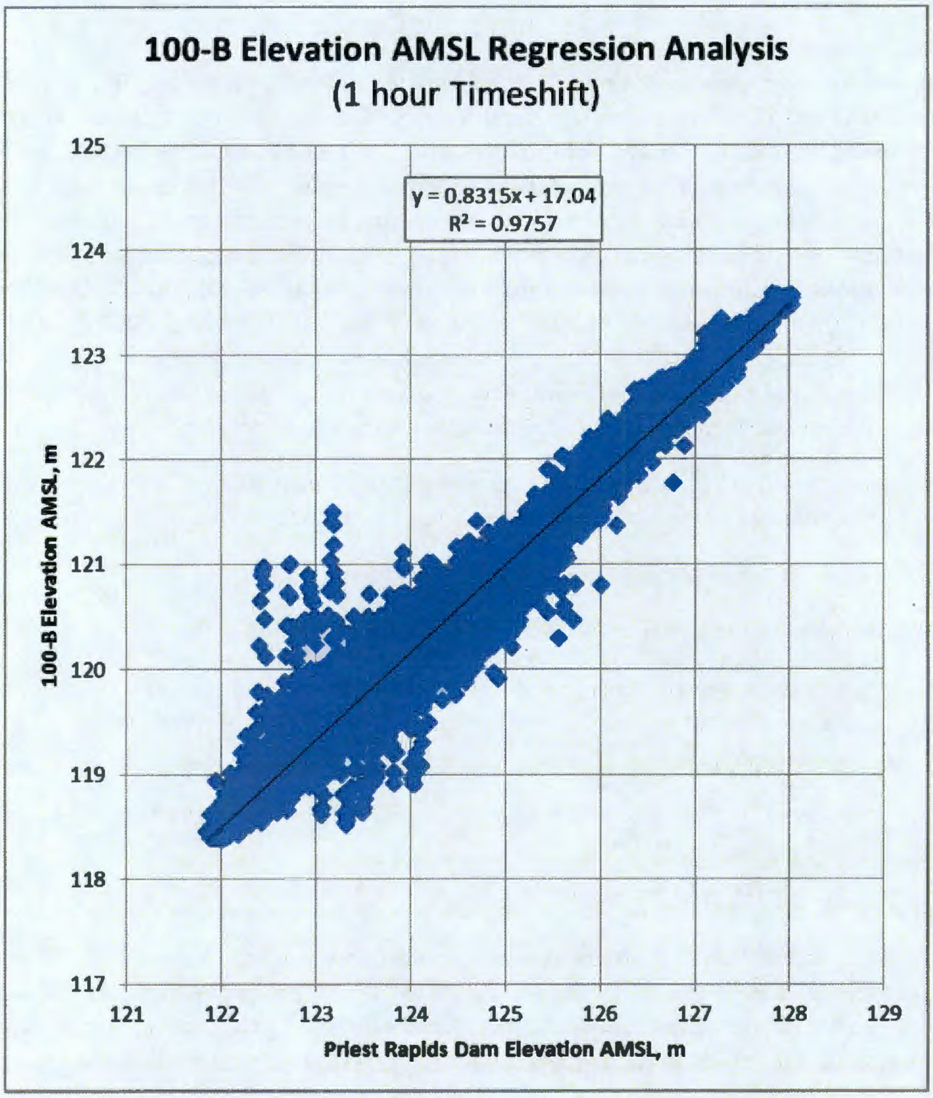


**Figure B-1. Regression Analysis of 100-B River Stage Data**

**Table B-1. 100-B Regression Residual Statistics**

| Property | Value | Units |
|---|---|---|
| Mean | 0.004 | m |
| Median | -0.001 | m |
| Standard Deviation | 0.165 | m |
| Standard Error | 0.001 | m |
| Minimum | -1.277 | m |
| Maximum | 2.120 | m |

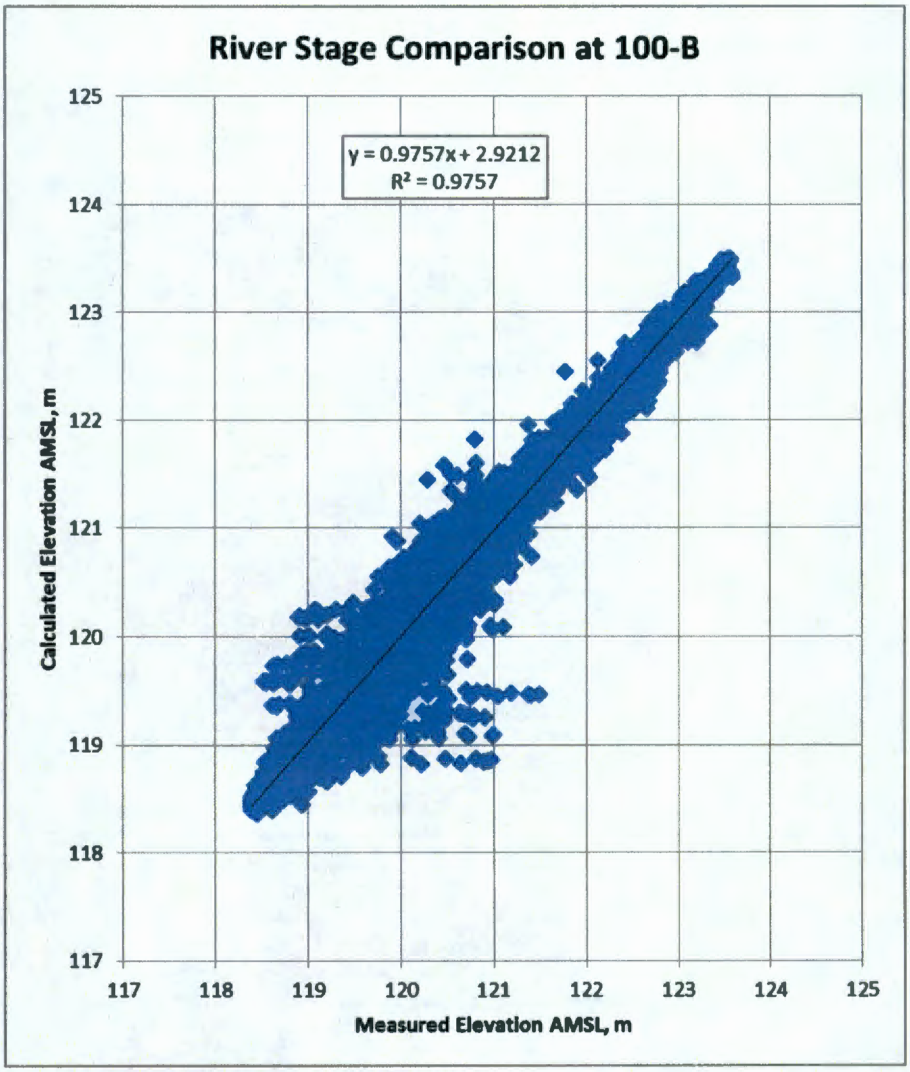


**Figure B-2. Measured Versus Regression-Calculated River Stage at 100-B**

Summary statistics for the residuals, evaluated by subtracting the regression-calculated values from the measured values, are presented in Table B-2. The measured and calculated residuals are plotted against each other in Figure B-6. A time-series plot of the measured and calculated river stages is presented in Figure B-7. A histogram of the residuals is shown in Figure B-8. The data suggest that there is higher variability at low river stage than high river stage. The regression plot in Figure B-5 shows that the coefficient of determination ($R^2$) is high. The mean and median residuals are close to zero, indicating the lack of bias in the regression.

## B2 Reference

ECF-Hanford-13-0028, 2014, *Columbia River Stage Correlation for the Hanford Area*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

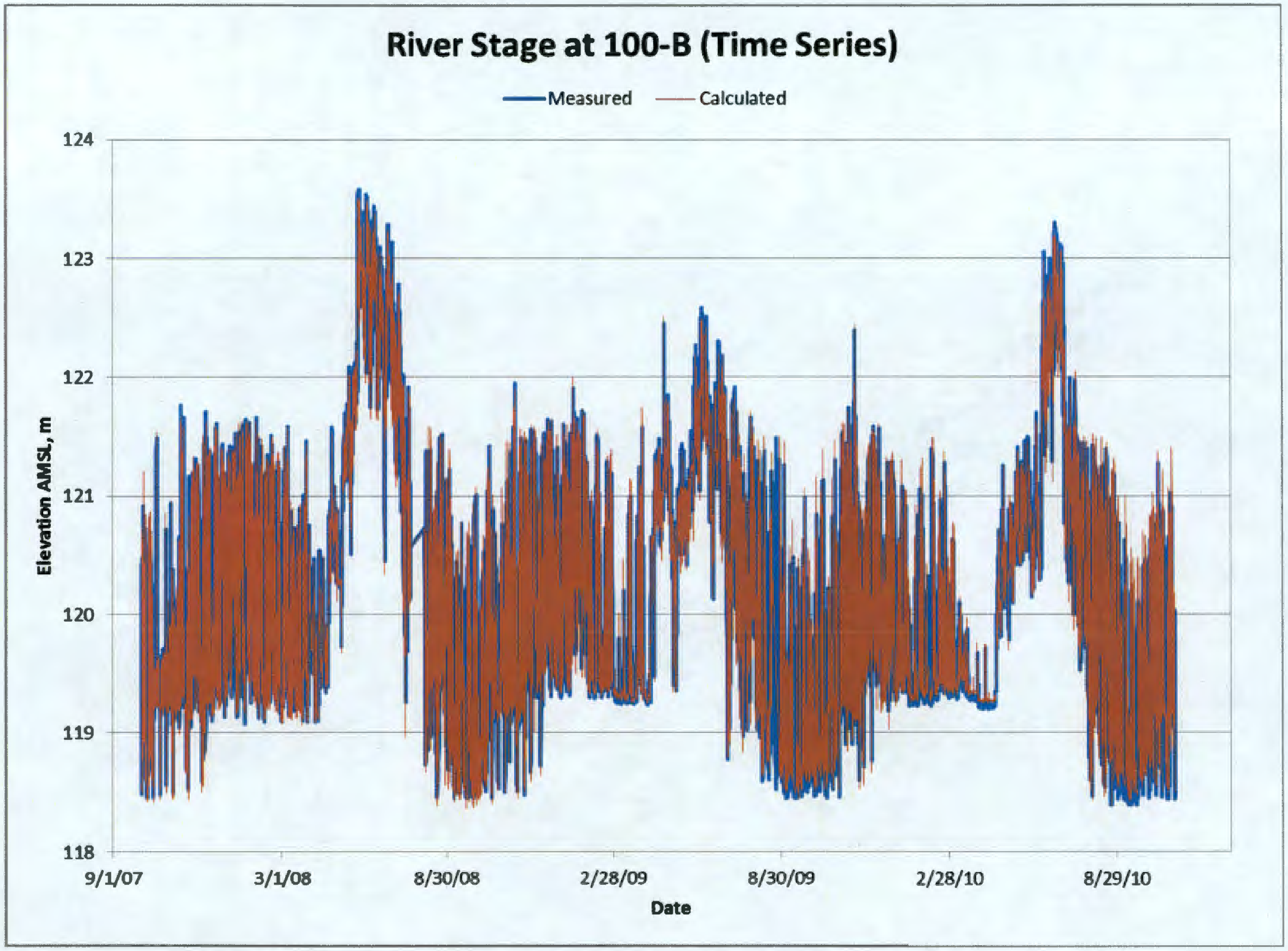


Figure B-3. Measured Versus Regression-Calculated River Stage (Time Series) at 100-B

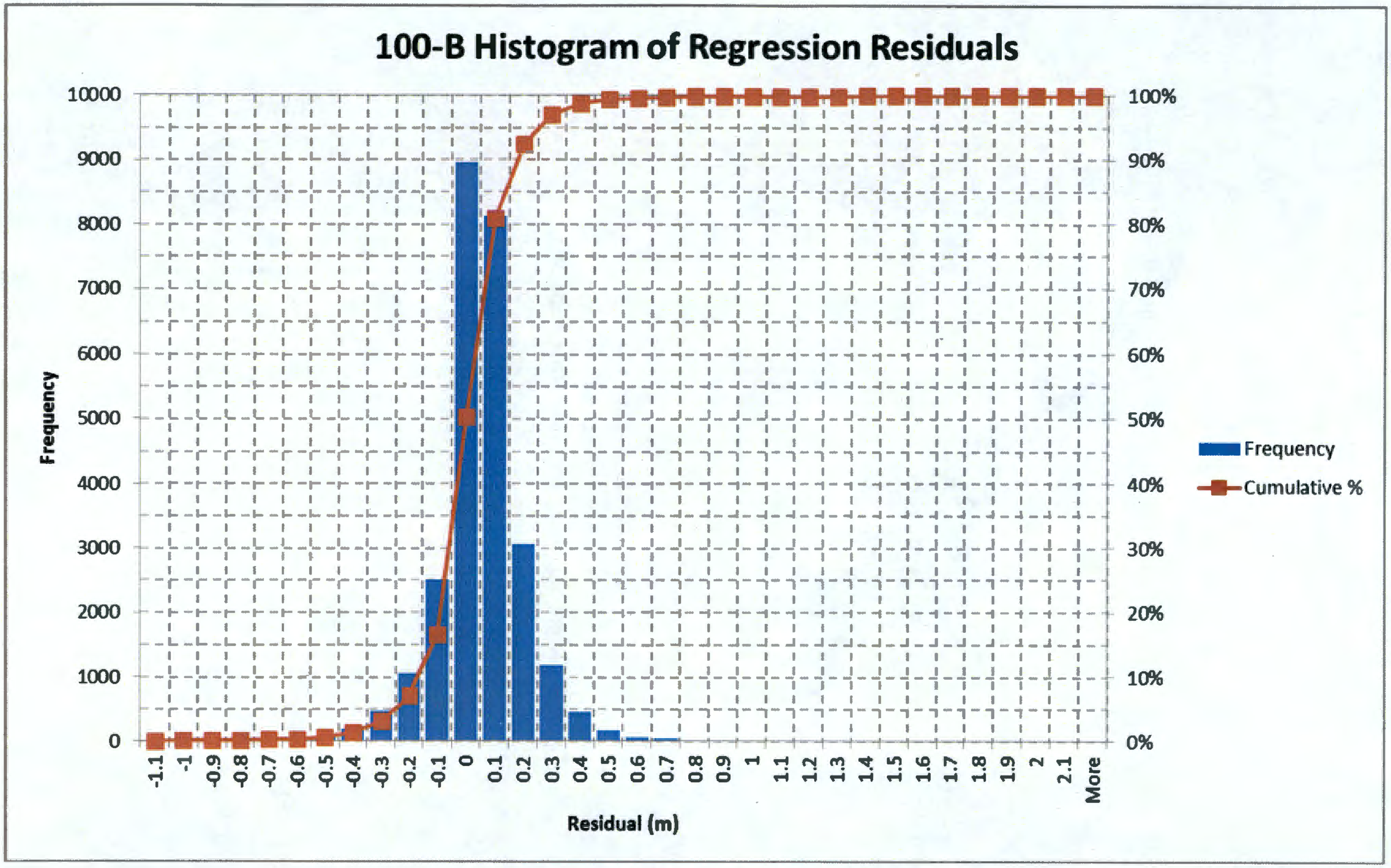


**Figure B-4. Histogram of Regression Residuals at 100-B**

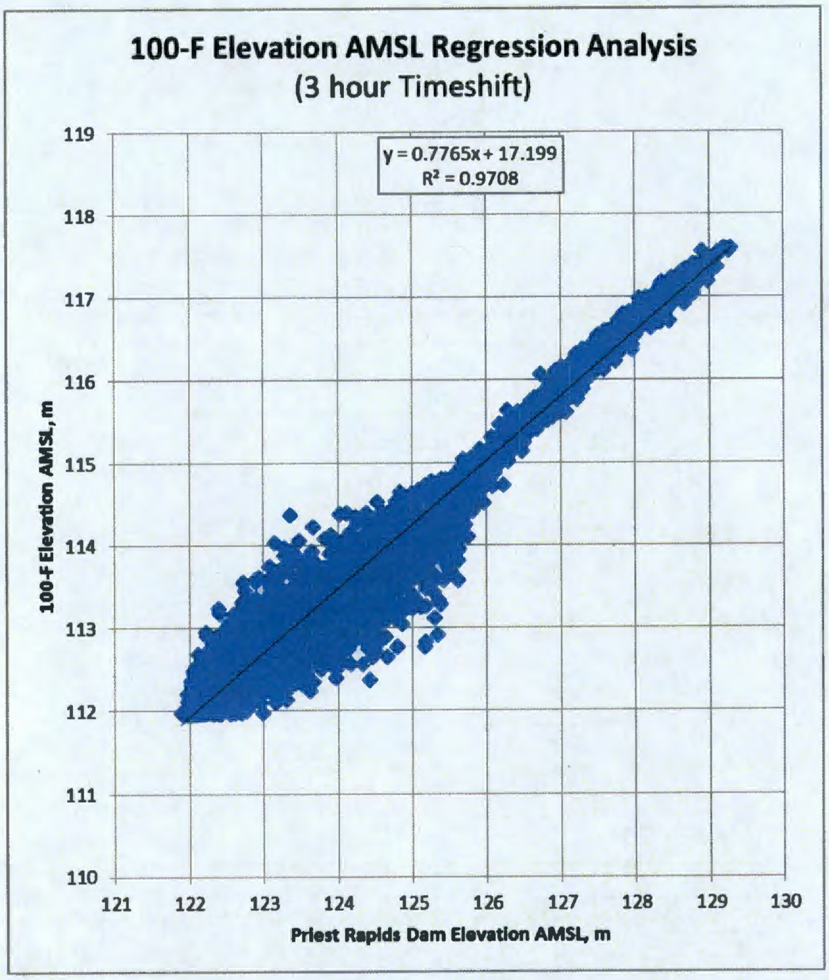


**Figure B-5. Regression Analysis of 100-F River Stage Data**

**Table B-2. 100-F Regression Residual Statistics**

| Property | Value | Units |
|---|---|---|
| Mean | -0.005 | meter |
| Median | 0.007 | meter |
| Standard Deviation | 0.249 | meter |
| Standard Error | 0.003 | meter |
| Minimum | -1.615 | meter |
| Maximum | 1.379 | meter |

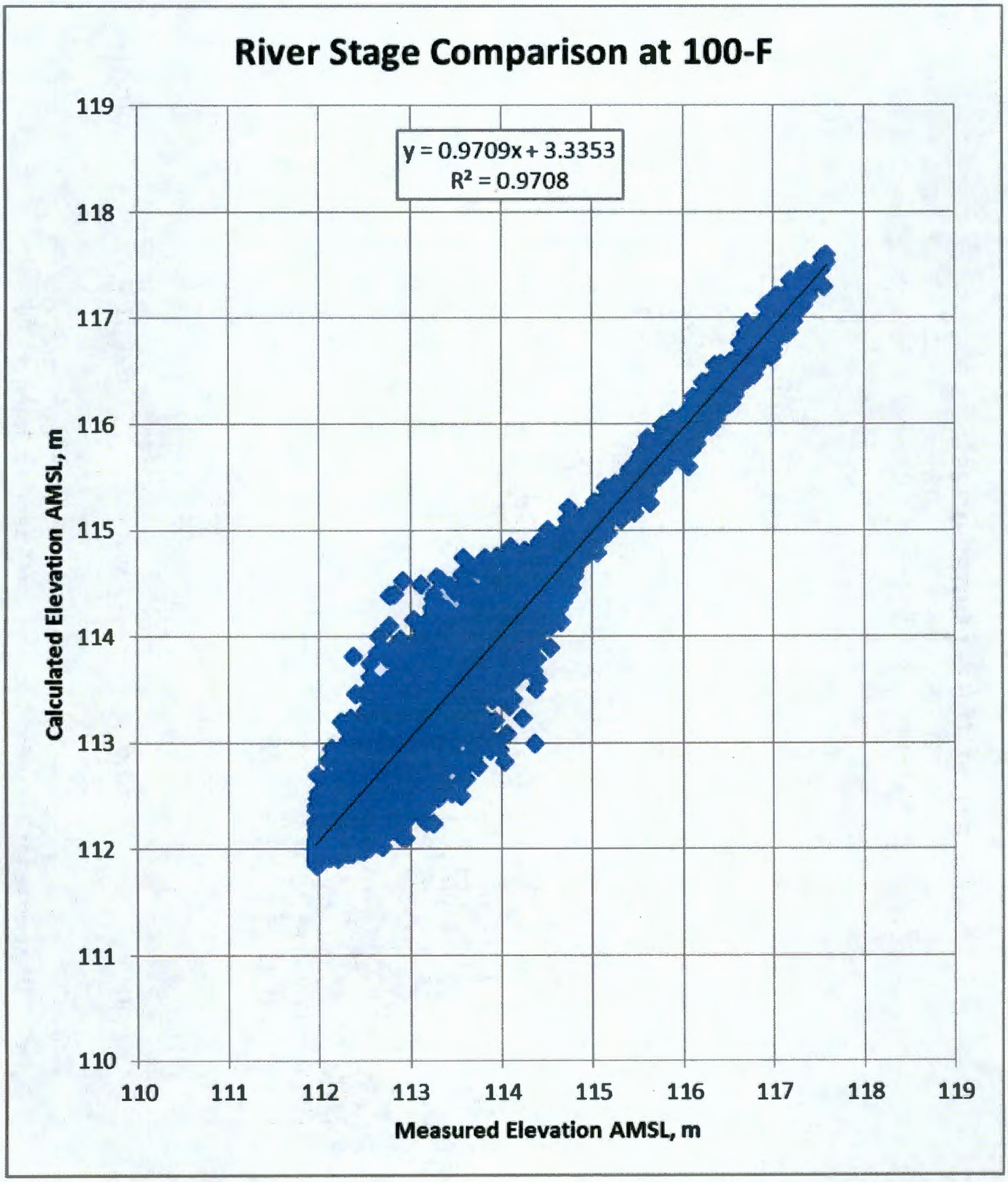


**Figure B-6. Measured Versus Regression-Calculated River Stage at 100-F**

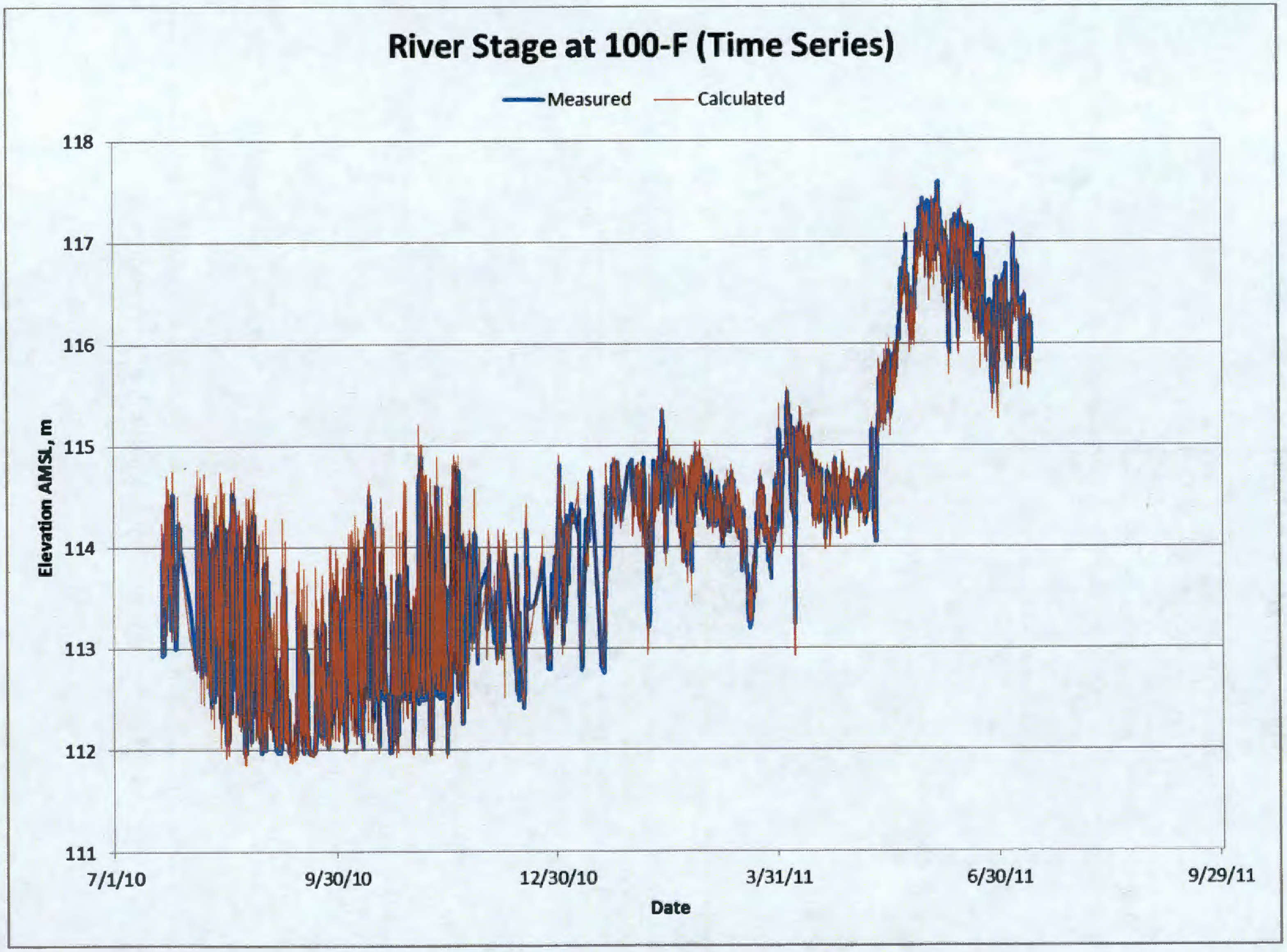


**Figure B-7. Measured Versus Regression-Calculated River Stage (Time Series) at 100-F**

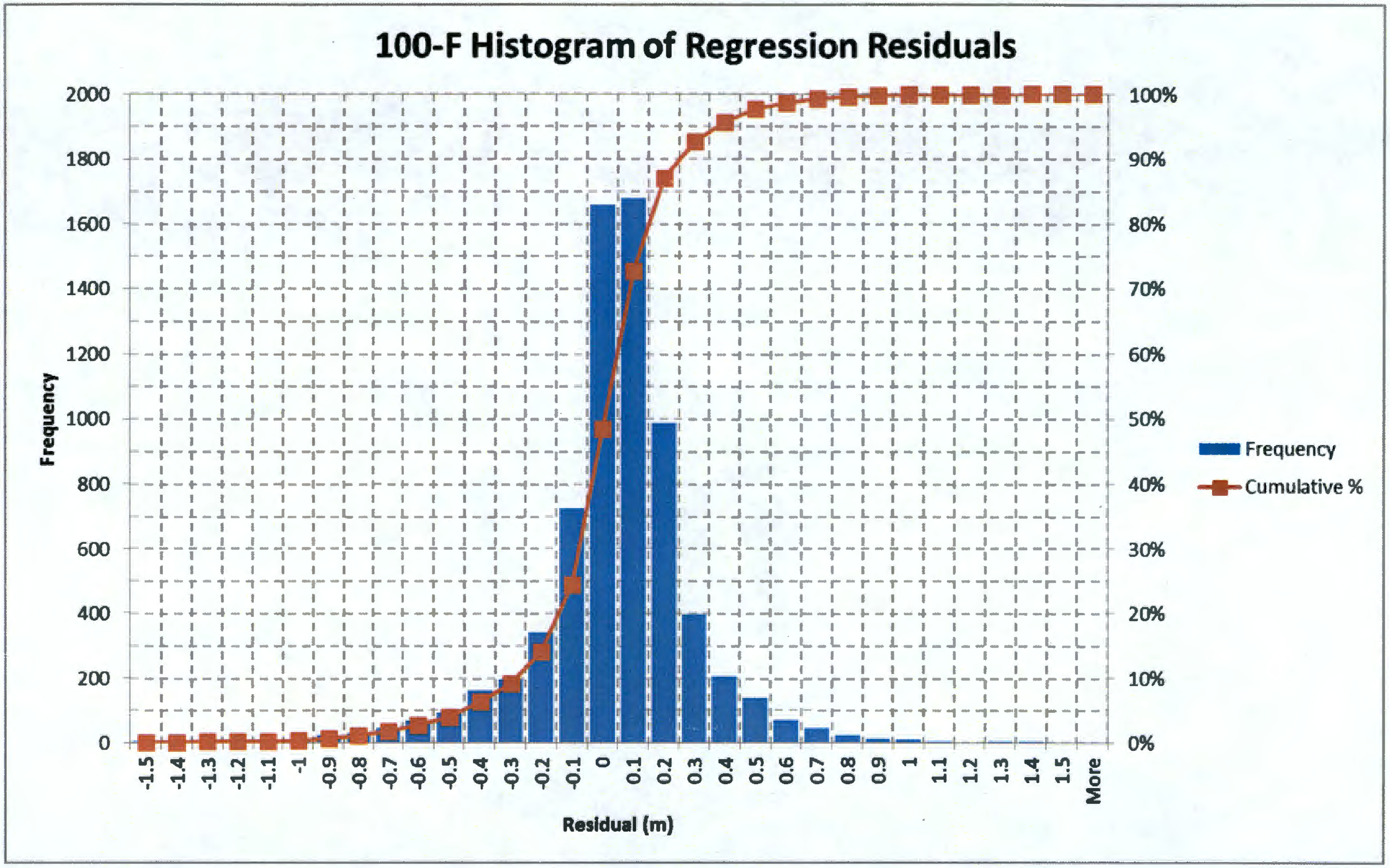


Figure B-8. Histogram of Regression Residuals at 100-F

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# Appendix C

# Pumping Well Information and Rates (2006 to 2014)

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# Contents



# Tables

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# C1 Introduction

Location and screen information for the pumping wells was obtained from two sources: HEIS database and "Well Construction" spreadsheets (provided by CHPRC). The well locations (Eastings and Northings) were obtained from the HEIS database. Screen elevations were not directly provided in the HEIS database. Instead, screen depths measured from a reference point were provided. The elevation of this reference point was provided either in the "DISC_Z" or in the "ELEVATION" attribute of the "WELLELEVATION" table. When the screen depths and the reference elevation were provided in HEIS, screen elevations were calculated. For wells with multiple screens, the entire screened interval was taken into account. When the screen elevations were not provided in the HEIS database, they were obtained from the "Well Construction" spreadsheets. The locations and screen information for all the pumping wells operating between 2006 and 2014 are provided in Table C-1. The well pumping rates, obtained from the HEIS database, are shown in Tables C-2 through C-7. Table C-8 presents average monthly pumping rates (gpm) (February 2009 to December 2011). Table C-9 provides the same information for January 2012 to December 2014). Table C-10 lists the rates for the DR5 treatment system (January 2006 to April 2011) and Table C-11 gives the information for the HR3 treatment system wells (January 2006 to May 2011).

**Table C-1. Pumping Well Location and Screen Information**

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-D2-10 | 199-D2-10_I_DX | DX | 574470.87 | 153465.19 | 6 | 15 | 117.29 | 112.72 | HEIS |
| 199-D2-12 | 199-D2-12_I_DX | DX | 574343.45 | 153300.01 | 6 | 15 | 116.96 | 112.39 | HEIS |
| 199-D4-101 | 199-D4-101_E_DX | DX | 572800.10 | 151425.94 | 6 | 20 | 118.86 | 112.76 | HEIS |
| 199-D4-14 | 199-D4-14_E_DX | DX | 572839.81 | 151641.64 | 6 | 20 | 120.28 | 114.17 | HEIS |
| 199-D4-34 | 199-D4-34_E_DX | DX | 572804.60 | 151590.03 | 6 | 15 | 118.22 | 113.64 | HEIS |
| 199-D4-38 | 199-D4-38_E_DX | DX | 572671.32 | 151537.86 | 6 | 20 | 119.86 | 113.76 | HEIS |
| 199-D4-39 | 199-D4-39_E_DX | DX | 572747.45 | 151650.84 | 6 | 20 | 120.57 | 114.47 | HEIS |
| 199-D4-83 | 199-D4-83_E_DX | DX | 572859.43 | 151723.42 | 6 | 15 | 119.42 | 114.85 | HEIS |
| 199-D4-84 | 199-D4-84_E_DX | DX | 572568.04 | 151433.52 | 6 | 25 | 120.48 | 112.86 | HEIS |
| 199-D4-85 | 199-D4-85_E_DX | DX | 572486.16 | 151324.20 | 6 | 30 | 119.53 | 110.39 | HEIS |
| 199-D4-95 | 199-D4-95_E_DX | DX | 572612.82 | 151226.70 | 6 | 35 | 119.24 | 108.57 | HEIS |
| 199-D4-96 | 199-D4-96_E_DX | DX | 572777.03 | 151519.78 | 6 | 10 | 117.38 | 114.33 | HEIS |
| 199-D4-97 | 199-D4-97_E_DX | DX | 572906.23 | 151625.33 | 6 | 15 | 117.02 | 112.45 | HEIS |
| 199-D4-98 | 199-D4-98_E_DX | DX | 572574.52 | 151481.65 | 6 | 20 | 118.66 | 112.56 | HEIS |
| 199-D4-99 | 199-D4-99_E_DX | DX | 572527.36 | 151377.08 | 6 | 30 | 119.47 | 110.32 | HEIS |
| 199-D5-101 | 199-D5-101_E_DX | DX | 572943.04 | 151521.52 | 6 | 30 | 120.59 | 111.44 | HEIS |
| 199-D5-104 | 199-D5-104_E_DR5 | DR5 | 573265.48 | 151422.43 | 6 | 30 | 119.66 | 110.52 | HEIS |
| 199-D5-104 | 199-D5-104_E_DX | DX | 573265.48 | 151422.43 | 6 | 30 | 119.66 | 110.52 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-D5-127 | 199-D5-127_E_DX | DX | 572992.26 | 151428.31 | 6 | 20 | 119.63 | 113.54 | HEIS |
| 199-D5-128 | 199-D5-128_I_DX | DX | 573622.40 | 151237.35 | 6 | 20 | 119.40 | 113.30 | HEIS |
| 199-D5-129 | 199-D5-129_I_DX | DX | 573735.50 | 151465.13 | 6 | 25 | 119.56 | 111.93 | HEIS |
| 199-D5-130 | 199-D5-130_E_DX | DX | 574039.20 | 151928.51 | 6 | 15 | 118.31 | 113.73 | HEIS |
| 199-D5-131 | 199-D5-131_E_DX | DX | 573684.39 | 152006.75 | 6 | 25 | 119.01 | 111.39 | HEIS |
| 199-D5-20 | 199-D5-20_E_DR5 | DR5 | 573239.97 | 152030.15 | 6 | 21 | 119.74 | 113.40 | Well Construction Data |
| 199-D5-20 | 199-D5-20_E_DX | DX | 573239.97 | 152030.15 | 6 | 21 | 119.74 | 113.40 | Well Construction Data |
| 199-D5-32 | 199-D5-32_E_DR5 | DR5 | 573372.04 | 151903.39 | 6 | 25 | 119.46 | 111.82 | Well Construction Data |
| 199-D5-32 | 199-D5-32_E_DX | DX | 573372.04 | 151903.39 | 6 | 25 | 119.46 | 111.82 | Well Construction Data |
| 199-D5-39 | 199-D5-39_E_DR5 | DR5 | 573142.86 | 151428.43 | 6 | 20 | 119.59 | 113.48 | HEIS |
| 199-D5-39 | 199-D5-39_E_DX | DX | 573142.86 | 151428.43 | 6 | 20 | 119.59 | 113.48 | HEIS |
| 199-D5-41 | 199-D5-41_I_DR5 | DR5 | 573358.16 | 151792.19 | 6 | 20 | 118.59 | 112.50 | HEIS |
| 199-D5-42 | 199-D5-42_I_DR5 | DR5 | 573479.77 | 151622.67 | 6 | 20 | 118.56 | 112.46 | HEIS |
| 199-D5-42 | 199-D5-42_I_DX | DX | 573479.77 | 151622.67 | 6 | 20 | 118.56 | 112.46 | HEIS |
| 199-D5-44 | 199-D5-44_I_DX | DX | 572993.58 | 151835.74 | 6 | 15 | 119.10 | 114.52 | HEIS |
| 199-D5-92 | 199-D5-92_E_DR5 | DR5 | 573131.93 | 152009.82 | 6 | 21 | 119.43 | 113.03 | HEIS |
| 199-D5-92 | 199-D5-92_E_DX | DX | 573131.93 | 152009.82 | 6 | 21 | 119.43 | 113.03 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-D6-1 | 199-D6-1_I_DX | DX | 574129.87 | 151691.71 | 6 | 20 | 119.84 | 113.74 | HEIS |
| 199-D6-2 | 199-D6-2_I_DX | DX | 574544.61 | 151970.20 | 6 | 25 | 119.40 | 111.77 | HEIS |
| 199-D7-3 | 199-D7-3_E_DX | DX | 574151.38 | 152363.41 | 6 | 35 | 120.97 | 110.30 | HEIS |
| 199-D7-4 | 199-D7-4_I_DX | DX | 574377.07 | 152369.64 | 6 | 20 | 118.52 | 112.42 | HEIS |
| 199-D7-5 | 199-D7-5_I_DX | DX | 574434.31 | 152678.72 | 6 | 20 | 121.32 | 115.22 | HEIS |
| 199-D7-6 | 199-D7-6_E_DX | DX | 574429.20 | 152980.43 | 6 | 20 | 120.31 | 114.19 | HEIS |
| 199-D8-53 | 199-D8-53_E_DX | DX | 573889.86 | 152452.26 | 6 | 21 | 119.18 | 112.93 | Well Construction Data |
| 199-D8-53 | 199-D8-53_E_HR3 | HR3 | 573889.86 | 152452.26 | 6 | 21 | 119.18 | 112.93 | Well Construction Data |
| 199-D8-54A | 199-D8-54A_E_HR3 | HR3 | 573781.17 | 152408.03 | 6 | 21 | 119.23 | 112.80 | Well Construction Data |
| 199-D8-55 | 199-D8-55_I_DX | DX | 573620.95 | 152364.35 | 6 | 21 | 118.66 | 112.41 | HEIS |
| 199-D8-6 | 199-D8-6_E_DX | DX | 573434.69 | 152060.82 | 6 | 20 | 118.75 | 112.56 | HEIS |
| 199-D8-68 | 199-D8-68_E_DX | DX | 573711.67 | 152427.10 | 6 | 25 | 120.19 | 112.57 | HEIS |
| 199-D8-68 | 199-D8-68_E_HR3 | HR3 | 573711.67 | 152427.10 | 6 | 25 | 120.19 | 112.57 | HEIS |
| 199-D8-69 | 199-D8-69_E_DX | DX | 573843.61 | 152552.20 | 6 | 20 | 119.22 | 113.13 | HEIS |
| 199-D8-72 | 199-D8-72_E_HR3 | HR3 | 573570.48 | 152211.77 | 6 | 20 | 118.66 | 112.71 | HEIS |
| 199-D8-73 | 199-D8-73_E_DX | DX | 573388.70 | 152167.38 | 6 | 17 | 120.06 | 114.88 | HEIS |
| 199-D8-88 | 199-D8-88_E_DX | DX | 573292.33 | 152141.26 | 6 | 21 | 118.41 | 111.99 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-D8-89 | 199-D8-89_E_DX | DX | 573478.64 | 152249.65 | 6 | 10 | 117.66 | 114.61 | HEIS |
| 199-D8-90 | 199-D8-90_E_DX | DX | 573948.64 | 152646.23 | 6 | 25 | 118.52 | 110.89 | HEIS |
| 199-D8-91 | 199-D8-91_E_DX | DX | 574036.89 | 152741.44 | 6 | 20 | 117.52 | 111.42 | HEIS |
| 199-D8-93 | 199-D8-93_I_DX | DX | 574148.70 | 153085.80 | 6 | 5 | 117.34 | 115.81 | HEIS |
| 199-D8-94 | 199-D8-94_I_DX | DX | 574047.82 | 152949.53 | 6 | 15 | 117.24 | 112.66 | HEIS |
| 199-D8-95 | 199-D8-95_E_DX | DX | 573611.96 | 152160.61 | 6 | 20 | 118.95 | 112.86 | HEIS |
| 199-D8-96 | 199-D8-96_E_DX | DX | 573706.00 | 152152.24 | 6 | 20 | 119.12 | 113.02 | HEIS |
| 199-D8-97 | 199-D8-97_E_DX | DX | 573859.56 | 152087.42 | 6 | 30 | 120.77 | 111.62 | HEIS |
| 199-D8-98 | 199-D8-98_E_DX | DX | 574013.12 | 152123.02 | 6 | 25 | 120.37 | 112.74 | HEIS |
| 199-D8-99 | 199-D8-99_I_DX | DX | 574006.77 | 152364.37 | 6 | 25 | 119.80 | 112.17 | HEIS |
| 199-H1-1 | 199-H1-1_E_HX | HX | 576702.31 | 153384.49 | 6 | 15 | 118.03 | 113.46 | HEIS |
| 199-H1-2 | 199-H1-2_E_HX | HX | 576451.07 | 153378.26 | 6 | 10 | 117.34 | 114.29 | HEIS |
| 199-H1-20 | 199-H1-20_I_HX | HX | 575706.04 | 154183.61 | 6 | 20 | 117.63 | 111.53 | HEIS |
| 199-H1-21 | 199-H1-21_I_HX | HX | 575896.84 | 154163.80 | 6 | 15 | 116.17 | 111.60 | HEIS |
| 199-H1-25 | 199-H1-25_E_HX | HX | 576279.64 | 154069.97 | 6 | 20 | 119.43 | 113.34 | HEIS |
| 199-H1-27 | 199-H1-27_E_HX | HX | 576403.86 | 154024.21 | 6 | 20 | 119.24 | 113.14 | HEIS |
| 199-H1-3 | 199-H1-3_E_HX | HX | 576163.04 | 153372.22 | 6 | 10 | 118.81 | 115.76 | HEIS |
| 199-H1-32 | 199-H1-32_E_HX | HX | 576767.07 | 153766.00 | 6 | 20 | 120.60 | 114.50 | HEIS |
| 199-H1-33 | 199-H1-33_E_HX | HX | 576833.29 | 153716.23 | 6 | 15 | 119.08 | 114.50 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-H1-34 | 199-H1-34_E_HX | HX | 576883.13 | 153667.06 | 6 | 15 | 118.47 | 113.90 | HEIS |
| 199-H1-35 | 199-H1-35_E_HX | HX | 576958.26 | 153628.14 | 6 | 15 | 117.80 | 113.23 | HEIS |
| 199-H1-36 | 199-H1-36_E_HX | HX | 576885.62 | 153486.51 | 6 | 15 | 118.45 | 113.87 | HEIS |
| 199-H1-37 | 199-H1-37_E_HX | HX | 577106.92 | 153641.63 | 6 | 15 | 118.28 | 113.70 | HEIS |
| 199-H1-38 | 199-H1-38_E_HX | HX | 577161.00 | 153555.01 | 6 | 15 | 118.16 | 113.58 | HEIS |
| 199-H1-39 | 199-H1-39_E_HX | HX | 577223.54 | 153533.40 | 6 | 15 | 118.56 | 113.98 | HEIS |
| 199-H1-4 | 199-H1-4_E_HX | HX | 575826.78 | 153366.87 | 6 | 10 | 118.37 | 115.32 | HEIS |
| 199-H1-40 | 199-H1-40_E_HX | HX | 577279.34 | 153500.19 | 6 | 15 | 118.94 | 114.37 | HEIS |
| 199-H1-42 | 199-H1-42_E_HX | HX | 577127.18 | 153391.65 | 6 | 10 | 116.04 | 112.99 | HEIS |
| 199-H1-43 | 199-H1-43_E_HX | HX | 577213.74 | 153384.28 | 6 | 10 | 115.59 | 112.55 | HEIS |
| 199-H1-45 | 199-H1-45_E_HX | HX | 577240.96 | 153062.41 | 6 | 15 | 116.05 | 111.47 | HEIS |
| 199-H1-5 | 199-H1-5_E_DX | DX | 574850.72 | 153090.30 | 6 | 25 | 119.09 | 111.47 | HEIS |
| 199-H1-6 | 199-H1-6_E_HX | HX | 576037.81 | 153745.74 | 6 | 10 | 117.55 | 114.50 | HEIS |
| 199-H3-25 | 199-H3-25_I_HX | HX | 577410.36 | 152978.49 | 6 | 20 | 117.52 | 111.42 | HEIS |
| 199-H3-26 | 199-H3-26_I_HX | HX | 577440.83 | 152846.50 | 6 | 15 | 116.65 | 112.07 | HEIS |
| 199-H3-27 | 199-H3-27_I_HX | HX | 577567.05 | 152811.14 | 6 | 20 | 117.45 | 111.36 | HEIS |
| 199-H3-2A | 199-H3-2A_E_HR3 | HR3 | 577624.61 | 152750.07 | 6 | 15 | 117.08 | 112.51 | HEIS |
| 199-H3-2A | 199-H3-2i_I_HR3 | HR3 | 577624.61 | 152750.07 | 6 | 15 | 117.08 | 112.51 | HEIS |
| 199-H3-3 | 199-H3-3_I_HR3 | HR3 | 577562.09 | 152363.17 | 6 | 20 | 119.21 | 113.12 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-H3-4 | 199-H3-4_E_HX | HX | 577544.29 | 152293.21 | 6 | 25 | 120.06 | 112.44 | HEIS |
| 199-H3-4 | 199-H3-4_I_HR3 | HR3 | 577544.29 | 152293.21 | 6 | 25 | 120.06 | 112.44 | HEIS |
| 199-H3-5 | 199-H3-5_I_HR3 | HR3 | 577454.70 | 152287.50 | 6 | 20 | 118.37 | 112.27 | HEIS |
| 199-H4-11 | 199-H4-11_E_HR3 | HR3 | 578141.91 | 152728.43 | 6 | 15 | 116.10 | 111.53 | HEIS |
| 199-H4-12A | 199-H4-12A_E_HR3 | HR3 | 578009.15 | 152912.73 | 6 | 15 | 116.41 | 111.84 | HEIS |
| 199-H4-14 | 199-H4-14_I_HR3 | HR3 | 577803.75 | 152752.36 | 6 | 15 | 117.03 | 112.46 | HEIS |
| 199-H4-14 | 199-H4-14_I_HX | HX | 577803.75 | 152752.36 | 6 | 15 | 117.03 | 112.46 | HEIS |
| 199-H4-15A | 199-H4-15A_E_HR3 | HR3 | 577904.31 | 153053.42 | 6 | 15 | 116.62 | 112.04 | HEIS |
| 199-H4-15A | 199-H4-15A_E_HX | HX | 577904.31 | 153053.42 | 6 | 15 | 116.62 | 112.04 | HEIS |
| 199-H4-17 | 199-H4-17_I_HR3 | HR3 | 577779.18 | 153037.64 | 6 | 10 | 117.69 | 114.64 | HEIS |
| 199-H4-17 | 199-H4-17_I_HX | HX | 577779.18 | 153037.64 | 6 | 10 | 117.69 | 114.64 | HEIS |
| 199-H4-18 | 199-H4-18_I_HR3 | HR3 | 578018.29 | 152756.48 | 6 | 10 | 116.91 | 113.86 | HEIS |
| 199-H4-18 | 199-H4-18_I_HX | HX | 578018.29 | 152756.48 | 6 | 10 | 116.91 | 113.86 | HEIS |
| 199-H4-3 | 199-H4-3_E_HR3 | HR3 | 577940.49 | 152858.54 | 6 | 21 | 118.12 | 111.72 | Well Construction Data |
| 199-H4-4 | 199-H4-4_E_HR3 | HR3 | 578060.86 | 152853.96 | 6 | 10 | 116.78 | 113.73 | Well Construction Data |
| 199-H4-4 | 199-H4-4_E_HX | HX | 578060.86 | 152853.96 | 6 | 10 | 116.78 | 113.73 | Well Construction Data |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-H4-63 | 199-H4-63_E_HR3 | HR3 | 578185.83 | 152665.53 | 6 | 20 | 116.52 | 110.44 | HEIS |
| 199-H4-63 | 199-H4-63_E_HX | HX | 578185.83 | 152665.53 | 6 | 20 | 116.52 | 110.44 | HEIS |
| 199-H4-64 | 199-H4-64_E_HR3 | HR3 | 577946.11 | 153010.58 | 6 | 20 | 118.64 | 112.55 | HEIS |
| 199-H4-64 | 199-H4-64_E_HX | HX | 577946.11 | 153010.58 | 6 | 20 | 118.64 | 112.55 | HEIS |
| 199-H4-65 | 199-H4-65_E_HR3 | HR3 | 577998.26 | 152787.29 | 6 | 10 | 116.94 | 113.89 | HEIS |
| 199-H4-69 | 199-H4-69_E_HX | HX | 578014.05 | 152686.66 | 6 | 10 | 115.44 | 112.39 | HEIS |
| 199-H4-7 | 199-H4-7_E_HR3 | HR3 | 577804.13 | 152890.85 | 6 | 15 | 117.17 | 112.60 | HEIS |
| 199-H4-70 | 199-H4-70_E_HX | HX | 578003.82 | 152646.45 | 6 | 10 | 115.89 | 112.84 | HEIS |
| 199-H4-71 | 199-H4-71_I_HX | HX | 578010.64 | 152581.53 | 6 | 15 | 116.06 | 111.47 | HEIS |
| 199-H4-72 | 199-H4-72_I_HX | HX | 578036.28 | 152500.14 | 6 | 15 | 116.21 | 111.63 | HEIS |
| 199-H4-73 | 199-H4-73_I_HX | HX | 577940.58 | 152369.98 | 6 | 20 | 116.13 | 110.03 | HEIS |
| 199-H4-74 | 199-H4-74_I_HX | HX | 577239.07 | 152268.83 | 6 | 15 | 118.34 | 113.77 | HEIS |
| 199-H4-75 | 199-H4-75_E_HX | HX | 577212.36 | 152704.64 | 6 | 15 | 118.03 | 113.45 | HEIS |
| 199-H4-76 | 199-H4-76_E_HX | HX | 576787.32 | 152976.85 | 6 | 10 | 118.38 | 115.33 | HEIS |
| 199-H4-77 | 199-H4-77_E_HX | HX | 576487.79 | 152975.43 | 6 | 10 | 117.95 | 114.91 | HEIS |
| 199-H4-78 | 199-H4-78_I_HX | HX | 576168.23 | 152166.12 | 6 | 20 | 117.96 | 111.86 | HEIS |
| 199-H4-79 | 199-H4-79_I_HX | HX | 575659.13 | 151989.31 | 6 | 20 | 119.39 | 113.29 | HEIS |
| 199-H4-80 | 199-H4-80_E_DX | DX | 575238.97 | 152568.16 | 6 | 35 | 119.83 | 109.17 | HEIS |
| 199-H4-81 | 199-H4-81_E_DX | DX | 575236.93 | 153035.36 | 6 | 20 | 119.15 | 113.05 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-H4-82 | 199-H4-82_E_DX | DX | 574906.99 | 152677.72 | 6 | 20 | 119.65 | 113.58 | HEIS |
| 199-H4-86 | 199-H4-86_E_HX | HX | 577704.55 | 152745.65 | 6 | 25 | 118.42 | 110.79 | HEIS |
| 199-H6-2 | 199-H6-2_I_HX | HX | 577886.50 | 152194.11 | 6 | 10 | 116.89 | 113.84 | HEIS |
| 199-K-112A | 199-K-112A_E_KR4 | KR4 | 570278.60 | 148503.44 | 6 | 25 | 120.18 | 112.54 | HEIS |
| 199-K-113A | 199-K-113A_E_KR4 | KR4 | 570098.07 | 148294.45 | 6 | 20 | 119.85 | 113.74 | HEIS |
| 199-K-114A | 199-K-114A_E_KR4 | KR4 | 570020.30 | 148280.55 | 6 | 15 | 119.32 | 114.73 | HEIS |
| 199-K-115A | 199-K-115A_E_KR4 | KR4 | 569939.99 | 148135.42 | 6 | 30 | 120.22 | 111.06 | HEIS |
| 199-K-116A | 199-K-116A_E_KR4 | KR4 | 569871.15 | 147960.50 | 6 | 55 | 120.53 | 103.70 | HEIS |
| 199-K-118A | 199-K-118A_E_KR4 | KR4 | 569703.06 | 147865.90 | 6 | 40 | 120.37 | 108.08 | HEIS |
| 199-K-119A | 199-K-119A_E_KR4 | KR4 | 569661.80 | 147649.69 | 6 | 50 | 121.47 | 106.23 | HEIS |
| 199-K-120A | 199-K-120A_E_KR4 | KR4 | 569399.62 | 147518.48 | 6 | 75 | 120.42 | 97.56 | HEIS |
| 199-K-121A | 199-K-121A_I_KR4 | KR4 | 570017.17 | 147418.26 | 6 | 30 | 123.74 | 114.58 | HEIS |
| 199-K-122A | 199-K-122A_I_KR4 | KR4 | 569975.07 | 147172.86 | 6 | 30 | 122.62 | 113.48 | HEIS |
| 199-K-123A | 199-K-123A_I_KR4 | KR4 | 569931.10 | 147090.24 | 6 | 30 | 124.56 | 115.40 | HEIS |

## Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-K-124A | 199-K-124A_I_KR4 | KR4 | 569867.94 | 146991.67 | 6 | 35 | 125.71 | 115.01 | HEIS |
| 199-K-125A | 199-K-125A_E_KR4 | KR4 | 569712.87 | 147866.01 | 6 | 40 | 120.42 | 108.23 | HEIS |
| 199-K-127 | 199-K-127_E_KR4 | KR4 | 569539.23 | 147539.00 | 6 | 60 | 119.96 | 101.66 | Well Construction Data |
| 199-K-128 | 199-K-128_I_KR4 | KR4 | 570009.54 | 147257.52 | 6 | 35 | 126.74 | 116.06 | Well Construction Data |
| 199-K-129 | 199-K-129_E_KR4 | KR4 | 570283.65 | 148503.07 | 6 | 25 | 120.04 | 112.42 | HEIS |
| 199-K-130 | 199-K-130_E_KX | KX | 570478.99 | 148661.18 | 6 | 30 | 119.67 | 110.49 | HEIS |
| 199-K-131 | 199-K-131_E_KX | KX | 570662.00 | 148903.85 | 6 | 30 | 118.62 | 109.47 | HEIS |
| 199-K-132 | 199-K-132_E_KW | KW | 568495.12 | 146670.82 | 6 | 25 | 120.71 | 113.09 | HEIS |
| 199-K-137 | 199-K-137_E_KW | KW | 568653.37 | 146374.51 | 6 | 50 | 128.16 | 112.92 | HEIS |
| 199-K-138 | 199-K-138_E_KW | KW | 568395.22 | 146616.64 | 6 | 35 | 119.48 | 108.82 | HEIS |
| 199-K-139 | 199-K-139_E_KW | KW | 568551.39 | 146518.39 | 6 | 35 | 123.42 | 112.75 | HEIS |
| 199-K-140 | 199-K-140_E_KW | KW | 568493.07 | 146493.66 | 6 | 35 | 123.36 | 112.69 | HEIS |
| 199-K-141 | 199-K-141_E_KX | KX | 569024.22 | 146818.49 | 6 | 35 | 119.32 | 108.65 | HEIS |
| 199-K-143 | 199-K-143_I_KX | KX | 570934.41 | 148088.28 | 6 | 35 | 119.53 | 108.88 | HEIS |
| 199-K-144 | 199-K-144_E_KR4 | KR4 | 569163.34 | 147265.96 | 6 | 75 | 120.52 | 97.66 | HEIS |
| 199-K-145 | 199-K-145_E_KR4 | KR4 | 569284.60 | 147425.66 | 6 | 100 | 120.02 | 89.54 | HEIS |
| 199-K-145 | 199-K-145_E_KX | KX | 569284.60 | 147425.66 | 6 | 100 | 120.02 | 89.54 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-K-146 | 199-K-146_E_KX | KX | 570197.60 | 148379.78 | 6 | 25 | 119.88 | 112.26 | HEIS |
| 199-K-147 | 199-K-147_E_KX | KX | 570411.64 | 148558.07 | 6 | 20 | 117.39 | 111.29 | HEIS |
| 199-K-148 | 199-K-148_E_KX | KX | 570584.74 | 148767.86 | 6 | 40 | 119.83 | 107.64 | HEIS |
| 199-K-149 | 199-K-149_E_KX | KX | 570778.25 | 148970.74 | 6 | 40 | 120.17 | 107.97 | HEIS |
| 199-K-150 | 199-K-150_E_KX | KX | 570787.67 | 149051.93 | 6 | 50 | 120.49 | 105.25 | HEIS |
| 199-K-152 | 199-K-152_E_KX | KX | 570736.25 | 148585.89 | 6 | 75 | 128.21 | 105.35 | HEIS |
| 199-K-153 | 199-K-153_E_KX | KX | 570530.04 | 148210.08 | 6 | 70 | 128.27 | 106.93 | HEIS |
| 199-K-154 | 199-K-154_E_KX | KX | 570321.06 | 148027.01 | 6 | 60 | 124.40 | 106.11 | HEIS |
| 199-K-156 | 199-K-156_I_KX | KX | 569674.01 | 147270.91 | 6 | 130 | 130.12 | 90.49 | HEIS |
| 199-K-158 | 199-K-158_I_KW | KW | 568627.45 | 146164.41 | 6 | 45 | 126.57 | 112.86 | HEIS |
| 199-K-159 | 199-K-159_I_KX | KX | 570911.73 | 149159.61 | 6 | 70 | 126.91 | 105.57 | HEIS |
| 199-K-160 | 199-K-160_I_KX | KX | 570919.58 | 149116.02 | 6 | 70 | 126.12 | 104.78 | HEIS |
| 199-K-161 | 199-K-161_E_KX | KX | 570004.64 | 148202.30 | 6 | 25 | 119.32 | 111.70 | HEIS |
| 199-K-162 | 199-K-162_E_KR4 | KR4 | 569340.00 | 147459.97 | 6 | 110 | 120.12 | 86.59 | HEIS |
| 199-K-162 | 199-K-162_E_KX | KX | 569340.00 | 147459.97 | 6 | 110 | 120.12 | 86.59 | HEIS |
| 199-K-163 | 199-K-163_E_KX | KX | 570230.66 | 147947.93 | 6 | 70 | 126.76 | 105.42 | HEIS |
| 199-K-164 | 199-K-164_I_KX | KX | 571202.22 | 148903.74 | 6 | 70 | 127.90 | 106.57 | HEIS |
| 199-K-165 | 199-K-165_E_KW | KW | 568674.96 | 146342.42 | 6 | 110 | 128.39 | 94.86 | HEIS |
| 199-K-166 | 199-K-166_E_KW | KW | 568594.56 | 146342.97 | 6 | 100 | 124.43 | 93.95 | HEIS |

Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-K-168 | 199-K-168_E_KW | KW | 568544.37 | 146513.63 | 6 | 60 | 111.91 | 93.69 | HEIS |
| 199-K-169 | 199-K-169_I_KX | KX | 569988.97 | 147554.98 | 6 | 100 | 132.11 | 101.63 | HEIS |
| 199-K-170 | 199-K-170_I_KX | KX | 570009.01 | 147491.37 | 6 | 120 | 135.02 | 98.45 | HEIS |
| 199-K-171 | 199-K-171_E_KX | KX | 570544.03 | 147187.86 | 6 | 120 | 135.69 | 99.11 | HEIS |
| 199-K-171 | 199-K-171i_I_KX | KX | 570544.03 | 147187.86 | 6 | 120 | 135.69 | 99.11 | HEIS |
| 199-K-172 | 199-K-172_I_KX | KX | 570871.69 | 147166.37 | 6 | 100 | 134.50 | 104.02 | HEIS |
| 199-K-173 | 199-K-173_E_KW | KW | 568674.07 | 146266.88 | 6 | 60 | 126.42 | 108.14 | HEIS |
| 199-K-173 | 199-K-173_I_KW | KW | 568674.07 | 146266.88 | 6 | 60 | 126.42 | 108.14 | HEIS |
| 199-K-174 | 199-K-174_I_KW | KW | 568915.38 | 146222.47 | 6 | 60 | 127.43 | 109.14 | HEIS |
| 199-K-175 | 199-K-175_I_KW | KW | 568882.72 | 146008.84 | 6 | 60 | 126.89 | 108.61 | HEIS |
| 199-K-178 | 199-K-178_E_KX | KX | 568963.01 | 146954.43 | 6 | 60 | 124.22 | 105.91 | HEIS |
| 199-K-179 | 199-K-179_I_KR4 | KR4 | 569847.25 | 147481.92 | 6 | 100 | 127.04 | 96.55 | HEIS |
| 199-K-180 | 199-K-180_I_KX | KX | 571116.08 | 147449.14 | 6 | 90 | 127.66 | 100.24 | HEIS |
| 199-K-182 | 199-K-182_E_KX | KX | 571185.32 | 148350.24 | 6 | 65 | 125.88 | 106.05 | HEIS |
| 199-K-196 | 199-K-196_E_KW | KW | 568433.30 | 146639.26 | 6 | 95 | 122.98 | 94.03 | HEIS |
| 199-K-196 | 199-K-196_I_KW | KW | 568433.30 | 146639.26 | 6 | 95 | 122.98 | 94.03 | HEIS |
| 199-K-198 | 199-K-198_E_KR4 | KR4 | 569304.19 | 147551.86 | 6 | 40 | 119.39 | 107.19 | HEIS |
| 199-K-199 | 199-K-199_E_KR4 | KR4 | 569339.76 | 147585.30 | 6 | 30 | 105.44 | 96.29 | HEIS |

## Table C-1. Pumping Well Location and Screen Information

| Well Name | Model Identifier | Treatment System | Easting (m) | Northing (m) | Well Diameter (inches) | Screen Length (ft) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Source for Screen Elevations |
|---|---|---|---|---|---|---|---|---|---|
| 199-K-35 | 199-K-35_I_KW | KW | 568832.33 | 146110.68 | 6 | 20 | 123.83 | 117.74 | Well Construction Data |
| 199-D5-146 | 199-D5-146_E_DX | DX | 573219.79 | 151345.59 | 6 | 35 | 120.74 | 110.06 | HEIS |
| 199-D5-148 | 199-D5-148_I_DX | DX | 573361.48 | 151083.48 | 6 | 40 | 122.62 | 110.43 | HEIS |
| 199-D5-153 | 199-D5-153_E_DX | DX | 573329.77 | 151992.82 | 6 | 25 | 119.24 | 111.61 | HEIS |
| 199-D8-55 | 199-D8-55_E_DX | DX | 573620.95 | 152364.35 | 6 | 21 | 118.66 | 112.41 | HEIS |
| 199-K-181 | 199-K-181_E_KX | KX | 568849.75 | 146892.82 | 6 | 60 | 125.00 | 106.71 | HEIS |
| 199-K-205 | 199-K-205_E_KW | KW | 568845.67 | 146090.86 | 6 | 100 | 123.62 | 93.13 | HEIS |
| 199-K-206 | 199-K-206_I_KW | KW | 568734.33 | 146049.54 | 6 | 100 | 125.75 | 95.26 | HEIS |
| 199-K-210 | 199-K-210_E_KX | KX | 569058.13 | 147155.25 | 6 | 100d | 120.73 | 90.23 | HEIS |
| 199-K-212 | 199-K-212_E_KX | KX | 569954.44 | 148047.71 | 6 | 45 | 119.87 | 106.14 | HEIS |
| 199-K-220 | 199-K-220_E_KX | KX | 569356.25 | 146417.52 | 6 | 95 | 124.30 | 95.33 | HEIS |

ft = foot
HEIS = Hanford Environmental Information System
m = meter

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**Table C-2. Average Monthly Pumping Rates (gpm) for Wells in the DX Treatment System (Dec 2010 to Dec 2012): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | D-10 | J-11 | F-11 | M-11 | A-11 | M-11 | J-11 | J-11 | A-11 | S-11 | O-11 | N-11 | D-11 | J-12 | F-12 | M-12 | A-12 | M-12 | J-12 | J-12 | A-12 | S-12 | O-12 | N-12 | D-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D2-10 | 1.4 | 2.8 | 2.8 | 0.4 | 0.5 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.6 | 0.1 | 0.1 | 0.0 | 1.2 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 1.2 |
| 199-D2-12 | 4.3 | 8.9 | 11.6 | 4.0 | 2.1 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 5.7 | 3.3 | 2.4 | 3.7 | 5.7 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 2.4 | 3.1 | 2.4 |
| 199-D4-101 | -1.6 | -3.3 | -4.0 | -2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -7.1 | -8.5 | -4.6 | 0.0 | -4.0 | -7.5 | -8.0 | -7.5 | -7.7 | -7.9 |
| 199-D4-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D4-34 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D4-38 | -4.1 | -8.5 | -8.0 | -7.6 | -7.7 | -6.3 | -7.7 | -9.0 | -7.7 | -8.5 | -8.0 | -5.7 | 0.0 | 0.0 | 0.0 | -6.4 | -8.0 | -8.0 | -7.8 | -8.0 | -8.0 | -8.0 | -7.5 | -7.7 | -7.9 |
| 199-D4-39 | -8.5 | -17.6 | -16.3 | -16.1 | -14.1 | -11.2 | -17.7 | -15.3 | -13.6 | -12.7 | -16.7 | -16.6 | -15.4 | -15.0 | -14.1 | -15.9 | -16.0 | -14.4 | -12.9 | -13.8 | -12.2 | -14.0 | -13.4 | -14.0 | -13.7 |
| 199-D4-83 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.4 | -9.6 | -11.0 | -11.0 | -9.0 | -12.2 | -12.3 | -11.6 |
| 199-D4-84 | -5.6 | -11.5 | -12.0 | -11.9 | -12.0 | -9.8 | -11.1 | -10.3 | -10.0 | -9.5 | -9.6 | -9.3 | -9.6 | -9.7 | -8.4 | -9.4 | -10.4 | -11.0 | -10.8 | -11.2 | -13.0 | -10.4 | -7.3 | -7.7 | -9.3 |
| 199-D4-85 | -10.2 | -21.0 | -20.0 | -18.7 | -14.1 | -12.5 | -17.2 | -16.5 | -15.0 | -15.4 | -16.6 | -11.4 | -13.2 | -14.2 | -17.4 | -16.5 | -18.8 | -19.0 | -18.2 | -16.9 | -15.0 | -15.0 | -17.2 | -18.0 | -15.2 |
| 199-D4-95 | -6.7 | -13.9 | -13.3 | -12.6 | -12.5 | -10.2 | -11.2 | -9.0 | -10.0 | -11.9 | -12.9 | -12.9 | -13.0 | -13.0 | -12.2 | -13.0 | -13.0 | -13.0 | -11.7 | -11.5 | -11.5 | -9.8 | -12.1 | -12.5 | -12.2 |
| 199-D4-96 | -6.8 | -14.0 | -13.6 | -12.7 | -13.6 | -10.5 | -14.2 | -15.0 | -14.9 | -14.4 | -16.4 | -13.4 | -10.6 | -7.7 | -5.0 | -5.7 | -2.9 | -7.1 | -7.2 | -8.0 | -11.3 | -11.6 | -11.2 | -11.5 | -11.9 |
| 199-D4-97 | -6.6 | -13.6 | -13.0 | -12.2 | -12.5 | -10.2 | -11.1 | -10.3 | -10.0 | -10.4 | -12.8 | -12.9 | -13.0 | -13.0 | -12.2 | -12.2 | -12.0 | -12.0 | -11.9 | -12.0 | -12.0 | -12.0 | -11.8 | -12.5 | -12.2 |
| 199-D4-98 | -6.7 | -13.9 | -13.2 | -12.7 | -12.2 | -10.2 | -11.0 | -11.5 | -10.1 | -10.5 | -12.0 | -11.9 | -12.6 | -13.0 | -11.9 | -13.0 | -13.0 | -13.0 | -12.8 | -13.0 | -12.1 | -12.0 | -12.2 | -12.4 | -12.3 |
| 199-D4-99 | -10.1 | -20.8 | -17.1 | -15.5 | -13.9 | -11.1 | -16.3 | -16.5 | -15.0 | -15.4 | -16.2 | -11.5 | -16.7 | -18.0 | -16.5 | -19.0 | -19.0 | -19.0 | -18.6 | -17.1 | -18.0 | -18.0 | -17.5 | -18.0 | -17.7 |
| 199-D5-101 | -11.9 | -24.7 | -22.2 | -21.5 | -15.2 | -11.2 | -21.0 | -22.3 | -22.4 | -14.2 | -22.4 | -27.0 | -26.3 | -26.0 | -24.5 | -27.0 | -27.0 | -27.0 | -26.8 | -25.0 | -24.1 | -24.0 | -24.7 | -25.7 | -22.5 |
| 199-D5-104 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -10.4 | -21.2 | -16.8 | -25.1 | -24.9 | -25.0 | -25.0 | -23.5 | -25.0 | -25.0 | -25.0 | -24.7 | -25.0 | -25.1 | -24.4 | -23.4 | -23.7 | -23.4 |
| 199-D5-127 | -9.2 | -19.1 | -18.7 | -14.2 | -13.4 | -11.1 | -13.5 | -13.9 | -10.7 | -9.2 | -8.0 | -3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.0 | -8.0 | -8.0 | -7.1 | -7.7 | -7.9 |
| 199-D5-128 | 39.9 | 82.6 | 86.1 | 80.4 | 74.1 | 61.2 | 70.3 | 81.9 | 77.6 | 72.3 | 81.2 | 75.8 | 77.1 | 74.9 | 62.3 | 82.0 | 87.0 | 91.3 | 90.4 | 90.2 | 90.4 | 89.5 | 84.7 | 84.1 | 70.2 |
| 199-D5-129 | 44.2 | 91.3 | 92.8 | 92.5 | 79.7 | 65.8 | 75.6 | 88.5 | 83.5 | 77.7 | 87.3 | 81.5 | 83.0 | 80.6 | 67.0 | 88.1 | 94.0 | 99.1 | 98.7 | 98.7 | 99.0 | 98.6 | 92.9 | 92.4 | 75.9 |
| 199-D5-130 | -7.5 | -15.5 | -14.8 | -15.0 | -13.5 | -13.3 | -12.2 | -13.4 | -14.6 | -14.6 | -15.6 | -16.0 | -15.8 | -14.6 | -11.2 | -12.0 | -12.0 | -11.9 | -11.5 | -8.8 | -12.0 | -12.6 | -11.6 | -11.5 | -10.2 |
| 199-D5-131 | -8.9 | -18.5 | -16.7 | -15.6 | -13.7 | -12.4 | -13.8 | -13.7 | -14.5 | -13.8 | -16.9 | -18.5 | -18.2 | -17.9 | -16.8 | -18.0 | -18.0 | -17.5 | -17.3 | -17.2 | -18.0 | -18.0 | -16.6 | -17.1 | -12.3 |
| 199-D5-20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -4.1 | -8.1 | -5.6 | -2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -8.2 | -9.5 | -9.4 | -9.8 | -8.4 | -5.1 | -1.0 | 0.0 | 0.0 |
| 199-D5-32 | -8.1 | -16.7 | -19.0 | -18.8 | -17.7 | -16.0 | -16.0 | -15.8 | -15.0 | -16.0 | -18.6 | -18.8 | -18.1 | -17.7 | -16.8 | -17.9 | -18.2 | -19.0 | -18.1 | -16.9 | -17.0 | -17.6 | -16.9 | -17.3 | -17.5 |
| 199-D5-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -10.3 | -24.2 | -21.7 | -24.9 | -25.3 | -24.6 | -24.6 | -23.3 | -24.9 | -24.6 | -25.0 | -23.8 | -24.8 | -25.1 | -25.0 | -23.4 | -24.0 | -24.4 |
| 199-D5-42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 16.0 | 33.0 | 30.4 | 26.3 | 23.4 | 23.7 | 22.9 | 18.3 | 24.5 | 26.7 | 25.3 | 23.3 | 24.6 | 24.1 | 24.8 | 24.1 | 24.1 | 19.4 |
| 199-D5-44 | 44.9 | 92.8 | 92.7 | 64.7 | 41.7 | 34.3 | 34.5 | 44.5 | 46.4 | 43.2 | 48.9 | 45.9 | 46.9 | 45.6 | 37.9 | 39.7 | 35.0 | 26.6 | 26.6 | 26.4 | 26.2 | 27.2 | 26.0 | 25.8 | 20.9 |
| 199-D5-92 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -10.3 | -23.2 | -16.6 | -17.8 | -16.2 | -17.9 | -18.9 | -22.7 | -29.2 | -30.8 | -33.0 | -31.2 | -29.8 | -25.6 | -20.2 | -15.7 | -17.6 | -17.8 |
| 199-D6-1 | 5.2 | 10.6 | 3.6 | 16.8 | 15.0 | 11.8 | 34.5 | 48.9 | 51.5 | 46.6 | 49.0 | 48.9 | 52.4 | 50.2 | 29.2 | 51.1 | 45.3 | 47.4 | 42.0 | 39.1 | 43.3 | 40.5 | 35.3 | 35.5 | 24.8 |
| 199-D6-2 | 27.0 | 55.8 | 52.7 | 72.1 | 71.8 | 61.9 | 49.3 | 54.8 | 54.2 | 50.5 | 53.6 | 52.5 | 44.8 | 35.9 | 26.6 | 36.3 | 31.6 | 24.1 | 27.0 | 28.8 | 30.1 | 29.3 | 23.9 | 20.6 | 16.2 |
| 199-D7-3 | -9.6 | -19.7 | -20.3 | -18.0 | -14.5 | -11.6 | -15.0 | -16.7 | -14.7 | -16.1 | -19.9 | -20.3 | -20.2 | -18.2 | -11.5 | -15.9 | -16.6 | -17.0 | -16.6 | -17.2 | -18.0 | -18.6 | -18.7 | -18.7 | -12.3 |
| 199-D7-4 | 11.2 | 23.2 | 27.6 | 22.4 | 17.8 | 15.6 | 31.9 | 34.0 | 39.6 | 37.0 | 39.2 | 38.5 | 41.6 | 41.6 | 31.8 | 51.0 | 82.4 | 101.8 | 106.9 | 115.0 | 111.5 | 111.6 | 102.4 | 104.2 | 94.1 |
| 199-D7-5 | 27.7 | 57.2 | 50.8 | 68.9 | 68.6 | 59.2 | 47.6 | 44.1 | 38.9 | 36.0 | 38.3 | 37.7 | 41.0 | 40.5 | 30.5 | 41.2 | 44.4 | 51.2 | 54.3 | 58.7 | 55.4 | 56.4 | 52.3 | 53.8 | 49.1 |
| 199-D7-6 | -8.6 | -17.8 | -17.4 | -16.4 | -13.2 | -11.6 | -14.8 | -14.9 | -12.3 | -16.0 | -13.9 | -12.4 | -14.7 | -14.0 | -4.1 | -15.8 | -16.2 | -17.5 | -17.5 | -17.2 | -13.7 | -18.3 | -16.9 | -15.3 | -10.2 |
| 199-D8-53 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-55 | 10.7 | 22.1 | 16.5 | 11.2 | 8.8 | 2.7 | 2.4 | 3.3 | 3.5 | 3.2 | 3.6 | 3.0 | 1.5 | 3.6 | 2.4 | 4.0 | 3.4 | 2.7 | 1.7 | 2.5 | 2.3 | 1.3 | 2.0 | 2.2 | 2.5 |
| 199-D8-6 | -7.6 | -15.8 | -15.2 | -13.7 | -10.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.2 | -6.9 | -6.4 | -5.5 | -0.7 | 0.0 | 0.0 |
| 199-D8-68 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-69 | -9.8 | -20.2 | -20.3 | -19.3 | -14.6 | -12.5 | -15.4 | -18.9 | -18.0 | -16.4 | -18.2 | -18.7 | -19.2 | -17.7 | -11.5 | -20.7 | -20.8 | -20.9 | -20.2 | -20.2 | -21.0 | -20.0 | -18.7 | -19.2 | -11.2 |
| 199-D8-73 | -1.6 | -3.4 | -3.4 | -3.8 | -3.9 | -3.2 | -3.2 | -3.8 | -3.6 | -3.6 | -2.5 | -2.9 | -3.1 | -3.0 | -1.1 | -0.1 | -4.9 | -5.4 | -5.3 | -5.4 | -5.4 | -4.9 | -1.2 | 0.0 | 0.0 |
| 199-D8-88 | 0.0 | 0.0 | 0.0 | -0.5 | -0.5 | -0.1 | -3.4 | -2.8 | -1.9 | -2.2 | -2.2 | -2.5 | -3.6 | -3.8 | -4.0 | -4.9 | -6.2 | -6.3 | -6.4 | -7.7 | -6.4 | -5.3 | -4.9 | -5.6 | -6.0 |
| 199-D8-89 | -5.9 | -12.2 | -12.0 | -14.1 | -14.3 | -12.4 | -14.0 | -18.6 | -18.9 | -14.0 | -13.0 | -12.4 | -11.0 | -10.7 | -10.3 | -11.2 | -11.5 | -12.1 | -12.0 | -12.4 | -12.1 | -13.2 | -11.1 | -10.7 | -11.2 |
| 199-D8-90 | -10.1 | -20.9 | -20.1 | -19.2 | -13.9 | -11.6 | -14.7 | -18.7 | -17.7 | -16.1 | -16.5 | -12.9 | -19.6 | -18.2 | -11.4 | -18.8 | -19.0 | -17.2 | -18.2 | -17.6 | -18.0 | -18.6 | -17.9 | -17.6 | -11.4 |
| 199-D8-91 | -10.1 | -21.0 | -20.3 | -20.1 | -14.2 | -11.6 | -15.3 | -22.9 | -23.1 | -17.2 | -16.8 | -17.5 | -20.7 | -18.7 | -11.5 | -16.8 | -17.9 | -18.9 | -18.3 | -17.6 | -18.0 | -18.6 | -18.7 | -18.4 | -12.3 |
| 199-D8-93 | 7.2 | 14.9 | 15.1 | 14.7 | 8.5 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-94 | 2.9 | 6.0 | 1.6 | 2.8 | 2.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 | 7.3 | 5.4 | 8.9 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 9.6 | 10.5 | 8.8 |
| 199-D8-95 | -8.5 | -17.6 | -17.4 | -16.9 | -14.1 | -12.4 | -14.5 | -16.0 | -14.5 | -13.3 | -16.1 | -18.3 | -15.7 | -16.9 | -11.6 | -17.9 | -18.3 | -17.9 | -17.6 | -17.6 | -17.8 | -18.0 | -16.9 | -17.0 | -12.3 |
| 199-D8-96 | -11.3 | -23.4 | -23.6 | -22.5 | -15.4 | -12.8 | -15.1 | -16.4 | -14.6 | -16.2 | -21.2 | -23.9 | -23.7 | -23.9 | -22.4 | -23.9 | -24.0 | -24.0 | -23.0 | -20.9 | -21.1 | -21.6 | -21.5 | -21.9 | -15.4 |
| 199-D8-97 | -9.1 | -18.7 | -18.3 | -19.6 | -15.0 | -12.5 | -16.8 | -19.2 | -19.4 | -17.7 | -20.8 | -21.8 | -21.1 | -18.8 | -12.5 | -17.9 | -18.2 | -18.9 | -18.3 | -17.6 | -18.0 | -18.6 | -18.7 | -18.6 | -12.3 |
| 199-D8-98 | -9.0 | -18.6 | -18.0 | -18.1 | -14.2 | -10.7 | -15.1 | -16.8 | -14.6 | -15.4 | -18.2 | -20.4 | -13.0 | -12.3 | -13.3 | -18.9 | -19.0 | -18.5 | -17.6 | -17.5 | -18.0 | -18.6 | -18.7 | -18.7 | -12.3 |

**Table C-2. Average Monthly Pumping Rates (gpm) for Wells in the DX Treatment System (Dec 2010 to Dec 2012): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | D-10 | J-11 | F-11 | M-11 | A-11 | M-11 | J-11 | J-11 | A-11 | S-11 | O-11 | N-11 | D-11 | J-12 | F-12 | M-12 | A-12 | M-12 | J-12 | J-12 | A-12 | S-12 | O-12 | N-12 | D-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D8-99 | 5.0 | 10.3 | 10.8 | 8.7 | 6.0 | 5.7 | 61.2 | 83.8 | 77.0 | 71.7 | 76.7 | 75.6 | 81.1 | 80.2 | 63.1 | 86.9 | 88.4 | 90.9 | 78.2 | 71.7 | 74.9 | 76.4 | 69.6 | 68.0 | 50.5 |
| 199-H1-5 | -9.8 | -20.3 | -20.3 | -19.3 | -13.9 | -11.6 | -16.8 | -18.9 | -19.3 | -17.1 | -11.9 | -11.3 | -14.7 | -14.0 | -4.1 | -15.8 | -16.2 | -17.5 | -17.5 | -17.2 | -13.3 | -18.6 | -19.0 | -16.5 | -9.9 |
| 199-H4-80 | -7.5 | -15.6 | -15.0 | -15.5 | -14.2 | -12.4 | -14.0 | -16.5 | -14.8 | -16.5 | -13.9 | -13.3 | -16.8 | -15.8 | -4.1 | -15.8 | -16.2 | -17.5 | -17.5 | -17.6 | -18.0 | -18.0 | -16.3 | -15.7 | -10.2 |
| 199-H4-81 | -7.6 | -15.7 | -15.4 | -15.2 | -13.8 | -12.4 | -12.8 | -15.5 | -14.6 | -15.6 | -14.4 | -13.9 | -15.9 | -15.6 | -4.4 | -15.1 | -15.7 | -16.5 | -16.6 | -16.9 | -17.0 | -17.0 | -15.1 | -15.0 | -10.3 |
| 199-H4-82 | -0.1 | -0.2 | -12.0 | -12.4 | -10.6 | -7.7 | -16.3 | -19.1 | -19.4 | -18.0 | -13.4 | -11.6 | -17.6 | -16.7 | -4.1 | -17.8 | -18.1 | -18.4 | -18.5 | -17.7 | -18.0 | -18.6 | -18.7 | -16.4 | -9.9 |
| 199-D5-146 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D5-148 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D5-153 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-55 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

**Table C-3. Average Monthly Pumping Rates (gpm) for Wells in the DX Treatment System (Jan 2013 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | J-13 | F-13 | M-13 | A-13 | M-13 | J-13 | J-13 | A-13 | S-13 | O-13 | N-13 | D-13 | J-14 | F-14 | M-14 | A-14 | M-14 | J-14 | J-14 | A-14 | S-14 | O-14 | N-14 | D-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D2-10 | 0.3 | 0.6 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D2-12 | 0.9 | 2.5 | 3.1 | 2.0 | 0.1 | 0.0 | 0.0 | 0.7 | 2.6 | 3.2 | 2.5 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D4-101 | -7.9 | -7.4 | -5.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -6.1 | -11.0 | -10.9 | -11.0 | -9.1 | -11.0 | -11.0 | -11.0 | -10.9 | -11.0 | -11.4 | -13.0 | -13.2 | -12.5 | -12.2 |
| 199-D4-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1 | -10.0 | -11.8 | -11.9 | -12.0 | -11.9 | -12.0 | -8.6 | -11.9 | -12.0 | -12.0 | -11.9 | -12.0 | -12.0 | -12.0 | -12.0 | -12.0 | -11.5 |
| 199-D4-34 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1 | -10.1 | -11.5 | -9.3 | -9.8 | -9.9 | -9.6 | -6.8 | -9.4 | -10.0 | -10.0 | -9.9 | -10.0 | -10.0 | -9.0 | -6.9 | -7.7 | -8.3 |
| 199-D4-38 | -7.9 | -8.0 | -8.0 | -8.0 | -8.0 | -7.9 | -7.6 | -8.0 | -7.8 | -7.5 | -8.0 | -7.9 | -8.0 | -7.8 | -8.0 | -8.0 | -8.0 | -8.7 | -8.0 | -8.0 | -7.6 | -7.1 | -8.0 | -7.7 |
| 199-D4-39 | -13.5 | -13.2 | -12.0 | -12.6 | -13.0 | -12.9 | -12.4 | -12.4 | -7.5 | -8.7 | -9.0 | -8.8 | -8.3 | -6.4 | -9.2 | -11.3 | -10.5 | -9.4 | -9.3 | -8.5 | -9.5 | -7.3 | -9.2 | -9.9 |
| 199-D4-83 | -10.8 | -12.7 | -15.2 | -15.7 | -15.0 | -14.9 | -14.3 | -15.0 | -14.6 | -13.5 | -15.0 | -14.9 | -15.0 | -10.7 | -14.9 | -15.0 | -15.0 | -14.9 | -13.0 | -14.8 | -13.3 | -13.5 | -14.0 | -12.8 |
| 199-D4-84 | -9.8 | -7.8 | -6.1 | -8.5 | -10.7 | -10.5 | -10.0 | -7.5 | -4.3 | -4.0 | -4.4 | -4.4 | -4.4 | -3.0 | -4.5 | -4.8 | -4.9 | -8.3 | -5.0 | -5.0 | -4.2 | -4.2 | -4.6 | -4.7 |
| 199-D4-85 | -16.0 | -17.0 | -19.0 | -19.0 | -19.0 | -17.9 | -17.2 | -18.0 | -17.7 | -16.7 | -18.0 | -17.9 | -18.0 | -17.1 | -17.9 | -18.0 | -18.0 | -17.9 | -18.0 | -18.0 | -18.7 | -18.7 | -18.0 | -16.5 |
| 199-D4-95 | -11.2 | -11.9 | -13.0 | -13.0 | -13.0 | -12.8 | -12.4 | -13.0 | -12.7 | -12.1 | -13.0 | -12.9 | -13.0 | -9.4 | -12.9 | -13.0 | -13.0 | -12.9 | -11.3 | -12.5 | -0.7 | 0.0 | -11.9 | -14.1 |
| 199-D4-96 | -11.9 | -6.5 | -11.8 | -11.5 | -7.7 | -8.1 | -7.6 | -8.0 | -7.8 | -7.4 | -8.0 | -7.9 | -8.0 | -5.8 | -8.0 | -8.0 | -8.0 | -7.9 | -8.3 | -9.7 | -8.9 | -9.8 | -8.9 | -8.6 |
| 199-D4-97 | -12.5 | -12.7 | -12.6 | -10.1 | -1.6 | 0.0 | 0.0 | -7.7 | -8.8 | -8.4 | -9.0 | -8.9 | -9.0 | -6.5 | -9.0 | -9.0 | -9.0 | -8.9 | -9.9 | -11.0 | -10.2 | -12.4 | -10.9 | -10.6 |
| 199-D4-98 | -12.6 | -12.8 | -13.0 | -13.0 | -13.0 | -12.8 | -12.4 | -13.0 | -12.8 | -12.1 | -13.0 | -12.9 | -13.0 | -9.4 | -12.9 | -13.0 | -13.0 | -12.9 | -13.0 | -12.7 | -12.9 | -12.6 | -12.0 | -11.5 |
| 199-D4-99 | -18.2 | -18.3 | -19.0 | -19.0 | -19.0 | -18.8 | -18.1 | -17.3 | -16.7 | -15.8 | -17.0 | -16.9 | -17.0 | -12.2 | -16.9 | -17.0 | -17.0 | -16.9 | -17.3 | -17.9 | -9.5 | 0.0 | -16.2 | -17.3 |
| 199-D5-101 | -21.4 | -26.5 | -27.1 | -27.0 | -27.0 | -26.8 | -24.7 | -25.4 | -26.4 | -24.5 | -26.0 | -25.8 | -26.0 | -21.9 | -24.9 | -25.0 | -25.0 | -24.8 | -25.3 | -26.0 | -25.8 | -24.6 | -24.9 | -22.3 |
| 199-D5-104 | -23.0 | -25.0 | -25.0 | -25.0 | -25.0 | -24.8 | -23.8 | -25.0 | -24.5 | -23.2 | -25.0 | -24.8 | -25.0 | -17.7 | -24.8 | -25.0 | -25.0 | -24.8 | -23.2 | -25.0 | -24.6 | -21.5 | -24.9 | -24.0 |
| 199-D5-127 | -7.9 | -8.0 | -8.0 | -8.0 | -8.0 | -8.0 | -7.7 | -8.0 | -7.9 | -7.5 | -8.0 | -7.9 | -8.0 | -5.8 | -8.0 | -8.0 | -8.0 | -7.9 | -8.3 | -9.4 | -9.5 | -14.0 | -13.8 | -13.2 |
| 199-D5-128 | 73.4 | 74.8 | 66.9 | 64.9 | 66.9 | 66.4 | 66.1 | 71.3 | 69.4 | 67.4 | 60.2 | 60.4 | 42.0 | 1.9 | 59.0 | 64.7 | 64.9 | 52.5 | 48.8 | 48.5 | 43.7 | 51.4 | 50.0 | 48.0 |
| 199-D5-129 | 91.2 | 99.0 | 100.6 | 96.5 | 97.2 | 98.6 | 97.8 | 105.5 | 101.7 | 100.9 | 106.6 | 106.7 | 72.6 | 6.8 | 118.0 | 118.9 | 117.0 | 108.7 | 107.8 | 97.4 | 80.8 | 95.5 | 124.7 | 110.3 |
| 199-D5-130 | -11.2 | -11.4 | -10.5 | -10.5 | -10.9 | -10.9 | -10.5 | -11.0 | -10.1 | -8.8 | -8.4 | -8.4 | -5.5 | -0.5 | -8.4 | -8.1 | -8.9 | -9.0 | -9.1 | -9.0 | -8.5 | -7.6 | -6.9 | -6.8 |
| 199-D5-131 | -15.5 | -17.3 | -18.0 | -17.9 | -17.9 | -17.8 | -17.2 | -18.0 | -17.2 | -17.7 | -18.0 | -17.8 | -11.8 | -0.8 | -16.6 | -17.2 | -17.0 | -16.9 | -17.7 | -18.4 | -8.7 | -2.1 | -18.1 | -17.1 |
| 199-D5-20 | -0.1 | -4.7 | -4.5 | -6.9 | -8.5 | -8.1 | -7.2 | -5.3 | -2.7 | -2.1 | -4.0 | -4.4 | -3.9 | -2.3 | -4.4 | -5.3 | -7.4 | -6.3 | -5.1 | -3.0 | -0.1 | 0.0 | 0.0 | 0.0 |
| 199-D5-32 | -17.9 | -18.0 | -18.0 | -18.0 | -18.0 | -17.9 | -17.2 | -18.0 | -17.6 | -17.8 | -18.0 | -17.8 | -18.0 | -12.6 | -17.9 | -18.0 | -18.0 | -17.8 | -18.4 | -18.0 | -18.0 | -18.0 | -17.1 | -16.3 |
| 199-D5-39 | -22.7 | -25.0 | -25.0 | -25.0 | -25.0 | -24.8 | -23.8 | -25.0 | -24.5 | -24.7 | -25.0 | -24.8 | -25.0 | -17.4 | -24.9 | -25.0 | -25.0 | -24.8 | -25.0 | -25.0 | -25.0 | -25.0 | -23.1 | -22.0 |
| 199-D5-42 | 18.2 | 16.4 | 22.4 | 22.2 | 22.4 | 24.2 | 18.9 | 20.6 | 23.6 | 20.2 | 18.0 | 17.7 | 9.2 | 1.1 | 18.6 | 20.3 | 20.0 | 19.4 | 18.2 | 17.2 | 17.9 | 17.7 | 18.4 | 16.3 |
| 199-D5-44 | 18.8 | 19.2 | 21.2 | 24.3 | 21.5 | 17.9 | 17.0 | 18.6 | 21.2 | 18.6 | 19.0 | 16.5 | 17.1 | 21.4 | 17.9 | 19.9 | 19.9 | 19.6 | 18.9 | 18.9 | 14.9 | 17.3 | 16.8 | 16.4 |
| 199-D5-92 | -18.2 | -12.9 | -8.0 | -8.0 | -8.0 | -7.9 | -7.6 | -8.0 | -8.6 | -8.0 | -8.0 | -7.9 | -8.5 | -5.9 | -17.1 | -18.0 | -18.0 | -17.8 | -18.0 | -15.7 | -11.9 | -8.8 | -11.0 | 0.0 |
| 199-D6-1 | 10.6 | 25.0 | 23.5 | 23.7 | 26.6 | 26.7 | 26.7 | 28.2 | 26.8 | 26.6 | 24.7 | 24.8 | 25.6 | 14.4 | 20.2 | 23.7 | 24.9 | 19.4 | 17.3 | 16.6 | 17.6 | 19.9 | 15.9 | 15.3 |
| 199-D6-2 | 14.3 | 18.8 | 23.5 | 23.4 | 22.4 | 26.4 | 20.2 | 22.0 | 21.0 | 20.9 | 24.9 | 23.1 | 18.8 | 15.8 | 21.9 | 23.3 | 27.9 | 19.8 | 16.8 | 18.6 | 15.3 | 19.3 | 19.2 | 16.5 |
| 199-D7-3 | -15.0 | -18.0 | -19.4 | -19.7 | -18.9 | -18.8 | -18.1 | -19.1 | -20.0 | -20.4 | -20.0 | -19.9 | -13.1 | -0.8 | -15.0 | -17.7 | -18.0 | -17.9 | -19.1 | -19.1 | -18.6 | -20.7 | -19.9 | -19.0 |
| 199-D7-4 | 107.5 | 117.0 | 122.6 | 127.7 | 133.3 | 140.0 | 142.5 | 147.8 | 136.1 | 137.3 | 153.7 | 155.2 | 161.3 | 108.5 | 155.0 | 152.2 | 150.5 | 130.1 | 134.0 | 123.1 | 110.2 | 117.6 | 115.4 | 111.3 |
| 199-D7-5 | 78.9 | 102.3 | 106.9 | 112.4 | 117.7 | 124.1 | 126.5 | 131.3 | 124.9 | 121.9 | 138.3 | 138.0 | 143.4 | 96.1 | 137.7 | 135.9 | 134.1 | 116.2 | 119.6 | 109.7 | 97.7 | 108.9 | 116.8 | 94.7 |

**Table C-3. Average Monthly Pumping Rates (gpm) for Wells in the DX Treatment System (Jan 2013 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | J-13 | F-13 | M-13 | A-13 | M-13 | J-13 | J-13 | A-13 | S-13 | O-13 | N-13 | D-13 | J-14 | F-14 | M-14 | A-14 | M-14 | J-14 | J-14 | A-14 | S-14 | O-14 | N-14 | D-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D7-6 | -14.8 | -17.4 | -17.9 | -18.0 | -17.9 | -17.9 | -17.2 | -18.0 | -17.1 | -15.3 | -16.8 | -16.8 | -11.2 | -0.9 | -16.6 | -15.8 | -15.9 | -15.8 | -17.4 | -14.7 | -8.6 | -17.2 | -16.5 | -15.1 |
| 199-D8-53 | 0.0 | 0.0 | 0.0 | 0.0 | -12.7 | -19.7 | -18.7 | -20.6 | -21.3 | -20.7 | -21.1 | -21.8 | -22.0 | -18.9 | -20.2 | -20.0 | -20.0 | -19.9 | -6.8 | 0.0 | 0.0 | -19.5 | -19.9 | -15.7 |
| 199-D8-55 | 2.3 | 3.7 | 2.4 | 2.7 | 1.7 | 1.8 | 2.0 | 2.3 | 2.0 | 2.4 | 2.8 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-6 | 0.0 | -4.1 | -0.7 | 0.0 | -0.2 | -5.0 | -4.4 | -4.0 | -0.3 | 0.0 | 0.0 | -1.9 | -2.8 | -1.3 | -1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-68 | 0.0 | 0.0 | 0.0 | 0.0 | -5.2 | -25.4 | -36.0 | -40.0 | -38.0 | -36.3 | -42.7 | -38.9 | -45.0 | -29.9 | -42.2 | -41.6 | -39.9 | -28.8 | -42.5 | -36.9 | -42.5 | -47.9 | -40.1 | -23.5 |
| 199-D8-69 | 0.0 | -18.1 | -21.0 | -20.9 | -20.7 | -20.8 | -20.0 | -21.0 | -20.6 | -20.1 | -20.6 | -20.8 | -21.0 | -18.8 | -19.9 | -20.0 | -20.0 | -18.9 | -20.0 | -20.0 | -20.2 | -20.5 | -19.9 | -15.8 |
| 199-D8-73 | 0.0 | 0.0 | -1.1 | -3.5 | -4.9 | -5.0 | -4.8 | -4.8 | -3.2 | -0.9 | -2.9 | -2.3 | -3.3 | -2.3 | -3.5 | -4.4 | -4.6 | -4.6 | -4.8 | -4.6 | -2.9 | -0.1 | 0.0 | 0.0 |
| 199-D8-88 | -6.2 | -5.5 | -5.1 | -5.0 | -5.0 | -5.4 | -5.3 | -5.0 | -4.9 | -4.9 | -5.0 | -5.0 | -5.0 | -3.6 | -6.1 | -6.5 | -7.0 | -6.5 | -5.9 | -4.7 | -3.7 | -3.4 | -4.1 | -4.3 |
| 199-D8-89 | -11.5 | -11.3 | -10.9 | -11.5 | -11.8 | -11.7 | -11.2 | -11.4 | -10.9 | -9.3 | -9.0 | -8.9 | -9.0 | -6.5 | -9.8 | -9.0 | -9.2 | -9.1 | -9.1 | -9.0 | -9.0 | -9.2 | -9.0 | -8.6 |
| 199-D8-90 | -14.0 | -17.8 | -19.0 | -19.0 | -19.1 | -19.8 | -19.0 | -20.0 | -19.6 | -17.9 | -20.0 | -19.8 | -20.0 | -9.6 | -12.7 | -12.3 | -12.0 | -11.9 | -17.1 | -20.0 | -14.3 | -19.3 | -18.9 | -17.2 |
| 199-D8-91 | -14.4 | -17.7 | -19.0 | -19.0 | -18.9 | -19.2 | -18.6 | -19.0 | -20.9 | -20.2 | -21.1 | -20.9 | -22.0 | -9.9 | -11.8 | -12.3 | -12.0 | -11.9 | -17.1 | -21.5 | -19.7 | -21.5 | -20.8 | -18.8 |
| 199-D8-93 | 0.0 | 0.0 | 2.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-94 | 1.8 | 8.0 | 8.4 | 5.5 | 1.0 | 2.1 | 0.6 | 3.8 | 7.5 | 5.0 | 6.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-D8-95 | -14.4 | -17.7 | -19.0 | -18.9 | -18.3 | -14.7 | -17.2 | -18.0 | -17.6 | -17.7 | -7.8 | 0.0 | 0.0 | -1.3 | -21.2 | -25.0 | -25.0 | -23.2 | -19.7 | -15.5 | -12.6 | -11.3 | -9.8 | -9.0 |
| 199-D8-96 | -19.0 | -23.3 | -23.9 | -23.8 | -23.8 | -23.6 | -22.7 | -23.9 | -23.0 | -22.3 | -20.0 | -19.8 | -13.1 | -0.9 | -20.1 | -22.9 | -23.0 | -22.8 | -23.0 | -23.0 | -22.9 | -20.8 | -19.2 | -18.1 |
| 199-D8-97 | -14.4 | -17.7 | -19.0 | -18.9 | -18.9 | -19.2 | -18.6 | -19.8 | -20.6 | -19.7 | -20.5 | -20.8 | -21.0 | -12.0 | -21.5 | -22.0 | -22.0 | -20.8 | -20.9 | -22.0 | -22.0 | -21.7 | -21.0 | -20.0 |
| 199-D8-98 | -15.0 | -18.5 | -20.0 | -19.9 | -19.9 | -19.8 | -19.1 | -20.0 | -19.6 | -19.7 | -19.6 | -19.4 | -12.6 | -0.9 | -16.9 | -17.0 | -17.0 | -16.9 | -19.1 | -16.3 | -16.7 | -19.5 | -18.9 | -18.1 |
| 199-D8-99 | 49.2 | 46.9 | 43.8 | 44.7 | 47.0 | 49.6 | 50.1 | 52.3 | 50.4 | 48.7 | 48.3 | 49.1 | 57.4 | 53.9 | 50.4 | 50.6 | 51.7 | 48.1 | 46.3 | 50.5 | 46.7 | 47.6 | 41.6 | 39.4 |
| 199-H1-5 | -14.5 | -17.4 | -19.0 | -19.0 | -18.7 | -17.9 | -14.0 | 0.0 | 0.0 | -11.1 | -18.4 | -18.8 | -12.5 | -1.0 | -17.4 | -15.8 | -16.0 | -15.8 | -17.6 | -12.9 | -8.8 | -19.9 | -18.3 | -15.0 |
| 199-H4-80 | -14.5 | -17.5 | -17.9 | -18.0 | -17.6 | -16.9 | -16.2 | -17.0 | -17.0 | -15.4 | -16.6 | -16.9 | -11.2 | -0.9 | -15.7 | -15.0 | -15.0 | -14.9 | -15.0 | -12.6 | -8.0 | -16.2 | -15.6 | -14.5 |
| 199-H4-81 | -14.1 | -16.5 | -16.9 | -17.0 | -16.2 | -13.6 | -15.1 | -17.0 | -15.8 | -13.5 | -14.6 | -14.9 | -10.0 | -0.7 | -14.6 | -15.0 | -15.0 | -14.9 | -15.0 | -10.4 | -8.0 | -15.2 | -14.4 | -13.2 |
| 199-H4-82 | -14.5 | -17.4 | -19.4 | -19.8 | -18.7 | -17.9 | -18.0 | -20.1 | -21.5 | -18.4 | -19.4 | -19.8 | -13.1 | -1.0 | -16.9 | -16.0 | -16.0 | -15.9 | -17.4 | -15.7 | -8.8 | -22.0 | -21.9 | -16.9 |
| 199-D5-146 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -25.6 | -28.0 | -28.0 | -28.0 | -28.0 | -27.8 | -26.8 |
| 199-D5-148 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 104.8 | 134.3 | 136.9 | 116.6 | 125.6 | 131.8 | 116.1 |
| 199-D5-153 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -14.4 | -23.3 | -26.0 | -23.3 | -28.0 | -27.8 | -26.9 |
| 199-D8-55 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -4.9 | -5.8 | -4.2 | -1.6 | 0.0 | 0.0 | 0.0 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

**Table C-4. Average Monthly Pumping Rates (gpm) for Wells in the HX Treatment System (Oct 2011 to Dec 2013): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | O-11 | N-11 | D-11 | J-12 | F-12 | M-12 | A-12 | M-12 | J-12 | J-12 | A-12 | S-12 | O-12 | N-12 | D-12 | J-13 | F-13 | M-13 | A-13 | M-13 | J-13 | J-13 | A-13 | S-13 | O-13 | N-13 | D-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H1-1 | -29.6 | -29.2 | -30.0 | -30.0 | -29.4 | -30.2 | -26.1 | -29.5 | -26.4 | -19.9 | -20.0 | -26.9 | -29.8 | -30.5 | -29.3 | -30.0 | -30.0 | -30.0 | -30.0 | -27.6 | -30.0 | -29.8 | -30.0 | -30.0 | -29.4 | -30.0 | -30.0 |
| 199-H1-2 | -3.1 | -2.6 | -2.4 | -2.1 | -1.9 | -1.9 | -2.2 | -4.7 | -6.1 | -6.8 | -6.3 | -4.4 | -3.2 | -2.8 | -2.7 | -3.2 | -2.8 | -2.4 | -2.4 | -3.0 | -4.6 | -4.7 | -3.7 | -2.4 | -2.0 | -2.1 | -1.3 |
| 199-H1-20 | 74.4 | 69.0 | 74.1 | 71.7 | 69.0 | 72.8 | 79.8 | 22.5 | 17.5 | 1.1 | 83.1 | 85.9 | 54.3 | 53.9 | 59.6 | 61.1 | 40.6 | 36.0 | 60.4 | 66.5 | 81.1 | 75.4 | 77.6 | 63.7 | 58.9 | 61.2 | 66.7 |
| 199-H1-21 | 98.8 | 89.0 | 94.4 | 92.0 | 89.9 | 93.9 | 97.0 | 66.6 | 63.1 | 4.1 | 94.9 | 100.8 | 60.3 | 72.9 | 70.8 | 71.4 | 48.8 | 44.6 | 75.3 | 81.3 | 100.2 | 97.3 | 99.6 | 78.5 | 66.2 | 69.6 | 84.6 |
| 199-H1-25 | -18.1 | -24.8 | -28.7 | -28.6 | -26.7 | -28.5 | -28.7 | -29.1 | -25.8 | -16.1 | -20.7 | -19.1 | -9.7 | -27.5 | -27.2 | -28.0 | -27.6 | -25.7 | -27.0 | -23.5 | -29.0 | -28.5 | -28.0 | -22.9 | -21.9 | -27.8 | -28.0 |
| 199-H1-27 | -11.6 | -18.2 | -22.0 | -21.4 | -18.8 | -23.9 | -29.0 | -29.6 | -26.0 | -19.0 | -19.5 | -11.2 | -5.6 | -17.6 | -24.2 | -27.6 | -18.4 | -13.6 | -22.3 | -20.2 | -30.0 | -29.8 | -29.0 | -14.0 | -12.2 | -13.9 | -9.1 |
| 199-H1-3 | -0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-H1-32 | -1.4 | -1.7 | -1.4 | -1.4 | -0.3 | -2.0 | -9.8 | -18.6 | -19.6 | -18.9 | -18.8 | -4.4 | -0.2 | -1.3 | -5.9 | -7.3 | -1.9 | -0.1 | -6.8 | -8.8 | -12.5 | -8.1 | -3.6 | -0.1 | 0.0 | 0.0 | 0.0 |
| 199-H1-33 | -5.0 | -7.7 | -11.5 | -6.6 | 0.0 | -7.1 | -22.9 | -27.8 | -25.0 | -19.9 | -23.9 | -18.7 | -1.6 | -5.9 | -20.8 | -26.5 | -11.6 | -0.1 | -19.6 | -23.0 | -27.0 | -26.8 | -24.8 | -3.3 | 0.0 | 0.0 | 0.0 |
| 199-H1-34 | -11.5 | -14.0 | -14.3 | -13.2 | -10.9 | -14.8 | -26.2 | -27.4 | -27.6 | -27.8 | -28.0 | -21.9 | -8.8 | -12.3 | -19.8 | -26.1 | -13.9 | -7.2 | -22.6 | -21.1 | -28.0 | -27.8 | -24.0 | -8.6 | -6.9 | -9.0 | -10.6 |
| 199-H1-35 | -24.4 | -25.5 | -28.5 | -27.3 | -22.8 | -25.2 | -26.3 | -22.0 | -26.5 | -26.8 | -27.0 | -27.9 | -25.1 | -27.5 | -27.4 | -28.0 | -27.7 | -19.8 | -26.9 | -23.7 | -28.0 | -27.8 | -27.9 | -22.1 | -17.7 | -20.3 | -22.9 |
| 199-H1-36 | -8.4 | -7.1 | -6.8 | -6.2 | -5.3 | -4.8 | -7.8 | -8.9 | -8.9 | -8.9 | -9.0 | -9.0 | -8.5 | -7.5 | -8.3 | -9.0 | -8.7 | -6.0 | -7.3 | -8.2 | -9.0 | -8.9 | -9.0 | -7.9 | -5.2 | -4.6 | -4.8 |
| 199-H1-37 | -8.0 | -10.9 | -12.6 | -7.6 | -2.9 | -11.0 | -27.5 | -27.8 | -27.6 | -27.8 | -28.0 | -23.3 | -4.6 | -10.7 | -24.1 | -28.0 | -15.6 | -0.7 | -22.9 | -21.1 | -28.0 | -27.8 | -27.6 | -6.0 | -0.4 | -3.4 | -7.7 |
| 199-H1-38 | -6.2 | -4.2 | -3.9 | -3.5 | -4.3 | -6.6 | -13.9 | -24.3 | -24.5 | -24.9 | -25.0 | -12.1 | -6.6 | -7.4 | -10.3 | -13.5 | -7.4 | -5.0 | -9.9 | -17.6 | -30.0 | -27.3 | -8.8 | -1.8 | -2.7 | -3.4 | -3.0 |
| 199-H1-39 | -1.9 | -1.8 | -1.0 | -1.0 | -0.6 | -2.8 | -33.7 | -41.1 | -37.2 | -29.8 | -30.0 | -23.6 | -3.0 | -3.8 | -17.6 | -28.0 | -4.7 | -0.3 | -13.6 | -18.9 | -30.0 | -29.7 | -25.3 | -2.3 | -0.5 | 0.0 | 0.0 |

Table C-4. Average Monthly Pumping Rates (gpm) for Wells in the HX Treatment System (Oct 2011 to Dec 2013): Extraction Rates are Negative and Injection Rates are Positive

| Well Name | O-11 | N-11 | D-11 | J-12 | F-12 | M-12 | A-12 | M-12 | J-12 | J-12 | A-12 | S-12 | O-12 | N-12 | D-12 | J-13 | F-13 | M-13 | A-13 | M-13 | J-13 | J-13 | A-13 | S-13 | O-13 | N-13 | D-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H1-4 | -1.4 | -0.5 | -0.1 | 0.0 | 0.0 | 0.0 | -0.2 | -0.2 | 0.0 | 0.0 | 0.0 | 0.0 | -2.0 | -1.5 | -1.2 | -1.2 | -1.2 | -1.0 | -0.9 | -0.4 | -2.0 | -2.6 | -2.3 | -0.4 | -1.1 | -0.7 | -0.1 |
| 199-H1-40 | -3.8 | -3.2 | -3.4 | -2.7 | -2.5 | -4.3 | -10.7 | -22.7 | -28.9 | -19.9 | -21.9 | -12.9 | -6.7 | -6.7 | -8.5 | -11.5 | -6.6 | -3.6 | -7.2 | -9.7 | -20.0 | -19.5 | -10.5 | -4.8 | -2.9 | -2.1 | -0.4 |
| 199-H1-42 | -28.1 | -27.6 | -28.6 | -27.9 | -28.9 | -27.7 | -28.2 | -29.0 | -27.9 | -27.8 | -28.0 | -28.7 | -28.1 | -29.0 | -28.3 | -29.0 | -28.8 | -27.2 | -28.1 | -23.1 | 0.0 | -1.3 | -29.0 | -28.6 | -24.3 | -22.8 | -22.1 |
| 199-H1-43 | -29.6 | -28.5 | -19.5 | -22.2 | -24.6 | -29.0 | -28.3 | -29.6 | -29.6 | -29.8 | -30.0 | -30.0 | -29.1 | -30.0 | -29.3 | -30.0 | -29.8 | -30.0 | -30.0 | -27.7 | -30.0 | -29.8 | -30.0 | -30.0 | -29.4 | -30.0 | -30.0 |
| 199-H1-45 | -26.6 | -25.6 | -26.5 | -26.7 | -27.0 | -26.9 | -26.7 | -8.4 | -5.0 | -27.0 | -27.0 | -24.7 | -23.3 | -26.0 | -19.6 | -27.0 | -25.3 | -27.0 | -26.6 | -22.4 | -27.0 | -26.8 | -27.0 | -27.0 | -26.4 | -27.0 | -27.0 |
| 199-H1-6 | -2.3 | -1.5 | -0.4 | 0.0 | -1.1 | -2.2 | -2.9 | -6.4 | -8.5 | -11.7 | -9.4 | -5.0 | -2.1 | -2.0 | -3.0 | -3.8 | -3.1 | -3.5 | -3.6 | -7.8 | -7.9 | -6.3 | -4.0 | -2.1 | -2.7 | -2.4 | -1.1 |
| 199-H3-25 | 45.6 | 49.4 | 53.2 | 51.3 | 49.8 | 53.4 | 66.8 | 90.9 | 88.5 | 93.7 | 77.9 | 66.6 | 53.0 | 57.1 | 62.8 | 69.5 | 62.2 | 59.8 | 61.4 | 56.5 | 67.0 | 64.0 | 64.2 | 53.4 | 50.0 | 51.4 | 55.6 |
| 199-H3-26 | 42.4 | 42.8 | 45.1 | 43.9 | 42.6 | 45.6 | 56.7 | 84.2 | 84.2 | 89.1 | 74.2 | 63.4 | 50.7 | 55.1 | 59.7 | 65.6 | 59.1 | 56.6 | 60.6 | 57.1 | 67.2 | 65.0 | 64.9 | 53.6 | 50.5 | 52.0 | 56.0 |
| 199-H3-27 | 36.2 | 36.9 | 38.9 | 37.9 | 36.6 | 39.8 | 55.8 | 73.6 | 71.1 | 74.8 | 60.2 | 52.8 | 44.4 | 47.9 | 52.8 | 58.3 | 52.3 | 50.4 | 51.8 | 47.6 | 56.3 | 54.2 | 54.4 | 44.5 | 41.7 | 43.0 | 46.5 |
| 199-H3-4 | -87.4 | -104.2 | -124.7 | -124.5 | -125.0 | -123.9 | -108.8 | -113.2 | -95.0 | -99.8 | -124.6 | -125.0 | -121.6 | -125.2 | -115.3 | -125.0 | -126.5 | -129.8 | -112.2 | -88.7 | -130.0 | -128.8 | -130.0 | -129.9 | -127.4 | -130.1 | -130.0 |
| 199-H4-14 | 20.3 | 20.7 | 15.3 | 14.9 | 14.5 | 15.5 | 11.0 | 10.9 | 8.6 | 11.5 | 7.8 | 6.8 | 7.5 | 8.1 | 11.8 | 11.6 | 10.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-H4-15A | -36.4 | -34.3 | -38.6 | -33.2 | -37.4 | -37.8 | -38.3 | -39.0 | -31.9 | -31.0 | -31.4 | -31.8 | -29.5 | -31.0 | -28.8 | -32.0 | -29.2 | -29.8 | -30.6 | -25.5 | -32.0 | -31.8 | -32.0 | -30.3 | -28.9 | -31.0 | -31.0 |
| 199-H4-17 | 8.8 | 10.8 | 11.6 | 9.6 | 10.4 | 9.1 | 7.0 | 5.7 | 5.2 | 6.9 | 6.1 | 5.2 | 6.8 | 9.1 | 9.5 | 11.6 | 10.6 | 9.9 | 8.4 | 6.6 | 8.2 | 7.1 | 6.9 | 4.1 | 3.9 | 5.4 | 2.9 |
| 199-H4-18 | 22.9 | 13.5 | 12.7 | 12.3 | 12.0 | 13.2 | 11.7 | 11.4 | 9.1 | 7.6 | 9.1 | 8.6 | 9.5 | 12.5 | 8.2 | 12.2 | 10.6 | 7.8 | 10.0 | 9.4 | 12.2 | 10.8 | 10.2 | 8.6 | 7.7 | 9.2 | 6.5 |
| 199-H4-4 | -2.5 | -4.6 | -5.2 | -4.2 | -2.5 | -6.5 | -10.9 | -11.0 | -10.9 | -11.0 | -11.0 | -4.3 | -1.3 | -5.0 | -9.7 | -11.2 | -5.0 | -0.2 | -6.1 | -10.8 | -11.2 | -11.4 | -8.6 | -0.7 | -0.6 | -1.9 | -4.3 |
| 199-H4-63 | -25.8 | -24.7 | -25.6 | -25.7 | -26.0 | -26.1 | -26.3 | -27.4 | -26.8 | -27.0 | -27.0 | -27.0 | -25.5 | -26.0 | -25.4 | -26.0 | -24.4 | -25.9 | -21.2 | -24.2 | -27.0 | -26.6 | -27.0 | -27.0 | -26.4 | -27.0 | -27.0 |
| 199-H4-64 | -8.5 | -12.2 | -13.3 | -12.3 | -11.7 | -15.1 | -23.1 | -20.7 | -19.8 | -15.0 | -16.8 | -13.5 | -7.9 | -14.5 | -18.3 | -18.4 | -12.8 | -6.6 | -17.7 | -17.0 | -21.0 | -20.7 | -17.5 | -7.0 | -6.5 | -9.8 | -10.8 |
| 199-H4-69 | -26.9 | -24.7 | -27.7 | -27.1 | -21.2 | -24.6 | -27.7 | -28.0 | -27.7 | -28.0 | -28.0 | -28.0 | -26.2 | -27.1 | -27.1 | -28.0 | -26.2 | -25.5 | -22.3 | -24.0 | -28.0 | -27.6 | -28.0 | -28.0 | -25.7 | -25.1 | -24.6 |
| 199-H4-70 | -23.5 | -22.7 | -23.6 | -23.7 | -24.0 | -23.9 | -23.3 | -21.0 | -22.4 | -23.0 | -23.7 | -25.0 | -24.0 | -24.0 | -23.4 | -24.0 | -22.5 | -23.9 | -19.6 | -20.1 | -25.0 | -1.2 | -20.6 | -24.1 | -23.5 | -24.0 | -24.0 |
| 199-H4-71 | 28.8 | 31.8 | 33.5 | 32.3 | 31.1 | 34.4 | 44.2 | 60.8 | 59.0 | 62.7 | 51.5 | 43.4 | 35.3 | 38.2 | 42.7 | 47.4 | 42.3 | 31.1 | 41.2 | 37.9 | 45.9 | 44.1 | 44.5 | 35.8 | 33.5 | 34.6 | 37.5 |
| 199-H4-72 | 15.2 | 20.5 | 23.0 | 22.2 | 20.6 | 24.4 | 34.2 | 59.4 | 58.8 | 62.5 | 51.2 | 43.3 | 35.8 | 39.1 | 43.3 | 48.1 | 42.4 | 31.5 | 41.6 | 37.9 | 46.1 | 44.2 | 44.7 | 36.5 | 33.8 | 34.9 | 38.0 |
| 199-H4-73 | 19.1 | 24.1 | 25.8 | 24.6 | 22.5 | 25.8 | 35.6 | 54.9 | 53.8 | 57.5 | 46.8 | 39.0 | 32.0 | 35.2 | 39.5 | 44.3 | 39.0 | 37.2 | 35.3 | 34.8 | 42.2 | 40.3 | 41.4 | 32.2 | 30.0 | 31.1 | 19.5 |
| 199-H4-74 | 35.4 | 33.9 | 35.6 | 34.7 | 33.4 | 36.2 | 46.4 | 67.1 | 69.2 | 75.4 | 62.1 | 52.2 | 42.8 | 47.2 | 52.2 | 57.8 | 51.6 | 49.4 | 50.7 | 46.3 | 55.8 | 54.1 | 54.5 | 42.8 | 39.9 | 41.0 | 45.0 |
| 199-H4-75 | -19.7 | -19.0 | -19.7 | -19.7 | -20.0 | -18.4 | -18.7 | -19.0 | -19.2 | -20.0 | -20.0 | -20.0 | -19.2 | -19.0 | -18.8 | -19.2 | -17.8 | -19.0 | -18.7 | -17.7 | -20.0 | -19.8 | -20.0 | -20.0 | -19.6 | -20.0 | -20.0 |
| 199-H4-76 | -14.3 | -9.0 | -3.8 | -1.0 | 0.0 | 0.0 | 0.0 | -3.8 | -13.9 | -17.9 | -18.0 | -18.0 | -17.5 | -17.6 | -11.9 | -10.0 | -8.8 | -5.7 | -3.0 | -4.3 | 0.0 | 0.0 | -14.8 | -13.6 | -7.3 | -3.9 | -3.1 |
| 199-H4-77 | -12.8 | -11.1 | -10.0 | -10.0 | -9.1 | -8.7 | -7.1 | -9.4 | -9.3 | -8.4 | -14.9 | -11.2 | -17.0 | -14.8 | -12.2 | -11.4 | -10.8 | -10.2 | -9.3 | -8.7 | -11.5 | -11.9 | -12.6 | -12.2 | -11.1 | -10.2 | -4.6 |
| 199-H4-78 | 52.4 | 54.8 | 58.1 | 55.8 | 52.0 | 56.5 | 72.9 | 101.4 | 97.0 | 121.9 | 102.2 | 86.6 | 67.6 | 74.3 | 67.6 | 86.3 | 77.4 | 74.6 | 82.1 | 78.4 | 92.8 | 88.4 | 91.6 | 73.0 | 68.9 | 70.6 | 75.0 |
| 199-H4-79 | 40.4 | 59.1 | 69.0 | 65.8 | 61.9 | 70.6 | 64.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 42.5 | 54.4 | 64.0 | 65.6 | 47.8 | 43.8 | 44.2 | 38.7 | 52.1 | 47.8 | 47.8 | 35.1 | 31.4 | 31.2 | 3.5 |
| 199-H6-2 | 15.6 | 18.3 | 20.2 | 19.2 | 17.7 | 20.6 | 30.5 | 50.3 | 52.5 | 55.9 | 41.2 | 34.0 | 24.1 | 29.7 | 30.3 | 33.6 | 29.3 | 26.9 | 25.8 | 25.2 | 34.0 | 32.2 | 33.4 | 22.4 | 20.3 | 21.2 | 10.6 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

Table C-5. Average Monthly Pumping Rates (gpm) for Wells in the HX Treatment System (Jan 2014 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Names | J-14 | F-14 | M-14 | A-14 | M-14 | J-14 | J-14 | A-14 | S-14 | O-14 | N-14 | D-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H1-1 | -30.0 | -30.0 | -29.9 | -23.8 | -24.3 | -29.8 | -29.8 | -30.0 | -30.0 | -30.0 | -29.2 | -28.3 |
| 199-H1-2 | -1.9 | -1.3 | -1.2 | -2.3 | -3.2 | -4.5 | -4.3 | -3.5 | -2.8 | -2.2 | -2.0 | -1.9 |
| 199-H1-20 | 54.9 | 60.1 | 54.5 | 52.0 | 33.9 | 47.5 | 58.5 | 58.4 | 48.8 | 47.6 | 56.6 | 53.9 |
| 199-H1-21 | 74.4 | 72.0 | 68.9 | 70.8 | 56.1 | 70.9 | 82.2 | 81.5 | 58.6 | 57.7 | 68.8 | 69.6 |
| 199-H1-25 | -28.0 | -22.7 | -27.9 | -27.9 | -27.3 | -27.9 | -27.8 | -28.0 | -15.0 | -17.4 | -25.2 | -25.9 |
| 199-H1-27 | -16.0 | -7.2 | -15.9 | -28.7 | -29.8 | -29.8 | -29.8 | -27.3 | -9.8 | -8.6 | -14.1 | -16.5 |
| 199-H1-3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.3 | -0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-H1-32 | -0.7 | 0.0 | -2.7 | -6.0 | -13.3 | -14.1 | -11.2 | -3.1 | -0.5 | 0.0 | -0.2 | -1.1 |
| 199-H1-33 | -4.7 | -0.4 | -9.5 | -21.2 | -25.7 | -26.9 | -26.8 | -23.8 | -3.0 | 0.0 | -1.5 | -9.3 |
| 199-H1-34 | -9.1 | -6.2 | -11.4 | -16.6 | -20.8 | -24.9 | -24.8 | -19.6 | -6.0 | -4.8 | -6.3 | -12.1 |
| 199-H1-35 | -19.6 | -16.8 | -21.8 | -28.0 | -27.4 | -26.4 | -26.8 | -27.6 | -18.1 | -13.7 | -22.2 | -24.4 |
| 199-H1-36 | -4.4 | -3.9 | -4.0 | -7.1 | -8.9 | -9.0 | -8.9 | -9.3 | -6.9 | -4.3 | -4.4 | -4.9 |

Table C-5. Average Monthly Pumping Rates (gpm) for Wells in the HX Treatment System (Jan 2014 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Names | J-14 | F-14 | M-14 | A-14 | M-14 | J-14 | J-14 | A-14 | S-14 | O-14 | N-14 | D-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H1-37 | -6.6 | -0.8 | -11.2 | -26.3 | -26.4 | -25.5 | -25.8 | -27.1 | -5.9 | -0.1 | -8.5 | -14.0 |
| 199-H1-38 | -5.5 | -2.8 | -6.7 | -9.5 | -18.6 | -29.8 | -29.4 | -11.3 | -4.8 | -3.9 | -4.6 | -4.6 |
| 199-H1-39 | -1.4 | -0.2 | -2.9 | -11.7 | -23.9 | -29.8 | -29.7 | -25.4 | -2.9 | -0.3 | -0.4 | -1.1 |
| 199-H1-4 | -0.7 | -0.5 | -0.5 | -0.9 | -1.4 | -2.0 | -2.6 | -2.2 | -1.9 | -1.3 | -0.8 | -0.8 |
| 199-H1-40 | -3.0 | -1.0 | -3.9 | -7.3 | -18.6 | -25.7 | -21.9 | -9.4 | -4.3 | -2.6 | -1.6 | -2.4 |
| 199-H1-42 | -19.7 | -17.1 | -16.9 | -21.7 | -26.3 | -25.8 | -29.0 | -23.2 | -17.7 | -13.6 | -13.0 | -13.4 |
| 199-H1-43 | -30.0 | -30.0 | -29.9 | -23.8 | -24.3 | -29.8 | -29.8 | -7.8 | 0.0 | -22.7 | -29.4 | -28.8 |
| 199-H1-45 | -27.0 | -27.0 | -26.9 | -27.0 | -26.9 | -26.9 | -26.8 | -27.0 | -27.0 | -27.2 | -26.6 | -25.9 |
| 199-H1-6 | -2.5 | -1.2 | -2.6 | -4.8 | -5.3 | -4.0 | -7.2 | -3.9 | -1.9 | -1.8 | -2.1 | -2.2 |
| 199-H3-25 | 49.5 | 45.6 | 45.6 | 53.2 | 61.6 | 69.0 | 66.9 | 57.7 | 39.0 | 38.6 | 11.1 | 44.0 |
| 199-H3-26 | 49.6 | 43.3 | 45.3 | 51.3 | 61.5 | 69.2 | 67.0 | 57.9 | 38.9 | 38.6 | 43.8 | 44.5 |
| 199-H3-27 | 41.6 | 37.8 | 37.8 | 43.3 | 52.1 | 58.2 | 56.6 | 48.8 | 32.9 | 32.6 | 40.7 | 37.3 |
| 199-H3-4 | -130.0 | -129.6 | -129.4 | -86.6 | -87.1 | -129.3 | -128.4 | -130.0 | -130.0 | -129.9 | -127.1 | -124.6 |
| 199-H4-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-H4-15A | -31.0 | -27.7 | -30.1 | -30.9 | -31.7 | -32.5 | -32.6 | -31.5 | -25.5 | -23.9 | -30.0 | -29.6 |
| 199-H4-17 | 3.9 | 6.4 | 8.0 | 7.2 | 9.5 | 10.1 | 9.8 | 7.1 | 5.7 | 5.8 | 5.5 | 7.7 |
| 199-H4-18 | 11.7 | 8.7 | 13.1 | 14.3 | 16.2 | 16.1 | 16.2 | 11.9 | 10.8 | 11.7 | 8.2 | 11.4 |
| 199-H4-4 | -4.2 | -0.4 | -7.0 | -10.0 | -10.9 | -10.9 | -10.9 | -8.4 | -0.3 | 0.0 | 0.0 | -4.1 |
| 199-H4-63 | -27.0 | -21.2 | -9.9 | -27.3 | -27.3 | -27.8 | -27.8 | -27.7 | -27.0 | -27.0 | -26.7 | -25.9 |
| 199-H4-64 | -10.4 | -6.4 | -14.3 | -18.4 | -20.3 | -20.6 | -20.8 | -15.3 | -6.0 | -4.9 | -11.3 | -12.4 |
| 199-H4-69 | -24.1 | -20.9 | -23.0 | -27.0 | -27.3 | -27.5 | -26.9 | -27.3 | -23.6 | -17.6 | -18.5 | -18.7 |
| 199-H4-70 | -24.0 | -21.8 | -22.5 | -24.0 | -23.9 | -23.9 | -23.8 | -24.1 | -24.0 | -22.8 | -20.5 | -20.4 |
| 199-H4-71 | 35.8 | 22.5 | 34.3 | 38.6 | 45.2 | 47.8 | 47.7 | 45.7 | 29.9 | 29.4 | 32.4 | 33.2 |
| 199-H4-72 | 37.1 | 22.7 | 33.4 | 39.3 | 47.5 | 52.1 | 50.7 | 45.7 | 30.5 | 29.6 | 32.7 | 32.6 |
| 199-H4-73 | 34.8 | 22.4 | 34.8 | 39.3 | 47.0 | 34.5 | 32.3 | 21.7 | 19.2 | 17.9 | 21.7 | 20.9 |
| 199-H4-74 | 45.5 | 41.5 | 44.9 | 51.1 | 61.5 | 58.9 | 56.5 | 49.3 | 32.9 | 32.6 | 37.8 | 36.9 |
| 199-H4-75 | -20.0 | -20.0 | -19.7 | -19.7 | -19.0 | -16.5 | -18.9 | -19.5 | -19.7 | -20.0 | -18.7 | -18.2 |
| 199-H4-76 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -7.3 | -10.5 | -15.1 | -11.4 | -5.6 | -0.6 | 0.0 |
| 199-H4-77 | -9.0 | -6.0 | -7.4 | -6.9 | -7.5 | -8.6 | -10.3 | -6.9 | 0.0 | -8.8 | -9.3 | -7.8 |
| 199-H4-78 | 67.4 | 63.4 | 66.4 | 75.1 | 90.0 | 99.7 | 96.9 | 84.8 | 56.7 | 56.3 | 64.5 | 63.5 |
| 199-H4-79 | 21.8 | 21.8 | 33.2 | 37.5 | 47.4 | 96.9 | 97.2 | 83.5 | 58.0 | 57.8 | 64.7 | 60.2 |
| 199-H6-2 | 30.9 | 22.1 | 34.8 | 38.7 | 44.0 | 32.9 | 29.7 | 24.7 | 17.3 | 17.4 | 18.3 | 18.5 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

Table C-6. Average Monthly Pumping Rates (gpm) for Wells in the KR4 Treatment System (Jan 2006 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Names | 199-K-113A | 199-K-114A | 199-K-115A | 199-K-116A | 199-K-119A | 199-K-120A | 199-K-121A | 199-K-122A | 199-K-123A | 199-K-124A | 199-K-125A | 199-K-127 | 199-K-128 | 199-K-129 | 199-K-144 | 199-K-145 | 199-K-162 | 199-K-179 | 199-K-198 | 199-K-199 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-06 | -8.7 | -22.6 | -38.3 | -44.5 | -39.3 | -32.8 | 42.7 | 78.6 | 62.0 | 21.9 | -42.5 | -41.3 | 78.2 | -8.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-06 | -9.8 | -25.1 | -42.8 | -40.8 | -39.5 | -33.3 | 47.1 | 81.0 | 63.1 | 21.1 | -42.7 | -41.3 | 77.5 | -11.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-06 | -8.9 | -25.0 | -41.4 | -35.4 | -41.1 | -33.1 | 41.4 | 71.0 | 56.1 | 16.6 | -13.3 | -41.1 | 68.5 | -20.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-06 | -11.2 | -20.8 | -42.5 | -41.1 | -36.9 | -34.2 | 39.9 | 68.4 | 54.7 | 15.8 | 0.0 | -41.2 | 66.1 | -23.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-06 | -15.1 | -19.5 | -32.3 | -35.9 | -36.2 | -35.4 | 41.7 | 72.1 | 57.5 | 16.0 | -22.3 | -39.4 | 69.8 | -21.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-06 | -15.1 | -19.9 | -24.4 | -33.9 | -40.3 | -34.5 | 36.9 | 69.1 | 55.4 | 12.4 | -22.7 | -33.4 | 66.9 | -22.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-06 | -14.7 | -21.6 | -21.8 | -35.8 | -40.4 | -34.7 | 40.2 | 70.7 | 56.4 | 12.5 | -24.4 | -31.1 | 68.5 | -26.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-06 | -12.8 | -22.9 | -27.3 | -37.4 | -36.4 | -34.8 | 43.2 | 75.3 | 57.6 | 17.5 | -33.6 | -34.6 | 72.7 | -25.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-06 | -9.9 | -20.0 | -31.1 | -39.8 | -30.8 | -31.0 | 38.8 | 70.3 | 54.5 | 14.0 | -38.8 | -30.8 | 67.9 | -17.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table C-6. Average Monthly Pumping Rates (gpm) for Wells in the KR4 Treatment System (Jan 2006 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Names | 199-K-113A | 199-K-114A | 199-K-115A | 199-K-116A | 199-K-119A | 199-K-120A | 199-K-121A | 199-K-122A | 199-K-123A | 199-K-124A | 199-K-125A | 199-K-127 | 199-K-128 | 199-K-129 | 199-K-144 | 199-K-145 | 199-K-162 | 199-K-179 | 199-K-198 | 199-K-199 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O-06 | -9.3 | -17.4 | -37.4 | -44.4 | -36.1 | -35.5 | 43.6 | 76.4 | 56.5 | 18.5 | -42.2 | -36.3 | 73.8 | -17.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-06 | -12.8 | -24.4 | -38.9 | -40.7 | -24.8 | -48.1 | 42.1 | 76.0 | 53.3 | 17.6 | -34.8 | -30.6 | 72.2 | -14.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-06 | -13.0 | -15.6 | -41.7 | -44.4 | -30.5 | -46.3 | 43.0 | 75.8 | 61.0 | 17.9 | -41.9 | -31.1 | 73.5 | -17.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-07 | -12.2 | -25.6 | -42.9 | -36.1 | -26.2 | -44.7 | 42.5 | 74.4 | 60.6 | 18.8 | -43.9 | -31.3 | 72.5 | -16.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-07 | -10.4 | -31.4 | -42.7 | -45.4 | -21.1 | -43.9 | 43.6 | 76.1 | 59.9 | 19.6 | -44.1 | -30.8 | 74.0 | -14.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-07 | -10.1 | -28.6 | -42.4 | -44.5 | -20.3 | -45.9 | 44.9 | 76.1 | 53.3 | 19.9 | -42.0 | -34.0 | 76.5 | -13.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-07 | -12.5 | -29.6 | -43.6 | -45.2 | -23.4 | -42.7 | 41.4 | 88.7 | 41.3 | 21.1 | -41.2 | -34.6 | 84.0 | -14.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-07 | -16.5 | -29.9 | -40.9 | -45.8 | -20.0 | -49.8 | 41.7 | 96.2 | 34.2 | 23.3 | -44.5 | -28.5 | 90.3 | -14.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-07 | -15.8 | -29.8 | -39.9 | -45.5 | -19.0 | -49.3 | 40.6 | 95.7 | 32.5 | 22.5 | -44.1 | -28.4 | 89.7 | -13.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-07 | -14.9 | -29.3 | -39.6 | -45.8 | -18.8 | -49.6 | 39.3 | 92.8 | 37.4 | 20.8 | -42.9 | -28.5 | 86.9 | -12.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-07 | -13.6 | -27.6 | -37.5 | -26.7 | -11.0 | -47.2 | 31.4 | 75.7 | 38.1 | 13.9 | -35.3 | -26.9 | 71.0 | -7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-07 | -12.4 | -9.7 | -25.5 | -36.7 | 0.0 | -41.1 | 23.1 | 62.7 | 17.1 | 6.6 | -15.1 | -25.9 | 58.9 | -8.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-07 | -11.4 | -22.6 | -31.9 | -44.2 | -18.3 | -43.7 | 34.0 | 79.6 | 34.4 | 17.4 | -38.0 | -30.6 | 75.4 | -8.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-07 | -11.7 | -21.3 | -35.4 | -44.9 | -19.6 | -49.0 | 37.6 | 85.5 | 32.1 | 21.1 | -42.1 | -35.2 | 81.1 | -7.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-07 | -12.4 | -27.2 | -37.1 | -44.6 | -20.1 | -49.8 | 39.0 | 89.5 | 33.8 | 22.2 | -43.5 | -35.9 | 84.6 | -8.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-08 | -12.1 | -27.7 | -37.5 | -45.1 | -19.1 | -48.6 | 37.9 | 89.3 | 33.5 | 22.6 | -43.7 | -36.0 | 84.6 | -8.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-08 | -10.6 | -36.8 | -39.2 | -45.4 | -18.6 | -49.2 | 36.9 | 86.9 | 31.8 | 21.6 | -26.6 | -36.2 | 82.4 | -7.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-08 | -10.4 | -19.3 | -33.9 | -44.6 | -17.7 | -48.2 | 36.4 | 85.9 | 28.6 | 20.8 | -43.8 | -38.9 | 81.2 | -5.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-08 | -11.2 | -26.8 | -35.7 | -45.3 | -17.9 | -48.9 | 37.6 | 88.5 | 31.2 | 21.7 | -43.9 | -40.0 | 85.7 | -5.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-08 | -14.4 | -39.3 | -36.7 | -44.9 | -21.0 | -43.6 | 35.5 | 84.1 | 34.9 | 19.9 | -16.8 | -39.1 | 80.0 | -8.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-08 | -12.7 | -29.5 | -30.6 | -36.1 | -18.3 | -32.7 | 26.8 | 57.6 | 27.7 | 11.5 | 0.0 | -31.2 | 60.8 | -1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-08 | -9.7 | -24.6 | -35.8 | -44.1 | -20.8 | -31.3 | 32.8 | 76.5 | 36.6 | 11.5 | -34.4 | -32.1 | 68.4 | -2.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-08 | -11.1 | -32.3 | -39.8 | -44.9 | -8.6 | -16.5 | 28.1 | 72.5 | 33.3 | 9.1 | -43.5 | -14.6 | 67.2 | -7.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-08 | -7.8 | -25.0 | -31.8 | -42.5 | -26.0 | -17.5 | 29.4 | 74.8 | 29.9 | 13.4 | -41.6 | -28.0 | 70.0 | -6.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-08 | -8.4 | -16.9 | -27.6 | -39.1 | -34.6 | -29.7 | 34.2 | 83.2 | 37.0 | 5.3 | -39.7 | -42.1 | 74.4 | -5.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-08 | -7.8 | -16.7 | -23.8 | -22.8 | -31.6 | -31.7 | 25.1 | 65.7 | 33.3 | 14.4 | -31.8 | -34.1 | 59.3 | -5.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-08 | -8.8 | -28.7 | -29.4 | -42.6 | -34.5 | -34.6 | 43.8 | 77.2 | 35.0 | 18.1 | -41.8 | -34.5 | 78.6 | -6.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-09 | -9.2 | -23.5 | -24.7 | -33.6 | -26.6 | -30.2 | 31.0 | 66.2 | 30.2 | 13.2 | -31.0 | -27.5 | 63.8 | -5.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-09 | -10.1 | -22.2 | -21.6 | -28.2 | -29.7 | -35.5 | 29.8 | 73.3 | 19.2 | 15.5 | -28.8 | -30.0 | 68.4 | -7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-09 | -7.7 | -13.5 | -22.2 | -43.7 | -28.1 | -46.7 | 35.9 | 88.2 | 8.4 | 23.8 | -42.7 | -40.8 | 82.3 | -1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-09 | -9.1 | -17.7 | -28.3 | -40.7 | -23.4 | -44.7 | 36.3 | 90.5 | 10.0 | 24.4 | -39.5 | -41.4 | 84.4 | -6.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-09 | -5.7 | -13.3 | -13.2 | -11.3 | -9.5 | -19.1 | 15.7 | 40.1 | 3.2 | 11.2 | -16.8 | -17.2 | 37.6 | -4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-09 | -15.2 | -35.8 | -34.0 | -30.1 | -24.6 | -49.4 | 41.0 | 103.8 | 9.9 | 29.8 | -44.0 | -44.4 | 97.6 | -10.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-09 | -11.9 | -32.9 | -31.3 | -34.6 | -9.0 | -43.2 | 31.3 | 83.8 | 7.6 | 20.5 | -16.3 | -38.7 | 78.2 | -8.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-09 | -6.3 | -17.0 | -15.3 | -22.0 | 0.0 | -14.6 | 12.0 | 37.8 | 4.0 | 5.5 | 0.0 | -14.6 | 33.0 | -3.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-09 | -4.6 | -9.3 | -13.3 | -30.6 | 0.0 | 0.0 | 0.0 | 32.4 | 0.0 | 0.0 | 0.0 | 0.0 | 26.8 | -3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-09 | -8.0 | -10.0 | -24.6 | -44.1 | 0.0 | 0.0 | 0.0 | 46.6 | 0.0 | 0.0 | 0.0 | 0.0 | 42.7 | -4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-09 | -10.0 | -11.8 | -22.6 | -21.0 | 0.0 | 0.0 | 0.9 | 47.9 | 0.0 | 0.0 | 0.0 | 0.0 | 21.5 | -7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-09 | -10.3 | -12.8 | -22.8 | 0.0 | 0.0 | 0.0 | 6.2 | 38.1 | 0.1 | 0.0 | 0.0 | 0.0 | 7.0 | -7.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-10 | -9.2 | -12.0 | -21.3 | -18.7 | 0.0 | 0.0 | 20.3 | 13.1 | 0.0 | 0.0 | 0.0 | 0.0 | 15.0 | -5.3 | 0.0 | 0.0 | 0.0 | 15.8 | 0.0 | 0.0 |
| F-10 | -7.9 | -15.4 | -21.0 | -35.4 | 0.0 | -29.9 | 35.2 | 46.2 | 13.8 | 0.0 | 0.0 | -25.1 | 44.5 | -6.0 | -17.4 | -24.1 | -30.2 | 60.0 | 0.0 | 0.0 |
| M-10 | -7.2 | -12.9 | -19.6 | -23.6 | 0.0 | -43.7 | 32.6 | 58.7 | 28.5 | 0.0 | 0.0 | -37.2 | 54.9 | -5.5 | -26.0 | -50.6 | -40.5 | 83.4 | 0.0 | 0.0 |
| A-10 | -6.2 | -11.4 | -18.1 | -44.5 | 0.0 | -44.4 | 31.3 | 63.6 | 17.8 | 0.0 | 0.0 | -38.1 | 60.8 | -5.2 | -24.7 | -43.3 | -34.2 | 87.5 | 0.0 | 0.0 |
| M-10 | 0.0 | -15.7 | -19.6 | -45.1 | 0.0 | -43.3 | 43.3 | 63.6 | 24.2 | 0.0 | 0.0 | -37.8 | 58.5 | -7.8 | -26.0 | -50.5 | -42.1 | 88.2 | 0.0 | 0.0 |
| J-10 | -11.3 | -18.4 | -21.6 | -45.0 | 0.0 | -10.9 | 32.5 | 60.4 | 9.6 | 0.0 | 0.0 | -26.2 | 54.2 | -7.7 | -30.3 | -36.0 | -42.0 | 84.5 | 0.0 | 0.0 |
| J-10 | -1.3 | -3.4 | -26.9 | -45.7 | 0.0 | -33.7 | 19.3 | 62.5 | 3.4 | 0.0 | 0.0 | -6.8 | 56.9 | -8.1 | -33.4 | -34.3 | -44.4 | 87.8 | 0.0 | 0.0 |
| A-10 | -0.7 | -6.2 | -20.4 | -44.8 | 0.0 | -13.0 | 27.5 | 42.5 | 23.1 | 0.0 | 0.0 | -16.9 | 49.4 | -8.7 | -36.4 | -36.7 | -27.6 | 61.3 | 0.0 | 0.0 |
| S-10 | -2.2 | -5.0 | -6.2 | -40.9 | 0.0 | -9.7 | 29.2 | 44.5 | 16.7 | 0.0 | 0.0 | -31.3 | 44.0 | -2.2 | -40.3 | -39.0 | -26.5 | 62.7 | 0.0 | 0.0 |
| O-10 | 0.0 | 0.0 | 0.0 | -6.6 | 0.0 | -1.7 | 2.1 | 8.4 | 0.0 | 0.0 | 0.0 | -5.1 | 7.7 | 0.0 | -6.6 | -6.5 | -5.1 | 12.2 | 0.0 | 0.0 |

Table C-6. Average Monthly Pumping Rates (gpm) for Wells in the KR4 Treatment System (Jan 2006 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Names | 199-K-113A | 199-K-114A | 199-K-115A | 199-K-116A | 199-K-119A | 199-K-120A | 199-K-121A | 199-K-122A | 199-K-123A | 199-K-124A | 199-K-125A | 199-K-127 | 199-K-128 | 199-K-129 | 199-K-144 | 199-K-145 | 199-K-162 | 199-K-179 | 199-K-198 | 199-K-199 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N-10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-11 | -5.4 | -8.8 | -12.2 | -8.7 | 0.0 | -7.5 | 16.0 | 24.8 | 10.2 | 0.0 | 0.0 | -7.5 | 20.7 | 0.0 | -16.0 | -20.5 | -12.5 | 25.9 | 0.0 | 0.0 |
| F-11 | -11.0 | -10.6 | -29.9 | -20.0 | 0.0 | -10.7 | 34.8 | 54.0 | 27.5 | 0.0 | 0.0 | -10.7 | 51.6 | 0.0 | -44.1 | -58.8 | -14.7 | 42.4 | 0.0 | 0.0 |
| M-11 | -6.5 | -6.6 | -18.4 | -19.0 | 0.0 | -8.2 | 26.8 | 40.1 | 15.2 | 0.0 | 0.0 | -2.7 | 34.3 | 0.0 | -32.5 | -36.5 | -12.6 | 26.7 | 0.0 | 0.0 |
| A-11 | -14.6 | -9.7 | -24.4 | -29.4 | 0.0 | -14.3 | 41.6 | 64.1 | 33.2 | 0.0 | 0.0 | -14.3 | 48.9 | 0.0 | -47.5 | -51.3 | -19.2 | 36.9 | 0.0 | 0.0 |
| M-11 | -8.3 | -1.4 | -3.3 | -3.8 | 0.0 | -2.1 | 25.2 | 38.2 | 17.2 | 0.0 | 0.0 | -5.3 | 26.7 | 0.0 | -46.7 | -56.3 | -2.6 | 22.5 | 0.0 | 0.0 |
| J-11 | -0.8 | -0.6 | -0.4 | -0.5 | 0.0 | -3.8 | 20.3 | 31.5 | 12.8 | 0.0 | 0.0 | -3.8 | 21.5 | 0.0 | -42.5 | -51.9 | -0.4 | 18.5 | 0.0 | 0.0 |
| J-11 | -0.4 | -0.4 | -0.3 | -0.4 | 0.0 | -0.3 | 19.8 | 33.2 | 12.9 | 0.0 | 0.0 | -0.3 | 19.9 | 0.0 | -46.6 | -55.9 | -0.4 | 19.3 | 0.0 | 0.0 |
| A-11 | -0.6 | -0.6 | -0.5 | -0.4 | 0.0 | -0.4 | 19.5 | 30.5 | 10.6 | 0.0 | 0.0 | -0.4 | 20.9 | 0.0 | -43.6 | -52.3 | -0.4 | 17.9 | 0.0 | 0.0 |
| S-11 | -0.3 | -0.3 | -10.1 | -8.9 | 0.0 | -0.3 | 24.5 | 39.4 | 14.3 | 0.0 | 0.0 | -0.3 | 28.3 | 0.0 | -49.5 | -59.4 | -0.4 | 23.2 | 0.0 | 0.0 |
| O-11 | -0.1 | -0.2 | -26.9 | -22.7 | 0.0 | -0.1 | 29.2 | 46.2 | 21.3 | 0.0 | 0.0 | -0.1 | 34.5 | 0.0 | -49.2 | -59.1 | -0.2 | 27.5 | 0.0 | 0.0 |
| N-11 | -0.6 | -0.4 | -28.0 | -23.0 | 0.0 | -1.1 | 29.8 | 47.5 | 23.5 | 0.0 | 0.0 | -1.0 | 36.5 | 0.0 | -49.9 | -59.9 | -1.8 | 28.4 | 0.0 | 0.0 |
| D-11 | 0.0 | 0.0 | -27.8 | -25.6 | 0.0 | 0.0 | 29.7 | 48.1 | 22.3 | 0.0 | 0.0 | 0.0 | 33.6 | 0.0 | -49.5 | -59.3 | 0.0 | 28.5 | 0.0 | 0.0 |
| J-12 | -0.2 | -0.2 | -26.3 | -23.0 | 0.0 | -0.3 | 29.7 | 46.6 | 19.9 | 0.0 | 0.0 | -0.3 | 35.9 | 0.0 | -48.8 | -58.6 | -2.1 | 27.7 | 0.0 | 0.0 |
| F-12 | -0.2 | -0.2 | -24.0 | -25.2 | 0.0 | -0.3 | 27.9 | 42.4 | 19.2 | 0.0 | 0.0 | -0.3 | 32.7 | 0.0 | -49.7 | -54.8 | -0.5 | 33.0 | 0.0 | 0.0 |
| M-12 | -0.4 | -0.6 | -24.1 | -25.0 | 0.0 | -0.7 | 5.5 | 51.8 | 25.6 | 0.0 | 0.0 | -0.7 | 39.8 | 0.0 | -49.8 | -54.8 | -0.7 | 34.1 | 0.0 | 0.0 |
| A-12 | -0.5 | -0.6 | -25.0 | -24.3 | 0.0 | -0.5 | 5.0 | 52.6 | 26.3 | 0.0 | 0.0 | -0.4 | 40.7 | 0.0 | -49.5 | -54.3 | -0.5 | 31.1 | 0.0 | 0.0 |
| M-12 | -1.0 | -0.7 | -6.0 | -20.6 | 0.0 | -1.8 | 27.6 | 29.5 | 24.7 | 0.0 | 0.0 | -1.5 | 27.9 | 0.0 | -49.7 | -54.4 | -0.7 | 26.6 | 0.0 | 0.0 |
| J-12 | -13.7 | -13.7 | -13.7 | -24.0 | 0.0 | -19.6 | 48.2 | 42.9 | 34.5 | 0.0 | 0.0 | -14.3 | 53.2 | 0.0 | -48.2 | -52.6 | -25.5 | 46.5 | 0.0 | 0.0 |
| J-12 | -22.9 | -25.0 | -25.0 | -30.0 | 0.0 | -19.0 | 51.3 | 53.5 | 38.6 | 0.0 | 0.0 | -14.2 | 73.7 | 0.0 | -47.3 | -52.2 | -40.0 | 58.5 | 0.0 | 0.0 |
| A-12 | -23.0 | -25.0 | -25.0 | -30.0 | 0.0 | -20.0 | 49.5 | 55.6 | 41.0 | 0.0 | 0.0 | -15.0 | 76.6 | 0.0 | -49.9 | -54.9 | -40.0 | 60.2 | 0.0 | 0.0 |
| S-12 | -12.6 | -25.0 | -24.5 | -30.0 | 0.0 | -20.0 | 42.7 | 56.7 | 37.9 | 0.0 | 0.0 | -15.0 | 73.8 | 0.0 | -50.0 | -55.0 | -40.0 | 61.0 | 0.0 | 0.0 |
| O-12 | -8.7 | -19.8 | -18.9 | -40.7 | 0.0 | -19.9 | 46.1 | 61.8 | 22.5 | 0.0 | 0.0 | -19.6 | 78.6 | 0.0 | -49.3 | -59.1 | -39.6 | 66.7 | 0.0 | 0.0 |
| N-12 | -12.3 | -24.9 | -21.2 | -44.9 | 0.0 | -25.0 | 44.3 | 69.5 | 28.1 | 0.0 | 0.0 | -20.0 | 88.4 | 0.0 | -49.9 | -59.9 | -44.9 | 72.8 | 0.0 | 0.0 |
| D-12 | -14.1 | -20.9 | -23.5 | -43.6 | 0.0 | -20.9 | 40.3 | 66.8 | 27.5 | 0.0 | 0.0 | -19.4 | 85.1 | 0.0 | -46.7 | -58.0 | -43.6 | 70.9 | 0.0 | 0.0 |
| J-13 | -14.9 | -19.9 | -24.9 | -44.7 | 0.0 | -19.9 | 35.6 | 68.1 | 23.1 | 0.0 | 0.0 | -20.0 | 87.2 | 0.0 | -44.8 | -59.7 | -44.7 | 72.4 | 0.0 | 0.0 |
| F-13 | -12.2 | -20.0 | -22.5 | -42.5 | 0.0 | -21.9 | 36.8 | 63.5 | 24.5 | 0.0 | 0.0 | -19.6 | 81.5 | 0.0 | -46.1 | -56.9 | -42.4 | 71.3 | 0.0 | 0.0 |
| M-13 | -8.2 | -17.7 | -16.7 | -41.6 | 0.0 | -22.9 | 32.8 | 63.8 | 22.7 | 0.0 | 0.0 | -19.9 | 82.0 | 0.0 | -46.8 | -55.5 | -46.3 | 68.4 | 0.0 | 0.0 |
| A-13 | -13.9 | -19.9 | -23.0 | -41.8 | 0.0 | -22.9 | 39.7 | 69.1 | 23.9 | 0.0 | 0.0 | -19.9 | 86.9 | 0.0 | -46.7 | -55.8 | -47.8 | 66.2 | 0.0 | 0.0 |
| M-13 | -15.0 | -20.0 | -25.0 | -41.4 | 0.0 | -23.0 | 44.4 | 68.3 | 27.1 | 0.0 | 0.0 | -20.0 | 82.6 | -0.2 | -47.0 | -55.9 | -47.1 | 64.7 | 0.0 | 0.0 |
| J-13 | -14.2 | -18.9 | -23.7 | -38.0 | 0.0 | -21.8 | 36.3 | 68.7 | 23.8 | 0.0 | 0.0 | -18.9 | 83.6 | -8.4 | -43.4 | -53.1 | -42.6 | 64.4 | 0.0 | 0.0 |
| J-13 | -15.0 | -20.0 | -25.0 | -40.0 | 0.0 | -22.2 | 38.3 | 71.7 | 23.3 | 0.0 | 0.0 | -19.2 | 82.7 | -10.0 | -43.3 | -53.8 | -45.2 | 67.0 | 0.0 | 0.0 |
| A-13 | -14.8 | -20.0 | -23.6 | -39.6 | 0.0 | -21.9 | 37.7 | 70.7 | 23.6 | 0.0 | 0.0 | -18.7 | 83.3 | -10.0 | -42.8 | -53.1 | -44.7 | 66.0 | 0.0 | 0.0 |
| S-13 | -9.6 | -19.5 | -17.4 | -36.2 | 0.0 | -20.3 | 21.0 | 64.0 | 24.1 | 0.0 | 0.0 | -17.2 | 79.1 | -10.0 | -39.6 | -49.2 | -38.7 | 60.9 | 0.0 | 0.0 |
| O-13 | -8.4 | -18.4 | -15.5 | -39.4 | 0.0 | -22.7 | 35.7 | 66.2 | 27.5 | 0.0 | 0.0 | -19.7 | 74.8 | -9.7 | -44.4 | -55.3 | -39.5 | 61.7 | 0.0 | 0.0 |
| N-13 | -10.7 | -19.9 | -17.1 | -44.1 | 0.0 | -20.3 | 34.3 | 59.8 | 27.0 | 0.0 | 0.0 | -19.8 | 67.2 | -9.9 | -13.9 | -50.4 | -43.9 | 56.2 | 0.0 | 0.0 |
| D-13 | -11.4 | -20.0 | -18.1 | -45.0 | 0.0 | -15.2 | 32.4 | 60.4 | 23.8 | 0.0 | 0.0 | -10.0 | 68.4 | -10.0 | -24.1 | -49.3 | -45.0 | 56.6 | 0.0 | 0.0 |
| J-14 | -11.3 | -20.0 | -18.0 | -44.2 | 0.0 | -13.4 | 37.4 | 70.1 | 28.0 | 0.0 | 0.0 | -11.5 | 79.4 | -10.0 | -43.6 | -44.5 | -43.9 | 65.4 | -11.0 | -13.7 |
| F-14 | -8.3 | -17.6 | -16.0 | -39.7 | 0.0 | 0.0 | 35.5 | 66.2 | 26.6 | 0.0 | 0.0 | 0.0 | 75.3 | -9.7 | -44.7 | -52.7 | -40.2 | 62.1 | -22.1 | -22.9 |
| M-14 | -9.7 | -19.8 | -18.8 | -18.4 | 0.0 | 0.0 | 28.7 | 53.7 | 21.6 | 0.0 | 0.0 | 0.0 | 60.9 | -9.9 | -44.8 | -52.0 | -16.0 | 50.2 | -15.1 | -15.1 |
| A-14 | -10.0 | -24.9 | -24.7 | -44.0 | 0.0 | 0.0 | 39.8 | 74.6 | 29.9 | 0.0 | 0.0 | 0.0 | 84.7 | -10.0 | -49.9 | -53.0 | -44.0 | 69.7 | -22.0 | -22.0 |
| M-14 | -10.0 | -25.0 | -25.0 | -44.0 | 0.0 | 0.0 | 39.5 | 74.0 | 29.6 | 0.0 | 0.0 | 0.0 | 83.9 | -10.0 | -50.0 | -53.0 | -44.0 | 69.1 | -20.5 | -20.5 |
| J-14 | -10.0 | -25.0 | -25.0 | -44.0 | 0.0 | 0.0 | 39.4 | 73.8 | 29.5 | 0.0 | 0.0 | 0.0 | 83.6 | -10.0 | -50.0 | -53.0 | -44.0 | 68.9 | -20.0 | -20.0 |
| J-14 | -9.9 | -24.7 | -24.7 | -43.6 | 0.0 | 0.0 | 38.9 | 72.8 | 29.2 | 0.0 | 0.0 | 0.0 | 81.3 | -9.9 | -49.3 | -52.4 | -43.6 | 68.1 | -19.8 | -19.8 |
| A-14 | -9.4 | -22.8 | -19.1 | -43.1 | 0.0 | -6.0 | 29.1 | 57.0 | 19.1 | 0.0 | 0.0 | -4.2 | 59.1 | -7.0 | -29.7 | -28.8 | -29.0 | 51.3 | -12.7 | -12.7 |
| S-14 | -2.3 | -5.9 | -4.3 | -12.2 | 0.0 | -6.0 | 10.7 | 20.1 | 8.0 | 0.0 | 0.0 | -4.5 | 22.8 | -1.9 | -11.9 | -9.0 | -12.0 | 18.7 | -6.0 | -6.0 |
| O-14 | -8.2 | -21.0 | -17.6 | -39.2 | 0.0 | -19.5 | 36.0 | 67.4 | 27.0 | 0.0 | 0.0 | -14.6 | 76.4 | -9.5 | -39.0 | -29.3 | -38.6 | 62.9 | -19.5 | -19.5 |
| N-14 | -11.6 | -33.3 | -16.8 | -39.7 | 0.0 | -19.3 | 36.8 | 68.9 | 27.6 | 0.0 | 0.0 | -16.8 | 78.2 | -9.9 | -17.3 | -29.0 | -41.0 | 64.4 | -23.9 | -23.9 |

Table C-6. Average Monthly Pumping Rates (gpm) for Wells in the KR4 Treatment System (Jan 2006 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Names | 199-K-113A | 199-K-114A | 199-K-115A | 199-K-116A | 199-K-119A | 199-K-120A | 199-K-121A | 199-K-122A | 199-K-123A | 199-K-124A | 199-K-125A | 199-K-127 | 199-K-128 | 199-K-129 | 199-K-144 | 199-K-145 | 199-K-162 | 199-K-179 | 199-K-198 | 199-K-199 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D-14 | -11.7 | -40.9 | -14.1 | -39.7 | 0.0 | -23.0 | 42.4 | 79.1 | 43.2 | 0.0 | 0.0 | -22.9 | 70.3 | -9.7 | -20.6 | -28.7 | -50.9 | 71.7 | -26.0 | -27.1 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

Table C-7. Average Monthly Pumping Rates (gpm) for Wells in the KW Treatment System (Jan 2007 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-K-132 | 199-K-137 | 199-K-138 | 199-K-139 | 199-K-140 | 199-K-158 | 199-K-165 | 199-K-166 | 199-K-168 | 199-K-173 | 199-K-173 | 199-K-174 | 199-K-175 | 199-K-196 | 199-K-196 | 199-K-35 | 199-K-205 | 199-K-206 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-07 | -2.0 | 0.0 | -2.0 | -2.4 | -1.8 | 5.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 0.0 | 0.0 |
| F-07 | -27.1 | 0.0 | -27.6 | -15.8 | -27.5 | 77.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.8 | 0.0 | 0.0 |
| M-07 | -24.0 | 0.0 | -22.2 | -30.6 | -24.5 | 81.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.9 | 0.0 | 0.0 |
| A-07 | -26.0 | 0.0 | -20.5 | -29.5 | -21.5 | 79.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.4 | 0.0 | 0.0 |
| M-07 | -16.6 | 0.0 | -11.1 | -26.5 | -22.8 | 66.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.8 | 0.0 | 0.0 |
| J-07 | -22.7 | 0.0 | -18.1 | -19.8 | -14.2 | 61.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 13.5 | 0.0 | 0.0 |
| J-07 | -26.3 | 0.0 | -24.8 | -23.0 | -16.2 | 72.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.7 | 0.0 | 0.0 |
| A-07 | -27.4 | 0.0 | -25.4 | -27.3 | -14.4 | 76.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.6 | 0.0 | 0.0 |
| S-07 | -29.3 | 0.0 | -27.4 | -29.5 | -15.5 | 82.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | 0.0 | 0.0 |
| O-07 | -28.9 | 0.0 | -26.8 | -29.3 | -15.4 | 81.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.8 | 0.0 | 0.0 |
| N-07 | -28.7 | 0.0 | -26.9 | -28.9 | -15.2 | 80.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.6 | 0.0 | 0.0 |
| D-07 | -29.4 | 0.0 | -27.5 | -24.4 | -17.6 | 80.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.4 | 0.0 | 0.0 |
| J-08 | -29.4 | 0.0 | -27.4 | -15.0 | -29.4 | 81.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.9 | 0.0 | 0.0 |
| F-08 | -29.2 | 0.0 | -27.3 | -14.9 | -29.2 | 81.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.9 | 0.0 | 0.0 |
| M-08 | -29.4 | 0.0 | -27.5 | -15.0 | -29.4 | 81.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | 0.0 | 0.0 |
| A-08 | -28.0 | 0.0 | -28.0 | -26.2 | -13.2 | 77.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.7 | 0.0 | 0.0 |
| M-08 | -23.8 | 0.0 | -27.7 | -31.6 | -16.5 | 80.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.5 | 0.0 | 0.0 |
| J-08 | -16.8 | 0.0 | -30.9 | -21.5 | -21.4 | 76.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 15.1 | 0.0 | 0.0 |
| J-08 | -18.4 | 0.0 | -31.2 | -25.2 | -26.8 | 82.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | 0.0 | 0.0 |
| A-08 | -29.4 | 0.0 | -29.4 | -29.5 | -13.5 | 82.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | 0.0 | 0.0 |
| S-08 | -26.6 | 0.0 | -28.9 | -28.0 | -13.2 | 78.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.1 | 0.0 | 0.0 |
| O-08 | -25.1 | 0.0 | -33.6 | -22.8 | -18.7 | 80.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.8 | 0.0 | 0.0 |
| N-08 | -24.3 | 0.0 | -29.7 | -29.3 | -14.5 | 78.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.6 | 0.0 | 0.0 |
| D-08 | -24.0 | 0.0 | -30.0 | -26.7 | -16.7 | 78.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.2 | 0.0 | 0.0 |
| J-09 | -23.9 | 0.0 | -32.2 | -26.5 | -15.7 | 77.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 21.4 | 0.0 | 0.0 |
| F-09 | -20.1 | 0.0 | -34.8 | -28.3 | -12.8 | 74.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 22.2 | 0.0 | 0.0 |
| M-09 | -13.0 | 0.0 | -29.3 | -7.4 | -18.4 | 52.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 16.2 | 0.0 | 0.0 |
| A-09 | -14.0 | -14.0 | -19.4 | 0.0 | -13.7 | 58.7 | -12.5 | -4.1 | -14.1 | 0.0 | 0.0 | 16.1 | 10.1 | 0.0 | 0.0 | 3.2 | 0.0 | 0.0 |
| M-09 | -23.0 | -39.2 | -25.4 | 0.0 | -6.3 | 106.1 | -41.3 | -10.1 | -38.8 | 0.0 | 0.0 | 68.5 | 8.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-09 | -26.8 | -38.1 | -29.3 | 0.0 | 0.0 | 89.9 | -46.9 | -9.8 | -5.0 | 0.0 | 0.0 | 57.2 | 7.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-09 | -20.1 | -39.1 | -27.1 | 0.0 | 0.0 | 21.9 | -45.0 | -9.6 | -35.8 | 0.0 | 0.0 | 83.3 | 54.5 | 0.0 | 0.0 | 16.8 | 0.0 | 0.0 |
| A-09 | -18.6 | -36.5 | -30.5 | 0.0 | 0.0 | 75.8 | -43.5 | -11.3 | -31.8 | 0.0 | 0.0 | 58.1 | 28.7 | 0.0 | 0.0 | 9.9 | 0.0 | 0.0 |
| S-09 | -10.3 | -36.0 | -24.5 | 0.0 | -0.1 | 76.4 | -48.4 | -17.1 | -29.2 | 0.0 | 0.0 | 61.3 | 19.8 | 0.0 | 0.0 | 7.8 | 0.0 | 0.0 |
| O-09 | -13.3 | -33.8 | -33.9 | 0.0 | -0.2 | 79.6 | -49.3 | -22.5 | -39.5 | 0.0 | 0.0 | 65.4 | 34.7 | 0.0 | 0.0 | 12.4 | 0.0 | 0.0 |
| N-09 | -15.8 | -34.9 | -34.8 | 0.0 | -0.1 | 79.9 | -51.0 | -19.9 | -39.8 | 0.0 | 0.0 | 65.8 | 40.1 | 0.0 | 0.0 | 10.2 | 0.0 | 0.0 |
| D-09 | -16.2 | -36.1 | -28.4 | 0.0 | -0.1 | 84.5 | -49.8 | -21.8 | -40.2 | 0.0 | 0.0 | 70.1 | 37.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-10 | -13.8 | -35.1 | -34.8 | 0.0 | -0.1 | 88.6 | -50.4 | -23.8 | -39.9 | 0.0 | 0.0 | 75.6 | 33.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-10 | -12.6 | -33.7 | -30.5 | 0.0 | -6.5 | 83.1 | -24.3 | -25.2 | -41.4 | 0.0 | 0.0 | 61.3 | 29.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-10 | -11.3 | -32.4 | -30.7 | 0.0 | -0.1 | 91.3 | -54.2 | -24.8 | -44.5 | 0.0 | 0.0 | 70.4 | 35.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-10 | -10.0 | -30.4 | -19.0 | -22.5 | 0.0 | 91.9 | -54.9 | -24.6 | -36.7 | 0.0 | 0.0 | 70.0 | 35.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table C-7. Average Monthly Pumping Rates (gpm) for Wells in the KW Treatment System (Jan 2007 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-K-132 | 199-K-137 | 199-K-138 | 199-K-139 | 199-K-140 | 199-K-158 | 199-K-165 | 199-K-166 | 199-K-168 | 199-K-173 | 199-K-173 | 199-K-174 | 199-K-175 | 199-K-196 | 199-K-196 | 199-K-35 | 199-K-205 | 199-K-206 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M-10 | -10.7 | -31.3 | -12.4 | -32.3 | 0.0 | 91.8 | -54.8 | -21.2 | -35.8 | 0.0 | 0.0 | 70.3 | 35.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-10 | -8.0 | -30.1 | -12.4 | -29.7 | 0.0 | 89.2 | -50.5 | -20.2 | -36.3 | 0.0 | 0.0 | 66.6 | 31.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-10 | -10.8 | -20.1 | -15.0 | -34.2 | 0.0 | 90.0 | -54.5 | -16.6 | -41.8 | 0.0 | 0.0 | 68.8 | 34.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-10 | -12.4 | -28.2 | -12.6 | -31.4 | 0.0 | 89.0 | -52.7 | -12.3 | -42.1 | 0.0 | 0.0 | 68.4 | 33.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-10 | -12.6 | -29.0 | -13.9 | -26.3 | 0.0 | 94.4 | -54.8 | -18.1 | -44.7 | 0.0 | 0.0 | 69.1 | 35.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-10 | -11.9 | -29.2 | -13.5 | -24.3 | 0.0 | 93.8 | -54.8 | -20.7 | -44.8 | 0.0 | 0.0 | 68.0 | 36.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-10 | -11.9 | -28.9 | -11.9 | -22.8 | 0.0 | 92.8 | -54.7 | -24.9 | -43.9 | 0.0 | 0.0 | 69.9 | 35.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-10 | -12.9 | -29.7 | -13.0 | -26.3 | 0.0 | 93.1 | -54.5 | -17.7 | -42.9 | 0.0 | 0.0 | 67.0 | 36.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-11 | -12.6 | -29.8 | -13.0 | -28.0 | 0.0 | 91.3 | -54.5 | -19.9 | -40.5 | 0.0 | 0.0 | 69.2 | 37.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-11 | -13.0 | -29.8 | -13.0 | -29.7 | 0.0 | 91.5 | -54.7 | -19.9 | -39.8 | 0.0 | 0.0 | 70.6 | 37.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-11 | -12.4 | -28.5 | -12.4 | -23.7 | 0.0 | 87.7 | -56.9 | -19.0 | -37.9 | 0.0 | 0.0 | 68.0 | 34.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-11 | -12.9 | -29.8 | -12.9 | -23.6 | 0.0 | 83.1 | -58.6 | -19.2 | -36.8 | 0.0 | 0.0 | 68.8 | 41.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-11 | -12.3 | -29.1 | -12.2 | -17.7 | 0.0 | 79.5 | -58.1 | -20.0 | -38.0 | 0.0 | 0.0 | 72.0 | 35.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-11 | -11.4 | -19.7 | -11.7 | -9.8 | 0.0 | 65.7 | -45.9 | -16.5 | -27.0 | 0.0 | 0.0 | 54.1 | 22.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-11 | -14.0 | -29.8 | -14.0 | -20.4 | 0.0 | 84.4 | -59.6 | -19.9 | -40.3 | 0.0 | 0.0 | 73.9 | 39.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-11 | -11.1 | -22.8 | -11.2 | -17.6 | 0.0 | 68.6 | -45.0 | -15.6 | -30.1 | 0.0 | 0.0 | 58.3 | 26.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-11 | -5.3 | -14.5 | -5.0 | -5.8 | 0.0 | 56.0 | -35.5 | -26.0 | -15.3 | 0.0 | 0.0 | 31.3 | 19.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-11 | -14.0 | -25.0 | -14.0 | -15.0 | 0.0 | 84.7 | -59.9 | -45.0 | -27.0 | 0.0 | 0.0 | 76.5 | 38.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-11 | -14.1 | -25.0 | -14.0 | -15.0 | 0.0 | 84.5 | -60.1 | -45.1 | -27.0 | 0.0 | 0.0 | 76.2 | 38.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-11 | -14.0 | -25.0 | -14.0 | -15.0 | 0.0 | 84.1 | -59.9 | -45.0 | -27.0 | 0.0 | 0.0 | 75.7 | 39.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-12 | -14.0 | -25.0 | -14.0 | -15.0 | 0.0 | 84.2 | -60.0 | -45.0 | -27.0 | 0.0 | 0.0 | 75.8 | 39.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-12 | -14.0 | -24.8 | -14.0 | -15.0 | 0.0 | 85.3 | -60.0 | -45.0 | -27.0 | 0.0 | 0.0 | 77.3 | 36.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-12 | -14.0 | -24.4 | -12.9 | -15.0 | 0.0 | 83.8 | -59.9 | -44.9 | -27.0 | 0.0 | 0.0 | 75.9 | 37.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-12 | -14.0 | -25.0 | -10.0 | -14.9 | 0.0 | 82.9 | -60.0 | -45.0 | -27.0 | 0.0 | 0.0 | 74.9 | 37.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-12 | -14.7 | -24.9 | -14.7 | -15.1 | 0.0 | 84.2 | -59.9 | -34.5 | -36.1 | 0.0 | 0.0 | 76.7 | 38.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-12 | -15.0 | -25.0 | -15.0 | -15.0 | 0.0 | 85.2 | -60.0 | -30.0 | -39.5 | 0.0 | 0.0 | 77.8 | 36.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-12 | -17.7 | -25.0 | -18.3 | -15.0 | 0.0 | 83.6 | -59.9 | -20.0 | -39.9 | 0.0 | 0.0 | 76.0 | 35.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-12 | -25.2 | -23.0 | -23.3 | -18.1 | 0.0 | 73.4 | -54.3 | -17.9 | -37.5 | 0.0 | 0.0 | 68.7 | 57.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-12 | -20.6 | -20.8 | -33.0 | -23.8 | 0.0 | 95.1 | -57.6 | -24.2 | -37.2 | -30.9 | 0.0 | 72.9 | 80.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-12 | -14.1 | -19.0 | -33.4 | -20.3 | 0.0 | 105.9 | -60.0 | -28.0 | -35.0 | -53.3 | 0.0 | 74.8 | 82.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-12 | -16.6 | -18.2 | -30.0 | -19.2 | 0.0 | 113.5 | -60.0 | -30.0 | -35.0 | -60.0 | 0.0 | 74.1 | 81.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-12 | -19.4 | -18.4 | -29.8 | -20.4 | 0.0 | 115.7 | -59.6 | -29.8 | -34.8 | -58.9 | 0.0 | 73.9 | 81.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-13 | -20.0 | -18.9 | -30.0 | -21.5 | 0.0 | 116.8 | -63.5 | -26.5 | -35.0 | -60.0 | 0.0 | 75.4 | 83.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-13 | -16.5 | -16.3 | -30.0 | -16.5 | 0.0 | 112.4 | -59.3 | -28.1 | -37.0 | -59.9 | 0.0 | 71.6 | 79.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-13 | -10.2 | -7.8 | -29.9 | -13.7 | 0.0 | 109.3 | -59.7 | -29.9 | -44.8 | -59.7 | 0.0 | 69.2 | 76.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-13 | -20.5 | 0.0 | -30.0 | -18.4 | 0.0 | 114.8 | -63.5 | -33.6 | -44.9 | -59.9 | 0.0 | 73.8 | 82.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-13 | -24.8 | -0.4 | -30.0 | -20.0 | 0.0 | 117.6 | -64.3 | -34.5 | -44.8 | -59.8 | 0.0 | 76.2 | 84.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-13 | -22.4 | -18.1 | -28.2 | -18.8 | 0.0 | 92.7 | -49.5 | -28.2 | -39.2 | -56.3 | 0.0 | 78.7 | 89.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-13 | -16.2 | -18.2 | -20.7 | -13.3 | 0.0 | 61.4 | -34.7 | -20.8 | -22.2 | -41.6 | 0.0 | 59.0 | 67.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-13 | -1.4 | -2.7 | -2.3 | -1.6 | 0.0 | 7.0 | -3.9 | -2.4 | -2.7 | 0.0 | 0.0 | 4.7 | 5.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S-13 | -11.7 | -34.7 | -19.7 | -20.1 | -11.0 | 89.9 | -49.2 | -40.7 | -30.4 | -9.3 | 5.7 | 60.5 | 68.6 | -3.7 | 5.7 | 0.0 | 0.0 | 0.0 |
| O-13 | -8.7 | -33.4 | -14.8 | -19.7 | -24.6 | 114.0 | -49.3 | -44.4 | -29.6 | -49.3 | 0.0 | 83.5 | 95.3 | -19.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-13 | -10.6 | -32.6 | -15.0 | -16.0 | -21.0 | 125.4 | -49.9 | -36.8 | -30.7 | -58.0 | 0.0 | 83.1 | 93.4 | -32.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-13 | -11.8 | -31.0 | -15.0 | -15.0 | -19.9 | 125.5 | -49.5 | -34.7 | -30.0 | -59.4 | 0.0 | 82.3 | 92.3 | -35.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-14 | -11.1 | -29.2 | -15.0 | -15.0 | -18.1 | 124.1 | -51.8 | -29.3 | -33.8 | -59.9 | 0.0 | 81.6 | 91.5 | -35.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-14 | -6.7 | -25.9 | -15.0 | -14.0 | -15.0 | 109.2 | -45.1 | -19.1 | -30.1 | -57.5 | 0.0 | 69.4 | 77.2 | -28.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-14 | -11.8 | -24.9 | -15.0 | -14.1 | -15.0 | 121.7 | -54.9 | -30.0 | -39.9 | -46.4 | 0.0 | 79.5 | 88.8 | -39.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| A-14 | -14.7 | -24.8 | -14.9 | -14.9 | -14.9 | 125.6 | -54.4 | -29.3 | -38.7 | -54.5 | 0.0 | 81.7 | 91.7 | -38.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-14 | -14.4 | -24.7 | -14.8 | -14.8 | -14.8 | 127.1 | -54.4 | -29.7 | -39.6 | -54.4 | 0.0 | 81.0 | 90.8 | -37.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| J-14 | -14.3 | -24.3 | -14.6 | -14.6 | -14.6 | 91.8 | -53.4 | -29.1 | -38.9 | -53.4 | 0.0 | 76.3 | 81.0 | -37.5 | 0.0 | 0.0 | 0.0 | 43.6 |

**Table C-7. Average Monthly Pumping Rates (gpm) for Wells in the KW Treatment System (Jan 2007 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | 199-K-132 | 199-K-137 | 199-K-138 | 199-K-139 | 199-K-140 | 199-K-158 | 199-K-165 | 199-K-166 | 199-K-168 | 199-K-173 | 199-K-173 | 199-K-174 | 199-K-175 | 199-K-196 | 199-K-196 | 199-K-35 | 199-K-205 | 199-K-206 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-14 | -14.8 | -23.1 | -14.8 | -14.8 | -14.8 | 53.6 | -45.6 | -27.1 | -34.3 | -46.4 | 0.0 | 67.2 | 67.2 | -33.5 | 0.0 | 0.0 | 0.0 | 80.4 |
| A-14 | -11.1 | -18.1 | -11.6 | -11.6 | -11.6 | 46.1 | -42.5 | -23.2 | -30.0 | -42.4 | 0.0 | 57.9 | 57.9 | -30.1 | 0.0 | 0.0 | 0.0 | 69.2 |
| S-14 | -6.1 | -19.5 | -15.0 | -15.0 | -15.2 | 93.8 | -54.6 | -29.8 | -39.7 | -54.5 | 0.0 | 48.7 | 48.7 | -38.5 | 0.0 | 0.0 | -9.6 | 104.2 |
| O-14 | 0.0 | -15.6 | -20.7 | -14.9 | -21.9 | 88.7 | -56.9 | -28.4 | -43.8 | -54.1 | 0.0 | 60.5 | 60.5 | -37.9 | 0.0 | 0.0 | -13.9 | 96.8 |
| N-14 | 0.0 | -14.5 | -22.0 | -15.0 | -22.8 | 94.1 | -53.2 | -28.2 | -45.1 | -52.6 | 0.0 | 64.1 | 64.1 | -36.6 | 0.0 | 0.0 | -36.5 | 102.6 |
| D-14 | 0.0 | -13.7 | -19.3 | -14.5 | -19.3 | 91.5 | -48.3 | -24.2 | -42.8 | -48.3 | 0.0 | 62.4 | 62.4 | -33.8 | 0.0 | 0.0 | -53.1 | 99.8 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

**Table C-8. Average Monthly Pumping Rates (gpm) for Wells in the KX Treatment System (Feb 2009 to Dec 2011): Extraction Rates are Negative and Injection Rates are Positive**

| | 2009 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Well Name | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 199-K-130 | -36.2 | -48.3 | -41.6 | -43.9 | -30.2 | -34.5 | -42.7 | -50.0 | -47.2 | -45.3 | -42.7 |
| 199-K-131 | -41.3 | -48.3 | -42.4 | -49.3 | -39.1 | -50.6 | -43.3 | -51.4 | -52.3 | -52.9 | -52.7 |
| 199-K-141 | 0.0 | 0.0 | 0.0 | -30.0 | -37.0 | -10.5 | 0.0 | 0.0 | 0.0 | -21.2 | -36.4 |
| 199-K-143 | 42.1 | 45.1 | 27.7 | 45.9 | 21.4 | 47.7 | 26.8 | 20.2 | 22.8 | 32.1 | 38.1 |
| 199-K-145 | -48.3 | -51.6 | -16.0 | -52.8 | -35.3 | -60.0 | -15.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-146 | -9.3 | -9.7 | -8.3 | -7.9 | -8.4 | -9.3 | -8.7 | -9.5 | -9.7 | -9.9 | -6.4 |
| 199-K-147 | -18.6 | -19.1 | -16.6 | -18.0 | -16.8 | -19.2 | -17.4 | -19.1 | -18.8 | -19.9 | -20.0 |
| 199-K-148 | -38.7 | -33.3 | -33.5 | -37.5 | -27.7 | -34.8 | -35.8 | -18.3 | -38.1 | -39.9 | -39.8 |
| 199-K-149 | -29.4 | -31.7 | -26.7 | -35.4 | -20.3 | -18.8 | -24.7 | -48.2 | -51.4 | -51.4 | -50.6 |
| 199-K-150 | -30.0 | -29.0 | -25.0 | -28.1 | -12.6 | -28.1 | -26.2 | -28.6 | -29.5 | -30.0 | -30.0 |
| 199-K-152 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-153 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-154 | 0.0 | 0.0 | 0.0 | -42.4 | -44.6 | -57.1 | -25.4 | -40.6 | -27.1 | -41.3 | -64.9 |
| 199-K-156 | 40.5 | 41.3 | 28.8 | 55.3 | 60.6 | 33.2 | 32.7 | 33.6 | 32.5 | 43.8 | 50.2 |
| 199-K-159 | 46.7 | 47.6 | 32.1 | 60.6 | 31.9 | 64.5 | 39.2 | 44.0 | 43.2 | 48.7 | 55.6 |
| 199-K-160 | 46.7 | 47.6 | 32.4 | 60.6 | 32.0 | 64.4 | 37.3 | 41.1 | 41.0 | 48.6 | 55.8 |
| 199-K-161 | -22.9 | -21.4 | -20.8 | -20.0 | -19.4 | -22.9 | -20.6 | -20.3 | -18.9 | -21.9 | -23.2 |
| 199-K-162 | -51.1 | -52.7 | -16.0 | -52.8 | -34.6 | -59.3 | -11.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-163 | 0.0 | 0.0 | 0.0 | -42.3 | -44.6 | -56.7 | -25.4 | -40.6 | -27.1 | -41.1 | -64.9 |
| 199-K-164 | 0.0 | 7.7 | 22.2 | 38.0 | 47.3 | 39.2 | 23.3 | 29.7 | 28.8 | 29.9 | 33.6 |
| 199-K-169 | 47.5 | 50.8 | 33.9 | 67.7 | 30.9 | 66.3 | 35.3 | 33.7 | 31.5 | 52.0 | 61.9 |
| 199-K-170 | 49.8 | 50.8 | 33.8 | 68.4 | 76.7 | 72.3 | 60.4 | 78.0 | 75.7 | 57.8 | 62.4 |
| 199-K-171 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-172 | 52.8 | 53.9 | 35.5 | 67.9 | 68.7 | 73.4 | 41.9 | 45.9 | 44.3 | 60.5 | 72.7 |
| 199-K-178 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-180 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | 2010 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well Name | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 199-K-130 | -38.3 | -30.3 | -26.4 | -30.4 | -28.3 | -29.4 | -29.6 | -27.6 | -22.9 | -22.8 | -23.1 | -23.1 |
| 199-K-131 | -51.5 | -46.0 | -46.6 | -52.9 | -49.8 | -53.0 | -52.1 | -52.0 | -48.2 | -53.0 | -52.3 | -52.9 |
| 199-K-141 | -35.0 | -29.1 | -0.4 | -30.9 | -33.6 | -33.7 | -33.5 | -31.0 | -30.4 | -32.4 | -32.2 | -32.4 |
| 199-K-143 | 36.9 | 29.8 | 24.6 | 26.6 | 28.1 | 29.5 | 19.5 | 18.2 | 14.7 | 16.2 | 11.8 | 15.8 |
| 199-K-145 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-146 | -9.5 | -7.7 | -7.6 | -7.6 | -9.0 | -10.0 | -9.8 | -9.8 | -7.7 | -8.0 | -8.7 | -9.0 |
| 199-K-147 | -18.1 | -12.1 | -16.8 | -18.3 | -18.3 | -18.8 | -19.7 | -18.5 | -16.4 | -17.6 | -17.4 | -17.7 |
| 199-K-148 | -34.3 | -30.7 | -33.3 | -34.9 | -36.1 | -42.9 | -49.2 | -49.1 | -44.4 | -40.0 | -39.5 | -37.4 |
| 199-K-149 | -34.8 | -41.3 | -39.5 | -40.0 | -37.5 | -27.4 | -0.5 | -0.7 | -0.7 | -0.7 | -0.6 | -0.4 |
| 199-K-150 | -30.0 | -2.6 | 0.0 | 0.0 | -9.6 | -3.5 | -0.3 | -0.4 | -0.5 | -0.4 | -0.4 | -0.2 |
| 199-K-152 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-153 | 0.0 | 0.0 | -8.6 | -32.4 | -64.5 | -70.5 | -70.6 | -68.8 | -62.1 | -66.3 | -68.5 | -66.8 |
| 199-K-154 | -64.3 | -57.0 | -53.5 | -56.4 | -58.3 | -63.3 | -61.7 | -56.3 | -54.6 | -59.9 | -58.5 | -57.0 |
| 199-K-156 | 47.2 | 39.0 | 39.3 | 62.6 | 74.8 | 79.1 | 66.6 | 57.4 | 62.0 | 68.0 | 70.0 | 67.6 |
| 199-K-159 | 52.1 | 43.2 | 46.0 | 62.3 | 66.9 | 70.6 | 61.5 | 57.6 | 54.8 | 60.1 | 60.5 | 58.8 |
| 199-K-160 | 53.1 | 44.0 | 45.3 | 63.1 | 67.6 | 71.4 | 61.9 | 57.8 | 55.0 | 60.3 | 60.8 | 59.2 |
| 199-K-161 | -20.6 | -16.0 | -15.7 | -16.6 | -18.6 | -23.1 | -4.7 | -0.5 | -0.3 | -14.9 | -18.3 | -19.7 |
| 199-K-162 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-163 | -64.2 | -56.5 | -53.5 | -56.5 | -58.3 | -63.3 | -58.7 | -55.7 | -54.6 | -59.9 | -58.5 | -57.0 |
| 199-K-164 | 30.6 | 24.4 | 27.2 | 49.0 | 56.6 | 61.5 | 52.7 | 51.7 | 46.6 | 51.1 | 51.7 | 49.9 |
| 199-K-169 | 56.8 | 47.6 | 46.3 | 53.8 | 63.8 | 64.6 | 55.7 | 50.5 | 48.8 | 53.9 | 53.1 | 52.8 |
| 199-K-170 | 58.0 | 47.7 | 47.0 | 54.3 | 60.0 | 63.5 | 52.3 | 47.0 | 43.6 | 47.8 | 49.0 | 48.0 |
| 199-K-171 | 0.0 | 0.0 | -29.1 | -49.5 | -57.7 | -60.3 | -57.9 | -53.1 | -54.3 | -58.9 | -58.7 | -56.6 |
| 199-K-172 | 65.1 | 53.3 | 51.2 | 58.0 | 71.4 | 65.9 | 66.3 | 62.3 | 59.0 | 64.6 | 65.4 | 62.7 |
| 199-K-178 | 0.0 | 0.0 | -7.2 | -53.9 | -69.6 | -69.5 | -39.0 | -22.3 | -34.5 | -39.3 | -39.0 | -36.0 |
| 199-K-180 | 0.0 | 0.0 | 10.6 | 49.5 | 58.7 | 61.3 | 50.2 | 45.3 | 46.0 | 50.4 | 51.1 | 49.4 |

| | 2011 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well Name | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 199-K-130 | -23.6 | -24.0 | -12.3 | -25.0 | -24.9 | -29.0 | -29.8 | -27.4 | -22.6 | -21.4 | -19.5 | -18.2 |
| 199-K-131 | -53.0 | -50.9 | -25.0 | -50.0 | -49.9 | -43.0 | -48.1 | -48.7 | -48.1 | -49.7 | -49.6 | -48.9 |
| 199-K-141 | -34.4 | -36.2 | -36.9 | -37.5 | -37.1 | -30.3 | -35.2 | -36.7 | -34.2 | -30.4 | -29.9 | -30.2 |
| 199-K-143 | 36.4 | 26.4 | 22.6 | 31.0 | 30.0 | 27.0 | 29.0 | 32.7 | 15.0 | 13.0 | 15.0 | 28.6 |
| 199-K-145 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-146 | -9.6 | -10.0 | -5.0 | -9.9 | -10.0 | -8.6 | -9.6 | -9.7 | -9.8 | -9.2 | -9.6 | -9.5 |
| 199-K-147 | -18.9 | -20.0 | -10.0 | -20.0 | -19.0 | -17.0 | -19.2 | -19.5 | -19.5 | -19.6 | -20.0 | -19.5 |
| 199-K-148 | -40.0 | -43.4 | -22.5 | -45.0 | -45.0 | -38.6 | -43.2 | -43.8 | -43.7 | -44.7 | -35.9 | -42.6 |
| 199-K-149 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-150 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-152 | 0.0 | 0.0 | 0.0 | -27.6 | -49.8 | -43.0 | -48.1 | -48.7 | -48.1 | -49.8 | -49.5 | -49.1 |
| 199-K-153 | -69.3 | -48.5 | -39.7 | -39.9 | -39.8 | -33.9 | -36.1 | -37.8 | -34.2 | -37.3 | -39.9 | -37.2 |
| 199-K-154 | -59.6 | -59.4 | -59.5 | -59.8 | -59.8 | -51.0 | -52.0 | -55.4 | -54.0 | -59.6 | -59.4 | -59.7 |
| 199-K-156 | 66.6 | 61.6 | 55.7 | 73.2 | 71.1 | 49.4 | 48.6 | 53.3 | 66.5 | 74.6 | 73.8 | 72.9 |
| 199-K-159 | 58.1 | 53.9 | 25.0 | 34.6 | 63.6 | 55.7 | 60.8 | 61.9 | 59.6 | 59.7 | 57.8 | 56.6 |
| 199-K-160 | 58.3 | 54.1 | 25.2 | 34.8 | 63.7 | 55.9 | 61.0 | 62.0 | 59.8 | 60.0 | 57.9 | 56.7 |
| 199-K-161 | -19.8 | -13.1 | -0.1 | -0.2 | -0.8 | -0.6 | -0.5 | -0.8 | -0.4 | -0.9 | -0.2 | -1.2 |
| 199-K-162 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-163 | -59.5 | -52.2 | -49.6 | -49.9 | -49.9 | -50.5 | -55.0 | -56.7 | -51.8 | -59.3 | -59.4 | -59.4 |
| 199-K-164 | 49.2 | 46.8 | 18.8 | 19.1 | 31.6 | 46.3 | 50.5 | 51.7 | 46.8 | 40.1 | 49.4 | 48.7 |
| 199-K-169 | 50.5 | 56.2 | 43.0 | 57.5 | 53.5 | 44.9 | 49.2 | 50.3 | 49.0 | 64.6 | 56.1 | 59.5 |
| 199-K-170 | 47.1 | 48.6 | 38.8 | 51.3 | 49.6 | 42.9 | 46.8 | 48.3 | 47.2 | 57.0 | 52.9 | 45.6 |
| 199-K-171 | -51.8 | -59.6 | -59.5 | -59.9 | -59.5 | -50.0 | -46.7 | -54.3 | -54.3 | -59.5 | -59.4 | -59.4 |
| 199-K-172 | 62.5 | 57.6 | 50.6 | 70.8 | 69.3 | 60.4 | 65.7 | 67.0 | 64.0 | 64.7 | 62.5 | 61.3 |
| 199-K-178 | -39.8 | -34.8 | 0.0 | -4.8 | -43.0 | -35.7 | -40.9 | -41.7 | -38.4 | -44.8 | -44.8 | -44.2 |
| 199-K-180 | 48.6 | 45.0 | 38.8 | 55.8 | 54.2 | 47.2 | 51.1 | 52.0 | 49.5 | 50.6 | 49.2 | 46.7 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

**Table C-9. Average Monthly Pumping Rates (gpm) for Wells in the KX Treatment System (Jan 2012 to Dec 2014): Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | 2012 Jan | 2012 Feb | 2012 Mar | 2012 Apr | 2012 May | 2012 Jun | 2012 Jul | 2012 Aug | 2012 Sep | 2012 Oct | 2012 Nov | 2012 Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-130 | -19.9 | -20.1 | -10.6 | 0.0 | 0.0 | -8.1 | -24.0 | -25.0 | -22.3 | -25.4 | -21.6 | -18.9 |
| 199-K-131 | -49.2 | -29.9 | -26.8 | -33.8 | -42.1 | -44.1 | -43.2 | -45.0 | -39.8 | -42.0 | -42.8 | -46.8 |
| 199-K-141 | -28.9 | -26.0 | -27.8 | -27.3 | -29.3 | -30.8 | -32.9 | -32.3 | -30.2 | -24.9 | -26.3 | -27.0 |
| 199-K-143 | 30.2 | 21.2 | 24.7 | 22.8 | 22.7 | 33.6 | 26.4 | 24.8 | 14.7 | 24.5 | 26.7 | 31.4 |
| 199-K-146 | -9.1 | -8.8 | -9.0 | -9.7 | -9.3 | -9.0 | -9.0 | -10.0 | -8.9 | -8.7 | -9.2 | -9.7 |
| 199-K-147 | -19.0 | -19.8 | -19.9 | -19.9 | -18.7 | -19.4 | -19.2 | -20.0 | -17.8 | -18.8 | -20.0 | -19.9 |
| 199-K-148 | -32.3 | -32.9 | -40.2 | -46.8 | -46.8 | -49.0 | -48.0 | -49.9 | -44.3 | -46.7 | -43.8 | -44.7 |
| 199-K-152 | -49.2 | -43.6 | -48.0 | -48.9 | -46.3 | -44.7 | -43.2 | -45.0 | -39.8 | -42.4 | -49.9 | -48.9 |
| 199-K-153 | -39.0 | -36.0 | -34.8 | -39.8 | -53.9 | -56.0 | -59.8 | -58.7 | -59.7 | -58.6 | -59.8 | -62.7 |
| 199-K-154 | -54.7 | -44.7 | -56.7 | -56.2 | -58.8 | -59.1 | -59.8 | -58.8 | -59.7 | -57.4 | -59.9 | -58.2 |
| 199-K-156 | 64.3 | 55.7 | 56.5 | 62.6 | 73.8 | 72.9 | 79.8 | 84.9 | 85.0 | 83.5 | 85.6 | 73.3 |
| 199-K-159 | 53.4 | 48.6 | 50.4 | 48.4 | 52.9 | 52.7 | 58.1 | 61.2 | 61.5 | 57.2 | 68.8 | 65.6 |
| 199-K-160 | 53.9 | 48.6 | 50.7 | 53.0 | 54.3 | 53.4 | 58.3 | 61.4 | 61.5 | 57.3 | 69.1 | 65.9 |
| 199-K-161 | 0.0 | -0.9 | -0.9 | -12.2 | -23.4 | -26.1 | -28.8 | -30.0 | -17.6 | -15.1 | -18.5 | -19.8 |
| 199-K-163 | -54.5 | -38.5 | -40.9 | -42.1 | -53.9 | -54.2 | -54.9 | -53.9 | -55.0 | -52.8 | -59.9 | -58.3 |
| 199-K-164 | 46.0 | 39.6 | 41.4 | 44.2 | 47.6 | 47.3 | 44.0 | 56.6 | 56.0 | 53.4 | 24.8 | 51.7 |
| 199-K-169 | 55.7 | 38.6 | 40.3 | 47.3 | 64.7 | 63.5 | 69.7 | 74.5 | 74.3 | 70.7 | 77.0 | 60.0 |
| 199-K-170 | 45.3 | 36.2 | 39.8 | 44.5 | 59.9 | 67.8 | 66.6 | 69.6 | 69.2 | 66.2 | 77.0 | 76.2 |
| 199-K-171 | -53.3 | -41.8 | -47.4 | -50.9 | -53.9 | -54.2 | -54.9 | -53.9 | -55.0 | -52.8 | -60.0 | -58.2 |
| 199-K-172 | 58.0 | 50.3 | 52.7 | 54.9 | 56.9 | 56.9 | 62.7 | 65.5 | 66.4 | 62.8 | 78.9 | 74.2 |
| 199-K-178 | -44.0 | -35.3 | -35.5 | -34.2 | -39.2 | -39.4 | -39.9 | -39.2 | -40.0 | -46.9 | -52.2 | -54.0 |
| 199-K-180 | 44.4 | 37.7 | 40.4 | 42.3 | 42.2 | 44.6 | 50.4 | 21.8 | 0.0 | 22.1 | 24.6 | 52.5 |
| 199-K-182 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -6.6 | -10.2 | -25.9 |
| 199-K-181 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-210 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-212 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-220 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Well Name | 2013 Jan | 2013 Feb | 2013 Mar | 2013 Apr | 2013 May | 2013 Jun | 2013 Jul | 2013 Aug | 2013 Sep | 2013 Oct | 2013 Nov | 2013 Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-130 | -19.1 | -19.3 | -20.1 | -20.1 | -21.3 | -23.1 | -23.3 | -22.8 | -21.6 | -22.8 | -22.3 | -22.5 |
| 199-K-131 | -49.9 | -44.3 | -42.2 | -44.6 | -43.9 | -43.8 | -45.0 | -44.7 | -45.0 | -41.5 | -45.9 | -45.7 |
| 199-K-141 | -28.2 | -25.9 | -24.6 | -26.3 | -28.6 | -29.2 | -29.5 | -26.7 | -23.6 | -20.7 | -22.9 | -23.1 |
| 199-K-143 | 30.1 | 27.2 | 29.5 | 29.1 | 31.1 | 32.8 | 33.0 | 35.5 | 32.6 | 31.4 | 30.1 | 27.6 |
| 199-K-146 | -10.0 | -9.8 | -1.2 | 0.0 | -1.6 | -6.0 | -8.5 | -8.5 | -8.5 | -8.2 | -8.3 | -8.4 |
| 199-K-147 | -20.0 | -19.6 | -19.2 | -19.9 | -20.0 | -19.5 | -20.0 | -19.9 | -20.0 | -19.7 | -20.0 | -19.9 |
| 199-K-148 | -44.9 | -37.2 | -41.0 | -43.8 | -42.5 | -43.8 | -44.5 | -39.8 | -31.3 | -34.9 | -39.6 | -35.1 |
| 199-K-152 | -49.9 | -48.7 | -49.6 | -49.9 | -49.1 | -48.7 | -49.8 | -49.9 | -49.8 | -47.6 | -50.1 | -49.6 |
| 199-K-153 | -64.6 | -59.6 | -60.7 | -65.0 | -61.3 | -64.1 | -64.4 | -64.9 | -64.7 | -63.1 | -65.1 | -64.4 |
| 199-K-154 | -59.7 | -58.8 | -59.0 | -60.0 | -60.0 | -59.2 | -59.6 | -59.9 | -60.0 | -58.5 | -60.1 | -38.9 |
| 199-K-156 | 72.4 | 63.2 | 66.4 | 57.9 | 61.0 | 71.7 | 72.3 | 70.6 | 68.4 | 69.2 | 66.2 | 60.6 |
| 199-K-159 | 65.0 | 59.6 | 59.8 | 63.7 | 62.4 | 58.5 | 64.1 | 62.7 | 60.6 | 61.0 | 58.6 | 53.7 |
| 199-K-160 | 65.1 | 59.9 | 59.9 | 63.9 | 62.8 | 66.1 | 66.4 | 68.5 | 65.1 | 64.4 | 62.8 | 57.5 |
| 199-K-161 | -20.0 | -19.2 | -18.3 | -19.8 | -20.0 | -19.5 | -20.0 | -20.0 | -18.7 | -16.8 | -18.8 | -19.9 |
| 199-K-163 | -59.6 | -55.2 | -56.2 | -60.0 | -60.0 | -58.9 | -59.6 | -56.8 | -30.4 | -58.4 | -14.0 | 0.0 |
| 199-K-164 | 62.1 | 55.8 | 54.3 | 57.6 | 54.1 | 46.0 | 50.4 | 49.2 | 47.6 | 43.6 | 41.9 | 38.4 |
| 199-K-169 | 57.5 | 57.2 | 47.6 | 53.4 | 59.6 | 65.2 | 65.3 | 54.6 | 0.0 | 25.6 | 50.2 | 46.0 |
| 199-K-170 | 75.2 | 68.2 | 70.7 | 76.2 | 76.2 | 75.6 | 76.0 | 74.3 | 71.9 | 72.8 | 69.5 | 63.7 |
| 199-K-171 | -59.6 | -55.9 | -57.2 | -60.0 | -60.0 | -58.4 | -59.6 | -56.9 | -30.4 | -58.5 | -60.1 | -59.4 |
| 199-K-172 | 72.8 | 65.9 | 66.2 | 70.5 | 69.8 | 73.2 | 72.6 | 71.9 | 69.5 | 69.6 | 67.0 | 61.5 |
| 199-K-178 | -53.5 | -35.5 | -38.3 | -40.0 | -40.0 | -39.5 | -40.0 | -39.9 | -33.6 | -9.6 | -40.0 | -39.6 |
| 199-K-180 | 62.7 | 56.2 | 56.5 | 60.6 | 54.9 | 47.4 | 47.6 | 46.8 | 45.2 | 45.4 | 43.6 | 39.9 |
| 199-K-182 | -25.9 | -25.9 | -24.8 | -25.0 | -24.9 | -24.3 | -25.0 | -25.0 | -25.0 | -24.6 | -25.0 | -24.8 |
| 199-K-181 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-210 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-212 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 199-K-220 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Well Name | 2014 Jan | 2014 Feb | 2014 Mar | 2014 Apr | 2014 May | 2014 Jun | 2014 Jul | 2014 Aug | 2014 Sep | 2014 Oct | 2014 Nov | 2014 Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-130 | -24.4 | -25.6 | -28.5 | -29.0 | -30.0 | -29.7 | -29.9 | -27.7 | -24.4 | -25.5 | -20.9 | -23.6 |
| 199-K-131 | -45.2 | -44.5 | -45.6 | -45.8 | -46.0 | -46.0 | -45.8 | -46.0 | -44.2 | -45.2 | -36.8 | -40.7 |
| 199-K-141 | -22.5 | -21.3 | -22.0 | -23.9 | -25.7 | -26.4 | -25.9 | -23.7 | -20.2 | -19.4 | -19.7 | -19.6 |
| 199-K-143 | 33.2 | 35.5 | 36.9 | 39.9 | 40.3 | 40.6 | 40.2 | 42.4 | 38.3 | 36.1 | 53.0 | 57.5 |
| 199-K-146 | -8.3 | -7.5 | -7.9 | -8.5 | -8.5 | -8.5 | -8.5 | -8.5 | -8.2 | -8.0 | -8.0 | -7.7 |
| 199-K-147 | -19.7 | -19.4 | -19.8 | -19.9 | -20.0 | -20.0 | -19.9 | -19.6 | -19.3 | -19.8 | -17.9 | -18.1 |
| 199-K-148 | -38.7 | -36.8 | -34.7 | -34.8 | -35.0 | -35.0 | -34.9 | -35.0 | -33.9 | -35.9 | -31.4 | -35.0 |
| 199-K-152 | -48.9 | -47.4 | -49.3 | -49.8 | -50.0 | -50.0 | -49.7 | -50.0 | -48.4 | -49.4 | -35.2 | -36.0 |
| 199-K-153 | -62.3 | -53.6 | -53.5 | -64.2 | -65.0 | -65.0 | -64.4 | -65.0 | -62.7 | -64.6 | -65.7 | -63.8 |
| 199-K-154 | -55.6 | -49.4 | -50.3 | -61.9 | -62.0 | -62.0 | -61.5 | -62.0 | -59.8 | -59.6 | -60.9 | -59.2 |
| 199-K-156 | 69.3 | 70.0 | 72.9 | 78.9 | 79.6 | 80.2 | 79.4 | 49.5 | 75.7 | 75.9 | 98.7 | 105.4 |
| 199-K-159 | 61.8 | 62.9 | 65.5 | 70.8 | 71.6 | 72.1 | 71.2 | 74.6 | 68.0 | 63.7 | 64.2 | 67.0 |
| 199-K-160 | 63.7 | 62.1 | 64.6 | 69.9 | 70.6 | 71.1 | 70.4 | 74.2 | 67.1 | 63.2 | 64.4 | 67.1 |
| 199-K-161 | -19.7 | -18.5 | -19.6 | -19.9 | -19.8 | -20.0 | -19.9 | -20.0 | -18.8 | -16.3 | -17.2 | -19.0 |
| 199-K-163 | -29.3 | -49.4 | -50.8 | -61.9 | -62.0 | -62.0 | -61.5 | -62.0 | -59.8 | -60.6 | -55.9 | -57.6 |
| 199-K-164 | 46.2 | 46.0 | 48.0 | 54.9 | 55.4 | 55.9 | 54.9 | 57.8 | 52.7 | 60.0 | 65.6 | 67.2 |
| 199-K-169 | 56.4 | 60.3 | 62.8 | 67.9 | 68.5 | 69.1 | 68.3 | 71.7 | 65.1 | 68.4 | 98.0 | 105.4 |
| 199-K-170 | 72.8 | 73.6 | 76.6 | 82.9 | 83.7 | 81.0 | 83.4 | 87.7 | 79.5 | 77.8 | 102.5 | 110.2 |
| 199-K-171 | -58.0 | -49.4 | -50.9 | -61.9 | -62.0 | -62.0 | -61.4 | -61.4 | -59.8 | -60.8 | -61.6 | -59.2 |
| 199-K-172 | 70.2 | 71.0 | 73.9 | 80.0 | 80.7 | 81.3 | 80.5 | 85.3 | 76.7 | 80.6 | 75.2 | 76.7 |
| 199-K-178 | -39.2 | -38.8 | -39.5 | -39.9 | -40.0 | -40.0 | -39.9 | -40.0 | -38.7 | -39.5 | -38.6 | -38.7 |
| 199-K-180 | 46.6 | 48.8 | 50.8 | 54.9 | 55.5 | 55.9 | 55.2 | 58.0 | 52.7 | 58.0 | 60.9 | 62.3 |
| 199-K-182 | -24.6 | -24.2 | -24.8 | -24.9 | -25.5 | -26.2 | -26.2 | -26.0 | -25.2 | -25.6 | -25.0 | -32.5 |
| 199-K-181 | -25.9 | -46.4 | -55.4 | -54.7 | -55.0 | -55.0 | -54.7 | -55.0 | -53.2 | -54.4 | -40.5 | -38.7 |
| 199-K-210 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -46.2 | -57.3 |
| 199-K-212 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -50.4 | -51.6 |
| 199-K-220 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -52.9 | -62.9 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

**Table C-10. Average Monthly Pumping Rates (gpm) for Wells in the DR5 Treatment System (Jan 2006 to Apr 2011) Extraction Rates are Negative and Injection Rates are Positive**

| Well Name | 199-D5-104 | 199-D5-20 | 199-D5-32 | 199-D5-39 | 199-D5-41 | 199-D5-42 | 199-D5-92 |
|---|---|---|---|---|---|---|---|
| J-06 | 0.0 | -8.7 | -16.8 | -16.8 | 0.0 | 50.9 | -8.7 |
| F-06 | 0.0 | -6.3 | -11.5 | -11.3 | 0.0 | 35.5 | -6.4 |
| M-06 | 0.0 | -7.1 | -13.6 | -13.6 | 0.0 | 41.3 | -7.1 |
| A-06 | 0.0 | -7.2 | -13.9 | -13.9 | 0.0 | 42.3 | -7.2 |
| M-06 | 0.0 | -7.2 | -19.7 | -7.9 | 0.0 | 42.3 | -7.5 |
| J-06 | 0.0 | -6.4 | -12.4 | -12.4 | 0.0 | 37.6 | -6.4 |
| J-06 | 0.0 | -6.0 | -12.8 | -12.8 | 0.0 | 38.2 | -6.6 |
| A-06 | 0.0 | -0.2 | -17.1 | -17.0 | 0.0 | 42.5 | -8.2 |
| S-06 | 0.0 | -0.2 | -17.7 | -12.2 | 0.0 | 41.8 | -11.7 |

Table C-10. Average Monthly Pumping Rates (gpm) for Wells in the DR5 Treatment System (Jan 2006 to Apr 2011) Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-D5-104 | 199-D5-20 | 199-D5-32 | 199-D5-39 | 199-D5-41 | 199-D5-42 | 199-D5-92 |
|---|---|---|---|---|---|---|---|
| O-06 | 0.0 | -6.4 | -14.5 | -14.4 | 0.0 | 43.3 | -7.9 |
| N-06 | 0.0 | -7.4 | -13.8 | -13.8 | 0.0 | 42.7 | -7.6 |
| D-06 | 0.0 | -7.4 | -12.3 | -12.3 | 0.0 | 39.4 | -7.5 |
| J-07 | 0.0 | -7.5 | -12.3 | -12.3 | 0.0 | 39.5 | -7.5 |
| F-07 | 0.0 | -7.5 | -14.1 | -14.1 | 0.0 | 43.1 | -7.5 |
| M-07 | 0.0 | -7.8 | -14.8 | -14.4 | 0.0 | 43.3 | -6.3 |
| A-07 | 0.0 | -9.4 | -16.4 | -14.4 | 0.0 | 40.2 | 0.0 |
| M-07 | 0.0 | -6.7 | -12.6 | -12.4 | 0.0 | 37.6 | -6.0 |
| J-07 | 0.0 | -7.4 | -14.4 | -12.5 | 0.0 | 41.7 | -7.3 |
| J-07 | 0.0 | -2.1 | -22.5 | -2.4 | 0.0 | 36.1 | -9.2 |
| A-07 | 0.0 | 0.0 | -30.8 | 0.0 | 0.0 | 35.6 | -4.8 |
| S-07 | 0.0 | -5.8 | -18.1 | -6.7 | 0.0 | 39.7 | -9.0 |
| O-07 | 0.0 | -5.9 | -12.8 | -15.2 | 0.0 | 39.8 | -5.9 |
| N-07 | 0.0 | -6.8 | -14.5 | -14.3 | 0.0 | 43.1 | -7.4 |
| D-07 | 0.0 | -6.1 | -13.1 | -12.6 | 0.0 | 39.3 | -7.5 |
| J-08 | 0.0 | -6.0 | -13.5 | -13.5 | 0.0 | 40.5 | -7.5 |
| F-08 | 0.0 | -4.4 | -14.3 | -13.8 | 0.0 | 40.4 | -7.8 |
| M-08 | 0.0 | -0.5 | -12.4 | -12.8 | 0.0 | 34.2 | -8.4 |
| A-08 | 0.0 | -4.1 | -14.5 | -14.0 | 0.0 | 41.2 | -8.6 |
| M-08 | 0.0 | -6.5 | -13.6 | -13.6 | 0.0 | 41.0 | -7.4 |
| J-08 | 0.0 | -5.1 | -10.9 | -11.2 | 0.0 | 33.1 | -5.9 |
| J-08 | 0.0 | -3.2 | -2.4 | -5.4 | 0.0 | 15.1 | -4.1 |
| A-08 | 0.0 | -6.5 | -13.9 | -14.0 | 0.0 | 38.9 | -4.5 |
| S-08 | 0.0 | -6.6 | -12.8 | -12.7 | 0.0 | 36.9 | -4.8 |
| O-08 | 0.0 | -5.5 | -10.6 | -10.8 | 0.0 | 35.4 | -8.5 |
| N-08 | 0.0 | -5.1 | -10.2 | -10.5 | 0.0 | 34.4 | -8.6 |
| D-08 | 0.0 | -5.3 | -10.2 | -10.8 | 0.0 | 35.2 | -8.9 |
| J-09 | 0.0 | -5.0 | -8.8 | -8.8 | 0.0 | 31.1 | -8.5 |
| F-09 | 0.0 | -5.3 | -7.8 | -8.0 | 0.0 | 29.9 | -8.8 |
| M-09 | 0.0 | -4.6 | -8.7 | -8.2 | 0.0 | 29.7 | -8.2 |
| A-09 | 0.0 | -4.2 | -7.8 | -6.9 | 0.0 | 25.8 | -7.0 |
| M-09 | 0.0 | -5.1 | -7.5 | -7.4 | 0.0 | 27.1 | -7.2 |
| J-09 | 0.0 | -5.1 | -6.9 | -7.9 | 0.0 | 27.2 | -7.3 |

Table C-10. Average Monthly Pumping Rates (gpm) for Wells in the DR5 Treatment System (Jan 2006 to Apr 2011) Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-D5-104 | 199-D5-20 | 199-D5-32 | 199-D5-39 | 199-D5-41 | 199-D5-42 | 199-D5-92 |
|---|---|---|---|---|---|---|---|
| J-09 | 0.0 | -5.2 | -7.6 | -9.3 | 0.0 | 29.5 | -7.3 |
| A-09 | 0.0 | -3.4 | -5.3 | -8.9 | 0.0 | 25.0 | -7.4 |
| S-09 | 0.0 | -1.0 | -6.1 | -6.6 | 0.0 | 20.8 | -7.1 |
| O-09 | 0.0 | 0.0 | 0.0 | -11.9 | 0.0 | 24.2 | -12.4 |
| N-09 | 0.0 | 0.0 | 0.0 | -9.3 | 0.0 | 18.6 | -9.3 |
| D-09 | 0.0 | 0.0 | 0.0 | -2.3 | 0.0 | 4.5 | -2.2 |
| J-10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F-10 | -3.5 | 0.0 | 0.0 | -4.0 | 0.0 | 14.0 | -6.4 |
| M-10 | -4.4 | 0.0 | 0.0 | -5.4 | 0.0 | 17.2 | -7.4 |
| A-10 | -1.3 | -0.1 | 0.0 | -7.2 | 9.7 | 9.7 | -10.9 |
| M-10 | -3.9 | 0.0 | 0.0 | -11.9 | 15.3 | 15.3 | -14.8 |
| J-10 | 0.0 | -4.3 | 0.0 | -10.7 | 13.5 | 13.5 | -11.9 |
| J-10 | -3.3 | -4.8 | 0.0 | -6.1 | 12.3 | 12.3 | -10.5 |
| A-10 | -3.7 | -0.5 | 0.0 | -8.4 | 14.0 | 14.0 | -15.5 |
| S-10 | -4.0 | -3.8 | 0.0 | -7.8 | 14.9 | 14.9 | -14.2 |
| O-10 | -4.4 | -4.3 | 0.0 | -7.9 | 16.2 | 16.2 | -15.7 |
| N-10 | -3.1 | -3.4 | 0.0 | -6.1 | 12.2 | 12.2 | -11.8 |
| D-10 | 0.0 | -4.0 | 0.0 | -4.5 | 10.7 | 10.7 | -12.8 |
| J-11 | 0.0 | -5.4 | 0.0 | -5.8 | 13.4 | 13.4 | -15.6 |
| F-11 | 0.0 | -5.9 | 0.0 | -6.0 | 13.7 | 13.7 | -15.5 |
| M-11 | 0.0 | -0.1 | 0.0 | -0.1 | 0.7 | 0.7 | -1.3 |
| A-11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.4 | -0.7 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm =gallons per minute

Table C-11. Average Monthly Pumping Rates (gpm) for Wells in the HR3 Treatment System (Jan 2006 to May 2011): Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-D8-53 | 199-D8-54A | 199-D8-68 | 199-D8-72 | 199-H3-2A | 199-H4-12A | 199-H4-14 | 199-H4-15A | 199-H4-17 | 199-H4-18 | 199-H4-3 | 199-H4-4 | 199-H4-63 | 199-H4-64 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-06 | -14.9 | -37.9 | -55.5 | -18.7 | 96.6 | -7.4 | 0.0 | -20.0 | 70.1 | 30.7 | -8.2 | -7.0 | -24.6 | -12.9 |
| F-06 | -14.5 | -41.9 | -55.0 | -20.0 | 5.3 | -8.3 | 42.6 | -19.9 | 125.5 | 26.6 | -9.8 | -8.1 | -20.4 | -10.0 |
| M-06 | -12.4 | -31.6 | -55.3 | -17.3 | 0.0 | -7.1 | 25.6 | -19.7 | 130.7 | 11.0 | -5.0 | -3.6 | -20.8 | -8.9 |
| A-06 | -22.0 | -41.1 | -55.7 | -18.2 | 0.0 | -10.4 | 39.3 | -19.9 | 139.6 | 23.6 | -5.3 | -8.0 | -24.3 | -17.5 |
| M-06 | -29.6 | -48.6 | -44.8 | -20.8 | 0.0 | -14.0 | 74.7 | -19.7 | 134.7 | 19.4 | -8.9 | -8.9 | -24.8 | -25.3 |
| J-06 | -25.9 | -44.9 | -33.6 | -23.3 | 0.0 | -17.4 | 103.6 | -19.1 | 115.8 | 13.0 | -6.9 | -10.2 | -23.9 | -40.0 |
| J-06 | -30.6 | -43.7 | -41.9 | -22.2 | 0.0 | -16.7 | 94.6 | -19.6 | 101.6 | 21.2 | -5.5 | -10.2 | -24.5 | -20.3 |
| A-06 | -17.8 | -28.0 | -46.4 | -15.8 | 0.0 | -9.0 | 82.2 | -19.8 | 84.3 | 6.9 | -5.1 | -8.9 | -24.6 | -13.1 |
| S-06 | -5.2 | -15.9 | -56.0 | -13.4 | 0.0 | -5.4 | 62.6 | -20.0 | 69.0 | 18.5 | -4.9 | -5.6 | -24.6 | -12.0 |

Table C-11. Average Monthly Pumping Rates (gpm) for Wells in the HR3 Treatment System (Jan 2006 to May 2011): Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-D8-53 | 199-D8-54A | 199-D8-68 | 199-D8-72 | 199-H3-2A | 199-H4-12A | 199-H4-14 | 199-H4-15A | 199-H4-17 | 199-H4-18 | 199-H4-3 | 199-H4-4 | 199-H4-63 | 199-H4-64 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O-06 | -5.9 | -13.4 | -55.6 | -10.2 | 0.0 | -5.4 | 62.7 | -19.6 | 57.2 | 24.9 | -5.7 | -5.4 | -24.1 | -9.4 |
| N-06 | -6.8 | -16.3 | -55.9 | -10.3 | 0.0 | -6.1 | 70.7 | -19.8 | 63.7 | 16.0 | -6.2 | -5.8 | -24.2 | -11.3 |
| D-06 | -9.6 | -13.9 | -55.8 | -10.4 | 0.0 | -6.3 | 73.9 | -18.9 | 64.8 | 11.6 | -7.5 | -5.1 | -24.5 | -12.0 |
| J-07 | -8.3 | -16.0 | -55.6 | -4.7 | 0.0 | -5.6 | 73.7 | -15.9 | 57.0 | 6.4 | -8.1 | -6.5 | -24.2 | -9.7 |
| F-07 | -9.8 | -15.5 | -55.9 | -11.1 | 0.0 | -5.9 | 73.5 | -10.1 | 64.0 | 0.3 | -8.5 | -6.7 | -24.2 | -8.6 |
| M-07 | -8.5 | -14.3 | -56.4 | -14.0 | 0.0 | -5.8 | 74.1 | -10.8 | 58.5 | 4.9 | -7.0 | -5.7 | -24.4 | -9.1 |
| A-07 | -9.7 | -16.4 | -51.6 | -16.0 | 0.0 | -9.2 | 71.8 | -13.0 | 64.1 | 15.4 | -6.5 | -6.2 | -23.0 | -11.2 |
| M-07 | -10.0 | -19.6 | -47.7 | -19.3 | 0.0 | -14.7 | 81.2 | -17.6 | 69.3 | 13.6 | -4.3 | -7.6 | -23.2 | -11.9 |
| J-07 | -10.6 | -20.4 | -49.8 | -17.2 | 0.0 | -15.1 | 91.2 | -18.1 | 70.7 | 7.0 | -7.1 | -7.7 | -23.7 | -15.4 |
| J-07 | -9.8 | -19.5 | -49.0 | -16.2 | 0.0 | -14.9 | 95.6 | -18.7 | 67.6 | 1.2 | -4.5 | -8.0 | -23.9 | -17.6 |
| A-07 | -9.4 | -19.4 | -49.7 | -14.4 | 0.0 | -10.6 | 79.1 | -19.1 | 72.7 | 1.4 | -5.5 | -3.0 | -24.1 | -18.2 |
| S-07 | -6.9 | -11.9 | -50.4 | -9.0 | 0.0 | -7.5 | 82.9 | -19.0 | 45.7 | 1.9 | -7.0 | -4.6 | -23.9 | -3.0 |
| O-07 | -7.0 | -8.9 | -50.3 | -7.2 | 0.0 | -5.2 | 79.9 | -19.1 | 40.2 | 2.1 | -3.0 | -4.4 | -23.9 | -5.9 |
| N-07 | -8.6 | -10.2 | -49.3 | -8.3 | 0.0 | -6.2 | 78.5 | -19.1 | 47.8 | 12.8 | -4.8 | -5.5 | -23.6 | -13.0 |
| D-07 | -9.1 | -9.9 | -28.1 | -8.2 | 0.0 | -6.6 | 70.1 | -19.2 | 38.0 | 14.7 | -6.6 | -7.0 | -21.3 | -13.0 |
| J-08 | -13.9 | -14.0 | -43.7 | -12.0 | 0.0 | -6.9 | 81.6 | -19.3 | 55.2 | 9.1 | -5.8 | -7.0 | -23.1 | -12.9 |
| F-08 | -13.1 | -13.4 | -50.3 | -11.5 | 0.0 | -6.9 | 81.1 | -19.3 | 55.4 | 21.2 | -8.3 | -6.9 | -23.8 | -11.3 |
| M-08 | -11.9 | -12.5 | -50.9 | -9.7 | 0.0 | -6.4 | 82.4 | -18.7 | 47.2 | 19.4 | -7.4 | -5.9 | -23.3 | -13.3 |
| A-08 | -14.2 | -12.9 | -52.2 | -8.3 | 0.0 | -6.0 | 80.2 | -18.4 | 48.9 | 17.9 | -6.8 | -5.6 | -21.7 | -13.9 |
| M-08 | -24.4 | -18.9 | -52.7 | -11.9 | 0.0 | -7.2 | 89.0 | -18.1 | 53.8 | 17.7 | -6.0 | -10.0 | -7.8 | -17.7 |
| J-08 | -26.8 | -22.3 | -51.2 | -11.4 | 0.0 | -9.5 | 105.6 | -18.0 | 63.7 | 22.7 | -12.0 | -13.7 | -22.1 | -17.7 |
| J-08 | -27.6 | -23.2 | -52.7 | -11.5 | 0.0 | -9.4 | 104.1 | -19.2 | 64.3 | 23.9 | -11.1 | -11.3 | -23.6 | -16.6 |
| A-08 | -22.6 | -17.1 | -49.2 | -12.2 | 0.0 | -7.4 | 87.5 | -18.1 | 52.7 | 19.1 | -9.7 | -5.7 | -19.7 | -10.3 |
| S-08 | -11.0 | -8.1 | -51.4 | -9.3 | 0.0 | -3.2 | 75.0 | -17.4 | 26.5 | 4.4 | -6.1 | -0.6 | 0.0 | -10.4 |
| O-08 | -7.1 | -6.2 | -52.5 | -6.6 | 0.0 | -5.0 | 76.4 | -17.8 | 27.7 | 7.3 | -4.7 | -0.3 | -13.1 | -8.8 |
| N-08 | -8.3 | -10.3 | -53.6 | -7.9 | 0.0 | -5.7 | 81.0 | -18.1 | 31.5 | 21.2 | -6.1 | -1.8 | -23.6 | -8.4 |
| D-08 | -4.5 | -5.7 | -25.1 | -4.7 | 0.0 | -2.8 | 39.2 | -8.8 | 18.4 | 10.9 | -3.2 | -2.8 | -11.5 | -3.9 |
| J-09 | -13.4 | -12.4 | -38.8 | -8.4 | 0.0 | -4.7 | 59.3 | -13.2 | 29.1 | 17.5 | -4.9 | -4.9 | 0.0 | -13.4 |
| F-09 | -16.3 | -15.1 | -50.8 | -10.3 | 0.0 | -6.2 | 89.3 | -17.6 | 39.9 | 18.1 | -6.3 | -3.9 | -20.8 | -11.1 |
| M-09 | -7.8 | -6.2 | -32.5 | -5.4 | 0.0 | -2.7 | 52.7 | -11.1 | 20.8 | 4.7 | -1.7 | 0.0 | -14.7 | -6.5 |
| A-09 | -13.7 | -11.4 | -47.5 | -8.5 | 0.0 | -4.5 | 79.0 | -11.9 | 24.7 | 6.5 | -0.3 | -0.6 | -15.5 | -10.9 |
| M-09 | -0.7 | -0.5 | -1.1 | -0.2 | 0.0 | -0.5 | 4.5 | -0.9 | 2.2 | 1.6 | -0.4 | -1.6 | -1.2 | -1.4 |
| J-09 | -21.9 | -17.0 | -27.4 | -7.7 | 0.0 | -6.4 | 74.9 | -11.8 | 39.8 | 11.5 | -0.3 | -12.0 | -15.8 | -16.2 |
| J-09 | -28.3 | -21.7 | -35.7 | -10.6 | 0.0 | -7.5 | 80.5 | -6.1 | 42.6 | 7.6 | 0.0 | -3.5 | -20.3 | -11.7 |
| A-09 | -8.3 | -8.0 | -18.8 | -5.2 | 0.0 | -2.0 | 35.4 | 0.0 | 10.5 | 3.1 | 0.0 | 0.0 | -8.6 | -3.9 |
| S-09 | -5.4 | -5.4 | -22.9 | -2.9 | 0.0 | 0.0 | 0.0 | 0.0 | 54.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-09 | -0.2 | -0.3 | -16.9 | -0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 82.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| N-09 | -7.2 | -9.9 | -30.4 | -6.9 | 0.0 | 0.0 | 0.0 | 0.0 | 63.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D-09 | -6.3 | -8.0 | -22.4 | -6.0 | 0.0 | 0.0 | 22.8 | -5.8 | 33.8 | 0.0 | 0.0 | 0.0 | -8.3 | 0.0 |
| J-10 | -10.6 | -14.3 | -42.5 | -11.9 | 0.0 | 0.0 | 70.1 | -18.5 | 48.2 | 0.0 | 0.0 | 0.0 | -24.0 | 0.0 |
| F-10 | -10.9 | -12.6 | -43.4 | -11.4 | 0.0 | -3.6 | 71.1 | -13.6 | 28.7 | 0.0 | 0.0 | 0.0 | -9.3 | 0.0 |
| M-10 | -13.1 | -12.5 | -43.4 | -10.2 | 0.0 | -9.1 | 80.2 | -17.6 | 45.8 | 0.0 | 0.0 | 0.0 | -17.1 | -7.1 |
| A-10 | -11.0 | -11.9 | -44.0 | -9.0 | 0.0 | -8.9 | 84.8 | -17.0 | 39.3 | 0.0 | 0.0 | 0.0 | -18.9 | -7.2 |
| M-10 | -13.9 | -17.2 | -47.6 | -11.8 | 0.0 | -10.5 | 100.3 | -18.2 | 50.2 | 0.0 | -2.5 | -0.8 | -20.4 | -12.3 |
| J-10 | -17.1 | -19.1 | -47.3 | -12.2 | 0.0 | -1.6 | 75.3 | -2.8 | 40.7 | 0.0 | -1.0 | -0.6 | -3.1 | -15.7 |
| J-10 | -5.8 | -6.5 | -15.4 | -4.7 | 0.0 | 0.0 | 24.0 | 0.0 | 12.3 | 0.0 | 0.0 | 0.0 | 0.0 | -5.4 |
| A-10 | -15.0 | -14.8 | -32.9 | -10.7 | 0.0 | 0.0 | 65.0 | -11.4 | 34.3 | 22.1 | -3.4 | 0.0 | -12.4 | 0.0 |
| S-10 | -12.1 | -10.7 | -47.4 | -9.3 | 0.0 | 0.0 | 82.0 | -16.6 | 47.7 | 26.5 | -4.4 | 0.0 | -18.7 | 0.0 |
| O-10 | -11.3 | -11.1 | -53.2 | -9.8 | 0.0 | 0.0 | 88.4 | -18.6 | 57.0 | 27.5 | -4.7 | 0.0 | -21.0 | 0.0 |
| N-10 | -11.2 | -13.4 | -51.8 | -9.0 | 0.0 | 0.0 | 81.7 | -13.5 | 45.9 | 30.1 | -3.3 | 0.0 | -15.5 | 0.0 |
| D-10 | -12.3 | -14.7 | -50.0 | -7.7 | 0.0 | 0.0 | 85.6 | -14.9 | 46.5 | 26.1 | -4.5 | 0.0 | -17.7 | 0.0 |
| J-11 | -17.0 | -18.6 | -51.9 | -3.7 | 0.0 | 0.0 | 91.0 | -19.0 | 52.2 | 40.4 | -0.6 | 0.0 | -24.0 | 0.0 |
| F-11 | -15.6 | -19.9 | -50.8 | -8.4 | 0.0 | 0.0 | 97.6 | -19.1 | 51.3 | 50.3 | 0.0 | -8.7 | -24.1 | 0.0 |

Table C-11. Average Monthly Pumping Rates (gpm) for Wells in the HR3 Treatment System (Jan 2006 to May 2011): Extraction Rates are Negative and Injection Rates are Positive

| Well Name | 199-D8-53 | 199-D8-54A | 199-D8-68 | 199-D8-72 | 199-H3-2A | 199-H4-12A | 199-H4-14 | 199-H4-15A | 199-H4-17 | 199-H4-18 | 199-H4-3 | 199-H4-4 | 199-H4-63 | 199-H4-64 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M-11 | -15.1 | -19.7 | -53.8 | -7.4 | 0.0 | 0.0 | 95.7 | -18.7 | 53.9 | 46.5 | 0.0 | -4.8 | -23.4 | 0.0 |
| A-11 | -14.4 | -17.3 | -49.9 | -7.2 | 0.0 | 0.0 | 90.4 | -17.9 | 49.1 | 42.8 | 0.0 | -5.5 | -20.4 | 0.0 |
| M-11 | -1.0 | -1.0 | -3.3 | -0.7 | 0.0 | 0.0 | 7.5 | -1.5 | 2.6 | 3.5 | 0.0 | -0.6 | -1.6 | 0.0 |

Note – Values for extraction rates are colored red and values for injection rates are colored blue

gpm = gallons per minute

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# Appendix D

# Aquifer Test Data for Model Calibration

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# Contents



# Tables

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# D1 Introduction

The aquifer test data from the model data packages are tabulated in Table D-1. Transmissivity estimates developed from Specific Capacity estimates are tabulated in Table D-2. At every location, unit-wise Hydraulic Conductivity estimates were developed using the PEST software as described in Section 3.5.1. These unit-wise Hydraulic Conductivity estimates are tabulated on Table D-3.

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Table D-1. Aquifer Test Data from Model Data Packages

| Well Name | Easting (m) | Northing (m) | Estimated Hydraulic Conductivity (m/d) | Aquifer Test Type | Test Reference | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-B2-14 | 565095.99 | 145232.26 | 12.0 | SlugTest/KGS | ECF-100BC5-11-0145 | 121.5 | 113.9 | 120.3 | 6.4 | - | - | 6.4 | - | - |
| 199-B2-16 | 564915.00 | 145190.68 | 6.4 | SlugTest/KGS | ECF-100BC5-11-0145 | 99.2 | 88.5 | 120.7 | 10.7 | - | - | 10.7 | - | - |
| 199-B3-47 | 565388.66 | 145368.95 | 16.0 | SlugTest/KGS | ECF-100BC5-11-0145 | 122.2 | 115.8 | 120.7 | 4.9 | 3.0 | - | 1.9 | - | - |
| 199-B3-51 | 565379.25 | 145362.36 | 2.5 | SlugTest/KGS | ECF-100BC5-11-0145 | 91.7 | 88.7 | 120.6 | 3.1 | - | - | 3.1 | - | - |
| 199-B5-5 | 564721.99 | 144955.49 | 15.0 | SlugTest/KGS | ECF-100BC5-11-0145 | 99.1 | 79.3 | 120.0 | 19.8 | - | - | 19.8 | - | - |
| 199-B5-6 | 564967.70 | 144316.44 | 9.1 | SlugTest/KGS | ECF-100BC5-11-0145 | 94.7 | 87.1 | 121.4 | 7.7 | - | - | 7.7 | - | - |
| 199-D2-11 | 573328.16 | 151120.73 | 63.0 | Pumping/Cooper-Jacob | SGW-38757 | 119.0 | 109.9 | 118.9 | 9.0 | 0.3 | 1.9 | 6.0 | 0.1 | 0.6 |
| 199-D2-5 | 573812.30 | 151148.18 | 182.0 | Pumping | PNL-10886 | 130.3 | 115.1 | 119.1 | 4.0 | 0.6 | - | 3.5 | - | - |
| 199-D2-6 | 573000.21 | 151119.86 | 12.0 | Slug | DOE/RL-93-43 | 119.8 | 113.5 | 118.4 | 4.9 | - | - | 4.9 | - | - |
| 199-D3-5 | 572787.66 | 150994.54 | 55.0 | Slug/KGS | ECF-100HR3-12-0011 | 121.6 | 112.4 | 118.2 | 5.7 | 0.4 | - | 4.7 | 0.7 | - |
| 199-D4-1 | 572752.85 | 151558.89 | 23.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 120.5 | 114.4 | 116.7 | 2.3 | - | - | 2.3 | - | - |
| 199-D4-11 | 572768.94 | 151554.14 | 12.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 118.9 | 114.4 | 116.7 | 2.4 | - | - | 2.4 | - | - |
| 199-D4-12 | 572771.58 | 151562.08 | 22.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 118.7 | 114.1 | 116.8 | 2.7 | - | - | 2.7 | - | - |
| 199-D4-2 | 572768.37 | 151543.96 | 18.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 118.3 | 113.7 | 116.8 | 3.1 | - | - | 2.7 | 0.1 | 0.3 |
| 199-D4-3 | 572766.08 | 151546.12 | 18.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 118.2 | 113.6 | 116.7 | 3.1 | - | - | 2.4 | 0.3 | 0.4 |
| 199-D4-4 | 572754.61 | 151571.61 | 32.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 119.8 | 113.7 | 116.7 | 3.1 | - | - | 2.5 | 0.6 | - |
| 199-D4-7 | 572760.87 | 151551.25 | 17.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 119.0 | 114.4 | 116.7 | 2.3 | - | - | 2.3 | - | - |
| 199-D4-8 | 572763.30 | 151552.65 | 11.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 120.2 | 114.2 | 116.7 | 2.5 | - | - | 2.3 | 0.2 | - |
| 199-D4-9 | 572758.20 | 151543.32 | 16.0 | Pumping/ISOAQX and WTAQ3 | PNNL-13349 | 119.1 | 114.3 | 116.7 | 2.4 | - | - | 2.4 | 0.0 | - |
| 199-D5-103 | 573505.87 | 151460.87 | 31.0 | Pumping/Cooper-Jacob | SGW-38757 | 119.1 | 110.0 | 119.4 | 9.1 | - | - | 9.0 | 0.1 | - |
| 199-D5-119 | 573306.17 | 151417.95 | 48.0 | Pumping/Cooper-Jacob | SGW-38757 | 119.5 | 110.3 | 118.7 | 8.4 | - | - | 6.6 | 1.6 | 0.1 |
| 199-D5-121 | 573430.24 | 151399.27 | 8.5 | Pumping/Cooper-Jacob | SGW-38757 | 120.3 | 111.2 | 119.1 | 7.9 | - | - | 7.9 | - | - |
| 199-D5-122 | 573300.25 | 151349.29 | 51.0 | Pumping/Cooper-Jacob | SGW-38757 | 120.0 | 110.8 | 118.7 | 8.0 | - | - | 7.9 | 0.1 | - |
| 199-D5-132 | 573875.35 | 151586.87 | 19.0 | Slug/KGS | ECF-100HR3-12-0011 | 119.7 | 112.1 | 119.6 | 7.4 | - | - | 6.5 | - | 0.9 |
| 199-D5-133 | 573731.55 | 151497.37 | 38.0 | Slug/KGS | ECF-100HR3-12-0011 | 120.6 | 111.4 | 120.5 | 9.1 | - | - | 8.6 | 0.5 | - |
| 199-D5-14 | 573789.63 | 151787.99 | 9.1 | Slug | DOE/RL-93-43 | 120.4 | 114.0 | 118.3 | 4.3 | - | - | 4.3 | - | - |
| 199-D5-143 | 573701.53 | 151784.26 | 20.0 | Slug/KGS | ECF-100HR3-12-0011 | 119.4 | 111.7 | 118.4 | 6.7 | - | - | 6.4 | 0.2 | - |

**Table D-1. Aquifer Test Data from Model Data Packages**

| Well Name | Easting (m) | Northing (m) | Estimated Hydraulic Conductivity (m/d) | Aquifer Test Type | Test Reference | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D5-144 | 573352.03 | 151404.83 | 23.0 | Slug/KGS | ECF-100HR3-12-0011 | 121.4 | 110.7 | 118.8 | 8.1 | - | - | 8.0 | 0.1 | - |
| 199-D5-15 | 573738.61 | 151673.75 | 9.1 | Slug | DOE/RL-93-43 | 120.4 | 114.1 | 119.1 | 5.0 | - | - | 5.0 | - | - |
| 199-D5-16 | 573917.45 | 151652.51 | 3.1 | Slug | DOE/RL-93-43 | 120.9 | 114.6 | 119.1 | 4.4 | - | - | 4.4 | - | - |
| 199-D5-17 | 573730.52 | 151322.83 | 3.1 | Slug | DOE/RL-93-43 | 120.3 | 114.5 | 119.8 | 5.3 | - | - | 5.3 | - | - |
| 199-D5-18 | 573861.70 | 151325.18 | 18.0 | Slug | DOE/RL-93-43 | 121.8 | 114.2 | 119.5 | 5.3 | - | - | 5.3 | - | - |
| 199-D5-19 | 573849.12 | 151243.19 | 12.0 | Slug | DOE/RL-93-43 | 119.2 | 113.1 | 119.2 | 6.1 | - | - | 5.9 | - | 0.2 |
| 199-D5-20 | 573239.97 | 152030.15 | 12.0 | Slug | DOE/RL-93-43 | 119.7 | 113.4 | 117.2 | 3.8 | - | - | 3.8 | - | - |
| 199-D5-99 | 573349.61 | 151402.01 | 28.0 | Pumping/Cooper-Jacob | SGW-38757 | 119.8 | 110.6 | 118.8 | 8.2 | - | - | 8.0 | 0.2 | - |
| 199-D6-3 | 574159.09 | 151643.85 | 12.0 | Slug/KGS | ECF-100HR3-12-0011 | 120.7 | 113.1 | 119.0 | 5.9 | - | - | 5.9 | - | - |
| 199-D8-3 | 573942.43 | 152347.93 | 560.0 | Pumping | PNL-10886 | 127.2 | 113.8 | 117.4 | 3.6 | 0.8 | - | 2.8 | - | - |
| 199-D8-53 | 573889.86 | 152452.26 | 162.0 | Slug | DOE/RL-93-43 | 119.2 | 112.9 | 117.2 | 4.3 | 2.1 | - | 2.2 | - | - |
| 199-D8-54A | 573781.17 | 152408.03 | 122.0 | Slug | DOE/RL-93-43 | 119.2 | 112.8 | 117.2 | 4.4 | 2.7 | - | 1.7 | - | - |
| 199-D8-55 | 573620.95 | 152364.35 | 6.1 | Slug | DOE/RL-93-43 | 118.7 | 112.4 | 117.2 | 4.8 | - | - | 2.9 | 0.4 | 1.5 |
| 199-F1-2 | 580011.04 | 148805.30 | 37.0 | Slug/Bouwer-Rice | WHC-SD-EN-TI-221 | 115.4 | 110.9 | 112.4 | 1.5 | 1.5 | - | - | - | - |
| 199-F5-42 | 581285.48 | 147834.82 | 18.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 114.7 | 108.6 | 112.2 | 3.6 | 3.6 | - | - | - | - |
| 199-F5-43A | 581183.87 | 147948.07 | 26.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 114.5 | 108.4 | 112.5 | 4.1 | 4.1 | - | - | - | - |
| 199-F5-44 | 581060.85 | 148043.20 | 14.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 114.4 | 108.3 | 112.4 | 4.1 | 4.1 | - | - | - | - |
| 199-F5-45 | 580706.88 | 147683.92 | 9.1 | Slug/Bouwer-Rice | WHC-SD-EN-TI-221 | 115.2 | 110.6 | 112.6 | 2.0 | 2.0 | - | - | - | - |
| 199-F5-46 | 580841.34 | 147781.51 | 48.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 114.1 | 110.2 | 112.3 | 2.1 | 2.1 | - | - | - | - |
| 199-F5-47 | 580495.51 | 147508.45 | 23.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 115.8 | 109.7 | 113.1 | 3.4 | 2.1 | - | - | - | 1.3 |
| 199-F5-48 | 580517.58 | 147690.10 | 20.0 | Slug/Bouwer-Rice | WHC-SD-EN-TI-221 | 115.7 | 111.0 | 112.8 | 1.8 | - | - | 1.4 | - | 0.4 |
| 199-F5-52 | 580672.81 | 148143.82 | 23.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 115.5 | 109.4 | 112.4 | 3.0 | 3.0 | - | - | - | - |
| 199-F5-54 | 581145.51 | 147576.44 | 34.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 115.0 | 108.9 | 112.5 | 3.6 | 3.6 | - | - | - | - |
| 199-F6-1 | 581375.87 | 147564.51 | 21.3 | Slug/Bouwer-Rice | WHC-SD-EN-TI-221 | 114.7 | 108.6 | 112.0 | 3.4 | 3.4 | - | - | - | - |
| 199-F7-1 | 579687.17 | 147022.43 | 225.0 | Not available | PNL-10886 | 116.4 | 111.9 | 115.3 | 3.4 | 1.3 | - | 1.6 | - | 0.4 |
| 199-F7-3 | 579884.71 | 147112.53 | 20.0 | SlugTest/KGS | ECF-100FR3-11-0146 | 115.3 | 110.7 | 113.9 | 3.1 | - | - | 2.1 | - | 1.0 |
| 199-F8-3 | 580253.99 | 147253.37 | 63.0 | Slug/Bouwer-Rice | WHC-SD-EN-TI-221 | 115.5 | 112.5 | 113.5 | 1.0 | 0.1 | - | 0.8 | - | 0.1 |

Table D-1. Aquifer Test Data from Model Data Packages

| Well Name | Easting (m) | Northing (m) | Estimated Hydraulic Conductivity (m/d) | Aquifer Test Type | Test Reference | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-F8-4 | 580958.51 | 147123.53 | 11.0 | Slug/Bouwer-Rice | WHC-SD-EN-TI-221 | 114.3 | 111.3 | 112.2 | 0.9 | 0.9 | - | - | - | - |
| 199-H3-2A | 577624.61 | 152750.07 | 579.0 | Pumping | PNL-6728 | 117.1 | 112.5 | 115.2 | 2.7 | 2.7 | - | - | - | - |
| 199-H3-2B | 577628.27 | 152757.16 | 30.0 | Slug/Bouwer-Rice | PNL-6728 | 113.5 | 112.0 | 115.0 | 1.5 | 1.5 | - | - | - | - |
| 199-H3-6 | 578266.47 | 152425.33 | 38.0 | SlugTest/KGS | ECF-100HR3-12-0011 | 118.0 | 111.9 | 114.0 | 2.1 | 1.6 | 0.4 | - | - | - |
| 199-H3-7 | 577931.74 | 152279.97 | 27.0 | SlugTest/KGS | ECF-100HR3-12-0011 | 117.7 | 113.1 | 114.6 | 1.5 | 1.5 | - | - | - | - |
| 199-H4-10 | 577827.21 | 153155.81 | 1798.0 | Pumping | PNL-6728 | 117.5 | 112.9 | 114.5 | 1.6 | 1.6 | - | 0.0 | - | - |
| 199-H4-11 | 578141.91 | 152728.43 | 17.7 | Geomean of Pumping, Slug/Bouwer-Rice | PNL-6471, PNL-6728 | 116.1 | 111.5 | 114.4 | 2.9 | - | 0.0 | 2.7 | 0.1 | - |
| 199-H4-12A | 578009.15 | 152912.73 | 67.1 | Geomean of Pumping/Theis, Pumping and Pumping | PNL-10886, PNL-6728, PNL-6471 | 116.4 | 111.8 | 114.4 | 2.5 | 1.8 | - | 0.7 | - | - |
| 199-H4-12B | 578004.39 | 152918.47 | 15.0 | Slug/Bouwer-Rice | PNL-6728 | 113.5 | 112.0 | 114.4 | 1.5 | 0.8 | - | 0.8 | - | - |
| 199-H4-13 | 578219.30 | 152595.27 | 128.0 | Slug/Bouwer-Rice | PNL-6728 | 117.4 | 112.8 | 114.8 | 2.0 | 0.1 | 1.3 | 0.7 | - | - |
| 199-H4-14 | 577803.75 | 152752.36 | 76.0 | Slug/Bouwer-Rice | PNL-6728 | 117.8 | 113.2 | 115.2 | 2.0 | - | - | 2.0 | - | - |
| 199-H4-15A | 577904.31 | 153053.42 | 48.0 | Geomean of Pumping, Pumping, Pumping | PNL-6471, PNL-6471, PNL-6728 | 117.1 | 112.5 | 114.5 | 2.0 | 0.7 | - | 1.3 | - | - |
| 199-H4-15B | 577899.60 | 153059.55 | 140.0 | Slug/Bouwer-Rice | PNL-6728 | 113.9 | 112.4 | 114.1 | 1.5 | 0.2 | - | 1.4 | - | - |
| 199-H4-16 | 577981.91 | 152591.57 | 67.0 | Slug/Bouwer-Rice | PNL-6728 | 117.5 | 112.7 | 115.3 | 2.7 | 2.7 | - | - | - | - |
| 199-H4-18 | 578018.29 | 152756.48 | 24.0 | Slug/Bouwer-Rice | PNL-6728 | 116.9 | 113.9 | 116.1 | 2.3 | 2.1 | - | - | 0.2 | - |
| 199-H4-3 | 577940.49 | 152858.54 | 52.0 | Pumping | PNL-10886 | 118.1 | 111.7 | 114.4 | 2.7 | 0.5 | - | 1.8 | - | 0.4 |
| 199-H4-45 | 578156.39 | 152433.39 | 30.0 | Slug | DOE/RL-93-43 | 117.3 | 111.0 | 114.2 | 3.2 | 2.3 | 0.5 | - | 0.0 | 0.2 |
| 199-H4-46 | 577883.86 | 152439.87 | 37.0 | Slug | DOE/RL-93-43 | 117.6 | 111.2 | 114.6 | 3.4 | 2.7 | - | 0.6 | 0.0 | - |
| 199-H4-47 | 577891.18 | 152553.30 | 27.0 | Slug | DOE/RL-93-43 | 117.7 | 111.4 | 114.6 | 3.2 | 1.9 | - | 1.3 | 0.0 | - |
| 199-H4-48 | 577792.66 | 152620.21 | 24.0 | Slug | DOE/RL-93-43 | 118.1 | 111.7 | 114.8 | 3.0 | - | - | 3.0 | - | - |
| 199-H4-49 | 577713.83 | 152445.15 | 27.0 | Slug | DOE/RL-93-43 | 118.0 | 113.2 | 115.0 | 1.7 | 1.7 | - | - | - | - |
| 199-H4-7 | 577804.13 | 152890.85 | 21.0 | Slug/Bouwer-Rice | PNL-6728 | 117.2 | 112.6 | 114.8 | 2.2 | 0.9 | - | 0.7 | 0.4 | 0.2 |
| 199-H5-1A | 577650.08 | 152257.72 | 34.0 | Slug/Bouwer-Rice | DOE/RL-93-43 | 117.6 | 112.7 | 114.9 | 2.2 | 1.4 | - | 0.7 | 0.1 | - |
| 199-H6-1 | 578236.56 | 152247.63 | 21.0 | Slug | DOE/RL-93-43 | 117.2 | 110.9 | 114.2 | 3.4 | 1.9 | 1.1 | - | - | 0.4 |
| 199-H6-3 | 578340.40 | 151929.35 | 27.0 | SlugTest/KGS | ECF-100HR3-12-0011 | 117.1 | 109.5 | 113.6 | 4.1 | 0.8 | 2.3 | - | 0.3 | 0.7 |

Table D-1. Aquifer Test Data from Model Data Packages

| Well Name | Easting (m) | Northing (m) | Estimated Hydraulic Conductivity (m/d) | Aquifer Test Type | Test Reference | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H6-4 | 577771.59 | 151737.10 | 118.0 | SlugTest/KGS | ECF-100HR3-12-0011 | 117.7 | 110.1 | 114.9 | 4.8 | - | - | 4.2 | 0.6 | 0.0 |
| 199-K-10 | 568912.76 | 146628.10 | 16.0 | Pumping/Cooper-Jacob | PNL-10886 | 142.8 | 92.7 | 119.3 | 26.6 | - | - | 26.4 | 0.2 | - |
| 199-K-106A | 568697.40 | 146502.39 | 2.6 | Slug/Bouwer-Rice | WHC-SD-EN-DP-090 | 121.2 | 114.9 | 119.4 | 4.5 | - | - | 4.5 | - | - |
| 199-K-107A | 568579.94 | 146468.81 | 3.2 | Slug/Bouwer-Rice | WHC-SD-EN-DP-090 | 120.8 | 114.5 | 119.0 | 4.5 | - | - | 4.5 | - | - |
| 199-K-108A | 568687.20 | 146396.14 | 2.4 | Slug/Bouwer-Rice | WHC-SD-EN-DP-090 | 121.6 | 115.4 | 119.3 | 3.9 | - | - | 3.9 | - | - |
| 199-K-110A | 569230.01 | 146677.91 | 9.8 | Slug/Bouwer-Rice, Slug/Bouwer-Rice | WHC-SD-EN-DP-090, WHC-SD-EN-TI-221 | 122.0 | 115.7 | 120.5 | 4.8 | - | - | 4.8 | - | - |
| 199-K-111A | 569308.17 | 146968.88 | 8.3 | Slug/Bouwer-Rice | WHC-SD-EN-DP-090 | 121.3 | 115.2 | 119.6 | 4.4 | - | - | 4.4 | - | - |
| 199-K-18 | 569353.69 | 147400.81 | 5.9 | Pumping/Cooper-Jacob | CCN 024566, SSPA Update | 124.9 | 106.6 | 119.4 | 12.8 | - | - | 12.8 | - | - |
| 199-K-183 | 568302.28 | 146439.70 | 13.0 | SlugTest/KGS | ECF-100KR4-12-0010 | 126.0 | 107.7 | 120.8 | 13.0 | - | - | 13.0 | - | - |
| 199-K-184 | 568618.68 | 146366.32 | 6.8 | SlugTest/KGS | ECF-100KR4-12-0010 | 106.9 | 93.2 | 118.0 | 13.7 | - | - | 13.4 | 0.3 | - |
| 199-K-185 | 568574.92 | 146726.17 | 2.3 | SlugTest/KGS | ECF-100KR4-12-0010 | 122.9 | 93.9 | 118.3 | 24.4 | - | - | 24.1 | 0.3 | - |
| 199-K-187 | 569499.00 | 146054.68 | 28.0 | SlugTest/KGS | ECF-100KR4-12-0010 | 125.8 | 95.3 | 120.5 | 25.2 | - | - | 25.2 | - | - |
| 199-K-188 | 569386.80 | 146370.11 | 16.0 | SlugTest/KGS | ECF-100KR4-12-0010 | 122.8 | 112.1 | 120.8 | 8.7 | - | - | 8.7 | - | - |
| 199-K-189 | 569150.27 | 146809.68 | 0.9 | SlugTest/KGS | ECF-100KR4-12-0010 | 122.7 | 95.3 | 119.5 | 24.2 | - | - | 24.2 | - | - |
| 199-K-19 | 569458.52 | 147386.64 | 4.9 | Pumping/Cooper-Jacob | CCN 024566, SSPA Update | 121.8 | 115.7 | 119.8 | 4.1 | - | - | 4.1 | - | - |
| 199-K-190 | 568835.28 | 146873.27 | 12.0 | SlugTest/KGS | ECF-100KR4-12-0010 | 106.9 | 94.7 | 117.2 | 12.2 | - | - | 11.8 | 0.2 | 0.2 |
| 199-K-191 | 569711.20 | 146886.65 | 1.0 | SlugTest/KGS | ECF-100KR4-12-0010 | 127.9 | 112.7 | 121.0 | 8.3 | - | - | 8.3 | - | - |
| 199-K-193 | 570641.99 | 146969.58 | 1.1 | SlugTest/KGS | ECF-100KR4-12-0010 | 126.2 | 95.7 | 120.7 | 25.0 | - | - | 20.1 | - | 4.9 |
| 199-K-194 | 571315.65 | 147281.98 | 0.7 | SlugTest/KGS | ECF-100KR4-12-0010 | 124.3 | 113.6 | 120.5 | 6.9 | - | - | 6.9 | - | - |
| 199-K-195 | 568850.08 | 146086.38 | 15.0 | SlugTest/KGS | ECF-100KR4-12-0010 | 123.0 | 109.3 | 121.3 | 12.0 | - | - | 12.0 | - | - |
| 199-K-196 | 568433.30 | 146639.26 | 8.8 | SlugTest/KGS | ECF-100KR4-12-0010 | 123.0 | 94.0 | 117.3 | 23.3 | - | - | 23.3 | - | - |
| 199-K-199 | 569339.76 | 147585.30 | 5.1 | SlugTest/KGS | ECF-100KR4-12-0010 | 105.4 | 96.3 | 118.0 | 9.1 | 8.7 | - | 0.4 | - | - |
| 199-K-20 | 569520.52 | 147687.24 | 101.7 | Pumping/Cooper-Jacob | CCN 024566, SSPA Update | 126.0 | 113.8 | 119.3 | 5.6 | 0.1 | - | 5.5 | - | - |
| 199-K-21 | 569769.90 | 147932.06 | 17.7 | Pumping/Cooper-Jacob | CCN 024566, SSPA Update | 126.1 | 113.9 | 118.5 | 4.7 | - | - | 4.7 | - | - |
| 199-K-22 | 570023.70 | 148097.38 | 3.0 | Pumping/Cooper-Jacob | CCN 024566, SSPA Update | 121.6 | 115.5 | 118.6 | 3.1 | - | - | 3.1 | - | - |
| 199-K-32A | 569024.15 | 147006.68 | 24.0 | Slug/Bouwer-Rice | DOE/RL-93-79 | 121.8 | 115.7 | 118.6 | 2.9 | - | - | 2.9 | - | - |

Table D-1. Aquifer Test Data from Model Data Packages

| Well Name | Easting (m) | Northing (m) | Estimated Hydraulic Conductivity (m/d) | Aquifer Test Type | Test Reference | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-33 | 568573.65 | 146713.25 | 5.8 | Slug/Bouwer-Rice | DOE/RL-93-79 | 121.4 | 115.3 | 118.1 | 2.8 | - | - | 2.8 | - | - |
| 199-K-34 | 568605.78 | 146501.94 | 21.0 | Slug/Bouwer-Rice | DOE/RL-93-79 | 122.4 | 116.3 | 119.3 | 3.0 | - | - | 3.0 | - | - |
| 199-K-35 | 568832.33 | 146110.68 | 38.0 | Slug/Bouwer-Rice | DOE/RL-93-79 | 123.8 | 117.7 | 121.0 | 3.2 | - | - | 3.2 | - | - |
| 199-K-36 | 569373.61 | 146390.47 | 27.0 | Slug/Bouwer-Rice | DOE/RL-93-79 | 123.7 | 117.6 | 121.2 | 3.6 | - | - | 3.6 | - | - |
| 199-K-37 | 570216.20 | 148226.54 | 44.0 | Slug/Bouwer-Rice | DOE/RL-93-79 | 121.6 | 115.5 | 118.1 | 2.7 | - | - | 2.7 | - | - |
| 199-N-119 | 571364.50 | 149968.34 | 6.5 | Slug/Type Curve Butler | PNNL-16894 | 117.8 | 115.7 | 118.2 | 2.1 | 0.1 | - | 2.0 | - | - |
| 199-N-120 | 571366.18 | 149970.76 | 6.4 | Slug/Type Curve Butler | PNNL-16894 | 114.9 | 113.4 | 118.2 | 1.5 | - | - | 1.5 | - | - |
| 199-N-121 | 571368.29 | 149973.29 | 3.7 | Slug/Type Curve Butler | PNNL-16894 | 111.4 | 109.9 | 118.2 | 1.5 | - | - | 1.5 | - | - |
| 199-N-182 | 571428.71 | 149819.87 | 4.1 | Slug/KGS | ECF-100NR2-12-0031 | 114.8 | 108.7 | 118.3 | 6.1 | - | - | 5.1 | - | 1.0 |
| 199-N-183 | 571269.69 | 149756.01 | 6.5 | Slug/KGS | ECF-100NR2-12-0031 | 120.0 | 113.9 | 118.3 | 4.4 | - | - | 4.4 | - | - |
| 199-N-184 | 571430.74 | 149817.82 | 3.8 | Slug/KGS | ECF-100NR2-12-0031 | 121.7 | 115.6 | 118.6 | 3.0 | - | - | 3.0 | - | - |
| 199-N-185 | 571546.33 | 150237.98 | 2.6 | Slug/KGS | ECF-100NR2-12-0031 | 110.9 | 109.4 | 118.5 | 1.5 | - | - | 1.0 | - | 0.6 |
| 199-N-186 | 571480.87 | 149715.06 | 4.4 | Slug/KGS | ECF-100NR2-12-0031 | 120.5 | 114.4 | 118.7 | 4.3 | - | - | 4.3 | - | - |
| 199-N-187 | 571565.90 | 149897.96 | 5.6 | Slug/KGS | ECF-100NR2-12-0031 | 119.4 | 113.3 | 118.7 | 5.4 | - | - | 5.4 | - | - |
| 199-N-188 | 571906.94 | 149581.53 | 6.8 | Slug/KGS | ECF-100NR2-12-0031 | 120.8 | 114.7 | 119.0 | 4.3 | - | - | 4.3 | - | - |
| 199-N-189 | 571431.65 | 148430.52 | 9.4 | Slug/KGS | ECF-100NR2-12-0031 | 124.7 | 111.0 | 119.4 | 8.4 | - | - | 8.4 | - | - |
| 699-71-30 | 580603.35 | 145226.91 | 33.0 | Not available | PNL-10886 | 115.5 | 96.9 | 114.1 | 17.2 | 1.2 | - | - | - | 16.0 |
| 699-71-52 | 573907.90 | 145214.84 | 271.0 | Pumping | PNL-10886 | 160.1 | 106.4 | 120.6 | 14.3 | 3.6 | - | 10.7 | - | - |
| 699-77-54 | 573385.97 | 146854.80 | 87.0 | Pumping | PNL-10886 | 147.3 | 112.0 | 120.2 | 8.2 | 2.0 | - | 6.2 | - | - |
| 699-86-60 | 571625.74 | 149600.80 | 78.0 | Pumping | PNL-10886 | 139.0 | 109.2 | 118.8 | 9.6 | - | - | 9.6 | - | - |
| 699-91-46A | 575910.95 | 151156.64 | 241.0 | Slug/Bouwer-Rice | DOE/RL-93-43 | 120.2 | 113.9 | 117.3 | 3.3 | 3.3 | - | - | - | - |
| 699-93-48A | 575094.13 | 151795.30 | 18.0 | Slug/Bouwer-Rice | DOE/RL-93-43 | 121.0 | 114.6 | 116.9 | 2.2 | - | - | 2.2 | - | - |
| 699-96-43 | 576761.45 | 152605.31 | 15.0 | Slug/Bouwer-Rice | DOE/RL-93-43 | 118.8 | 113.9 | 115.8 | 1.9 | - | - | 1.6 | - | 0.3 |

RUM = Ringold Upper Mud

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, m²/d) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-B2-13 | 564086.52 | 145264.56 | 6.9 | 2.3 | 3.0 | 69.4 | 123.3 | 117.0 | 120.7 | 3.8 | 3.8 | - | - | - | - |
| 199-B3-46 | 565899.57 | 145369.04 | 14.9 | 15.0 | 1.0 | 23.0 | 121.2 | 114.9 | 120.2 | 5.4 | 0.6 | - | 4.8 | - | - |
| 199-B4-9 | 565395.64 | 144563.93 | 15.0 | 0.1 | 166.7 | 3,874.8 | 125.5 | 119.4 | 121.5 | 2.1 | 2.1 | - | - | - | - |
| 199-B5-2 | 565405.43 | 144939.70 | 14.9 | 0.1 | 124.2 | 2,886.7 | 123.3 | 117.2 | 121.3 | 4.1 | 3.8 | - | 0.2 | - | - |
| 199-B9-2 | 565534.79 | 144078.08 | 14.1 | 0.1 | 201.7 | 4,689.7 | 124.2 | 118.1 | 122.5 | 4.4 | 4.4 | - | - | - | - |
| 199-B9-3 | 565667.36 | 144046.72 | 14.5 | 0.1 | 241.8 | 5,622.4 | 124.4 | 118.3 | 121.5 | 3.2 | 3.2 | - | - | - | - |
| 199-D2-10 | 574470.87 | 153465.19 | 15.0 | 4.5 | 3.3 | 77.5 | 117.3 | 112.7 | 118.6 | 4.6 | 4.6 | - | - | - | - |
| 199-D2-12 | 574343.45 | 153300.01 | 41.0 | 1.2 | 33.7 | 783.2 | 117.0 | 112.4 | 118.7 | 4.6 | 4.2 | - | - | - | 0.3 |
| 199-D3-4 | 572468.16 | 151170.97 | 31.0 | 4.0 | 7.7 | 178.7 | 118.2 | 109.0 | 118.0 | 8.9 | - | - | 8.7 | 0.3 | - |
| 199-D4-14 | 572839.81 | 151641.64 | 35.0 | 7.4 | 4.7 | 109.8 | 120.3 | 114.2 | 117.6 | 3.4 | - | - | 3.4 | - | - |
| 199-D4-15 | 572936.64 | 151424.86 | 60.0 | 1.4 | 42.9 | 996.4 | 120.0 | 113.9 | 117.7 | 3.8 | - | - | 3.8 | - | - |
| 199-D4-23 | 572672.46 | 151592.87 | 8.0 | 4.9 | 1.6 | 37.7 | 120.8 | 114.7 | 117.5 | 2.8 | - | - | 2.7 | - | 0.2 |
| 199-D4-24 | 572699.89 | 151471.43 | 8.5 | 5.5 | 1.5 | 35.9 | 118.8 | 114.2 | 117.1 | 2.8 | - | - | 2.8 | - | - |
| 199-D4-25 | 572711.44 | 151476.24 | 12.0 | 3.6 | 3.3 | 77.5 | 117.9 | 113.3 | 117.3 | 3.9 | - | - | 3.9 | - | - |
| 199-D4-29 | 572736.86 | 151510.69 | 13.0 | 8.6 | 1.5 | 35.1 | 118.6 | 114.1 | 117.8 | 3.7 | - | - | 3.3 | 0.4 | - |
| 199-D4-30 | 572737.44 | 151523.22 | 20.0 | 6.6 | 3.0 | 70.5 | 119.2 | 114.6 | 117.9 | 3.3 | - | - | 3.3 | - | - |
| 199-D4-35 | 572806.31 | 151602.28 | 22.5 | 2.0 | 11.4 | 266.1 | 118.7 | 114.1 | 118.6 | 4.5 | - | - | 4.2 | 0.2 | - |
| 199-D4-39 | 572747.45 | 151650.84 | 20.0 | 9.5 | 2.1 | 48.9 | 120.6 | 114.5 | 117.6 | 3.1 | - | - | 3.1 | - | - |
| 199-D4-41 | 572834.11 | 151634.66 | 30.0 | 4.4 | 6.8 | 158.5 | 118.4 | 113.9 | 118.3 | 4.4 | - | - | 4.3 | 0.1 | - |
| 199-D4-61 | 572620.66 | 151363.70 | 15.0 | 8.6 | 1.7 | 40.6 | 116.8 | 112.3 | 117.3 | 4.5 | - | - | 2.0 | 2.5 | - |
| 199-D4-62 | 572619.52 | 151351.07 | 15.5 | 7.6 | 2.0 | 47.4 | 117.7 | 110.1 | 117.4 | 7.3 | - | - | 0.2 | 7.0 | - |
| 199-D4-68 | 572581.32 | 151299.84 | 30.0 | 4.9 | 6.1 | 142.3 | 118.5 | 109.4 | 117.9 | 8.5 | - | - | 6.6 | 1.9 | - |
| 199-D4-69 | 572569.00 | 151295.69 | 31.0 | 5.9 | 5.2 | 121.5 | 117.7 | 110.1 | 118.7 | 7.6 | - | - | 6.2 | 1.4 | - |
| 199-D4-70 | 572568.79 | 151282.68 | 30.0 | 6.0 | 5.0 | 117.2 | 118.2 | 110.6 | 119.0 | 7.6 | - | - | 7.6 | - | - |
| 199-D4-71 | 572556.29 | 151278.50 | 31.0 | 2.0 | 15.2 | 353.2 | 118.9 | 109.9 | 118.8 | 8.9 | - | - | 8.8 | 0.1 | - |
| 199-D4-73 | 572542.17 | 151262.72 | 30.0 | 0.8 | 38.9 | 904.6 | 118.6 | 109.6 | 119.3 | 9.1 | - | - | 9.1 | - | - |
| 199-D4-74 | 572539.80 | 151249.80 | 31.0 | 3.5 | 9.0 | 208.9 | 118.2 | 109.2 | 113.8 | 4.6 | - | - | 4.6 | - | - |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, m²/d) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D4-75 | 572527.76 | 151246.95 | 31.0 | 2.8 | 11.2 | 260.2 | 118.1 | 109.1 | 118.4 | 9.0 | - | - | 9.0 | - | - |
| 199-D4-76 | 572526.06 | 151234.24 | 31.0 | 0.7 | 47.0 | 1,092.0 | 118.2 | 109.2 | 118.5 | 9.1 | - | - | 9.1 | - | - |
| 199-D4-78 | 572511.28 | 151218.26 | 31.0 | 1.5 | 20.7 | 480.5 | 118.3 | 109.3 | 117.9 | 8.7 | - | - | 8.6 | 0.1 | - |
| 199-D4-79 | 572498.24 | 151214.02 | 31.0 | 0.6 | 56.4 | 1,310.4 | 118.8 | 109.8 | 118.7 | 8.9 | - | - | 8.9 | - | - |
| 199-D4-80 | 572496.87 | 151202.59 | 31.0 | 0.9 | 33.0 | 766.7 | 118.7 | 109.7 | 117.4 | 7.7 | - | - | 7.7 | - | - |
| 199-D4-81 | 572484.36 | 151199.64 | 31.0 | 0.3 | 91.7 | 2,131.1 | 118.6 | 109.5 | 117.9 | 8.4 | - | - | 8.4 | - | - |
| 199-D4-82 | 572470.26 | 151183.89 | 31.0 | 0.6 | 54.6 | 1,269.2 | 118.2 | 109.2 | 117.9 | 8.8 | - | - | 8.8 | - | - |
| 199-D4-83 | 572859.43 | 151723.42 | 25.0 | 4.4 | 5.7 | 133.6 | 119.4 | 114.8 | 117.3 | 2.4 | - | - | 0.9 | 1.6 | - |
| 199-D4-85 | 572486.16 | 151324.20 | 35.0 | 4.1 | 8.5 | 197.8 | 119.5 | 110.4 | 118.4 | 8.0 | - | - | 8.0 | 0.0 | - |
| 199-D4-86 | 572389.06 | 151202.14 | 37.0 | 0.5 | 71.2 | 1,654.3 | 119.2 | 110.1 | 118.4 | 8.3 | - | - | 8.3 | - | - |
| 199-D4-95 | 572612.82 | 151226.70 | 19.0 | 3.5 | 5.4 | 125.1 | 119.2 | 108.6 | 118.5 | 9.9 | - | - | 9.7 | 0.1 | - |
| 199-D4-96 | 572777.03 | 151519.78 | 15.0 | 6.4 | 2.3 | 54.5 | 117.4 | 114.3 | 117.3 | 3.0 | - | - | 3.0 | - | - |
| 199-D4-97 | 572906.23 | 151625.33 | 41.0 | 6.1 | 6.7 | 156.0 | 117.0 | 112.4 | 117.4 | 4.6 | - | - | 4.6 | - | - |
| 199-D4-98 | 572574.52 | 151481.65 | 44.9 | 1.1 | 40.4 | 940.0 | 118.7 | 112.6 | 117.2 | 4.6 | - | - | 4.6 | 0.0 | - |
| 199-D4-99 | 572527.36 | 151377.08 | 23.0 | 4.7 | 4.9 | 113.0 | 119.5 | 110.3 | 118.1 | 7.8 | - | - | 7.6 | 0.2 | - |
| 199-D5-101 | 572943.04 | 151521.52 | 75.0 | 3.0 | 24.9 | 579.3 | 120.6 | 111.4 | 117.6 | 6.2 | - | - | 4.8 | 0.3 | 1.0 |
| 199-D5-102 | 573428.15 | 151340.23 | 10.1 | 1.9 | 5.3 | 123.4 | 120.0 | 110.9 | 119.0 | 8.2 | - | - | 8.2 | - | - |
| 199-D5-104 | 573265.48 | 151422.43 | 9.5 | 1.8 | 5.2 | 121.6 | 119.7 | 110.5 | 118.3 | 7.8 | - | - | 7.5 | 0.3 | - |
| 199-D5-108 | 572923.34 | 151222.90 | 10.0 | 2.2 | 4.5 | 105.7 | 118.8 | 112.7 | 117.9 | 5.2 | - | - | 5.1 | 0.0 | - |
| 199-D5-110 | 572931.57 | 151277.61 | 9.5 | 1.6 | 5.9 | 138.0 | 119.6 | 113.5 | 117.9 | 4.4 | - | - | 4.1 | 0.3 | - |
| 199-D5-111 | 572943.24 | 151281.47 | 15.5 | 4.2 | 3.7 | 85.5 | 119.7 | 113.6 | 117.9 | 4.3 | - | - | 4.2 | 0.1 | - |
| 199-D5-113 | 572927.02 | 151288.45 | 36.3 | 11.5 | 3.1 | 73.2 | 115.0 | 113.5 | 119.6 | 1.5 | - | - | 1.5 | - | - |
| 199-D5-114 | 572918.04 | 151223.75 | 20.0 | 2.0 | 9.9 | 230.2 | 119.0 | 112.8 | 117.9 | 5.1 | - | - | 5.1 | - | - |
| 199-D5-115 | 572923.15 | 151221.12 | 30.0 | 3.2 | 9.4 | 218.6 | 119.0 | 112.9 | 117.9 | 5.0 | - | - | 5.0 | - | - |
| 199-D5-116 | 572926.93 | 151222.35 | 8.3 | 2.1 | 4.0 | 93.2 | 119.0 | 112.9 | 119.7 | 6.1 | - | - | 6.1 | - | - |
| 199-D5-118 | 572921.03 | 151224.45 | 16.7 | 5.9 | 2.8 | 65.9 | 114.4 | 112.9 | 119.7 | 1.5 | - | - | 1.5 | - | - |
| 199-D5-120 | 573377.18 | 151406.84 | 23.0 | 2.8 | 8.3 | 193.4 | 119.8 | 110.6 | 118.1 | 7.5 | - | - | 7.4 | 0.1 | 0.1 |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, m²/d) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D5-123 | 573824.21 | 151639.41 | 11.5 | 1.0 | 11.5 | 267.4 | 120.2 | 107.9 | 118.0 | 10.1 | - | - | 6.7 | 3.4 | - |
| 199-D5-125 | 573667.39 | 151746.18 | 5.0 | 1.4 | 3.6 | 83.0 | 119.9 | 111.3 | 118.1 | 6.7 | - | - | 6.1 | 0.6 | - |
| 199-D5-126 | 573705.71 | 151843.28 | 14.0 | 1.2 | 11.9 | 275.8 | 119.2 | 110.1 | 117.9 | 7.8 | - | - | 5.7 | 2.1 | - |
| 199-D5-127 | 572992.26 | 151428.31 | 23.0 | 4.9 | 4.7 | 109.1 | 119.6 | 113.5 | 117.6 | 4.0 | - | - | 4.0 | 0.0 | - |
| 199-D5-128 | 573622.40 | 151237.35 | 20.0 | 1.7 | 12.0 | 280.1 | 119.4 | 113.3 | 117.9 | 4.6 | - | - | 4.6 | - | - |
| 199-D5-129 | 573735.50 | 151465.13 | 47.9 | 0.9 | 54.4 | 1,265.5 | 119.6 | 111.9 | 117.8 | 5.9 | - | - | 5.5 | 0.4 | - |
| 199-D5-13 | 573535.53 | 151955.18 | 12.5 | 3.1 | 4.0 | 93.7 | 120.4 | 114.1 | 117.5 | 3.4 | - | - | 3.4 | - | - |
| 199-D5-130 | 574039.20 | 151928.51 | 11.0 | 5.1 | 2.2 | 50.5 | 118.3 | 113.7 | 117.4 | 3.7 | - | - | 3.7 | - | - |
| 199-D5-131 | 573684.39 | 152006.75 | 30.0 | 2.4 | 12.4 | 288.2 | 119.0 | 111.4 | 117.5 | 6.1 | - | - | 6.0 | 0.1 | - |
| 199-D5-140 | 573750.68 | 151778.82 | 9.3 | 3.7 | 2.5 | 58.4 | 119.2 | 111.5 | 118.0 | 6.4 | - | - | 6.2 | 0.2 | - |
| 199-D5-141 | 573243.43 | 151424.51 | 2.0 | 42.9 | 0.0 | 1.1 | 95.1 | 92.1 | 118.0 | 3.0 | - | - | - | - | 3.0 |
| 199-D5-32 | 573372.04 | 151903.39 | 36.0 | 4.9 | 7.3 | 170.7 | 119.5 | 111.8 | 117.7 | 5.9 | - | - | 5.9 | - | - |
| 199-D5-34 | 573240.42 | 151554.12 | 37.0 | 3.4 | 10.8 | 251.2 | 120.3 | 112.7 | 118.1 | 5.4 | - | - | 5.4 | - | - |
| 199-D5-38 | 572996.82 | 151545.59 | 45.0 | 13.8 | 3.3 | 75.8 | 119.0 | 112.9 | 118.3 | 5.4 | - | - | 5.4 | - | - |
| 199-D5-39 | 573142.86 | 151428.43 | 50.0 | 10.8 | 4.6 | 107.6 | 119.6 | 113.5 | 118.5 | 5.0 | - | - | 5.0 | - | - |
| 199-D5-92 | 573131.93 | 152009.82 | 25.0 | 3.5 | 7.1 | 166.1 | 119.4 | 113.0 | 117.8 | 4.7 | - | - | 4.7 | - | - |
| 199-D5-97 | 573250.11 | 151302.47 | 11.0 | 0.7 | 15.1 | 351.3 | 119.3 | 110.2 | 118.7 | 8.5 | - | - | 8.0 | 0.2 | 0.3 |
| 199-D5-98 | 573369.56 | 151272.44 | 9.0 | 1.9 | 4.7 | 108.9 | 118.8 | 109.7 | 118.9 | 9.1 | - | - | 8.7 | 0.4 | - |
| 199-D6-2 | 574544.61 | 151970.20 | 44.0 | 5.4 | 8.1 | 189.4 | 119.4 | 111.8 | 121.5 | 7.6 | - | - | 7.6 | - | - |
| 199-D7-3 | 574151.38 | 152363.41 | 50.8 | 3.8 | 13.4 | 310.8 | 121.0 | 110.3 | 117.9 | 7.6 | 6.7 | - | 0.7 | 0.3 | - |
| 199-D7-6 | 574429.20 | 152980.43 | 44.8 | 1.1 | 40.7 | 946.9 | 120.3 | 114.2 | 117.8 | 3.6 | - | - | 3.6 | - | - |
| 199-D8-101 | 574069.46 | 152262.43 | 7.5 | 4.9 | 1.5 | 35.6 | 118.2 | 115.1 | 117.6 | 2.4 | 2.4 | - | - | - | - |
| 199-D8-6 | 573434.69 | 152060.82 | 5.5 | 0.9 | 5.9 | 136.0 | 118.7 | 112.6 | 118.7 | 6.1 | - | - | 6.1 | - | - |
| 199-D8-68 | 573711.67 | 152427.10 | 97.0 | 0.4 | 269.4 | 6,264.3 | 120.2 | 112.6 | 119.8 | 7.2 | 5.4 | - | 1.7 | 0.0 | - |
| 199-D8-69 | 573843.61 | 152552.20 | 97.0 | 0.2 | 485.0 | 11,275.8 | 119.2 | 113.1 | 117.4 | 4.3 | 4.3 | - | - | - | - |
| 199-D8-70 | 573942.10 | 152508.74 | 101.0 | 0.5 | 202.0 | 4,696.3 | 119.5 | 110.3 | 117.3 | 7.0 | 6.3 | - | 0.4 | 0.2 | 0.1 |
| 199-D8-71 | 573837.10 | 152429.39 | 97.0 | 8.8 | 11.0 | 256.3 | 119.7 | 110.6 | 117.2 | 6.7 | 4.9 | - | 1.6 | 0.2 | - |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, m²/d) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-d8-89 | 573478.64 | 152249.65 | 19.4 | 4.9 | 4.0 | 92.0 | 117.7 | 114.6 | 116.9 | 2.3 | - | - | 2.3 | - | - |
| 199-D8-90 | 573948.64 | 152646.23 | 32.9 | 12.0 | 2.7 | 63.7 | 118.5 | 110.9 | 117.0 | 6.1 | 6.1 | - | - | - | - |
| 199-D8-91 | 574036.89 | 152741.44 | 29.9 | 5.6 | 5.3 | 124.1 | 117.5 | 111.4 | 117.5 | 6.1 | 5.6 | - | 0.4 | 0.1 | - |
| 199-D8-95 | 573611.96 | 152160.61 | 33.0 | 7.4 | 4.5 | 103.6 | 119.0 | 112.9 | 117.5 | 4.6 | - | - | 4.6 | - | - |
| 199-D8-96 | 573706.00 | 152152.24 | 38.8 | 11.3 | 3.4 | 79.8 | 119.1 | 113.0 | 117.5 | 4.5 | - | - | 4.5 | - | - |
| 199-D8-97 | 573859.56 | 152087.42 | 18.0 | 5.3 | 3.4 | 79.0 | 120.8 | 111.6 | 121.9 | 9.2 | 0.3 | - | 8.2 | 0.6 | - |
| 199-D8-98 | 574013.12 | 152123.02 | 27.0 | 5.0 | 5.4 | 125.8 | 120.4 | 112.7 | 117.4 | 4.7 | 4.1 | - | 0.6 | - | - |
| 199-D8-99 | 574006.77 | 152364.37 | 45.0 | 12.2 | 3.7 | 86.0 | 119.8 | 112.2 | 125.1 | 7.6 | 2.2 | - | 5.4 | - | - |
| 199-F5-55 | 581076.10 | 147797.57 | 10.0 | 2.3 | 4.3 | 99.4 | 114.7 | 111.7 | 114.3 | 2.7 | 2.7 | - | - | - | - |
| 199-F5-56 | 580440.62 | 147556.36 | 9.0 | 1.3 | 6.7 | 156.1 | 115.3 | 112.2 | 114.0 | 1.7 | 1.4 | - | 0.3 | - | - |
| 199-H1-1 | 576702.31 | 153384.49 | 72.0 | 0.3 | 240.0 | 5,579.8 | 118.0 | 113.5 | 117.7 | 4.3 | 2.5 | - | 1.8 | - | - |
| 199-H1-20 | 575706.04 | 154183.61 | 83.7 | 0.4 | 214.6 | 4,989.6 | 117.6 | 111.5 | 116.5 | 5.0 | 5.0 | - | - | - | - |
| 199-H1-21 | 575896.84 | 154163.80 | 80.7 | 5.1 | 15.8 | 367.9 | 116.2 | 111.6 | 116.5 | 4.6 | - | - | 4.6 | - | - |
| 199-H1-32 | 576767.07 | 153766.00 | 6.0 | 1.8 | 3.3 | 77.5 | 120.6 | 114.5 | 116.5 | 2.0 | 1.0 | 0.6 | 0.3 | - | - |
| 199-H1-33 | 576833.29 | 153716.23 | 30.0 | 2.3 | 13.0 | 303.2 | 119.1 | 114.5 | 116.5 | 2.0 | 1.0 | 0.6 | 0.4 | - | - |
| 199-H1-35 | 576958.26 | 153628.14 | 15.0 | 0.4 | 37.5 | 871.8 | 117.8 | 113.2 | 116.1 | 2.9 | 0.6 | 0.8 | 1.3 | 0.1 | - |
| 199-H1-36 | 576885.62 | 153486.51 | 6.7 | 1.8 | 3.7 | 86.5 | 118.4 | 113.9 | 116.3 | 2.4 | - | 0.5 | 2.0 | - | - |
| 199-H1-37 | 577106.92 | 153641.63 | 56.8 | 4.9 | 11.6 | 269.5 | 118.3 | 113.7 | 116.5 | 2.8 | 2.7 | 0.1 | - | - | - |
| 199-H1-42 | 577127.18 | 153391.65 | 14.9 | 1.2 | 12.1 | 281.6 | 116.0 | 113.0 | 116.0 | 3.0 | 0.2 | 2.5 | 0.4 | - | - |
| 199-H1-43 | 577213.74 | 153384.28 | 67.3 | 1.0 | 67.3 | 1,564.7 | 115.6 | 112.5 | 116.8 | 3.0 | 2.8 | 0.2 | - | - | - |
| 199-H1-45 | 577240.96 | 153062.41 | 63.0 | 1.0 | 63.0 | 1,464.7 | 116.1 | 111.5 | 117.0 | 4.6 | 4.5 | - | 0.0 | - | - |
| 199-H1-5 | 574850.72 | 153090.30 | 71.8 | 9.7 | 7.4 | 172.1 | 119.1 | 111.5 | 117.6 | 6.1 | 5.2 | - | 0.9 | - | - |
| 199-H3-10 | 577545.14 | 152723.52 | 24.0 | 56.4 | 0.4 | 9.9 | 96.9 | 93.8 | 115.1 | 3.0 | - | - | - | - | 3.0 |
| 199-H3-11 | 577786.74 | 152490.41 | 12.0 | 1.7 | 7.1 | 164.1 | 117.4 | 114.3 | 116.8 | 2.5 | 2.5 | - | - | - | - |
| 199-H3-25 | 577410.36 | 152978.49 | 60.1 | 0.2 | 300.5 | 6,986.3 | 117.5 | 111.4 | 115.0 | 3.5 | 3.5 | - | - | - | - |
| 199-H3-26 | 577440.83 | 152846.50 | 67.3 | 0.3 | 232.1 | 5,395.4 | 116.6 | 112.1 | 116.4 | 4.3 | 4.3 | - | - | - | - |
| 199-H3-27 | 577567.05 | 152811.14 | 37.0 | 9.1 | 4.1 | 94.4 | 117.5 | 111.4 | 118.2 | 6.1 | 6.1 | - | - | - | - |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, m²/d) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H3-4 | 577544.29 | 152293.21 | 105.0 | 0.1 | 1166.7 | 27,123.8 | 120.1 | 112.4 | 116.1 | 3.7 | 2.8 | 0.1 | 0.4 | 0.1 | 0.3 |
| 199-H3-5 | 577454.70 | 152287.50 | 105.0 | 0.2 | 456.5 | 10,613.7 | 118.4 | 112.3 | 116.9 | 4.6 | 0.5 | 0.5 | 3.0 | 0.4 | 0.3 |
| 199-h4-63 | 578185.83 | 152665.53 | 105.0 | 2.2 | 47.7 | 1,109.6 | 116.5 | 110.4 | 116.5 | 6.0 | - | 0.6 | 5.3 | 0.1 | - |
| 199-H4-64 | 577946.11 | 153010.58 | 65.0 | 12.3 | 5.3 | 122.4 | 118.6 | 112.5 | 116.3 | 3.8 | 2.1 | - | 1.6 | - | - |
| 199-H4-69 | 578014.05 | 152686.66 | 26.9 | 5.3 | 5.1 | 117.8 | 115.4 | 112.4 | 115.3 | 2.9 | 2.9 | - | - | - | - |
| 199-H4-70 | 578003.82 | 152646.45 | 26.9 | 3.9 | 6.9 | 160.4 | 115.9 | 112.8 | 116.2 | 3.0 | 3.0 | - | - | - | - |
| 199-H4-71 | 578010.64 | 152581.53 | 23.1 | 2.6 | 9.1 | 210.6 | 116.1 | 111.5 | 119.0 | 4.6 | 4.6 | - | - | - | - |
| 199-H4-72 | 578036.28 | 152500.14 | 37.4 | 8.8 | 4.3 | 98.8 | 116.2 | 111.6 | 116.4 | 4.6 | 4.6 | - | - | - | - |
| 199-H4-73 | 577940.58 | 152369.98 | 15.2 | 1.1 | 14.5 | 336.6 | 116.1 | 110.0 | 117.3 | 6.1 | 5.3 | - | 0.4 | 0.4 | - |
| 199-H4-74 | 577239.07 | 152268.83 | 21.0 | 2.5 | 8.4 | 195.3 | 118.3 | 113.8 | 116.8 | 3.0 | 0.8 | - | 2.2 | - | - |
| 199-H4-76 | 576787.32 | 152976.85 | 30.0 | 1.5 | 19.6 | 455.9 | 118.4 | 115.3 | 117.5 | 2.2 | 1.9 | - | - | 0.3 | - |
| 199-H4-80 | 575238.97 | 152568.16 | 68.8 | 1.3 | 52.9 | 1,230.4 | 119.8 | 109.2 | 119.3 | 10.1 | 2.0 | - | 8.1 | - | - |
| 199-H4-81 | 575236.93 | 153035.36 | 60.0 | 13.0 | 4.6 | 107.1 | 119.2 | 113.1 | 119.2 | 6.1 | 3.0 | - | 3.1 | - | - |
| 199-H4-82 | 574906.99 | 152677.72 | 38.8 | 4.8 | 8.1 | 187.9 | 119.6 | 113.6 | 119.2 | 5.6 | 5.3 | 0.0 | 0.2 | - | - |
| 199-K-114A | 570020.30 | 148280.55 | 85.0 | 2.2 | 38.6 | 898.3 | 119.3 | 114.7 | 118.2 | 3.5 | - | - | 3.5 | - | - |
| 199-K-115A | 569939.99 | 148135.42 | 38.0 | 12.9 | 2.9 | 68.5 | 120.2 | 111.1 | 118.4 | 7.3 | - | - | 7.3 | - | - |
| 199-K-116A | 569871.15 | 147960.50 | 82.0 | 0.7 | 124.2 | 2,888.5 | 120.5 | 103.7 | 119.5 | 15.8 | - | - | 12.1 | - | 3.7 |
| 199-K-118A | 569703.06 | 147865.90 | 34.0 | 2.8 | 12.1 | 281.5 | 120.4 | 108.1 | 120.5 | 12.3 | - | - | 12.3 | - | - |
| 199-K-119A | 569661.80 | 147649.69 | 68.0 | 12.3 | 5.5 | 128.2 | 121.5 | 106.2 | 120.3 | 14.1 | - | - | 14.1 | - | - |
| 199-K-120A | 569399.62 | 147518.48 | 50.0 | 1.5 | 34.2 | 796.2 | 120.4 | 97.6 | 120.9 | 22.9 | - | - | 22.9 | - | - |
| 199-K-125A | 569712.87 | 147866.01 | 45.0 | 6.6 | 6.8 | 158.8 | 120.4 | 108.2 | 119.6 | 11.3 | - | - | 11.3 | - | - |
| 199-K-126 | 570574.73 | 148509.65 | 17.0 | 8.0 | 2.1 | 49.4 | 120.1 | 114.0 | 119.3 | 5.3 | - | - | 5.3 | - | - |
| 199-K-127 | 569539.23 | 147539.00 | 52.5 | 7.3 | 7.2 | 167.2 | 120.0 | 101.7 | 119.5 | 17.9 | - | - | 17.9 | - | - |
| 199-K-130 | 570478.99 | 148661.18 | 20.0 | 3.7 | 5.4 | 126.7 | 119.7 | 110.5 | 119.5 | 9.0 | - | - | 9.0 | - | - |
| 199-K-131 | 570662.00 | 148903.85 | 22.0 | 2.2 | 10.0 | 232.5 | 118.6 | 109.5 | 118.5 | 9.0 | - | - | 9.0 | - | - |
| 199-K-132 | 568495.12 | 146670.82 | 35.0 | 11.2 | 3.1 | 72.6 | 120.7 | 113.1 | 118.6 | 5.5 | - | - | 5.5 | - | - |
| 199-K-138 | 568395.22 | 146616.64 | 28.0 | 2.8 | 10.0 | 232.5 | 119.5 | 108.8 | 119.5 | 10.7 | - | - | 10.7 | - | - |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, m²/d) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-139 | 568551.39 | 146518.39 | 29.7 | 4.5 | 6.7 | 154.8 | 123.4 | 112.8 | 119.3 | 6.5 | - | - | 6.5 | - | - |
| 199-K-141 | 569024.22 | 146818.49 | 33.0 | 5.9 | 5.6 | 130.0 | 119.3 | 108.7 | 119.9 | 10.7 | - | - | 10.7 | - | - |
| 199-K-142 | 569104.26 | 146870.94 | 18.0 | 25.6 | 0.7 | 16.3 | 119.8 | 111.3 | 119.8 | 8.4 | - | - | 8.4 | - | - |
| 199-K-143 | 570934.41 | 148088.28 | 17.6 | 1.3 | 13.5 | 314.8 | 119.5 | 108.9 | 119.2 | 10.3 | - | - | 10.3 | - | - |
| 199-K-145 | 569284.60 | 147425.66 | 10.0 | 0.6 | 16.2 | 377.4 | 120.0 | 89.5 | 119.9 | 30.4 | - | - | 29.8 | 0.3 | 0.4 |
| 199-K-146 | 570197.60 | 148379.78 | 10.5 | 5.3 | 2.0 | 46.1 | 119.9 | 112.3 | 118.4 | 6.1 | - | - | 6.1 | - | - |
| 199-K-147 | 570411.64 | 148558.07 | 22.5 | 4.5 | 5.0 | 116.2 | 117.4 | 111.3 | 118.7 | 6.1 | - | - | 5.9 | 0.2 | - |
| 199-K-148 | 570584.74 | 148767.86 | 37.5 | 2.5 | 15.0 | 348.7 | 119.8 | 107.6 | 118.6 | 11.0 | - | - | 11.0 | - | - |
| 199-K-149 | 570778.25 | 148970.74 | 16.5 | 2.0 | 8.3 | 191.8 | 120.2 | 108.0 | 117.7 | 9.7 | - | - | 9.7 | - | - |
| 199-K-150 | 570787.67 | 149051.93 | 12.0 | 0.7 | 18.5 | 429.2 | 120.5 | 105.2 | 118.7 | 13.5 | - | - | 13.4 | - | 0.1 |
| 199-K-151 | 570941.32 | 148686.44 | 43.0 | 0.1 | 430.0 | 9,997.1 | 126.2 | 104.9 | 118.9 | 14.0 | - | - | 14.0 | - | - |
| 199-K-152 | 570736.25 | 148585.89 | 27.3 | 2.4 | 11.6 | 270.1 | 128.2 | 105.3 | 117.9 | 12.5 | - | - | 12.5 | - | - |
| 199-K-153 | 570530.04 | 148210.08 | 20.0 | 0.9 | 23.5 | 547.0 | 128.3 | 106.9 | 119.1 | 12.1 | - | - | 12.1 | - | - |
| 199-K-154 | 570321.06 | 148027.01 | 18.8 | 0.2 | 98.7 | 2,294.3 | 124.4 | 106.1 | 119.3 | 13.2 | - | - | 13.2 | - | - |
| 199-K-158 | 568627.45 | 146164.41 | 30.0 | 0.2 | 150.0 | 3,487.3 | 126.6 | 112.9 | 121.2 | 8.4 | - | - | 8.4 | - | - |
| 199-K-159 | 570911.73 | 149159.61 | 21.4 | 1.9 | 11.3 | 261.9 | 126.9 | 105.6 | 122.6 | 17.1 | - | 6.1 | 10.9 | - | - |
| 199-K-160 | 570919.58 | 149116.02 | 20.0 | 1.5 | 13.3 | 310.0 | 126.1 | 104.8 | 122.7 | 17.9 | 0.1 | 5.9 | 11.8 | - | 0.1 |
| 199-K-161 | 570004.64 | 148202.30 | 30.0 | 4.2 | 7.1 | 166.1 | 119.3 | 111.7 | 118.5 | 6.8 | 0.1 | - | 6.7 | - | - |
| 199-K-163 | 570230.66 | 147947.93 | 31.6 | 2.1 | 15.4 | 358.4 | 126.8 | 105.4 | 119.1 | 13.6 | - | - | 13.6 | - | - |
| 199-K-164 | 571202.22 | 148903.74 | 15.8 | 1.1 | 14.1 | 328.0 | 127.9 | 106.6 | 122.4 | 15.8 | 1.3 | - | 14.6 | - | - |
| 199-K-165 | 568674.96 | 146342.42 | 20.0 | 0.5 | 40.0 | 930.0 | 128.4 | 94.9 | 119.9 | 25.0 | - | - | 25.0 | - | - |
| 199-K-166 | 568594.56 | 146342.97 | 18.8 | 0.2 | 110.3 | 2,564.2 | 124.4 | 93.9 | 121.1 | 27.2 | - | - | 27.2 | - | - |
| 199-K-168 | 568544.37 | 146513.63 | 12.5 | 1.9 | 6.4 | 150.0 | 111.9 | 93.7 | 117.8 | 18.2 | - | - | 16.4 | 1.7 | 0.1 |
| 199-K-169 | 569988.97 | 147554.98 | 17.6 | 1.2 | 14.7 | 341.8 | 132.1 | 101.6 | 125.8 | 24.2 | 3.8 | - | 20.4 | - | - |
| 199-K-170 | 570009.01 | 147491.37 | 17.7 | 1.5 | 12.2 | 283.0 | 135.0 | 98.4 | 126.2 | 27.7 | - | - | 27.7 | - | - |
| 199-K-171 | 570544.03 | 147187.86 | 17.7 | 0.5 | 39.2 | 911.9 | 135.7 | 99.1 | 121.7 | 22.6 | - | - | 22.4 | - | 0.2 |
| 199-K-172 | 570871.69 | 147166.37 | 14.0 | 1.0 | 13.5 | 313.3 | 134.5 | 104.0 | 125.7 | 21.7 | - | - | 21.7 | - | - |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, $m^2/d$) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-173 | 568674.07 | 146266.88 | 15.7 | 0.9 | 16.7 | 388.3 | 126.4 | 108.1 | 121.7 | 13.5 | - | - | 13.5 | - | - |
| 199-K-174 | 568915.38 | 146222.47 | 17.6 | 2.0 | 8.8 | 205.6 | 127.4 | 109.1 | 126.6 | 17.4 | - | - | 17.4 | - | - |
| 199-K-179 | 569847.25 | 147481.92 | 40.0 | 2.9 | 13.8 | 320.7 | 127.0 | 96.6 | 125.4 | 28.9 | - | - | 28.2 | - | 0.7 |
| 199-K-180 | 571116.08 | 147449.14 | 19.4 | 2.0 | 9.7 | 225.5 | 127.7 | 100.2 | 120.6 | 20.4 | - | - | 20.0 | 0.4 | - |
| 199-K-181 | 568849.75 | 146892.82 | 17.6 | 0.8 | 23.2 | 538.4 | 125.0 | 106.7 | 117.8 | 11.1 | - | - | 11.1 | - | - |
| 199-K-182 | 571185.32 | 148350.24 | 23.1 | 3.8 | 6.2 | 143.2 | 125.9 | 106.0 | 119.9 | 13.8 | - | - | 13.8 | - | - |
| 199-K-198 | 569304.19 | 147551.86 | 24.0 | 2.0 | 11.8 | 273.5 | 119.4 | 107.2 | 122.0 | 12.2 | 12.2 | - | - | - | - |
| 199-K-29 | 569205.08 | 146790.13 | 8.0 | 3.0 | 2.7 | 62.2 | 122.7 | 116.6 | 121.3 | 4.7 | - | - | 4.7 | - | - |
| 199-N-14 | 571713.10 | 150243.37 | 10.0 | 1.1 | 9.2 | 213.3 | 120.4 | 114.3 | 118.4 | 4.0 | - | - | 4.0 | - | - |
| 199-N-141 | 571303.97 | 149909.49 | 8.0 | 8.0 | 1.0 | 23.2 | 120.1 | 114.9 | 119.6 | 4.7 | 2.2 | - | 2.5 | - | - |
| 199-N-142 | 571310.19 | 149916.16 | 10.0 | 6.5 | 1.5 | 35.7 | 120.1 | 114.9 | 119.7 | 4.8 | 2.0 | - | 2.7 | - | - |
| 199-N-147 | 571338.34 | 149946.51 | 8.6 | 1.0 | 8.9 | 206.6 | 120.1 | 114.9 | 118.3 | 3.4 | 1.4 | - | 2.1 | - | - |
| 199-N-159 | 571340.00 | 149942.84 | 8.1 | 7.4 | 1.1 | 25.6 | 116.8 | 114.7 | 118.1 | 2.1 | - | - | 2.1 | - | - |
| 199-N-160 | 571333.43 | 149938.01 | 7.5 | 5.1 | 1.5 | 34.1 | 116.8 | 114.6 | 118.2 | 2.1 | 0.0 | - | 2.1 | - | - |
| 199-N-161 | 571326.49 | 149932.43 | 15.0 | 6.4 | 2.3 | 54.3 | 116.8 | 114.7 | 118.4 | 2.1 | - | - | 2.1 | - | - |
| 199-N-162 | 571319.68 | 149926.60 | 6.8 | 4.8 | 1.4 | 32.7 | 117.0 | 114.9 | 118.3 | 2.1 | - | - | 2.1 | - | - |
| 199-N-20 | 571200.98 | 149660.67 | 5.0 | 1.3 | 3.9 | 91.5 | 136.5 | 116.3 | 117.8 | 1.4 | - | - | 1.4 | - | - |
| 199-N-201 | 571198.46 | 149759.46 | 1.2 | 0.6 | 2.0 | 47.3 | 118.1 | 116.0 | 117.5 | 1.5 | - | - | 1.5 | - | - |
| 199-N-209 | 571216.09 | 149791.71 | 1.3 | 1.3 | 1.0 | 22.7 | 118.0 | 115.8 | 117.5 | 1.6 | - | - | 1.6 | - | - |
| 199-N-21 | 571177.78 | 149629.41 | 11.0 | 3.0 | 3.7 | 86.7 | 135.9 | 115.9 | 118.3 | 2.3 | - | - | 2.3 | - | - |
| 199-N-248 | 571383.91 | 149997.93 | 1.2 | 0.5 | 2.5 | 58.4 | 117.0 | 114.8 | 117.4 | 2.1 | - | - | 2.1 | - | - |
| 199-N-250 | 571388.88 | 150005.61 | 1.2 | 0.4 | 2.7 | 63.8 | 116.7 | 114.6 | 117.4 | 2.1 | - | - | 2.1 | - | - |
| 199-N-252 | 571394.10 | 150013.22 | 1.2 | 0.3 | 3.7 | 85.0 | 116.8 | 114.7 | 117.5 | 2.1 | - | - | 2.1 | - | - |
| 199-N-260 | 571413.69 | 150043.62 | 2.3 | 1.0 | 2.2 | 51.7 | 116.5 | 114.4 | 117.8 | 2.1 | 1.3 | - | 0.8 | - | - |
| 199-N-262 | 571418.51 | 150051.20 | 2.3 | 0.5 | 5.0 | 117.3 | 116.5 | 114.3 | 117.2 | 2.2 | - | - | 2.2 | - | - |
| 199-N-266 | 571428.76 | 150067.07 | 2.4 | 0.7 | 3.6 | 82.8 | 116.5 | 114.4 | 117.5 | 2.1 | - | - | 2.1 | - | - |
| 199-N-27 | 572052.62 | 149659.79 | 10.0 | 1.0 | 10.4 | 242.2 | 127.9 | 116.6 | 119.4 | 2.8 | - | - | 2.8 | - | - |

Table D-2. Transmissivity Estimates from Specific Capacity Calculations

| Well Name | Easting (m) | Northing (m) | Pumping Rate during Drawdown Test (gpm) | Drawdown (ft) | Specific Capacity (SC, gpm/ft) | Transmissivity (T=1.3*SC, $m^2/d$) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Calculated Saturated Thickness in Hanford Formation (m) | Calculated Saturated Thickness in Reworked Ringold E Formation (m) | Calculated Saturated Thickness in Ringold E Formation (m) | Calculated Saturated Thickness in Reworked RUM Formation (m) | Calculated Saturated Thickness in RUM Formation (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-N-270 | 571438.52 | 150082.34 | 2.4 | 0.8 | 3.0 | 69.7 | 116.3 | 114.2 | 117.6 | 2.1 | - | - | 2.1 | - | - |
| 199-N-276 | 571450.74 | 150106.59 | 2.3 | 0.9 | 2.5 | 58.6 | 116.5 | 114.4 | 117.4 | 2.1 | 2.1 | - | 0.0 | - | - |
| 199-N-280 | 571457.93 | 150122.77 | 2.4 | 0.6 | 4.4 | 103.1 | 116.2 | 114.1 | 117.5 | 2.1 | - | - | 2.1 | - | - |
| 199-N-29 | 571841.35 | 149489.23 | 7.0 | 0.6 | 11.1 | 258.3 | 128.5 | 117.4 | 119.7 | 2.3 | - | - | 2.3 | - | - |
| 199-N-310 | 571542.79 | 150228.42 | 2.0 | 1.2 | 1.7 | 38.7 | 116.5 | 114.4 | 117.2 | 2.1 | - | - | 2.1 | - | - |
| 199-N-312 | 571548.23 | 150235.72 | 2.0 | 0.4 | 4.6 | 107.1 | 116.3 | 114.1 | 117.2 | 2.1 | - | - | 2.1 | - | - |
| 199-N-318 | 571563.67 | 150258.74 | 2.0 | 0.8 | 2.6 | 59.6 | 116.4 | 114.3 | 117.2 | 2.1 | - | - | 2.1 | - | - |
| 199-N-32 | 571907.62 | 149708.50 | 5.0 | 3.7 | 1.3 | 31.2 | 128.6 | 117.6 | 118.3 | 0.7 | - | - | 0.7 | - | - |
| 199-N-322 | 571572.74 | 150274.27 | 2.0 | 0.6 | 3.6 | 83.0 | 116.5 | 114.4 | 117.2 | 2.1 | - | - | 2.1 | - | - |
| 199-N-334 | 571600.32 | 150322.03 | 2.1 | 0.5 | 4.1 | 96.3 | 116.9 | 114.7 | 117.3 | 2.1 | - | - | 2.1 | - | - |
| 199-N-346 | 571203.32 | 149780.23 | 2.1 | 1.1 | 2.0 | 45.9 | 118.3 | 116.2 | 117.5 | 1.3 | - | - | 1.3 | - | - |
| 199-N-348 | 571248.28 | 149845.23 | 2.2 | 1.3 | 1.7 | 40.0 | 117.9 | 115.7 | 117.5 | 1.7 | - | - | 1.7 | - | - |
| 199-N-349 | 571267.16 | 149866.13 | 2.0 | 0.8 | 2.5 | 57.8 | 117.8 | 115.7 | 117.4 | 1.7 | - | - | 1.7 | - | - |
| 199-N-357 | 571456.35 | 150125.44 | 2.2 | 1.8 | 1.2 | 28.4 | 116.4 | 114.2 | 117.4 | 2.1 | 1.4 | - | 0.7 | - | - |
| 199-N-358 | 571466.28 | 150148.67 | 2.4 | 1.1 | 2.1 | 49.8 | 116.3 | 114.2 | 117.4 | 2.1 | 0.8 | - | 1.4 | - | - |
| 199-N-359 | 571484.18 | 150168.77 | 2.1 | 0.8 | 2.8 | 65.5 | 116.6 | 114.5 | 118.2 | 2.1 | - | - | 2.1 | - | - |
| 199-N-363 | 571554.65 | 150249.90 | 2.1 | 0.2 | 13.4 | 311.0 | 116.6 | 114.4 | 117.2 | 2.1 | - | - | 2.1 | - | - |
| 199-N-43 | 572366.18 | 150139.95 | 3.0 | 0.4 | 7.5 | 174.4 | 122.5 | 116.4 | 118.2 | 1.8 | - | - | 1.8 | - | - |
| 199-N-76 | 571560.08 | 150122.12 | 15.5 | 4.6 | 3.4 | 78.0 | 119.2 | 113.1 | 118.4 | 5.2 | - | - | 5.2 | - | - |
| 199-N-77 | 571309.79 | 149243.05 | 14.3 | 3.8 | 3.8 | 88.4 | 114.2 | 111.2 | 119.4 | 3.0 | - | - | 3.0 | - | - |

gpm = gallons per minute
RUM = Ringold Upper Mud

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2/d$) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-B2-13 | 564086.52 | 145264.56 | 123.30 | 116.96 | 120.7 | 3.8 | 69.4 | 18.3 | 18.3 | - | - | - |
| 199-B2-14 | 565095.99 | 145232.26 | 121.53 | 113.91 | 120.3 | 6.4 | 77.0 | 12.0 | - | - | 12.0 | - |
| 199-B2-16 | 564915.00 | 145190.68 | 99.21 | 88.54 | 120.7 | 10.7 | 68.3 | 6.4 | - | - | 6.4 | - |
| 199-B3-46 | 565899.57 | 145369.04 | 121.20 | 114.86 | 120.2 | 5.4 | 23.0 | 4.3 | 27.2 | - | 2.3 | - |
| 199-B3-47 | 565388.66 | 145368.95 | 122.24 | 115.81 | 120.7 | 4.9 | 78.2 | 16.0 | 24.8 | - | 2.0 | - |
| 199-B3-51 | 565379.25 | 145362.36 | 91.71 | 88.66 | 120.6 | 3.1 | 7.6 | 2.5 | - | - | 2.5 | - |
| 199-B4-9 | 565395.64 | 144563.93 | 125.52 | 119.42 | 121.5 | 2.1 | 3,874.8 | 1,842.4 | 1,842.4 | - | - | - |
| 199-B5-2 | 565405.43 | 144939.70 | 123.34 | 117.25 | 121.3 | 4.1 | 2,886.7 | 712.1 | 751.2 | - | 57.8 | - |
| 199-B5-5 | 564721.99 | 144955.49 | 99.10 | 79.29 | 120.0 | 19.8 | 297.2 | 15.0 | - | - | 15.0 | - |
| 199-B5-6 | 564967.70 | 144316.44 | 94.71 | 87.06 | 121.4 | 7.7 | 69.6 | 9.1 | - | - | 9.1 | - |
| 199-B9-2 | 565534.79 | 144078.08 | 124.18 | 118.08 | 122.5 | 4.4 | 4,689.7 | 1,073.0 | 1,073.0 | - | - | - |
| 199-B9-3 | 565667.36 | 144046.72 | 124.41 | 118.32 | 121.5 | 3.2 | 5,622.4 | 1,743.5 | 1,743.5 | - | - | - |
| 199-D2-10 | 574470.87 | 153465.19 | 117.29 | 112.72 | 118.6 | 4.6 | 77.5 | 17.0 | 17.0 | - | - | - |
| 199-D2-11 | 573328.16 | 151120.73 | 119.05 | 109.89 | 118.9 | 9.0 | 564.8 | 63.0 | 172.4 | 69.0 | 57.0 | - |
| 199-D2-12 | 574343.45 | 153300.01 | 116.96 | 112.39 | 118.7 | 4.6 | 783.2 | 171.3 | 171.3 | - | - | - |
| 199-D2-5 | 573812.30 | 151148.18 | 130.33 | 115.09 | 119.1 | 4.0 | 731.6 | 182.0 | 429.8 | - | 141.1 | - |
| 199-D2-6 | 573000.21 | 151119.86 | 119.82 | 113.48 | 118.4 | 4.9 | 58.4 | 12.0 | - | - | 12.0 | - |
| 199-D3-4 | 572468.16 | 151170.97 | 118.17 | 109.04 | 118.0 | 8.9 | 178.7 | 20.0 | - | - | 20.4 | 7.1 |
| 199-D3-5 | 572787.66 | 150994.54 | 121.56 | 112.41 | 118.2 | 5.7 | 315.9 | 55.0 | 156.7 | - | 51.3 | 17.8 |
| 199-D4-1 | 572752.85 | 151558.89 | 120.49 | 114.39 | 116.7 | 2.3 | 54.0 | 23.0 | - | - | 23.0 | - |
| 199-D4-11 | 572768.94 | 151554.14 | 118.93 | 114.36 | 116.7 | 2.4 | 28.6 | 12.0 | - | - | 12.0 | - |
| 199-D4-12 | 572771.58 | 151562.08 | 118.67 | 114.10 | 116.8 | 2.7 | 58.6 | 22.0 | - | - | 22.0 | - |
| 199-D4-14 | 572839.81 | 151641.64 | 120.28 | 114.17 | 117.6 | 3.4 | 109.8 | 32.2 | - | - | 32.2 | - |
| 199-D4-15 | 572936.64 | 151424.86 | 119.99 | 113.90 | 117.7 | 3.8 | 996.4 | 263.9 | - | - | 263.9 | - |
| 199-D4-2 | 572768.37 | 151543.96 | 118.25 | 113.69 | 116.8 | 3.1 | 55.7 | 18.0 | - | - | 18.0 | - |
| 199-D4-23 | 572672.46 | 151592.87 | 120.79 | 114.70 | 117.5 | 2.8 | 37.7 | 13.3 | - | - | 13.3 | - |
| 199-D4-24 | 572699.89 | 151471.43 | 118.80 | 114.23 | 117.1 | 2.8 | 35.9 | 12.7 | - | - | 12.7 | - |
| 199-D4-25 | 572711.44 | 151476.24 | 117.93 | 113.34 | 117.3 | 3.9 | 77.5 | 19.7 | - | - | 19.7 | - |
| 199-D4-29 | 572736.86 | 151510.69 | 118.65 | 114.07 | 117.8 | 3.7 | 35.1 | 9.4 | - | - | 10.2 | 3.9 |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2$/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D4-3 | 572766.08 | 151546.12 | 118.21 | 113.65 | 116.7 | 3.1 | 55.7 | 18.0 | - | - | 19.3 | 6.9 |
| 199-D4-30 | 572737.44 | 151523.22 | 119.18 | 114.60 | 117.9 | 3.3 | 70.5 | 21.2 | - | - | 21.2 | - |
| 199-D4-35 | 572806.31 | 151602.28 | 118.73 | 114.15 | 118.6 | 4.5 | 266.1 | 59.7 | - | - | 61.9 | 21.4 |
| 199-D4-39 | 572747.45 | 151650.84 | 120.57 | 114.47 | 117.6 | 3.1 | 48.9 | 15.5 | - | - | 15.5 | - |
| 199-D4-4 | 572754.61 | 151571.61 | 119.75 | 113.66 | 116.7 | 3.1 | 98.7 | 32.0 | - | - | 36.4 | 12.6 |
| 199-D4-41 | 572834.11 | 151634.66 | 118.42 | 113.85 | 118.3 | 4.4 | 158.5 | 36.0 | - | - | 36.7 | 12.8 |
| 199-D4-61 | 572620.66 | 151363.70 | 116.83 | 112.31 | 117.3 | 4.5 | 40.6 | 9.0 | - | - | 14.0 | 5.1 |
| 199-D4-62 | 572619.52 | 151351.07 | 117.71 | 110.14 | 117.4 | 7.3 | 47.4 | 6.5 | - | - | 18.2 | 6.2 |
| 199-D4-68 | 572581.32 | 151299.84 | 118.52 | 109.39 | 117.9 | 8.5 | 142.3 | 16.7 | - | - | 19.5 | 6.8 |
| 199-D4-69 | 572569.00 | 151295.69 | 117.74 | 110.13 | 118.7 | 7.6 | 121.5 | 16.0 | - | - | 18.1 | 6.4 |
| 199-D4-7 | 572760.87 | 151551.25 | 118.98 | 114.42 | 116.7 | 2.3 | 39.5 | 17.0 | - | - | 17.0 | - |
| 199-D4-70 | 572568.79 | 151282.68 | 118.18 | 110.56 | 119.0 | 7.6 | 117.2 | 15.4 | - | - | 15.4 | - |
| 199-D4-71 | 572556.29 | 151278.50 | 118.92 | 109.86 | 118.8 | 8.9 | 353.2 | 39.7 | - | - | 40.0 | 13.9 |
| 199-D4-73 | 572542.17 | 151262.72 | 118.61 | 109.56 | 119.3 | 9.1 | 904.6 | 99.9 | - | - | 99.9 | - |
| 199-D4-74 | 572539.80 | 151249.80 | 118.23 | 109.18 | 113.8 | 4.6 | 208.9 | 45.4 | - | - | 45.4 | - |
| 199-D4-75 | 572527.76 | 151246.95 | 118.14 | 109.11 | 118.4 | 9.0 | 260.2 | 28.8 | - | - | 28.8 | - |
| 199-D4-76 | 572526.06 | 151234.24 | 118.24 | 109.18 | 118.5 | 9.1 | 1,092.0 | 120.5 | - | - | 120.5 | - |
| 199-D4-78 | 572511.28 | 151218.26 | 118.31 | 109.25 | 117.9 | 8.7 | 480.5 | 55.4 | - | - | 55.4 | - |
| 199-D4-79 | 572498.24 | 151214.02 | 118.84 | 109.78 | 118.7 | 8.9 | 1,310.4 | 146.9 | - | - | 146.9 | - |
| 199-D4-8 | 572763.30 | 151552.65 | 120.18 | 114.20 | 116.7 | 2.5 | 27.9 | 11.0 | - | - | 11.9 | 4.5 |
| 199-D4-80 | 572496.87 | 151202.59 | 118.73 | 109.67 | 117.4 | 7.7 | 766.7 | 99.1 | - | - | 99.1 | - |
| 199-D4-81 | 572484.36 | 151199.64 | 118.56 | 109.50 | 117.9 | 8.4 | 2,131.1 | 252.7 | - | - | 252.7 | - |
| 199-D4-82 | 572470.26 | 151183.89 | 118.24 | 109.18 | 117.9 | 8.8 | 1,269.2 | 144.9 | - | - | 144.9 | - |
| 199-D4-83 | 572859.43 | 151723.42 | 119.42 | 114.85 | 117.3 | 2.4 | 133.6 | 54.7 | - | - | 94.4 | 32.7 |
| 199-D4-85 | 572486.16 | 151324.20 | 119.53 | 110.39 | 118.4 | 8.0 | 197.8 | 24.6 | - | - | 24.6 | - |
| 199-D4-86 | 572389.06 | 151202.14 | 119.20 | 110.08 | 118.4 | 8.3 | 1,654.3 | 199.5 | - | - | 199.5 | - |
| 199-D4-9 | 572758.20 | 151543.32 | 119.12 | 114.26 | 116.7 | 2.4 | 39.0 | 16.0 | - | - | 16.0 | - |
| 199-D4-95 | 572612.82 | 151226.70 | 119.24 | 108.57 | 118.5 | 9.9 | 125.1 | 12.7 | - | - | 12.8 | 4.5 |
| 199-D4-96 | 572777.03 | 151519.78 | 117.38 | 114.33 | 117.3 | 3.0 | 54.5 | 18.3 | - | - | 18.3 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2$/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D4-97 | 572906.23 | 151625.33 | 117.02 | 112.45 | 117.4 | 4.6 | 156.0 | 34.1 | - | - | 34.1 | - |
| 199-D4-98 | 572574.52 | 151481.65 | 118.66 | 112.56 | 117.2 | 4.6 | 940.0 | 204.3 | - | - | 204.3 | - |
| 199-D4-99 | 572527.36 | 151377.08 | 119.47 | 110.32 | 118.1 | 7.8 | 113.0 | 14.5 | - | - | 14.8 | 5.2 |
| 199-D5-101 | 572943.04 | 151521.52 | 120.59 | 111.44 | 117.6 | 6.2 | 579.3 | 94.1 | - | - | 98.3 | 33.8 |
| 199-D5-102 | 573428.15 | 151340.23 | 120.00 | 110.86 | 119.0 | 8.2 | 123.4 | 15.1 | - | - | 15.1 | - |
| 199-D5-103 | 573505.87 | 151460.87 | 119.13 | 110.05 | 119.4 | 9.1 | 281.6 | 31.0 | - | - | 31.3 | 10.9 |
| 199-D5-104 | 573265.48 | 151422.43 | 119.66 | 110.52 | 118.3 | 7.8 | 121.6 | 15.7 | - | - | 16.0 | 5.6 |
| 199-D5-108 | 572923.34 | 151222.90 | 118.84 | 112.74 | 117.9 | 5.2 | 105.7 | 20.5 | - | - | 20.5 | - |
| 199-D5-110 | 572931.57 | 151277.61 | 119.58 | 113.48 | 117.9 | 4.4 | 138.0 | 31.5 | - | - | 33.1 | 11.5 |
| 199-D5-111 | 572943.24 | 151281.47 | 119.68 | 113.58 | 117.9 | 4.3 | 85.5 | 20.0 | - | - | 20.3 | 7.1 |
| 199-D5-113 | 572927.02 | 151288.45 | 114.98 | 113.45 | 119.6 | 1.5 | 73.2 | 48.0 | - | - | 48.0 | - |
| 199-D5-114 | 572918.04 | 151223.75 | 119.00 | 112.81 | 117.9 | 5.1 | 230.2 | 45.3 | - | - | 45.3 | - |
| 199-D5-115 | 572923.15 | 151221.12 | 119.00 | 112.90 | 117.9 | 5.0 | 218.6 | 43.5 | - | - | 43.5 | - |
| 199-D5-116 | 572926.93 | 151222.35 | 119.03 | 112.93 | 119.7 | 6.1 | 93.2 | 15.3 | - | - | 15.3 | - |
| 199-D5-118 | 572921.03 | 151224.45 | 114.44 | 112.95 | 119.7 | 1.5 | 65.9 | 44.1 | - | - | 44.1 | - |
| 199-D5-119 | 573306.17 | 151417.95 | 119.49 | 110.30 | 118.7 | 8.4 | 403.7 | 48.0 | - | - | 55.1 | 19.1 |
| 199-D5-120 | 573377.18 | 151406.84 | 119.82 | 110.63 | 118.1 | 7.5 | 193.4 | 25.8 | - | - | 25.8 | - |
| 199-D5-121 | 573430.24 | 151399.27 | 120.30 | 111.16 | 119.1 | 7.9 | 67.5 | 8.5 | - | - | 8.5 | - |
| 199-D5-122 | 573300.25 | 151349.29 | 119.98 | 110.79 | 118.7 | 8.0 | 405.9 | 51.0 | - | - | 51.0 | - |
| 199-D5-123 | 573824.21 | 151639.41 | 120.16 | 107.89 | 118.0 | 10.1 | 267.4 | 26.5 | - | - | 34.1 | 11.8 |
| 199-D5-125 | 573667.39 | 151746.18 | 119.91 | 111.33 | 118.1 | 6.7 | 83.0 | 12.3 | - | - | 13.1 | 4.7 |
| 199-D5-126 | 573705.71 | 151843.28 | 119.24 | 110.10 | 117.9 | 7.8 | 275.8 | 35.6 | - | - | 43.0 | 14.9 |
| 199-D5-127 | 572992.26 | 151428.31 | 119.63 | 113.54 | 117.6 | 4.0 | 109.1 | 27.1 | - | - | 27.1 | - |
| 199-D5-128 | 573622.40 | 151237.35 | 119.40 | 113.30 | 117.9 | 4.6 | 280.1 | 60.4 | - | - | 60.4 | - |
| 199-D5-129 | 573735.50 | 151465.13 | 119.56 | 111.93 | 117.8 | 5.9 | 1,265.5 | 214.7 | - | - | 225.8 | 77.1 |
| 199-D5-13 | 573535.53 | 151955.18 | 120.39 | 114.08 | 117.5 | 3.4 | 93.7 | 27.2 | - | - | 27.2 | - |
| 199-D5-130 | 574039.20 | 151928.51 | 118.31 | 113.73 | 117.4 | 3.7 | 50.5 | 13.6 | - | - | 13.6 | - |
| 199-D5-131 | 573684.39 | 152006.75 | 119.01 | 111.39 | 117.5 | 6.1 | 288.2 | 46.9 | - | - | 47.6 | 16.5 |
| 199-D5-132 | 573875.35 | 151586.87 | 119.72 | 112.10 | 119.6 | 7.4 | 141.5 | 19.0 | - | - | 19.0 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval (m²/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D5-133 | 573731.55 | 151497.37 | 120.58 | 111.44 | 120.5 | 9.1 | 345.8 | 38.0 | - | - | 39.3 | 13.7 |
| 199-D5-14 | 573789.63 | 151787.99 | 120.35 | 114.01 | 118.3 | 4.3 | 39.3 | 9.1 | - | - | 9.1 | - |
| 199-D5-140 | 573750.68 | 151778.82 | 119.17 | 111.54 | 118.0 | 6.4 | 58.4 | 9.1 | - | - | 9.3 | 3.4 |
| 199-D5-143 | 573701.53 | 151784.26 | 119.36 | 111.74 | 118.4 | 6.7 | 133.1 | 20.0 | - | - | 20.5 | 7.2 |
| 199-D5-144 | 573352.03 | 151404.83 | 121.37 | 110.70 | 118.8 | 8.1 | 187.3 | 23.0 | - | - | 23.3 | 8.1 |
| 199-D5-15 | 573738.61 | 151673.75 | 120.40 | 114.06 | 119.1 | 5.0 | 45.8 | 9.1 | - | - | 9.1 | - |
| 199-D5-16 | 573917.45 | 151652.51 | 120.86 | 114.61 | 119.1 | 4.4 | 13.8 | 3.1 | - | - | 3.1 | - |
| 199-D5-17 | 573730.52 | 151322.83 | 120.34 | 114.50 | 119.8 | 5.3 | 16.5 | 3.1 | - | - | 3.1 | - |
| 199-D5-18 | 573861.70 | 151325.18 | 121.82 | 114.17 | 119.5 | 5.3 | 95.3 | 18.0 | - | - | 18.0 | - |
| 199-D5-19 | 573849.12 | 151243.19 | 119.19 | 113.06 | 119.2 | 6.1 | 73.5 | 12.0 | - | - | 12.0 | - |
| 199-D5-20 | 573239.97 | 152030.15 | 119.74 | 113.40 | 117.2 | 3.8 | 45.0 | 12.0 | - | - | 12.0 | - |
| 199-D5-32 | 573372.04 | 151903.39 | 119.46 | 111.82 | 117.7 | 5.9 | 170.7 | 29.1 | - | - | 29.1 | - |
| 199-D5-34 | 573240.42 | 151554.12 | 120.32 | 112.69 | 118.1 | 5.4 | 251.2 | 46.8 | - | - | 46.8 | - |
| 199-D5-38 | 572996.82 | 151545.59 | 119.01 | 112.91 | 118.3 | 5.4 | 75.8 | 14.1 | - | - | 14.1 | - |
| 199-D5-39 | 573142.86 | 151428.43 | 119.59 | 113.48 | 118.5 | 5.0 | 107.6 | 21.6 | - | - | 21.6 | - |
| 199-D5-92 | 573131.93 | 152009.82 | 119.43 | 113.03 | 117.8 | 4.7 | 166.1 | 35.1 | - | - | 35.1 | - |
| 199-D5-97 | 573250.11 | 151302.47 | 119.34 | 110.20 | 118.7 | 8.5 | 351.3 | 41.3 | - | - | 42.1 | 14.6 |
| 199-D5-98 | 573369.56 | 151272.44 | 118.83 | 109.68 | 118.9 | 9.1 | 108.9 | 11.9 | - | - | 12.3 | 4.3 |
| 199-D5-99 | 573349.61 | 151402.01 | 119.82 | 110.64 | 118.8 | 8.2 | 228.5 | 28.0 | - | - | 28.5 | 9.9 |
| 199-D6-2 | 574544.61 | 151970.20 | 119.40 | 111.77 | 121.5 | 7.6 | 189.4 | 24.8 | - | - | 24.8 | - |
| 199-D6-3 | 574159.09 | 151643.85 | 120.73 | 113.11 | 119.0 | 5.9 | 70.9 | 12.0 | - | - | 12.0 | - |
| 199-D7-3 | 574151.38 | 152363.41 | 120.97 | 110.30 | 117.9 | 7.6 | 310.8 | 40.9 | 44.9 | - | 14.9 | 5.2 |
| 199-D7-6 | 574429.20 | 152980.43 | 120.31 | 114.19 | 117.8 | 3.6 | 946.9 | 263.0 | - | - | 263.0 | - |
| 199-D8-101 | 574069.46 | 152262.43 | 118.17 | 115.12 | 117.6 | 2.4 | 35.6 | 14.6 | 14.6 | - | - | - |
| 199-D8-3 | 573942.43 | 152347.93 | 127.21 | 113.80 | 117.4 | 3.6 | 2,020.9 | 560.0 | 1,191.2 | - | 390.0 | - |
| 199-D8-53 | 573889.86 | 152452.26 | 119.18 | 112.93 | 117.2 | 4.3 | 698.5 | 162.0 | 249.8 | - | 81.2 | - |
| 199-D8-54A | 573781.17 | 152408.03 | 119.23 | 112.80 | 117.2 | 4.4 | 532.5 | 122.0 | 164.7 | - | 53.5 | - |
| 199-D8-55 | 573620.95 | 152364.35 | 118.66 | 112.41 | 117.2 | 4.8 | 29.5 | 6.1 | - | - | 7.4 | 3.1 |
| 199-D8-6 | 573434.69 | 152060.82 | 118.75 | 112.56 | 118.7 | 6.1 | 136.0 | 22.3 | - | - | 22.3 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval (m²/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-D8-68 | 573711.67 | 152427.10 | 120.19 | 112.57 | 119.8 | 7.2 | 6,264.3 | 871.7 | 1,046.9 | - | 335.1 | - |
| 199-D8-69 | 573843.61 | 152552.20 | 119.22 | 113.13 | 117.4 | 4.3 | 1,1275.8 | 2,639.6 | 2,639.6 | - | - | - |
| 199-D8-70 | 573942.10 | 152508.74 | 119.45 | 110.31 | 117.3 | 7.0 | 4,696.3 | 667.5 | 720.4 | - | 226.1 | 15.4 |
| 199-D8-71 | 573837.10 | 152429.39 | 119.70 | 110.55 | 117.2 | 6.7 | 256.3 | 38.3 | 47.2 | - | 15.6 | 5.5 |
| 199-D8-89 | 573478.64 | 152249.65 | 117.66 | 114.61 | 116.9 | 2.3 | 92.0 | 40.2 | - | - | 40.2 | - |
| 199-D8-90 | 573948.64 | 152646.23 | 118.52 | 110.89 | 117.0 | 6.1 | 63.7 | 10.5 | 10.5 | - | - | - |
| 199-D8-91 | 574036.89 | 152741.44 | 117.52 | 111.42 | 117.5 | 6.1 | 124.1 | 20.5 | 21.6 | - | 7.2 | - |
| 199-D8-95 | 573611.96 | 152160.61 | 118.95 | 112.86 | 117.5 | 4.6 | 103.6 | 22.5 | - | - | 22.5 | - |
| 199-D8-96 | 573706.00 | 152152.24 | 119.12 | 113.02 | 117.5 | 4.5 | 79.8 | 17.9 | - | - | 17.9 | - |
| 199-D8-97 | 573859.56 | 152087.42 | 120.77 | 111.62 | 121.9 | 9.2 | 79.0 | 8.6 | 26.5 | - | 8.3 | 3.0 |
| 199-D8-98 | 574013.12 | 152123.02 | 120.37 | 112.74 | 117.4 | 4.7 | 125.8 | 26.9 | 29.2 | - | 9.7 | - |
| 199-D8-99 | 574006.77 | 152364.37 | 119.80 | 112.17 | 125.1 | 7.6 | 86.0 | 11.3 | 21.6 | - | 7.1 | - |
| 199-F1-2 | 580011.04 | 148805.30 | 115.43 | 110.86 | 112.4 | 1.5 | 55.7 | 37.0 | 37.0 | - | - | - |
| 199-F5-42 | 581285.48 | 147834.82 | 114.70 | 108.60 | 112.2 | 3.6 | 64.1 | 18.0 | 18.0 | - | - | - |
| 199-F5-43A | 581183.87 | 147948.07 | 114.48 | 108.39 | 112.5 | 4.1 | 106.2 | 26.0 | 26.0 | - | - | - |
| 199-F5-44 | 581060.85 | 148043.20 | 114.41 | 108.31 | 112.4 | 4.1 | 57.8 | 14.0 | 14.0 | - | - | - |
| 199-F5-45 | 580706.88 | 147683.92 | 115.24 | 110.58 | 112.6 | 2.0 | 18.2 | 9.1 | 9.1 | - | - | - |
| 199-F5-46 | 580841.34 | 147781.51 | 114.15 | 110.18 | 112.3 | 2.1 | 103.1 | 48.0 | 48.0 | - | - | - |
| 199-F5-47 | 580495.51 | 147508.45 | 115.77 | 109.67 | 113.1 | 3.4 | 78.1 | 23.0 | 23.0 | - | - | - |
| 199-F5-48 | 580517.58 | 147690.10 | 115.71 | 111.04 | 112.8 | 1.8 | 35.1 | 20.0 | - | - | 20.0 | - |
| 199-F5-52 | 580672.81 | 148143.82 | 115.45 | 109.36 | 112.4 | 3.0 | 69.1 | 23.0 | 23.0 | - | - | - |
| 199-F5-54 | 581145.51 | 147576.44 | 115.00 | 108.91 | 112.5 | 3.6 | 123.1 | 34.0 | 34.0 | - | - | - |
| 199-F5-55 | 581076.10 | 147797.57 | 114.71 | 111.66 | 114.3 | 2.7 | 99.4 | 37.5 | 37.5 | - | - | - |
| 199-F5-56 | 580440.62 | 147556.36 | 115.28 | 112.23 | 114.0 | 1.7 | 156.1 | 89.9 | 102.6 | - | 33.4 | - |
| 199-F6-1 | 581375.87 | 147564.51 | 114.70 | 108.60 | 112.0 | 3.4 | 71.6 | 21.3 | 21.3 | - | - | - |
| 199-F7-1 | 579687.17 | 147022.43 | 116.44 | 111.87 | 115.3 | 3.4 | 761.3 | 225.0 | 355.8 | - | 115.5 | - |
| 199-F7-3 | 579884.71 | 147112.53 | 115.29 | 110.72 | 113.9 | 3.1 | 62.8 | 20.0 | - | - | 20.0 | - |
| 199-F8-3 | 580253.99 | 147253.37 | 115.55 | 112.50 | 113.5 | 1.0 | 61.6 | 63.0 | - | - | 63.0 | - |
| 199-F8-4 | 580958.51 | 147123.53 | 114.35 | 111.30 | 112.2 | 0.9 | 9.5 | 11.0 | 11.0 | - | - | - |

**Table D-3. Unit-Wise Hydraulic Conductivity Estimates**

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval (m²/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H1-1 | 576702.31 | 153384.49 | 118.03 | 113.46 | 117.7 | 4.3 | 5,579.8 | 1,304.9 | 1,836.6 | - | 588.8 | - |
| 199-H1-20 | 575706.04 | 154183.61 | 117.63 | 111.53 | 116.5 | 5.0 | 4,989.6 | 1,000.2 | 1,000.2 | - | - | - |
| 199-H1-21 | 575896.84 | 154163.80 | 116.17 | 111.60 | 116.5 | 4.6 | 367.9 | 80.4 | - | - | 80.4 | - |
| 199-H1-32 | 576767.07 | 153766.00 | 120.60 | 114.50 | 116.5 | 2.0 | 77.5 | 39.4 | 55.6 | 22.5 | 18.6 | - |
| 199-H1-33 | 576833.29 | 153716.23 | 119.08 | 114.50 | 116.5 | 2.0 | 303.2 | 152.4 | 224.5 | 88.3 | 71.9 | - |
| 199-H1-35 | 576958.26 | 153628.14 | 117.80 | 113.23 | 116.1 | 2.9 | 871.8 | 303.2 | 628.6 | 246.0 | 198.9 | 68.0 |
| 199-H1-36 | 576885.62 | 153486.51 | 118.45 | 113.87 | 116.3 | 2.4 | 86.5 | 35.3 | - | 41.2 | 34.0 | - |
| 199-H1-37 | 577106.92 | 153641.63 | 118.28 | 113.70 | 116.5 | 2.8 | 269.5 | 94.8 | 97.4 | 38.8 | - | - |
| 199-H1-42 | 577127.18 | 153391.65 | 116.04 | 112.99 | 116.0 | 3.0 | 281.6 | 92.6 | 215.9 | 86.5 | 70.4 | - |
| 199-H1-43 | 577213.74 | 153384.28 | 115.59 | 112.55 | 116.8 | 3.0 | 1,564.7 | 513.3 | 535.7 | 209.7 | - | - |
| 199-H1-45 | 577240.96 | 153062.41 | 116.05 | 111.47 | 117.0 | 4.6 | 1,464.7 | 319.9 | 319.9 | - | - | - |
| 199-H1-5 | 574850.72 | 153090.30 | 119.09 | 111.47 | 117.6 | 6.1 | 172.1 | 28.3 | 31.3 | - | 10.4 | - |
| 199-H3-11 | 577786.74 | 152490.41 | 117.39 | 114.33 | 116.8 | 2.5 | 164.1 | 66.4 | 66.4 | - | - | - |
| 199-H3-25 | 577410.36 | 152978.49 | 117.52 | 111.42 | 115.0 | 3.5 | 6,986.3 | 1,974.2 | 1,974.2 | - | - | - |
| 199-H3-26 | 577440.83 | 152846.50 | 116.65 | 112.07 | 116.4 | 4.3 | 5,395.4 | 1,245.8 | 1,245.8 | - | - | - |
| 199-H3-27 | 577567.05 | 152811.14 | 117.45 | 111.36 | 118.2 | 6.1 | 94.4 | 15.5 | 15.5 | - | - | - |
| 199-H3-2A | 577624.61 | 152750.07 | 117.08 | 112.51 | 115.2 | 2.7 | 1,581.3 | 579.0 | 579.0 | - | - | - |
| 199-H3-2B | 577628.27 | 152757.16 | 113.48 | 111.95 | 115.0 | 1.5 | 45.7 | 30.0 | 30.0 | - | - | - |
| 199-H3-4 | 577544.29 | 152293.21 | 120.06 | 112.44 | 116.1 | 3.7 | 27,123.8 | 7,328.7 | 8,491.9 | 2,992.7 | 2,266.9 | 756.6 |
| 199-H3-5 | 577454.70 | 152287.50 | 118.37 | 112.27 | 116.9 | 4.6 | 10,613.7 | 2,290.9 | 5,896.9 | 2,340.4 | 1,954.2 | 655.8 |
| 199-H3-6 | 578266.47 | 152425.33 | 118.02 | 111.92 | 114.0 | 2.1 | 78.8 | 38.0 | 43.4 | 17.6 | - | - |
| 199-H3-7 | 577931.74 | 152279.97 | 117.71 | 113.14 | 114.6 | 1.5 | 40.2 | 27.0 | 27.0 | - | - | - |
| 199-H4-10 | 577827.21 | 153155.81 | 117.45 | 112.88 | 114.5 | 1.6 | 2,893.6 | 1,798.0 | 1,798.0 | - | - | - |
| 199-H4-11 | 578141.91 | 152728.43 | 116.10 | 111.53 | 114.4 | 2.9 | 51.1 | 17.7 | - | - | 18.6 | 6.6 |
| 199-H4-12A | 578009.15 | 152912.73 | 116.41 | 111.84 | 114.4 | 2.5 | 169.8 | 67.1 | 82.1 | - | 26.8 | - |
| 199-H4-12B | 578004.39 | 152918.47 | 113.51 | 111.98 | 114.4 | 1.5 | 22.9 | 15.0 | 24.6 | - | 9.2 | - |
| 199-H4-13 | 578219.30 | 152595.27 | 117.37 | 112.80 | 114.8 | 2.0 | 256.7 | 128.0 | - | 141.5 | 115.3 | - |
| 199-H4-14 | 577803.75 | 152752.36 | 117.79 | 113.22 | 115.2 | 2.0 | 152.2 | 76.0 | - | - | 76.0 | - |
| 199-H4-15A | 577904.31 | 153053.42 | 117.07 | 112.50 | 114.5 | 2.0 | 95.6 | 48.0 | 87.7 | - | 28.6 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2/d$) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-H4-15B | 577899.60 | 153059.55 | 113.93 | 112.41 | 114.1 | 1.5 | 213.4 | 140.0 | 346.7 | - | 114.2 | - |
| 199-H4-16 | 577981.91 | 152591.57 | 117.54 | 112.66 | 115.3 | 2.7 | 179.3 | 67.0 | 67.0 | - | - | - |
| 199-H4-18 | 578018.29 | 152756.48 | 116.91 | 113.86 | 116.1 | 2.3 | 54.6 | 24.0 | 26.0 | - | - | 3.1 |
| 199-H4-3 | 577940.49 | 152858.54 | 118.12 | 111.72 | 114.4 | 2.7 | 139.5 | 52.0 | 109.6 | - | 35.8 | - |
| 199-H4-45 | 578156.39 | 152433.39 | 117.31 | 111.03 | 114.2 | 3.2 | 94.7 | 30.0 | 34.3 | 13.9 | - | - |
| 199-H4-46 | 577883.86 | 152439.87 | 117.58 | 111.24 | 114.6 | 3.4 | 124.2 | 37.0 | 42.8 | - | 14.1 | - |
| 199-H4-47 | 577891.18 | 152553.30 | 117.73 | 111.39 | 114.6 | 3.2 | 87.2 | 27.0 | 37.6 | - | 12.5 | - |
| 199-H4-48 | 577792.66 | 152620.21 | 118.08 | 111.74 | 114.8 | 3.0 | 72.4 | 24.0 | - | - | 24.0 | - |
| 199-H4-49 | 577713.83 | 152445.15 | 118.03 | 113.25 | 115.0 | 1.7 | 46.3 | 27.0 | 27.0 | - | - | - |
| 199-H4-63 | 578185.83 | 152665.53 | 116.52 | 110.44 | 116.5 | 6.0 | 1,109.6 | 183.9 | - | 219.6 | 182.6 | - |
| 199-H4-64 | 577946.11 | 153010.58 | 118.64 | 112.55 | 116.3 | 3.8 | 122.4 | 32.5 | 45.8 | - | 15.1 | - |
| 199-H4-69 | 578014.05 | 152686.66 | 115.44 | 112.39 | 115.3 | 2.9 | 117.8 | 41.0 | 41.0 | - | - | - |
| 199-H4-7 | 577804.13 | 152890.85 | 117.17 | 112.60 | 114.8 | 2.2 | 46.7 | 21.0 | 35.5 | - | 12.3 | 4.4 |
| 199-H4-70 | 578003.82 | 152646.45 | 115.89 | 112.84 | 116.2 | 3.0 | 160.4 | 52.6 | 52.6 | - | - | - |
| 199-H4-71 | 578010.64 | 152581.53 | 116.06 | 111.47 | 119.0 | 4.6 | 210.6 | 46.0 | 46.0 | - | - | - |
| 199-H4-72 | 578036.28 | 152500.14 | 116.21 | 111.63 | 116.4 | 4.6 | 98.8 | 21.6 | 21.6 | - | - | - |
| 199-H4-73 | 577940.58 | 152369.98 | 116.13 | 110.03 | 117.3 | 6.1 | 336.6 | 55.2 | 61.4 | - | 20.2 | 7.1 |
| 199-H4-74 | 577239.07 | 152268.83 | 118.34 | 113.77 | 116.8 | 3.0 | 195.3 | 65.1 | 130.0 | - | 42.4 | - |
| 199-H4-76 | 576787.32 | 152976.85 | 118.38 | 115.33 | 117.5 | 2.2 | 455.9 | 209.4 | 236.7 | - | - | 26.7 |
| 199-H4-80 | 575238.97 | 152568.16 | 119.83 | 109.17 | 119.3 | 10.1 | 1,230.4 | 121.5 | 262.4 | - | 85.8 | - |
| 199-H4-81 | 575236.93 | 153035.36 | 119.15 | 113.05 | 119.2 | 6.1 | 107.1 | 17.6 | 26.7 | - | 8.8 | - |
| 199-H4-82 | 574906.99 | 152677.72 | 119.65 | 113.58 | 119.2 | 5.6 | 187.9 | 33.7 | 34.8 | - | 11.5 | - |
| 199-H5-1A | 577650.08 | 152257.72 | 117.56 | 112.75 | 114.9 | 2.2 | 74.6 | 34.0 | 45.3 | - | 15.0 | - |
| 199-H6-1 | 578236.56 | 152247.63 | 117.22 | 110.88 | 114.2 | 3.4 | 70.6 | 21.0 | 26.8 | 11.1 | - | - |
| 199-H6-3 | 578340.40 | 151929.35 | 117.12 | 109.50 | 113.6 | 4.1 | 111.9 | 27.0 | 52.4 | 21.0 | - | 6.1 |
| 199-H6-4 | 577771.59 | 151737.10 | 117.73 | 110.11 | 114.9 | 4.8 | 564.7 | 118.0 | - | - | 128.7 | 44.2 |
| 199-K-10 | 568912.76 | 146628.10 | 142.82 | 92.70 | 119.3 | 26.6 | 425.8 | 16.0 | - | - | 16.1 | 1.9 |
| 199-K-106A | 568697.40 | 146502.39 | 121.19 | 114.87 | 119.4 | 4.5 | 11.7 | 2.6 | - | - | 2.6 | - |
| 199-K-107A | 568579.94 | 146468.81 | 120.80 | 114.48 | 119.0 | 4.5 | 14.5 | 3.2 | - | - | 3.2 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2/d$) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-108A | 568687.20 | 146396.14 | 121.64 | 115.43 | 119.3 | 3.9 | 9.5 | 2.4 | - | - | 2.4 | - |
| 199-K-110A | 569230.01 | 146677.91 | 122.04 | 115.72 | 120.5 | 4.8 | 46.8 | 9.8 | - | - | 9.8 | - |
| 199-K-111A | 569308.17 | 146968.88 | 121.26 | 115.16 | 119.6 | 4.4 | 36.9 | 8.3 | - | - | 8.3 | - |
| 199-K-114A | 570020.30 | 148280.55 | 119.32 | 114.73 | 118.2 | 3.5 | 898.3 | 257.3 | - | - | 257.3 | - |
| 199-K-115A | 569939.99 | 148135.42 | 120.22 | 111.06 | 118.4 | 7.3 | 68.5 | 9.4 | - | - | 9.4 | - |
| 199-K-116A | 569871.15 | 147960.50 | 120.53 | 103.70 | 119.5 | 15.8 | 2,888.5 | 182.5 | - | - | 182.5 | - |
| 199-K-118A | 569703.06 | 147865.90 | 120.37 | 108.08 | 120.5 | 12.3 | 281.5 | 22.9 | - | - | 22.9 | - |
| 199-K-119A | 569661.80 | 147649.69 | 121.47 | 106.23 | 120.3 | 14.1 | 128.2 | 9.1 | - | - | 9.1 | - |
| 199-K-120A | 569399.62 | 147518.48 | 120.42 | 97.56 | 120.9 | 22.9 | 796.2 | 34.8 | - | - | 34.8 | - |
| 199-K-125A | 569712.87 | 147866.01 | 120.42 | 108.23 | 119.6 | 11.3 | 158.8 | 14.0 | - | - | 14.0 | - |
| 199-K-126 | 570574.73 | 148509.65 | 120.09 | 114.00 | 119.3 | 5.3 | 49.4 | 9.4 | - | - | 9.4 | - |
| 199-K-127 | 569539.23 | 147539.00 | 119.96 | 101.67 | 119.5 | 17.9 | 167.2 | 9.4 | - | - | 9.4 | - |
| 199-K-130 | 570478.99 | 148661.18 | 119.67 | 110.49 | 119.5 | 9.0 | 126.7 | 14.1 | - | - | 14.1 | - |
| 199-K-131 | 570662.00 | 148903.85 | 118.62 | 109.47 | 118.5 | 9.0 | 232.5 | 25.8 | - | - | 25.8 | - |
| 199-K-132 | 568495.12 | 146670.82 | 120.71 | 113.09 | 118.6 | 5.5 | 72.6 | 13.2 | - | - | 13.2 | - |
| 199-K-138 | 568395.22 | 146616.64 | 119.48 | 108.82 | 119.5 | 10.7 | 232.5 | 21.8 | - | - | 21.8 | - |
| 199-K-139 | 568551.39 | 146518.39 | 123.42 | 112.75 | 119.3 | 6.5 | 154.8 | 23.7 | - | - | 23.7 | - |
| 199-K-141 | 569024.22 | 146818.49 | 119.32 | 108.65 | 119.9 | 10.7 | 130.0 | 12.2 | - | - | 12.2 | - |
| 199-K-142 | 569104.26 | 146870.94 | 119.85 | 111.31 | 119.8 | 8.4 | 16.3 | 1.9 | - | - | 1.9 | - |
| 199-K-143 | 570934.41 | 148088.28 | 119.53 | 108.88 | 119.2 | 10.3 | 314.8 | 30.5 | - | - | 30.5 | - |
| 199-K-145 | 569284.60 | 147425.66 | 120.02 | 89.54 | 119.9 | 30.4 | 377.4 | 12.4 | - | - | 12.5 | 1.5 |
| 199-K-146 | 570197.60 | 148379.78 | 119.88 | 112.26 | 118.4 | 6.1 | 46.1 | 7.5 | - | - | 7.5 | - |
| 199-K-147 | 570411.64 | 148558.07 | 117.39 | 111.29 | 118.7 | 6.1 | 116.2 | 19.1 | - | - | 19.7 | 2.3 |
| 199-K-148 | 570584.74 | 148767.86 | 119.83 | 107.64 | 118.6 | 11.0 | 348.7 | 31.8 | - | - | 31.8 | - |
| 199-K-149 | 570778.25 | 148970.74 | 120.17 | 107.97 | 117.7 | 9.7 | 191.8 | 19.7 | - | - | 19.7 | - |
| 199-K-150 | 570787.67 | 149051.93 | 120.49 | 105.25 | 118.7 | 13.5 | 429.2 | 31.9 | - | - | 31.9 | - |
| 199-K-151 | 570941.32 | 148686.44 | 126.25 | 104.91 | 118.9 | 14.0 | 9,997.1 | 714.9 | - | - | 714.9 | - |
| 199-K-152 | 570736.25 | 148585.89 | 128.21 | 105.35 | 117.9 | 12.5 | 270.1 | 21.6 | - | - | 21.6 | - |
| 199-K-153 | 570530.04 | 148210.08 | 128.27 | 106.93 | 119.1 | 12.1 | 547.0 | 45.1 | - | - | 45.1 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2$/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-154 | 570321.06 | 148027.01 | 124.40 | 106.11 | 119.3 | 13.2 | 2,294.3 | 173.9 | - | - | 173.9 | - |
| 199-K-158 | 568627.45 | 146164.41 | 126.57 | 112.86 | 121.2 | 8.4 | 3,487.3 | 415.9 | - | - | 415.9 | - |
| 199-K-159 | 570911.73 | 149159.61 | 126.91 | 105.57 | 122.6 | 17.1 | 261.9 | 15.4 | - | 19.1 | 13.2 | - |
| 199-K-160 | 570919.58 | 149116.02 | 126.12 | 104.78 | 122.7 | 17.9 | 310.0 | 17.3 | 74.6 | 21.2 | 14.6 | - |
| 199-K-161 | 570004.64 | 148202.30 | 119.32 | 111.70 | 118.5 | 6.8 | 166.1 | 24.5 | - | - | 24.5 | - |
| 199-K-163 | 570230.66 | 147947.93 | 126.76 | 105.42 | 119.1 | 13.6 | 358.4 | 26.3 | - | - | 26.3 | - |
| 199-K-164 | 571202.22 | 148903.74 | 127.90 | 106.57 | 122.4 | 15.8 | 328.0 | 20.7 | 79.4 | - | 15.6 | - |
| 199-K-165 | 568674.96 | 146342.42 | 128.39 | 94.86 | 119.9 | 25.0 | 930.0 | 37.2 | - | - | 37.2 | - |
| 199-K-166 | 568594.56 | 146342.97 | 124.43 | 93.95 | 121.1 | 27.2 | 2,564.2 | 94.4 | - | - | 94.4 | - |
| 199-K-168 | 568544.37 | 146513.63 | 111.91 | 93.69 | 117.8 | 18.2 | 150.0 | 8.2 | - | - | 9.0 | 1.0 |
| 199-K-169 | 569988.97 | 147554.98 | 132.11 | 101.63 | 125.8 | 24.2 | 341.8 | 14.1 | 43.7 | - | 8.6 | - |
| 199-K-170 | 570009.01 | 147491.37 | 135.02 | 98.45 | 126.2 | 27.7 | 283.0 | 10.2 | - | - | 10.2 | - |
| 199-K-171 | 570544.03 | 147187.86 | 135.69 | 99.11 | 121.7 | 22.6 | 911.9 | 40.4 | - | - | 40.4 | - |
| 199-K-172 | 570871.69 | 147166.37 | 134.50 | 104.02 | 125.7 | 21.7 | 313.3 | 14.4 | - | - | 14.4 | - |
| 199-K-173 | 568674.07 | 146266.88 | 126.42 | 108.14 | 121.7 | 13.5 | 388.3 | 28.7 | - | - | 28.7 | - |
| 199-K-174 | 568915.38 | 146222.47 | 127.43 | 109.14 | 126.6 | 17.4 | 205.6 | 11.8 | - | - | 11.8 | - |
| 199-K-179 | 569847.25 | 147481.92 | 127.04 | 96.55 | 125.4 | 28.9 | 320.7 | 11.1 | - | - | 11.1 | - |
| 199-K-18 | 569353.69 | 147400.81 | 124.92 | 106.63 | 119.4 | 12.8 | 74.7 | 5.9 | - | - | 5.9 | - |
| 199-K-180 | 571116.08 | 147449.14 | 127.66 | 100.24 | 120.6 | 20.4 | 225.5 | 11.1 | - | - | 11.2 | 1.3 |
| 199-K-181 | 568849.75 | 146892.82 | 125.00 | 106.71 | 117.8 | 11.1 | 538.4 | 48.5 | - | - | 48.5 | - |
| 199-K-182 | 571185.32 | 148350.24 | 125.88 | 106.05 | 119.9 | 13.8 | 143.2 | 10.4 | - | - | 10.4 | - |
| 199-K-183 | 568302.28 | 146439.70 | 126.00 | 107.72 | 120.8 | 13.0 | 169.6 | 13.0 | - | - | 13.0 | - |
| 199-K-184 | 568618.68 | 146366.32 | 106.94 | 93.22 | 118.0 | 13.7 | 93.3 | 6.8 | - | - | 6.9 | 0.8 |
| 199-K-185 | 568574.92 | 146726.17 | 122.88 | 93.93 | 118.3 | 24.4 | 56.1 | 2.3 | - | - | 2.3 | 0.3 |
| 199-K-187 | 569499.00 | 146054.68 | 125.75 | 95.27 | 120.5 | 25.2 | 706.0 | 28.0 | - | - | 28.0 | - |
| 199-K-188 | 569386.80 | 146370.11 | 122.79 | 112.12 | 120.8 | 8.7 | 138.8 | 16.0 | - | - | 16.0 | - |
| 199-K-189 | 569150.27 | 146809.68 | 122.72 | 95.29 | 119.5 | 24.2 | 21.8 | 0.9 | - | - | 0.9 | - |
| 199-K-19 | 569458.52 | 147386.64 | 121.76 | 115.67 | 119.8 | 4.1 | 20.3 | 4.9 | - | - | 4.9 | - |
| 199-K-190 | 568835.28 | 146873.27 | 106.91 | 94.71 | 117.2 | 12.2 | 146.4 | 12.0 | - | - | 12.2 | 1.4 |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2/d$) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-K-191 | 569711.20 | 146886.65 | 127.92 | 112.67 | 121.0 | 8.3 | 8.3 | 1.0 | - | - | 1.0 | - |
| 199-K-193 | 570641.99 | 146969.58 | 126.19 | 95.71 | 120.7 | 25.0 | 27.5 | 1.1 | - | - | 1.1 | - |
| 199-K-194 | 571315.65 | 147281.98 | 124.29 | 113.62 | 120.5 | 6.9 | 4.8 | 0.7 | - | - | 0.7 | - |
| 199-K-195 | 568850.08 | 146086.38 | 123.03 | 109.30 | 121.3 | 12.0 | 180.1 | 15.0 | - | - | 15.0 | - |
| 199-K-196 | 568433.30 | 146639.26 | 122.98 | 94.03 | 117.3 | 23.3 | 205.1 | 8.8 | - | - | 8.8 | - |
| 199-K-198 | 569304.19 | 147551.86 | 119.39 | 107.19 | 122.0 | 12.2 | 273.5 | 22.4 | 22.4 | - | - | - |
| 199-K-199 | 569339.76 | 147585.30 | 105.44 | 96.29 | 118.0 | 9.1 | 46.6 | 5.1 | 5.4 | - | 1.2 | - |
| 199-K-20 | 569520.52 | 147687.24 | 125.95 | 113.76 | 119.3 | 5.6 | 568.3 | 101.7 | - | - | 101.7 | - |
| 199-K-21 | 569769.90 | 147932.06 | 126.06 | 113.86 | 118.5 | 4.7 | 82.6 | 17.7 | - | - | 17.7 | - |
| 199-K-22 | 570023.70 | 148097.38 | 121.57 | 115.47 | 118.6 | 3.1 | 9.4 | 3.0 | - | - | 3.0 | - |
| 199-K-29 | 569205.08 | 146790.13 | 122.71 | 116.61 | 121.3 | 4.7 | 62.2 | 13.1 | - | - | 13.1 | - |
| 199-K-32A | 569024.15 | 147006.68 | 121.84 | 115.75 | 118.6 | 2.9 | 69.3 | 24.0 | - | - | 24.0 | - |
| 199-K-33 | 568573.65 | 146713.25 | 121.37 | 115.27 | 118.1 | 2.8 | 16.3 | 5.8 | - | - | 5.8 | - |
| 199-K-34 | 568605.78 | 146501.94 | 122.36 | 116.26 | 119.3 | 3.0 | 64.0 | 21.0 | - | - | 21.0 | - |
| 199-K-35 | 568832.33 | 146110.68 | 123.83 | 117.74 | 121.0 | 3.2 | 122.4 | 38.0 | - | - | 38.0 | - |
| 199-K-36 | 569373.61 | 146390.47 | 123.66 | 117.57 | 121.2 | 3.6 | 96.9 | 27.0 | - | - | 27.0 | - |
| 199-K-37 | 570216.20 | 148226.54 | 121.56 | 115.47 | 118.1 | 2.7 | 117.5 | 44.0 | - | - | 44.0 | - |
| 199-N-119 | 571364.50 | 149968.34 | 117.76 | 115.66 | 118.2 | 2.1 | 13.7 | 6.5 | 55.5 | - | 7.9 | - |
| 199-N-120 | 571366.18 | 149970.76 | 114.89 | 113.39 | 118.2 | 1.5 | 9.5 | 6.4 | - | - | 6.3 | - |
| 199-N-121 | 571368.29 | 149973.29 | 111.41 | 109.91 | 118.2 | 1.5 | 5.5 | 3.7 | - | - | 3.7 | - |
| 199-N-14 | 571713.10 | 150243.37 | 120.41 | 114.31 | 118.4 | 4.0 | 213.3 | 52.7 | - | - | 52.7 | - |
| 199-N-141 | 571303.97 | 149909.49 | 120.13 | 114.94 | 119.6 | 4.7 | 23.2 | 4.9 | 9.2 | - | 2.3 | - |
| 199-N-142 | 571310.19 | 149916.16 | 120.06 | 114.88 | 119.7 | 4.8 | 35.7 | 7.5 | 13.8 | - | 3.1 | - |
| 199-N-147 | 571338.34 | 149946.51 | 120.09 | 114.91 | 118.3 | 3.4 | 206.6 | 60.4 | 116.8 | - | 22.9 | - |
| 199-N-159 | 571340.00 | 149942.84 | 116.83 | 114.70 | 118.1 | 2.1 | 25.6 | 12.0 | - | - | 12.0 | - |
| 199-N-160 | 571333.43 | 149938.01 | 116.76 | 114.62 | 118.2 | 2.1 | 34.1 | 16.0 | - | - | 16.0 | - |
| 199-N-161 | 571326.49 | 149932.43 | 116.81 | 114.68 | 118.4 | 2.1 | 54.3 | 25.5 | - | - | 25.5 | - |
| 199-N-162 | 571319.68 | 149926.60 | 117.00 | 114.87 | 118.3 | 2.1 | 32.7 | 15.3 | - | - | 15.3 | - |
| 199-N-182 | 571428.71 | 149819.87 | 114.80 | 108.70 | 118.3 | 6.1 | 25.0 | 4.1 | - | - | 4.1 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2$/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-N-183 | 571269.69 | 149756.01 | 119.97 | 113.87 | 118.3 | 4.4 | 28.8 | 6.5 | - | - | 6.5 | - |
| 199-N-184 | 571430.74 | 149817.82 | 121.69 | 115.56 | 118.6 | 3.0 | 11.4 | 3.8 | - | - | 3.8 | - |
| 199-N-185 | 571546.33 | 150237.98 | 110.95 | 109.42 | 118.5 | 1.5 | 4.0 | 2.6 | - | - | 2.6 | - |
| 199-N-186 | 571480.87 | 149715.06 | 120.45 | 114.36 | 118.7 | 4.3 | 19.0 | 4.4 | - | - | 4.4 | - |
| 199-N-187 | 571565.90 | 149897.96 | 119.39 | 113.30 | 118.7 | 5.4 | 30.1 | 5.6 | - | - | 5.6 | - |
| 199-N-188 | 571906.94 | 149581.53 | 120.78 | 114.69 | 119.0 | 4.3 | 29.3 | 6.8 | - | - | 6.8 | - |
| 199-N-189 | 571431.65 | 148430.52 | 124.71 | 110.99 | 119.4 | 8.4 | 79.4 | 9.4 | - | - | 9.4 | - |
| 199-N-20 | 571200.98 | 149660.67 | 136.46 | 116.35 | 117.8 | 1.4 | 91.5 | 64.6 | - | - | 64.6 | - |
| 199-N-201 | 571198.46 | 149759.46 | 118.12 | 115.99 | 117.5 | 1.5 | 47.3 | 32.0 | - | - | 32.0 | - |
| 199-N-209 | 571216.09 | 149791.71 | 117.97 | 115.83 | 117.5 | 1.6 | 22.7 | 13.9 | - | - | 13.9 | - |
| 199-N-21 | 571177.78 | 149629.41 | 135.92 | 115.93 | 118.3 | 2.3 | 86.7 | 37.2 | - | - | 37.2 | - |
| 199-N-248 | 571383.91 | 149997.93 | 116.95 | 114.82 | 117.4 | 2.1 | 58.4 | 27.4 | - | - | 27.4 | - |
| 199-N-250 | 571388.88 | 150005.61 | 116.72 | 114.59 | 117.4 | 2.1 | 63.8 | 29.9 | - | - | 29.9 | - |
| 199-N-252 | 571394.10 | 150013.22 | 116.81 | 114.67 | 117.5 | 2.1 | 85.0 | 39.8 | - | - | 39.8 | - |
| 199-N-260 | 571413.69 | 150043.62 | 116.49 | 114.36 | 117.8 | 2.1 | 51.7 | 24.3 | 35.5 | - | 7.3 | - |
| 199-N-262 | 571418.51 | 150051.20 | 116.46 | 114.30 | 117.2 | 2.2 | 117.3 | 54.2 | - | - | 54.2 | - |
| 199-N-266 | 571428.76 | 150067.07 | 116.54 | 114.41 | 117.5 | 2.1 | 82.8 | 38.9 | - | - | 38.9 | - |
| 199-N-27 | 572052.62 | 149659.79 | 127.91 | 116.63 | 119.4 | 2.8 | 242.2 | 86.5 | - | - | 86.5 | - |
| 199-N-270 | 571438.52 | 150082.34 | 116.35 | 114.22 | 117.6 | 2.1 | 69.7 | 32.7 | - | - | 32.7 | - |
| 199-N-276 | 571450.74 | 150106.59 | 116.51 | 114.38 | 117.4 | 2.1 | 58.6 | 27.5 | 27.5 | - | - | - |
| 199-N-280 | 571457.93 | 150122.77 | 116.21 | 114.09 | 117.5 | 2.1 | 103.1 | 48.5 | - | - | 48.5 | - |
| 199-N-29 | 571841.35 | 149489.23 | 128.51 | 117.38 | 119.7 | 2.3 | 258.3 | 111.1 | - | - | 111.1 | - |
| 199-N-310 | 571542.79 | 150228.42 | 116.50 | 114.37 | 117.2 | 2.1 | 38.7 | 18.2 | - | - | 18.2 | - |
| 199-N-312 | 571548.23 | 150235.72 | 116.26 | 114.13 | 117.2 | 2.1 | 107.1 | 50.2 | - | - | 50.2 | - |
| 199-N-318 | 571563.67 | 150258.74 | 116.41 | 114.28 | 117.2 | 2.1 | 59.6 | 27.9 | - | - | 27.9 | - |
| 199-N-32 | 571907.62 | 149708.50 | 128.61 | 117.64 | 118.3 | 0.7 | 31.2 | 46.5 | - | - | 46.5 | - |
| 199-N-322 | 571572.74 | 150274.27 | 116.50 | 114.37 | 117.2 | 2.1 | 83.0 | 39.0 | - | - | 39.0 | - |
| 199-N-334 | 571600.32 | 150322.03 | 116.88 | 114.74 | 117.3 | 2.1 | 96.3 | 45.1 | - | - | 45.1 | - |
| 199-N-346 | 571203.32 | 149780.23 | 118.31 | 116.17 | 117.5 | 1.3 | 45.9 | 34.9 | - | - | 34.9 | - |

Table D-3. Unit-Wise Hydraulic Conductivity Estimates

| Well Name | Easting (m) | Northing (m) | Top of Screen Elevation (m) | Bottom of Screen Elevation (m) | Water Table Elevation (m) | Calculated Saturated Screen Length (m) | Transmissivity of Screened Interval ($m^2$/d) | Effective Hydraulic Conductivity (m/d) | Calculated Hydraulic Conductivity in Hanford Formation (m/d) | Calculated Hydraulic Conductivity in Reworked Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Ringold E Formation (m/d) | Calculated Hydraulic Conductivity in Reworked RUM Formation (m/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199-N-348 | 571248.28 | 149845.23 | 117.86 | 115.73 | 117.5 | 1.7 | 40.0 | 23.1 | - | - | 23.1 | - |
| 199-N-349 | 571267.16 | 149866.13 | 117.83 | 115.70 | 117.4 | 1.7 | 57.8 | 33.2 | - | - | 33.2 | - |
| 199-N-357 | 571456.35 | 150125.44 | 116.37 | 114.24 | 117.4 | 2.1 | 28.4 | 13.3 | 19.1 | - | 4.4 | - |
| 199-N-358 | 571466.28 | 150148.67 | 116.31 | 114.17 | 117.4 | 2.1 | 49.8 | 23.3 | 48.0 | - | 9.7 | - |
| 199-N-359 | 571484.18 | 150168.77 | 116.59 | 114.46 | 118.2 | 2.1 | 65.5 | 30.7 | - | - | 30.7 | - |
| 199-N-363 | 571554.65 | 150249.90 | 116.57 | 114.44 | 117.2 | 2.1 | 311.0 | 146.0 | - | - | 146.0 | - |
| 199-N-43 | 572366.18 | 150139.95 | 122.50 | 116.41 | 118.2 | 1.8 | 174.4 | 97.5 | - | - | 97.5 | - |
| 199-N-76 | 571560.08 | 150122.12 | 119.23 | 113.14 | 118.4 | 5.2 | 78.0 | 15.0 | - | - | 15.0 | - |
| 199-N-77 | 571309.79 | 149243.05 | 114.22 | 111.19 | 119.4 | 3.0 | 88.4 | 29.2 | - | - | 29.2 | - |
| 699-71-30 | 580603.35 | 145226.91 | 115.51 | 96.92 | 114.1 | 17.2 | 568.6 | 33.0 | 33.0 | - | - | - |
| 699-71-52 | 573907.90 | 145214.84 | 160.06 | 106.36 | 120.6 | 14.3 | 3,872.9 | 271.0 | 677.8 | - | 132.7 | - |
| 699-77-54 | 573385.97 | 146854.80 | 147.35 | 111.99 | 120.2 | 8.2 | 717.1 | 87.0 | 220.2 | - | 43.2 | - |
| 699-86-60 | 571625.74 | 149600.80 | 139.03 | 109.16 | 118.8 | 9.6 | 752.7 | 78.0 | - | - | 78.0 | - |
| 699-91-46A | 575910.95 | 151156.64 | 120.24 | 113.90 | 117.3 | 3.3 | 806.6 | 241.0 | 241.0 | - | - | - |
| 699-93-48A | 575094.13 | 151795.30 | 120.99 | 114.65 | 116.9 | 2.2 | 40.5 | 18.0 | - | - | 18.0 | - |
| 699-96-43 | 576761.45 | 152605.31 | 118.84 | 113.93 | 115.8 | 1.9 | 28.5 | 15.0 | - | - | 15.0 | - |

RUM = Ringold Upper Mud

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# Appendix E

# Three-Point Gradients for Model Calibration

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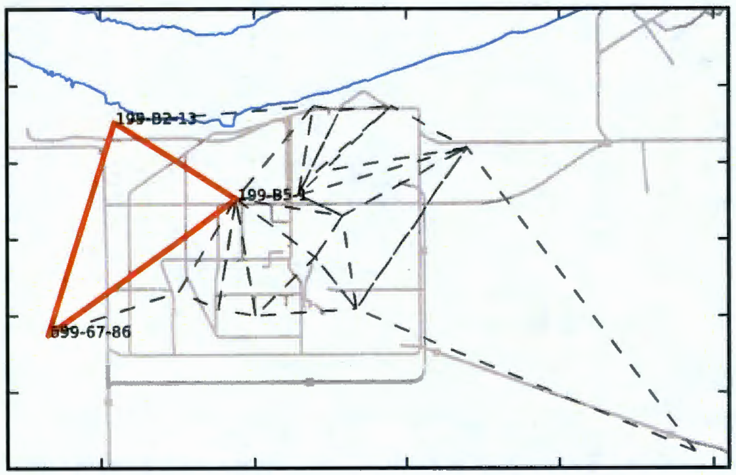
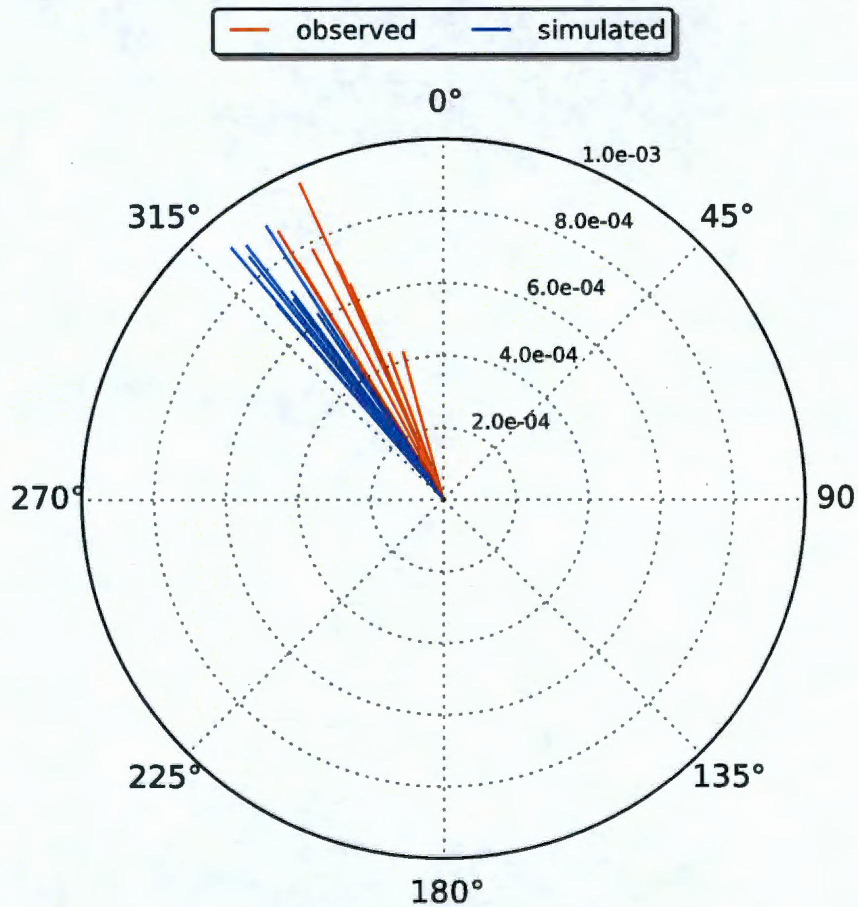
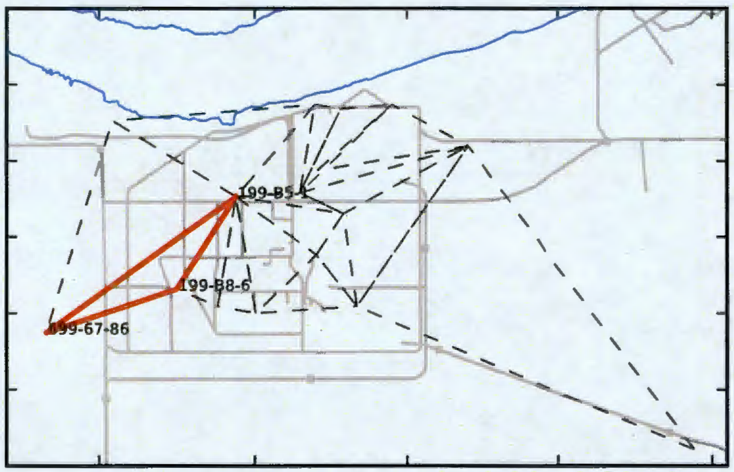
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 1*

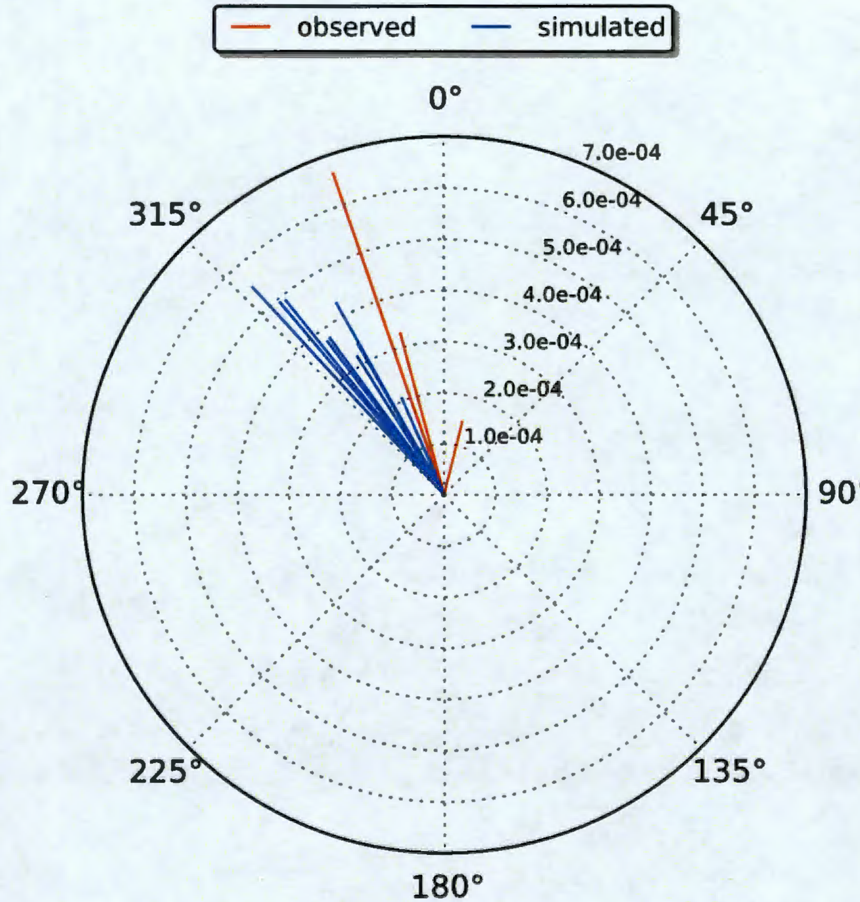



| | Observed | Simulated |
|---|---|---|
| Data Points | 9 | 9 |
| Minimum Azimuth | 328.6 | 319.7 |
| Maximum Azimuth | 345.0 | 327.2 |
| Minimum Magnitude | 4.2e-04 | 6.2e-04 |
| Maximum Magnitude | 9.6e-04 | 9.1e-04 |

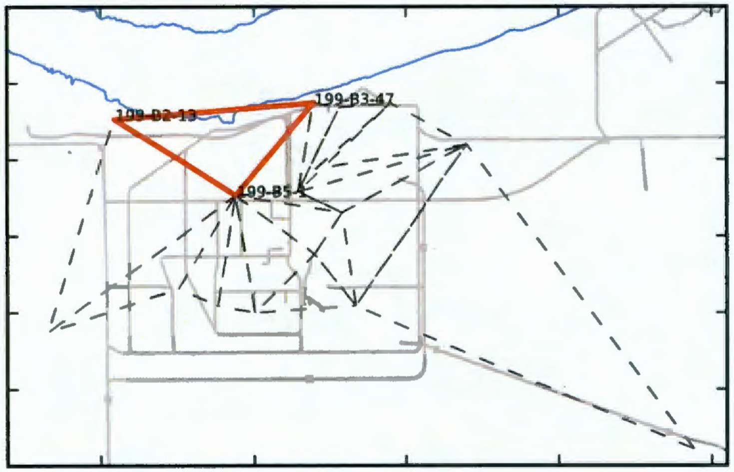
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 2*

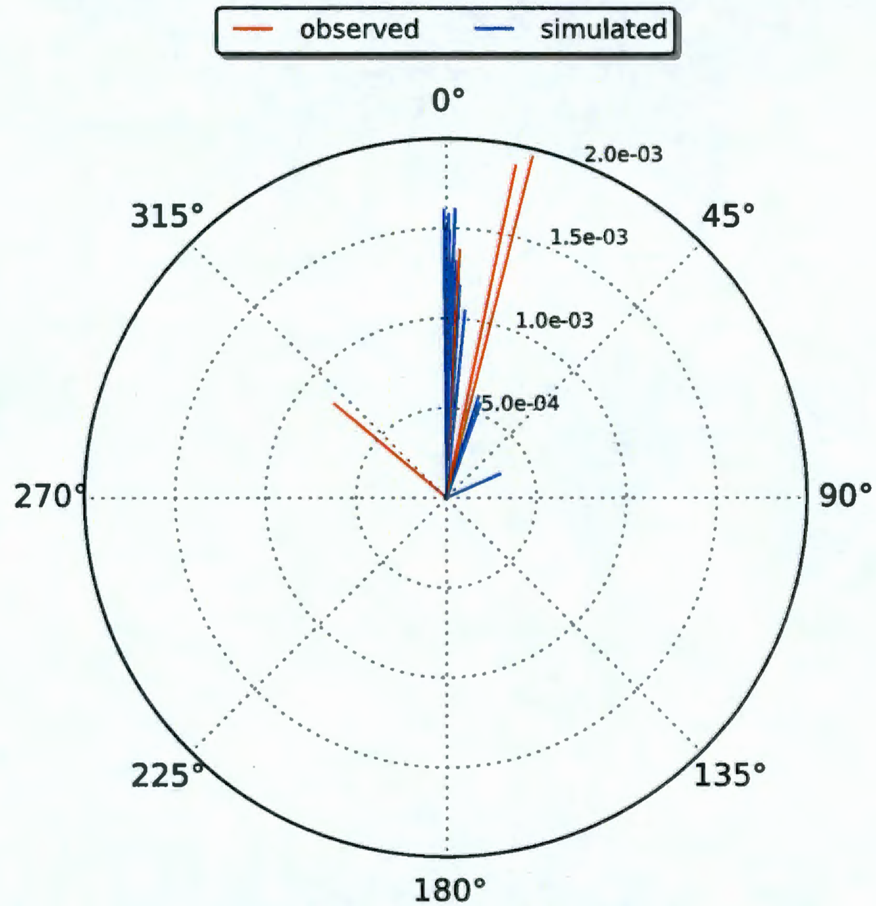



| | Observed | Simulated |
|---|---|---|
| Data Points | 10 | 10 |
| Minimum Azimuth | 13.8 | 317.6 |
| Maximum Azimuth | 345.2 | 336.8 |
| Minimum Magnitude | 1.5e-04 | 2.1e-04 |
| Maximum Magnitude | 6.6e-04 | 5.5e-04 |

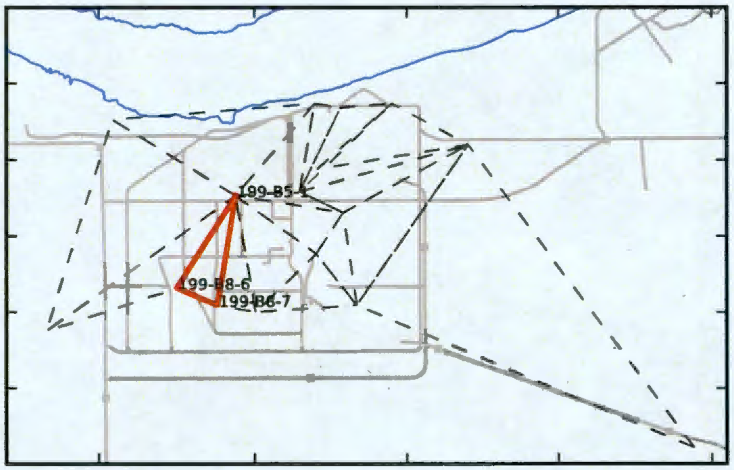
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 3*

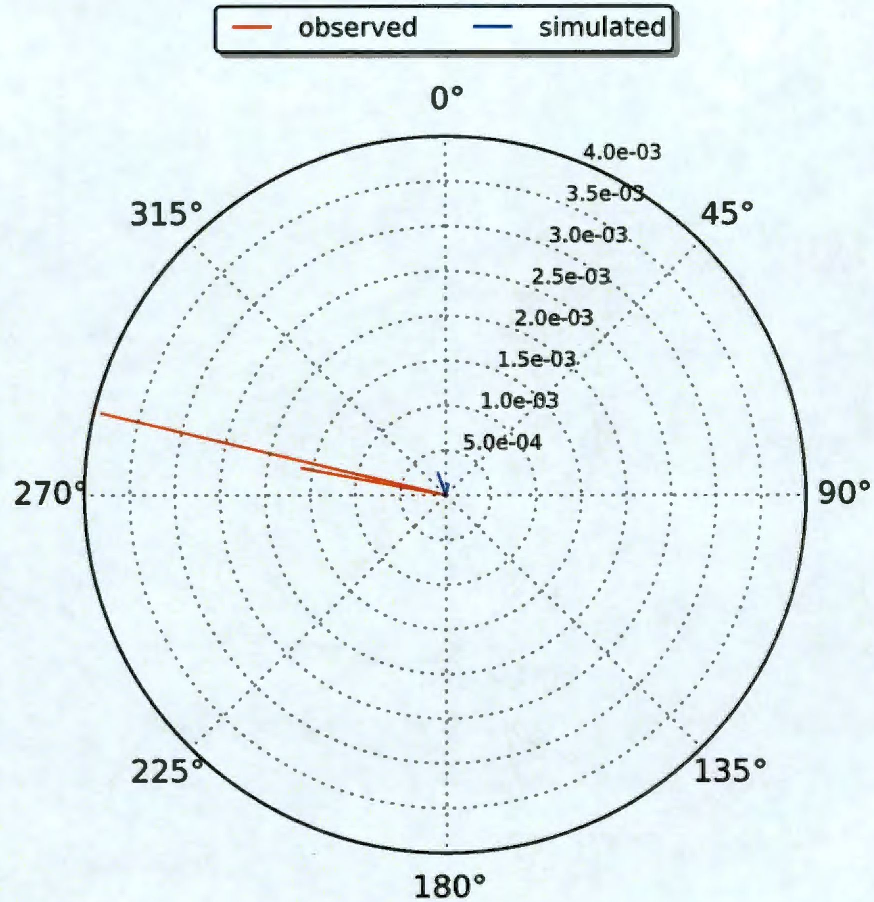



| | Observed | Simulated |
|---|---|---|
| Data Points | 17 | 17 |
| Minimum Azimuth | 3.1 | 0.1 |
| Maximum Azimuth | 333.4 | 359.5 |
| Minimum Magnitude | 2.2e-17 | 3.2e-04 |
| Maximum Magnitude | 2.0e-03 | 1.6e-03 |

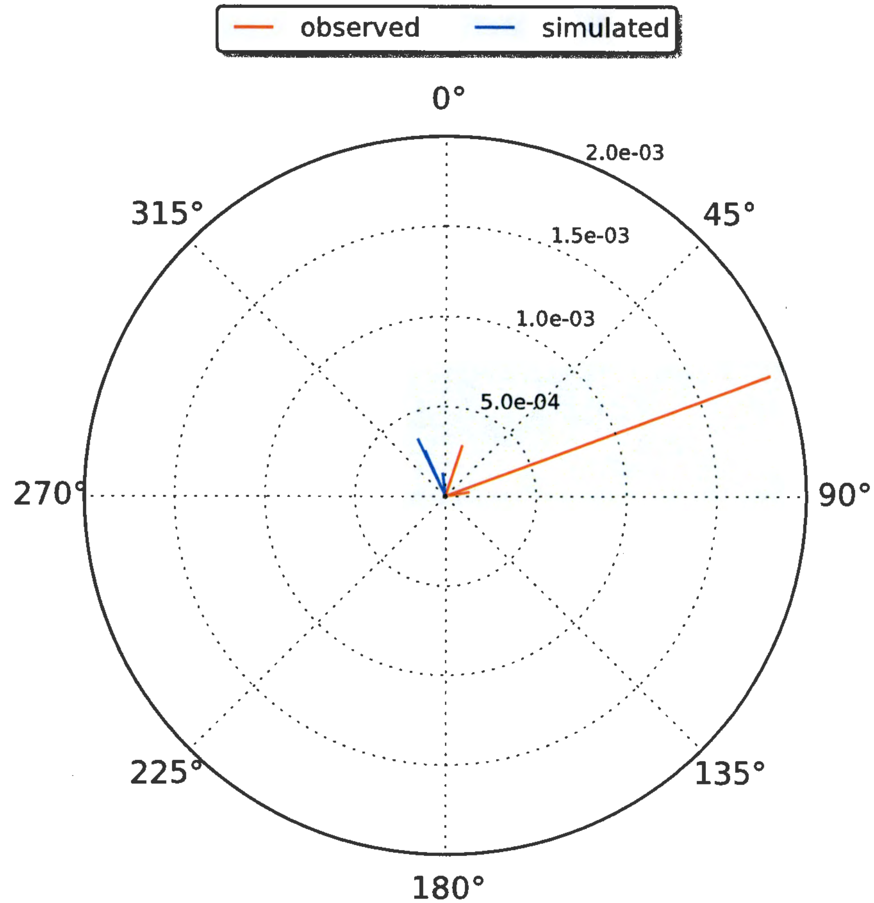
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 4*



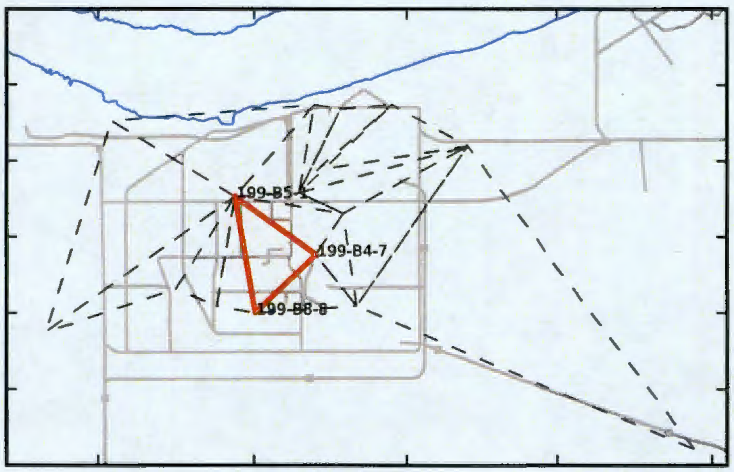

| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 280.7 | 11.5 |
| Maximum Azimuth | 283.5 | 340.0 |
| Minimum Magnitude | 1.6e-03 | 1.2e-04 |
| Maximum Magnitude | 3.9e-03 | 2.6e-04 |

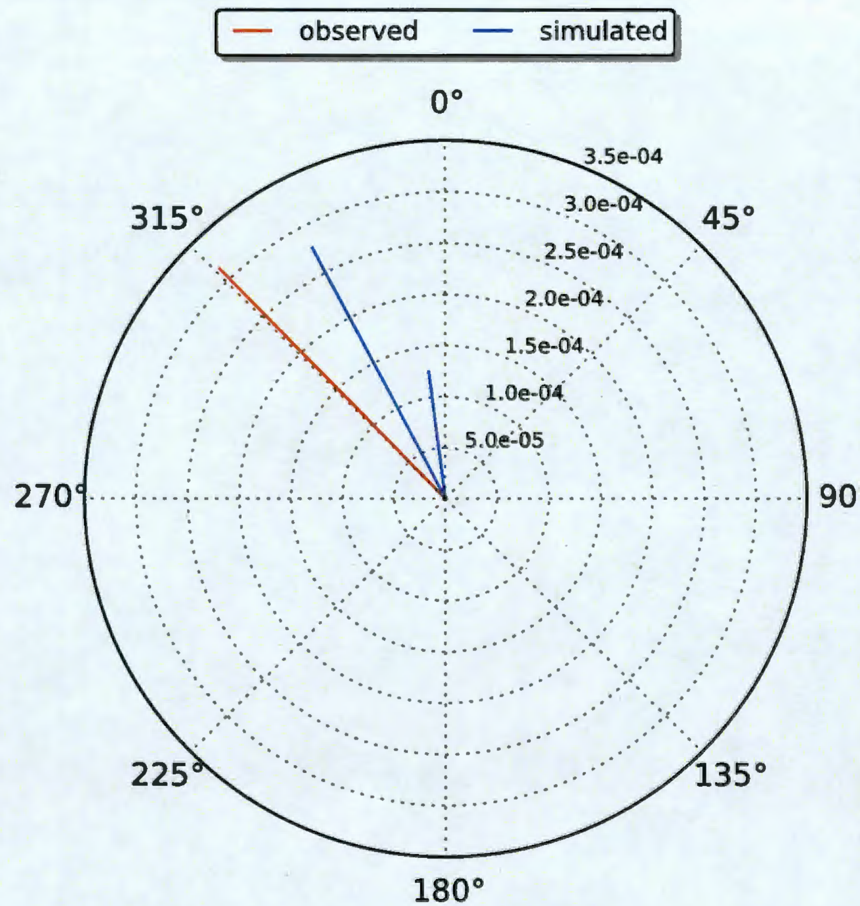
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 5*


| [redacted] | [redacted] | |
|---|---|---|
| | 3 | 3 |
| | 18.1 | 334.2 |
| | 80.5 | 353.5 |
| | 1.3e-04 | 1.3e-04 |
| | 1.9e-03 | 3.5e-04 |

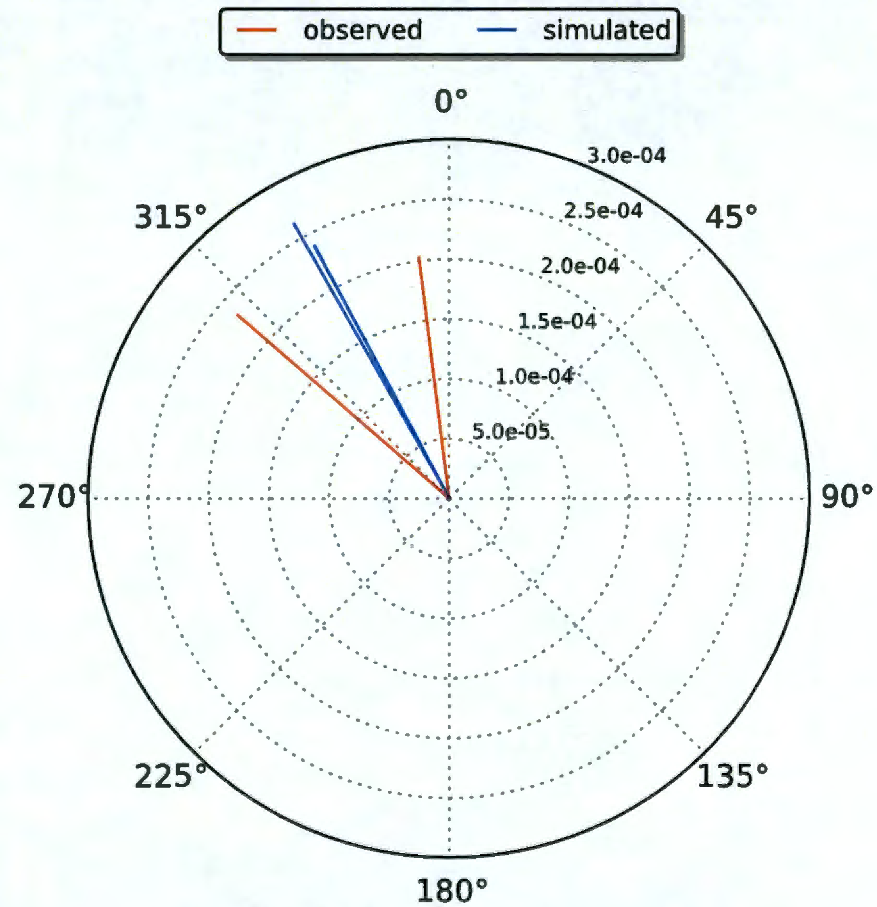
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 6*



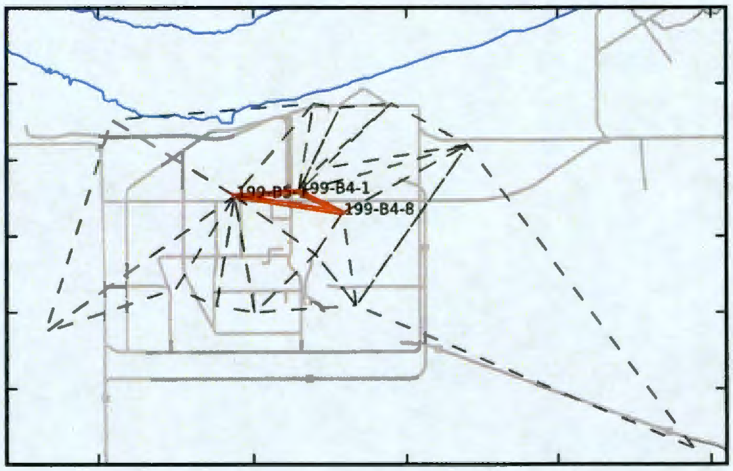

| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 90.0 | 332.3 |
| Maximum Azimuth | 315.8 | 352.5 |
| Minimum Magnitude | 2.1e-17 | 1.3e-04 |
| Maximum Magnitude | 3.1e-04 | 2.8e-04 |

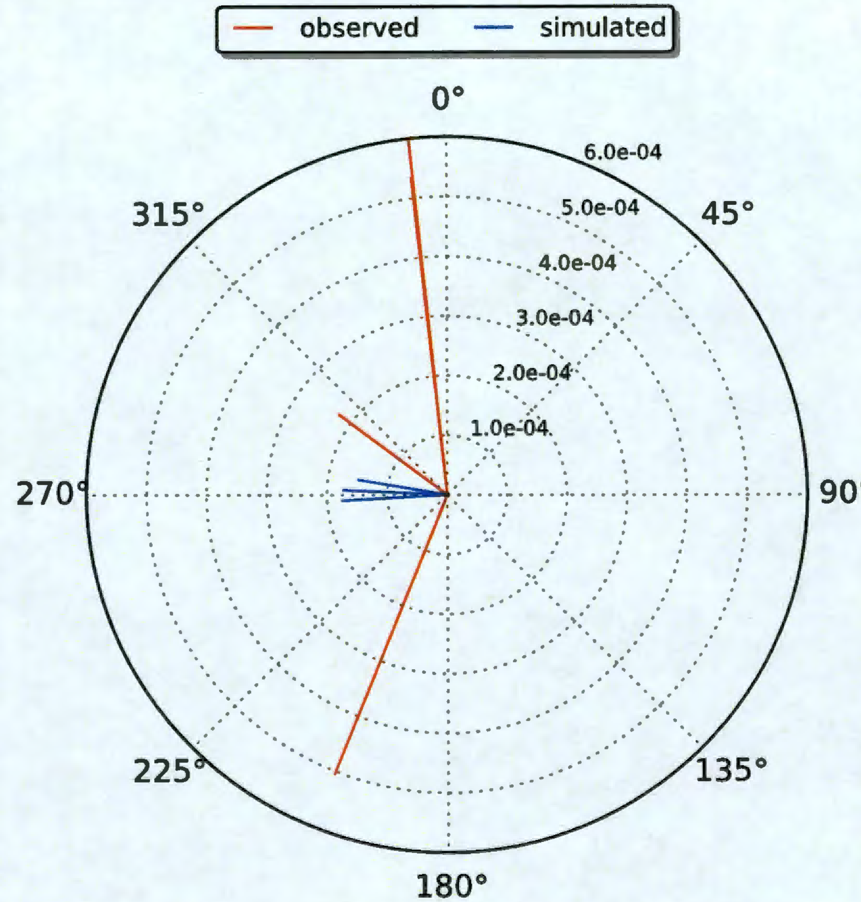
# Three-Point Gradients (Observed vs.Simulated) at Triangle 7


| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 311.1 | 330.6 |
| Maximum Azimuth | 352.9 | 332.0 |
| Minimum Magnitude | 2.0e-04 | 2.4e-04 |
| Maximum Magnitude | 2.3e-04 | 2.6e-04 |

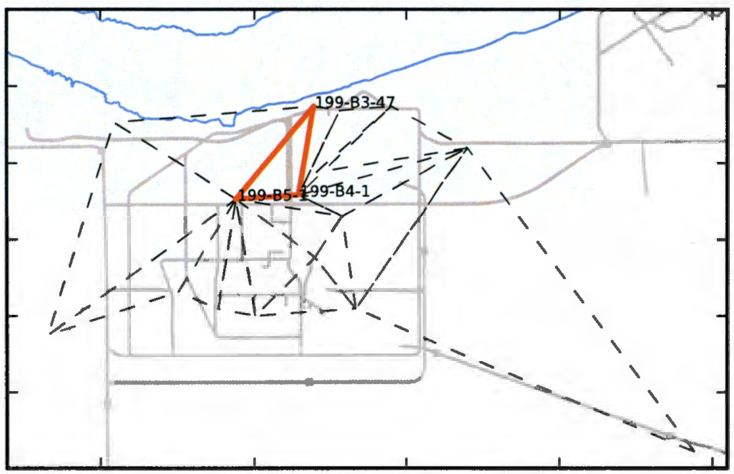
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 8*

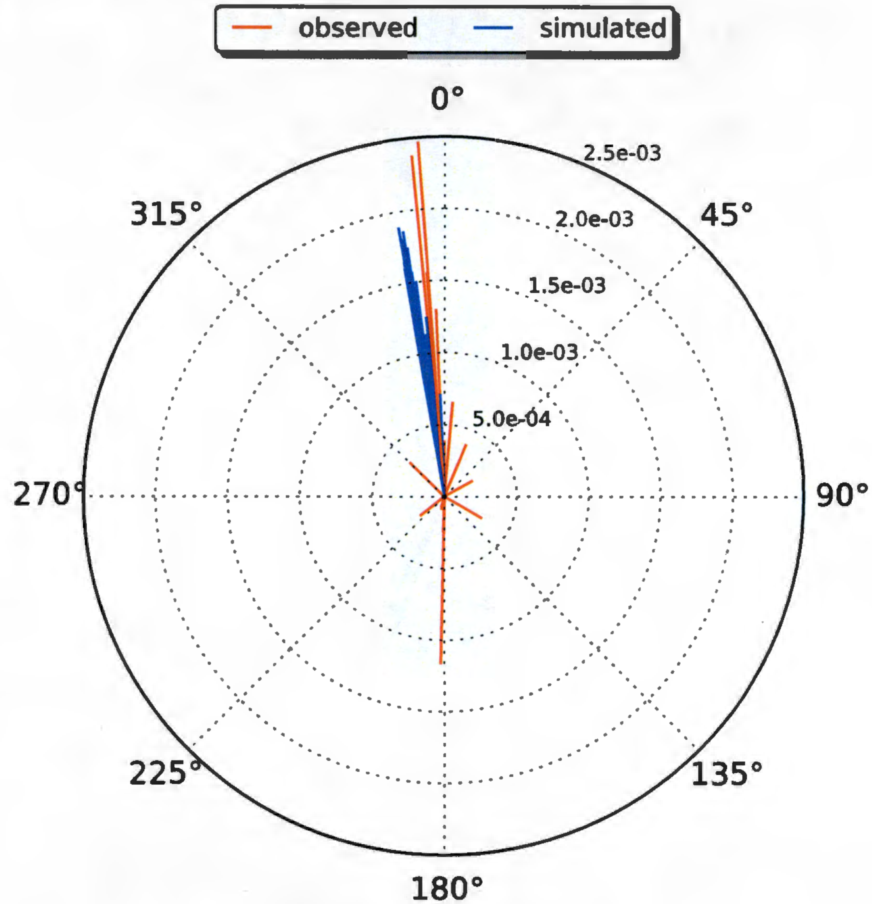



| | Observed | Simulated |
|---|---|---|
| Data Points | 4 | 4 |
| Minimum Azimuth | 202.0 | 266.9 |
| Maximum Azimuth | 354.0 | 279.7 |
| Minimum Magnitude | 2.2e-04 | 1.5e-04 |
| Maximum Magnitude | 6.0e-04 | 1.7e-04 |

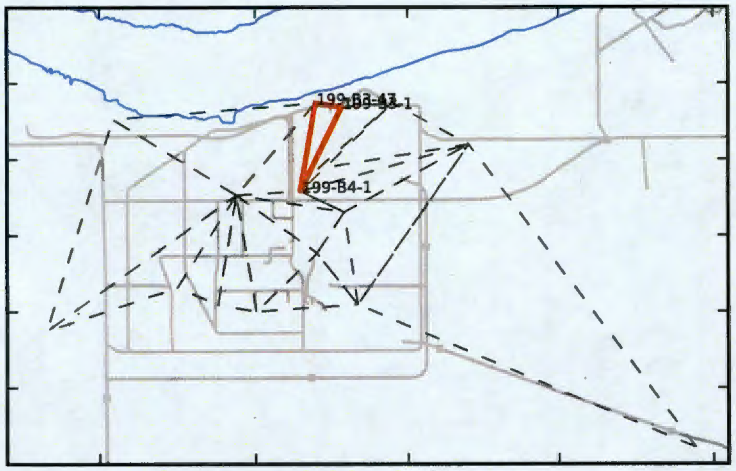
# Three-Point Gradients (Observed vs.Simulated) at Triangle 9

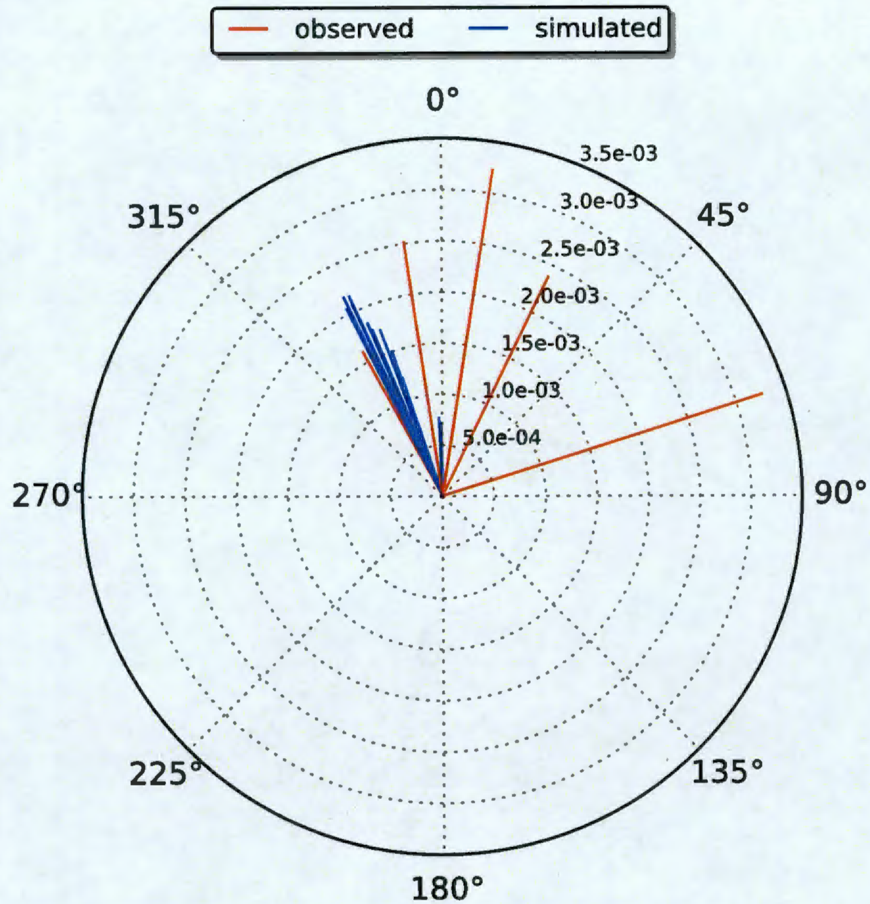



| | Observed | Simulated |
|---|---|---|
| Data Points | 15 | 15 |
| Minimum Azimuth | 4.9 | 350.1 |
| Maximum Azimuth | 359.9 | 357.5 |
| Minimum Magnitude | 6.9e-05 | 7.1e-04 |
| Maximum Magnitude | 2.5e-03 | 1.9e-03 |

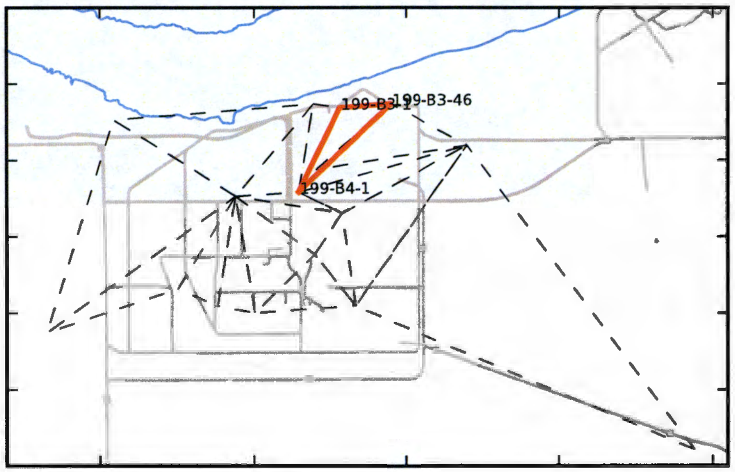
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 10*

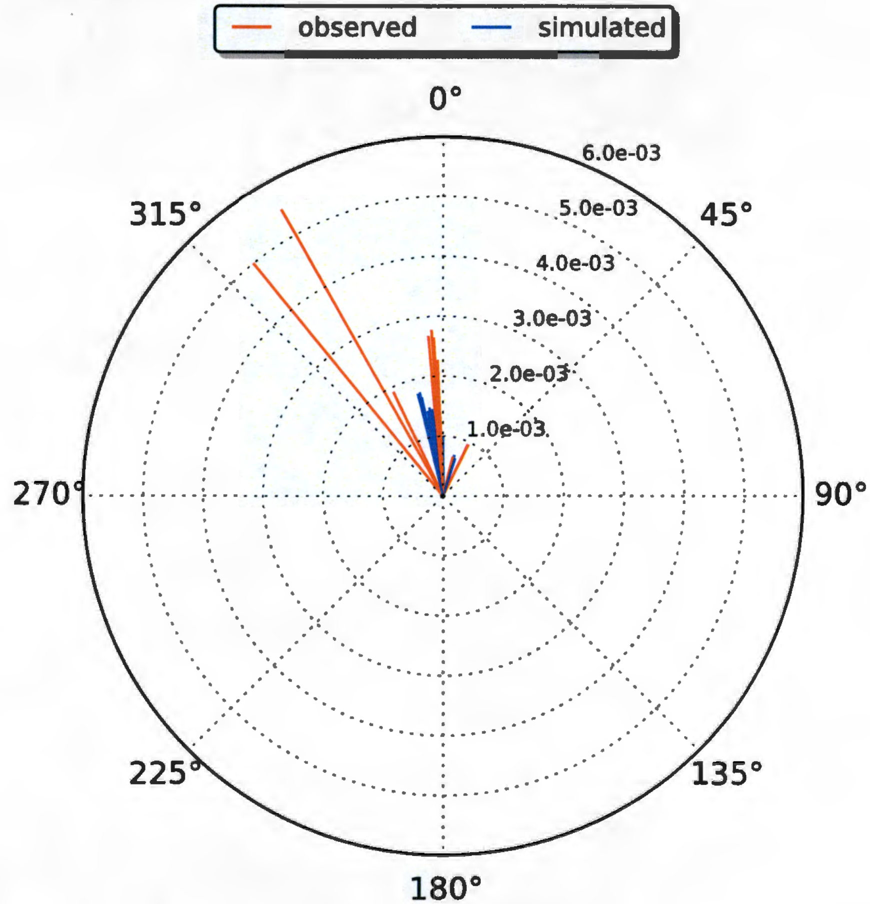



| | Observed | Simulated |
|---|---|---|
| Data Points | 14 | 14 |
| Minimum Azimuth | 8.8 | 333.2 |
| Maximum Azimuth | 351.6 | 359.0 |
| Minimum Magnitude | 5.5e-04 | 7.0e-04 |
| Maximum Magnitude | 3.3e-03 | 2.2e-03 |

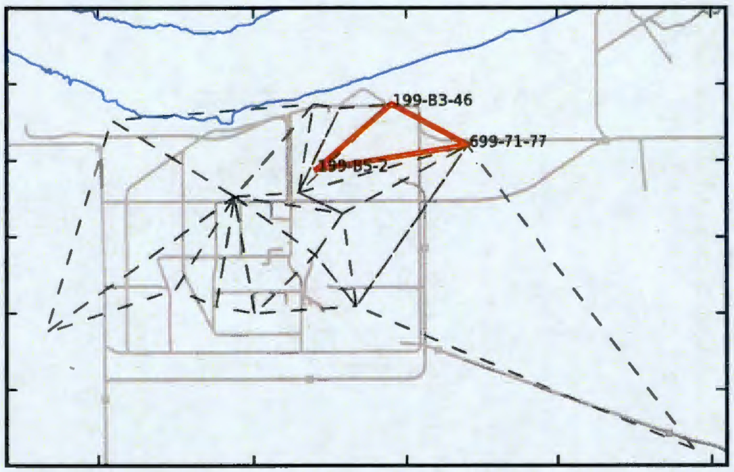
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 11*

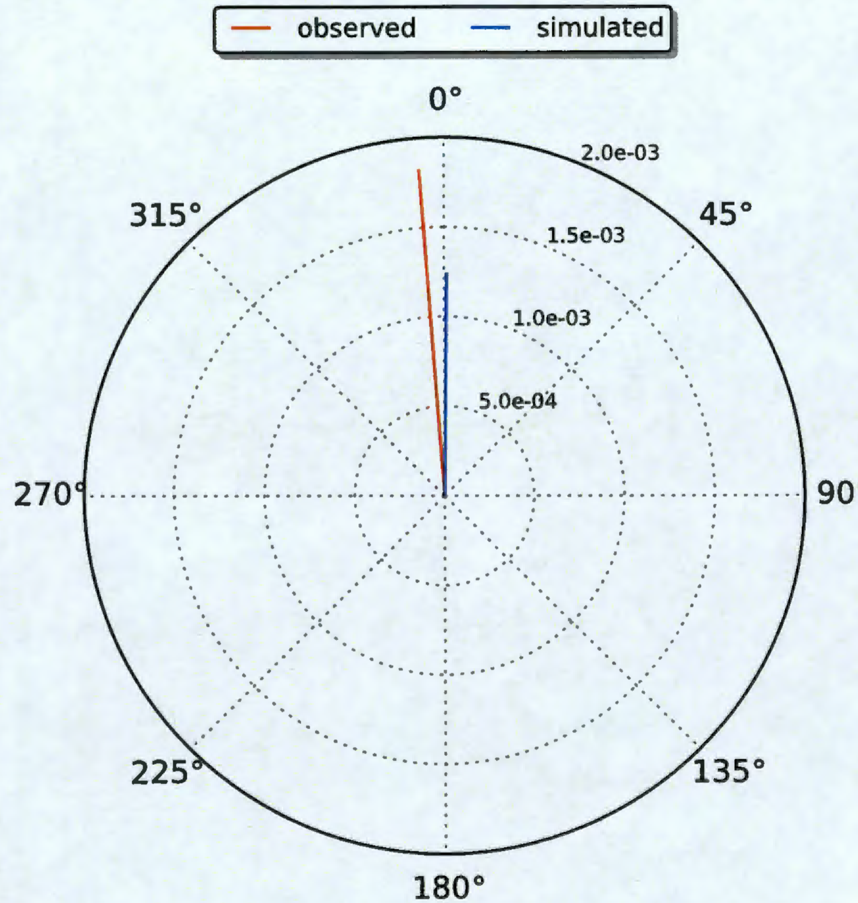



| | Observed | Simulated |
|---|---|---|
| Data Points | 14 | 14 |
| Minimum Azimuth | 13.9 | 15.2 |
| Maximum Azimuth | 358.1 | 359.8 |
| Minimum Magnitude | 5.3e-04 | 6.3e-04 |
| Maximum Magnitude | 5.5e-03 | 1.7e-03 |

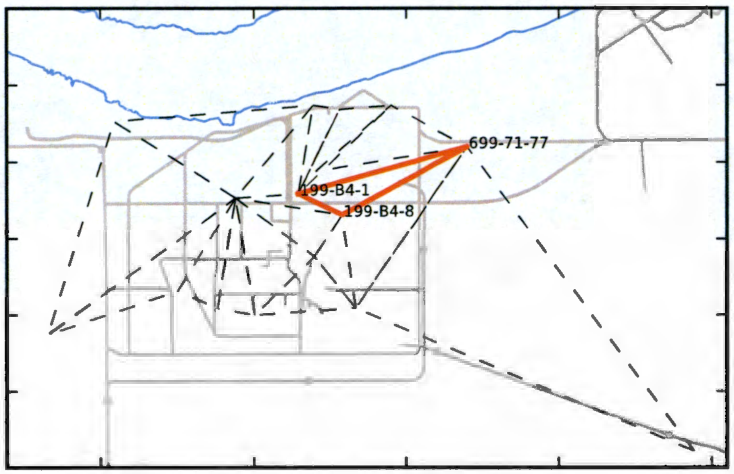
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 12*

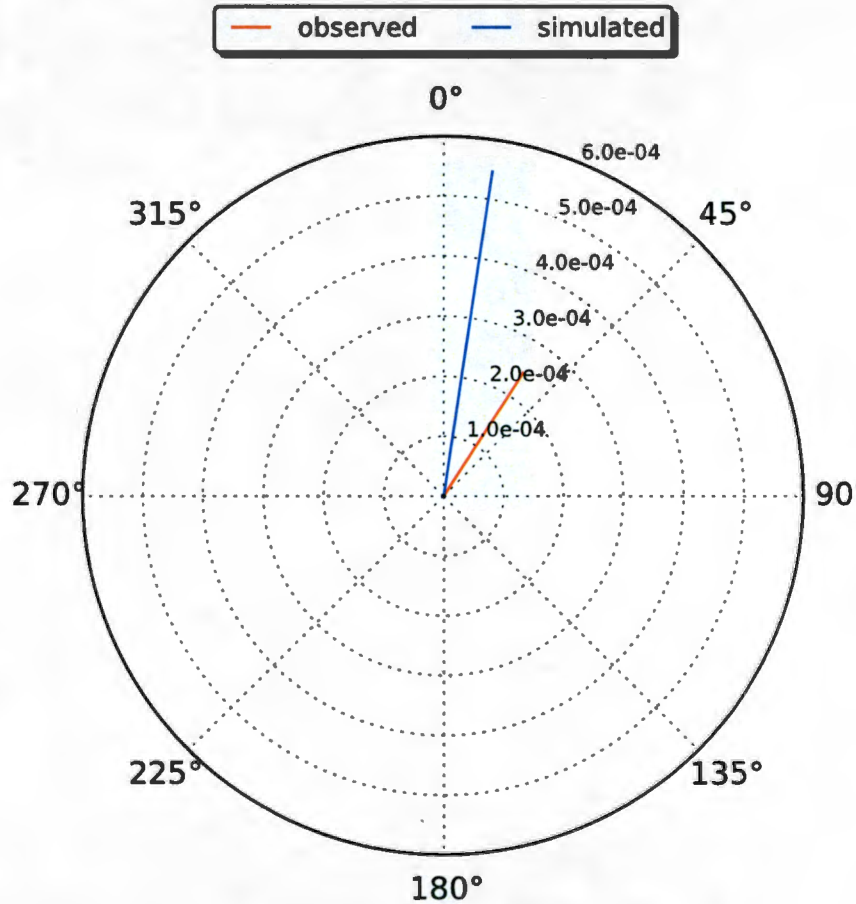



| | Observed | Simulated |
|---|---|---|
| Data Points | 1 | 1 |
| Minimum Azimuth | 355.6 | 0.6 |
| Maximum Azimuth | 355.6 | 0.6 |
| Minimum Magnitude | 1.8e-03 | 1.2e-03 |
| Maximum Magnitude | 1.8e-03 | 1.2e-03 |

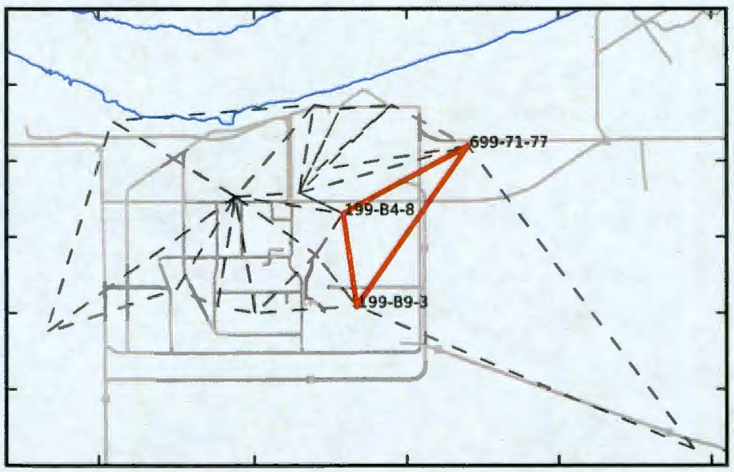
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 13*

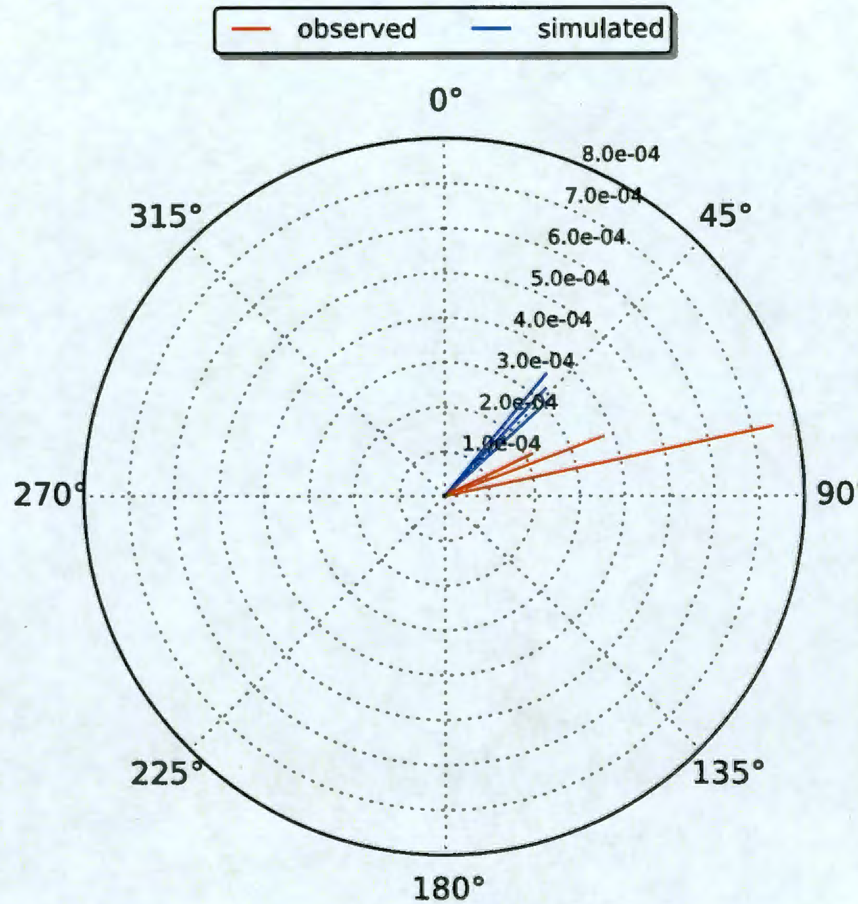



| | Observed | Simulated |
|---|---|---|
| Data Points | 1 | 1 |
| Minimum Azimuth | 32.9 | 8.5 |
| Maximum Azimuth | 32.9 | 8.5 |
| Minimum Magnitude | 2.4e-04 | 5.5e-04 |
| Maximum Magnitude | 2.4e-04 | 5.5e-04 |

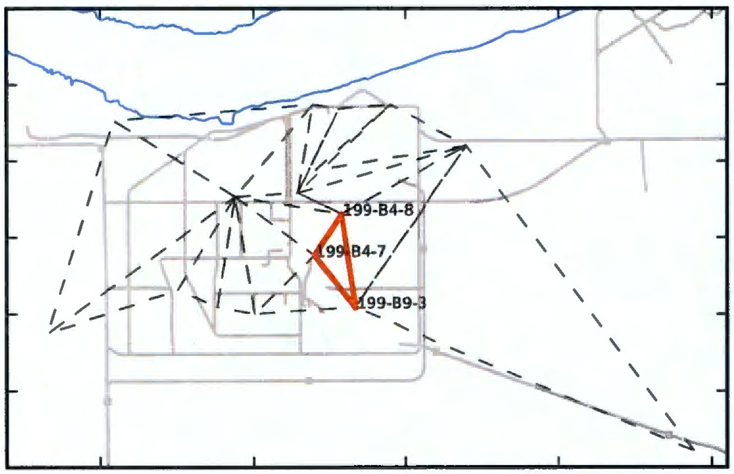
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 14*

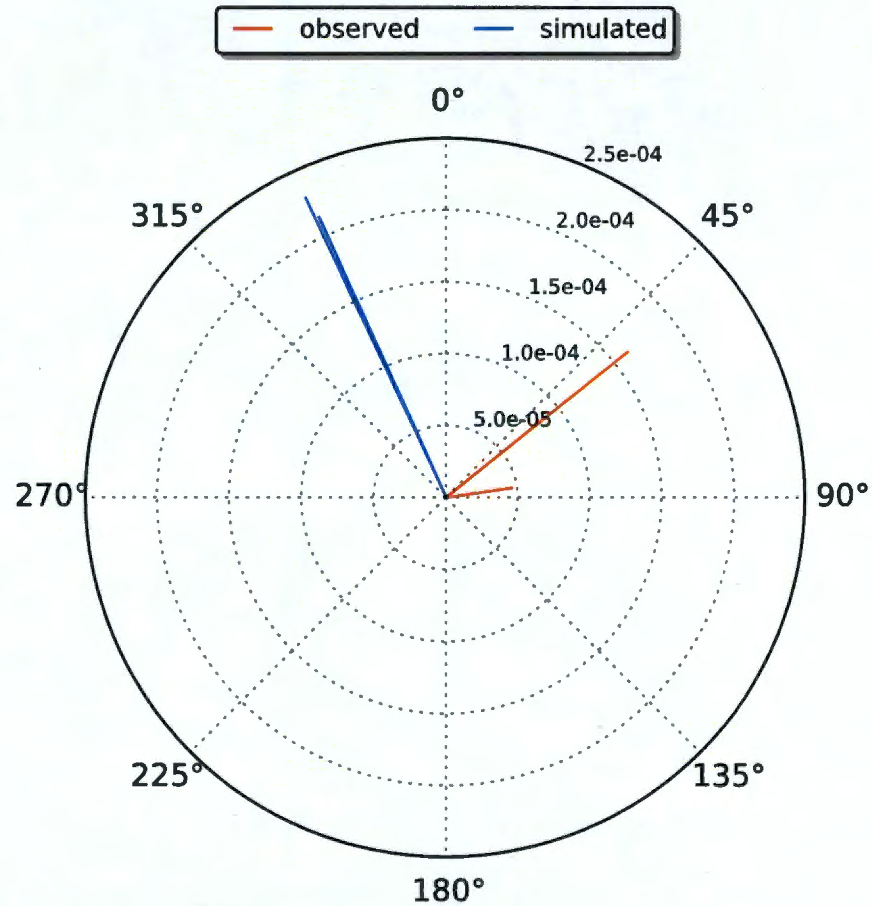



| | Observed | Simulated |
|---|---|---|
| Data Points | 3 | 3 |
| Minimum Azimuth | 63.9 | 39.5 |
| Maximum Azimuth | 77.9 | 47.2 |
| Minimum Magnitude | 2.1e-04 | 3.2e-04 |
| Maximum Magnitude | 7.5e-04 | 3.5e-04 |

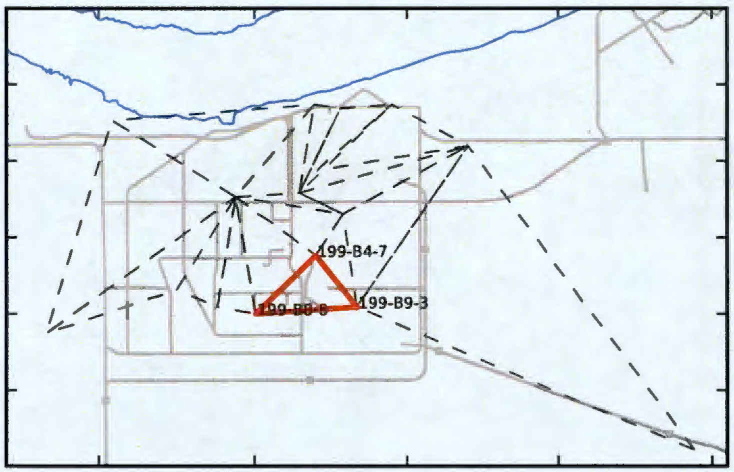
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 15*

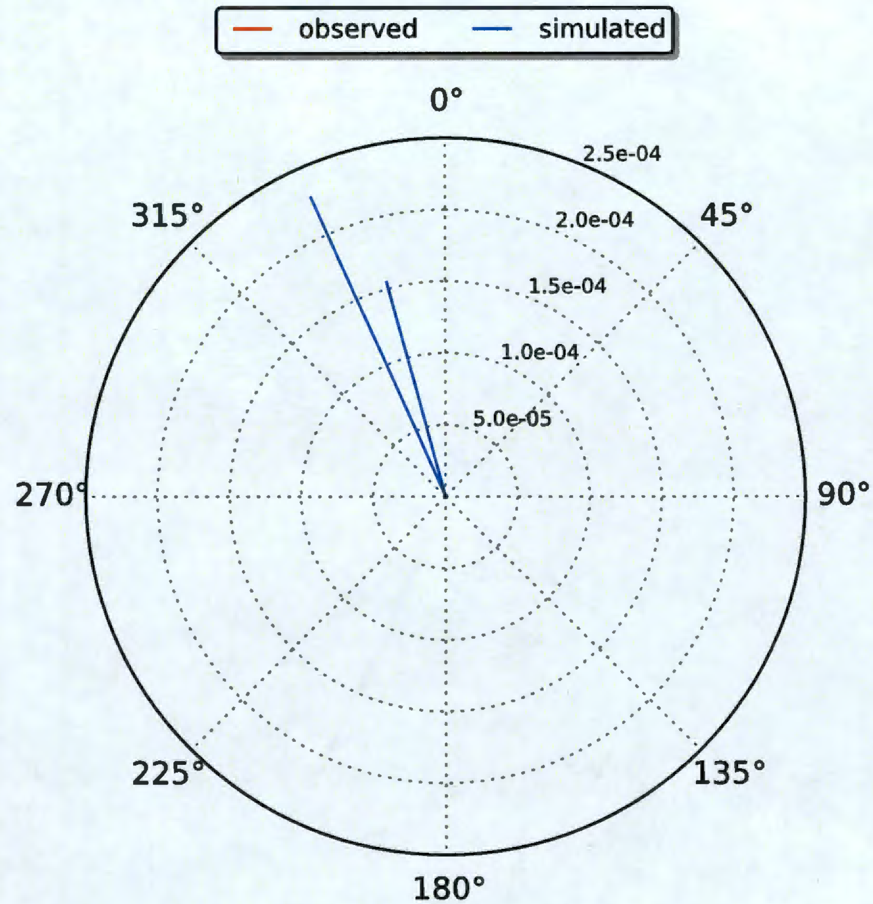



| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 51.4 | 335.0 |
| Maximum Azimuth | 81.7 | 335.7 |
| Minimum Magnitude | 4.6e-05 | 2.1e-04 |
| Maximum Magnitude | 1.6e-04 | 2.3e-04 |

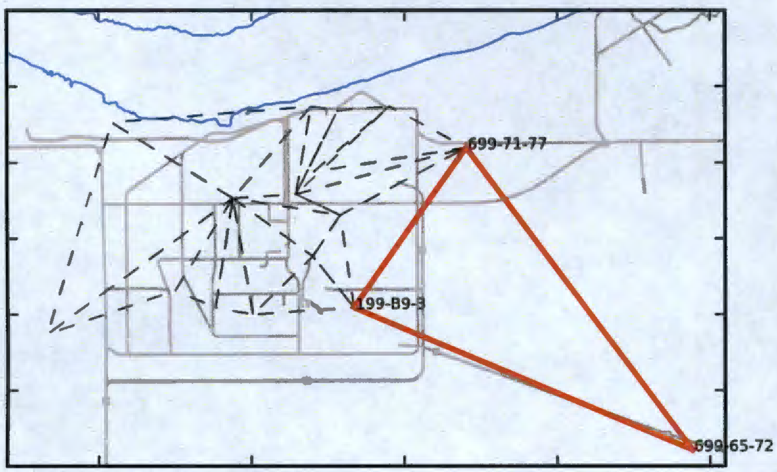
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 16*

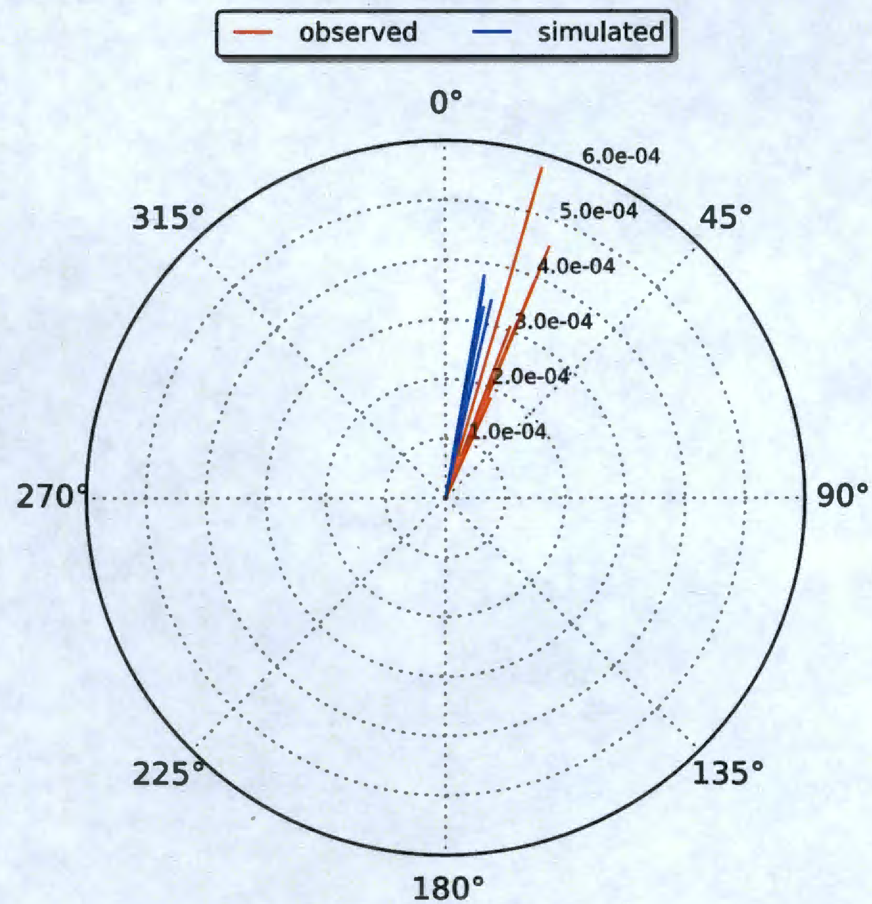



| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 180.0 | 335.9 |
| Maximum Azimuth | 180.0 | 344.8 |
| Minimum Magnitude | 0.0e+00 | 1.5e-04 |
| Maximum Magnitude | 0.0e+00 | 2.3e-04 |

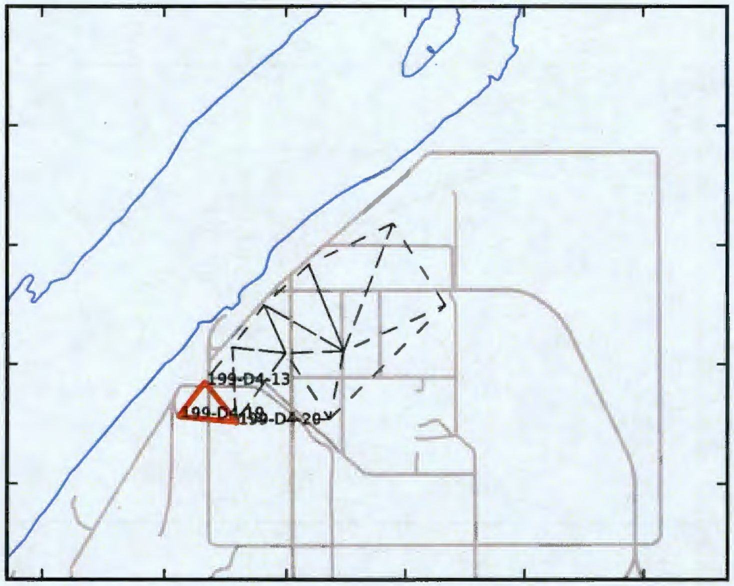
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 17*

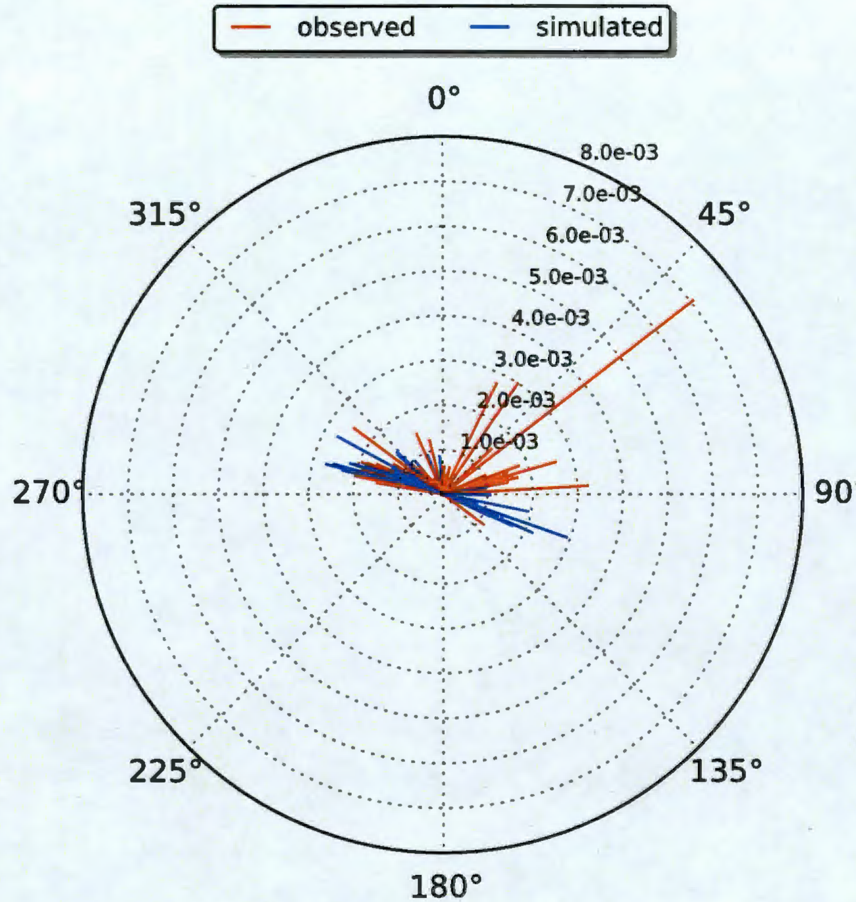



| | Observed | Simulated |
|---|---|---|
| Data Points | 6 | 6 |
| Minimum Azimuth | 16.3 | 9.9 |
| Maximum Azimuth | 24.3 | 13.0 |
| Minimum Magnitude | 1.8e-04 | 3.3e-04 |
| Maximum Magnitude | 5.8e-04 | 3.8e-04 |

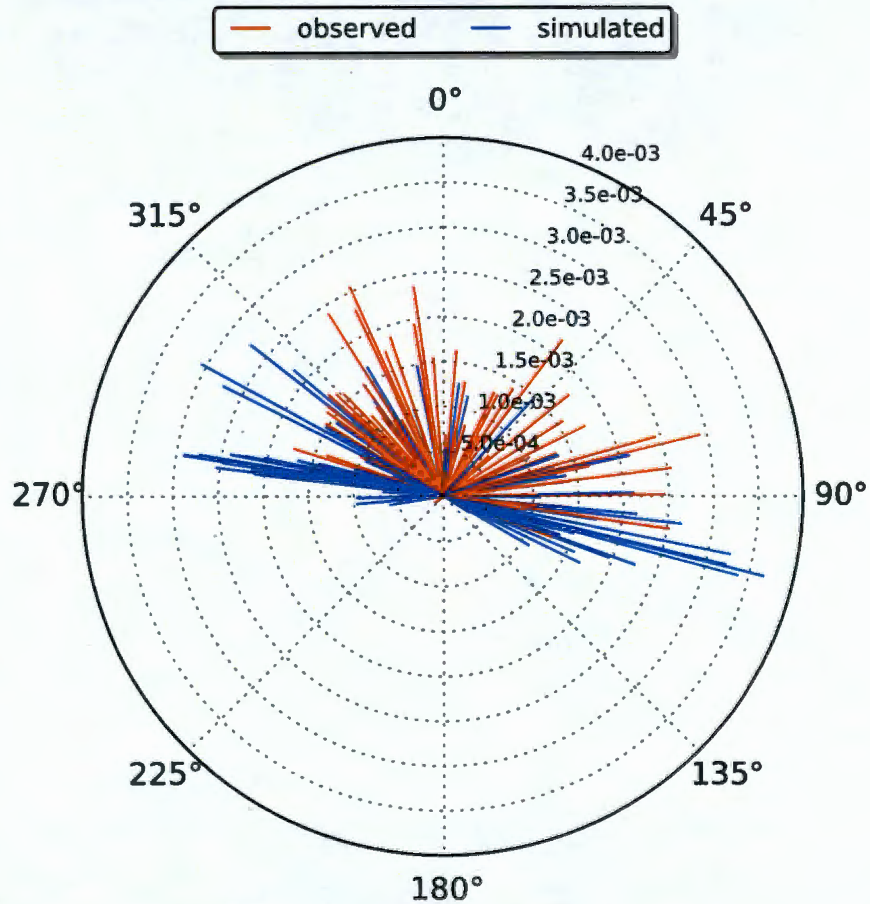
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 18*



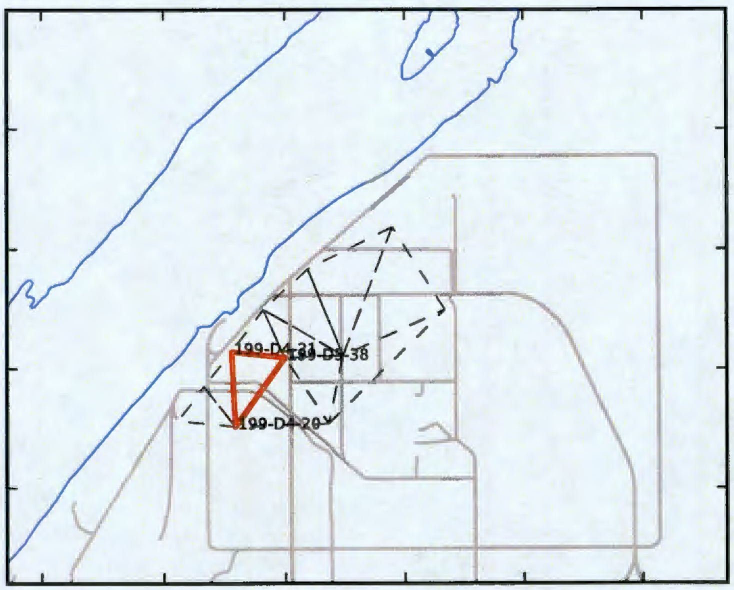

| | Observed | Simulated |
|---|---|---|
| Data Points | 65 | 65 |
| Minimum Azimuth | 2.0 | 32.5 |
| Maximum Azimuth | 359.1 | 355.2 |
| Minimum Magnitude | 2.6e-04 | 1.3e-04 |
| Maximum Magnitude | 7.1e-03 | 2.9e-03 |

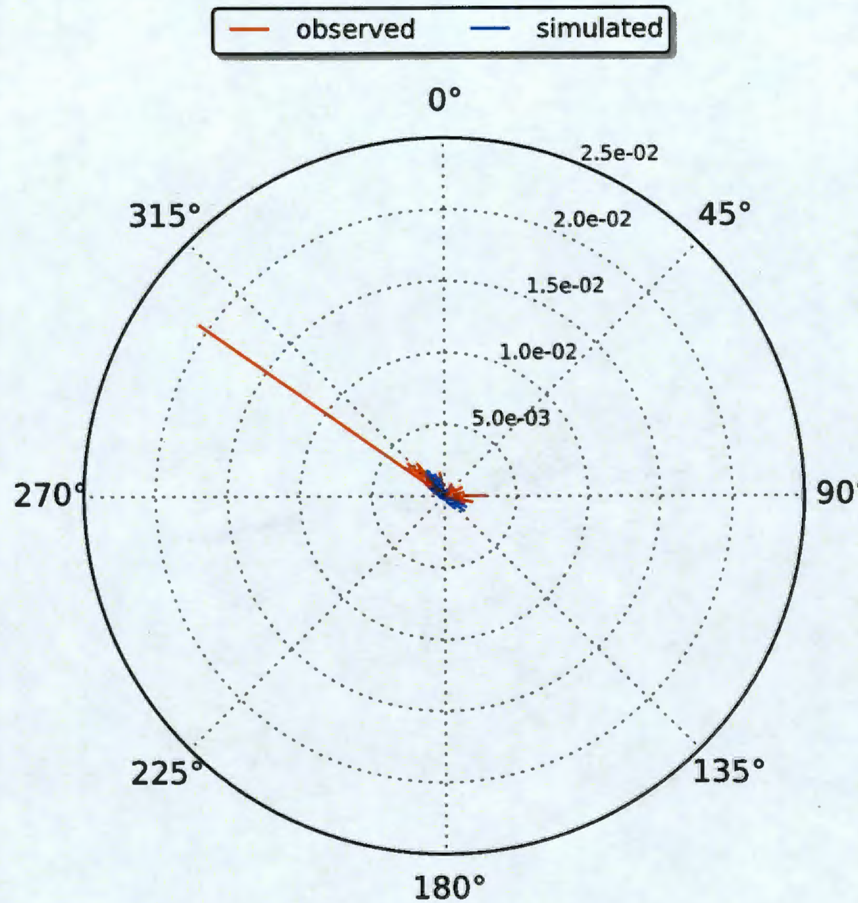
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 19*


| | Observed | Simulated |
|---|---|---|
| Data Points | 89 | 89 |
| Minimum Azimuth | 1.6 | 2.4 |
| Maximum Azimuth | 355.8 | 348.3 |
| Minimum Magnitude | 1.1e-04 | 8.4e-05 |
| Maximum Magnitude | 2.9e-03 | 3.7e-03 |

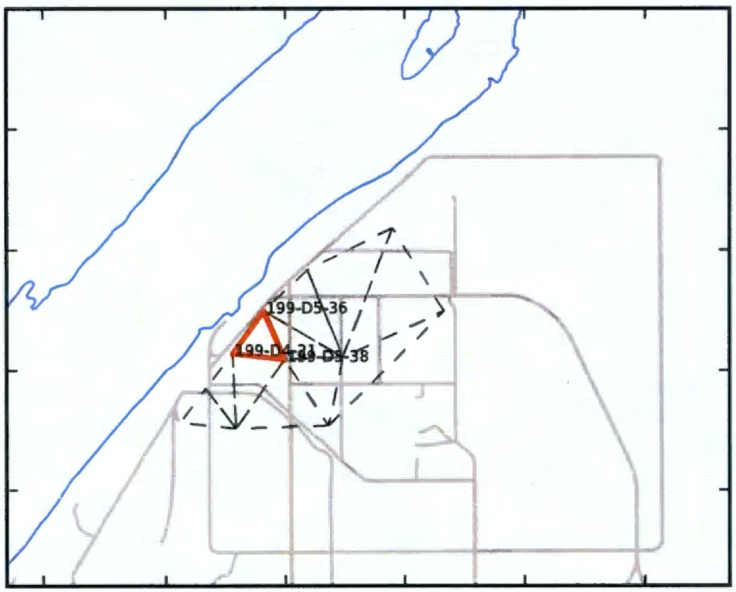
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 20*

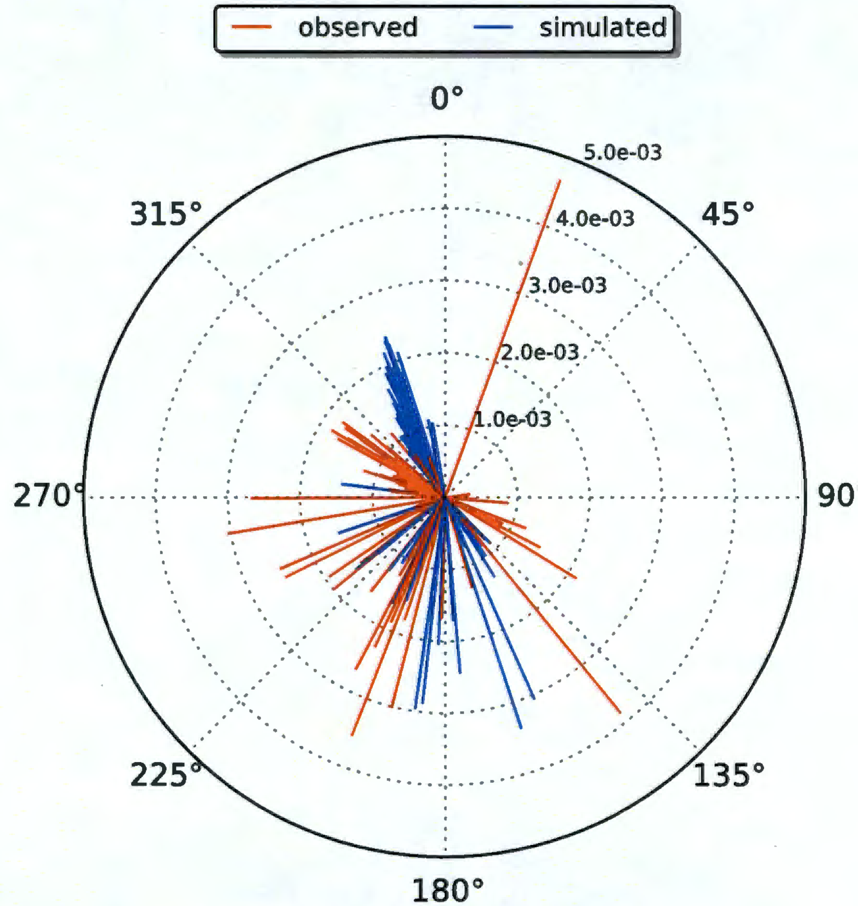



| | Observed | Simulated |
|---|---|---|
| Data Points | 87 | 87 |
| Minimum Azimuth | 23.5 | 7.9 |
| Maximum Azimuth | 348.3 | 346.8 |
| Minimum Magnitude | 1.9e-04 | 1.6e-04 |
| Maximum Magnitude | 2.1e-02 | 2.1e-03 |

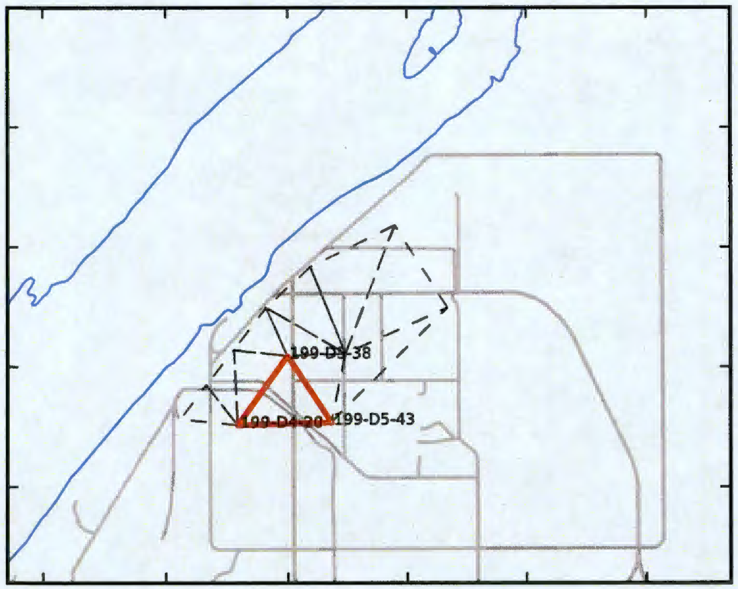
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 21*

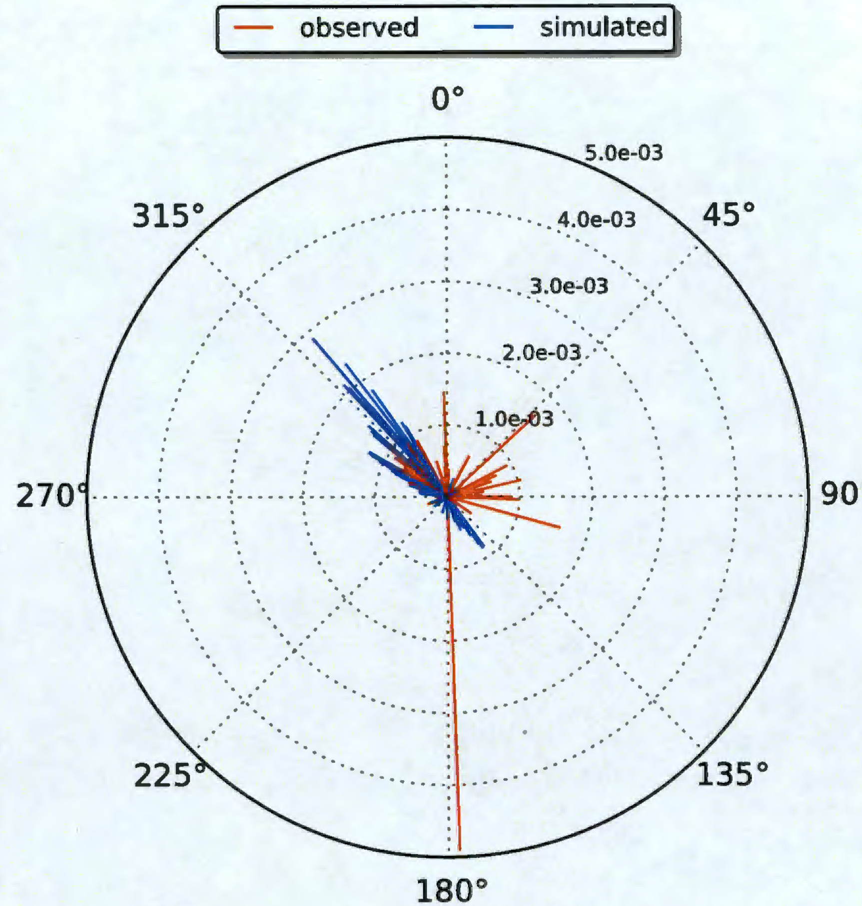



| | Observed | Simulated |
|---|---|---|
| Data Points | 80 | 80 |
| Minimum Azimuth | 19.9 | 116.1 |
| Maximum Azimuth | 338.9 | 350.2 |
| Minimum Magnitude | 9.1e-05 | 1.3e-04 |
| Maximum Magnitude | 4.7e-03 | 3.4e-03 |

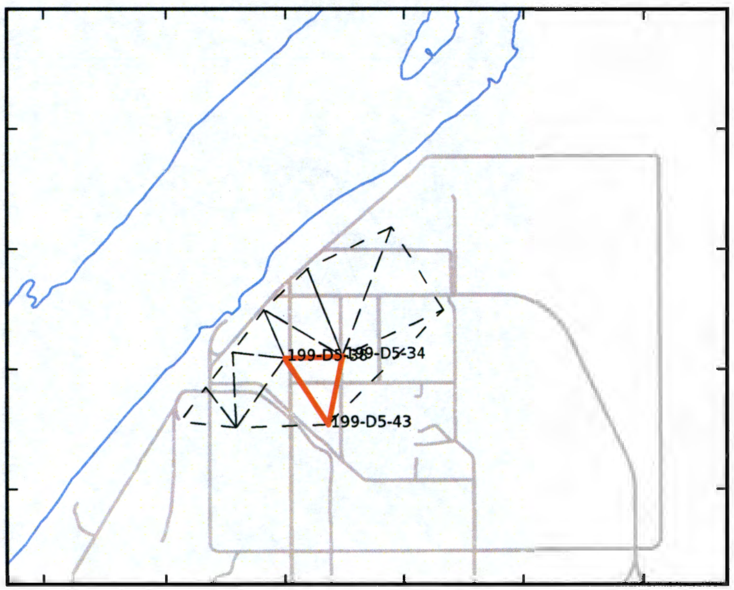
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 22*

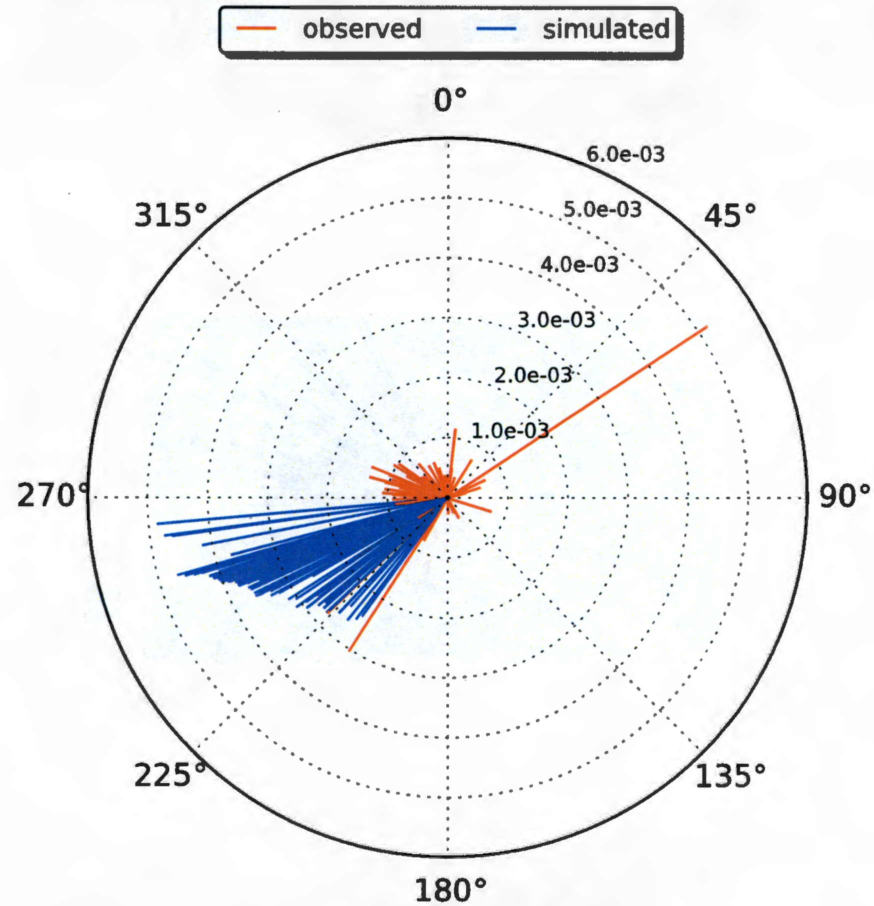



| | Observed | Simulated |
|---|---|---|
| Data Points | 76 | 76 |
| Minimum Azimuth | 2.2 | 17.7 |
| Maximum Azimuth | 358.2 | 329.4 |
| Minimum Magnitude | 3.5e-05 | 1.5e-04 |
| Maximum Magnitude | 4.9e-03 | 2.9e-03 |

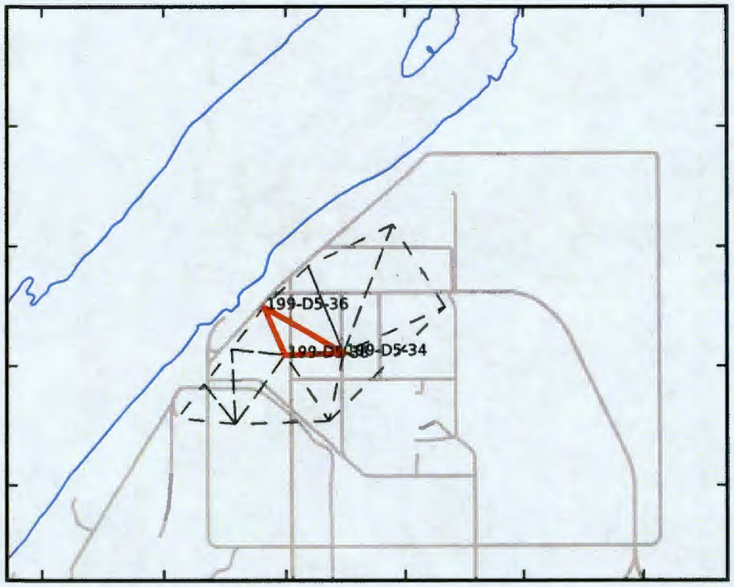
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 23*

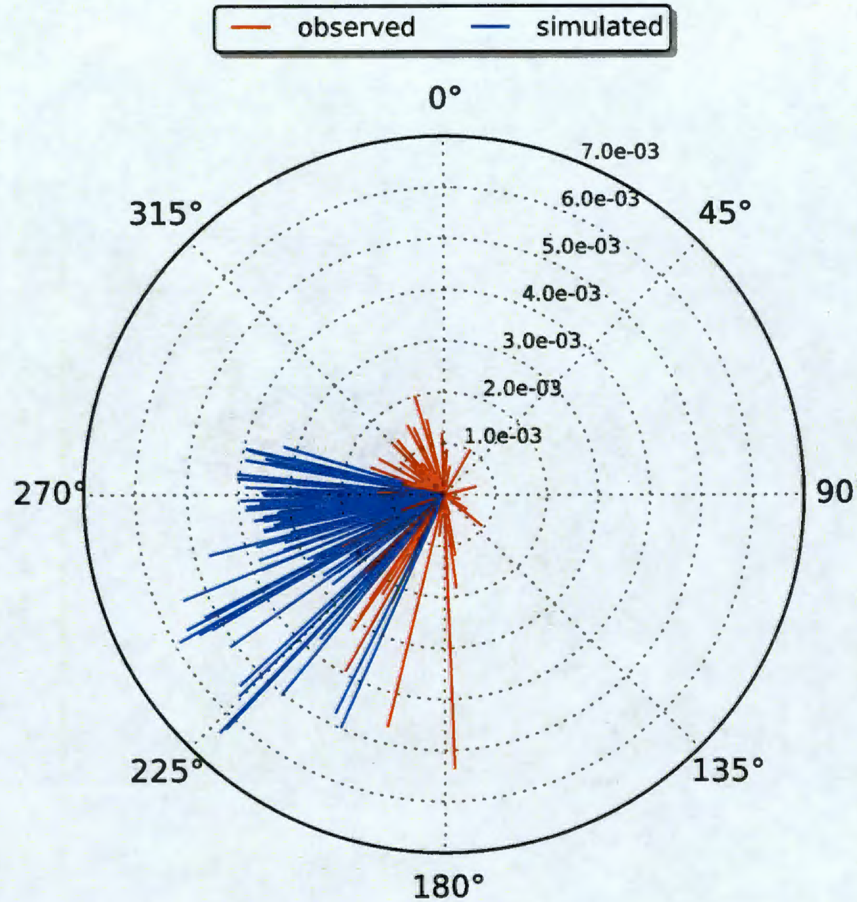



| | Observed | Simulated |
|---|---|---|
| Data Points | 73 | 73 |
| Minimum Azimuth | 6.3 | 215.9 |
| Maximum Azimuth | 358.0 | 264.9 |
| Minimum Magnitude | 5.3e-17 | 2.4e-03 |
| Maximum Magnitude | 5.2e-03 | 4.8e-03 |

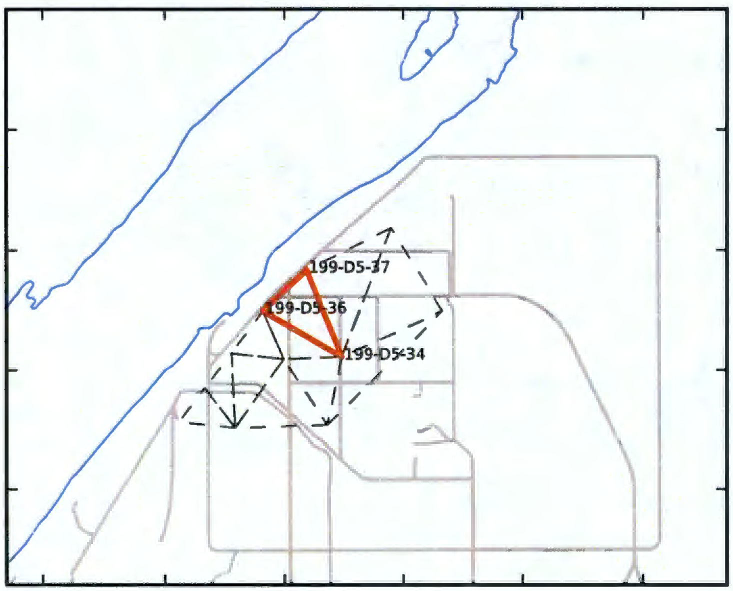
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 24*

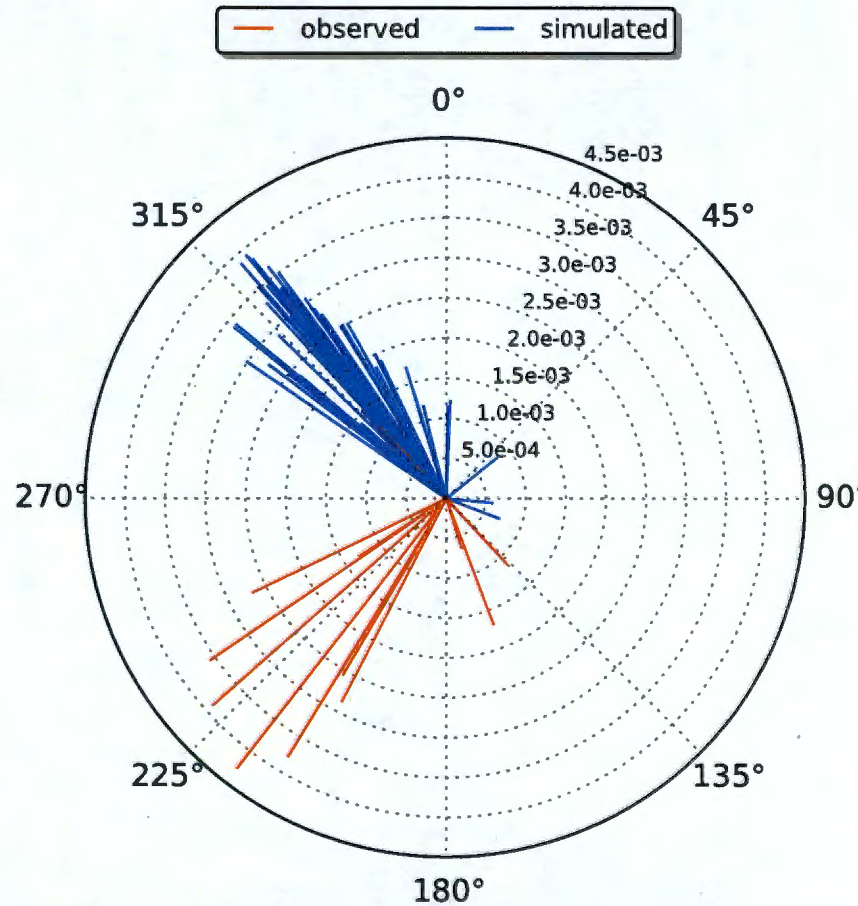



| | Observed | Simulated |
|---|---|---|
| Data Points | 78 | 78 |
| Minimum Azimuth | 3.4 | 204.1 |
| Maximum Azimuth | 358.0 | 286.8 |
| Minimum Magnitude | 2.6e-04 | 1.9e-03 |
| Maximum Magnitude | 5.4e-03 | 6.4e-03 |

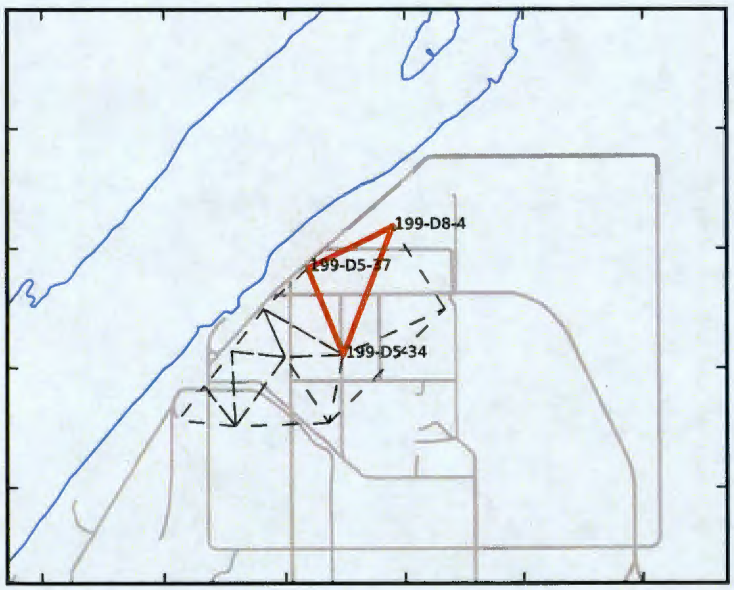
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 25*

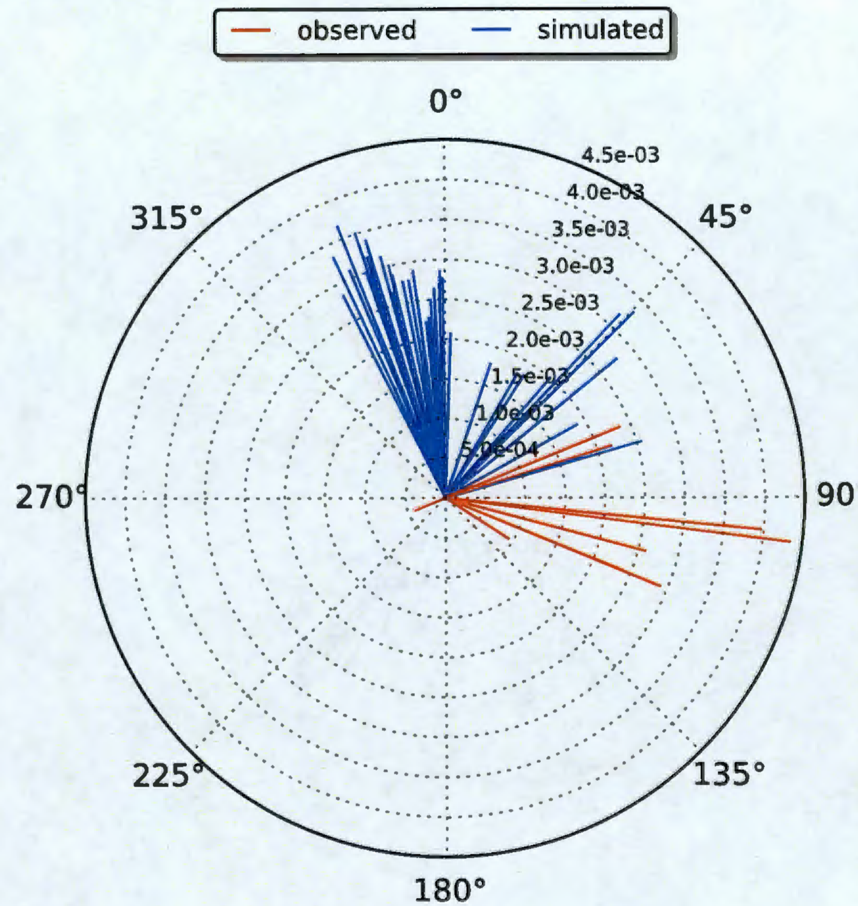



| | Observed | Simulated |
|---|---|---|
| Data Points | 59 | 59 |
| Minimum Azimuth | 26.6 | 0.8 |
| Maximum Azimuth | 317.0 | 346.0 |
| Minimum Magnitude | 4.0e-17 | 5.8e-04 |
| Maximum Magnitude | 4.3e-03 | 3.9e-03 |

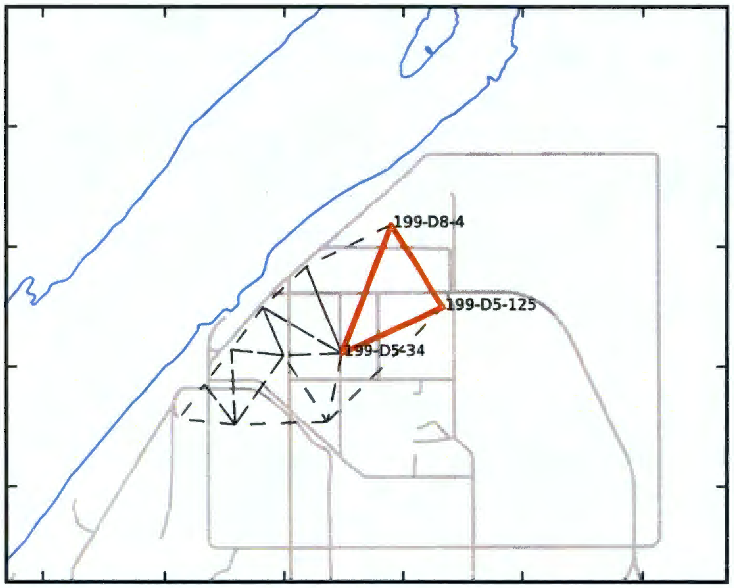
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 26*

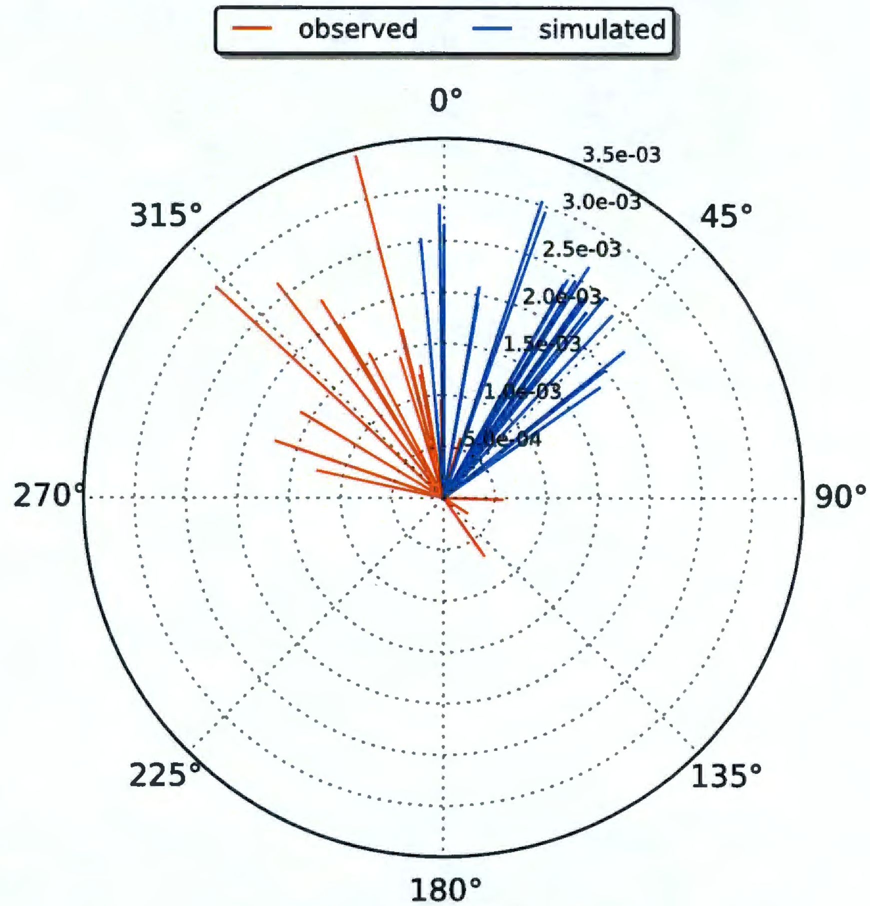



| | Observed | Simulated |
|---|---|---|
| Data Points | 38 | 38 |
| Minimum Azimuth | 67.8 | 1.9 |
| Maximum Azimuth | 247.8 | 359.4 |
| Minimum Magnitude | 7.6e-05 | 1.8e-03 |
| Maximum Magnitude | 4.3e-03 | 3.7e-03 |

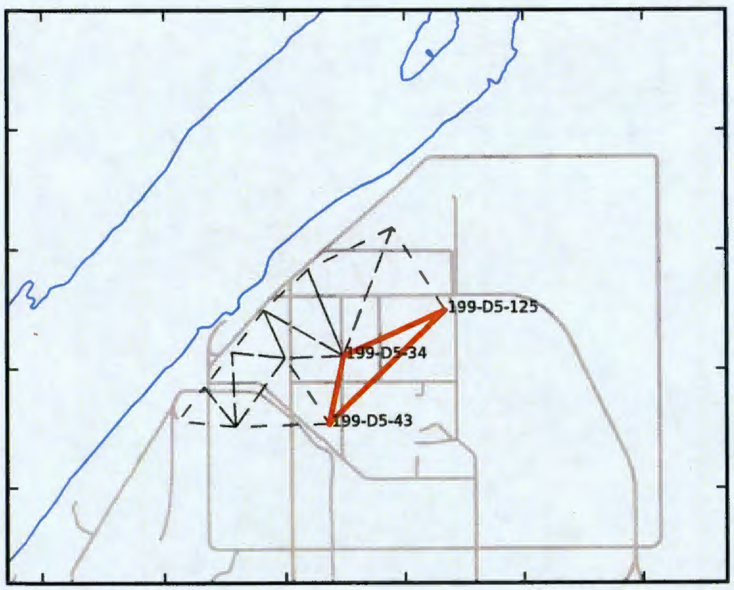
# Three-Point Gradients (Observed vs.Simulated) at Triangle 27

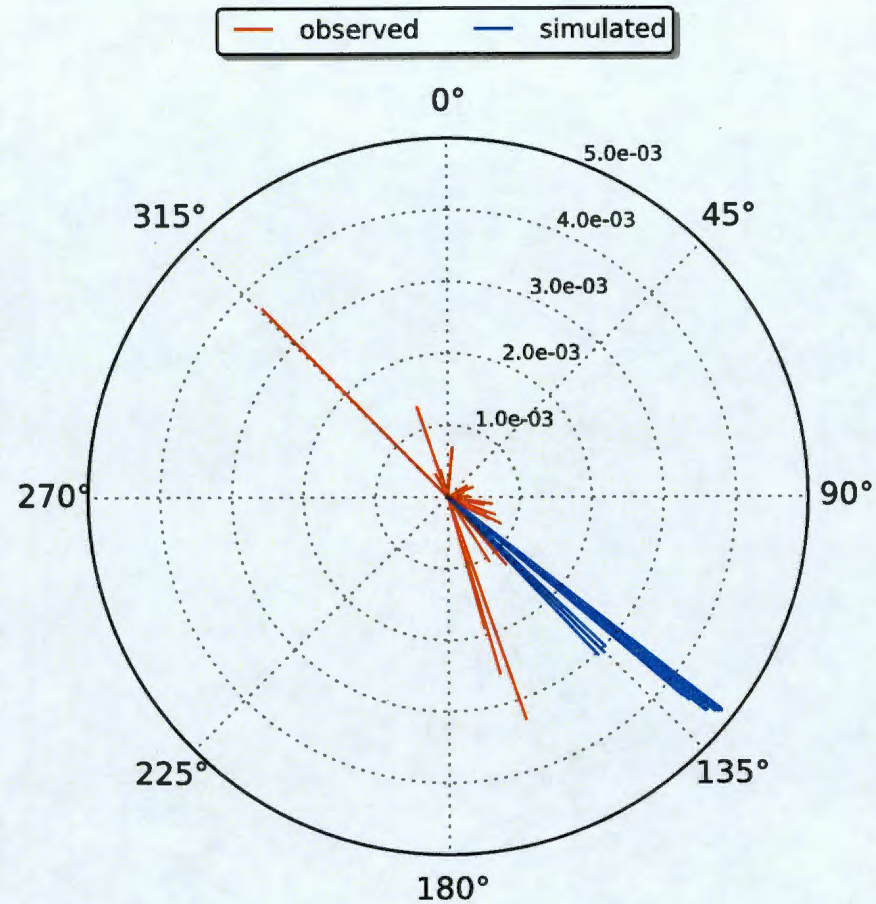



| | Observed | Simulated |
|---|---|---|
| Data Points | 21 | 21 |
| Minimum Azimuth | 16.1 | 9.5 |
| Maximum Azimuth | 359.6 | 360.0 |
| Minimum Magnitude | 2.7e-04 | 1.5e-03 |
| Maximum Magnitude | 3.4e-03 | 3.0e-03 |

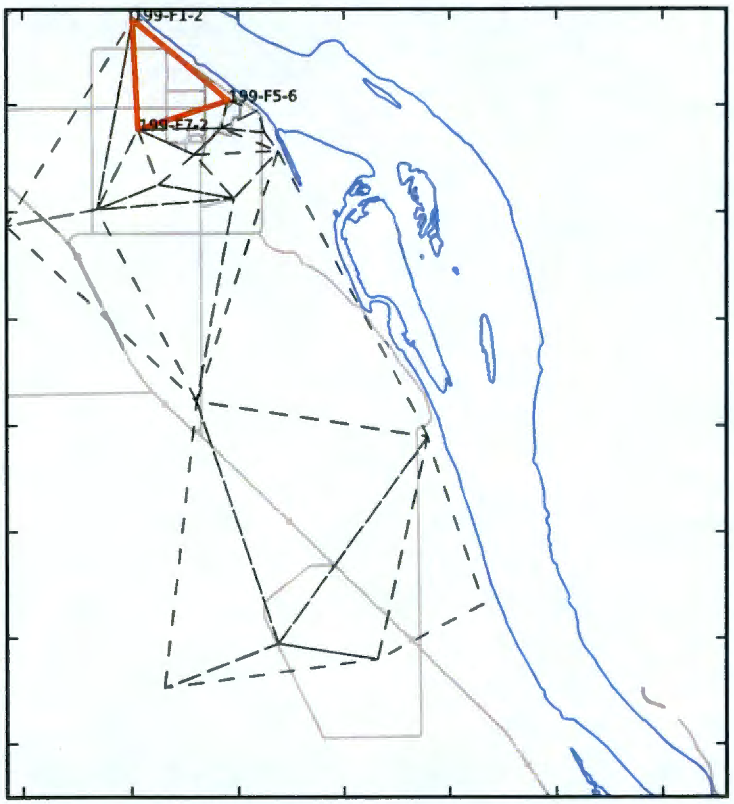
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 28*

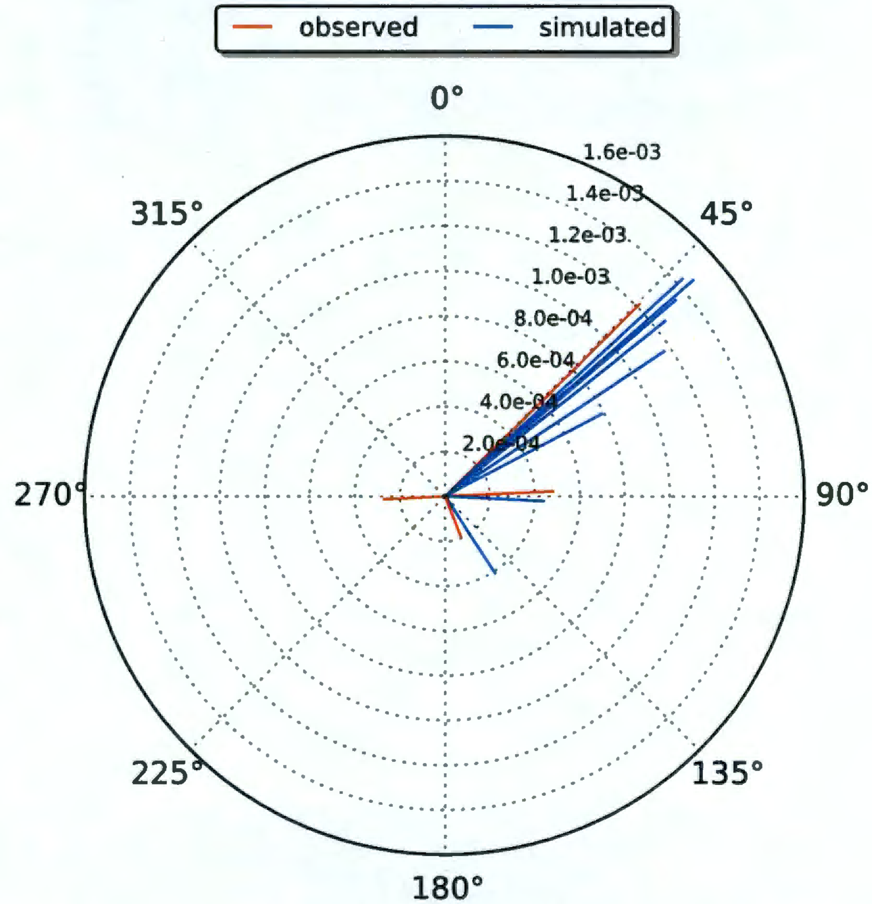



| | Observed | Simulated |
|---|---|---|
| Data Points | 29 | 29 |
| Minimum Azimuth | 1.7 | 128.2 |
| Maximum Azimuth | 345.4 | 136.8 |
| Minimum Magnitude | 2.2e-04 | 2.5e-03 |
| Maximum Magnitude | 3.7e-03 | 4.8e-03 |

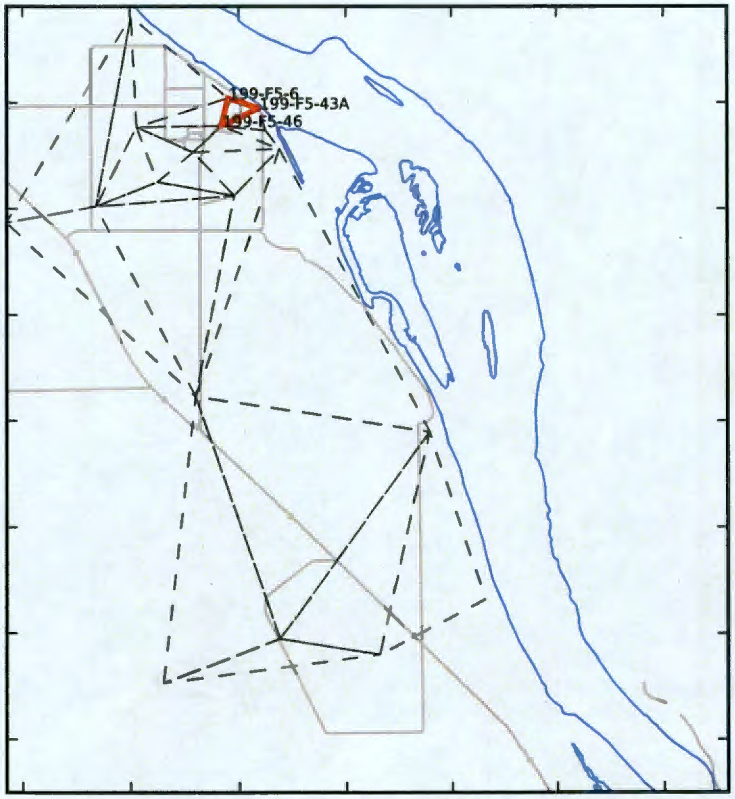
# Three-Point Gradients (Observed vs.Simulated) at Triangle 29

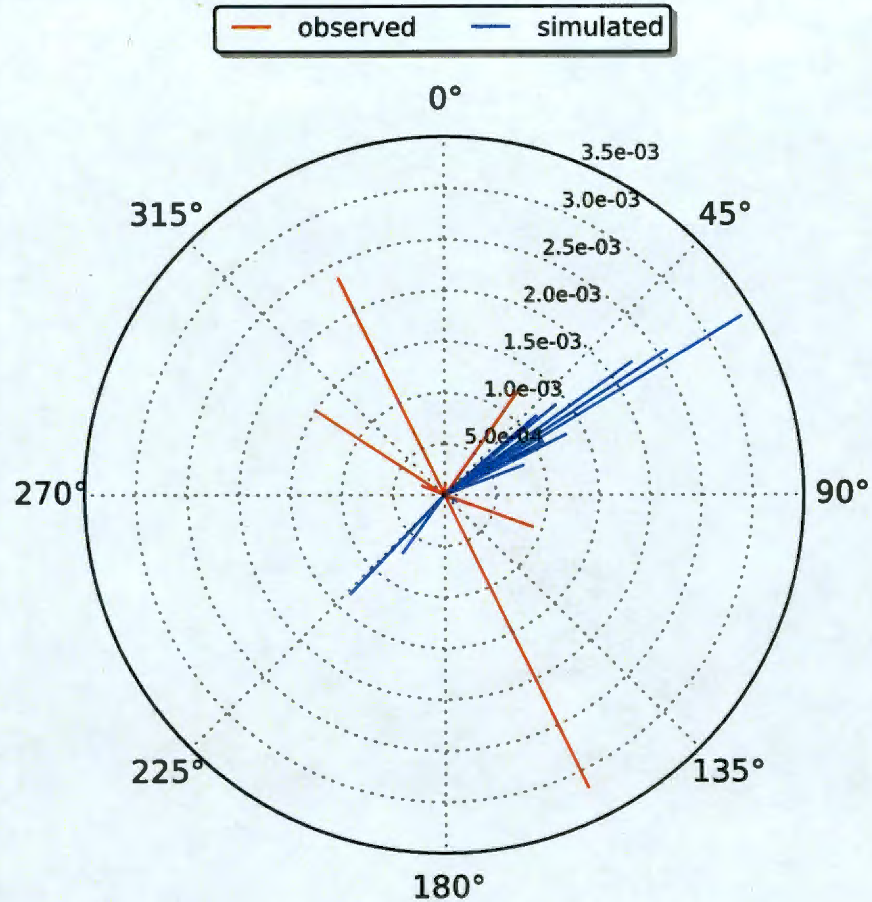



| | Observed | Simulated |
|---|---|---|
| Data Points | 8 | 8 |
| Minimum Azimuth | 45.4 | 47.6 |
| Maximum Azimuth | 267.3 | 147.2 |
| Minimum Magnitude | 1.2e-05 | 4.1e-04 |
| Maximum Magnitude | 1.2e-03 | 1.5e-03 |

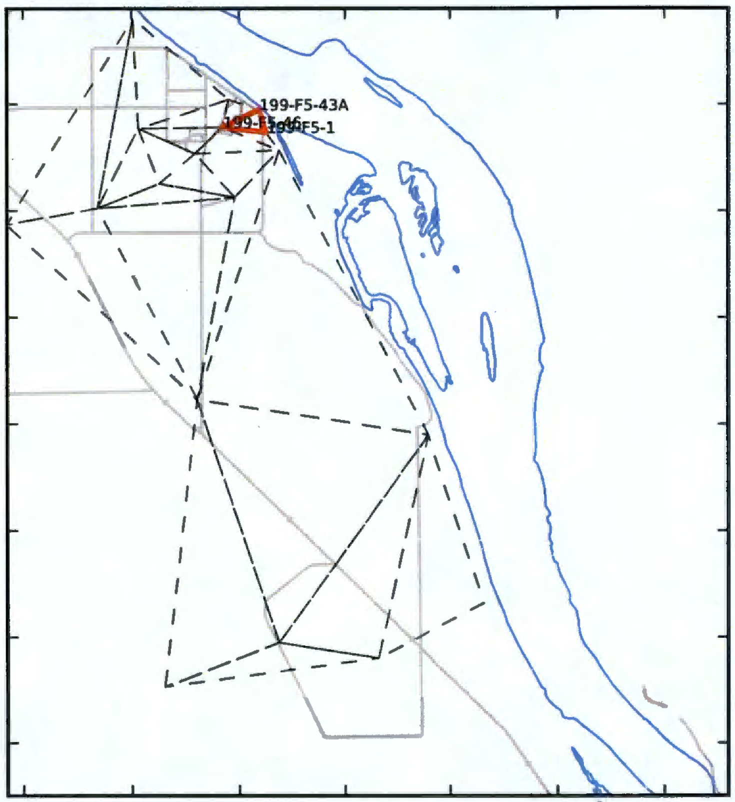
# Three-Point Gradients (Observed vs.Simulated) at Triangle 30

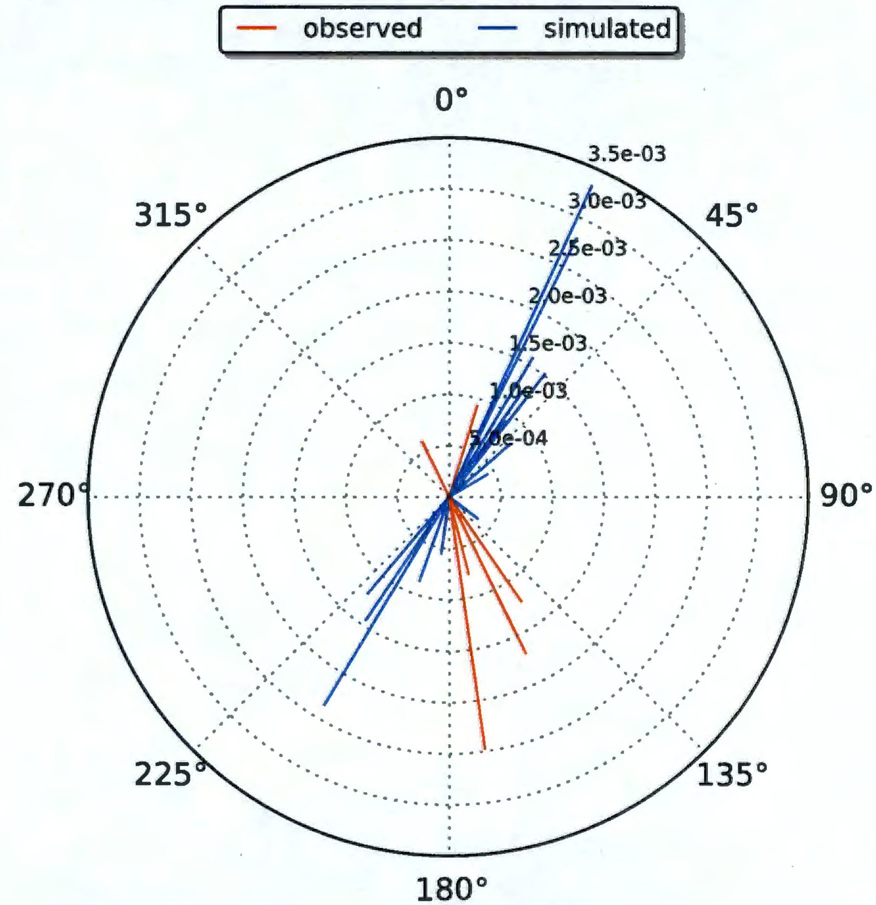



| | Observed | Simulated |
|---|---|---|
| Data Points | 14 | 14 |
| Minimum Azimuth | 1.3 | 47.5 |
| Maximum Azimuth | 334.1 | 223.6 |
| Minimum Magnitude | 4.8e-05 | 1.3e-04 |
| Maximum Magnitude | 3.2e-03 | 3.4e-03 |

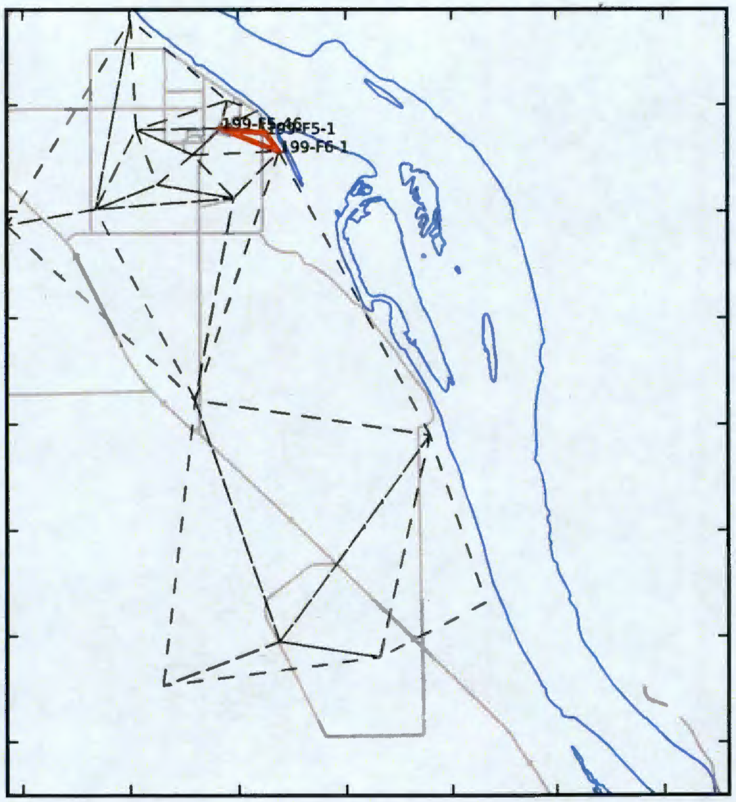
# Three-Point Gradients (Observed vs.Simulated) at Triangle 31

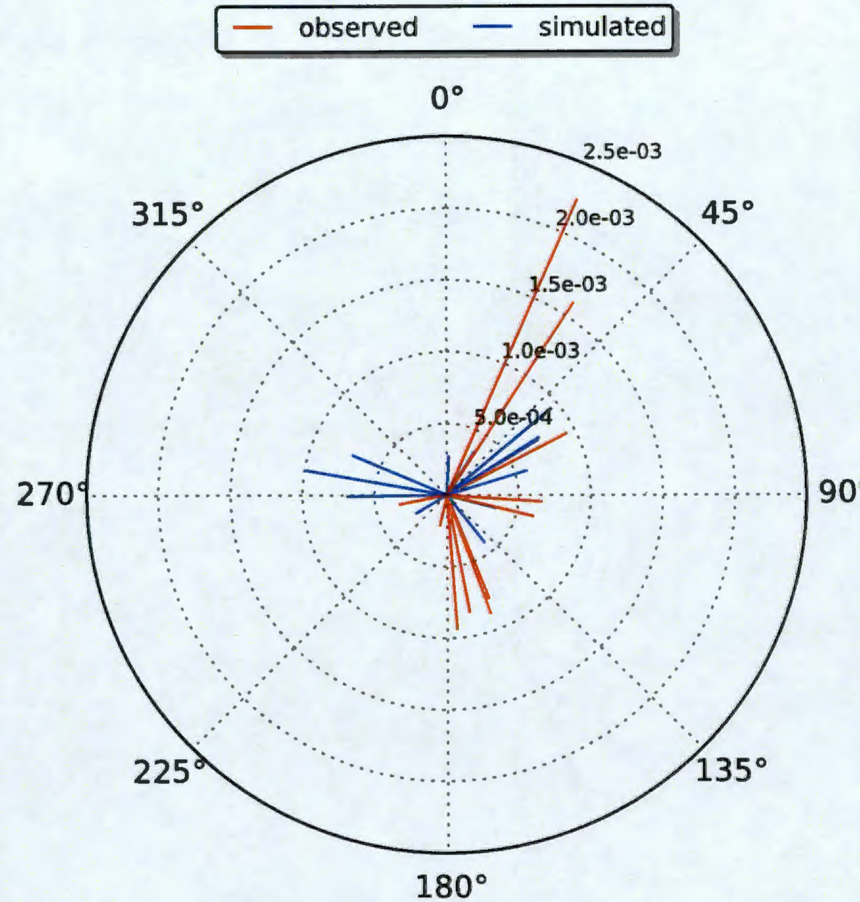



| | Observed | Simulated |
|---|---|---|
| Data Points | 16 | 16 |
| Minimum Azimuth | 16.8 | 24.5 |
| Maximum Azimuth | 334.1 | 220.1 |
| Minimum Magnitude | 4.6e-05 | 1.9e-04 |
| Maximum Magnitude | 2.5e-03 | 3.3e-03 |

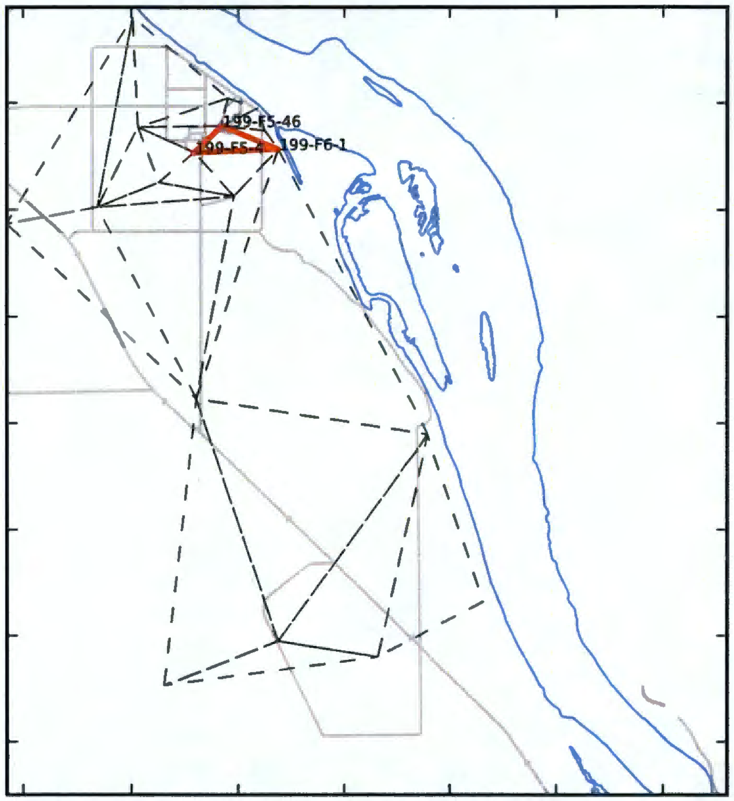
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 32*

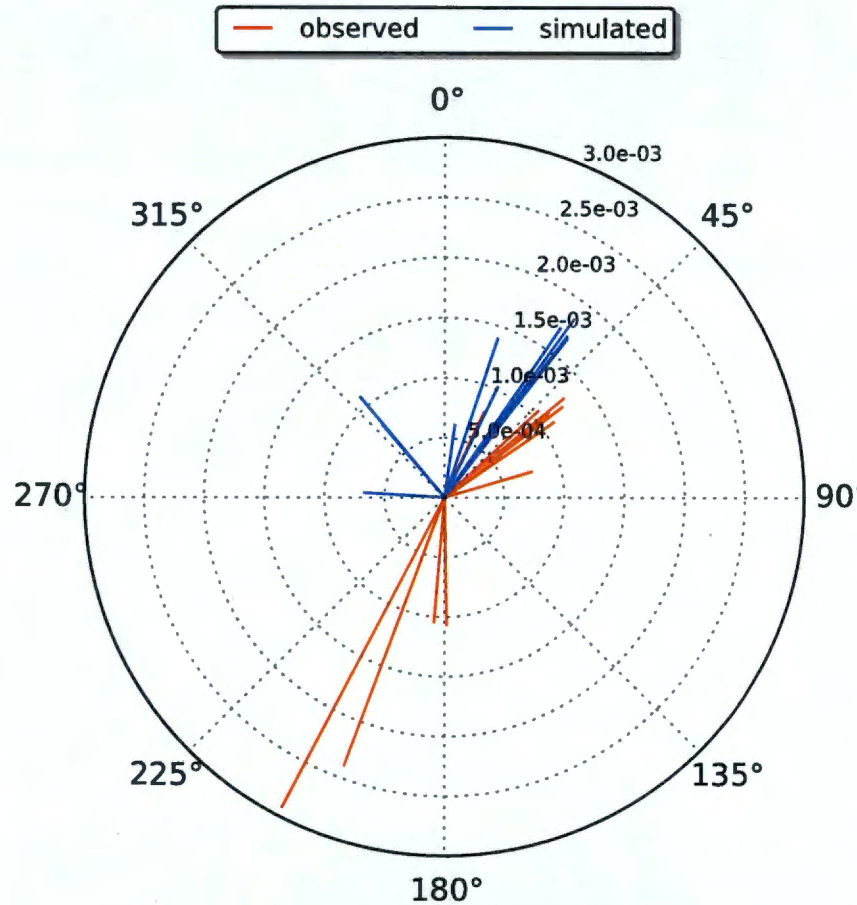



| | Observed | Simulated |
|---|---|---|
| Data Points | 12 | 12 |
| Minimum Azimuth | 23.9 | 2.6 |
| Maximum Azimuth | 259.0 | 293.1 |
| Minimum Magnitude | 2.1e-04 | 2.5e-04 |
| Maximum Magnitude | 2.2e-03 | 9.9e-04 |

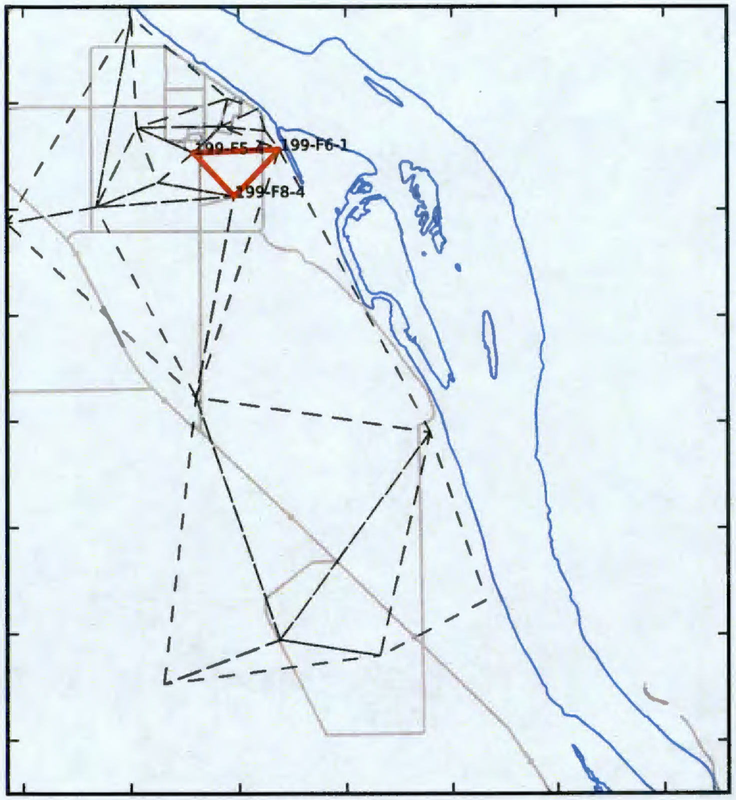
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 33*

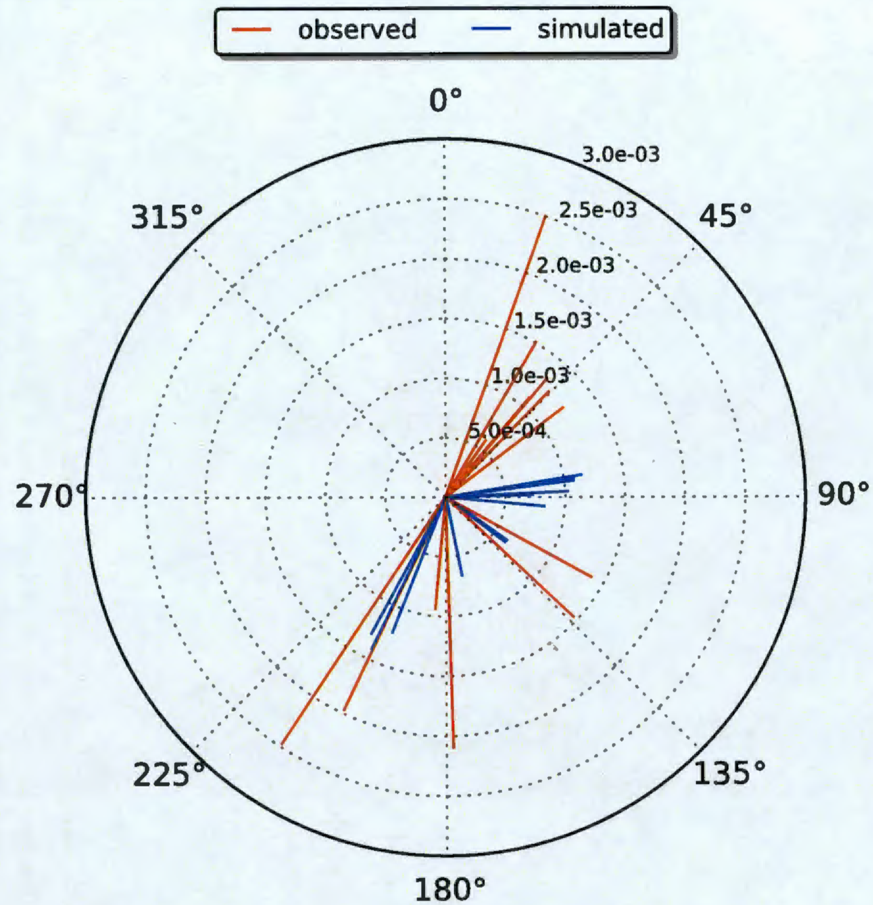



| | Observed | Simulated |
|---|---|---|
| Data Points | 12 | 12 |
| Minimum Azimuth | 24.6 | 7.9 |
| Maximum Azimuth | 207.5 | 320.0 |
| Minimum Magnitude | 7.5e-04 | 6.1e-04 |
| Maximum Magnitude | 2.9e-03 | 1.8e-03 |

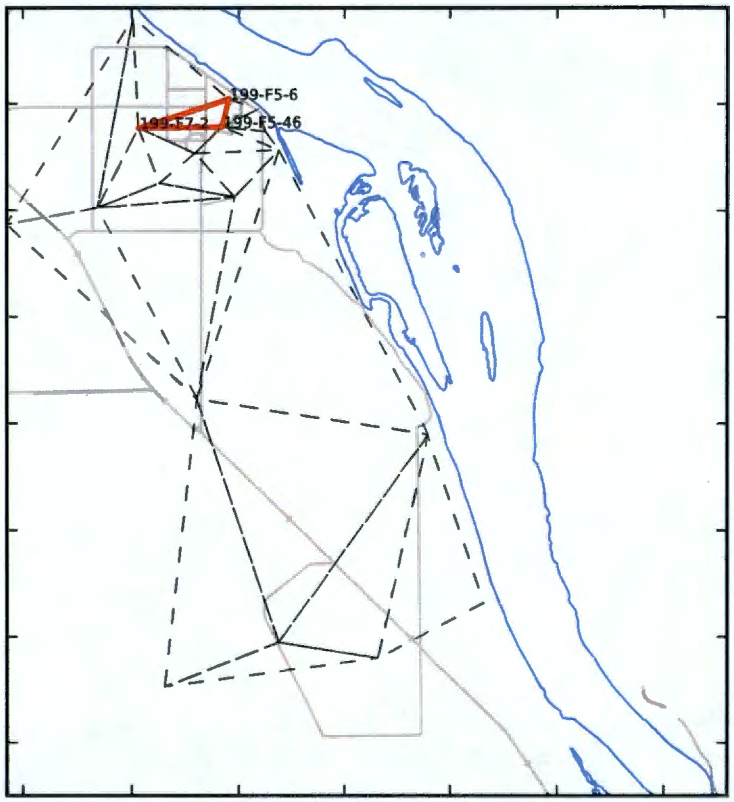
# Three-Point Gradients (Observed vs.Simulated) at Triangle 34

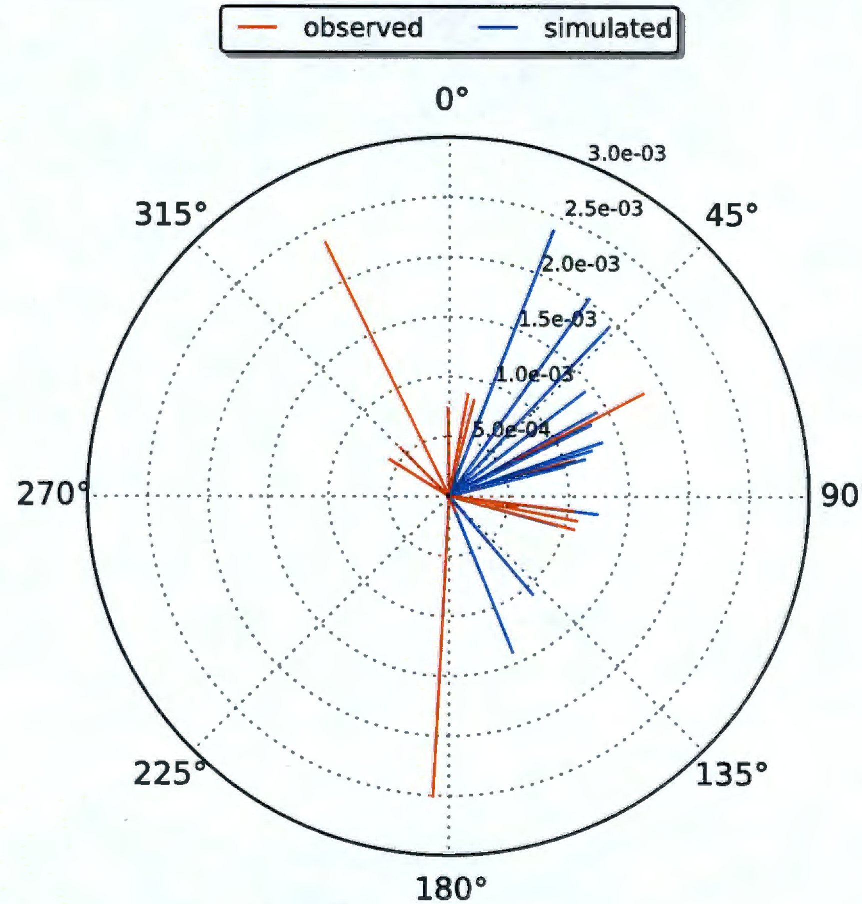



| | Observed | Simulated |
|---|---|---|
| Data Points | 13 | 13 |
| Minimum Azimuth | 19.7 | 80.6 |
| Maximum Azimuth | 213.7 | 208.6 |
| Minimum Magnitude | 5.8e-04 | 6.2e-04 |
| Maximum Magnitude | 2.5e-03 | 1.4e-03 |

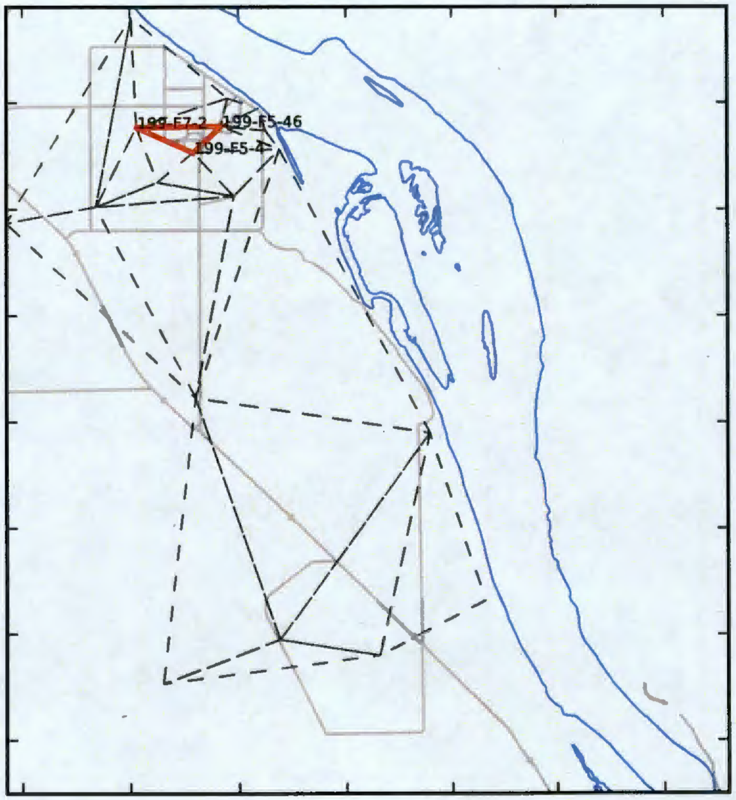
# Three-Point Gradients (Observed vs.Simulated) at Triangle 35

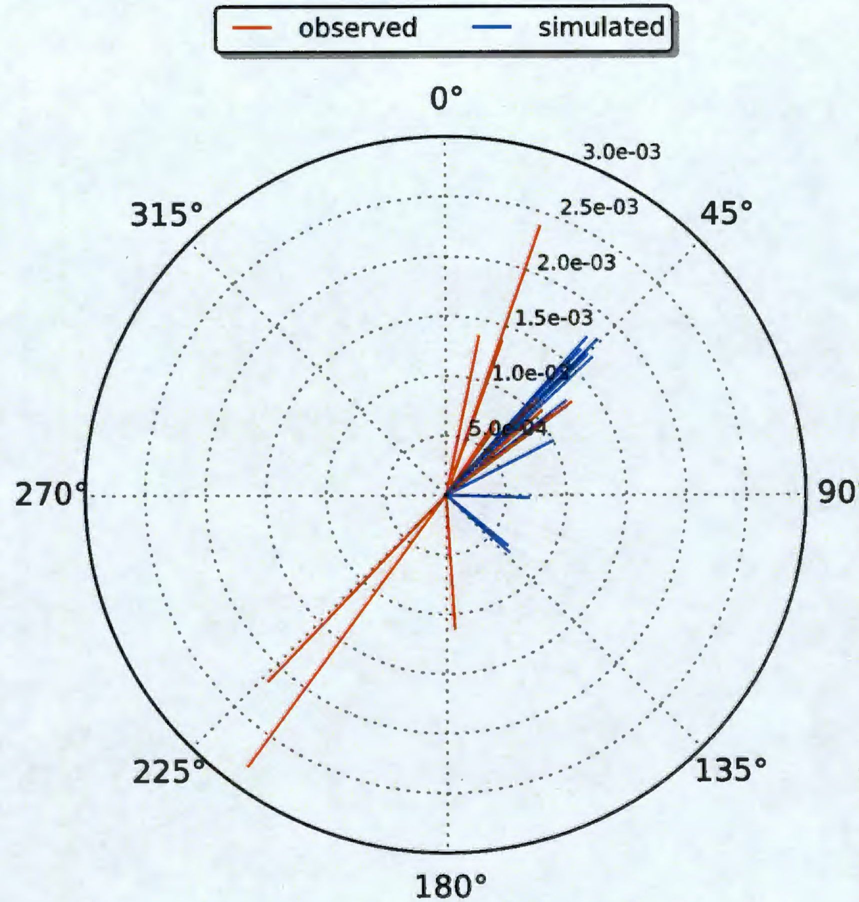



| | Observed | Simulated |
|---|---|---|
| Data Points | 14 | 14 |
| Minimum Azimuth | 10.3 | 21.3 |
| Maximum Azimuth | 359.2 | 157.8 |
| Minimum Magnitude | 1.4e-04 | 9.3e-04 |
| Maximum Magnitude | 2.5e-03 | 2.4e-03 |

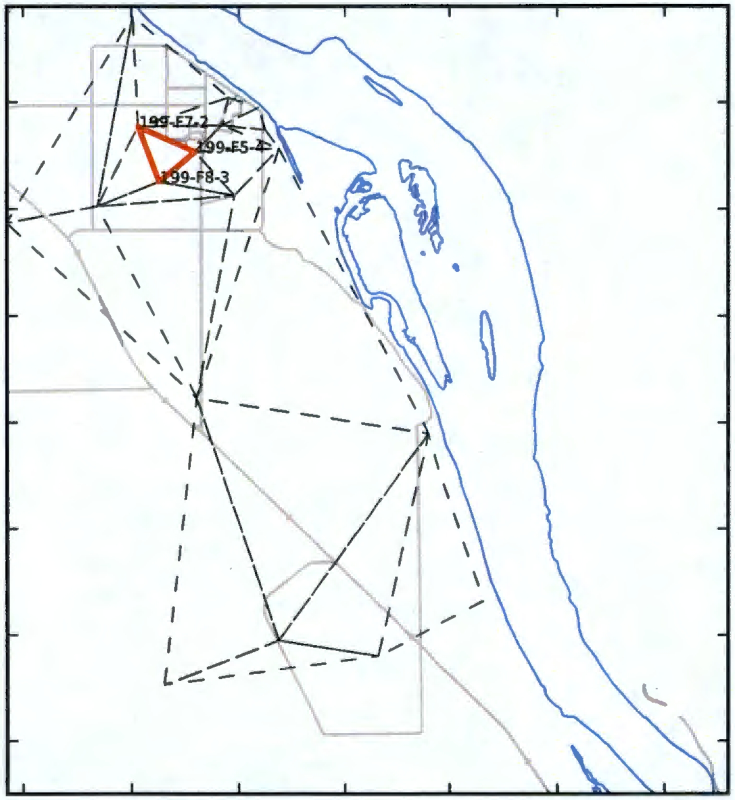
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 36*

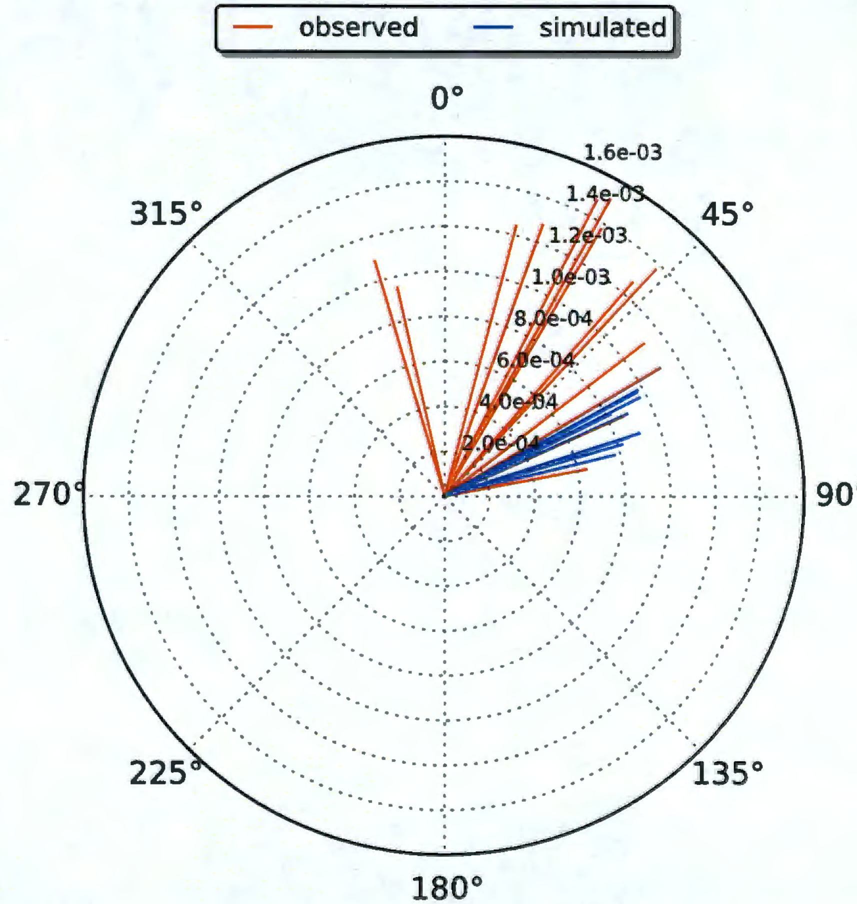



| | Observed | Simulated |
|---|---|---|
| Data Points | 12 | 12 |
| Minimum Azimuth | 11.7 | 41.6 |
| Maximum Azimuth | 223.7 | 132.5 |
| Minimum Magnitude | 6.8e-04 | 6.6e-04 |
| Maximum Magnitude | 2.8e-03 | 1.8e-03 |

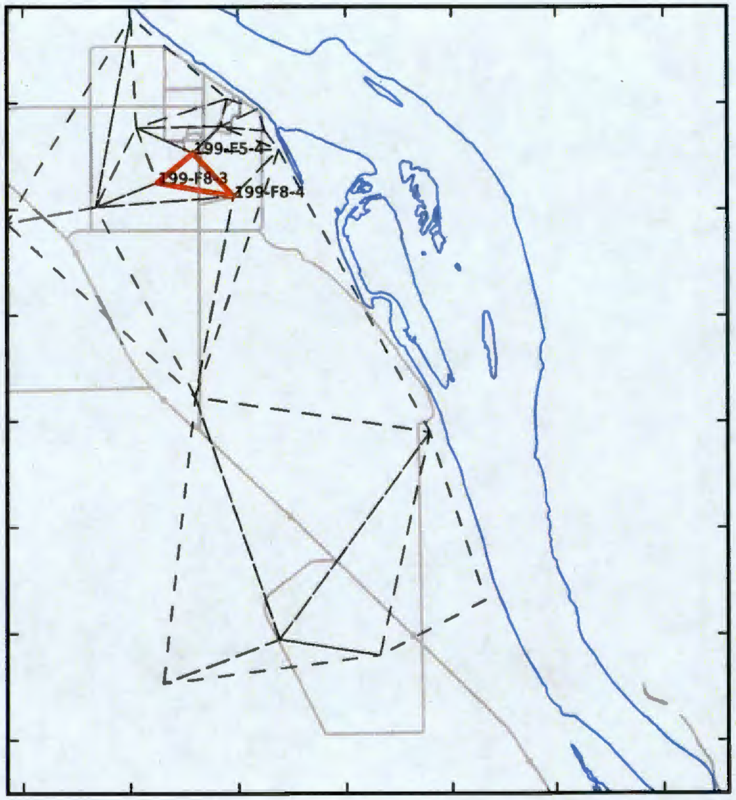
# Three-Point Gradients (Observed vs.Simulated) at Triangle 37

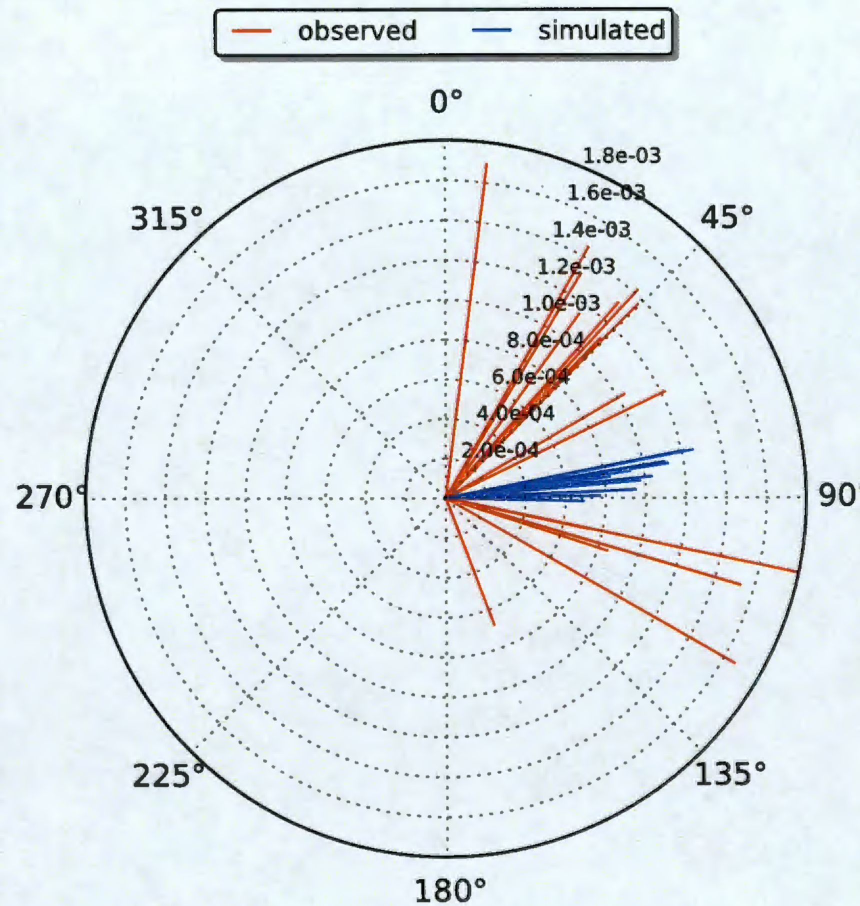



| | Observed | Simulated |
|---|---|---|
| Data Points | 13 | 13 |
| Minimum Azimuth | 14.6 | 59.0 |
| Maximum Azimuth | 347.1 | 76.4 |
| Minimum Magnitude | 6.4e-04 | 6.6e-04 |
| Maximum Magnitude | 1.5e-03 | 1.1e-03 |

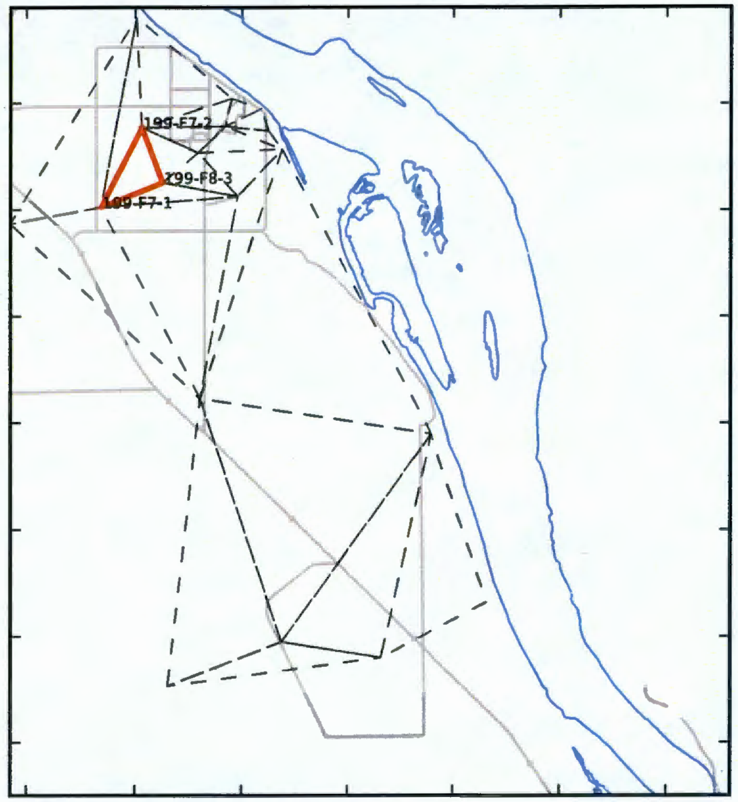
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 38*

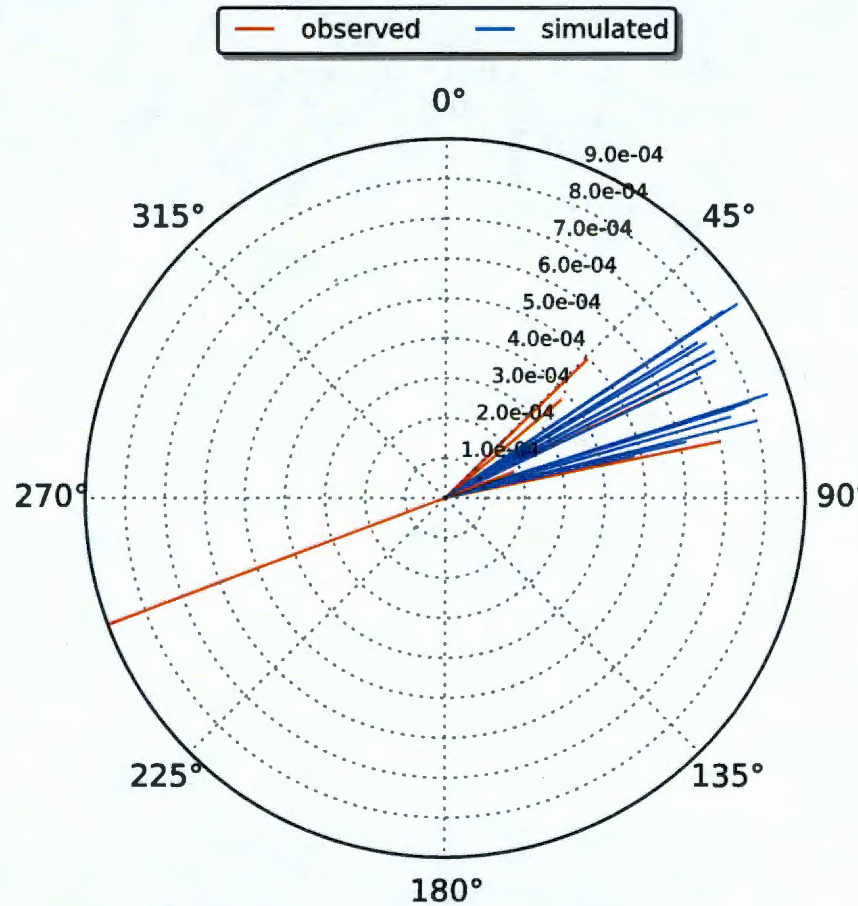



| | Observed | Simulated |
|---|---|---|
| Data Points | 16 | 16 |
| Minimum Azimuth | 7.1 | 78.6 |
| Maximum Azimuth | 159.5 | 91.4 |
| Minimum Magnitude | 6.8e-04 | 6.9e-04 |
| Maximum Magnitude | 1.8e-03 | 1.3e-03 |

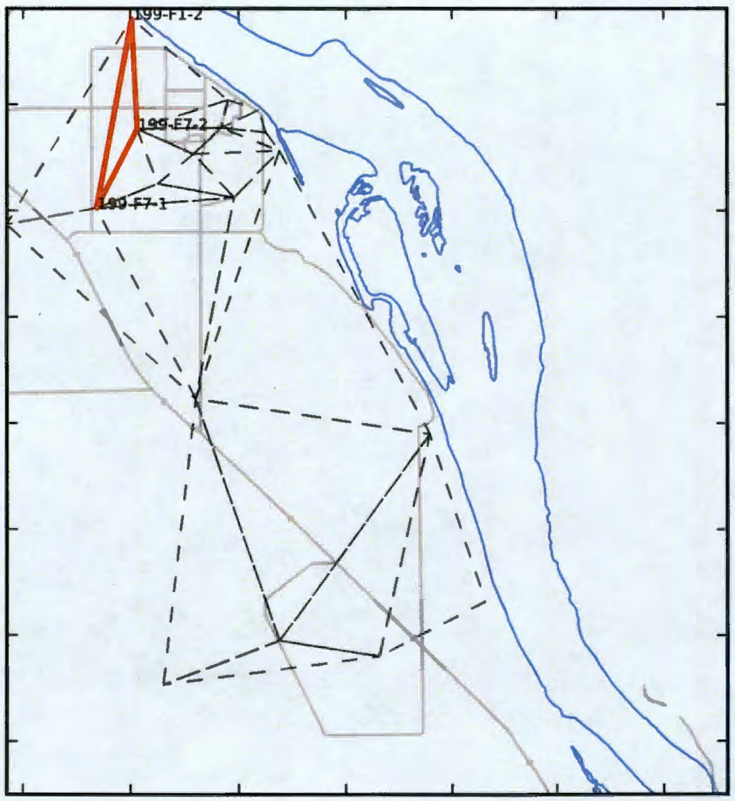
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 39*

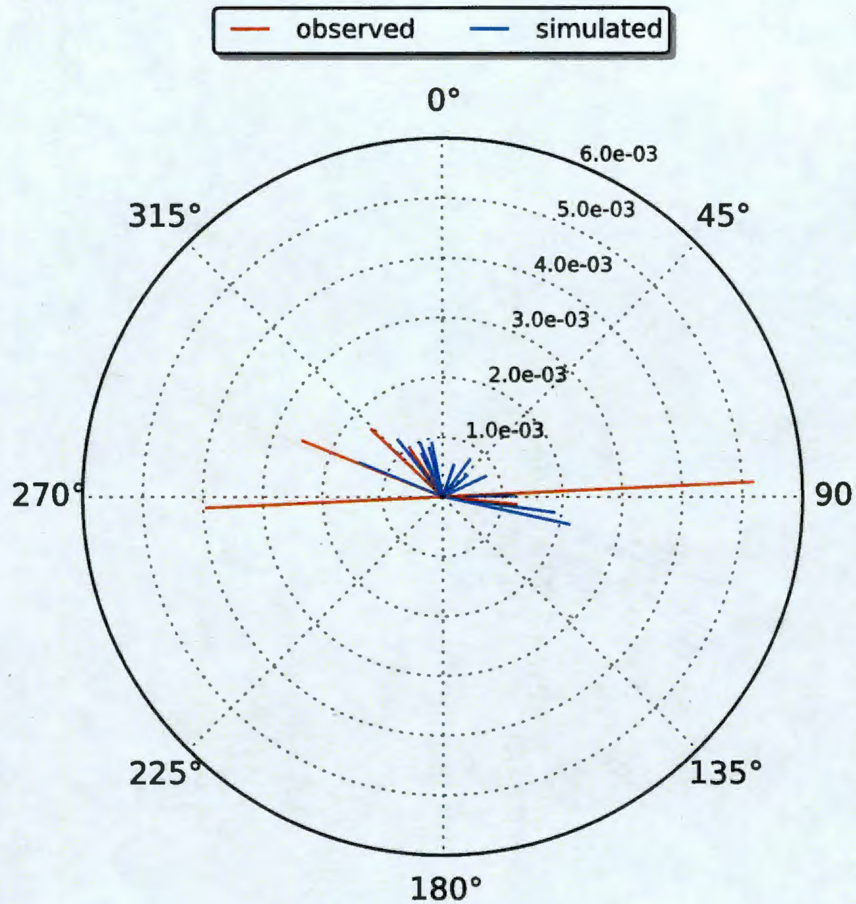



| | Observed | Simulated |
|---|---|---|
| Data Points | 15 | 15 |
| Minimum Azimuth | 45.7 | 56.0 |
| Maximum Azimuth | 249.4 | 77.5 |
| Minimum Magnitude | 1.6e-05 | 4.8e-04 |
| Maximum Magnitude | 9.0e-04 | 8.7e-04 |

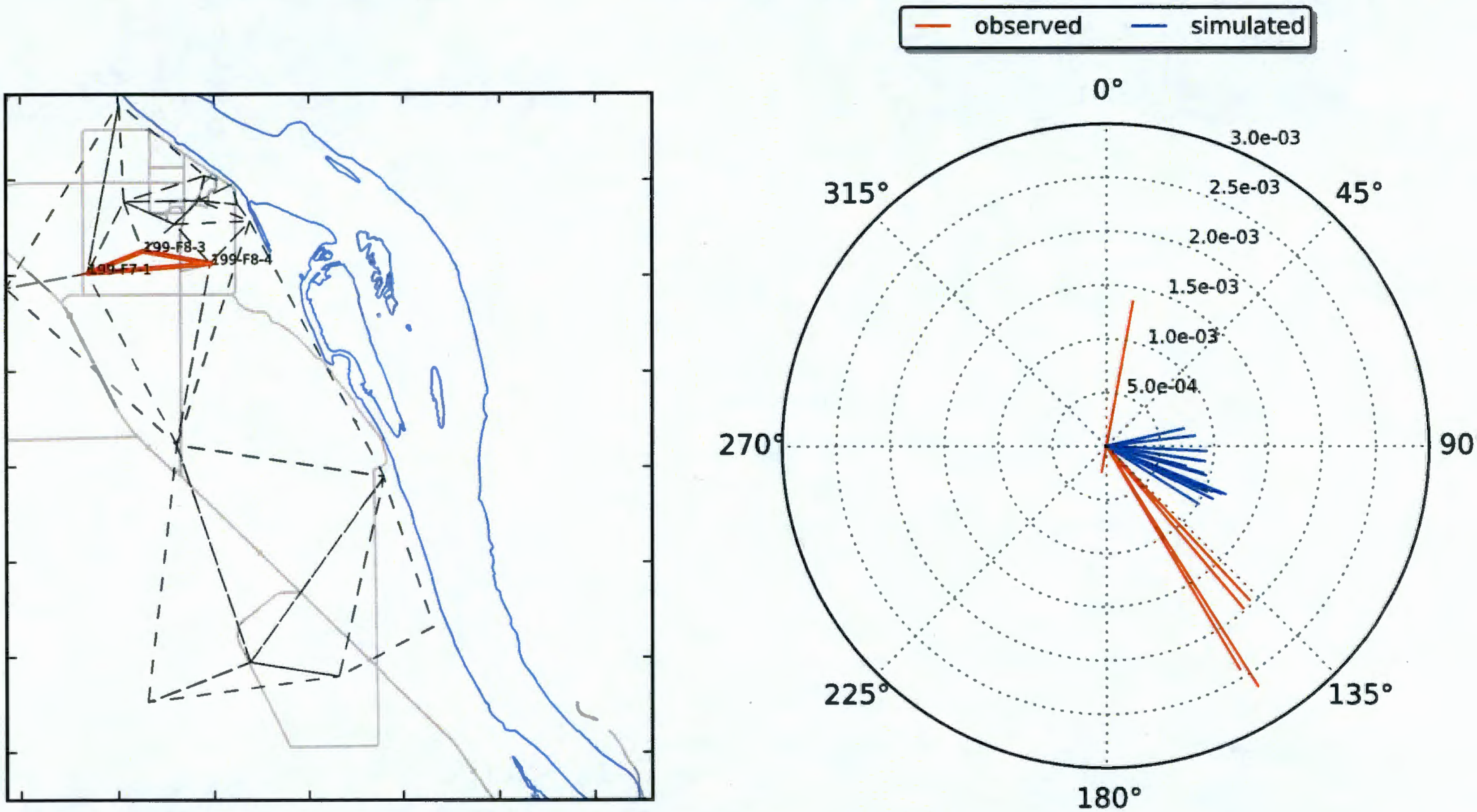
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 40*



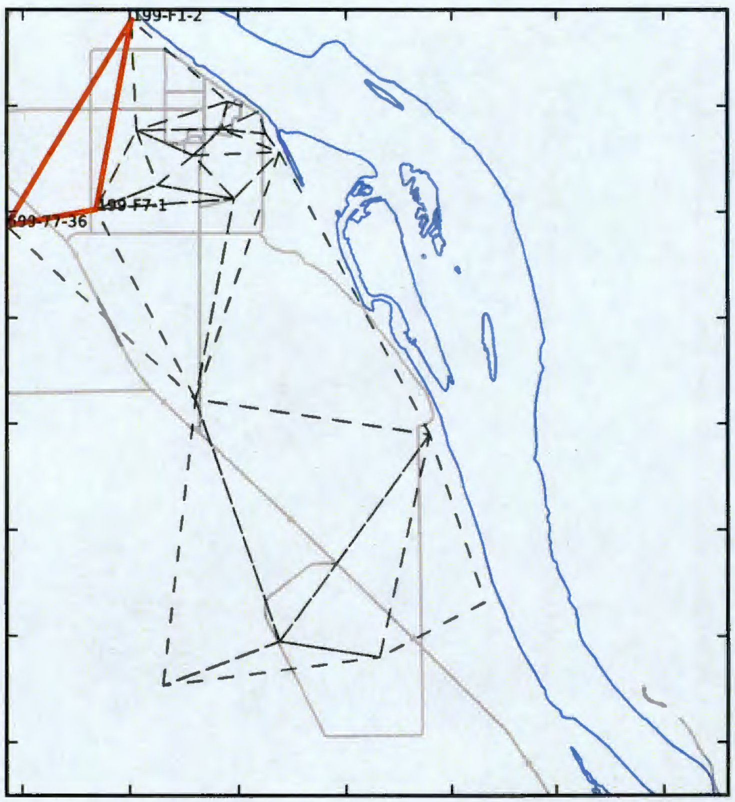

| | Observed | Simulated |
|---|---|---|
| Data Points | 13 | 13 |
| Minimum Azimuth | 87.3 | 19.1 |
| Maximum Azimuth | 325.9 | 348.7 |
| Minimum Magnitude | 1.7e-04 | 5.4e-04 |
| Maximum Magnitude | 5.2e-03 | 2.2e-03 |

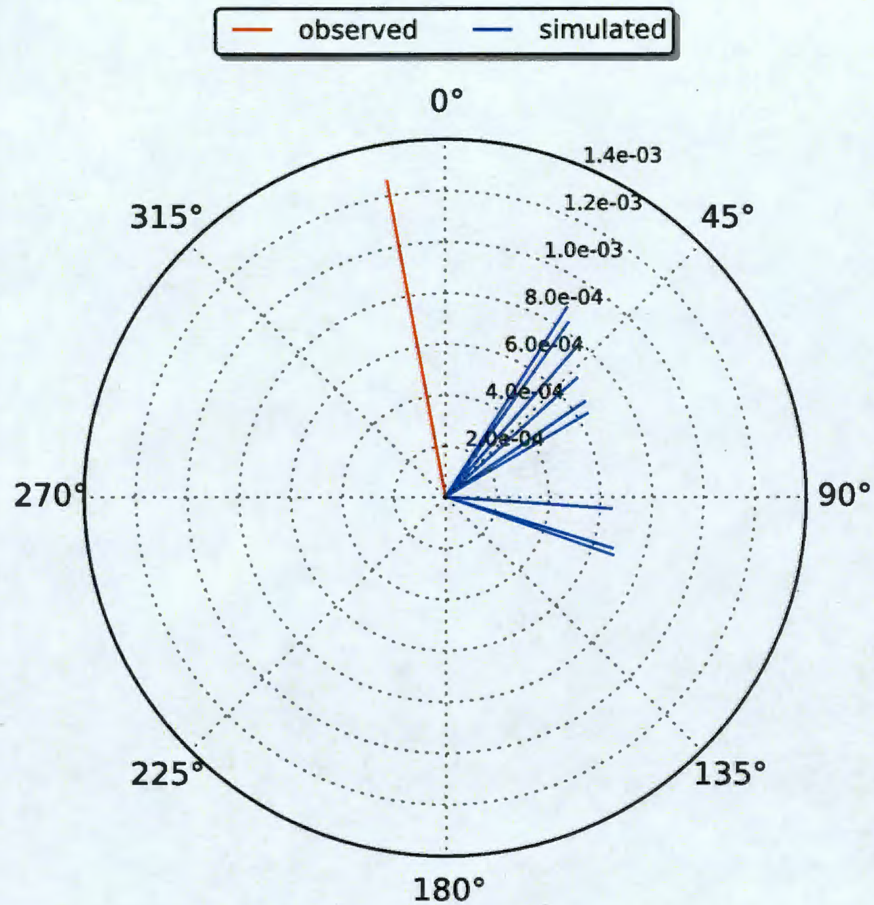
# Three-Point Gradients (Observed vs.Simulated) at Triangle 41




| | Observed | Simulated |
|---|---|---|
| Data Points | 16 | 16 |
| Minimum Azimuth | 10.4 | 77.2 |
| Maximum Azimuth | 190.4 | 122.2 |
| Minimum Magnitude | 3.0e-05 | 7.2e-04 |
| Maximum Magnitude | 2.6e-03 | 1.2e-03 |

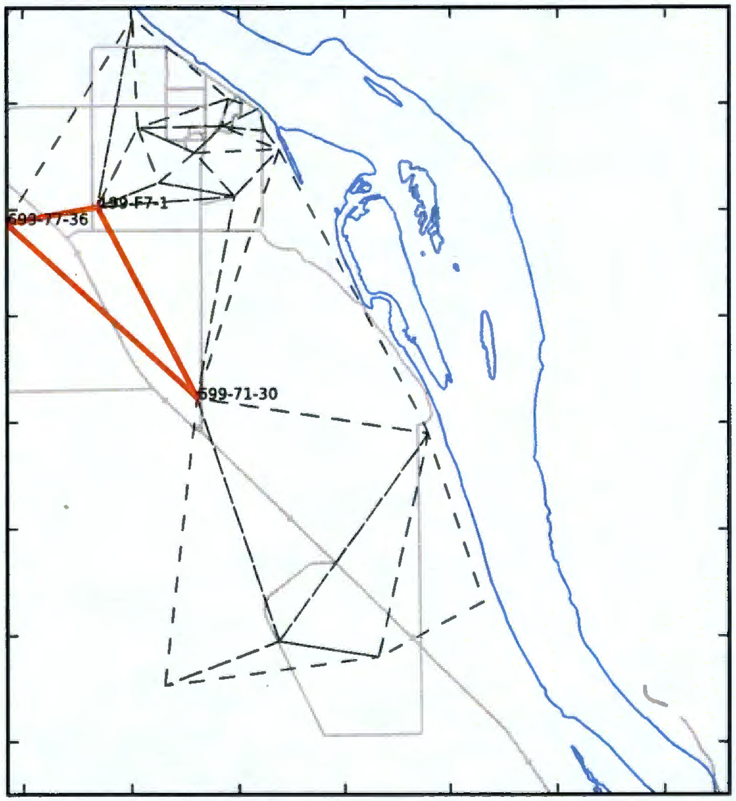
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 42*

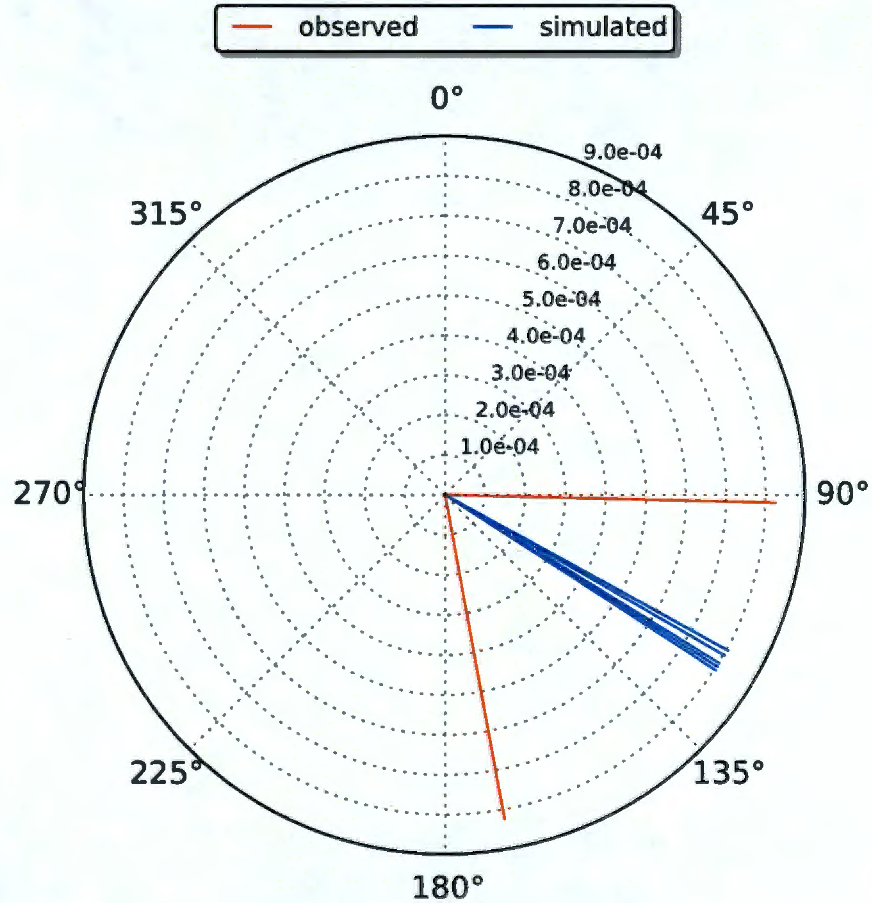



| | Observed | Simulated |
|---|---|---|
| Data Points | 9 | 9 |
| Minimum Azimuth | 349.6 | 32.4 |
| Maximum Azimuth | 349.6 | 109.3 |
| Minimum Magnitude | 4.1e-05 | 6.4e-04 |
| Maximum Magnitude | 1.3e-03 | 8.8e-04 |

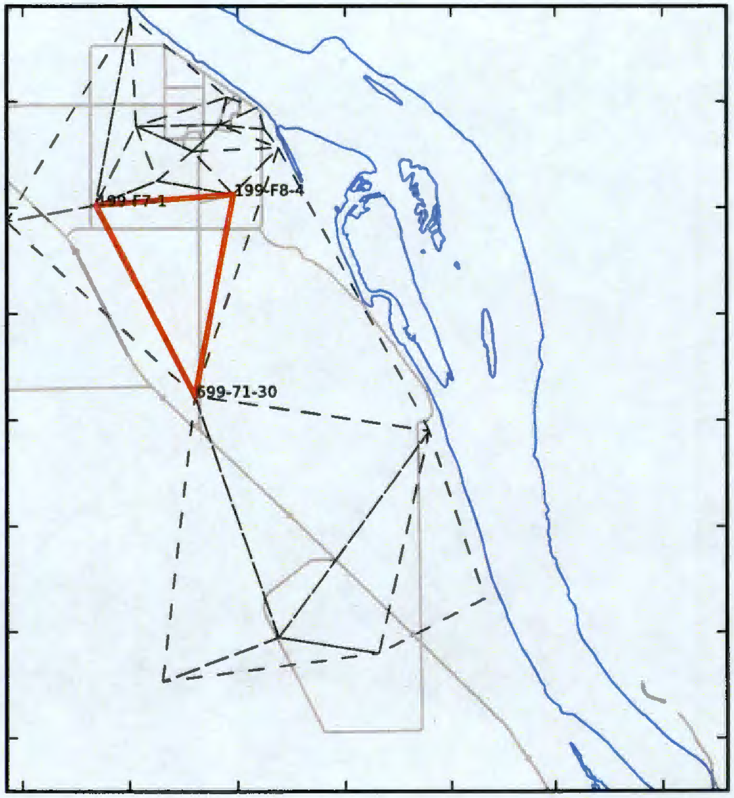
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 43*

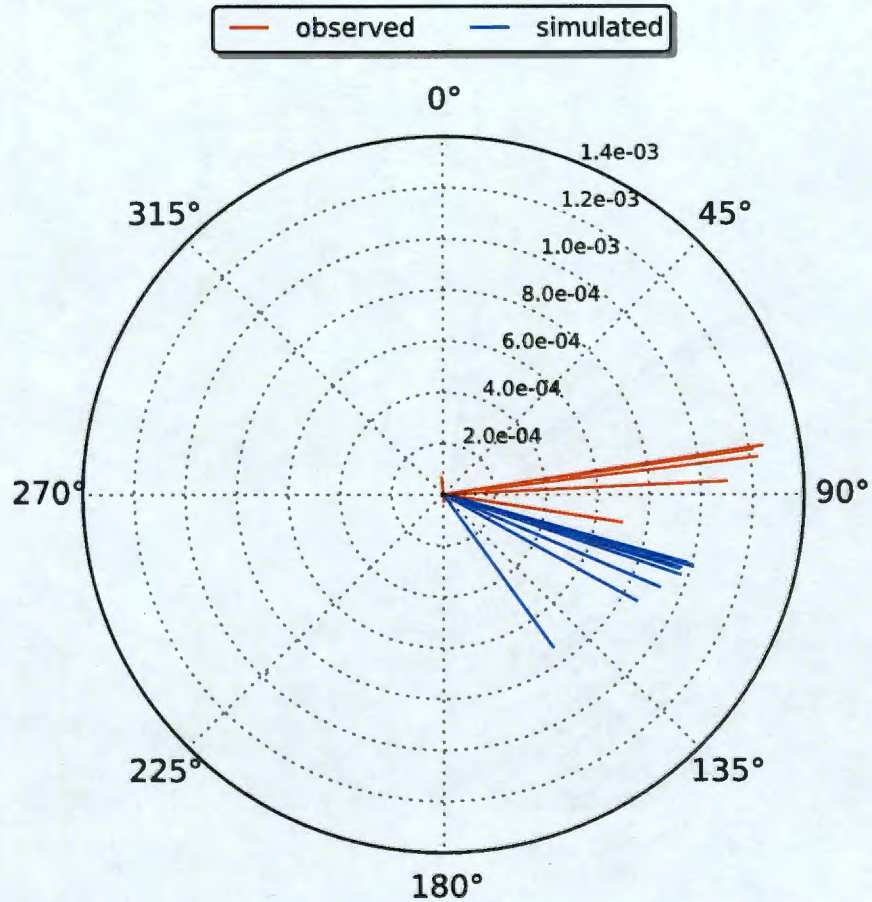



| | Observed | Simulated |
|---|---|---|
| Data Points | 5 | 5 |
| Minimum Azimuth | 91.3 | 118.9 |
| Maximum Azimuth | 169.6 | 123.0 |
| Minimum Magnitude | 7.7e-04 | 8.0e-04 |
| Maximum Magnitude | 8.3e-04 | 8.0e-04 |

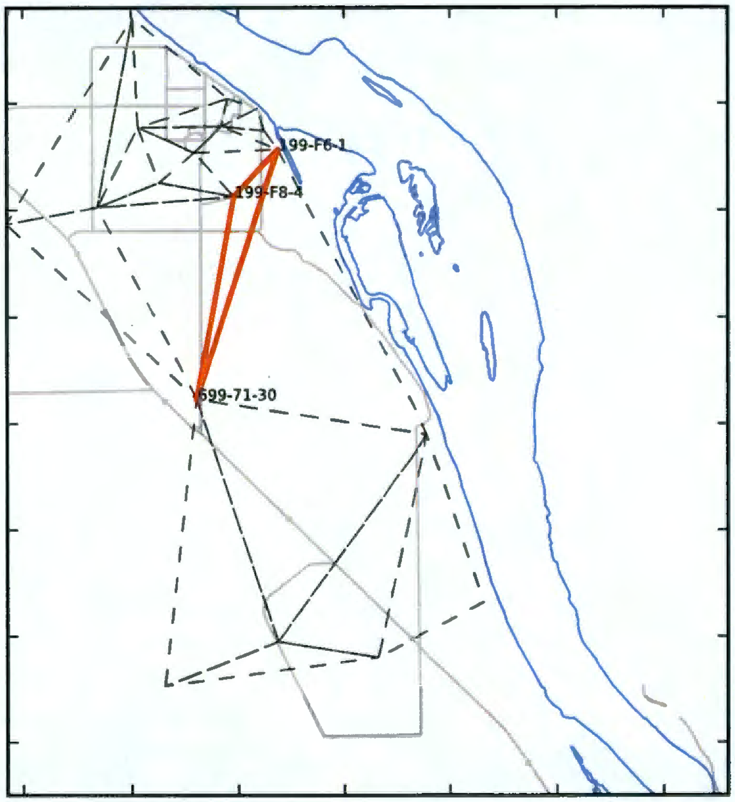
# Three-Point Gradients (Observed vs.Simulated) at Triangle 44

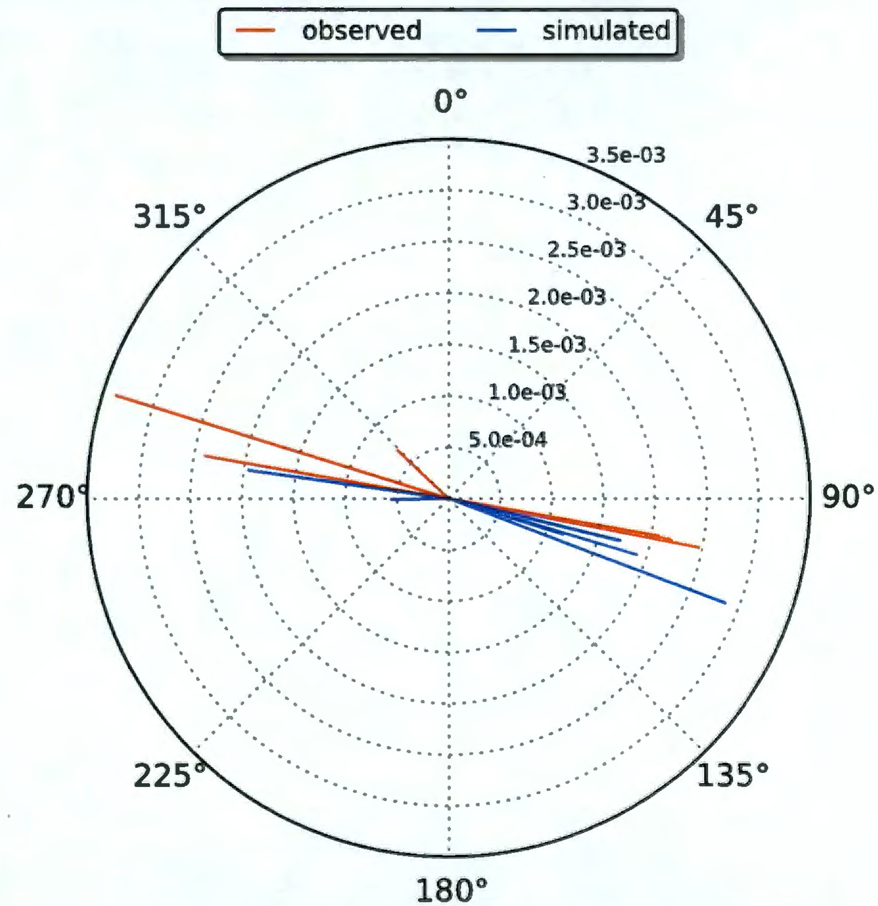



| | Observed | Simulated |
|---|---|---|
| Data Points | 9 | 9 |
| Minimum Azimuth | 81.2 | 105.7 |
| Maximum Azimuth | 355.5 | 144.5 |
| Minimum Magnitude | 5.4e-06 | 7.3e-04 |
| Maximum Magnitude | 1.3e-03 | 1.0e-03 |

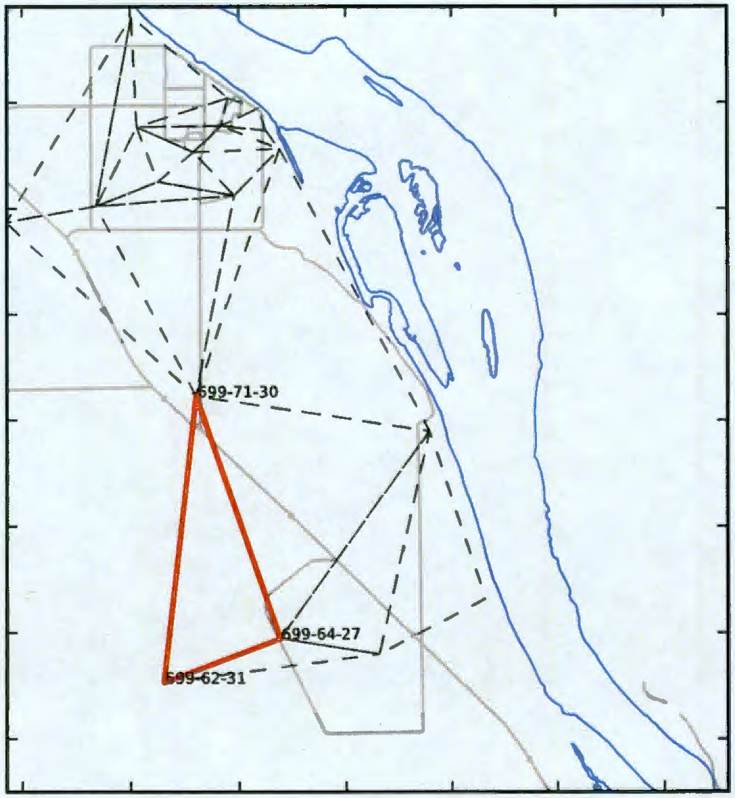
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 45*

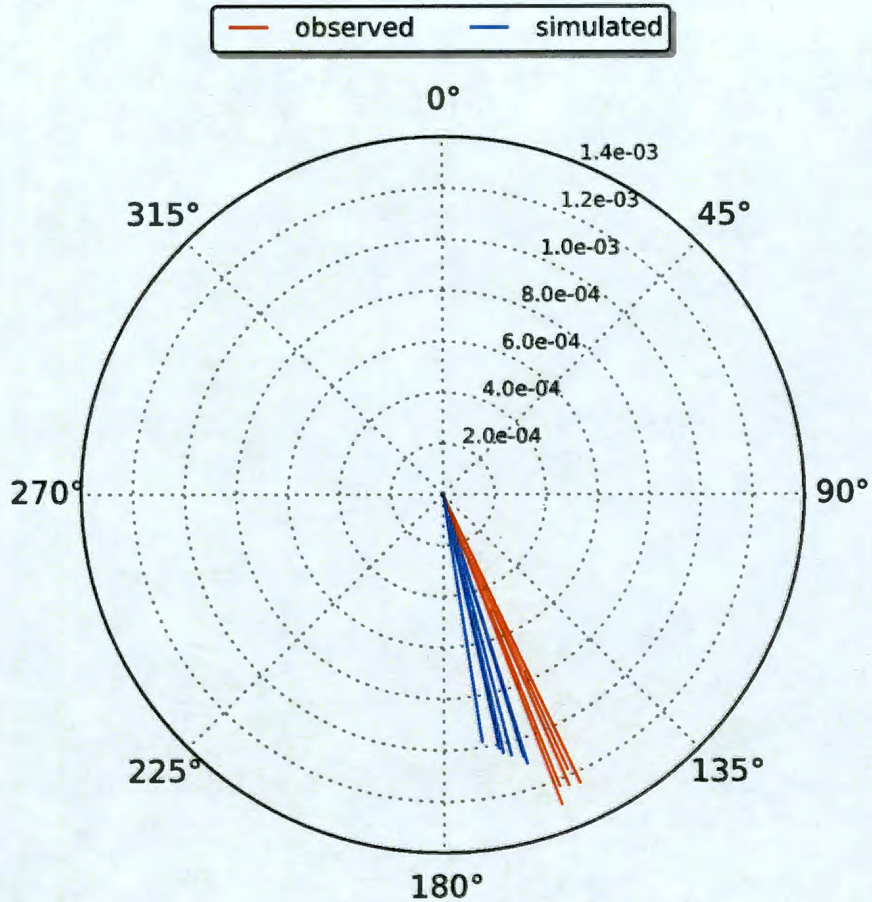



| | Observed | Simulated |
|---|---|---|
| Data Points | 7 | 7 |
| Minimum Azimuth | 100.0 | 103.8 |
| Maximum Azimuth | 313.4 | 278.0 |
| Minimum Magnitude | 6.8e-04 | 5.5e-04 |
| Maximum Magnitude | 3.4e-03 | 2.9e-03 |

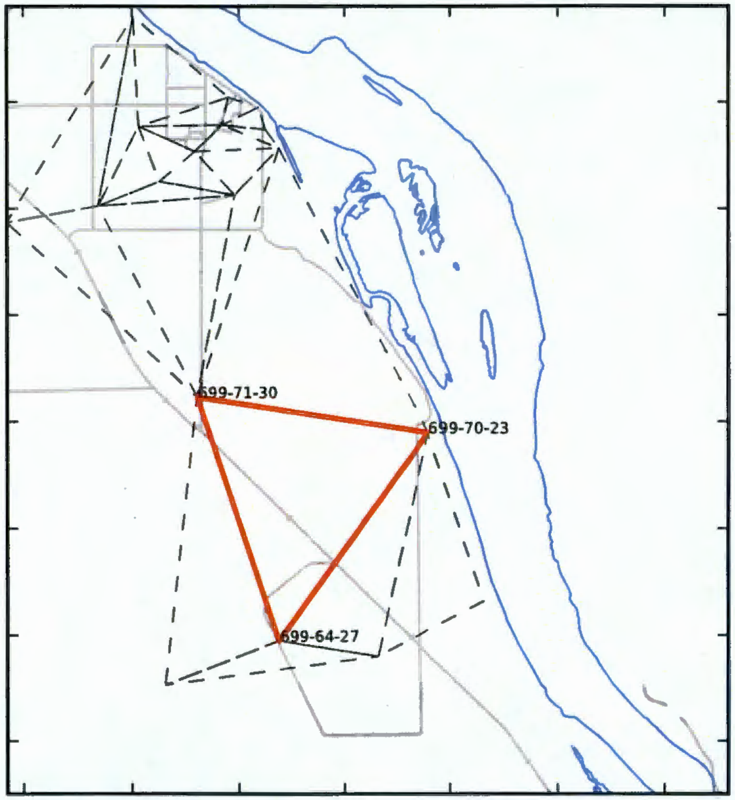
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 46*

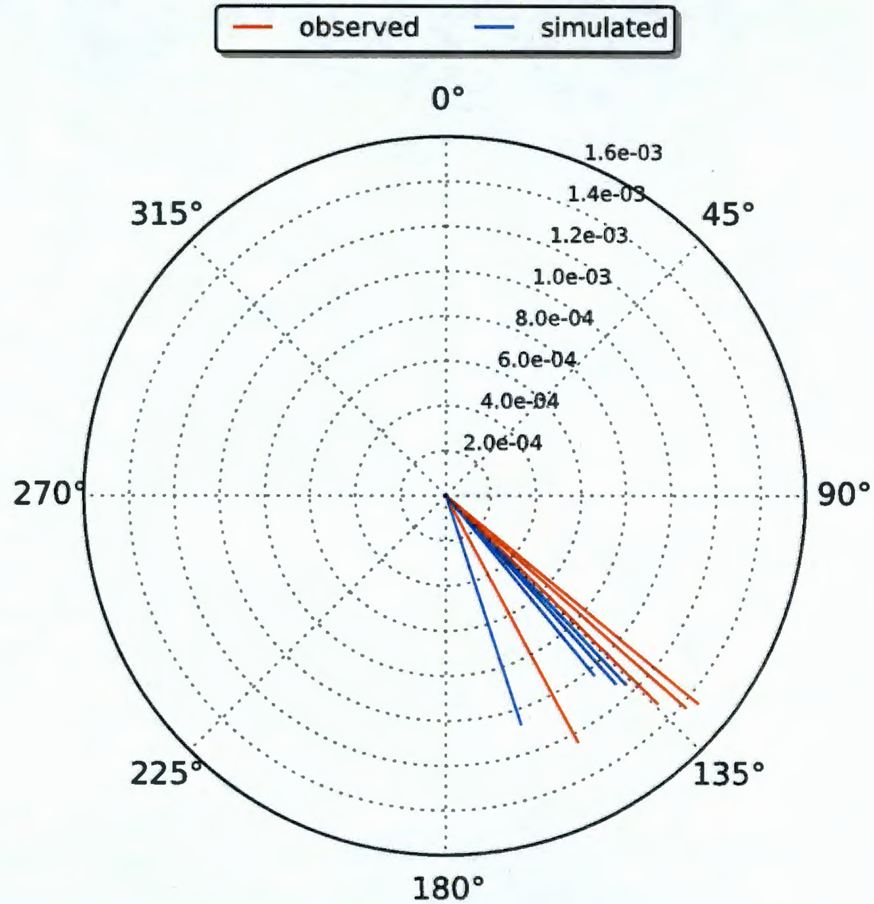



| | Observed | Simulated |
|---|---|---|
| Data Points | 6 | 6 |
| Minimum Azimuth | 154.9 | 162.9 |
| Maximum Azimuth | 159.3 | 171.3 |
| Minimum Magnitude | 1.2e-03 | 9.8e-04 |
| Maximum Magnitude | 1.3e-03 | 1.1e-03 |

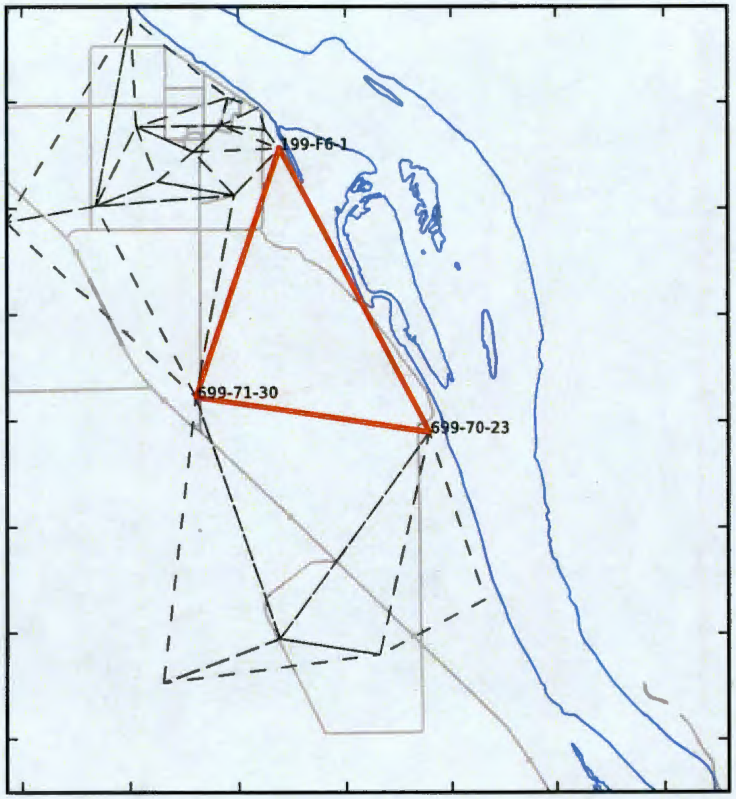
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 47*

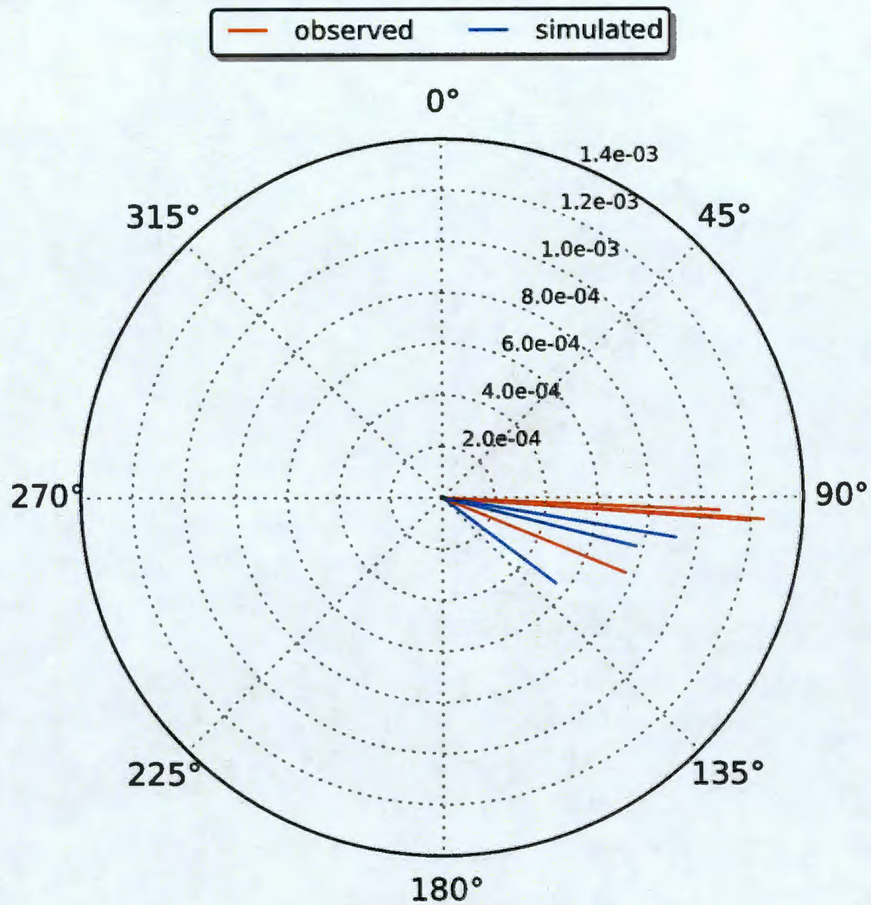



| | Observed | Simulated |
|---|---|---|
| Data Points | 4 | 4 |
| Minimum Azimuth | 129.4 | 136.3 |
| Maximum Azimuth | 151.8 | 161.8 |
| Minimum Magnitude | 1.2e-03 | 1.0e-03 |
| Maximum Magnitude | 1.4e-03 | 1.2e-03 |

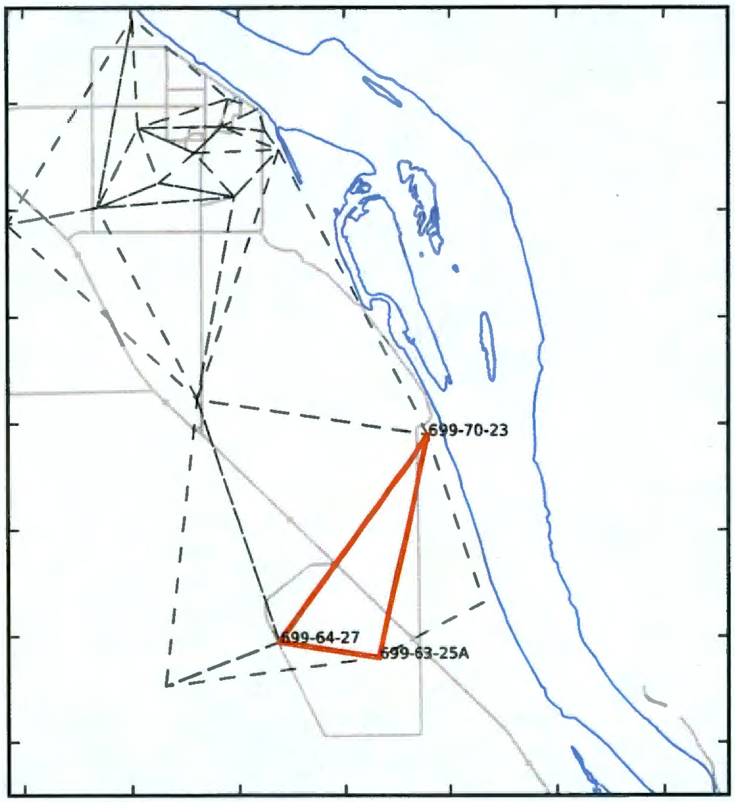
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 48*

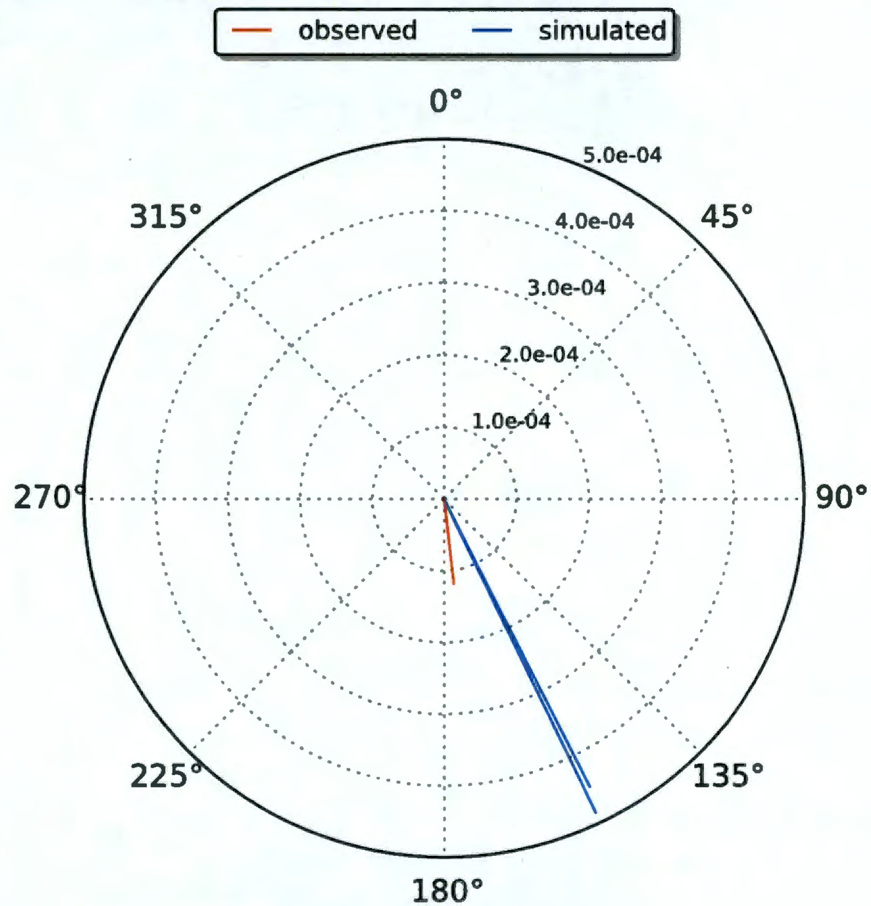



| | Observed | Simulated |
|---|---|---|
| Data Points | 4 | 4 |
| Minimum Azimuth | 92.7 | 99.8 |
| Maximum Azimuth | 112.6 | 127.5 |
| Minimum Magnitude | 7.6e-04 | 5.5e-04 |
| Maximum Magnitude | 1.2e-03 | 9.1e-04 |

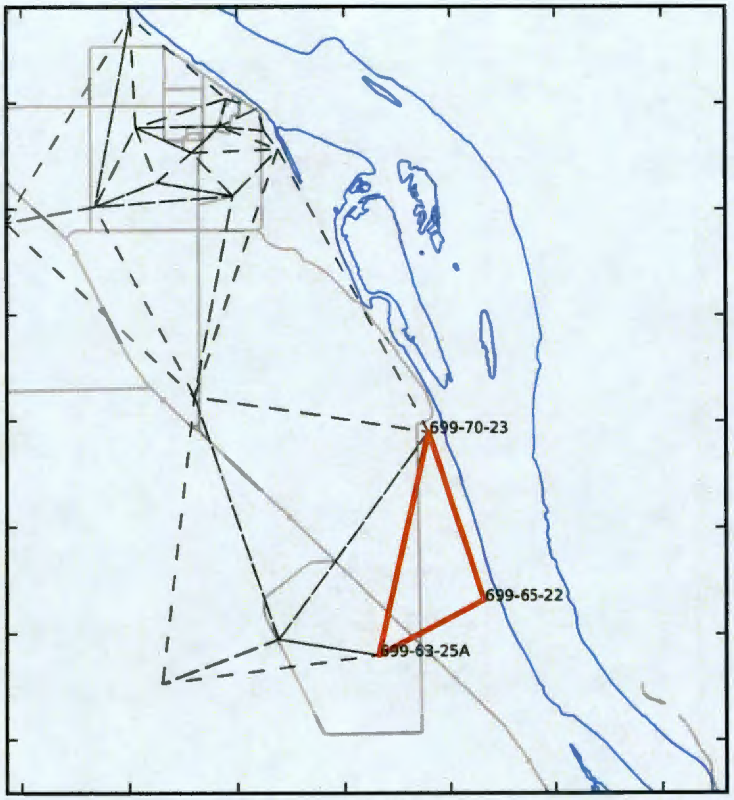
# Three-Point Gradients (Observed vs.Simulated) at Triangle 49

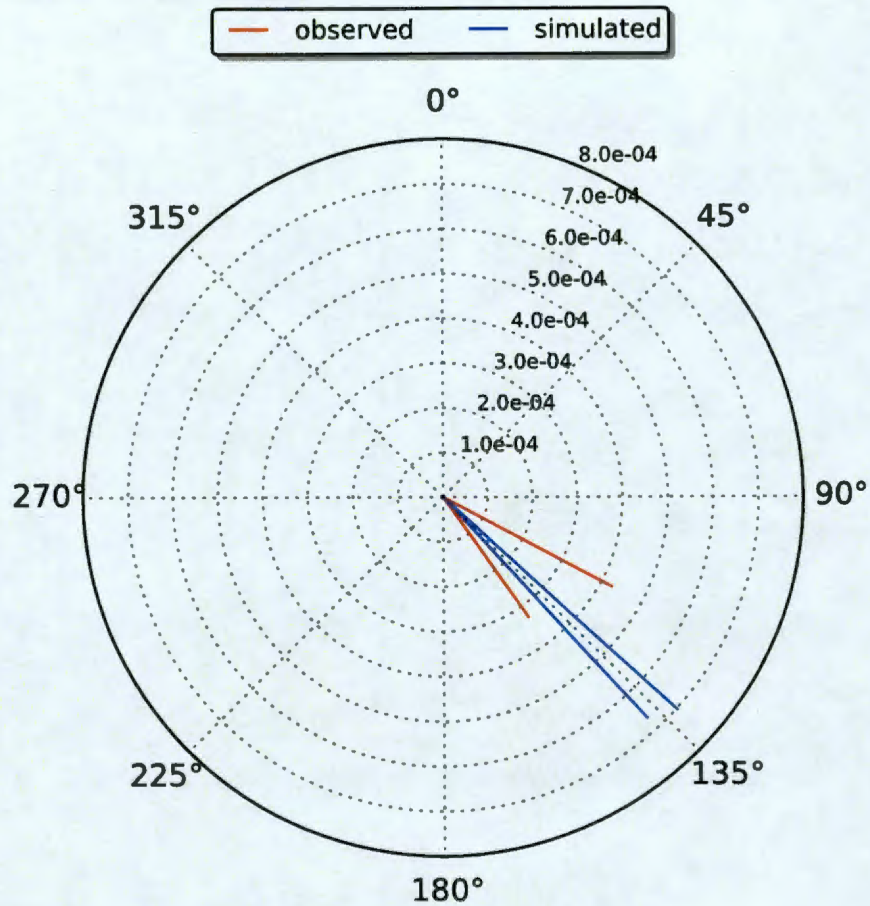



| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 154.5 | 153.5 |
| Maximum Azimuth | 173.5 | 154.5 |
| Minimum Magnitude | 1.2e-04 | 4.5e-04 |
| Maximum Magnitude | 2.8e-04 | 4.8e-04 |

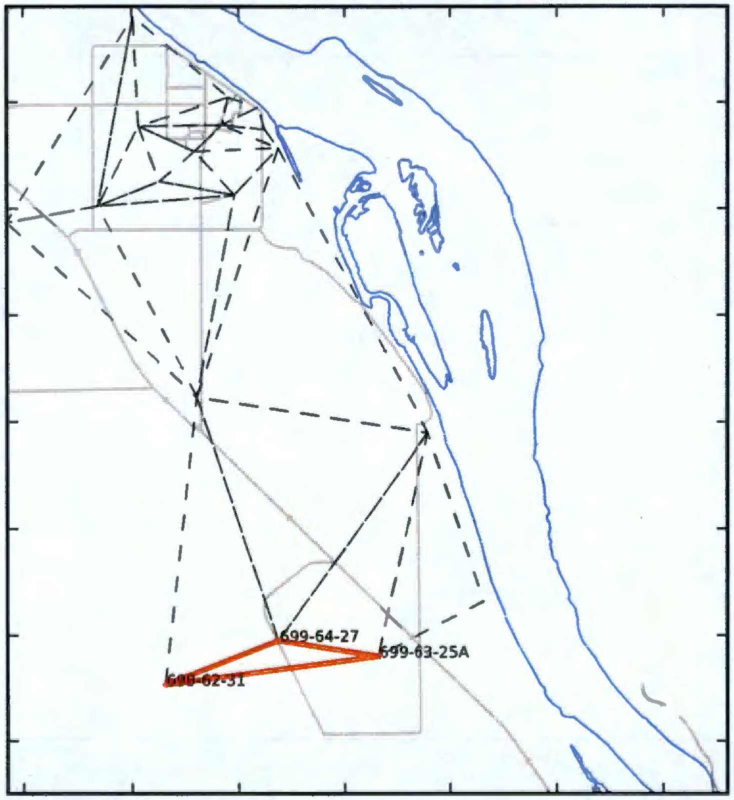
# Three-Point Gradients (Observed vs.Simulated) at Triangle 50

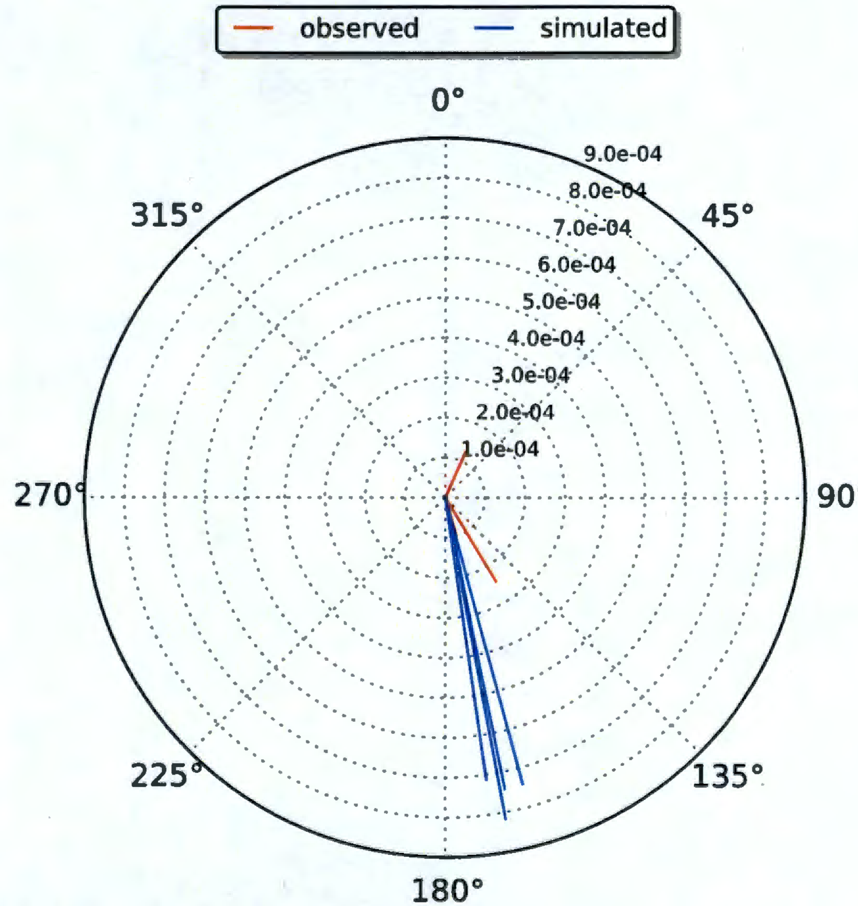



| | Observed | Simulated |
|---|---|---|
| Data Points | 2 | 2 |
| Minimum Azimuth | 118.0 | 132.4 |
| Maximum Azimuth | 144.7 | 137.5 |
| Minimum Magnitude | 3.3e-04 | 6.7e-04 |
| Maximum Magnitude | 4.2e-04 | 7.0e-04 |

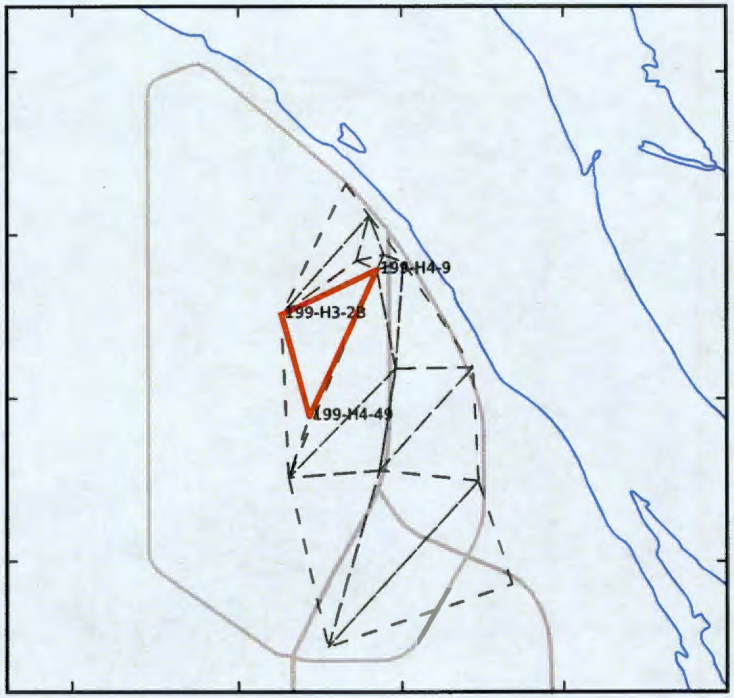
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 51*

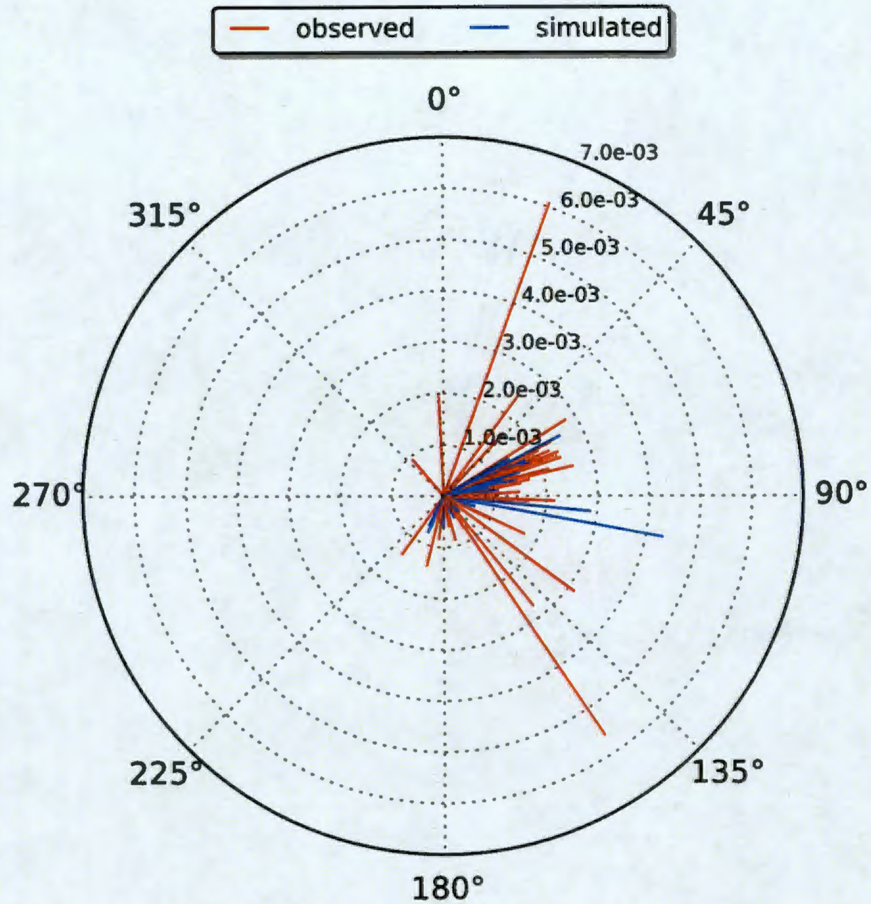



| | Observed | Simulated |
|---|---|---|
| Data Points | 4 | 4 |
| Minimum Azimuth | 23.8 | 164.8 |
| Maximum Azimuth | 163.9 | 171.7 |
| Minimum Magnitude | 9.9e-05 | 7.1e-04 |
| Maximum Magnitude | 2.4e-04 | 8.2e-04 |

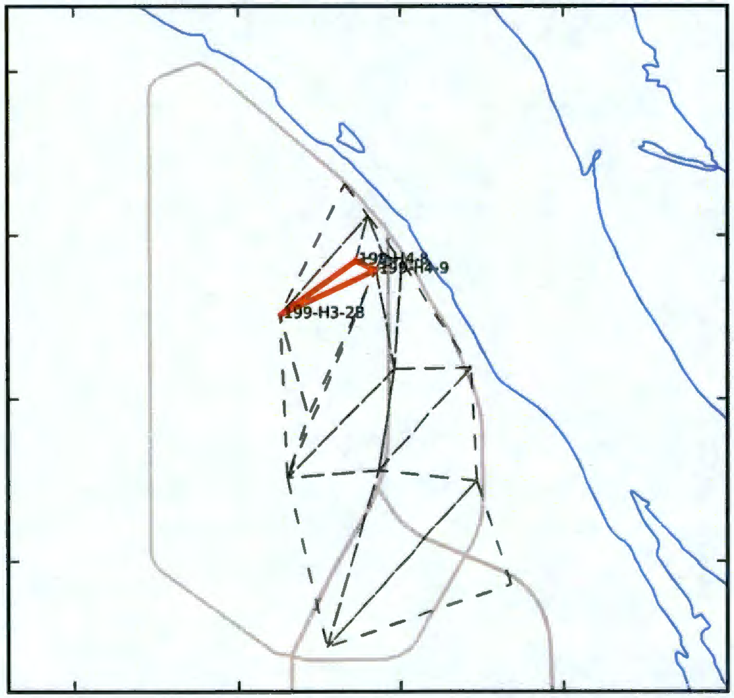
# Three-Point Gradients (Observed vs.Simulated) at Triangle 52

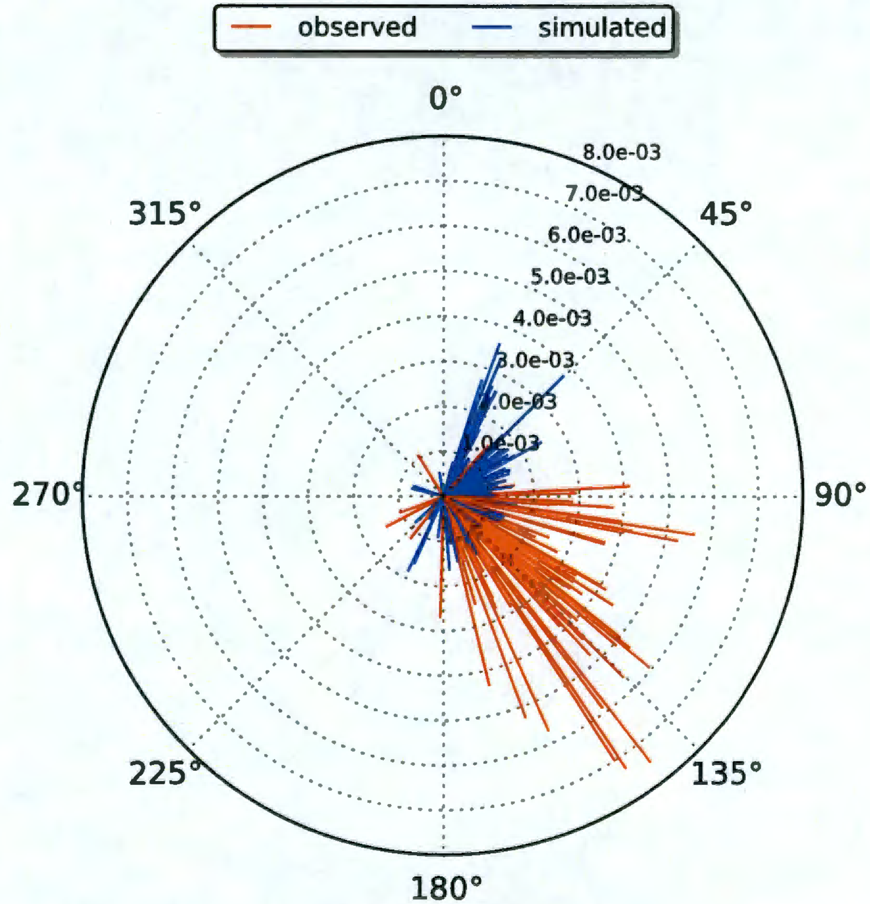



| | Observed | Simulated |
|---|---|---|
| Data Points | 46 | 46 |
| Minimum Azimuth | 20.0 | 60.0 |
| Maximum Azimuth | 357.2 | 206.5 |
| Minimum Magnitude | 3.1e-04 | 2.1e-04 |
| Maximum Magnitude | 6.1e-03 | 4.3e-03 |

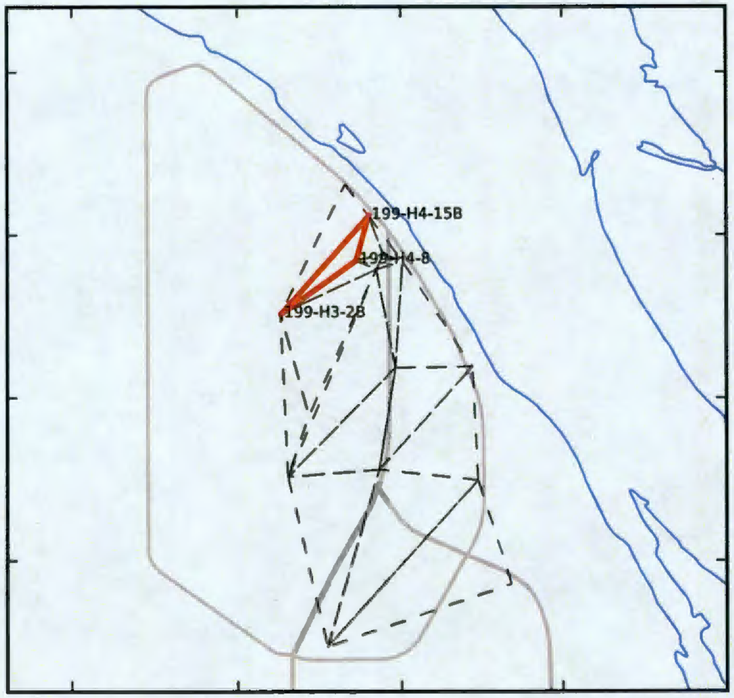
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 53*

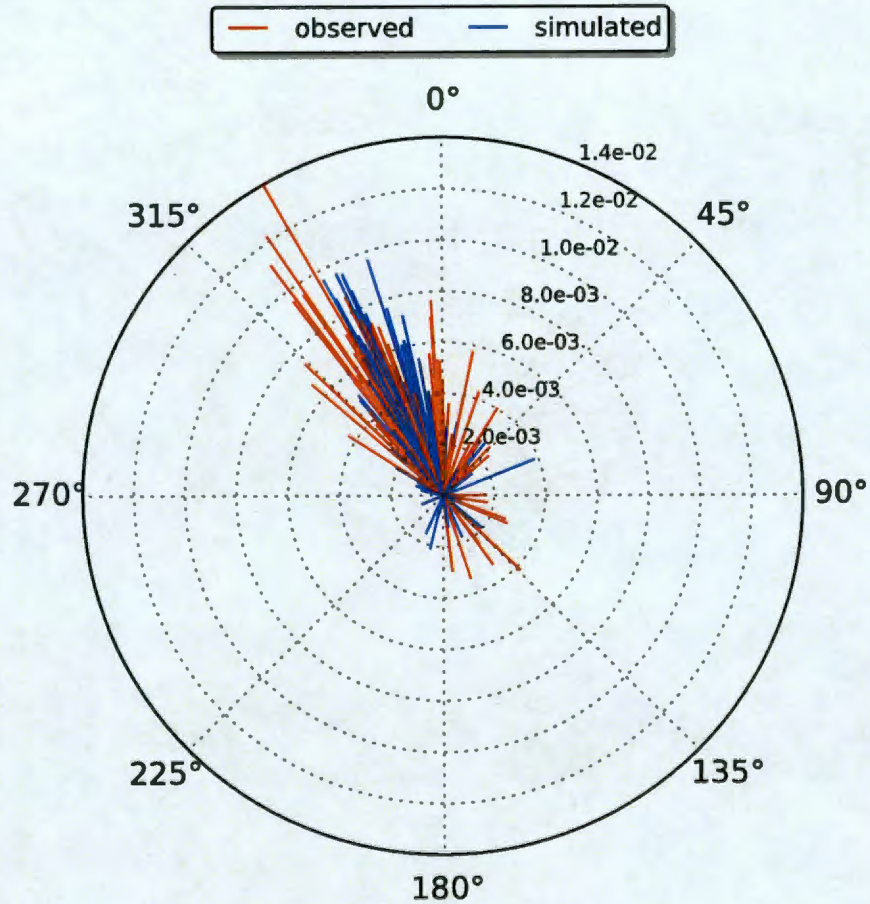



| | Observed | Simulated |
|---|---|---|
| Data Points | 88 | 88 |
| Minimum Azimuth | 41.2 | 14.3 |
| Maximum Azimuth | 328.5 | 350.3 |
| Minimum Magnitude | 4.7e-04 | 1.1e-04 |
| Maximum Magnitude | 7.5e-03 | 3.8e-03 |

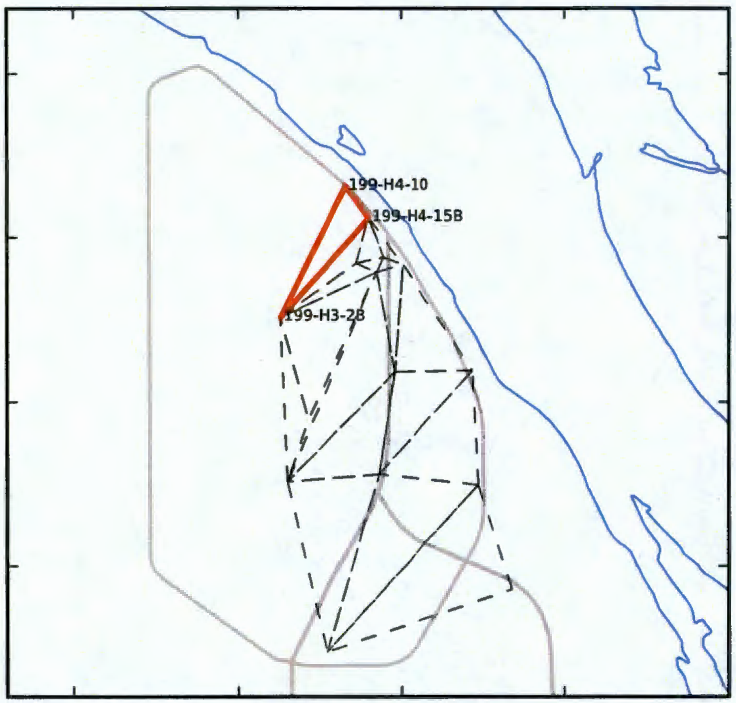
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 54*

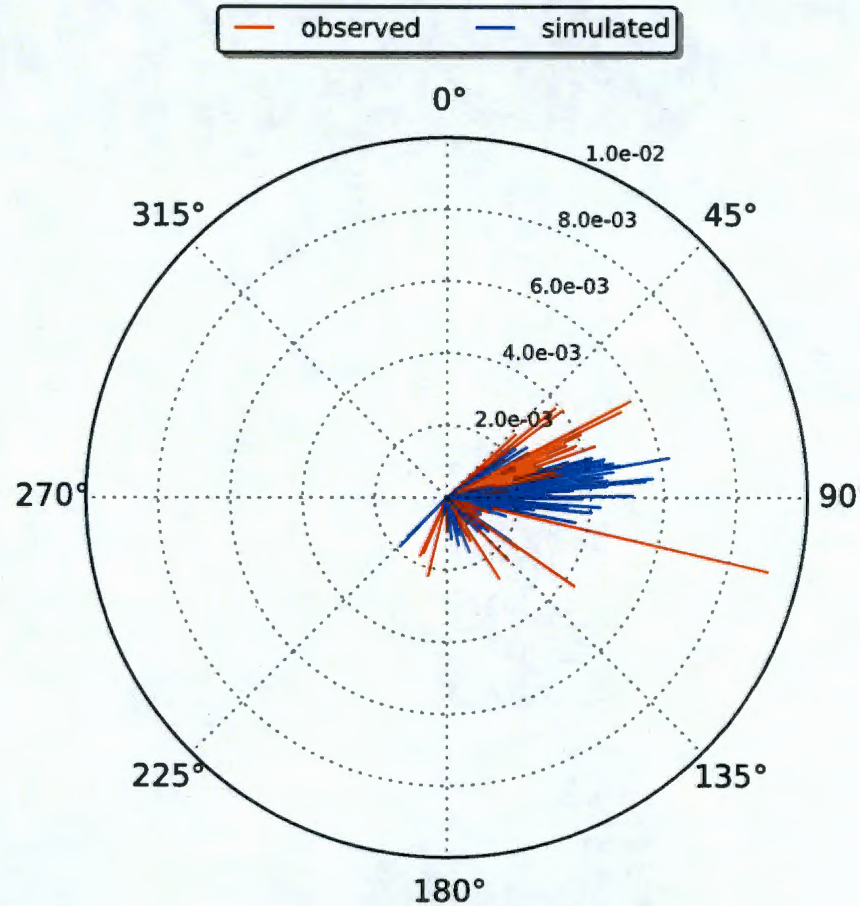



| | Observed | Simulated |
|---|---|---|
| Data Points | 95 | 95 |
| Minimum Azimuth | 0.5 | 2.6 |
| Maximum Azimuth | 360.0 | 358.2 |
| Minimum Magnitude | 4.6e-04 | 9.7e-05 |
| Maximum Magnitude | 1.4e-02 | 9.6e-03 |

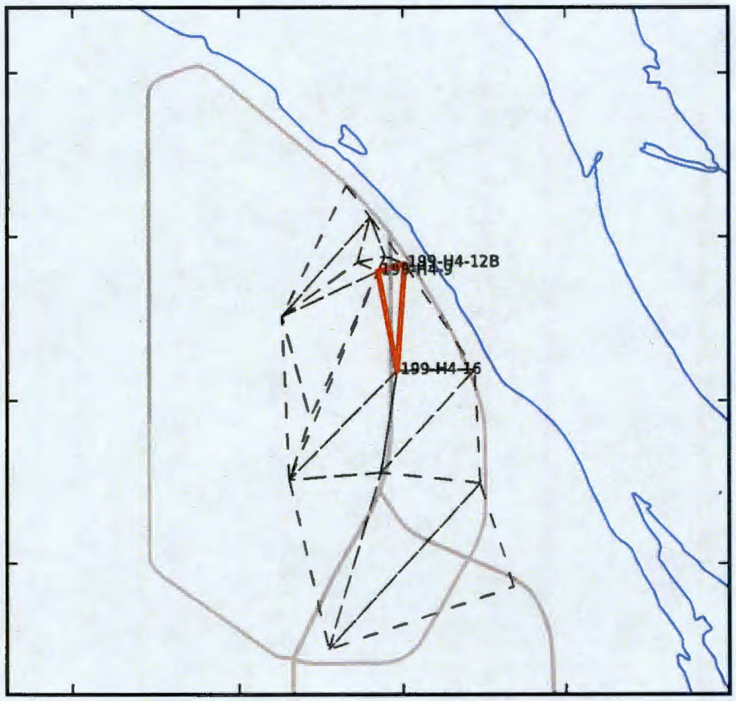
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 55*

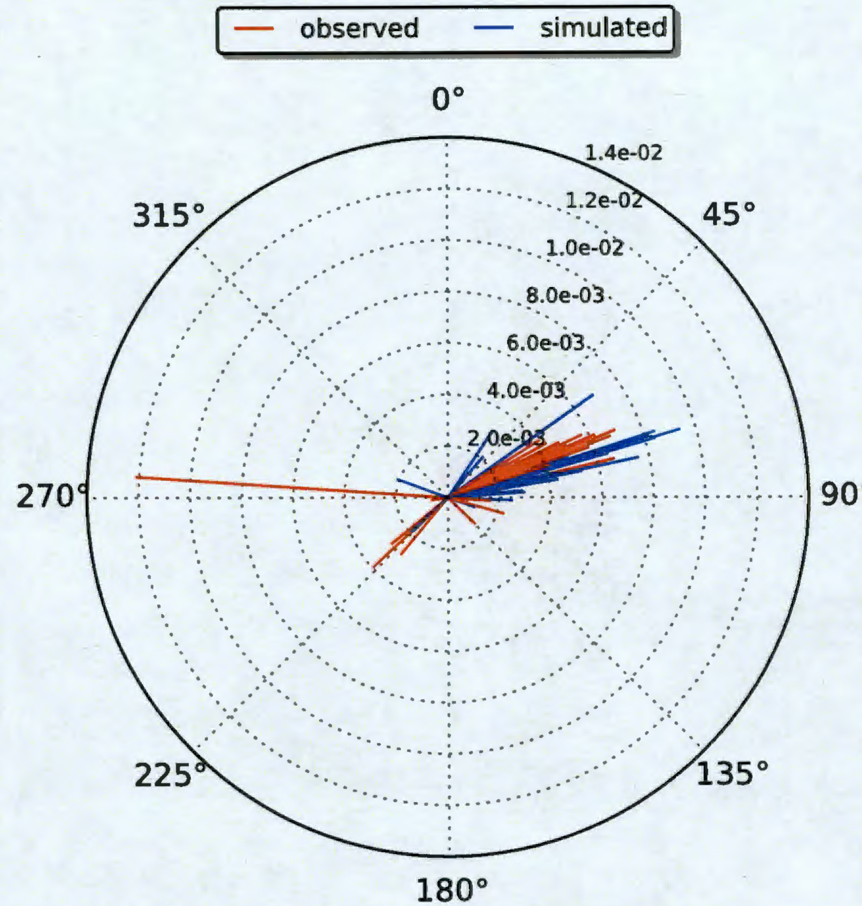



| | Observed | Simulated |
|---|---|---|
| Data Points | 94 | 94 |
| Minimum Azimuth | 47.5 | 54.7 |
| Maximum Azimuth | 204.8 | 225.2 |
| Minimum Magnitude | 6.8e-04 | 4.7e-04 |
| Maximum Magnitude | 9.1e-03 | 6.2e-03 |

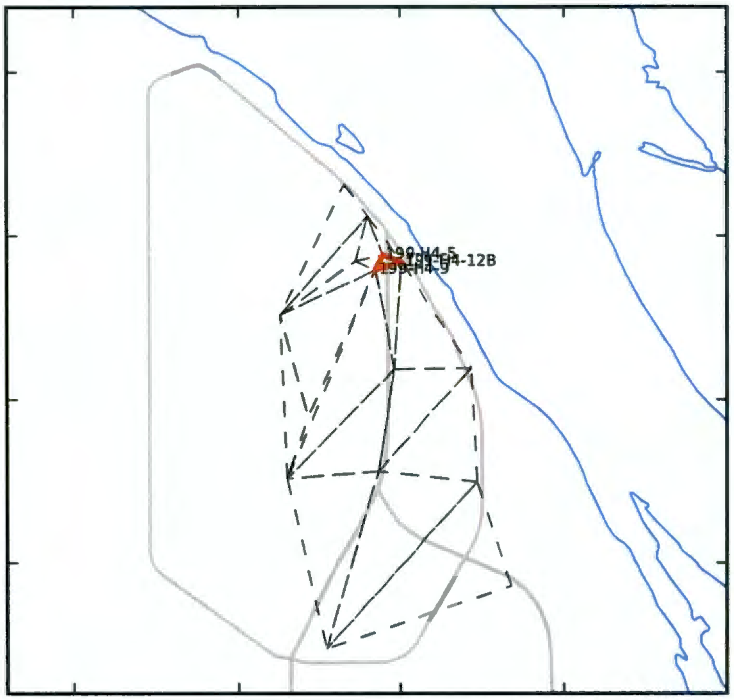
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 56*

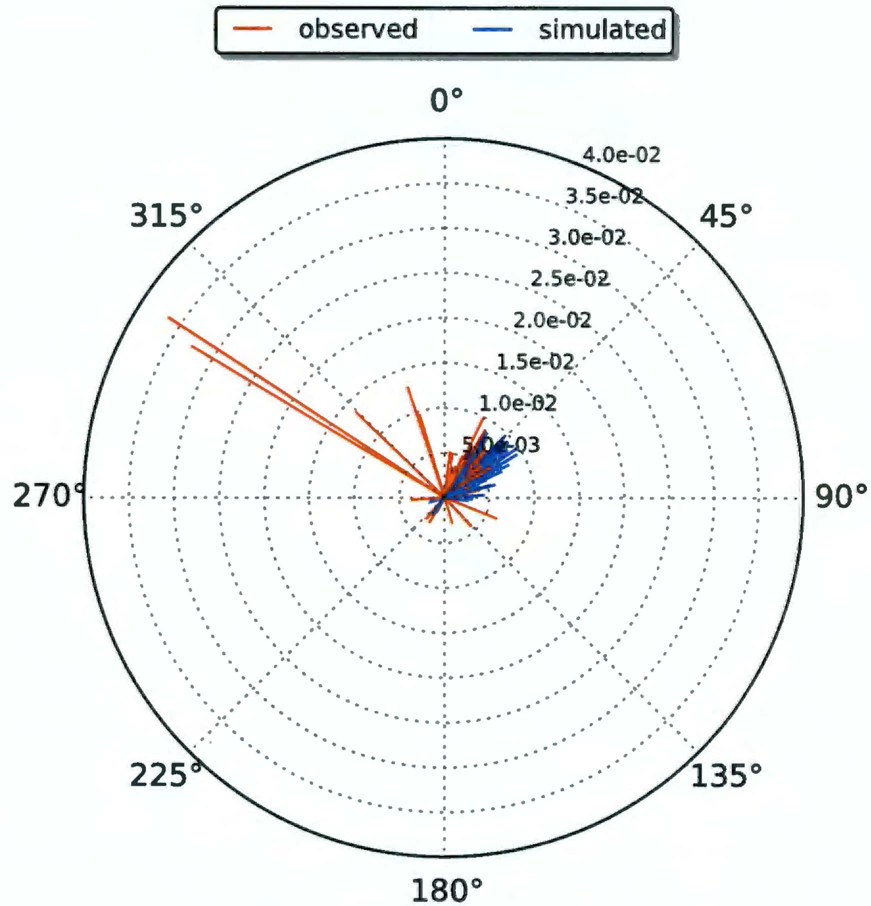



| | Observed | Simulated |
|---|---|---|
| Data Points | 32 | 32 |
| Minimum Azimuth | 57.9 | 33.9 |
| Maximum Azimuth | 273.9 | 290.2 |
| Minimum Magnitude | 6.0e-04 | 1.1e-03 |
| Maximum Magnitude | 1.2e-02 | 9.4e-03 |

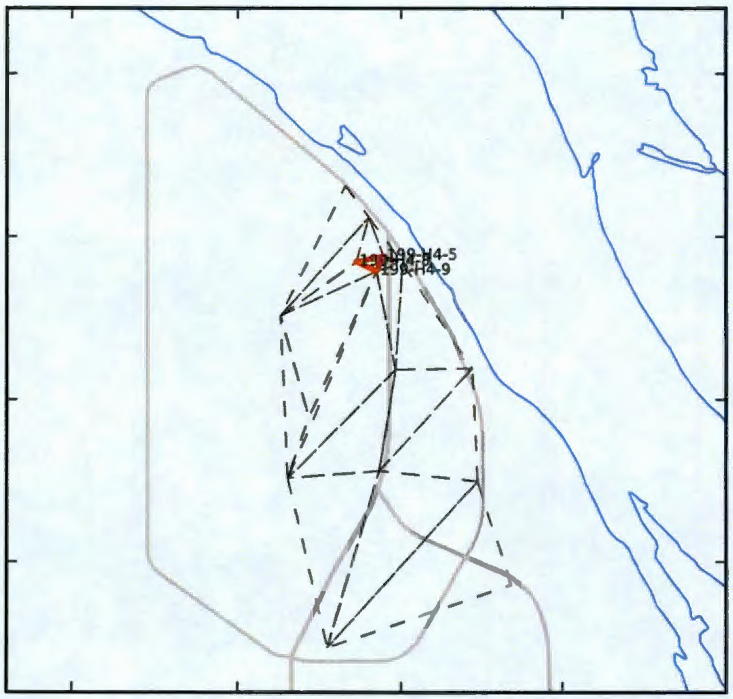
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 57*

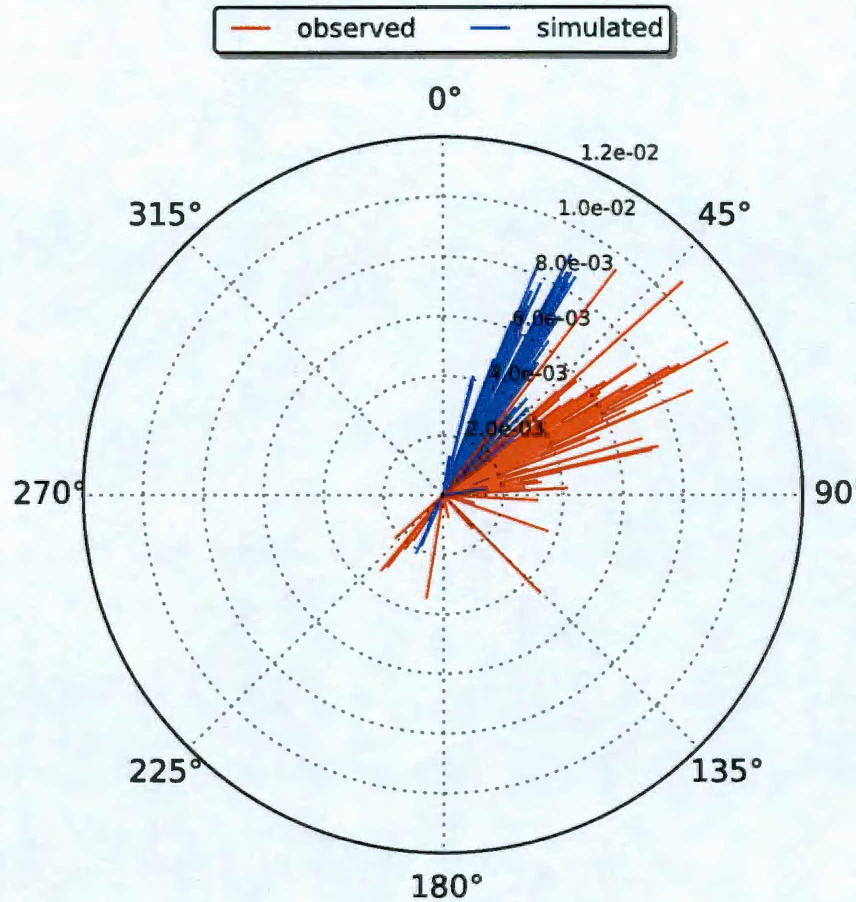





| | Observed | Simulated |
|---|---|---|
| Data Points | 75 | 75 |
| Minimum Azimuth | 6.9 | 14.8 |
| Maximum Azimuth | 343.2 | 252.5 |
| Minimum Magnitude | 8.0e-04 | 8.6e-04 |
| Maximum Magnitude | 3.6e-02 | 9.8e-03 |

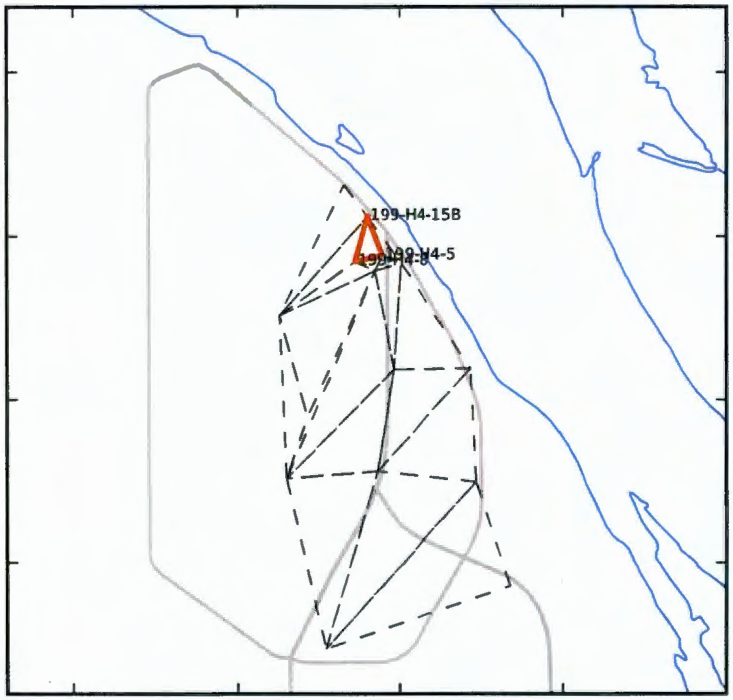
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 58*

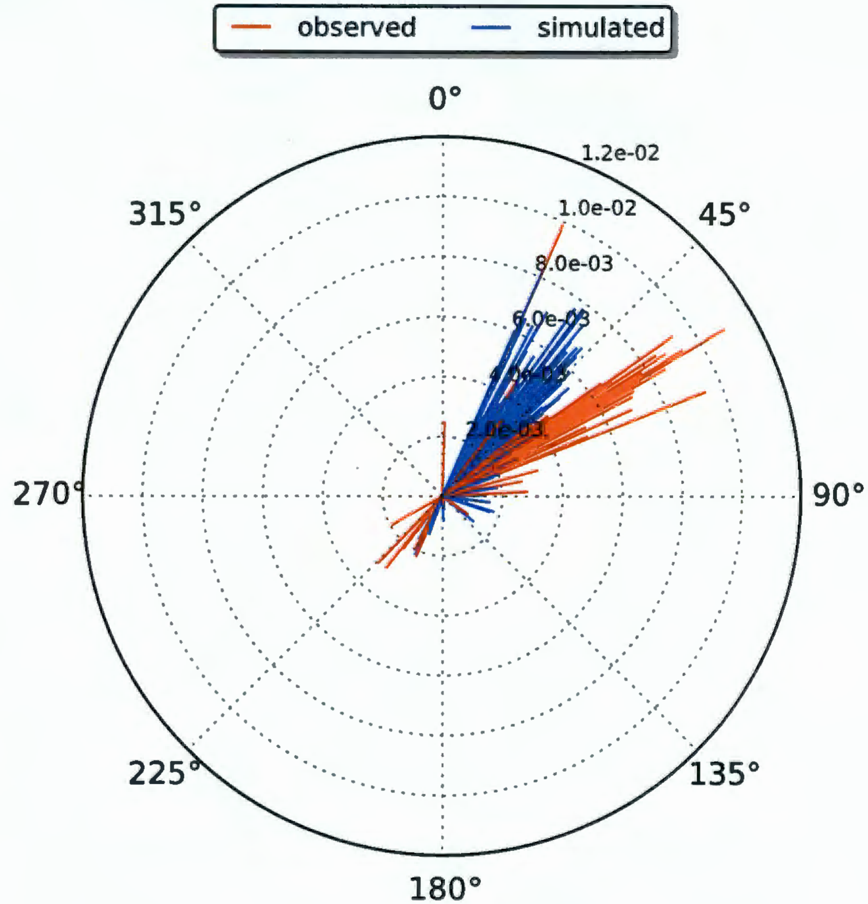





| | Observed | Simulated |
|---|---|---|
| Data Points | 87 | 87 |
| Minimum Azimuth | 32.5 | 8.9 |
| Maximum Azimuth | 228.2 | 209.3 |
| Minimum Magnitude | 6.1e-04 | 4.1e-04 |
| Maximum Magnitude | 1.1e-02 | 9.1e-03 |

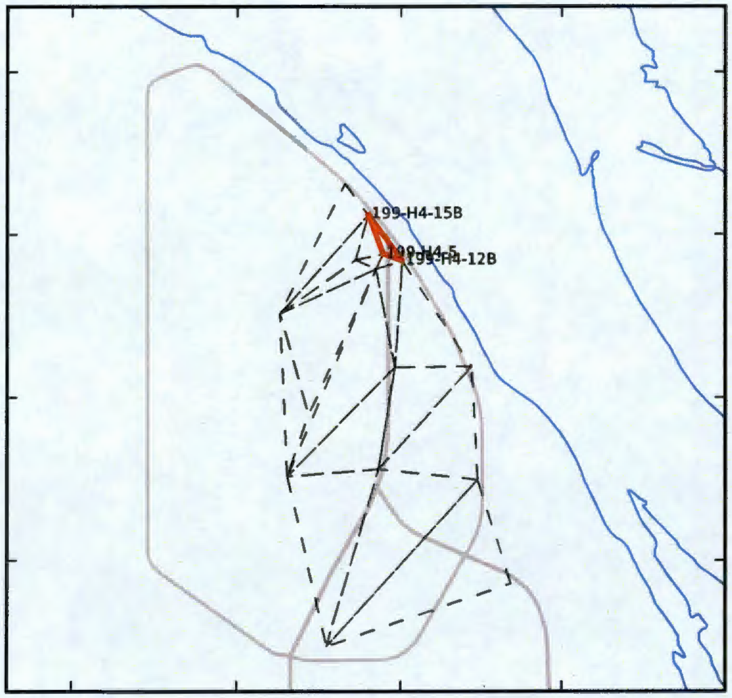
# Three-Point Gradients (Observed vs.Simulated) at Triangle 59

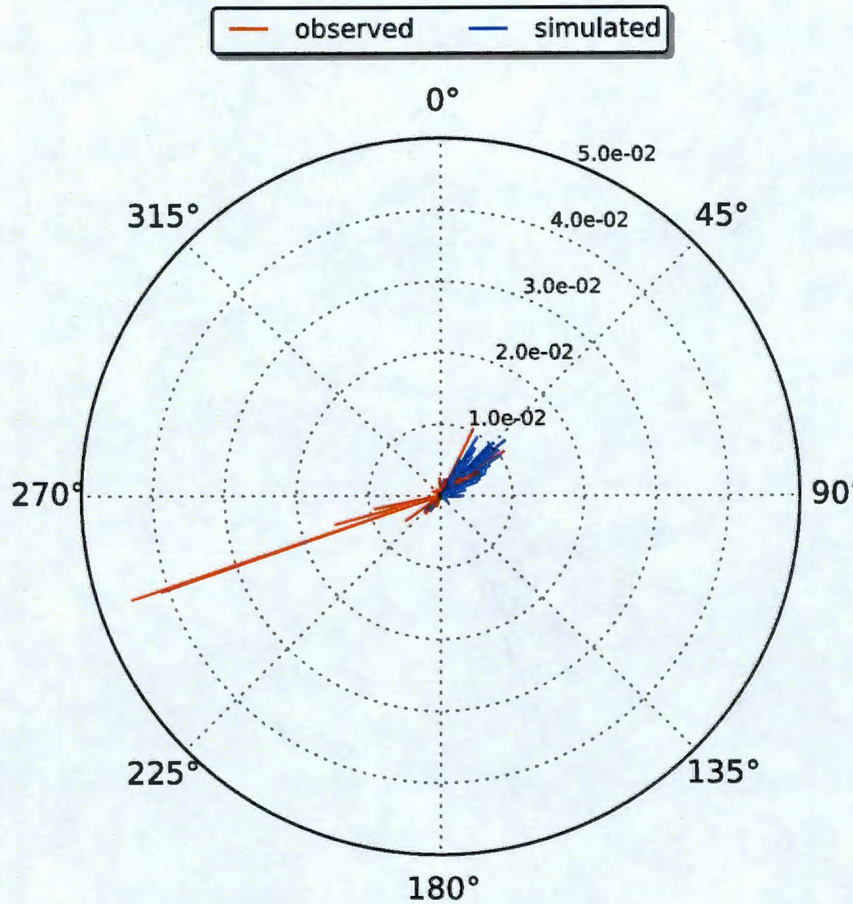



| | Observed | Simulated |
|---|---|---|
| Data Points | 94 | 94 |
| Minimum Azimuth | 1.6 | 23.3 |
| Maximum Azimuth | 240.1 | 208.8 |
| Minimum Magnitude | 2.4e-04 | 2.7e-04 |
| Maximum Magnitude | 1.1e-02 | 8.1e-03 |

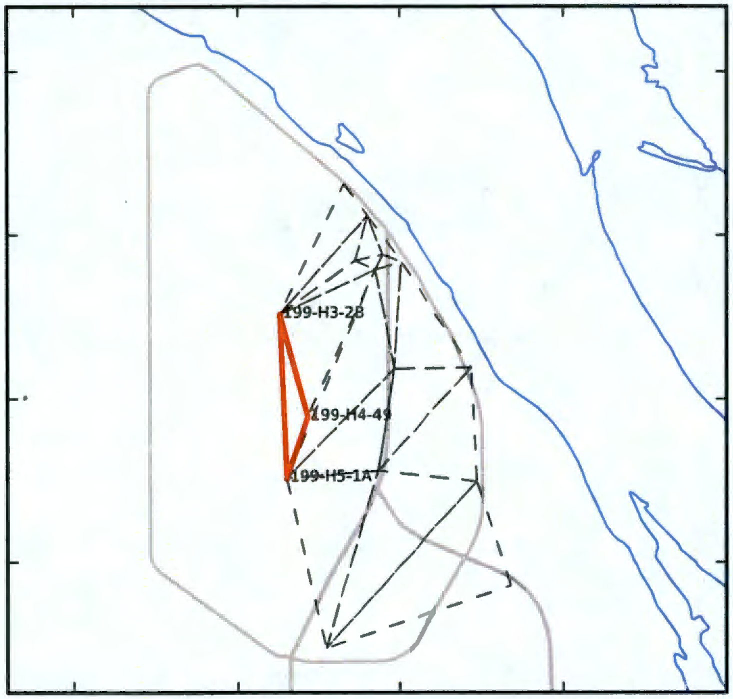
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 60*

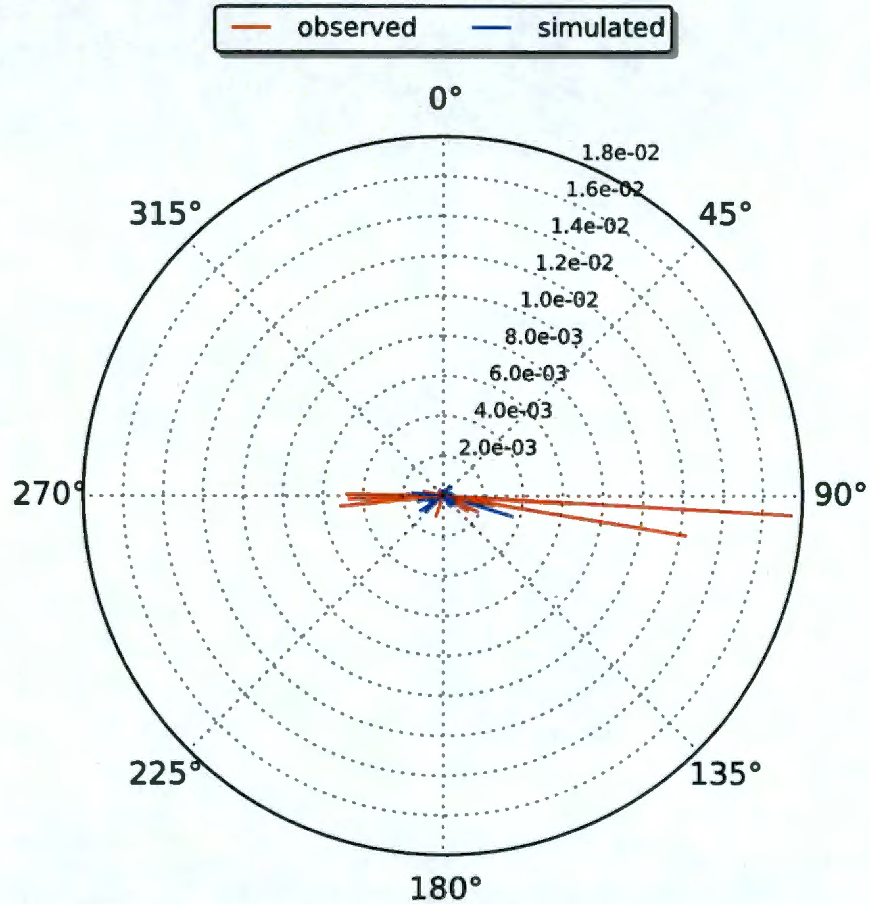



| | Observed | Simulated |
|---|---|---|
| Data Points | 76 | 76 |
| Minimum Azimuth | 19.7 | 12.3 |
| Maximum Azimuth | 356.0 | 227.9 |
| Minimum Magnitude | 1.6e-04 | 3.8e-04 |
| Maximum Magnitude | 4.5e-02 | 1.2e-02 |

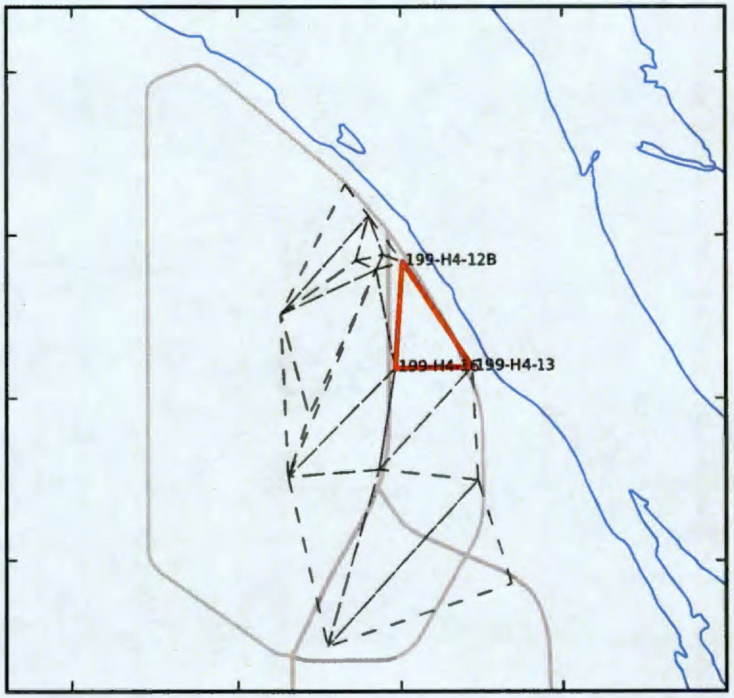
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 61*

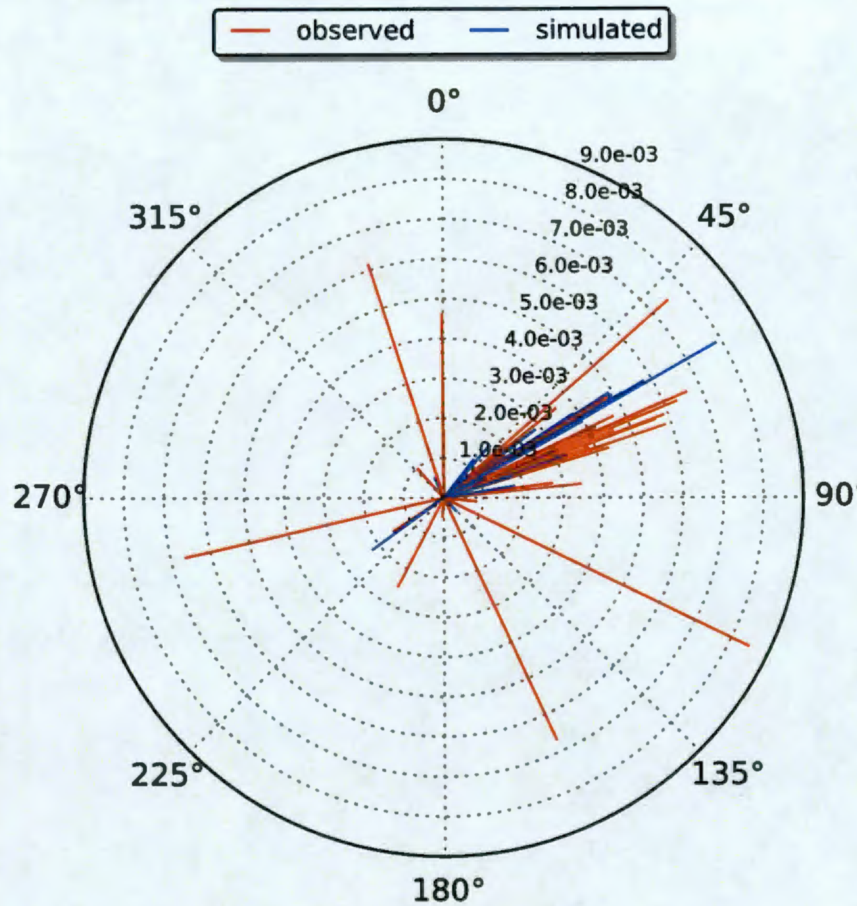



| | Observed | Simulated |
|---|---|---|
| Data Points | 48 | 48 |
| Minimum Azimuth | 20.0 | 11.8 |
| Maximum Azimuth | 343.6 | 355.4 |
| Minimum Magnitude | 9.0e-05 | 7.1e-05 |
| Maximum Magnitude | 1.7e-02 | 3.6e-03 |

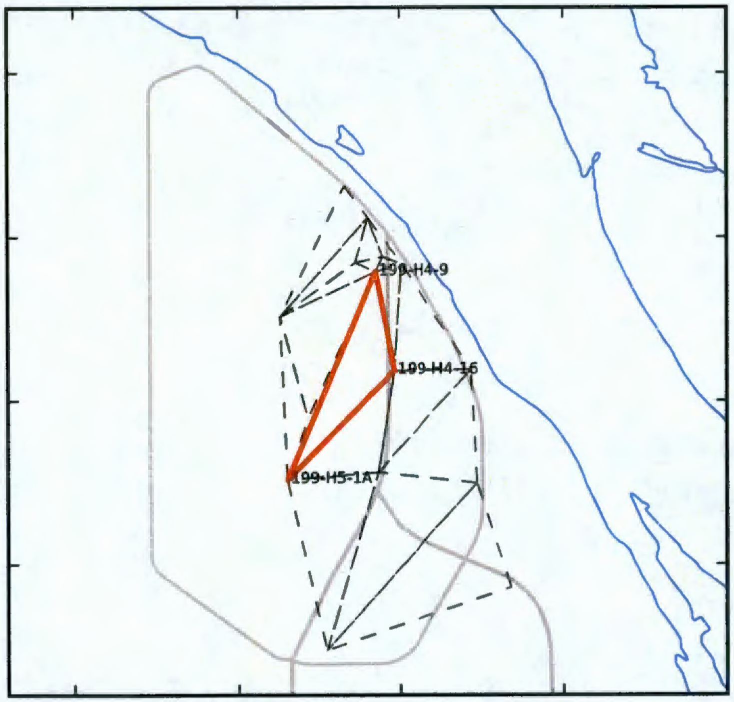
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 62*

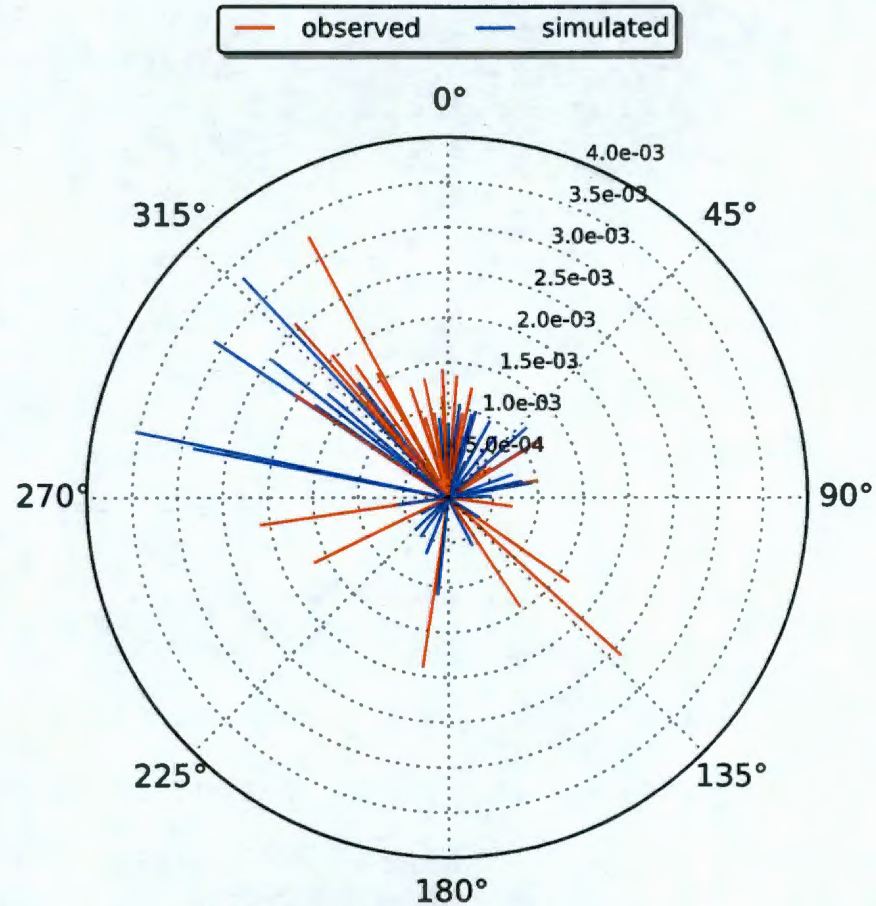



| | Observed | Simulated |
|---|---|---|
| Data Points | 31 | 31 |
| Minimum Azimuth | 48.6 | 37.7 |
| Maximum Azimuth | 359.6 | 336.0 |
| Minimum Magnitude | 4.6e-04 | 1.7e-04 |
| Maximum Magnitude | 8.5e-03 | 7.8e-03 |

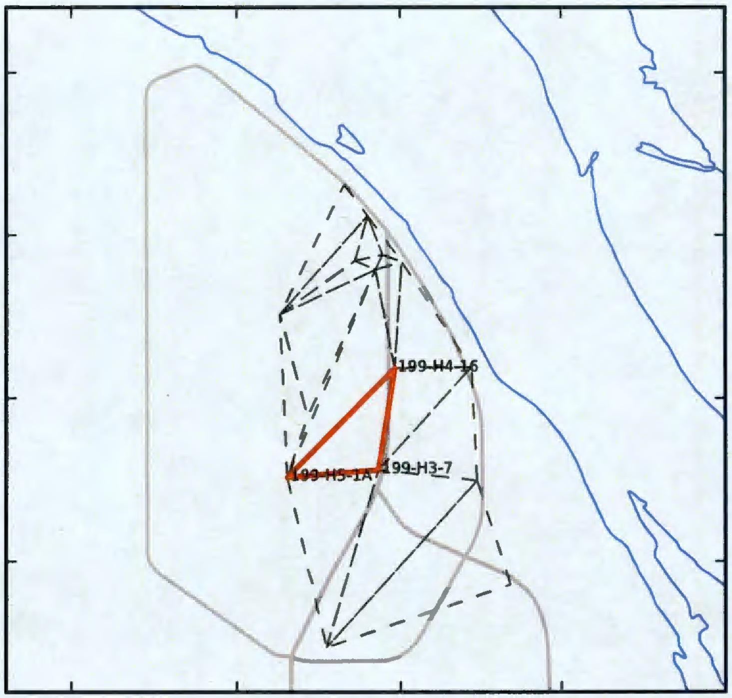
# Three-Point Gradients (Observed vs.Simulated) at Triangle 63

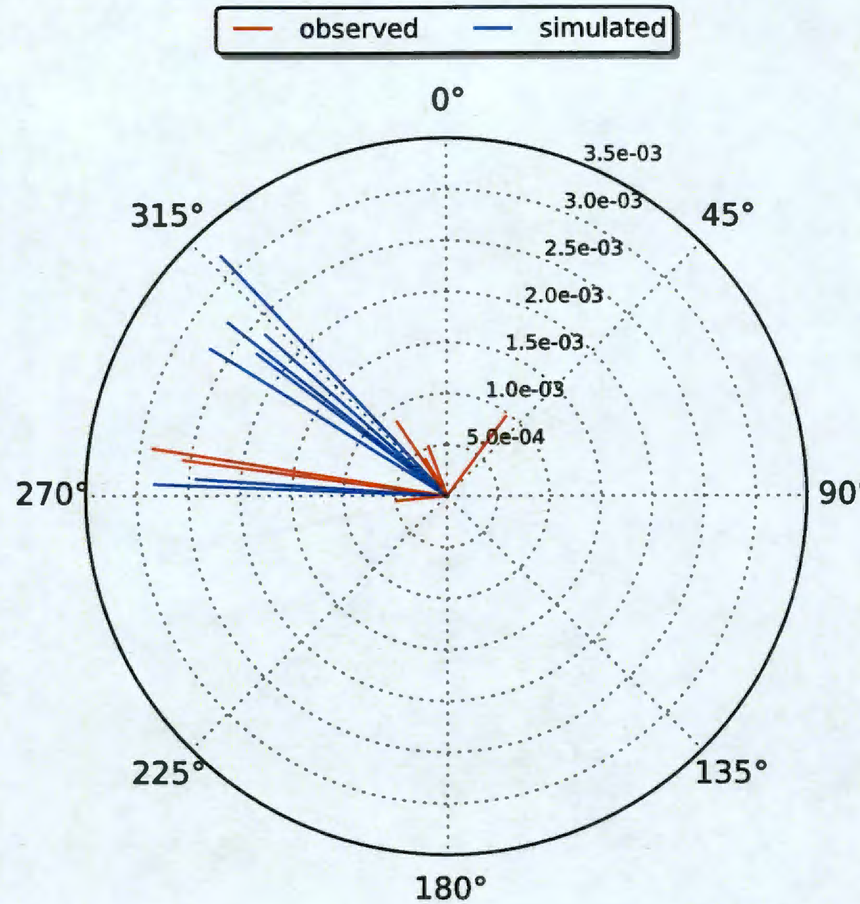



| | Observed | Simulated |
|---|---|---|
| Data Points | 36 | 36 |
| Minimum Azimuth | 4.1 | 0.4 |
| Maximum Azimuth | 357.6 | 353.9 |
| Minimum Magnitude | 7.8e-05 | 1.6e-04 |
| Maximum Magnitude | 3.3e-03 | 3.5e-03 |

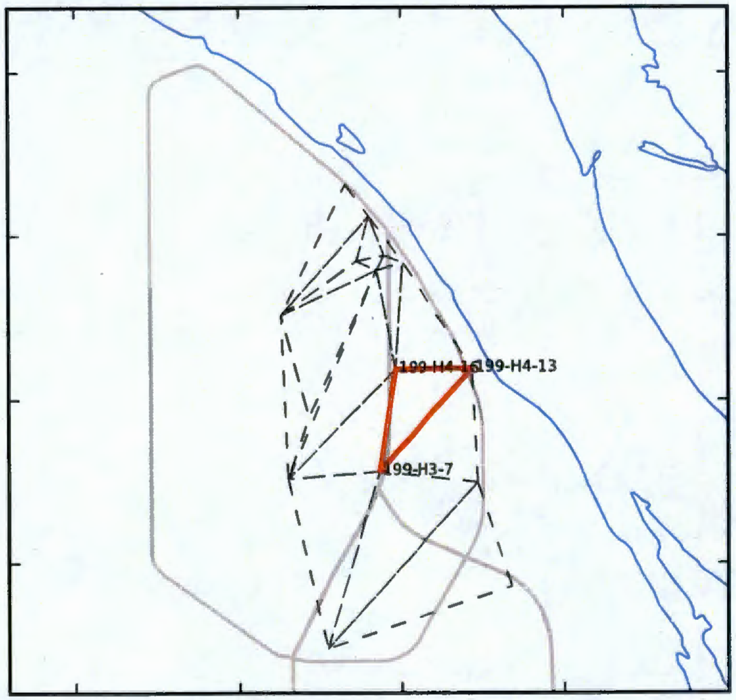
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 64*

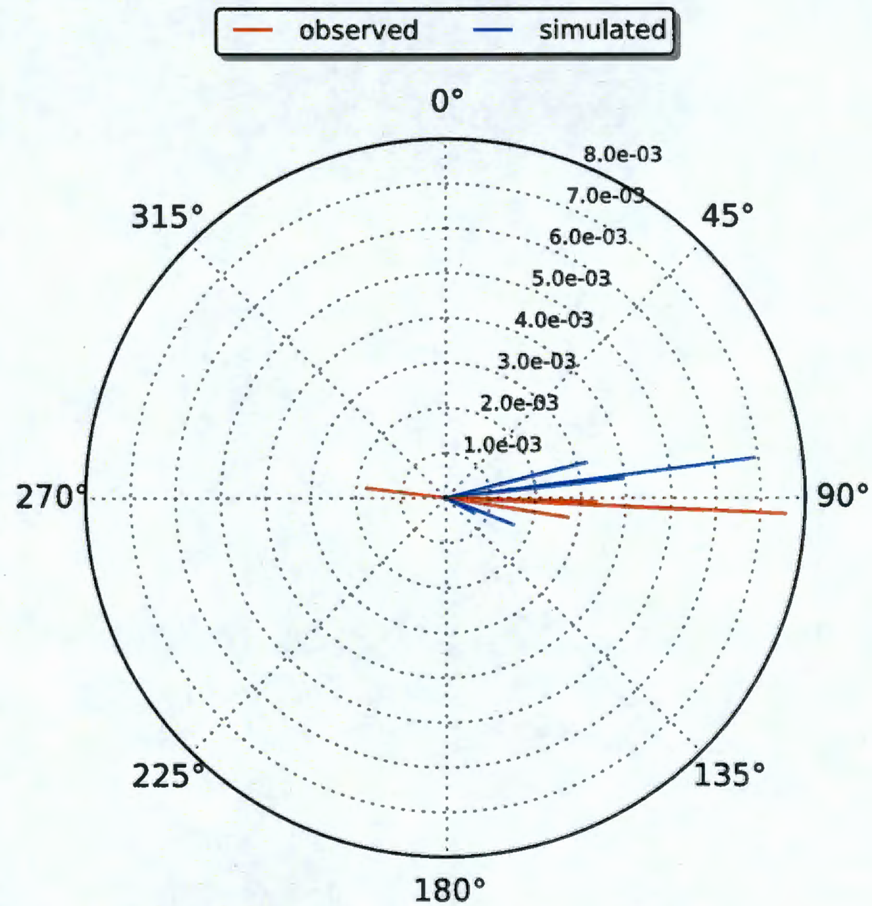



| | Observed | Simulated |
|---|---|---|
| Data Points | 7 | 7 |
| Minimum Azimuth | 36.8 | 272.3 |
| Maximum Azimuth | 339.4 | 317.1 |
| Minimum Magnitude | 4.1e-04 | 2.3e-03 |
| Maximum Magnitude | 2.9e-03 | 3.2e-03 |

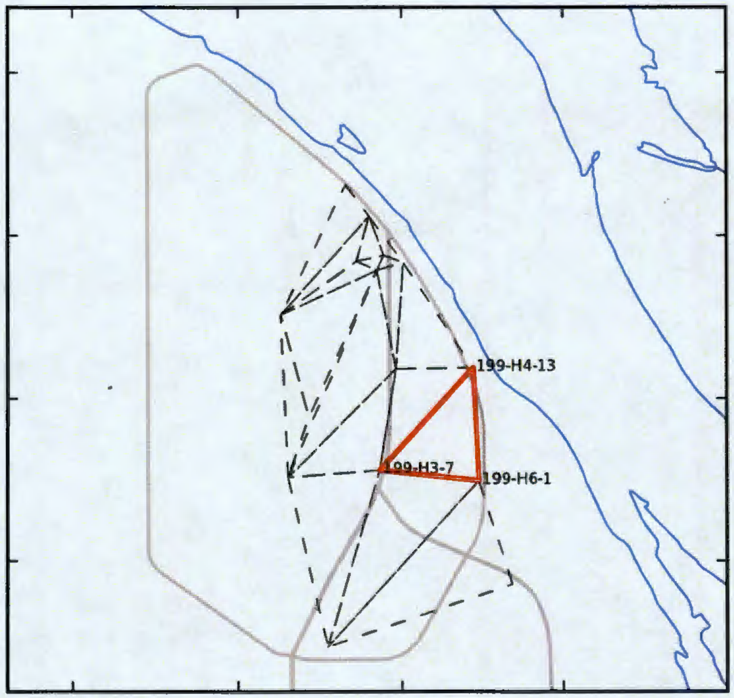
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 65*

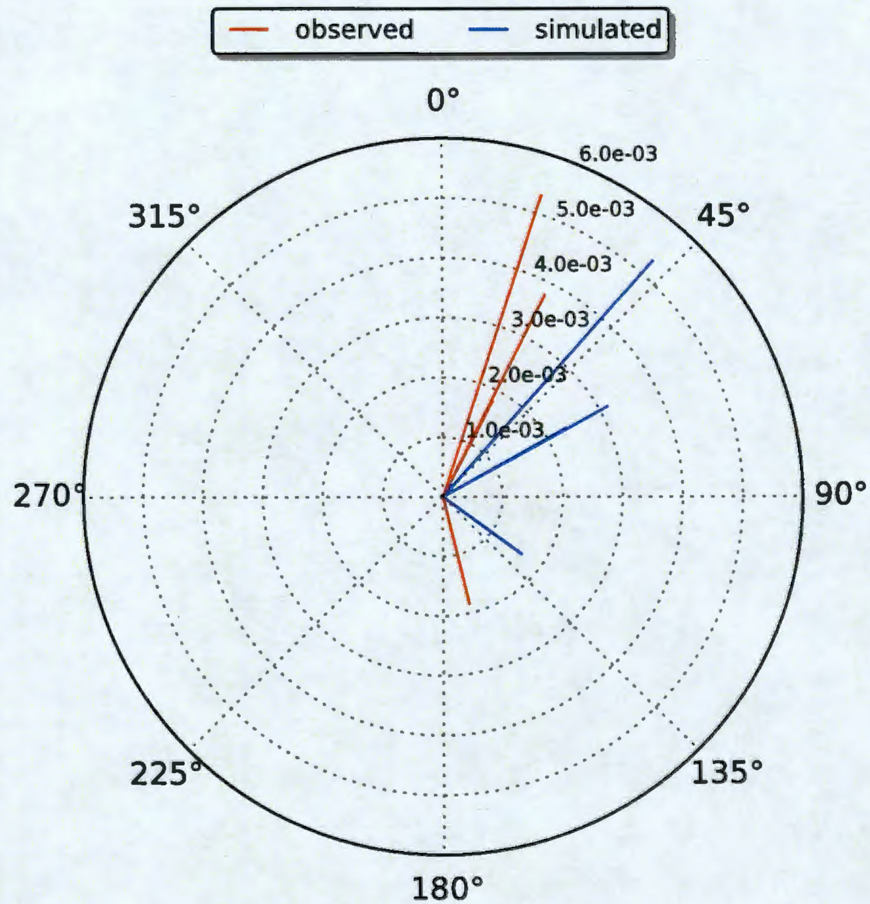



| | Observed | Simulated |
|---|---|---|
| Data Points | 6 | 6 |
| Minimum Azimuth | 91.5 | 75.5 |
| Maximum Azimuth | 277.1 | 117.9 |
| Minimum Magnitude | 1.8e-03 | 7.0e-04 |
| Maximum Magnitude | 7.6e-03 | 6.9e-03 |

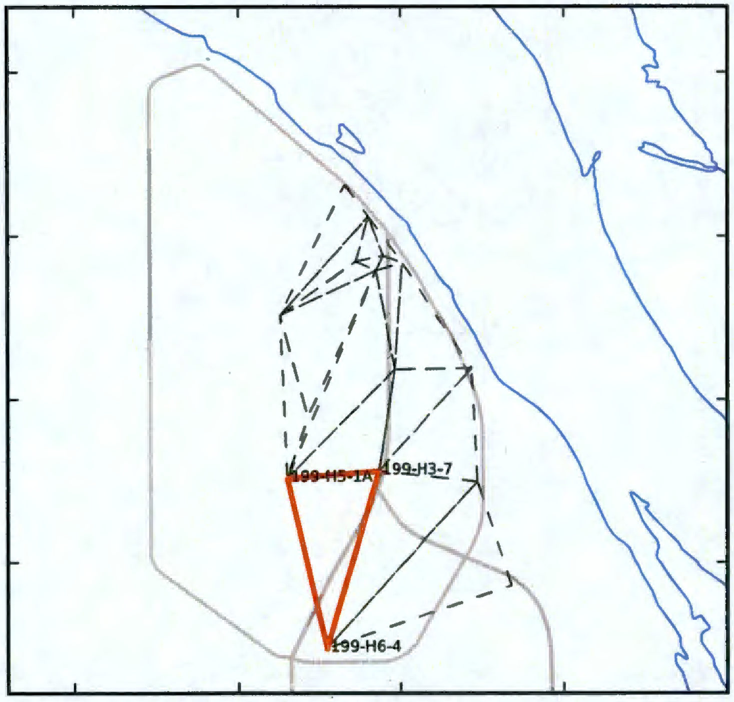
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 66*

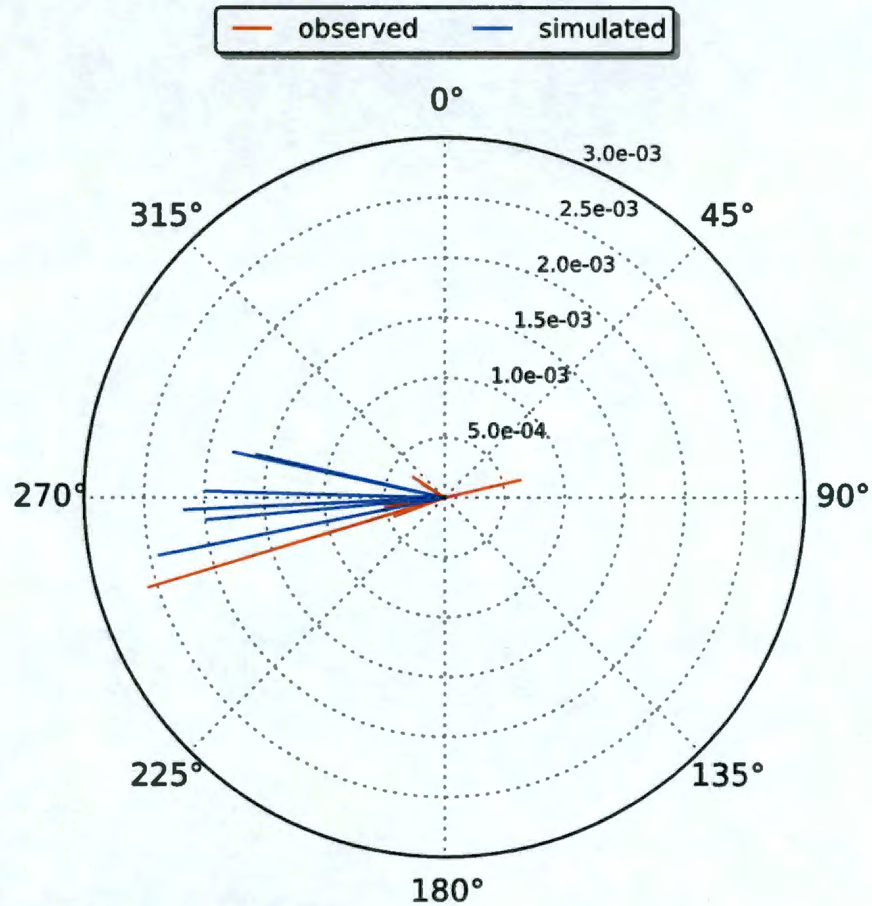



| | Observed | Simulated |
|---|---|---|
| Data Points | 4 | 4 |
| Minimum Azimuth | 18.2 | 41.7 |
| Maximum Azimuth | 166.4 | 126.1 |
| Minimum Magnitude | 1.8e-03 | 1.6e-03 |
| Maximum Magnitude | 5.3e-03 | 5.3e-03 |

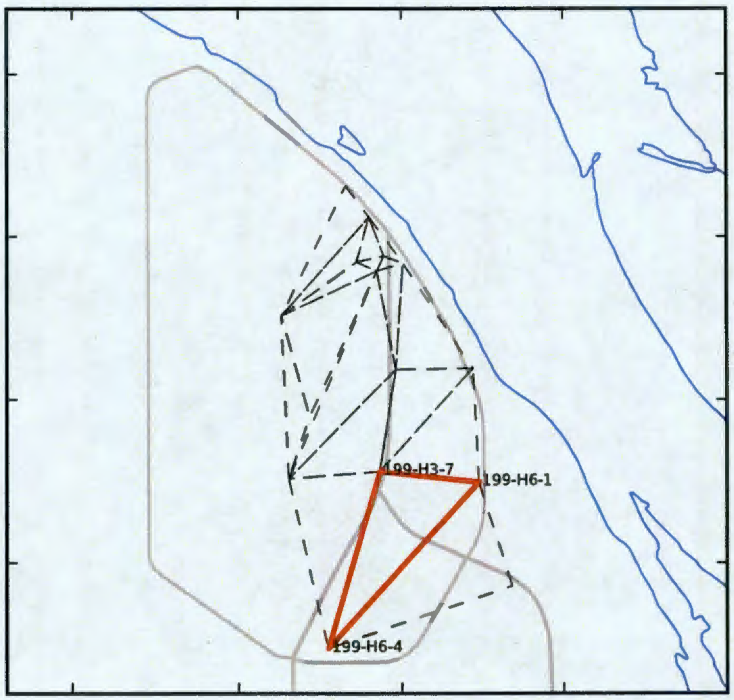
# Three-Point Gradients (Observed vs.Simulated) at Triangle 67

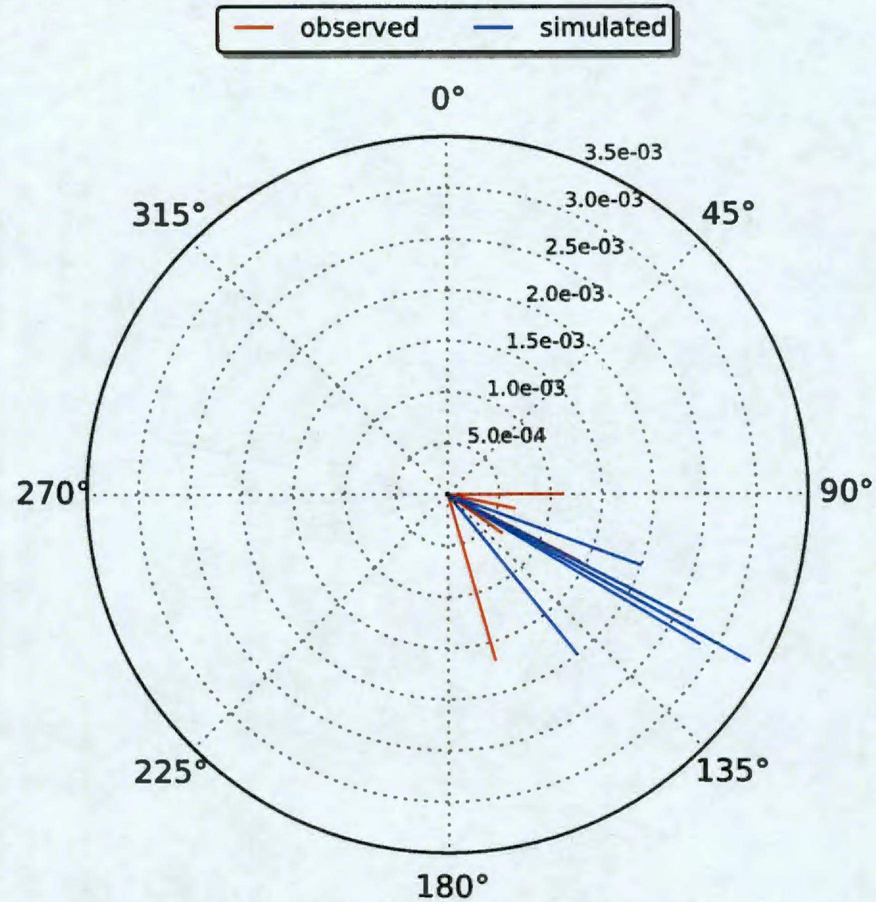



| | Observed | Simulated |
|---|---|---|
| Data Points | 6 | 6 |
| Minimum Azimuth | 76.9 | 258.6 |
| Maximum Azimuth | 302.9 | 283.0 |
| Minimum Magnitude | 2.2e-04 | 1.6e-03 |
| Maximum Magnitude | 2.6e-03 | 2.4e-03 |

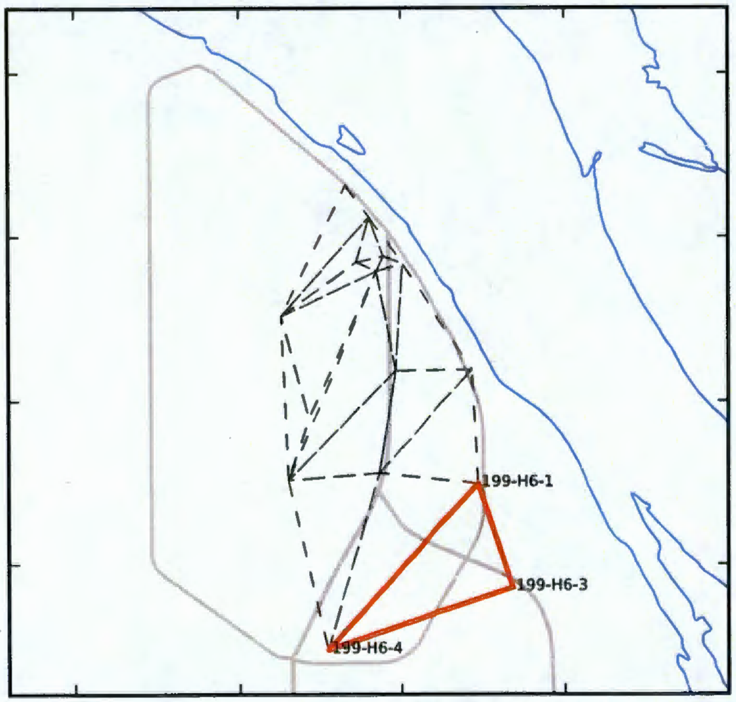
# Three-Point Gradients (Observed vs.Simulated) at Triangle 68

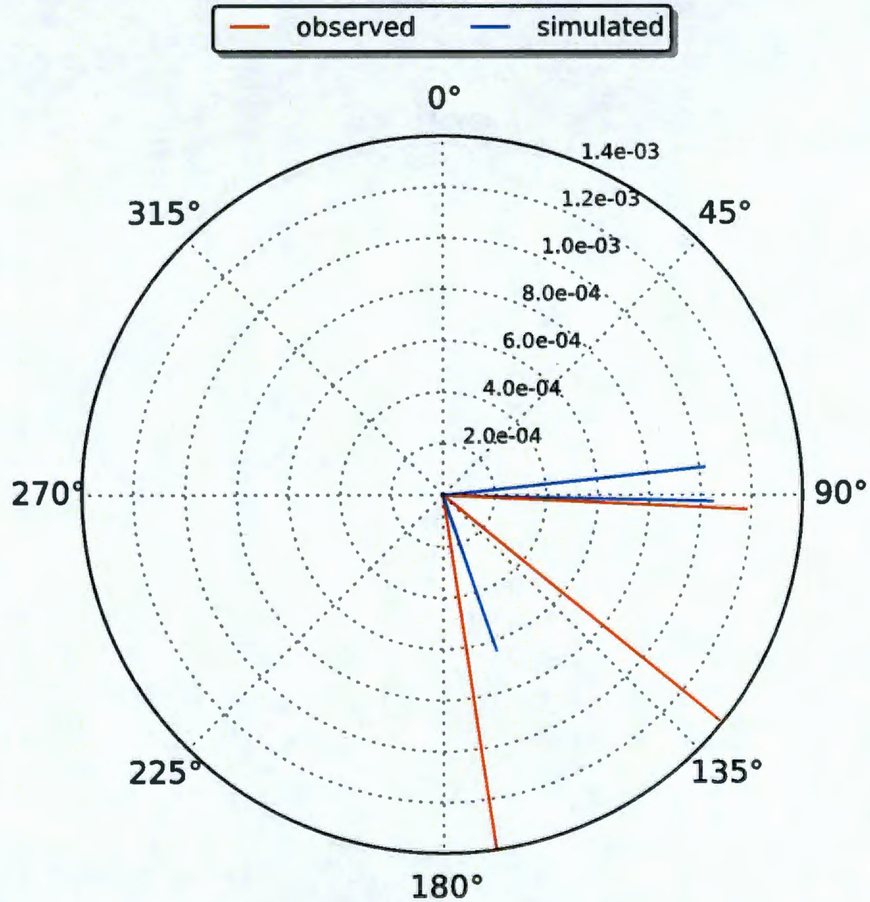



| | Observed | Simulated |
|---|---|---|
| Data Points | 5 | 5 |
| Minimum Azimuth | 89.9 | 110.2 |
| Maximum Azimuth | 164.3 | 141.2 |
| Minimum Magnitude | 6.4e-04 | 2.0e-03 |
| Maximum Magnitude | 1.7e-03 | 3.3e-03 |

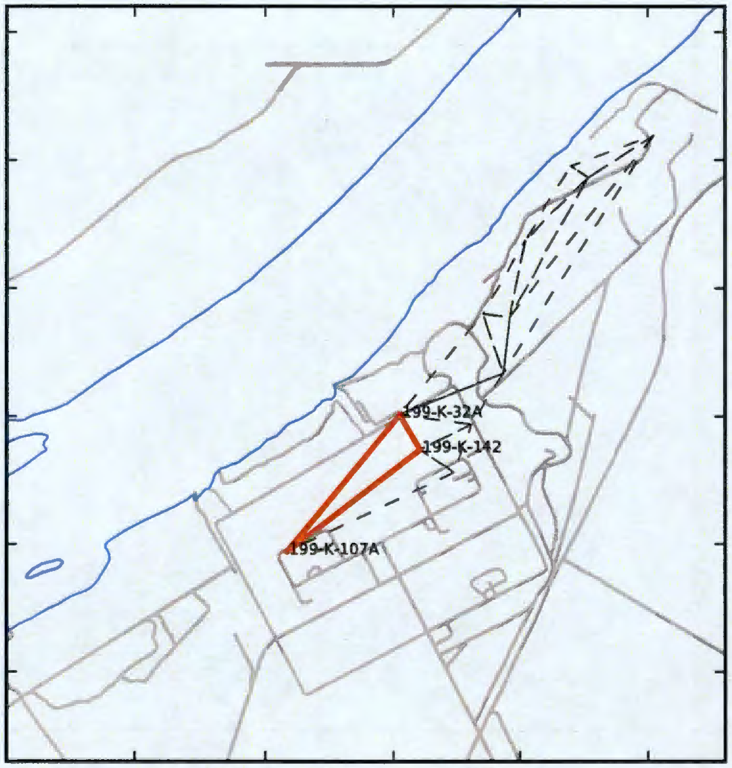
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 69*

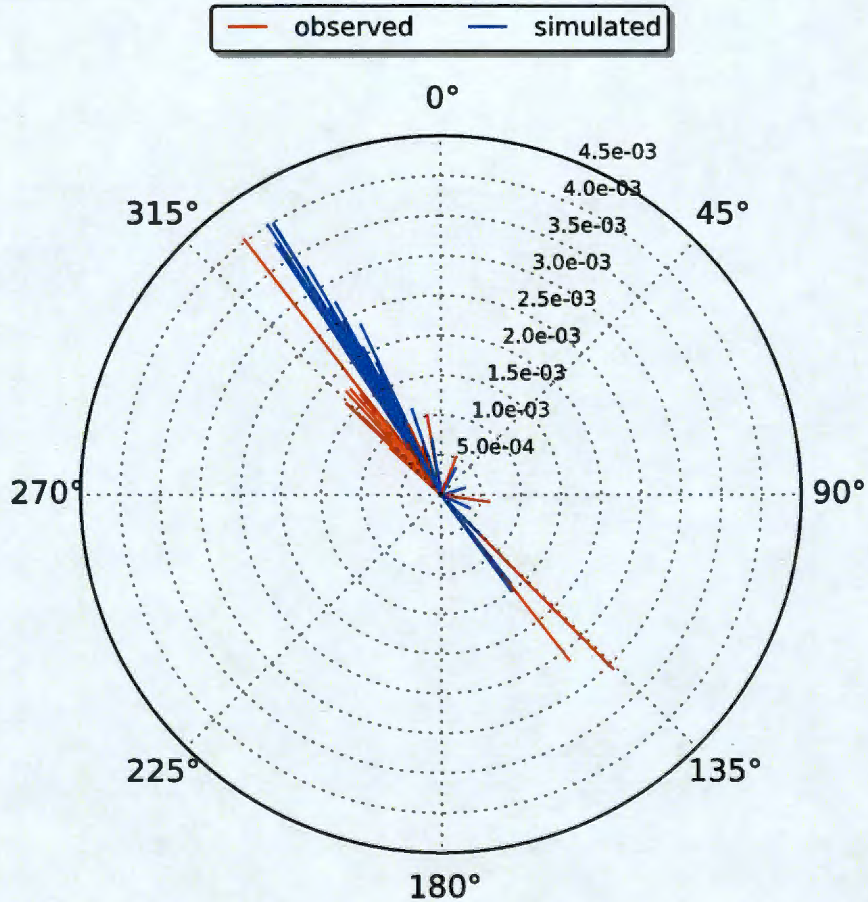



| | Observed | Simulated |
|---|---|---|
| Data Points | 3 | 3 |
| Minimum Azimuth | 92.7 | 83.8 |
| Maximum Azimuth | 171.6 | 161.2 |
| Minimum Magnitude | 1.2e-03 | 6.4e-04 |
| Maximum Magnitude | 1.4e-03 | 1.0e-03 |

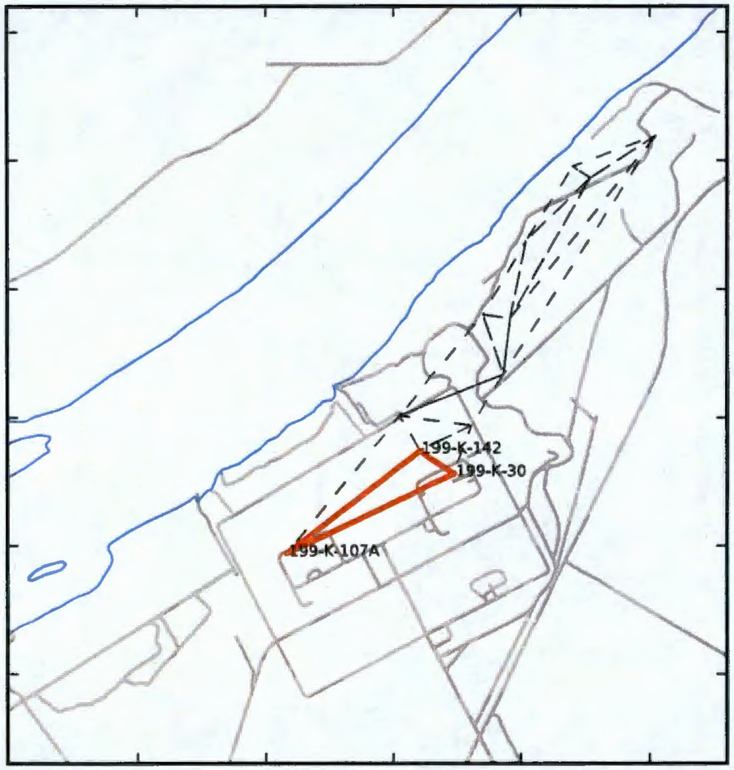
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 70*

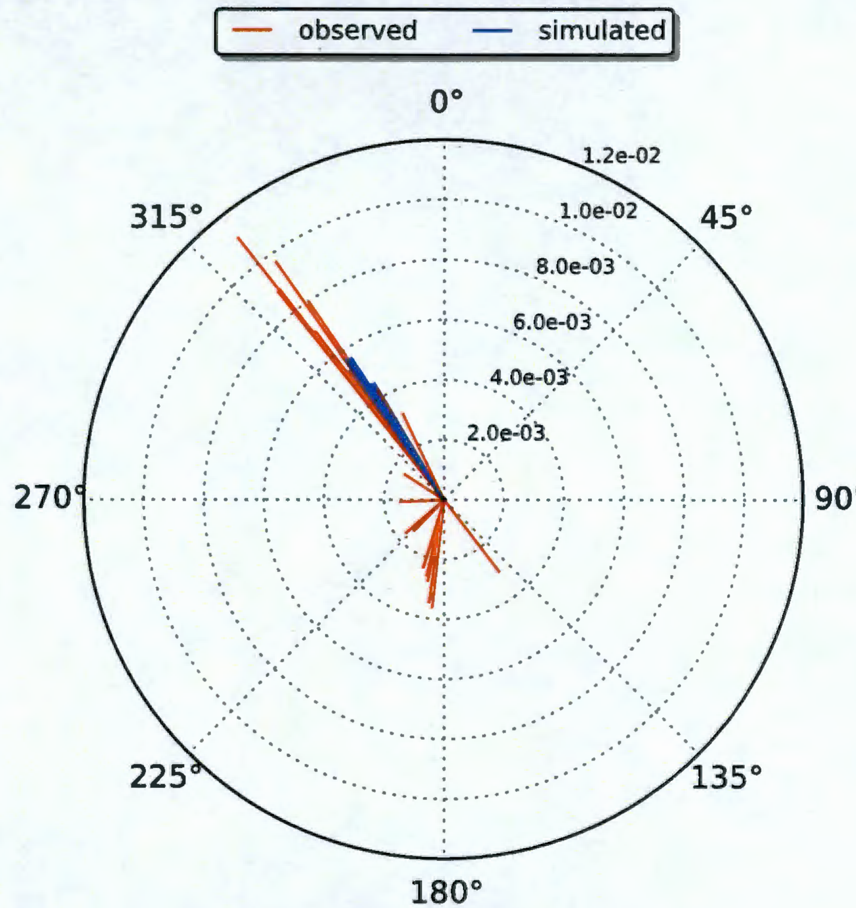



| | Observed | Simulated |
|---|---|---|
| Data Points | 45 | 45 |
| Minimum Azimuth | 21.3 | 17.9 |
| Maximum Azimuth | 360.0 | 352.2 |
| Minimum Magnitude | 0.0e+00 | 9.7e-05 |
| Maximum Magnitude | 4.0e-03 | 4.0e-03 |

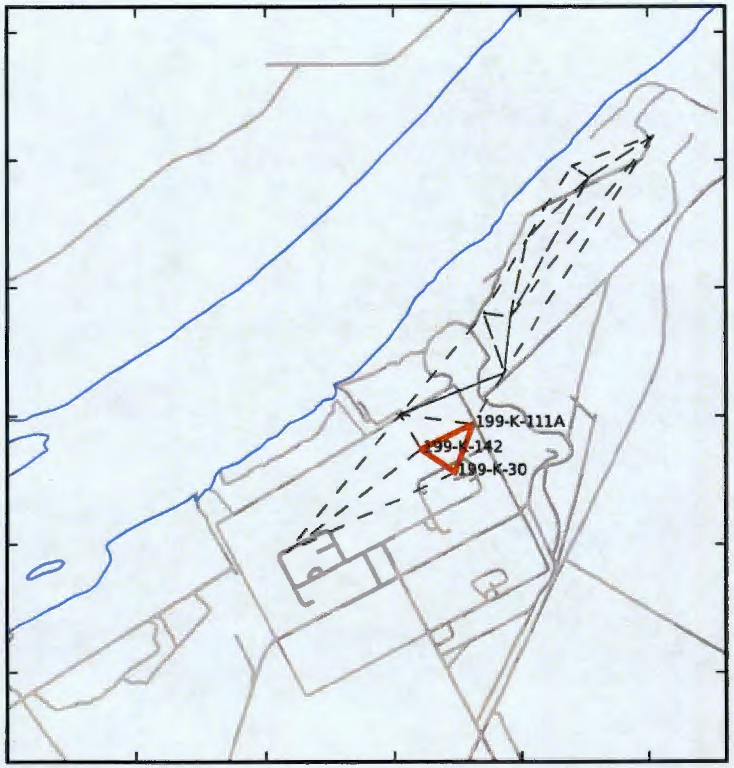
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 71*

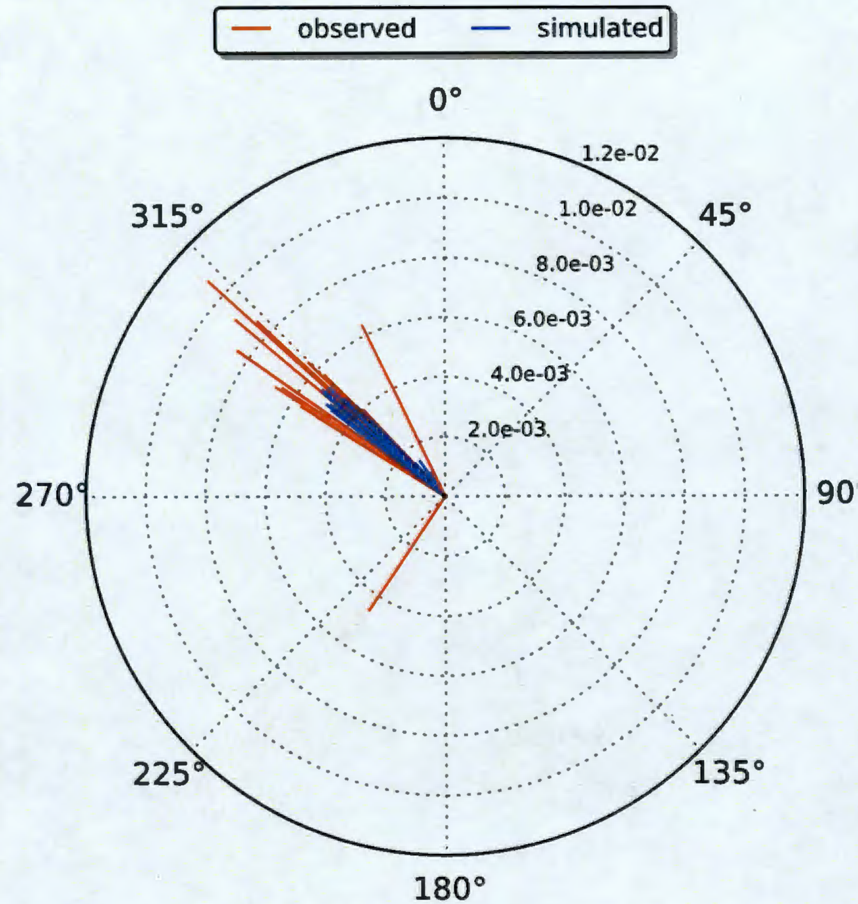



| | Observed | Simulated |
|---|---|---|
| Data Points | 29 | 29 |
| Minimum Azimuth | 142.5 | 324.9 |
| Maximum Azimuth | 334.6 | 329.0 |
| Minimum Magnitude | 7.2e-05 | 8.7e-04 |
| Maximum Magnitude | 1.1e-02 | 5.8e-03 |

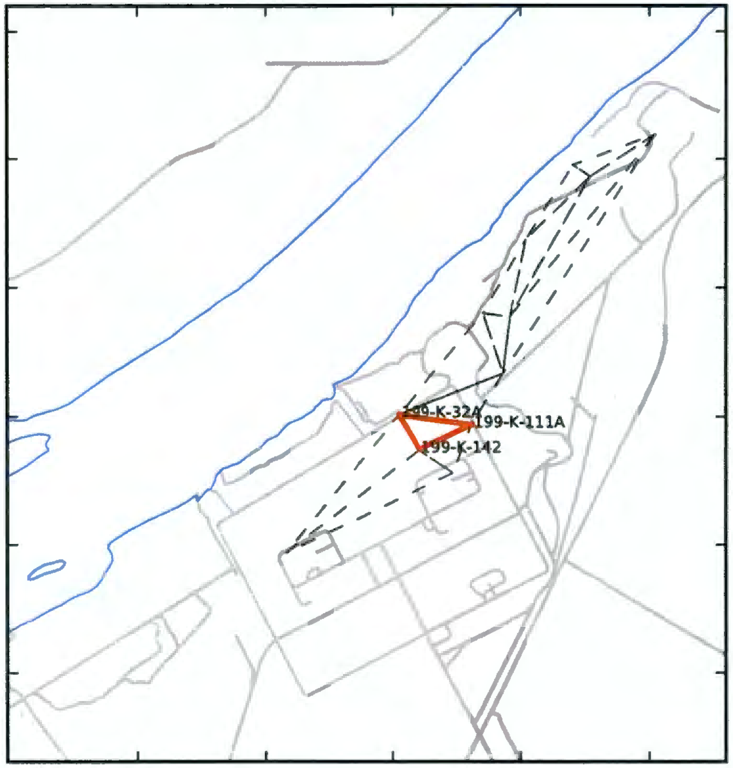
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 72*

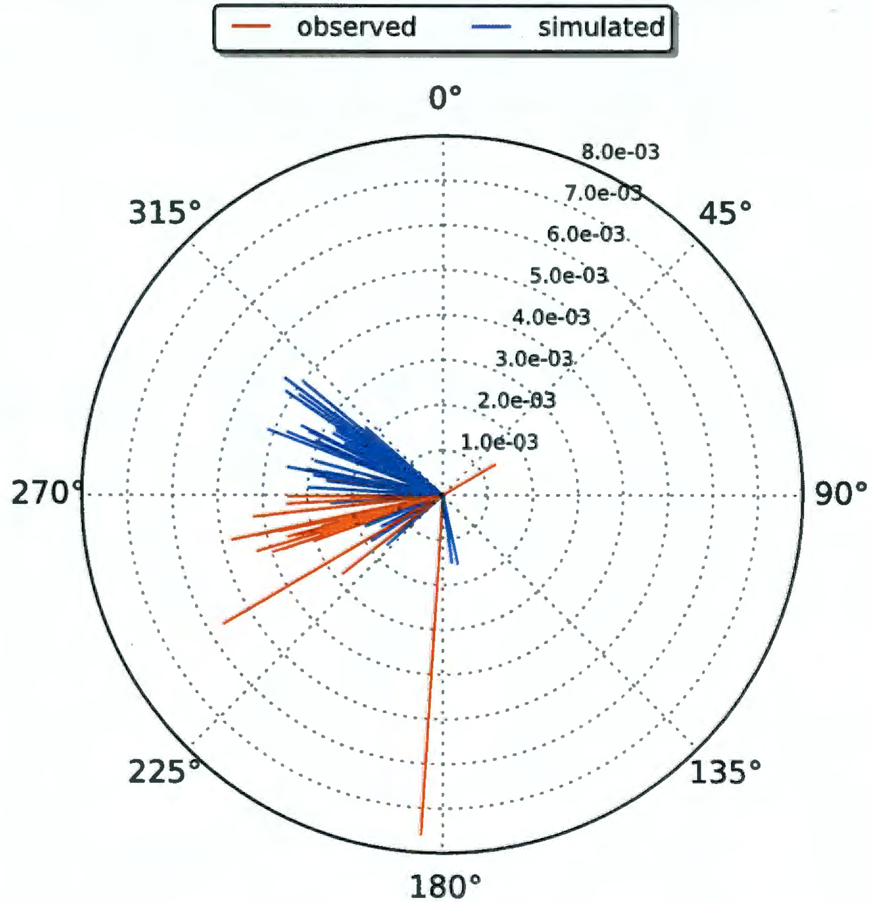



| | Observed | Simulated |
|---|---|---|
| Data Points | 29 | 29 |
| Minimum Azimuth | 213.9 | 302.2 |
| Maximum Azimuth | 334.3 | 332.1 |
| Minimum Magnitude | 4.3e-04 | 9.2e-04 |
| Maximum Magnitude | 1.1e-02 | 5.4e-03 |

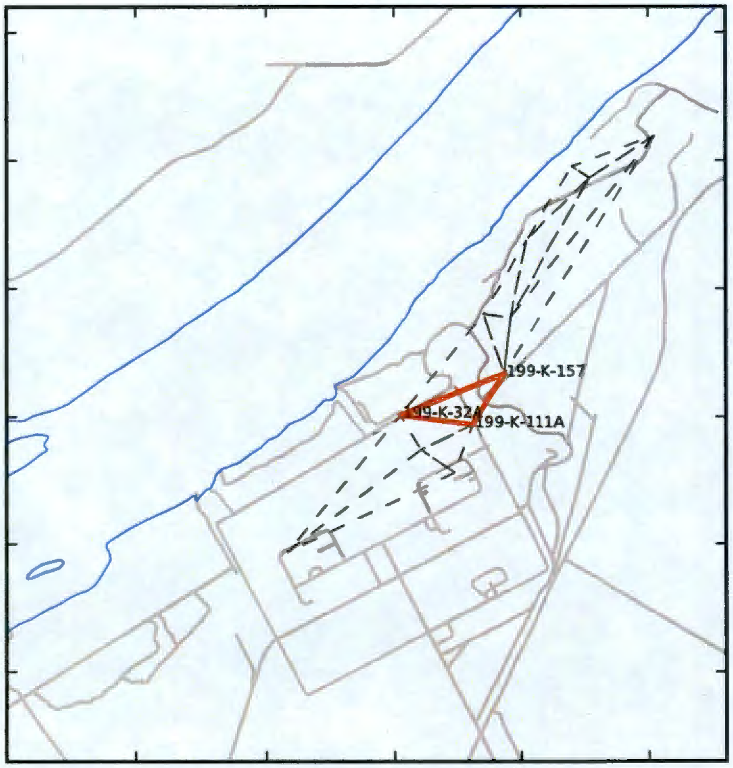
# Three-Point Gradients (Observed vs.Simulated) at Triangle 73

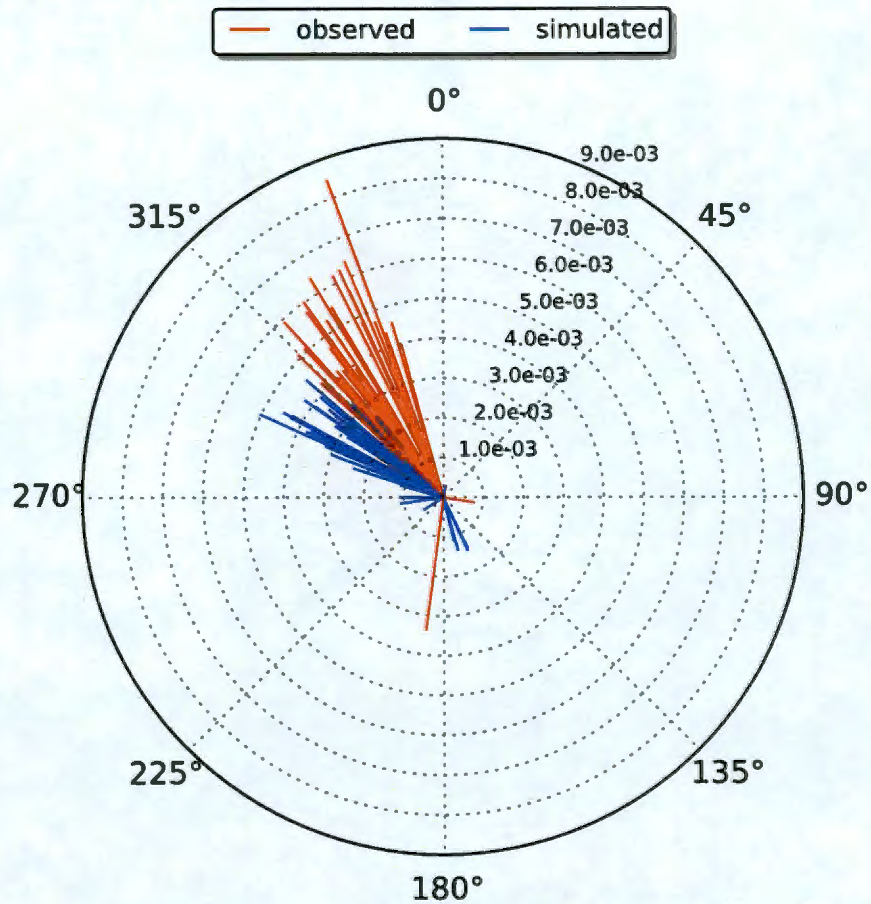



| | Observed | Simulated |
|---|---|---|
| Data Points | 44 | 44 |
| Minimum Azimuth | 59.4 | 167.7 |
| Maximum Azimuth | 360.0 | 311.4 |
| Minimum Magnitude | 0.0e+00 | 9.3e-05 |
| Maximum Magnitude | 7.6e-03 | 4.3e-03 |

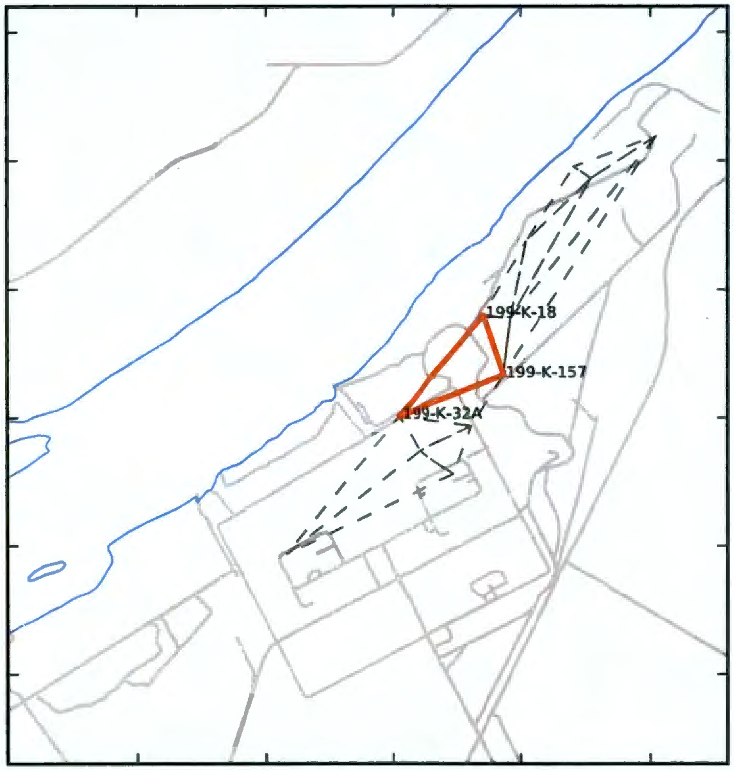
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 74*

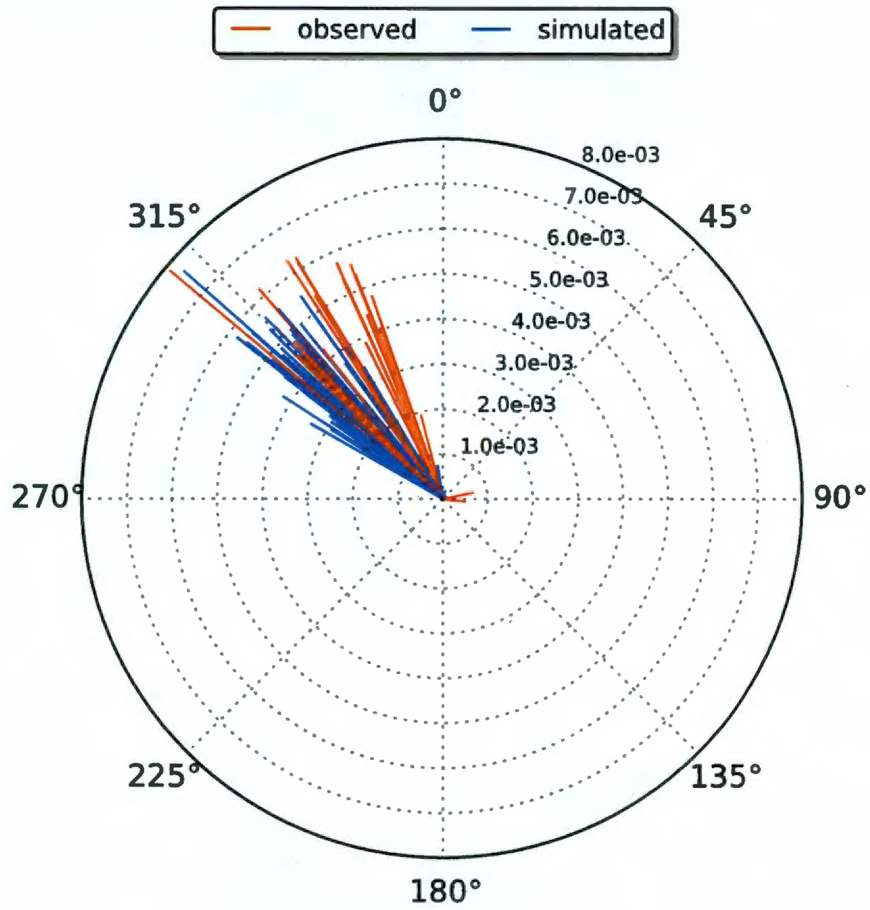



| | Observed | Simulated |
|---|---|---|
| Data Points | 49 | 49 |
| Minimum Azimuth | 99.0 | 11.0 |
| Maximum Azimuth | 360.0 | 321.0 |
| Minimum Magnitude | 0.0e+00 | 3.0e-04 |
| Maximum Magnitude | 8.4e-03 | 5.0e-03 |

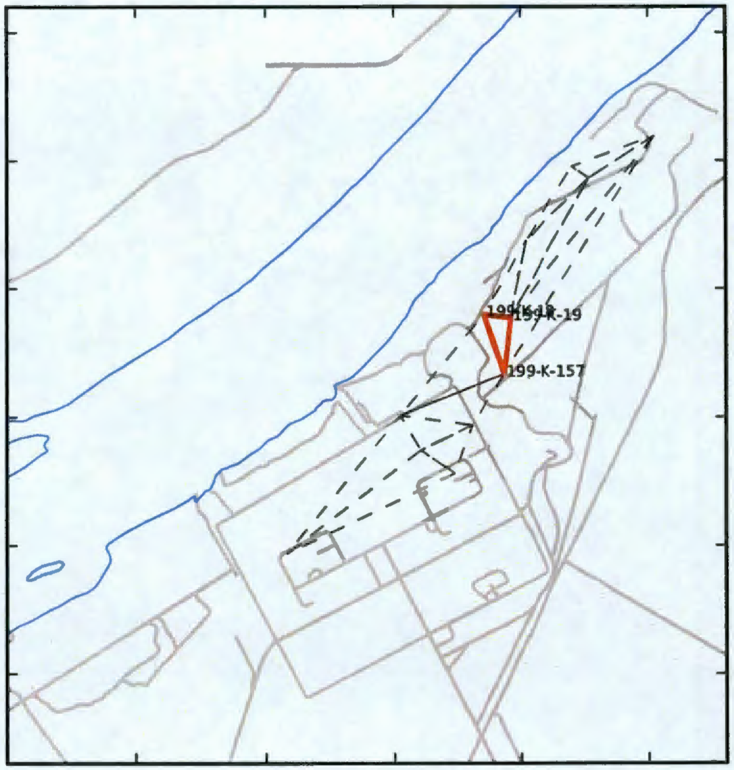
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 75*

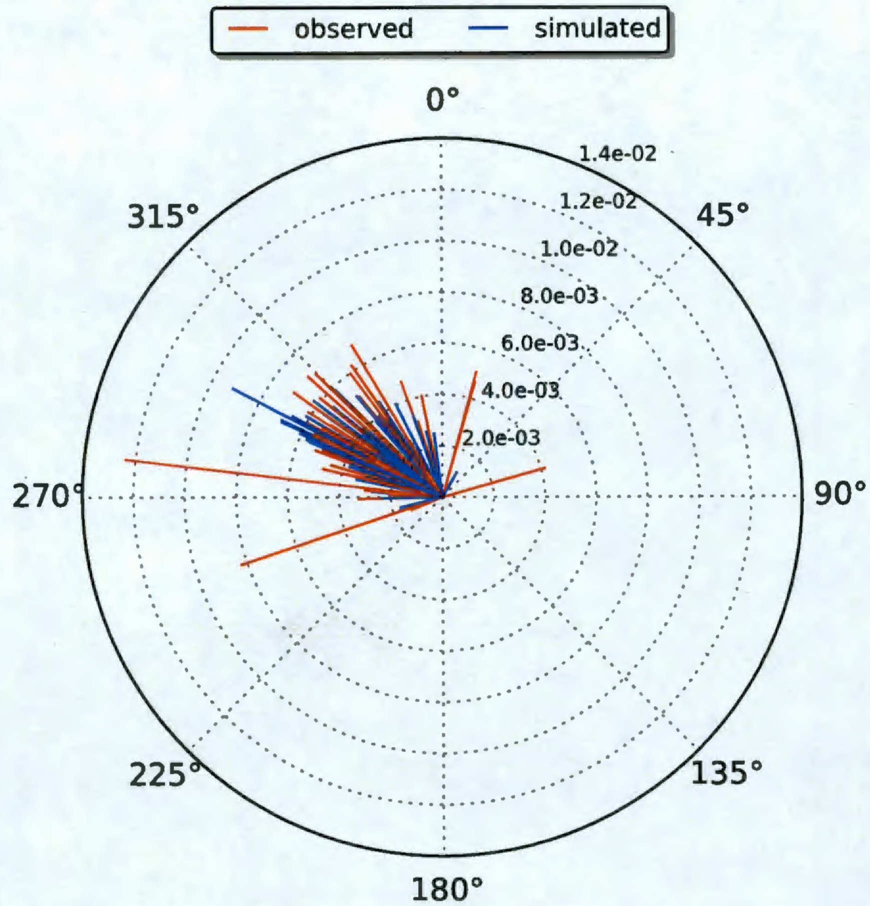



| | Observed | Simulated |
|---|---|---|
| Data Points | 53 | 53 |
| Minimum Azimuth | 78.3 | 13.9 |
| Maximum Azimuth | 345.3 | 350.8 |
| Minimum Magnitude | 4.9e-04 | 7.8e-05 |
| Maximum Magnitude | 7.9e-03 | 7.6e-03 |

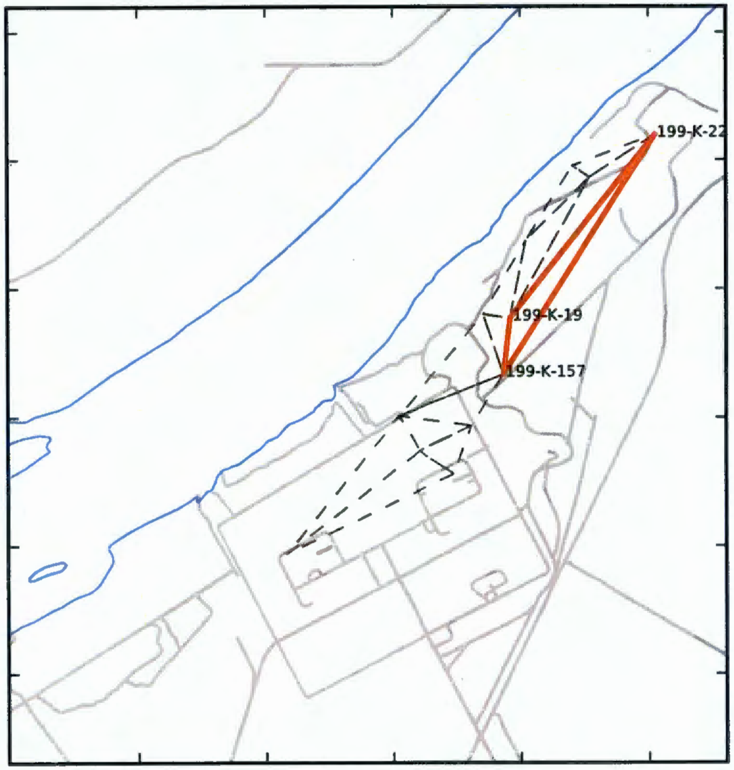
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 76*

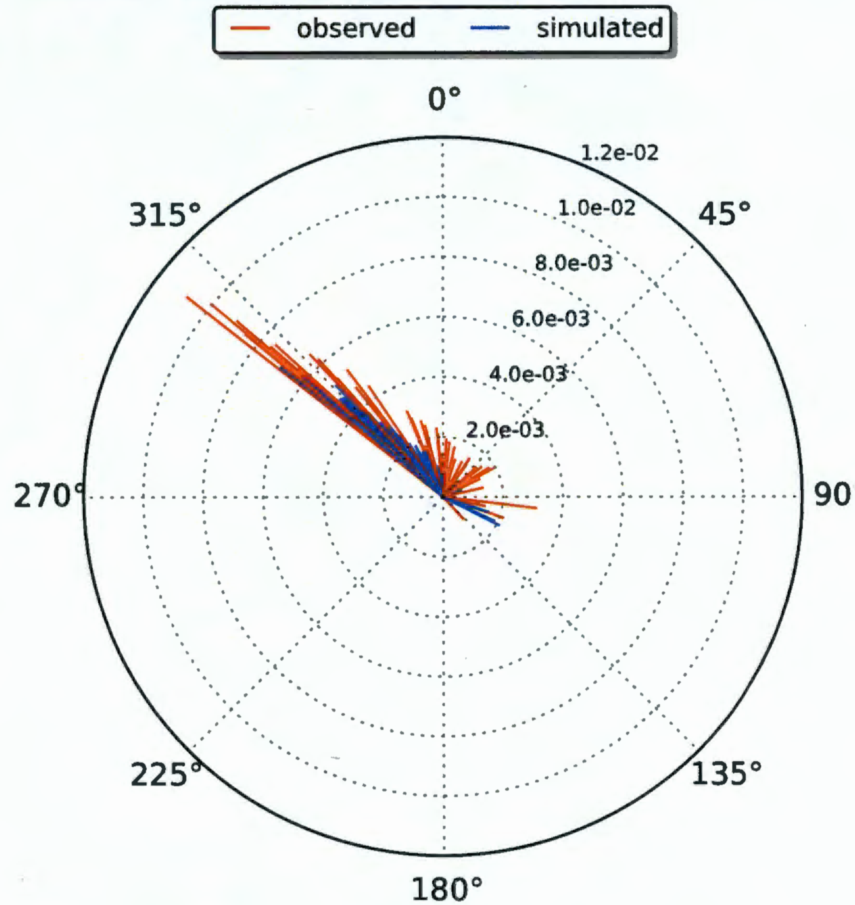



| | Observed | Simulated |
|---|---|---|
| Data Points | 53 | 53 |
| Minimum Azimuth | 15.2 | 29.8 |
| Maximum Azimuth | 348.5 | 352.8 |
| Minimum Magnitude | 0.0e+00 | 1.1e-03 |
| Maximum Magnitude | 1.2e-02 | 9.2e-03 |

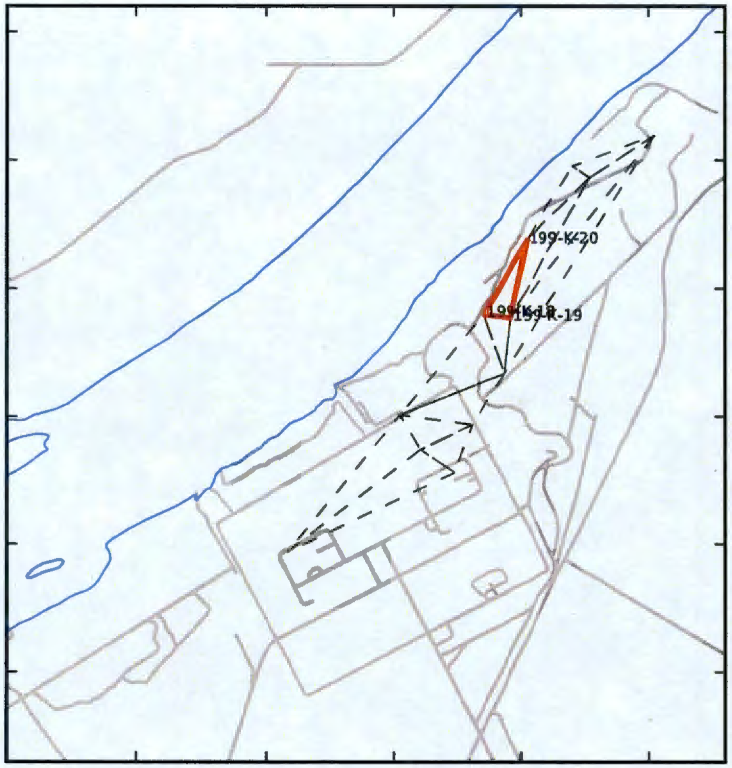
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 77*

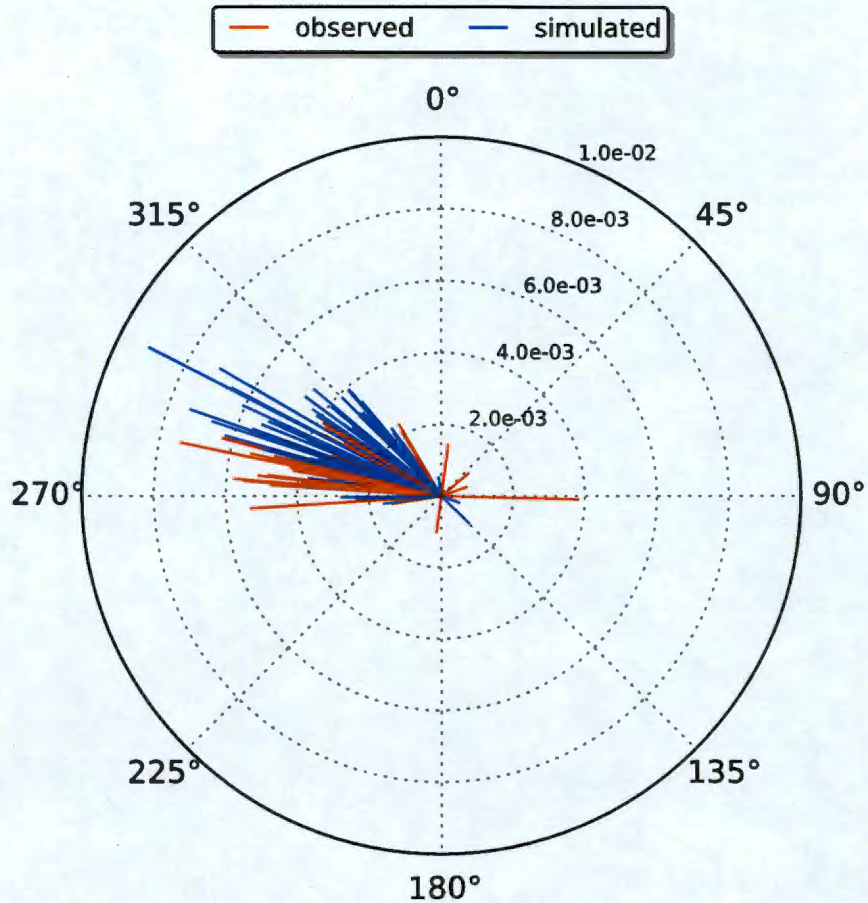



| | Observed | Simulated |
|---|---|---|
| Data Points | 54 | 54 |
| Minimum Azimuth | 3.4 | 45.3 |
| Maximum Azimuth | 358.5 | 358.6 |
| Minimum Magnitude | 2.9e-04 | 5.4e-04 |
| Maximum Magnitude | 1.1e-02 | 6.9e-03 |

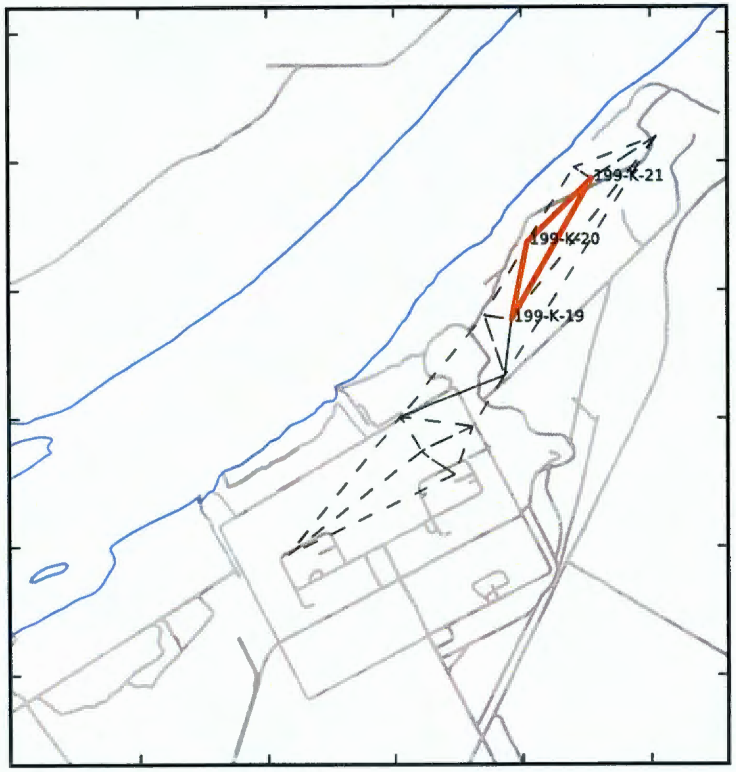
# Three-Point Gradients (Observed vs.Simulated) at Triangle 78

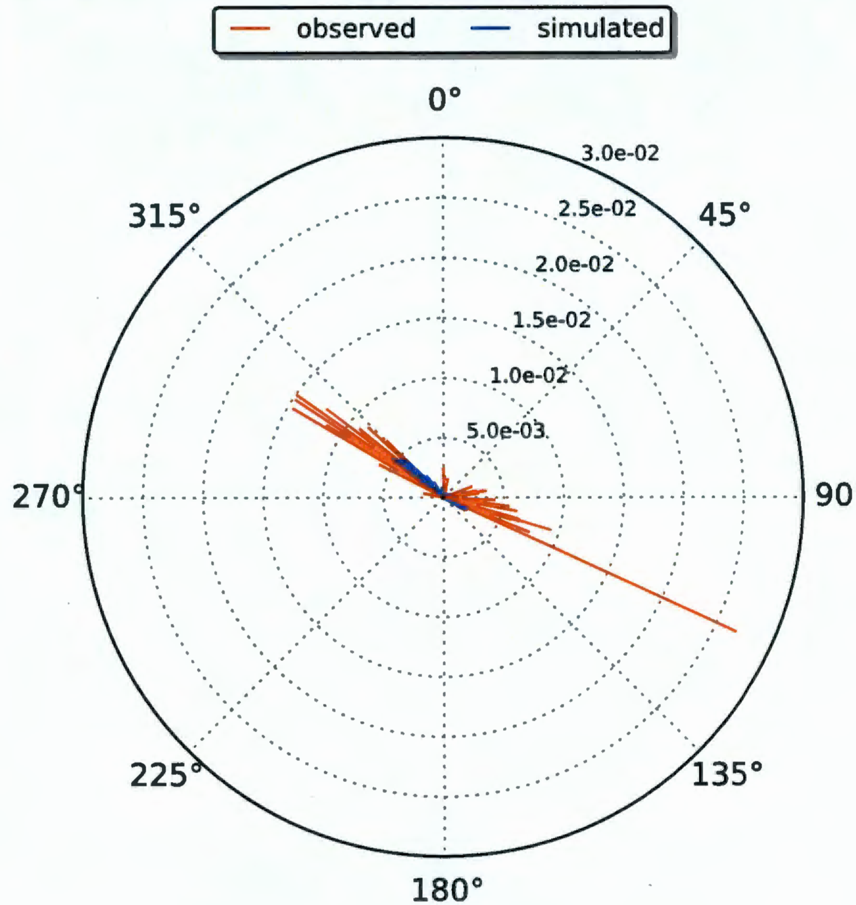



| | Observed | Simulated |
|---|---|---|
| Data Points | 78 | 78 |
| Minimum Azimuth | 7.7 | 7.7 |
| Maximum Azimuth | 329.9 | 351.9 |
| Minimum Magnitude | 6.5e-05 | 1.0e-04 |
| Maximum Magnitude | 7.4e-03 | 9.1e-03 |

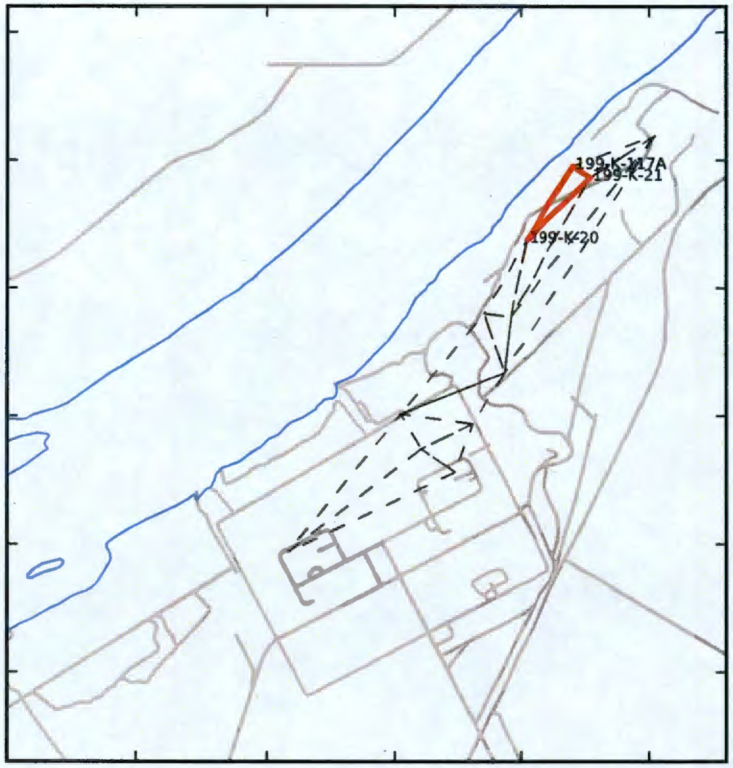
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 79*

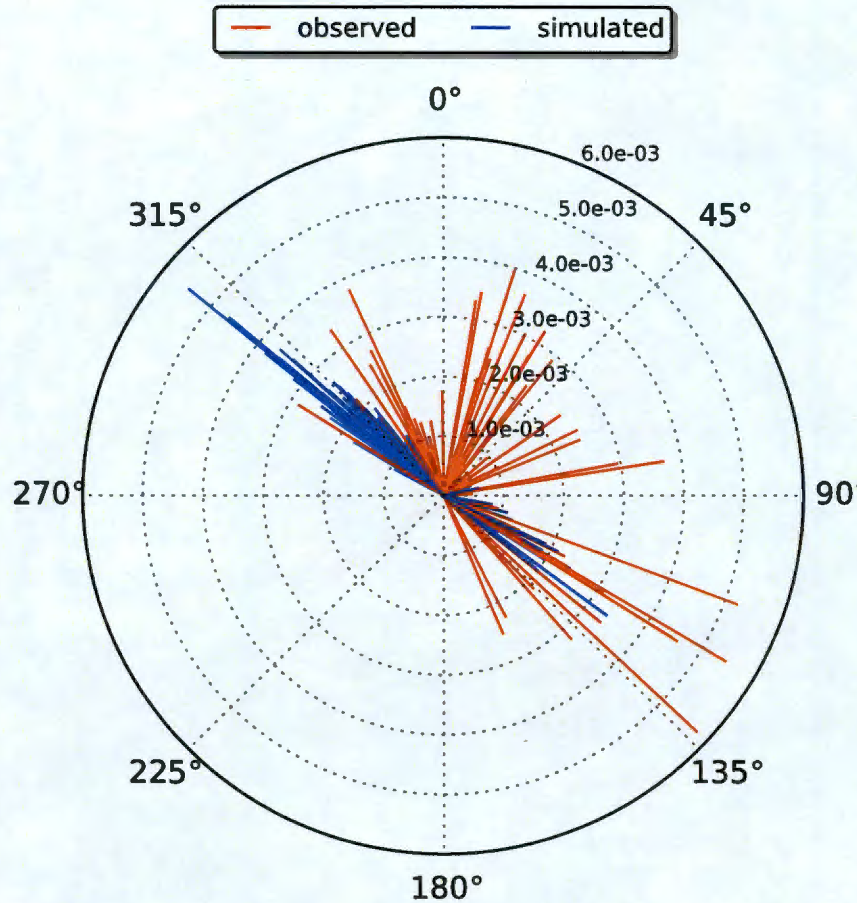



| | Observed | Simulated |
|---|---|---|
| Data Points | 78 | 78 |
| Minimum Azimuth | 3.0 | 31.2 |
| Maximum Azimuth | 359.5 | 353.3 |
| Minimum Magnitude | 5.1e-05 | 2.5e-04 |
| Maximum Magnitude | 2.7e-02 | 5.3e-03 |

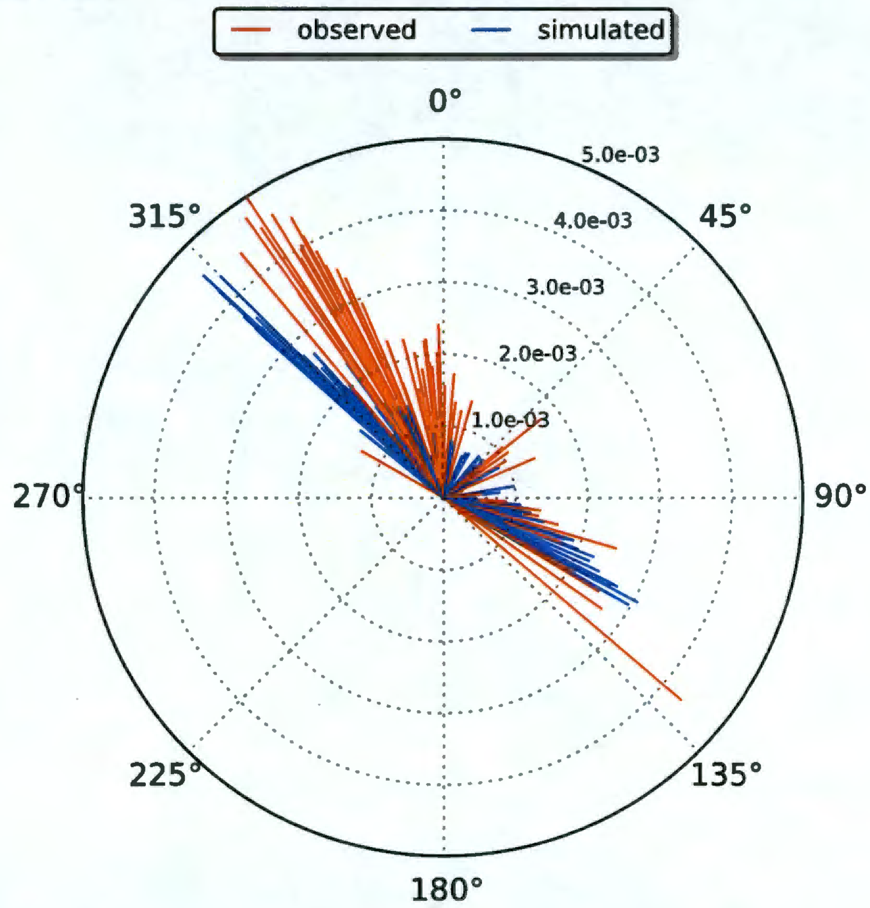
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 80*



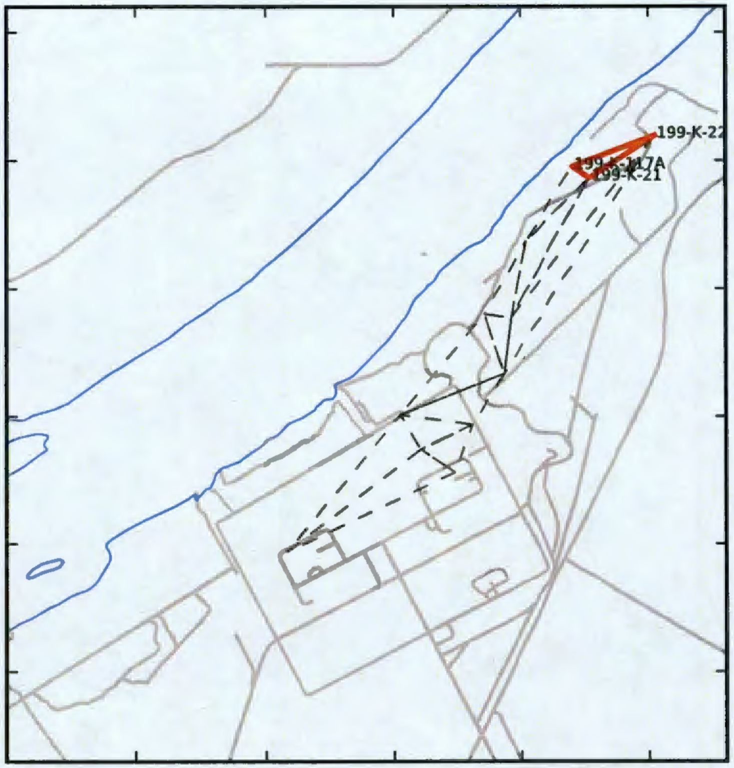

| | Observed | Simulated |
|---|---|---|
| Data Points | 79 | 79 |
| Minimum Azimuth | 9.4 | 44.0 |
| Maximum Azimuth | 359.1 | 339.8 |
| Minimum Magnitude | 2.5e-04 | 4.0e-05 |
| Maximum Magnitude | 5.8e-03 | 5.5e-03 |

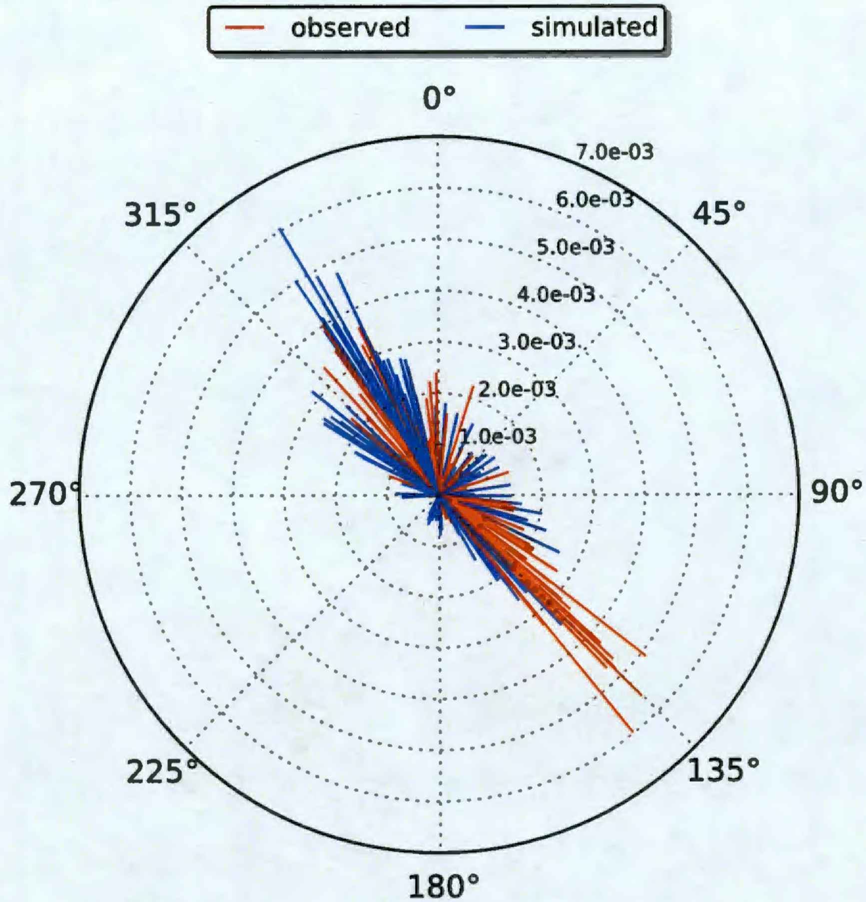
# *Three-Point Gradients (Observed vs.Simulated) at Triangle 81*


| | Observed | Simulated |
|---|---|---|
| Data Points | 90 | 90 |
| Minimum Azimuth | 0.6 | 7.6 |
| Maximum Azimuth | 358.4 | 351.5 |
| Minimum Magnitude | 1.4e-04 | 2.0e-04 |
| Maximum Magnitude | 5.0e-03 | 4.5e-03 |

# *Three-Point Gradients (Observed vs.Simulated) at Triangle 82*




| | Observed | Simulated |
|---|---|---|
| Data Points | 91 | 91 |
| Minimum Azimuth | 1.6 | 4.3 |
| Maximum Azimuth | 358.8 | 358.0 |
| Minimum Magnitude | 1.8e-04 | 1.7e-04 |
| Maximum Magnitude | 6.0e-03 | 6.0e-03 |

# Appendix F

# Model Calibration: Measured versus Simulated Flow Rates per P&T Well

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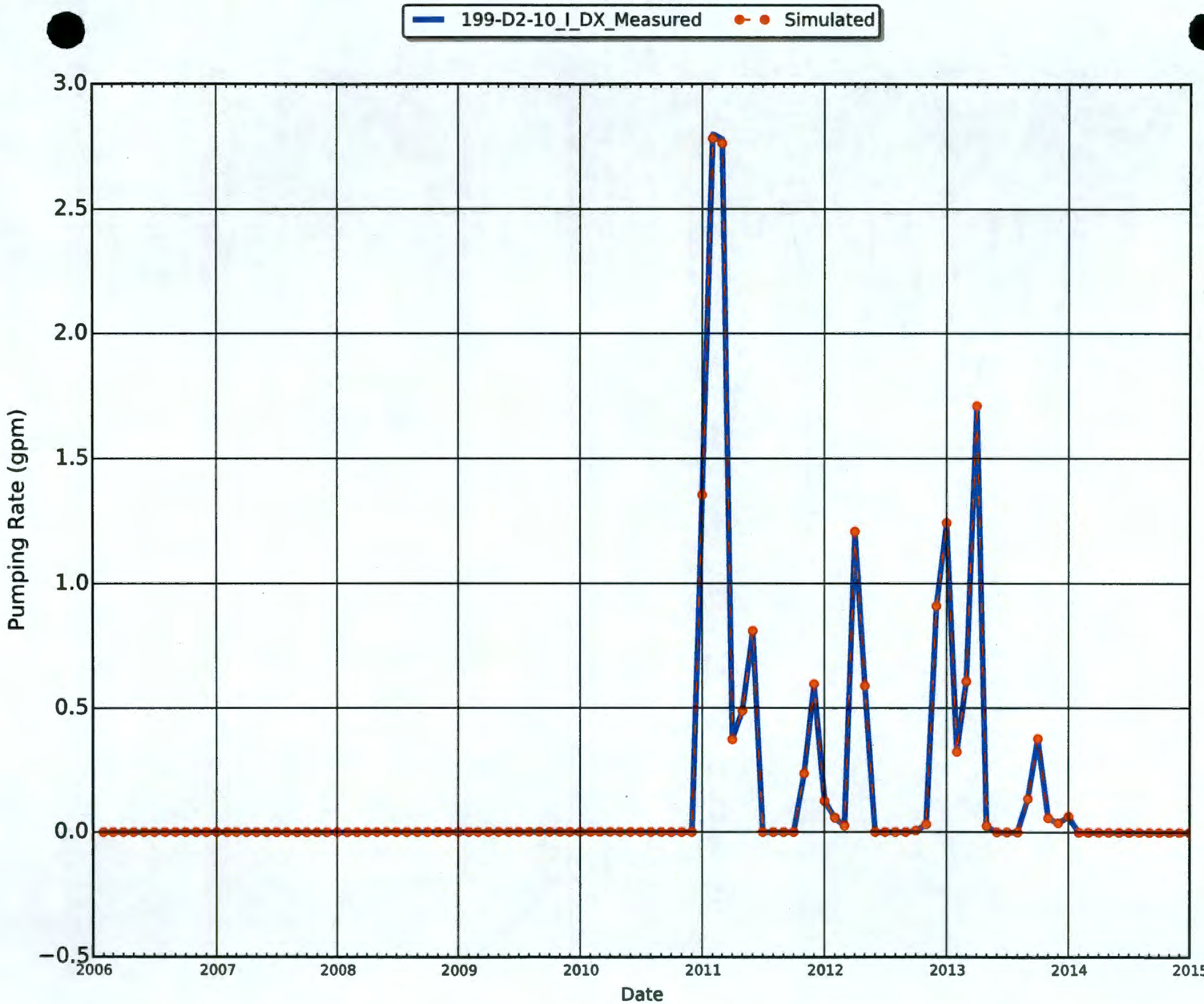
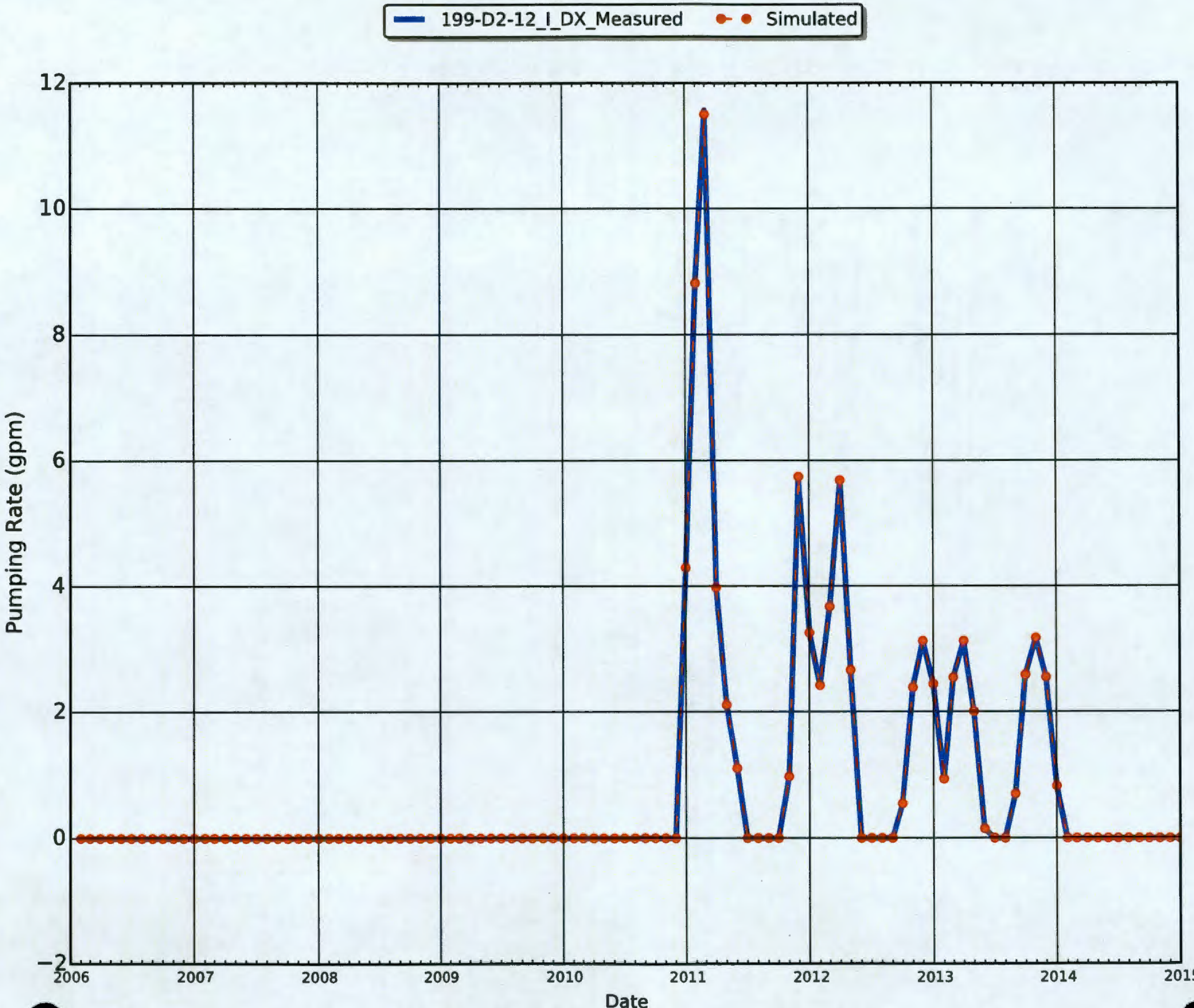
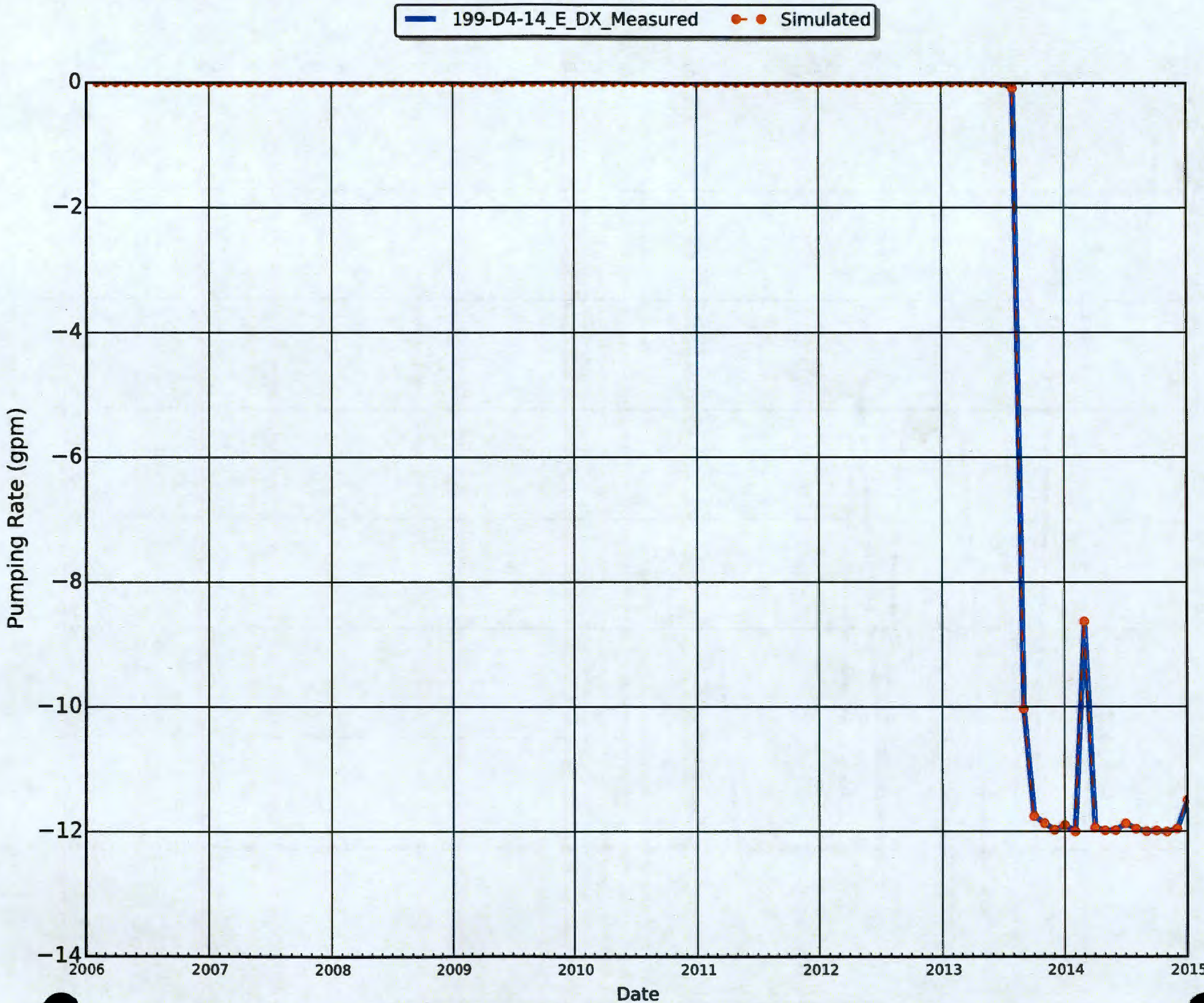
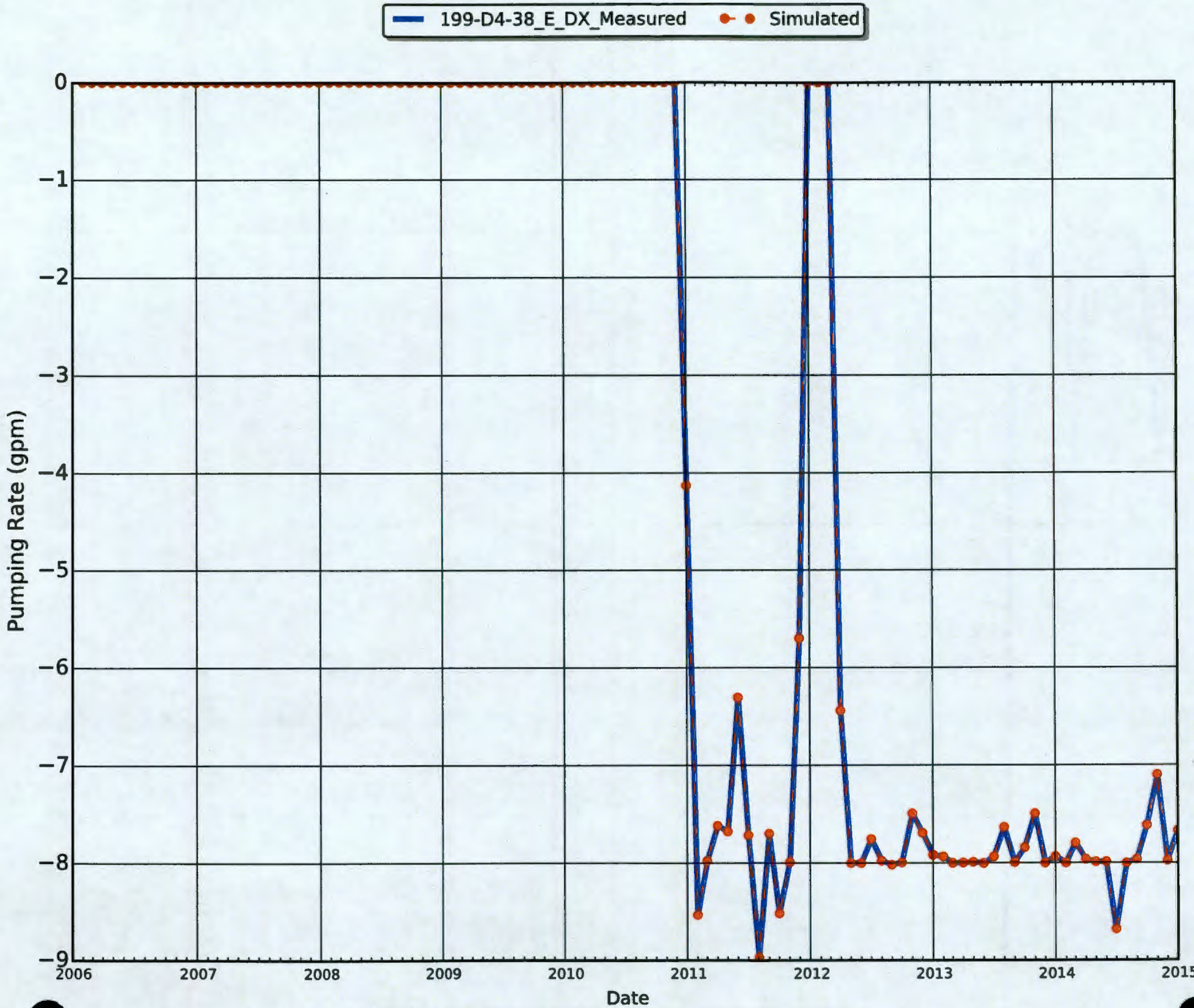

199-D2-10_I_DX_Measured
Simulated
Pumping Rate (gpm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

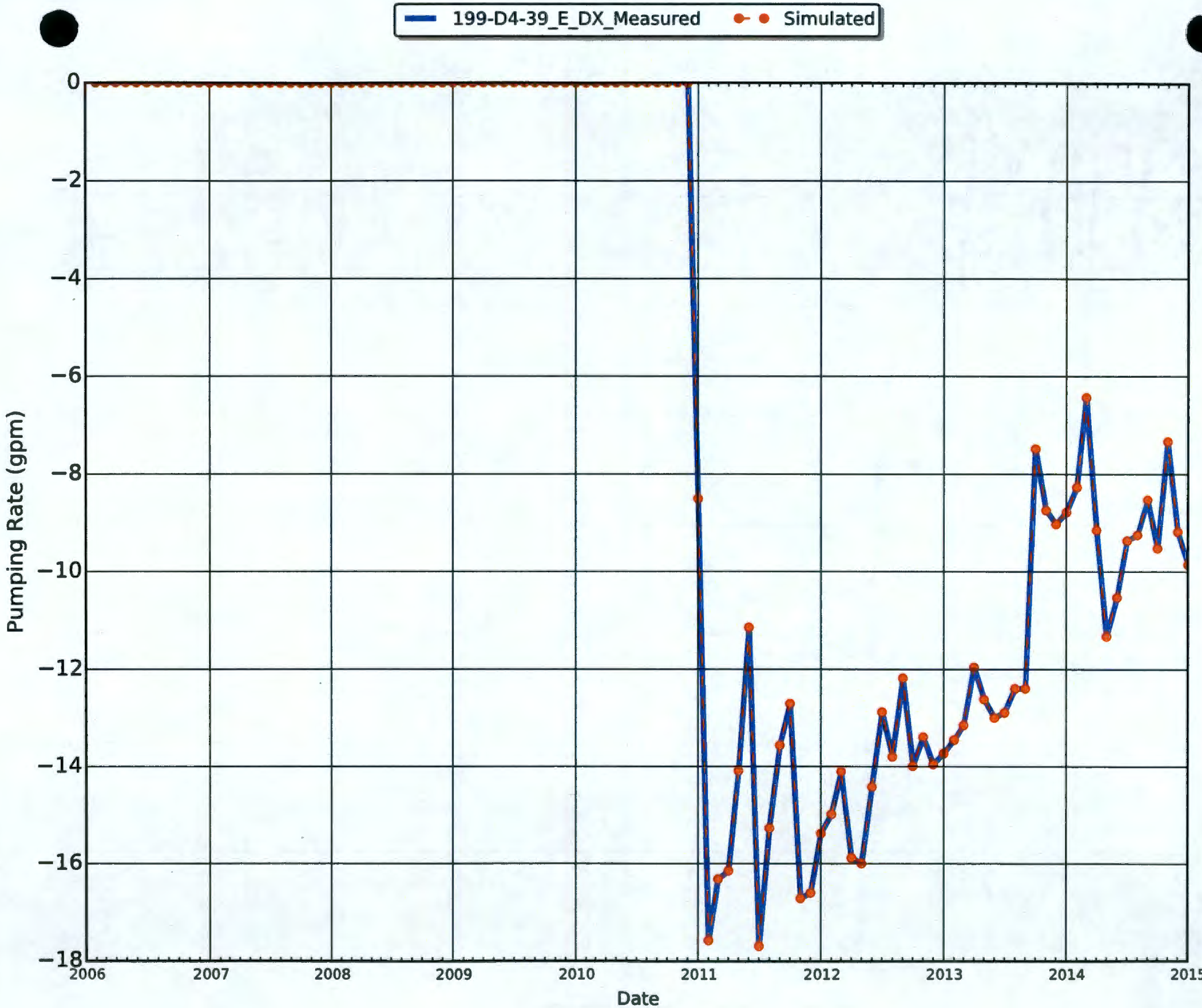

199-D2-12_I_DX_Measured
Simulated
Pumping Rate (gpm)
Date
12
10
8
6
4
2
0
−2
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

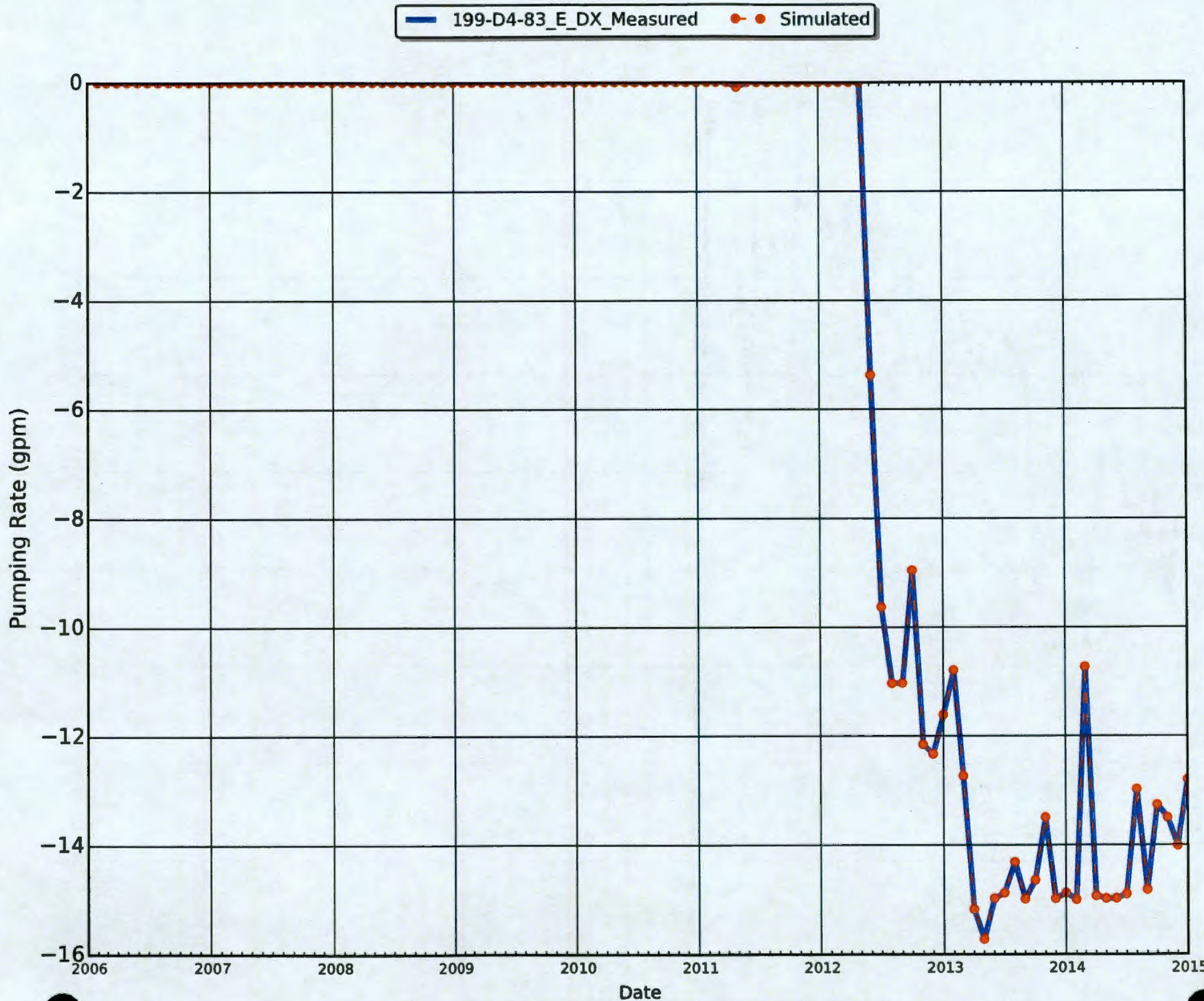
199-D4-101_E_DX_Measured
Simulated
Pumping Rate (gpm)
2
0
−2
−4
−6
−8
−10
−12
−14
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D4-14_E_DX_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
−12
−14
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

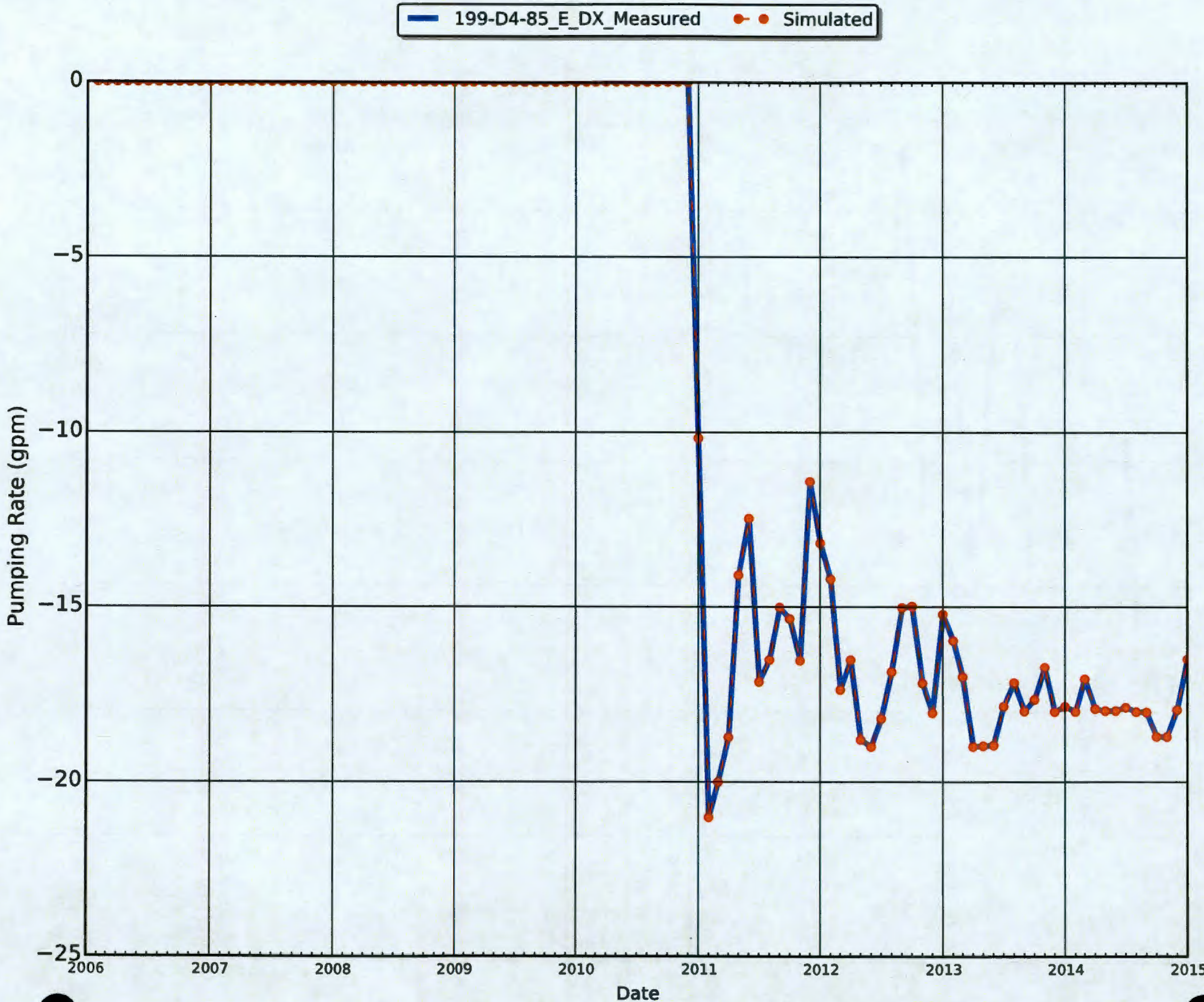

199-D4-34_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

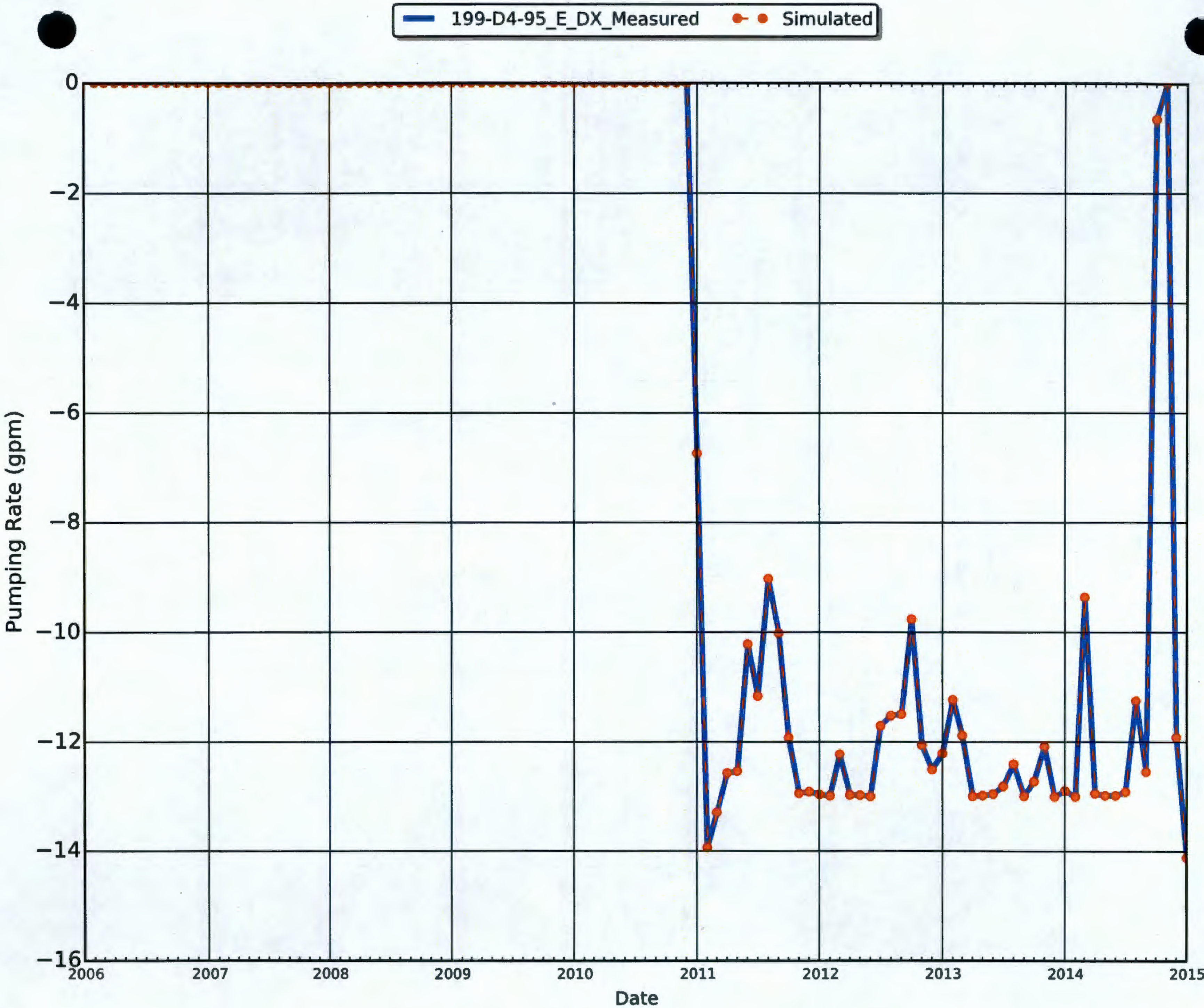

199-D4-38_E_DX_Measured
Simulated
0
−1
−2
−3
−4
−5
−6
−7
−8
−9
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

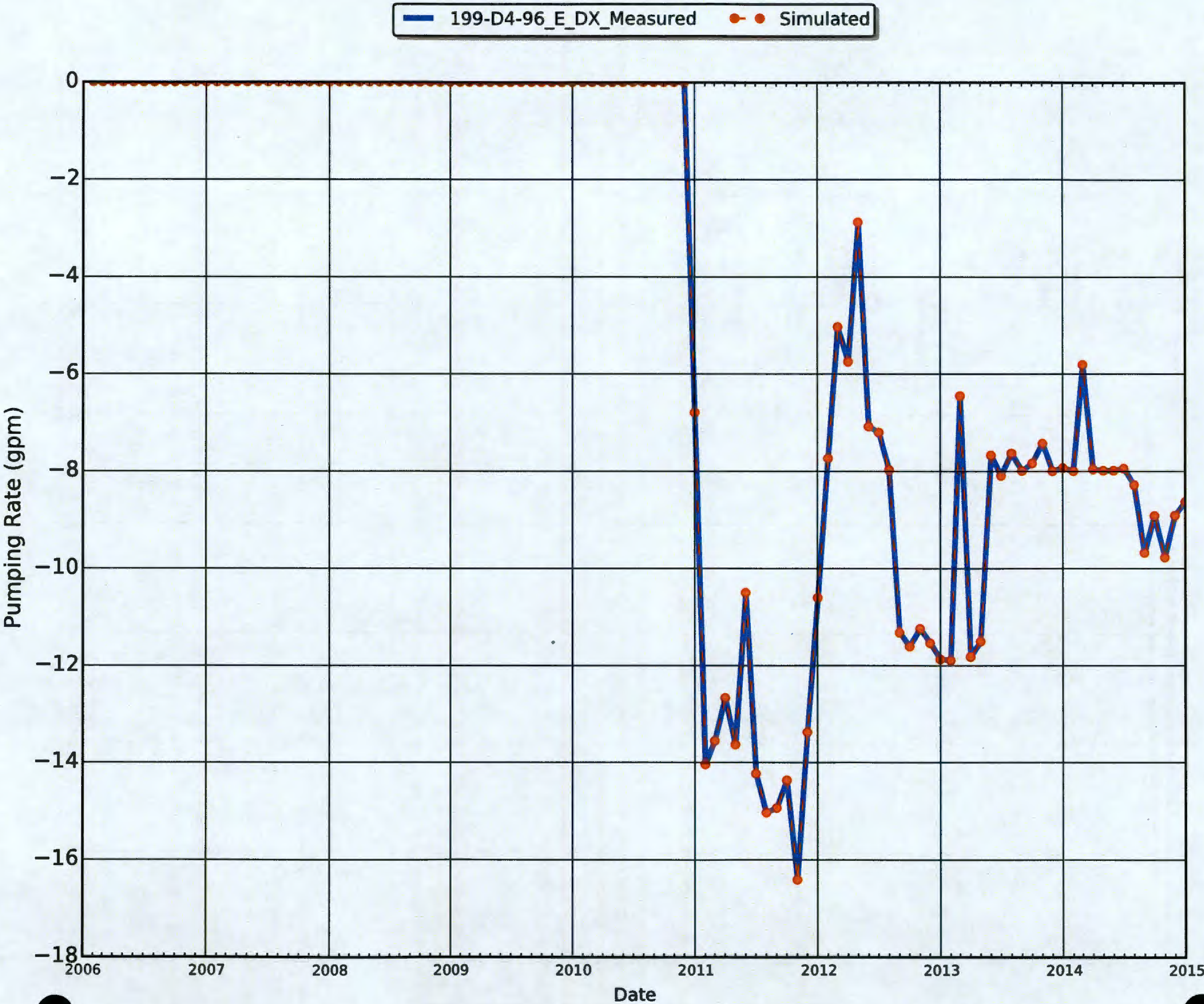

199-D4-39_E_DX_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D4-83_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

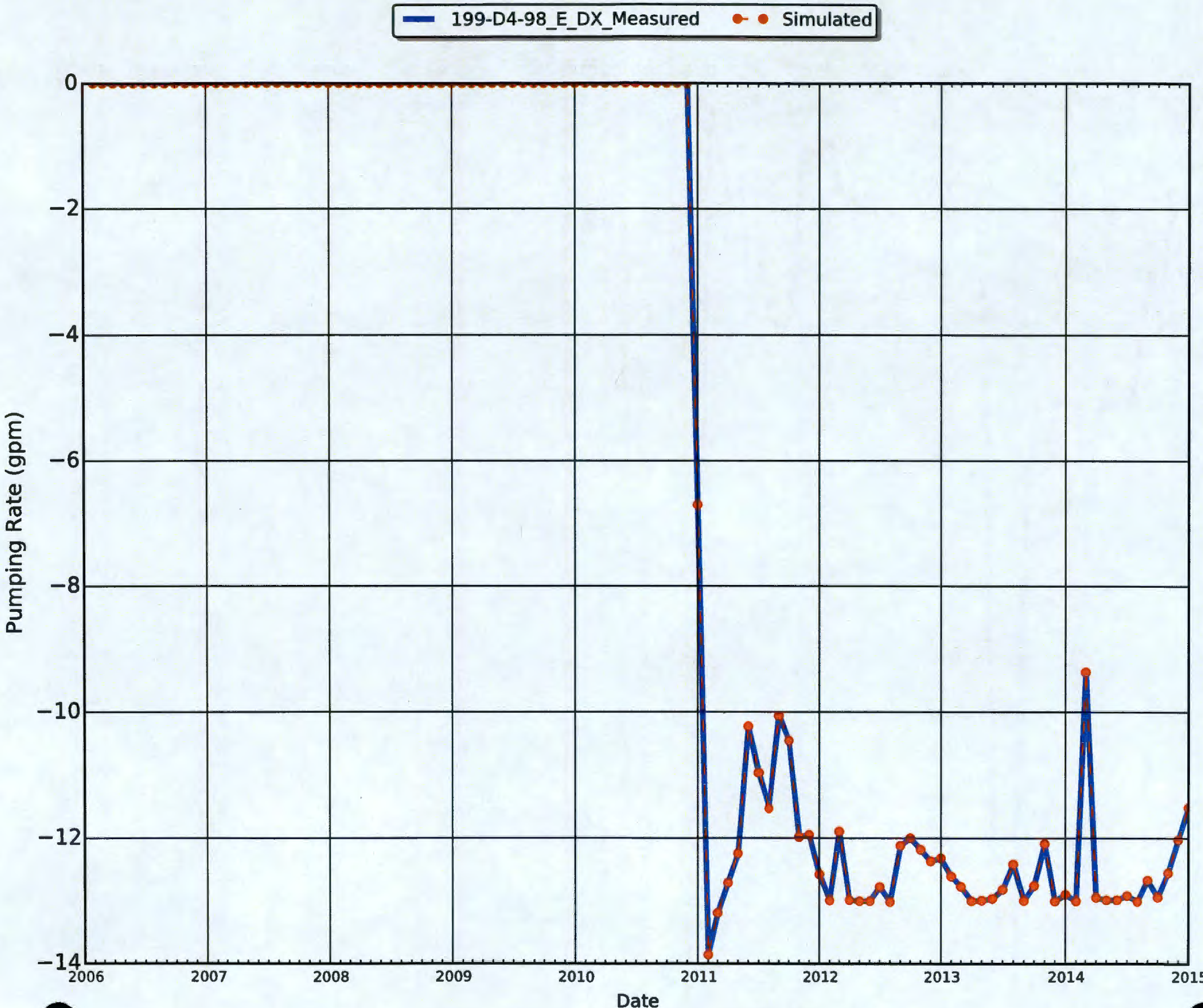

199-D4-84_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D4-85_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D4-95_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

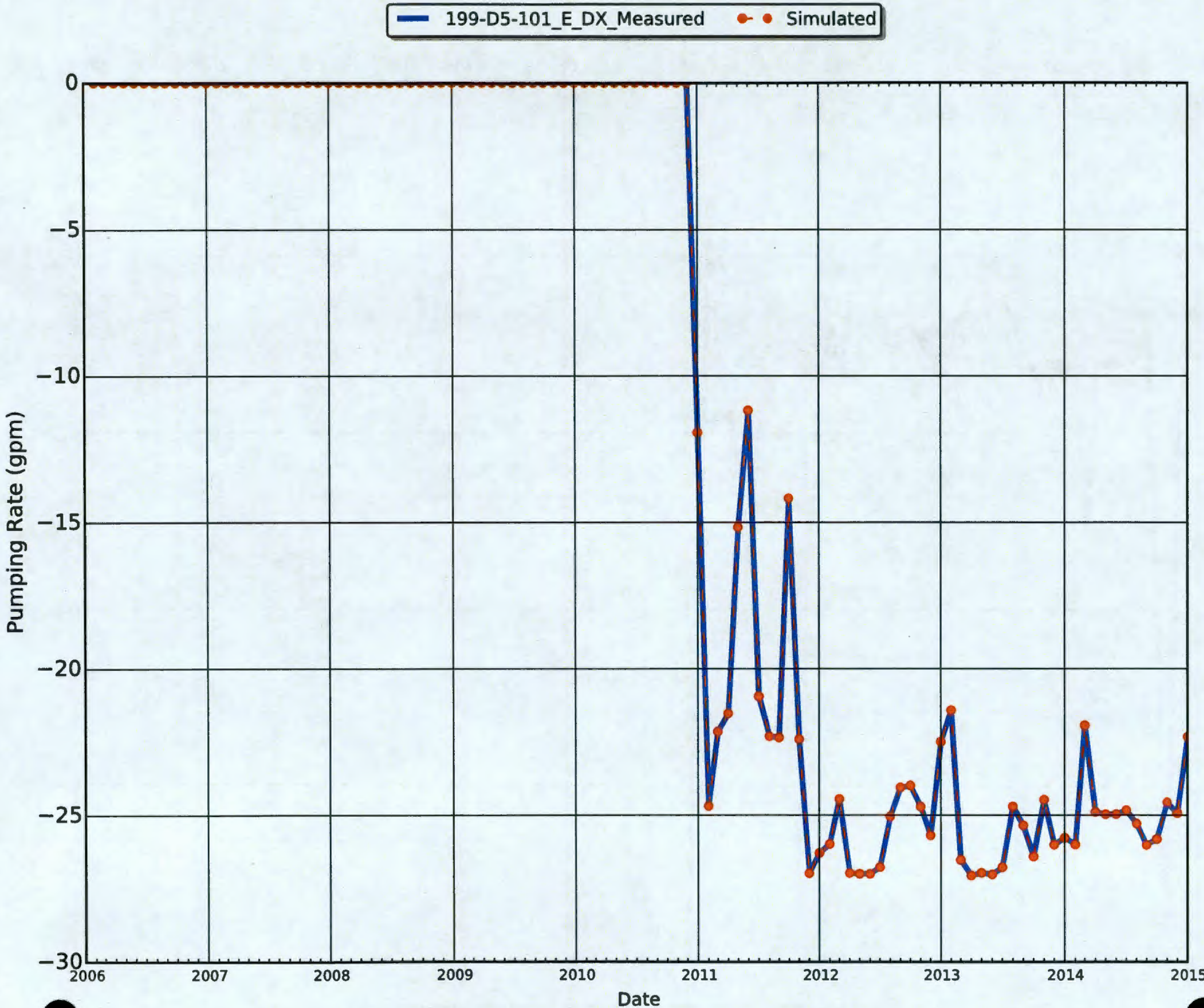

199-D4-96_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

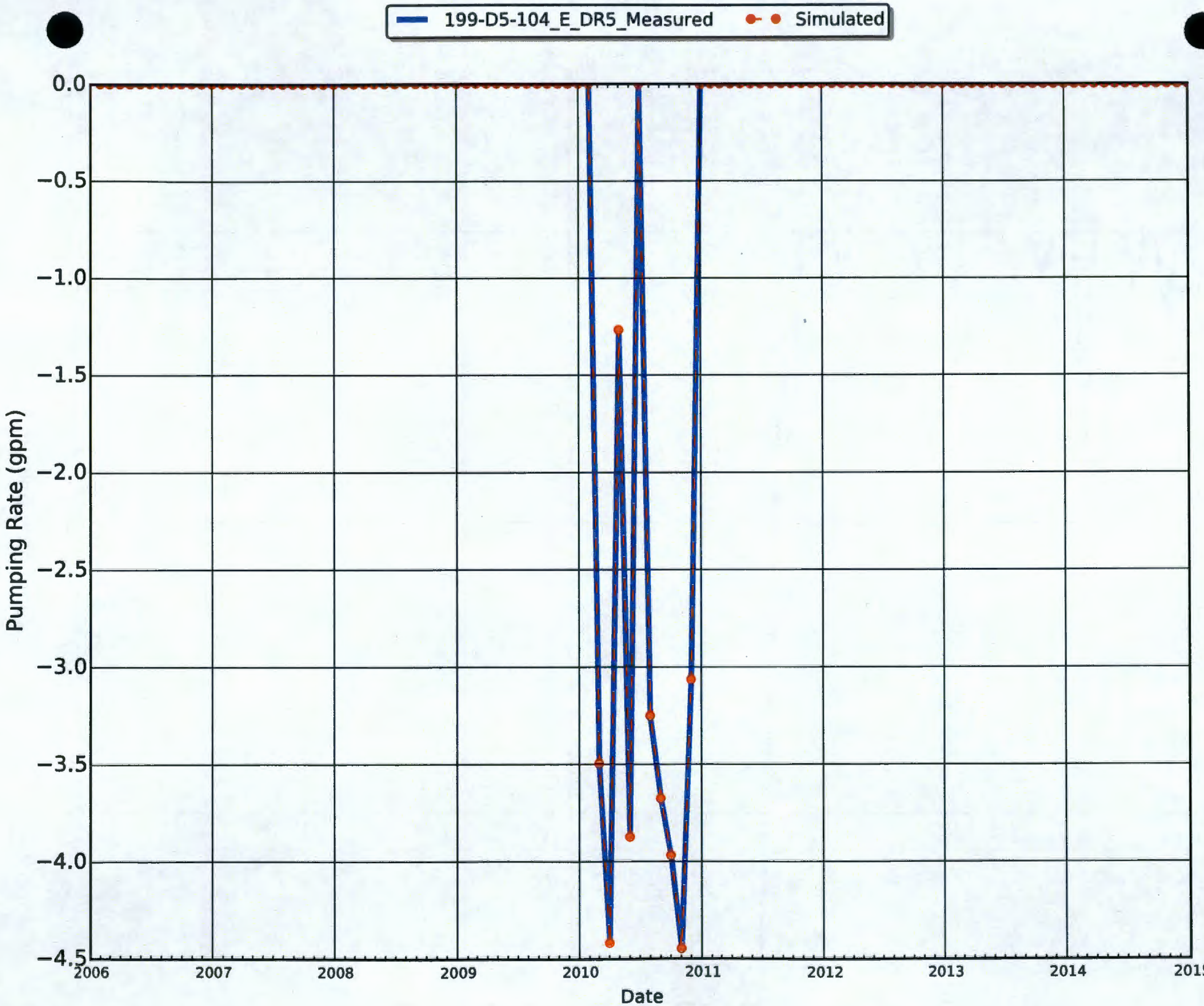
199-D4-97_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

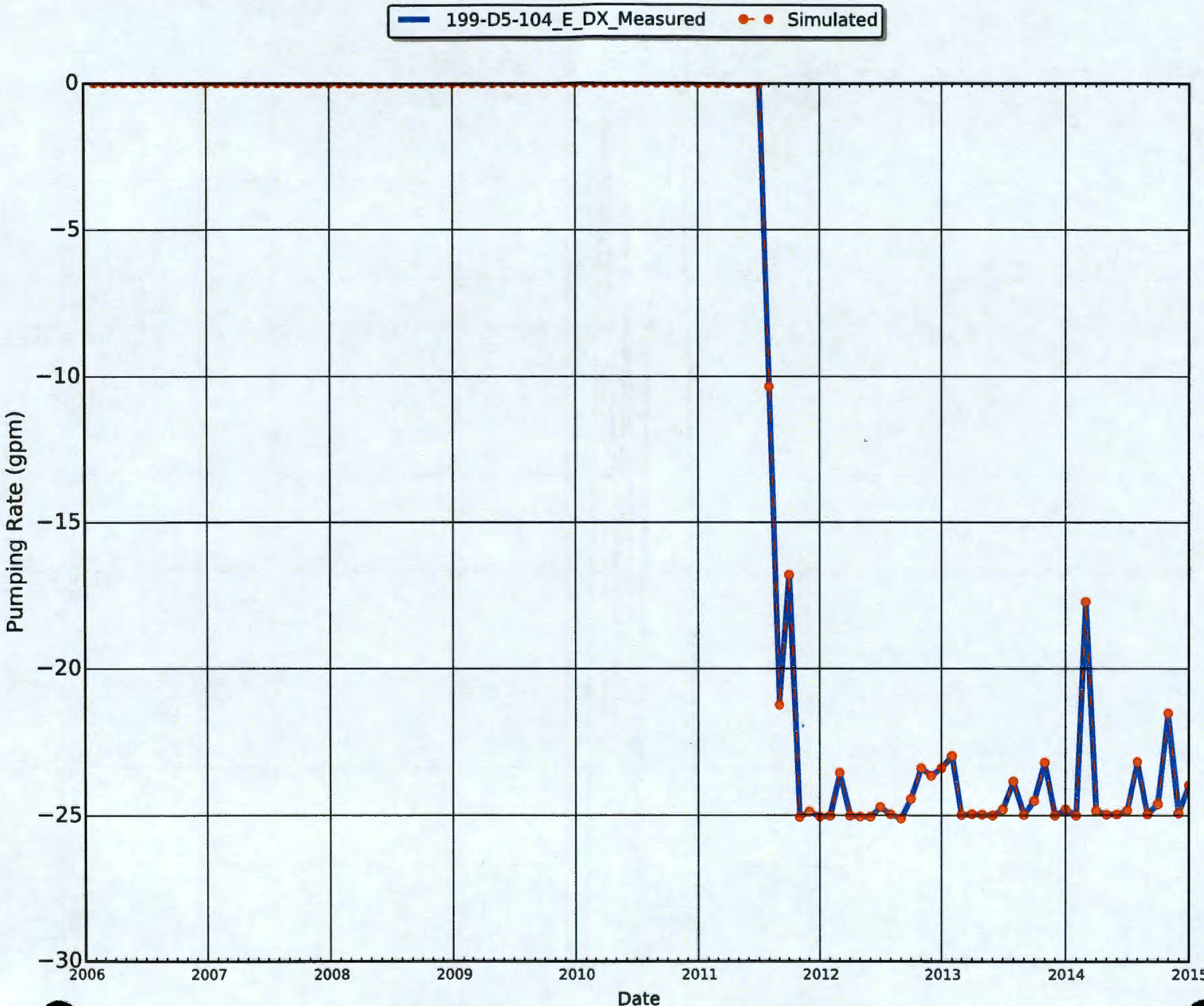


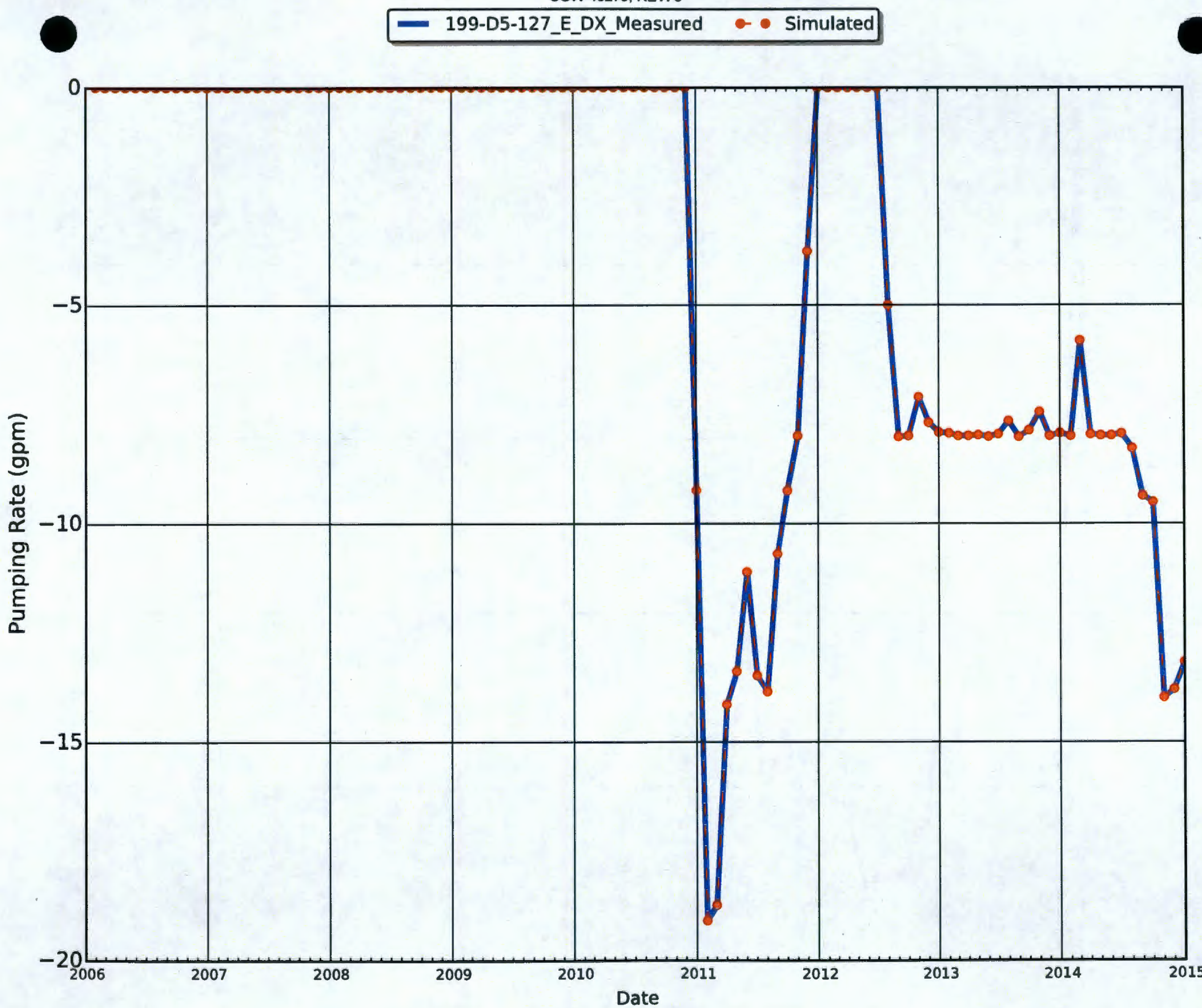
199-D4-98_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D4-99_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

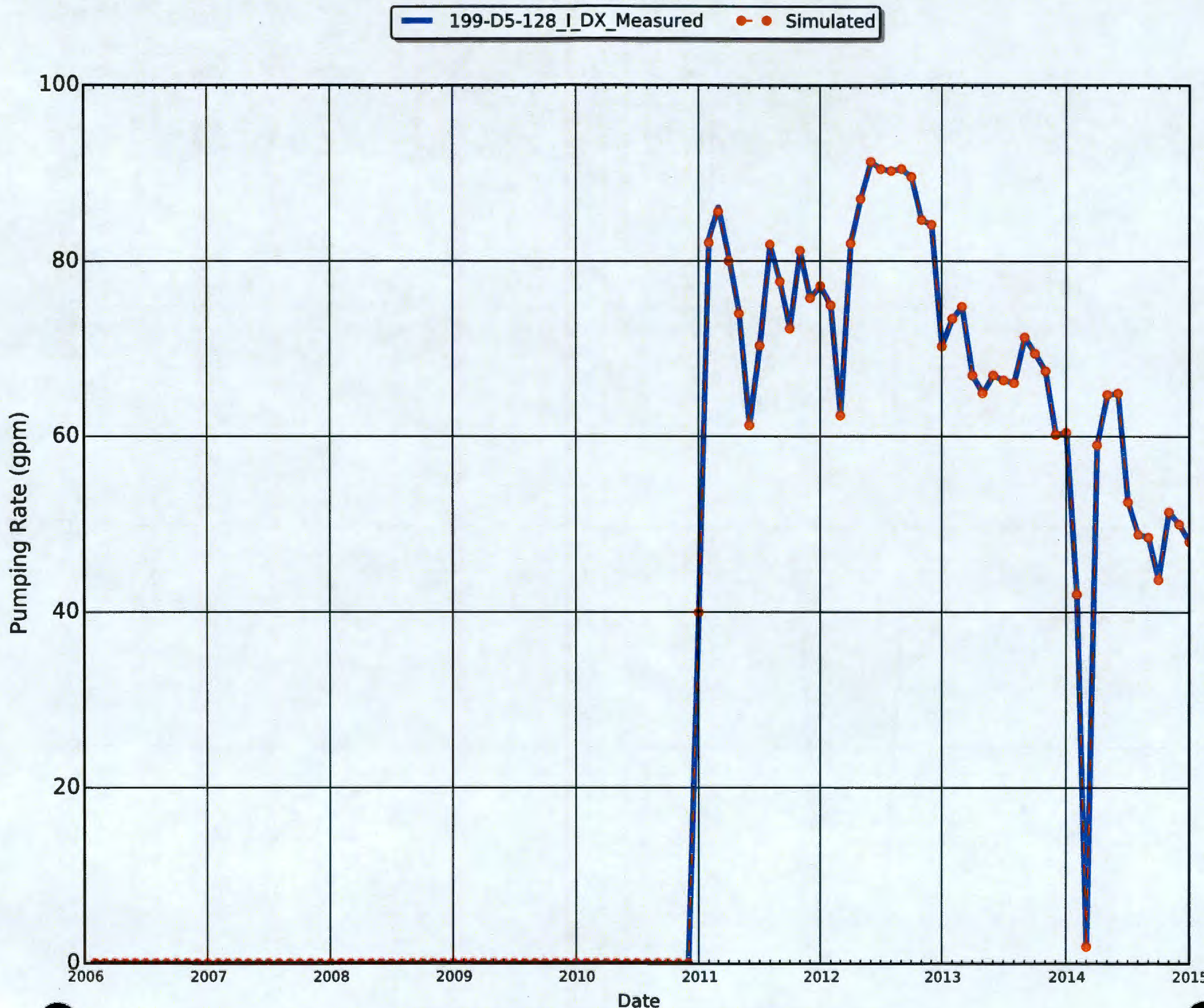

199-D5-101_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-104_E_DR5_Measured
Simulated
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
−4.0
−4.5
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

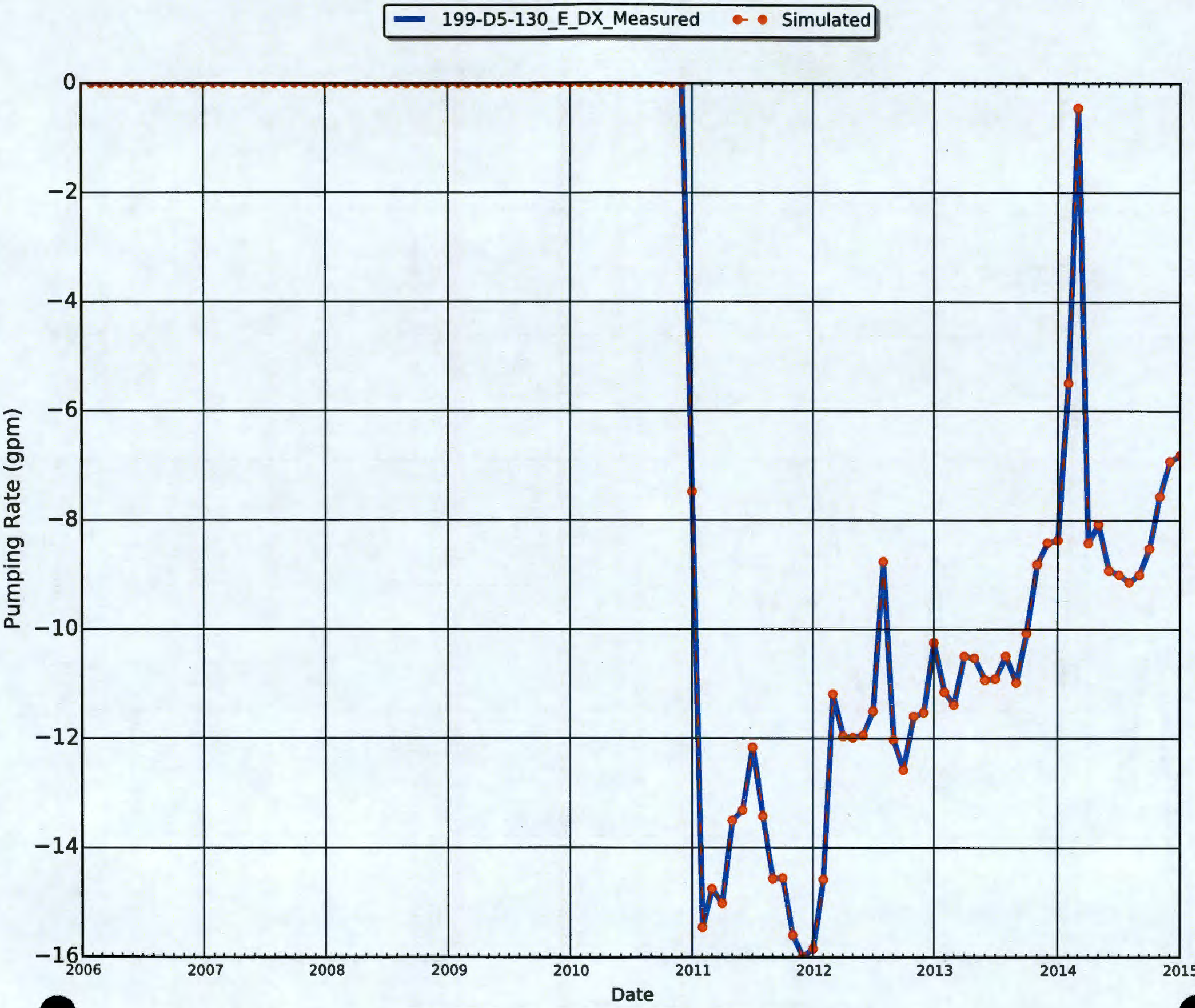

199-D5-104_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

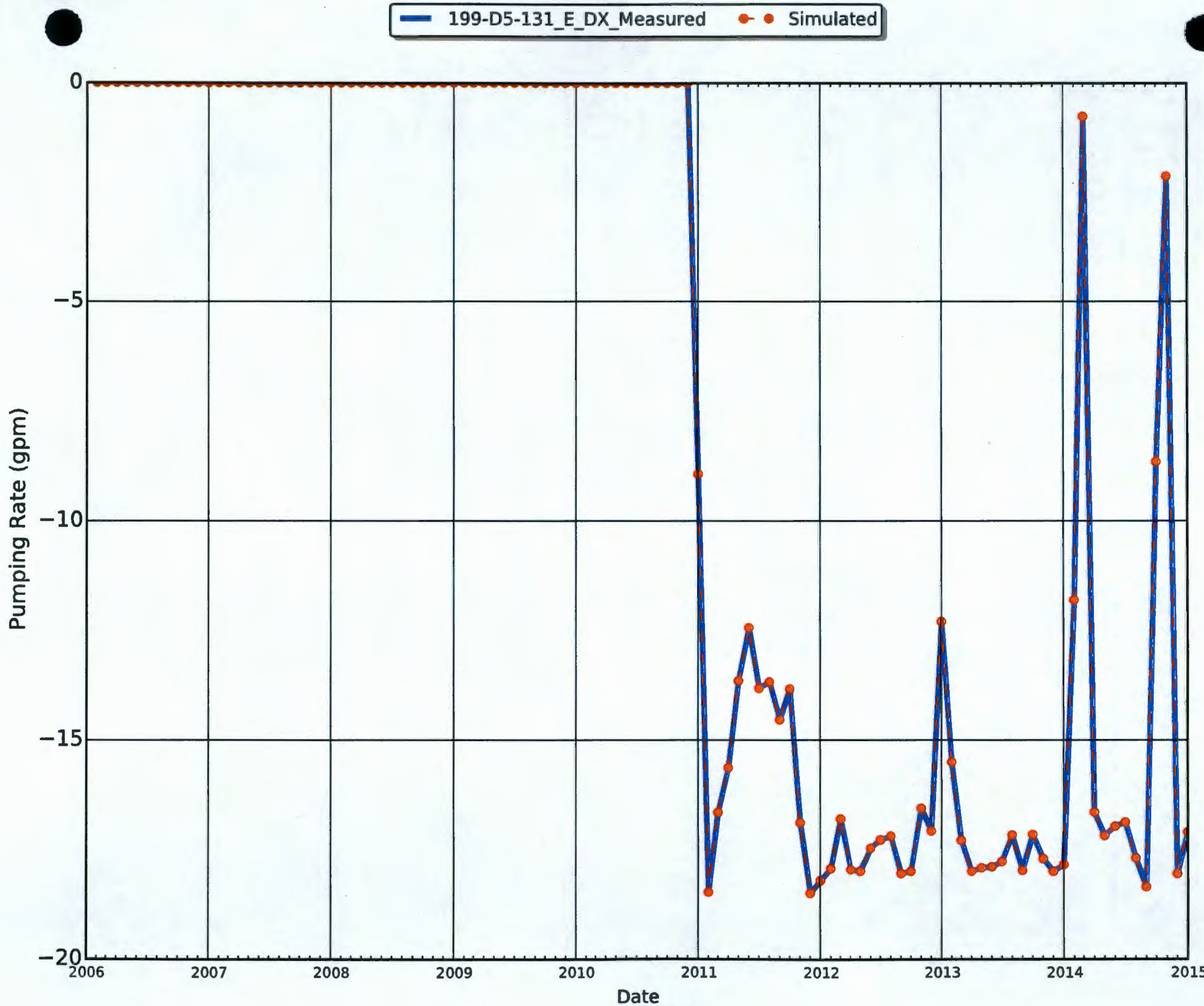


199-D5-127_E_DX_Measured
Simulated
0
−5
−10
−15
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

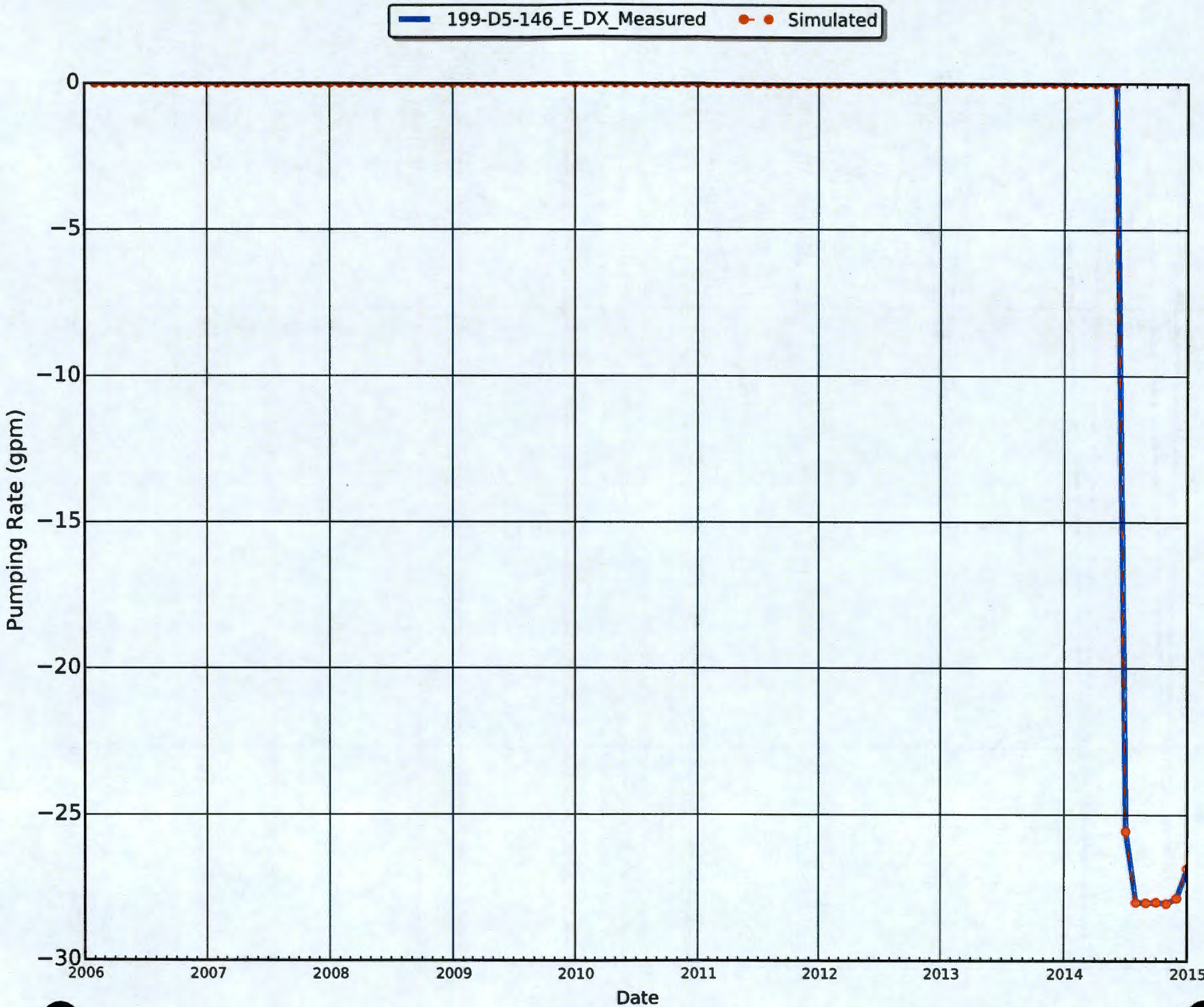

199-D5-128_I_DX_Measured
Simulated
100
80
60
40
20
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

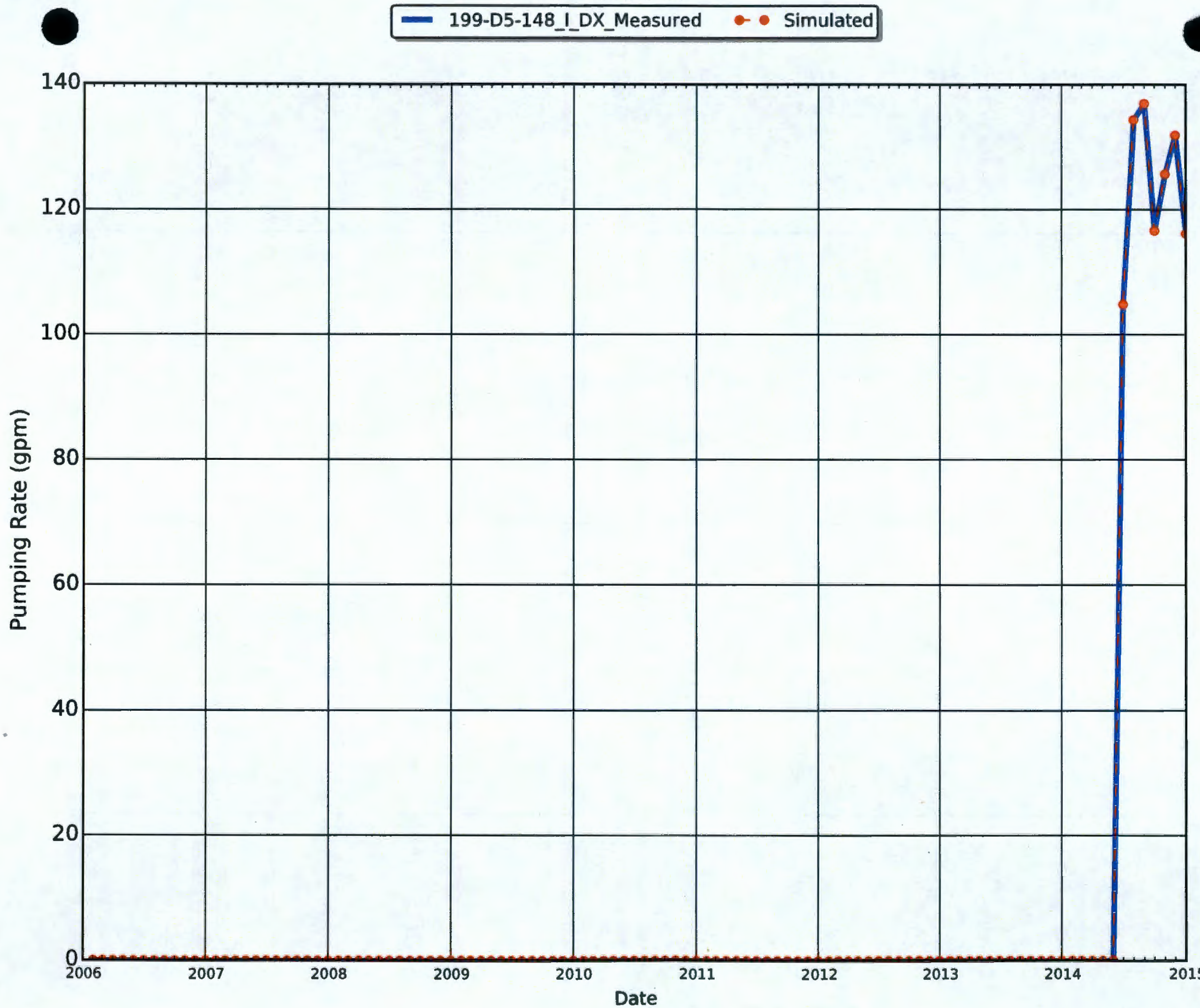

199-D5-129_I_DX_Measured
Simulated
Pumping Rate (gpm)
0
20
40
60
80
100
120
140
Date
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


199-D5-130_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

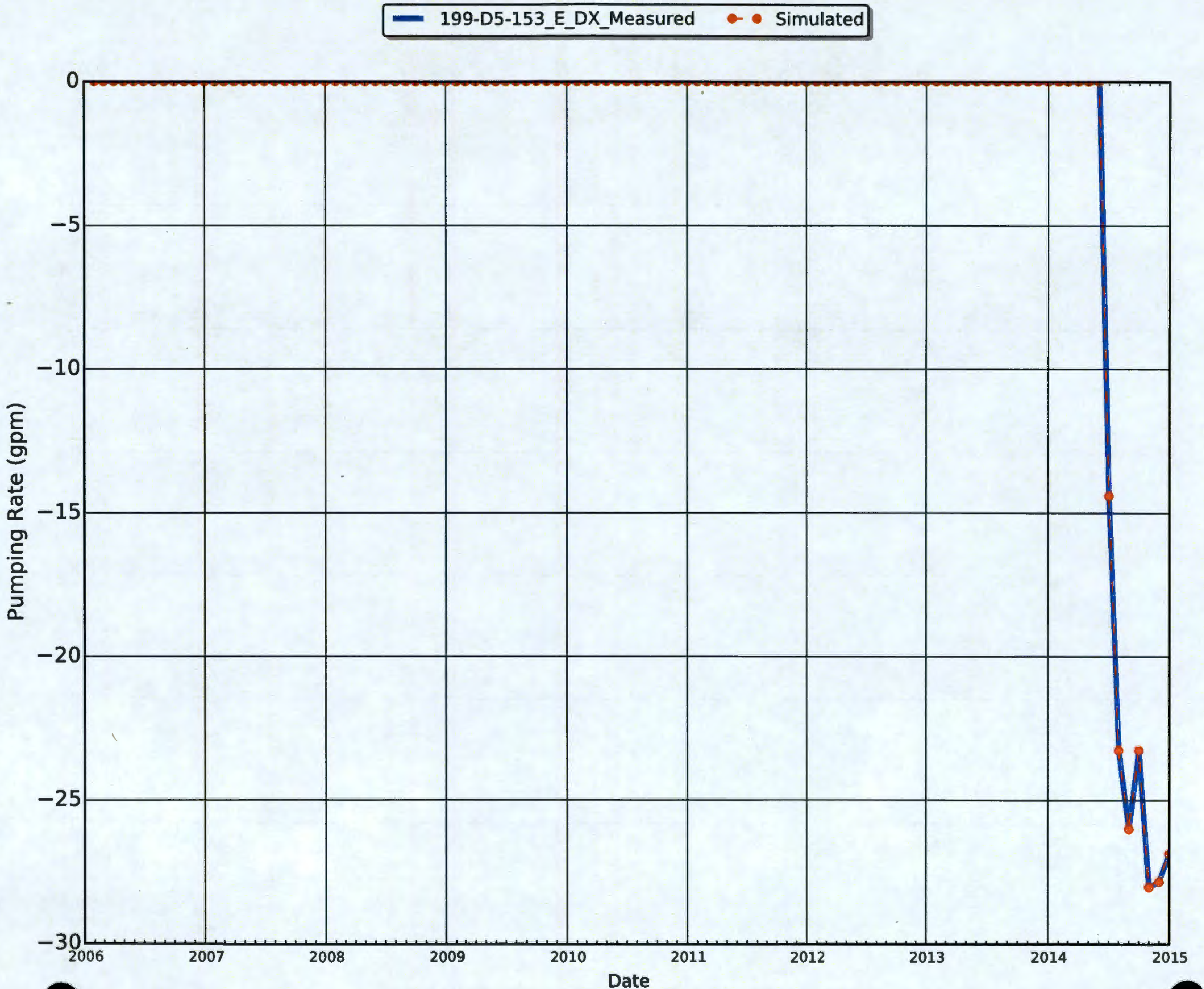


199-D5-131_E_DX_Measured
Simulated
0
−5
−10
−15
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-146_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

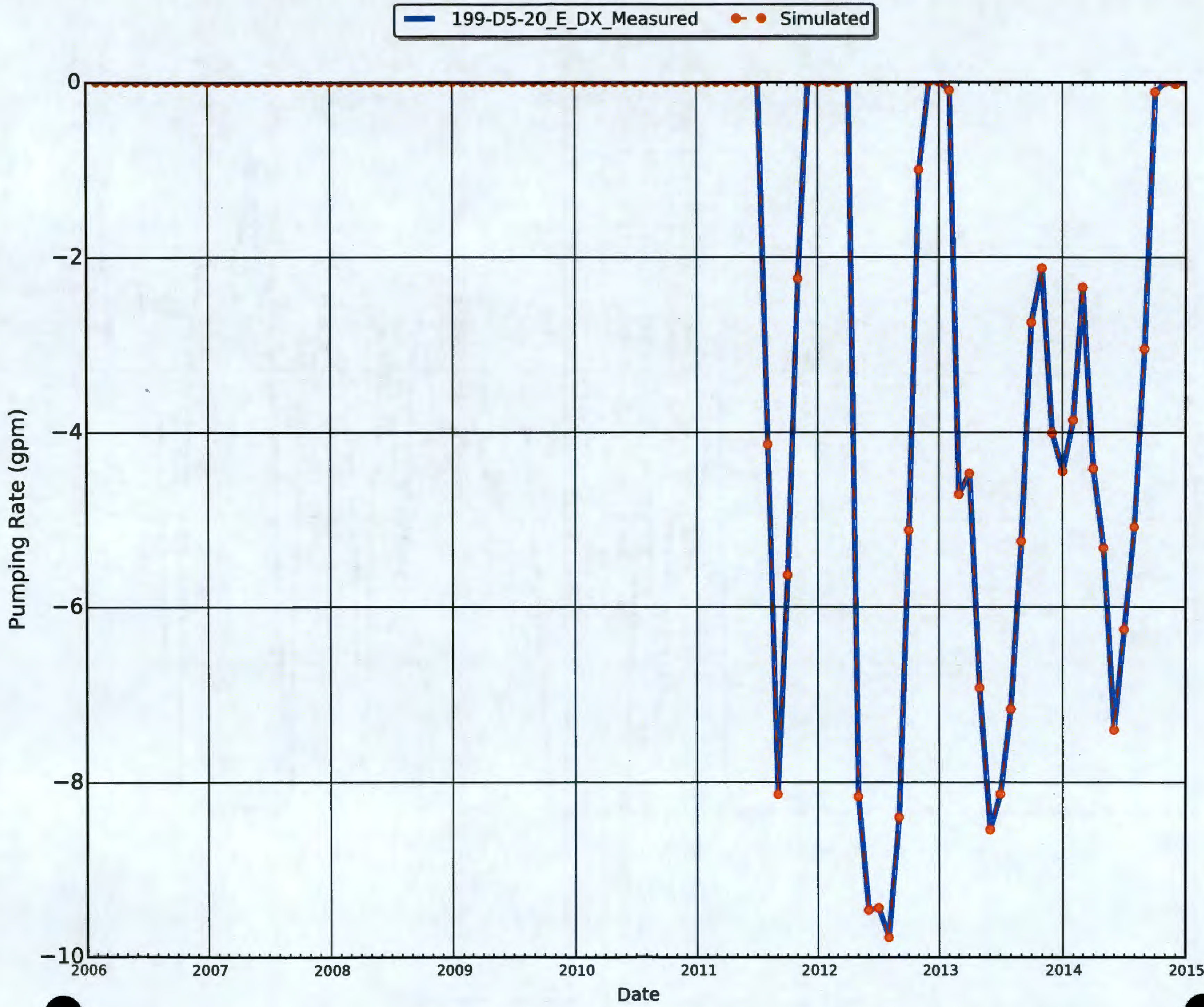


199-D5-148_I_DX_Measured
Simulated
Pumping Rate (gpm)
0
20
40
60
80
100
120
140
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

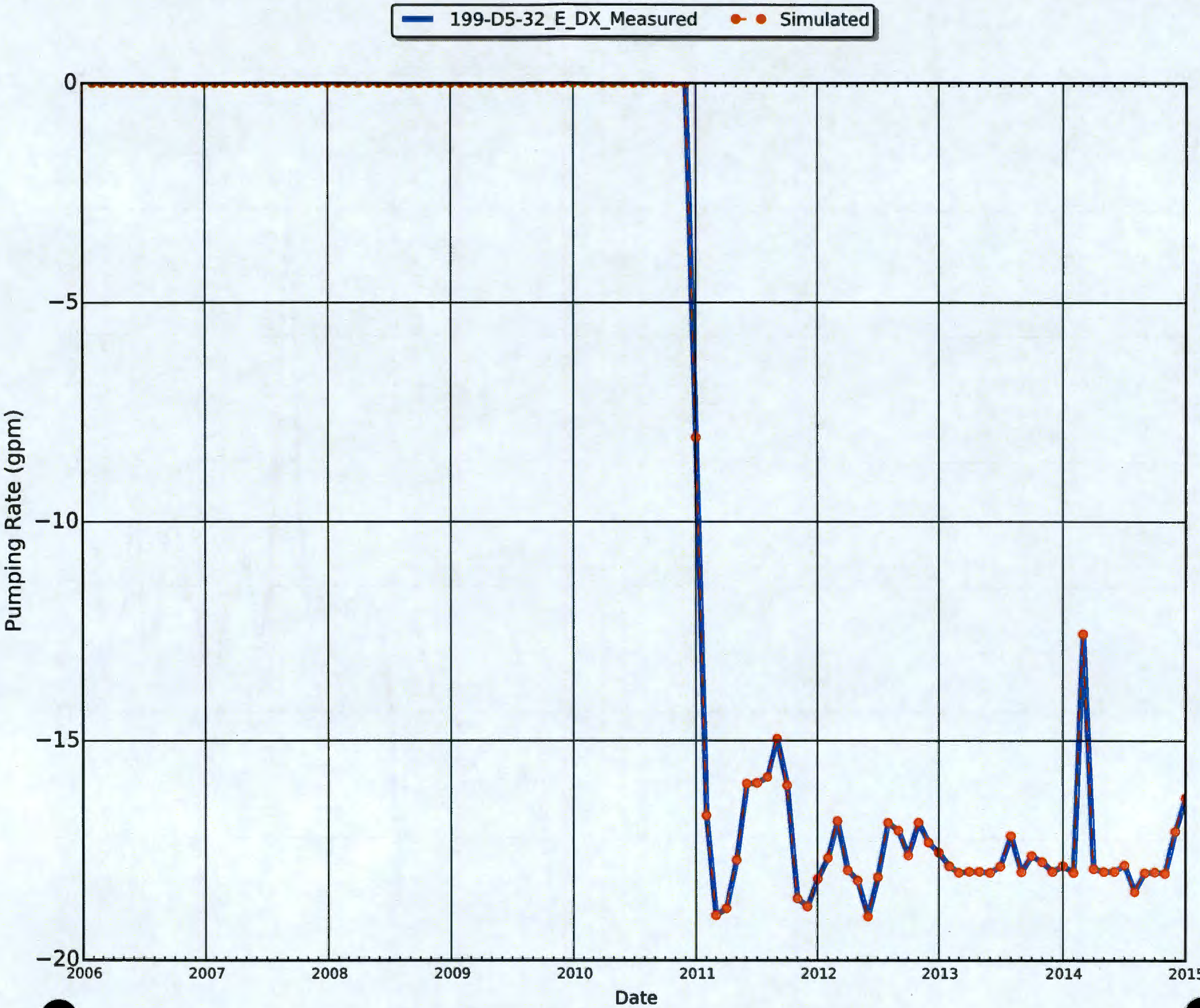


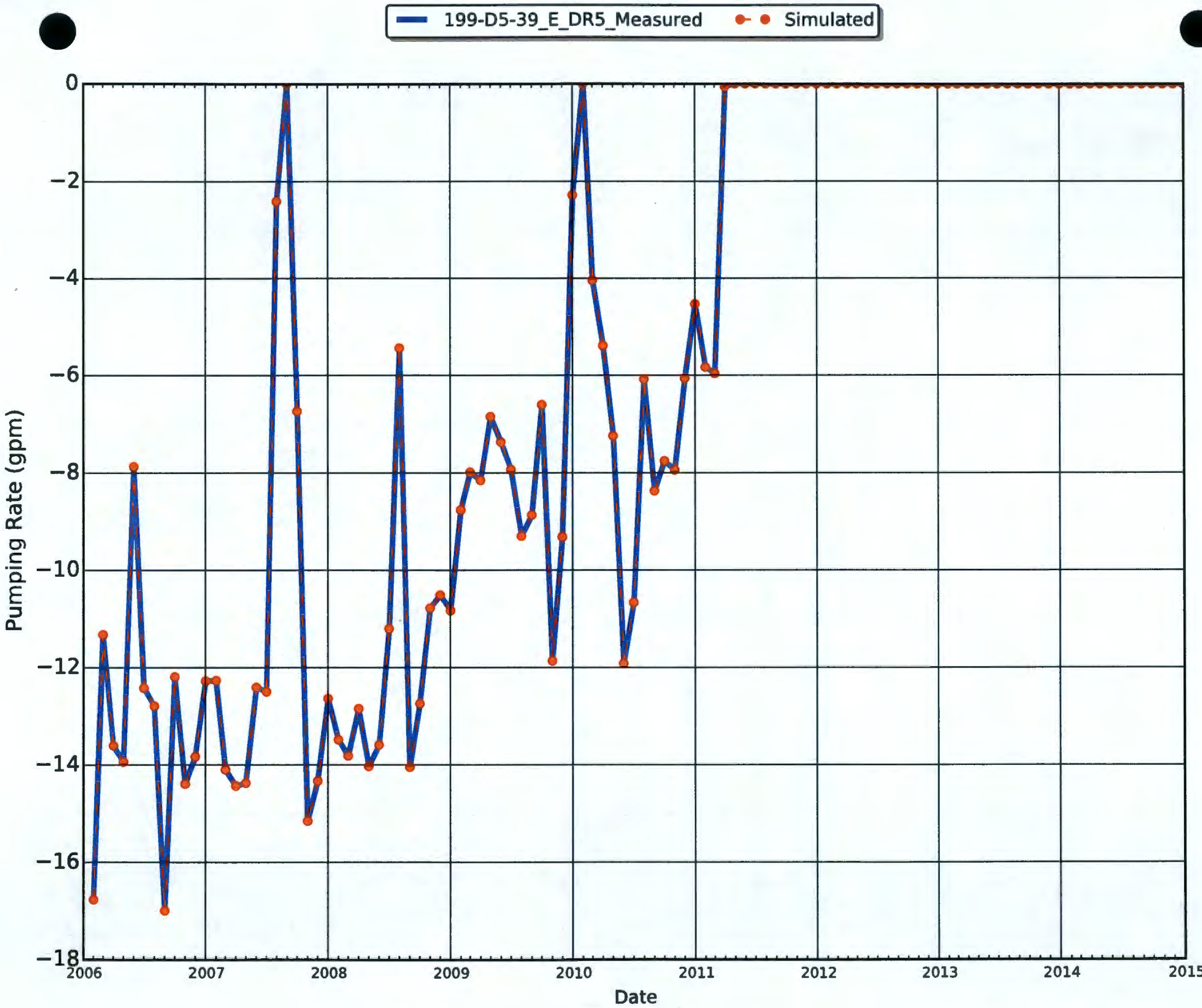
199-D5-153_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-20_E_DR5_Measured
Simulated
Pumping Rate (gpm)
2
0
−2
−4
−6
−8
−10
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

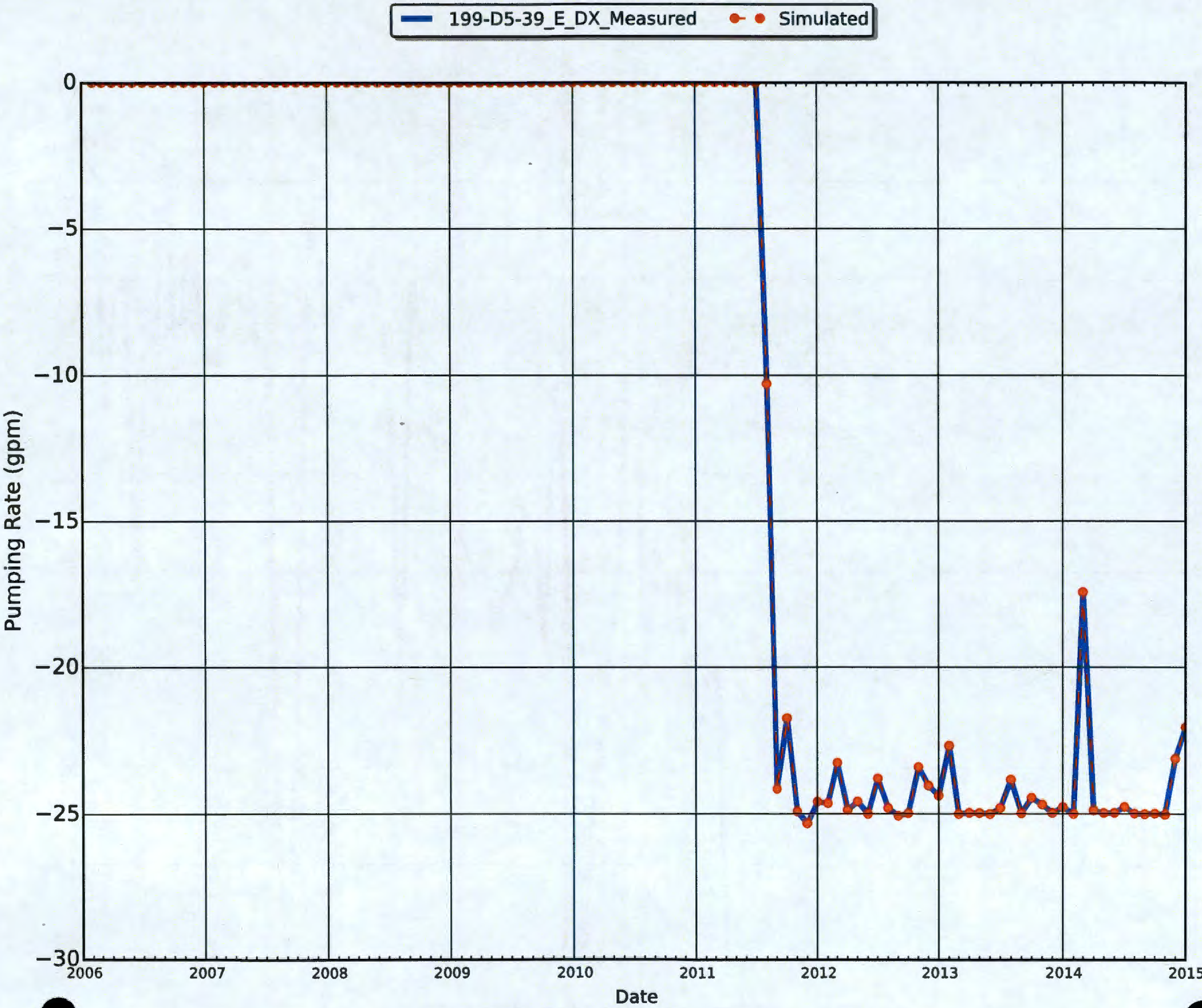

199-D5-20_E_DX_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

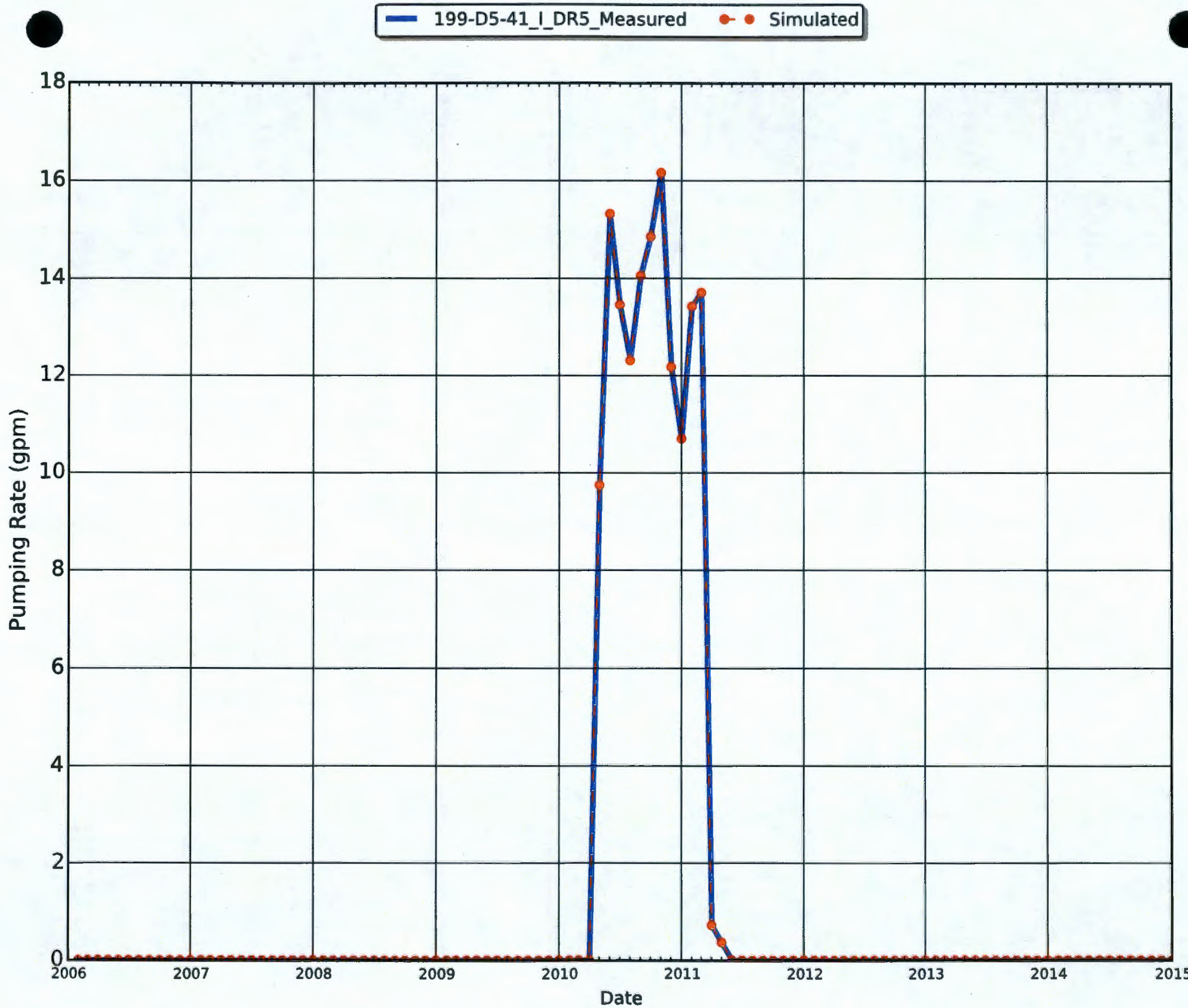

199-D5-32_E_DR5_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-32_E_DX_Measured
Simulated
0
−5
−10
−15
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

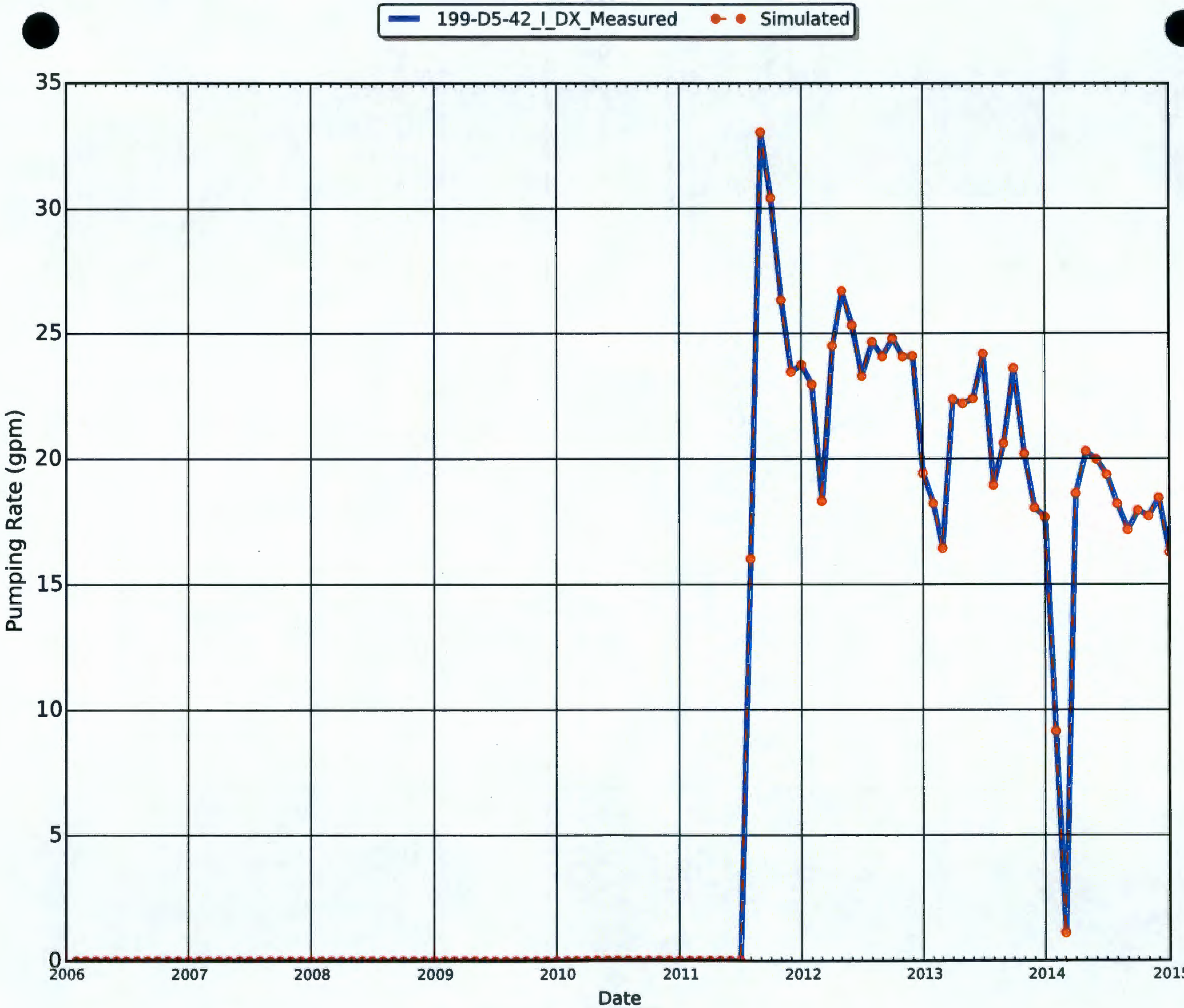


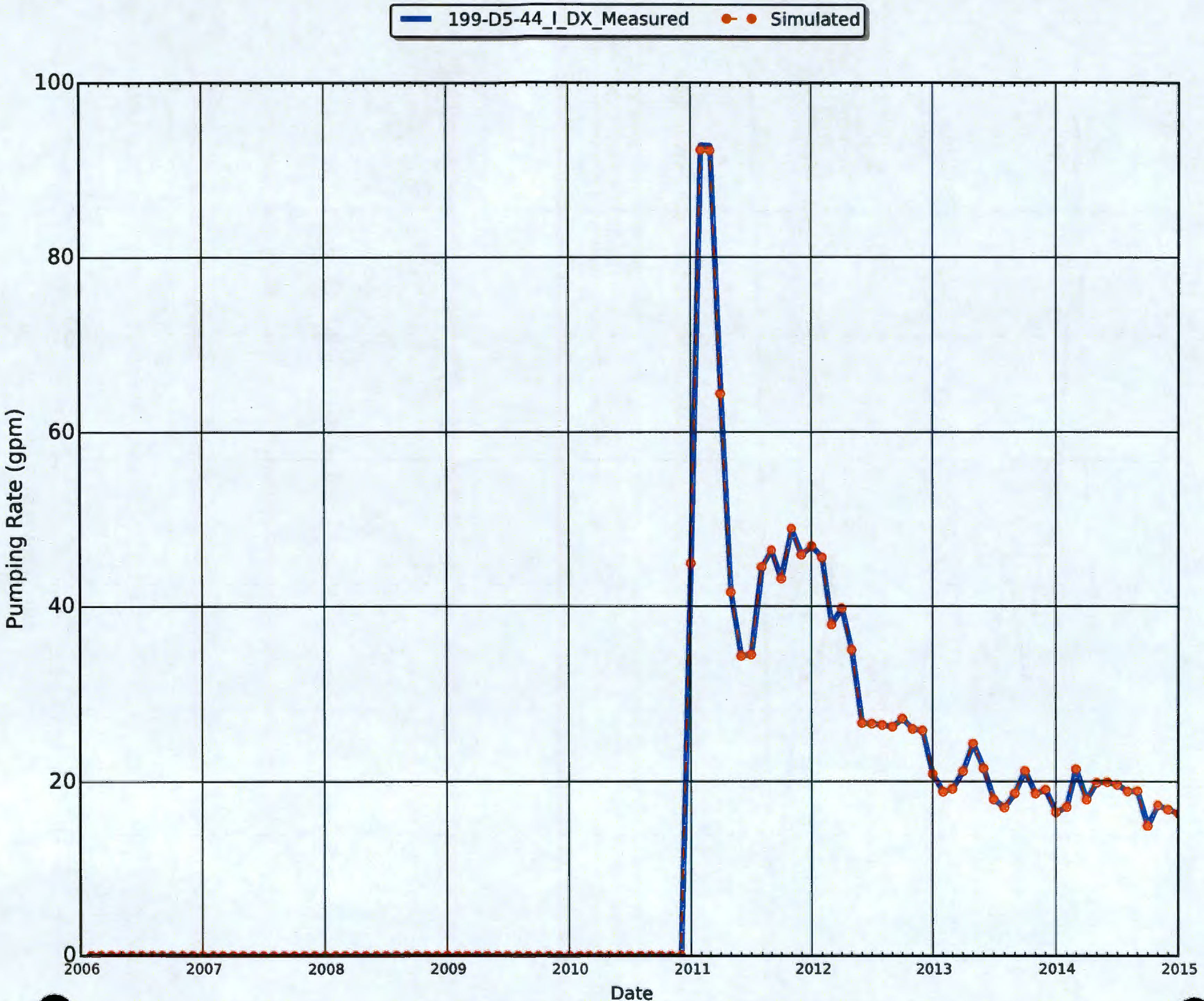
199-D5-39_E_DR5_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

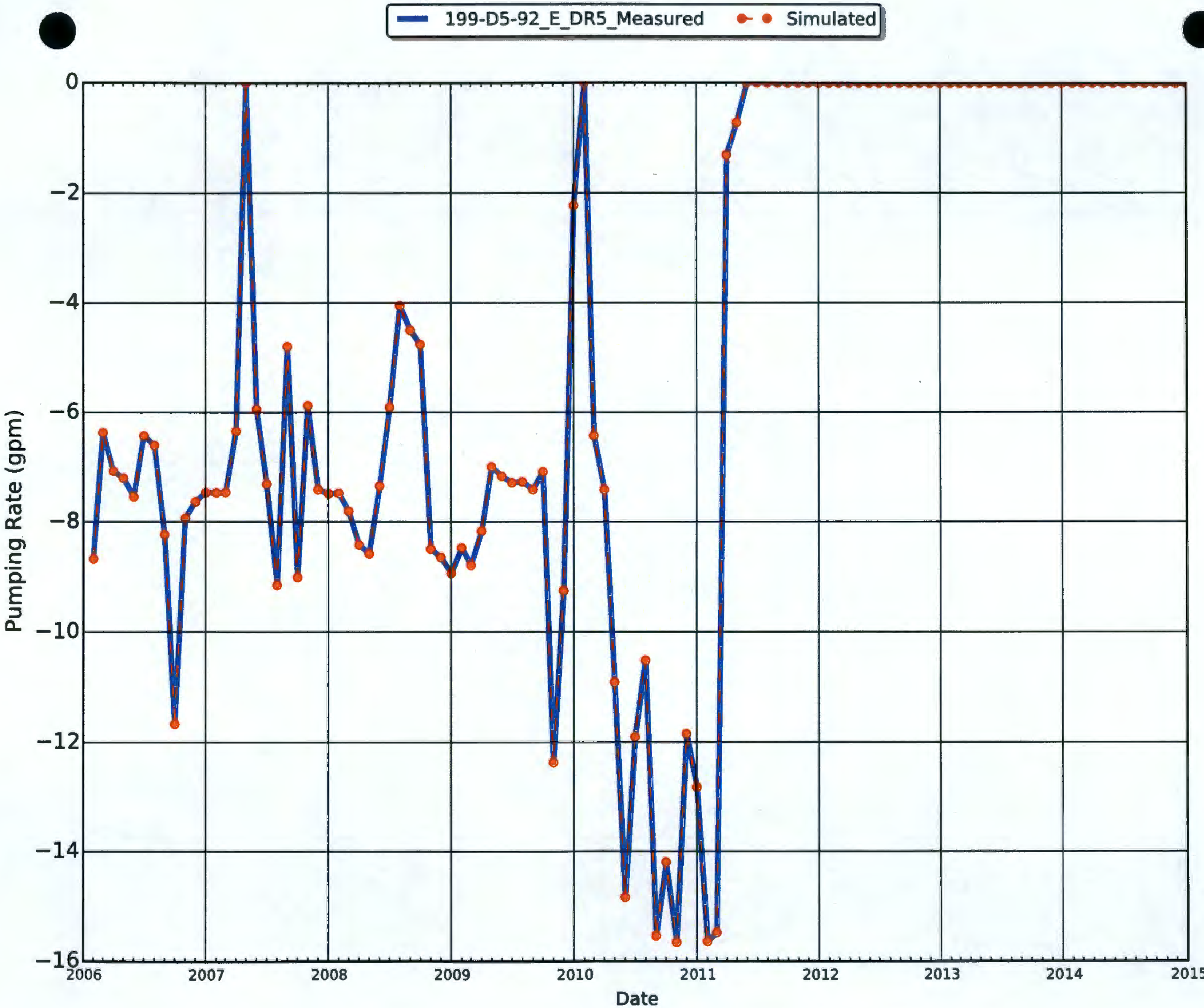

199-D5-39_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-41_I_DR5_Measured
Simulated
Pumping Rate (gpm)
18
16
14
12
10
8
6
4
2
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-42_I_DR5_Measured
Simulated
Pumping Rate (gpm)
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-42_I_DX_Measured
Simulated
35
30
25
20
15
10
5
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-44_I_DX_Measured
Simulated
Pumping Rate (gpm)
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-92_E_DR5_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
−12
−14
−16
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D5-92_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

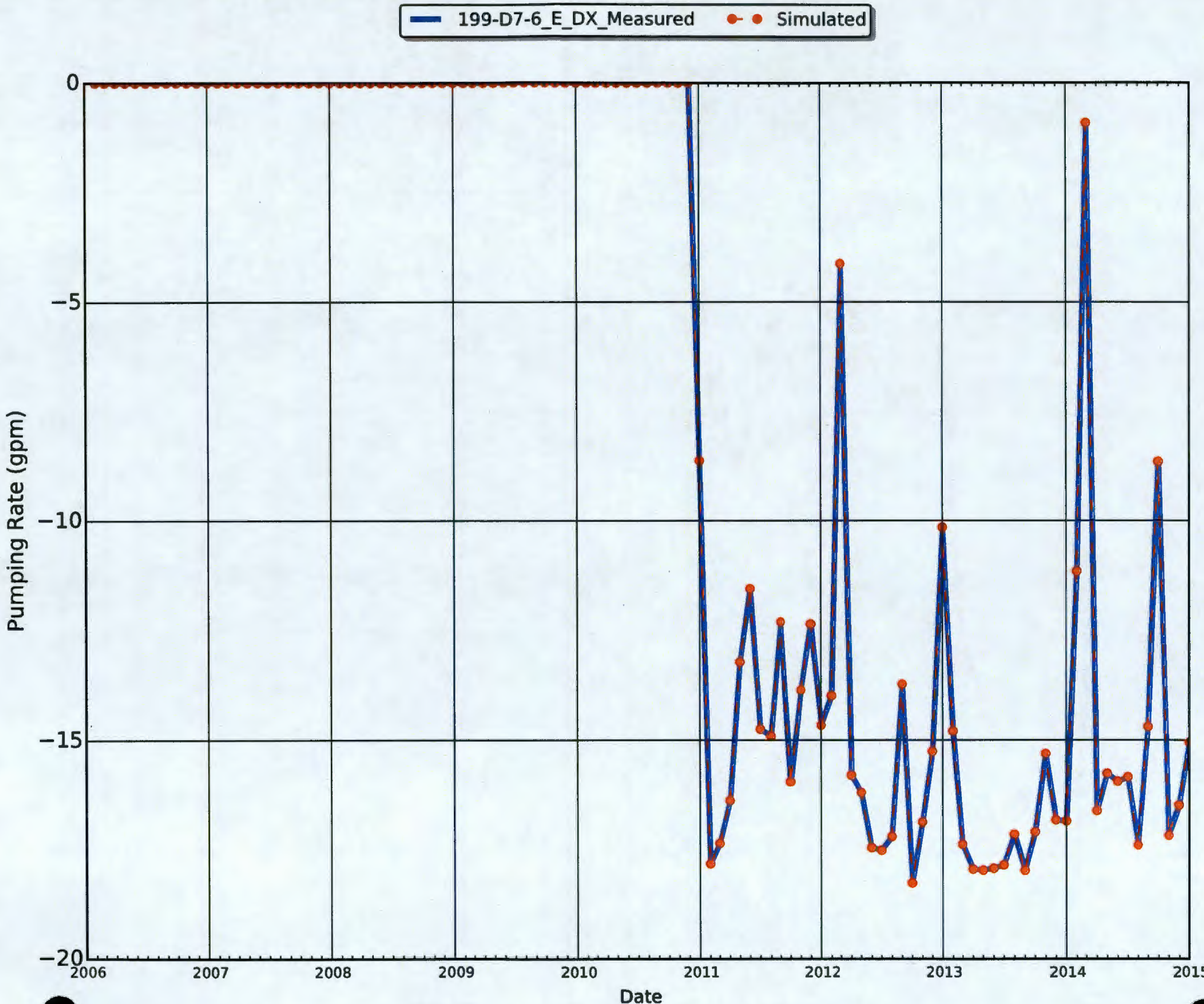

199-D6-1_I_DX_Measured
Simulated
Pumping Rate (gpm)
Date
0
10
20
30
40
50
60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


199-D6-2_I_DX_Measured
Simulated
Pumping Rate (gpm)
80
70
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D7-3_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

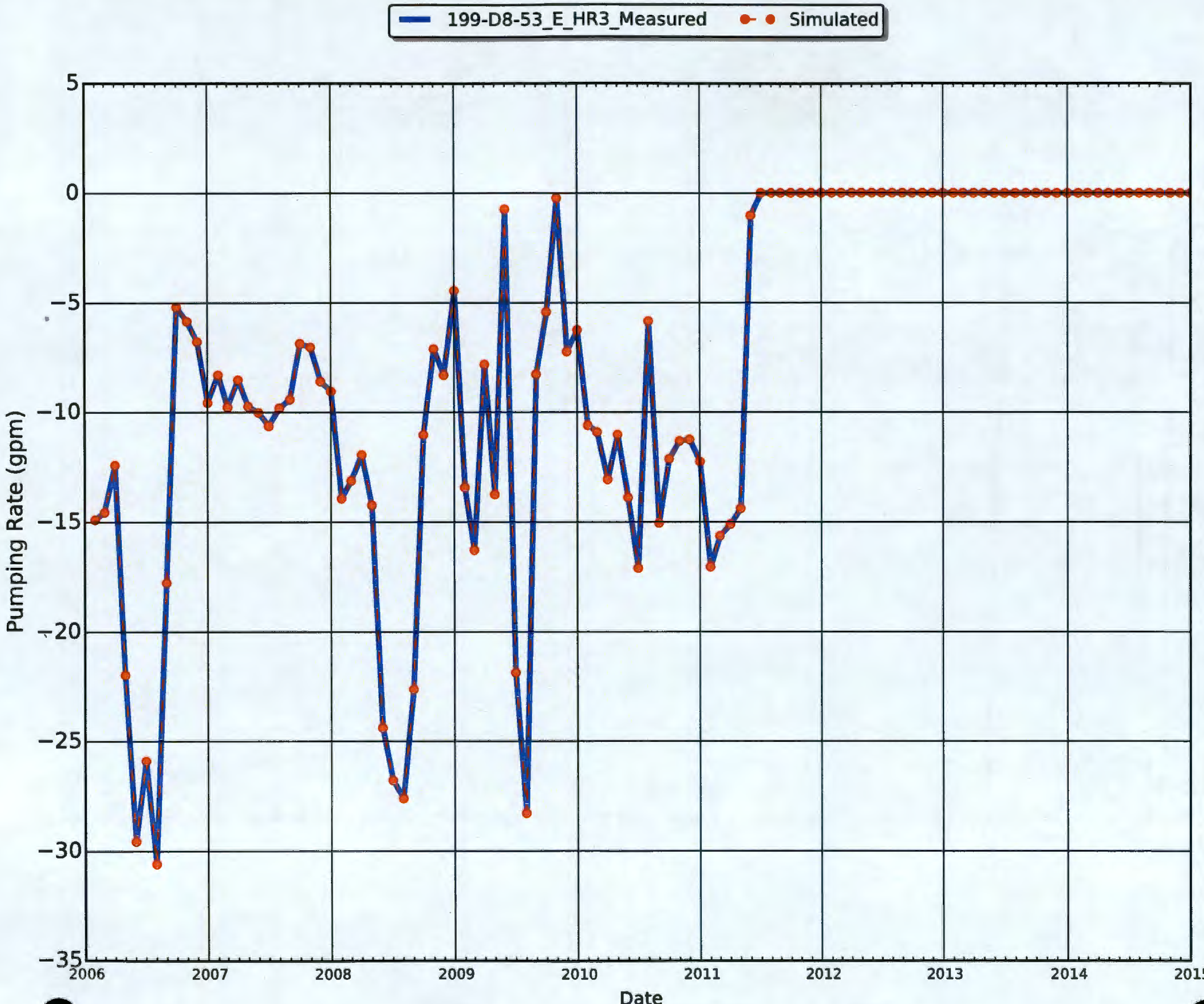

199-D7-4_I_DX_Measured
Simulated
Pumping Rate (gpm)
180
160
140
120
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-D7-5_I_DX_Measured
Simulated
Pumping Rate (gpm)
0
20
40
60
80
100
120
140
160
Date
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

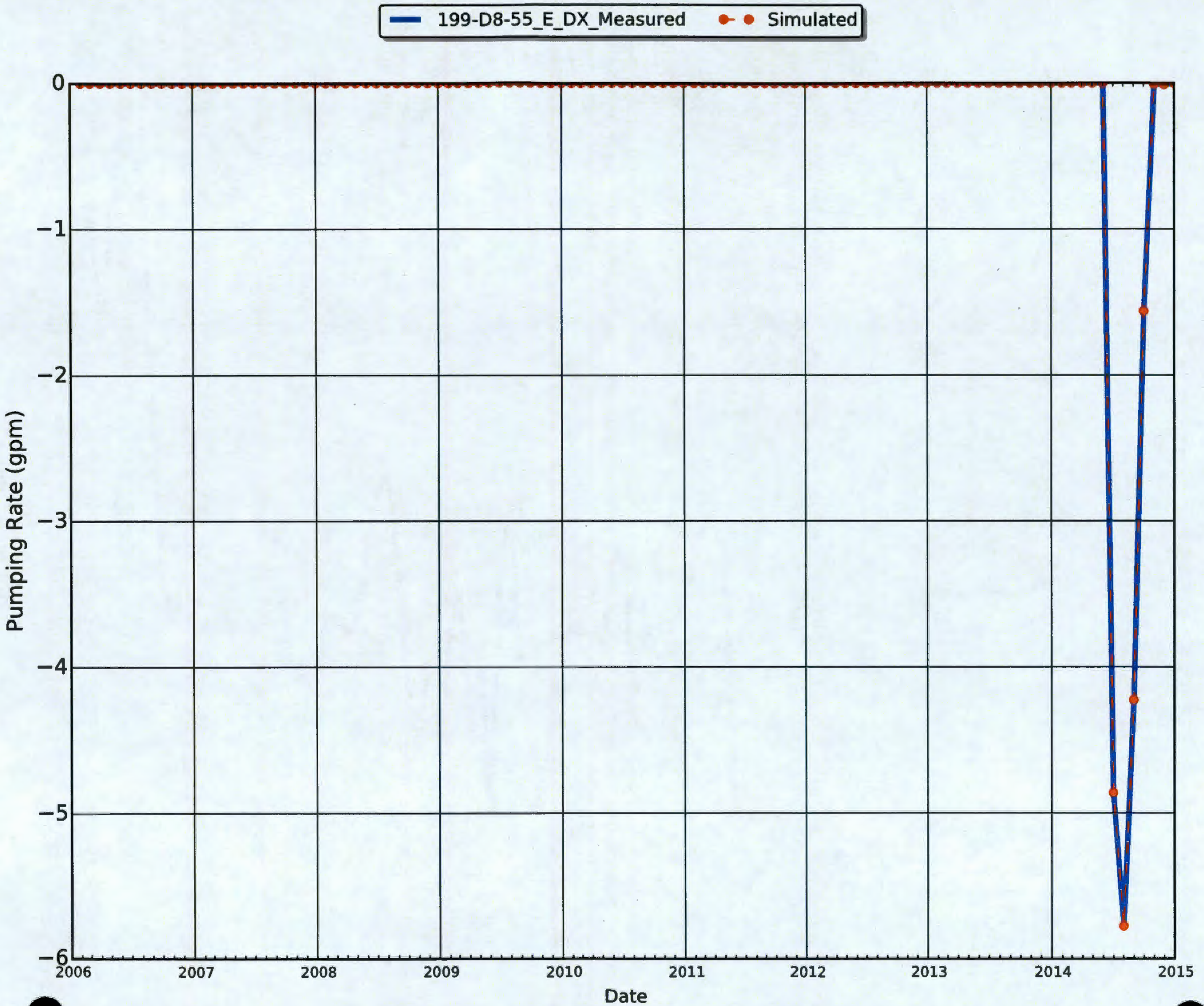


199-D7-6_E_DX_Measured
Simulated
0
−5
−10
−15
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

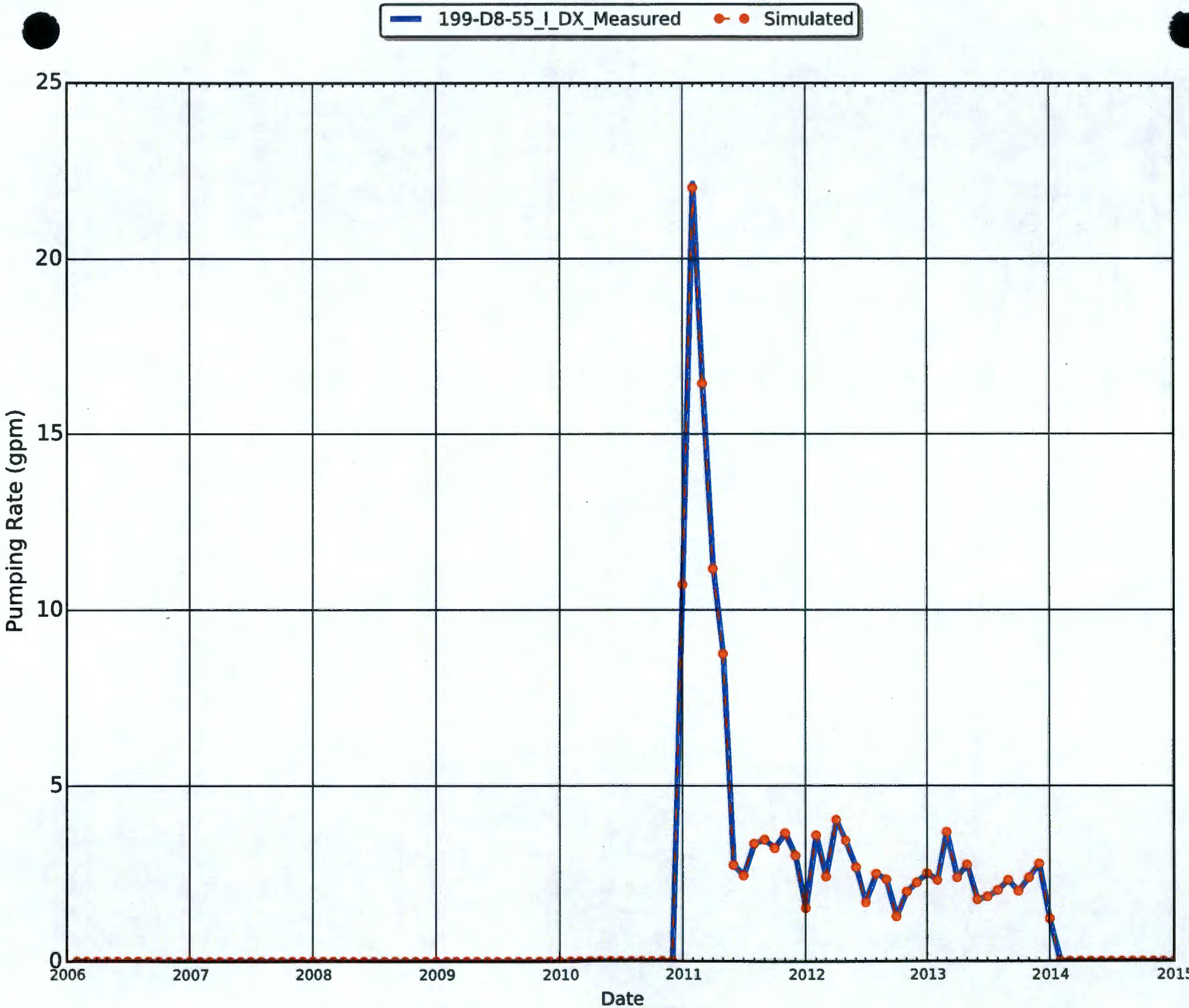
199-D8-53_E_DX_Measured
Simulated
5
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

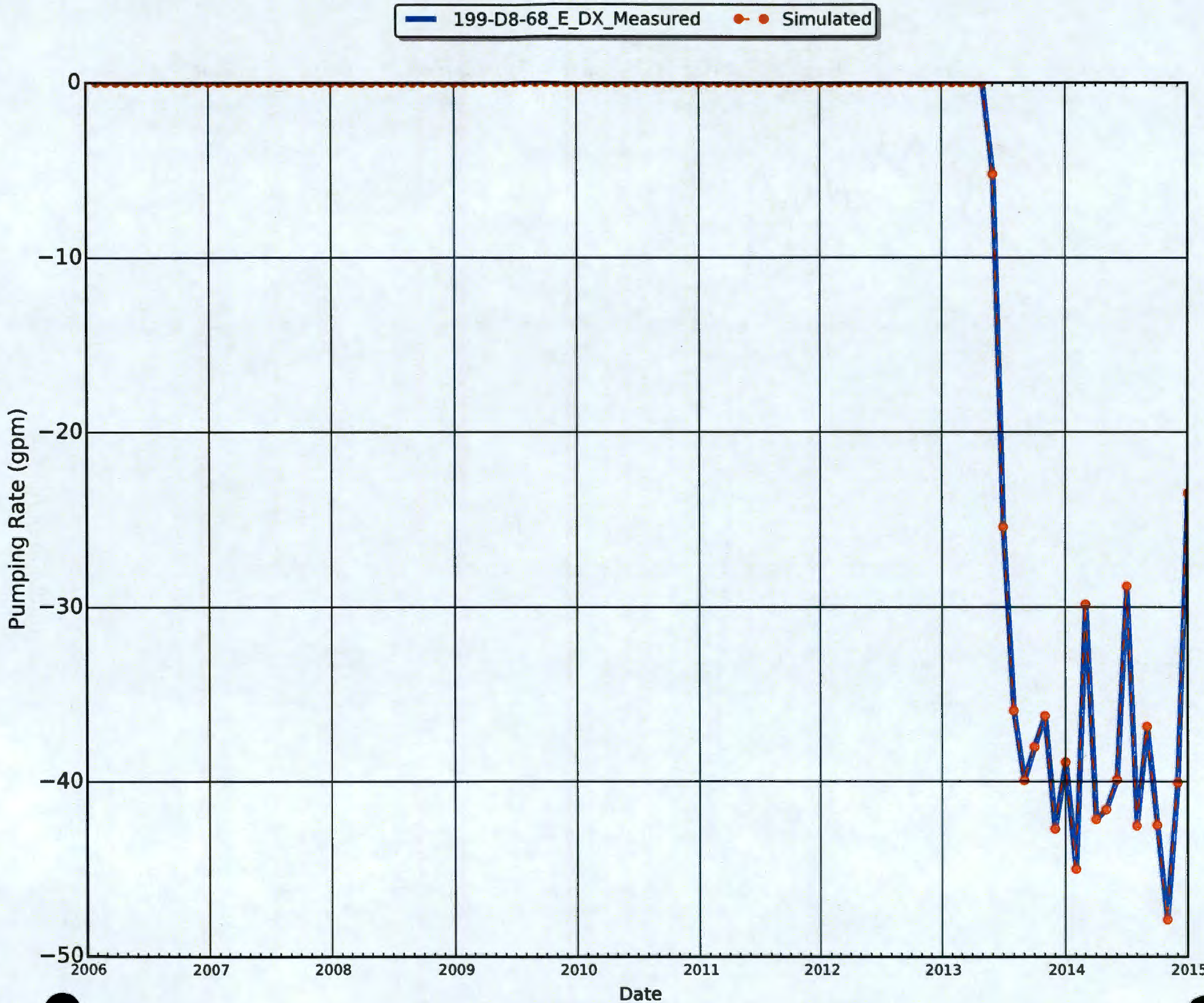

199-D8-53_E_HR3_Measured
Simulated
5
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D8-54A_E_HR3_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

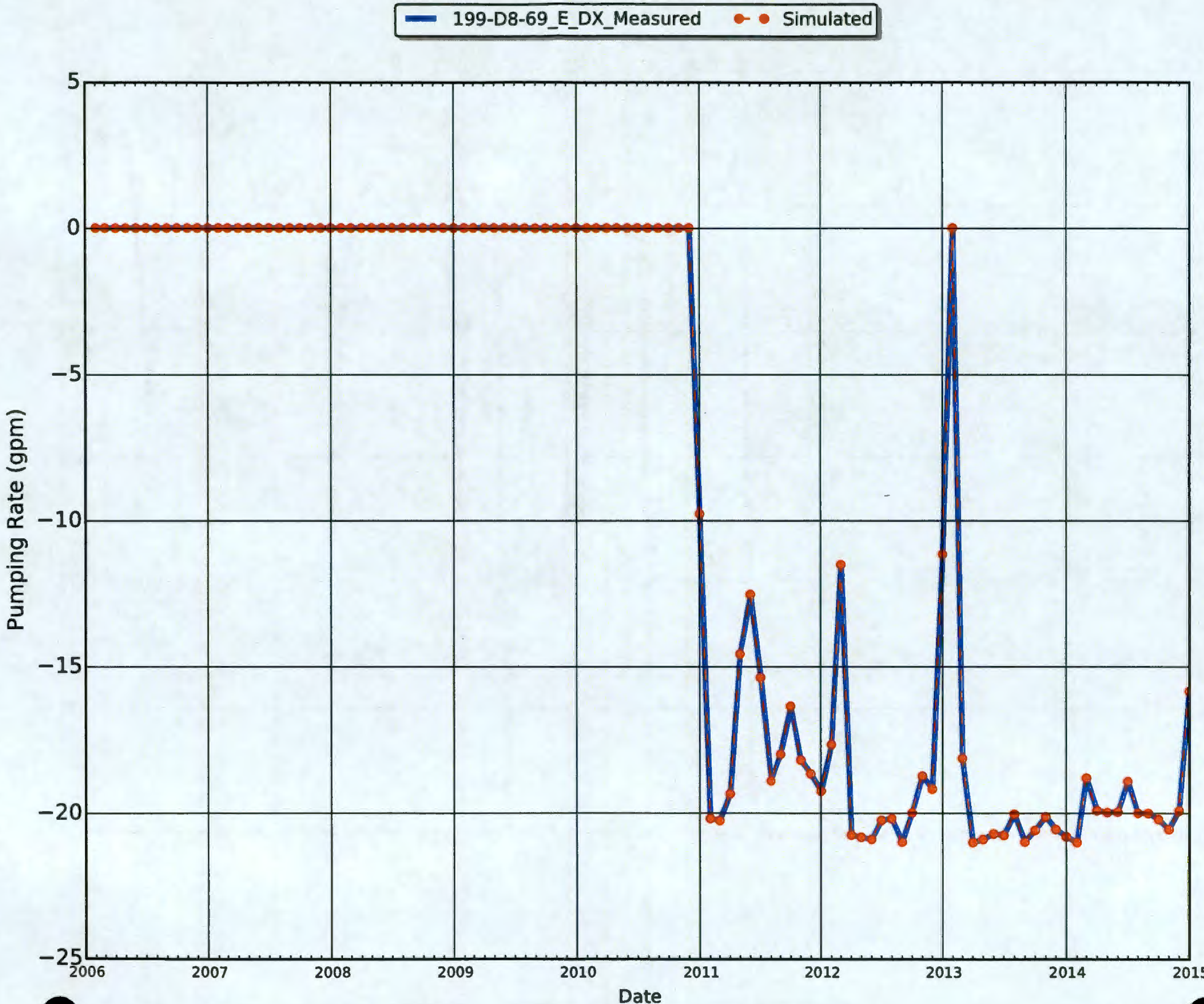


199-D8-55_E_DX_Measured
Simulated
0
−1
−2
−3
−4
−5
−6
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

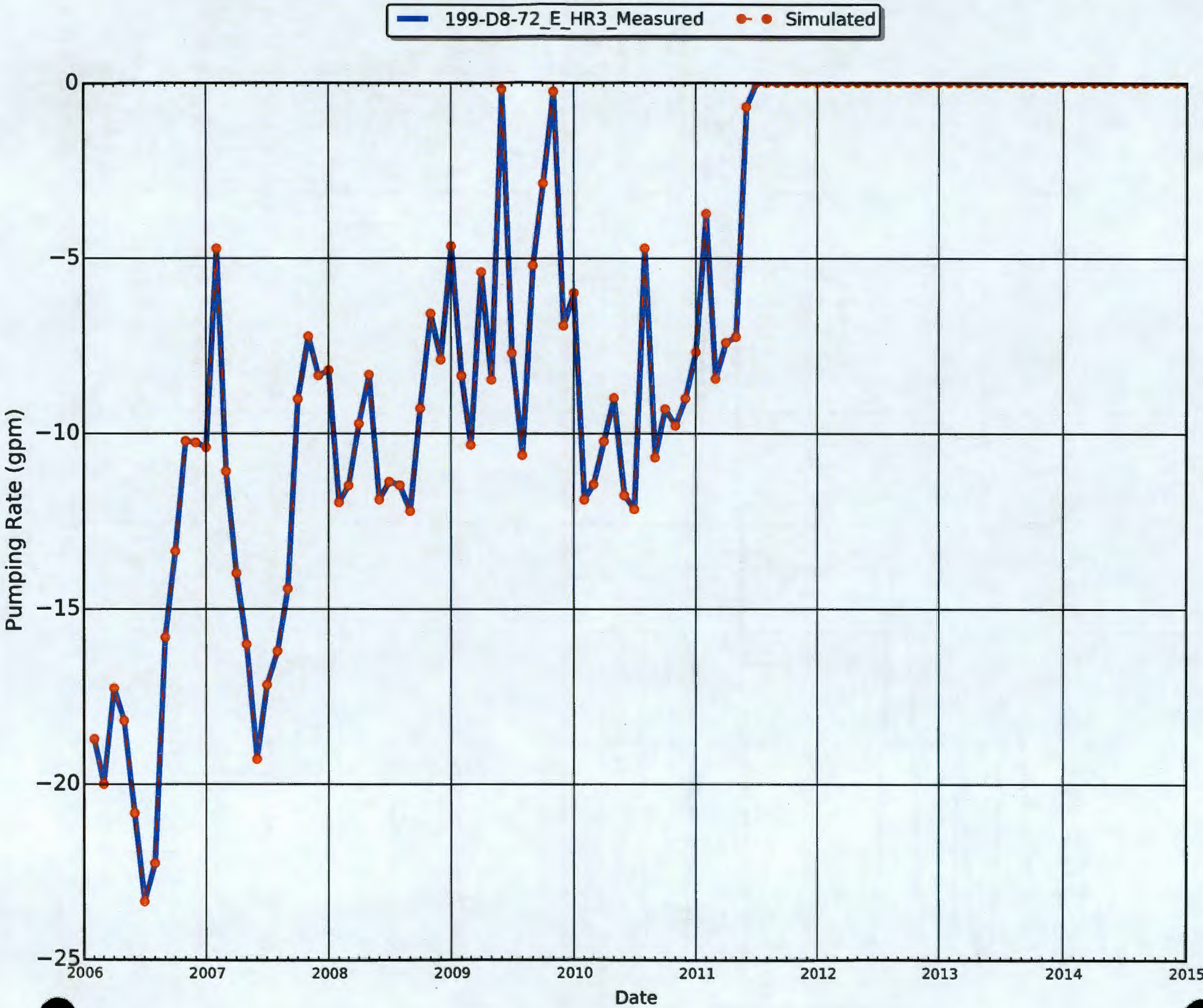

199-D8-55_I_DX_Measured
Simulated
25
20
15
10
5
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

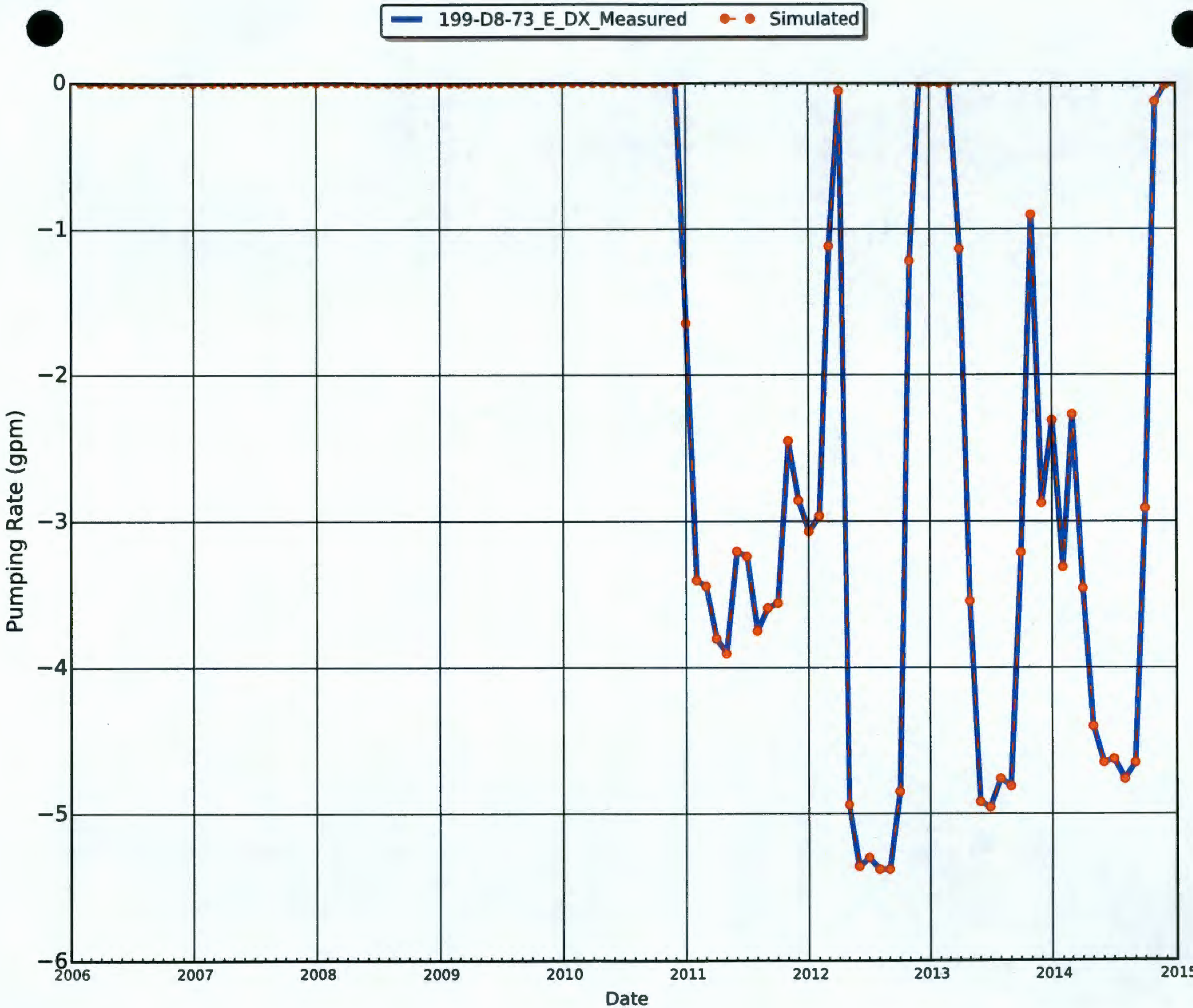

199-D8-68_E_DX_Measured
Simulated
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D8-68_E_HR3_Measured
Simulated
Pumping Rate (gpm)
10
0
−10
−20
−30
−40
−50
−60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D8-69_E_DX_Measured
Simulated
5
0
−5
−10
−15
−20
−25
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Pumping Rate (gpm)
Date

199-D8-6_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D8-72_E_HR3_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

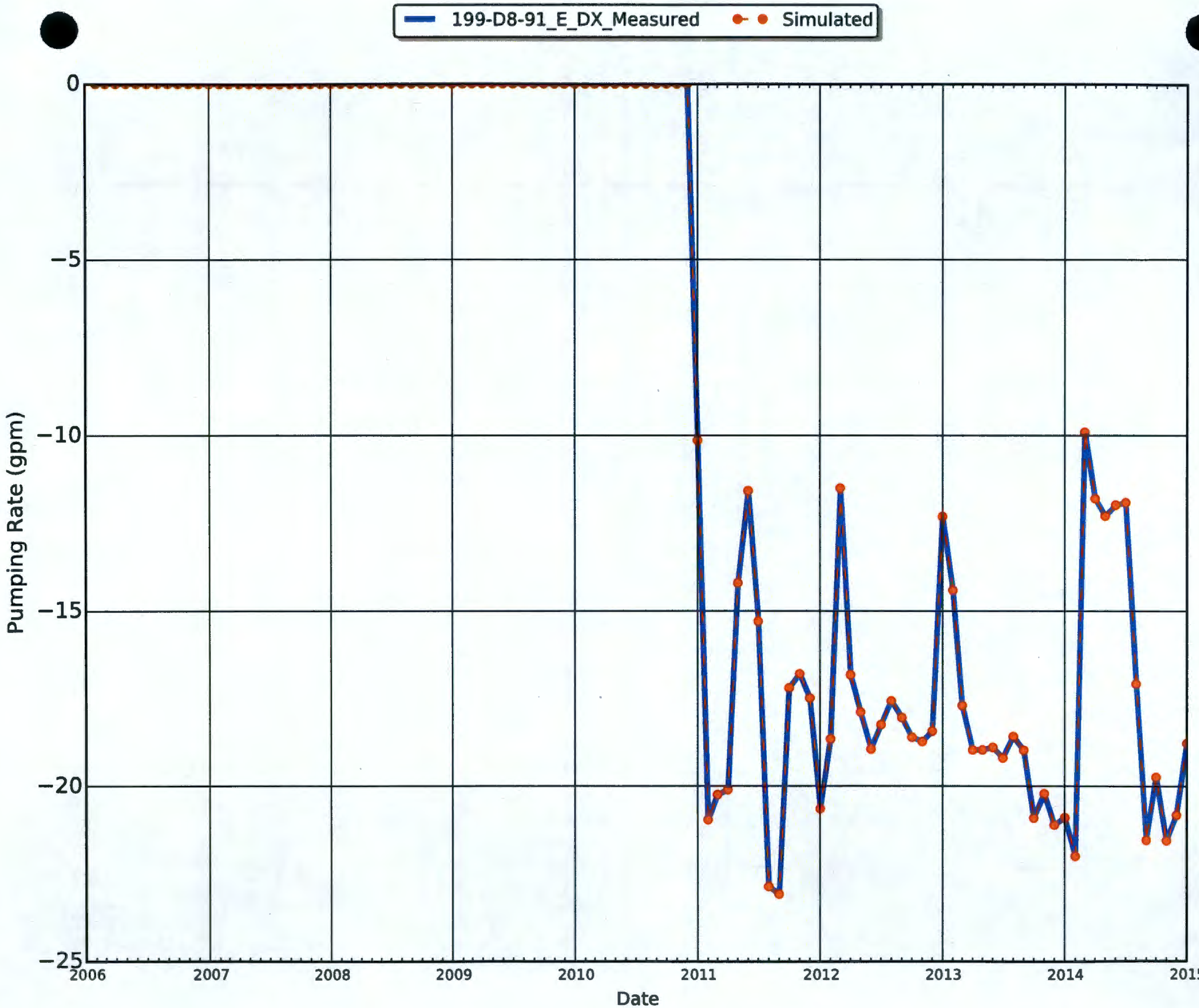


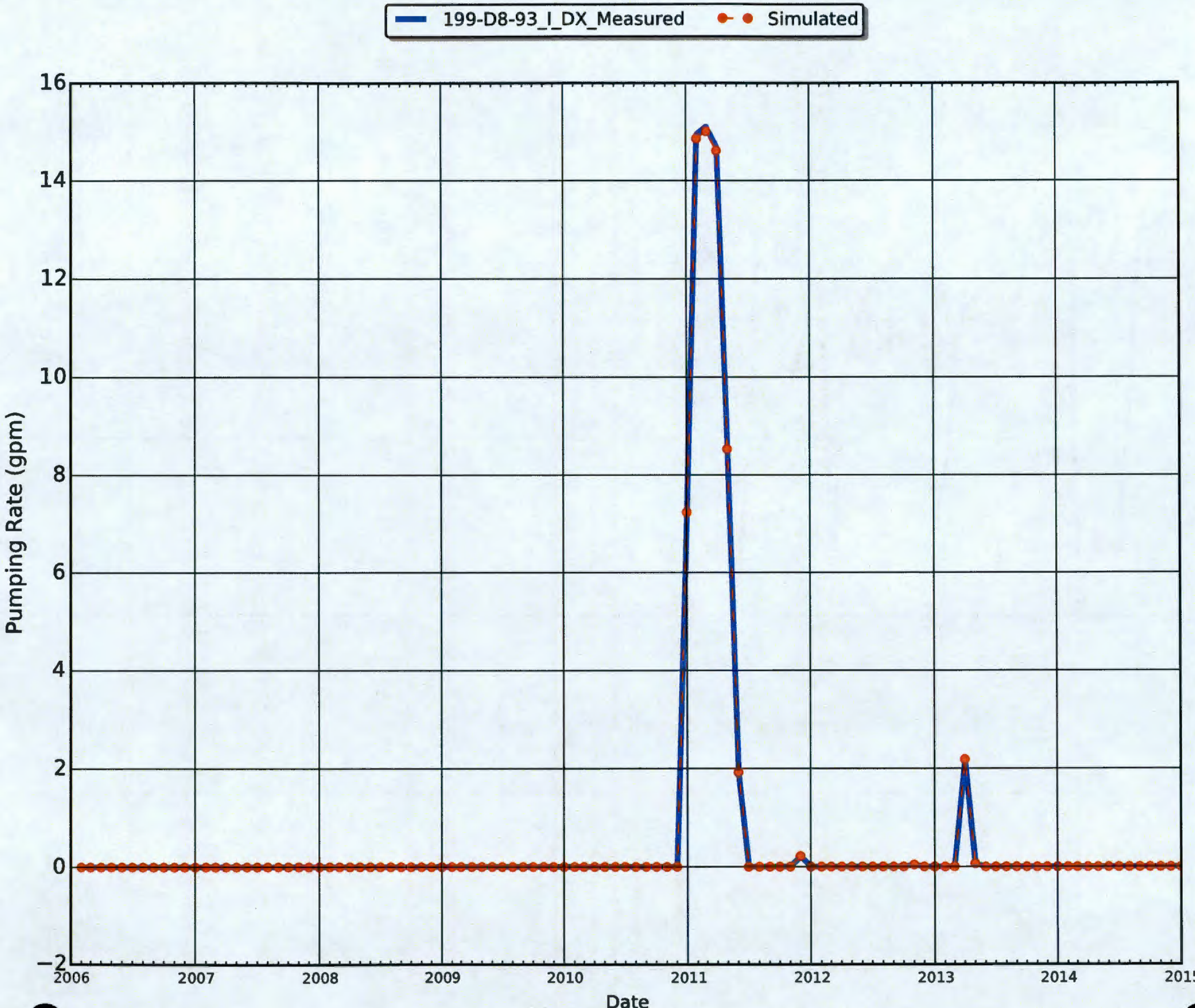
199-D8-73_E_DX_Measured
Simulated
0
−1
−2
−3
−4
−5
−6
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-D8-88_E_DX_Measured
Simulated
0
−1
−2
−3
−4
−5
−6
−7
−8
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

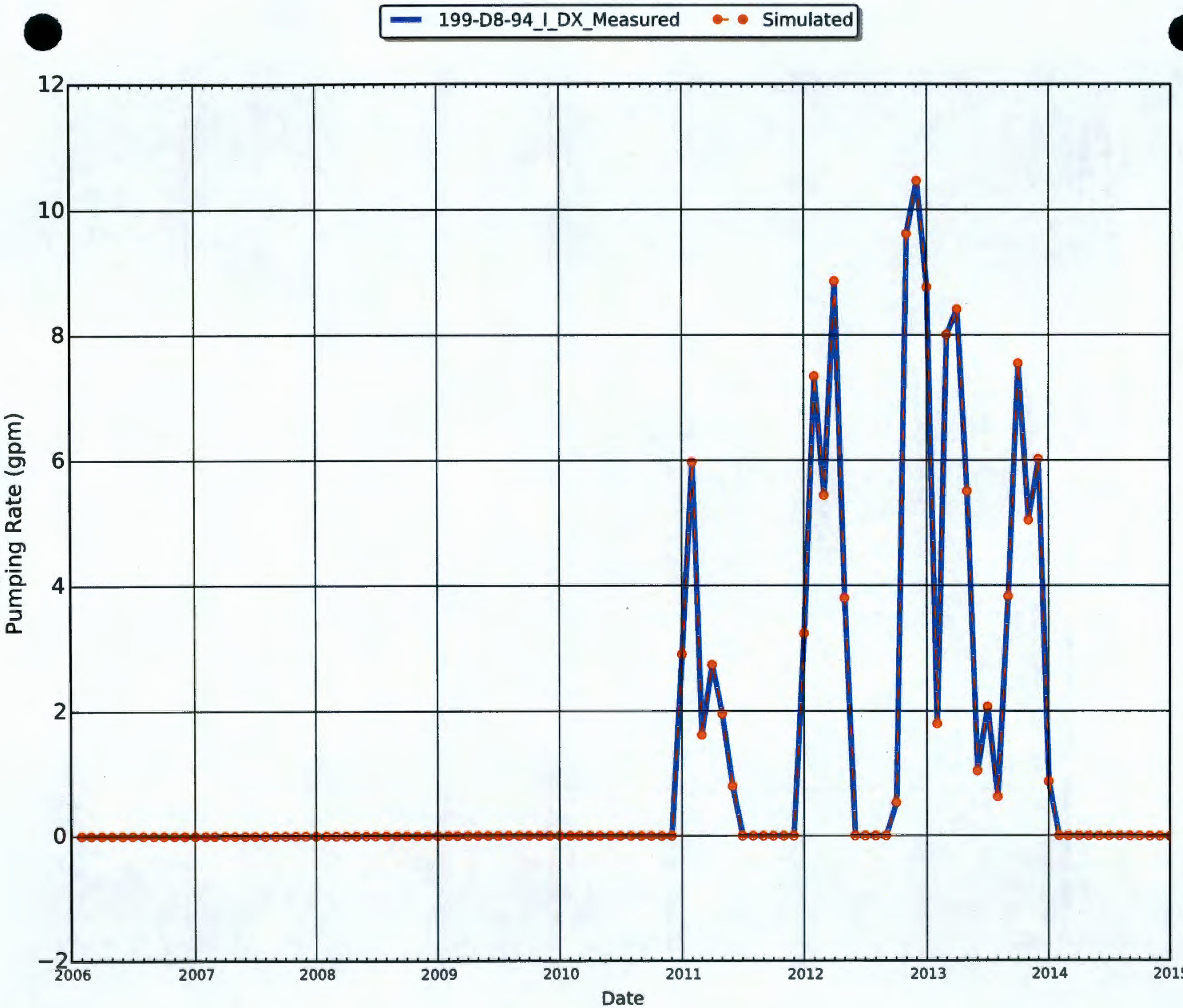

199-D8-89_E_DX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

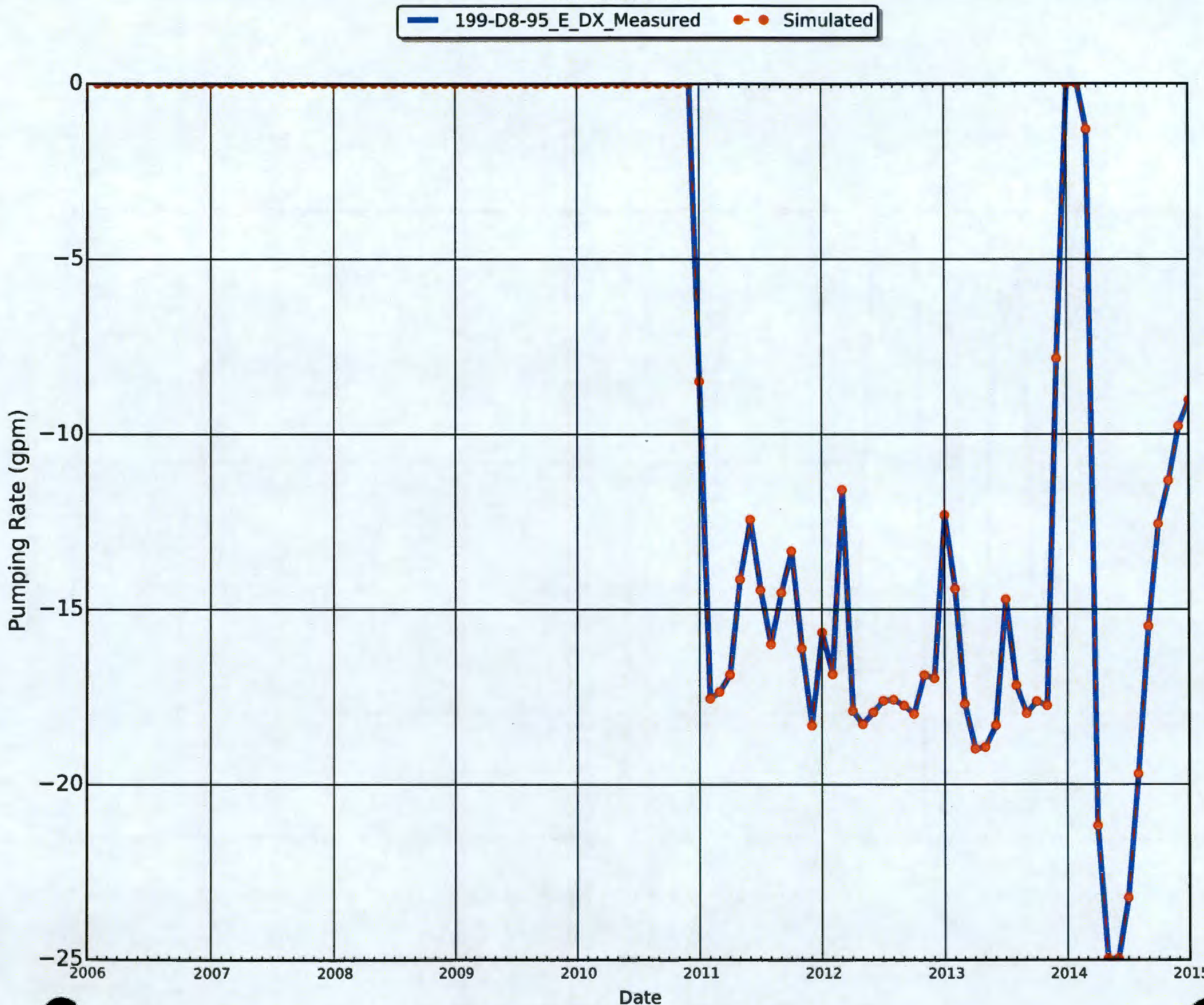
199-D8-90_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

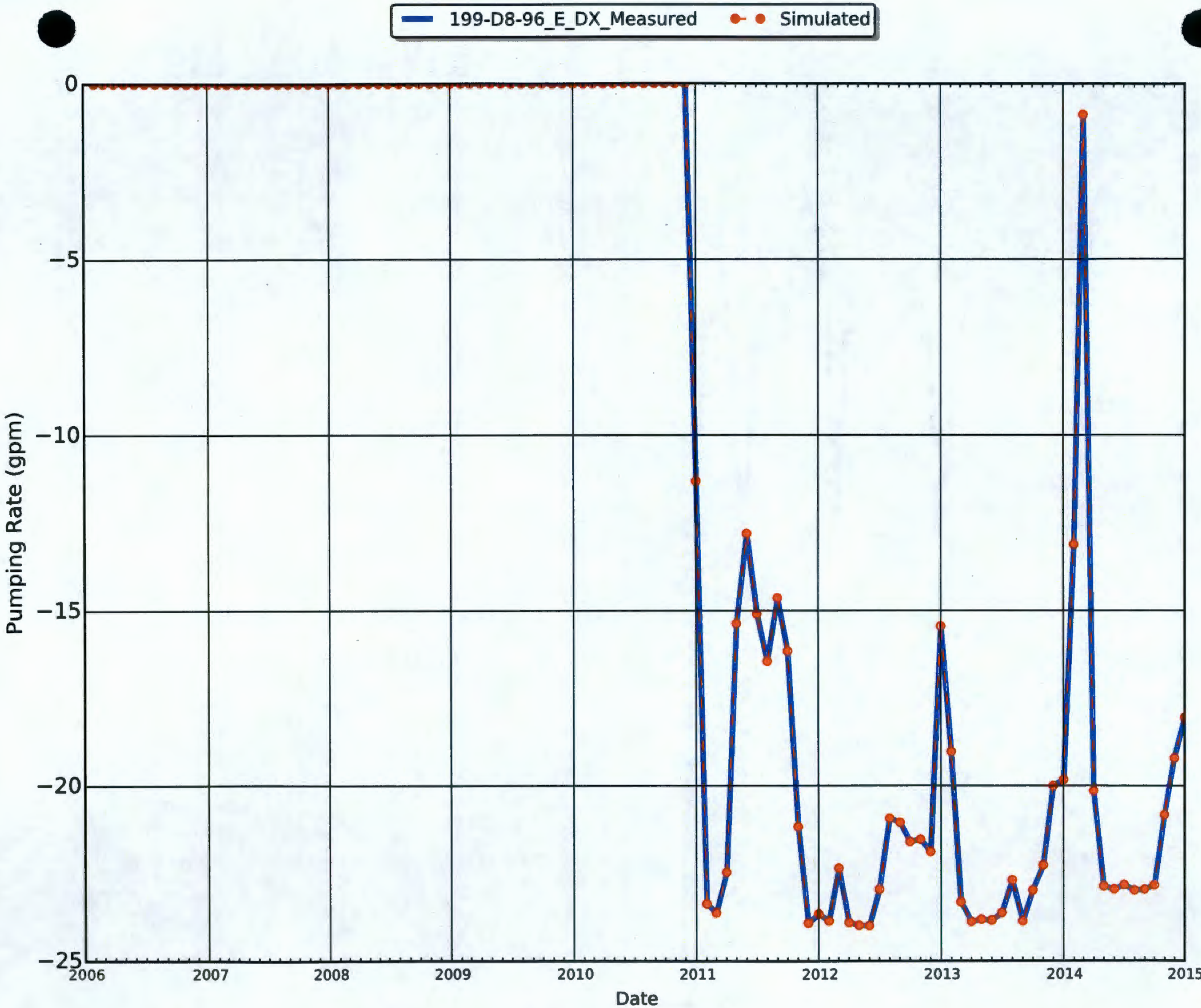

199-D8-91_E_DX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

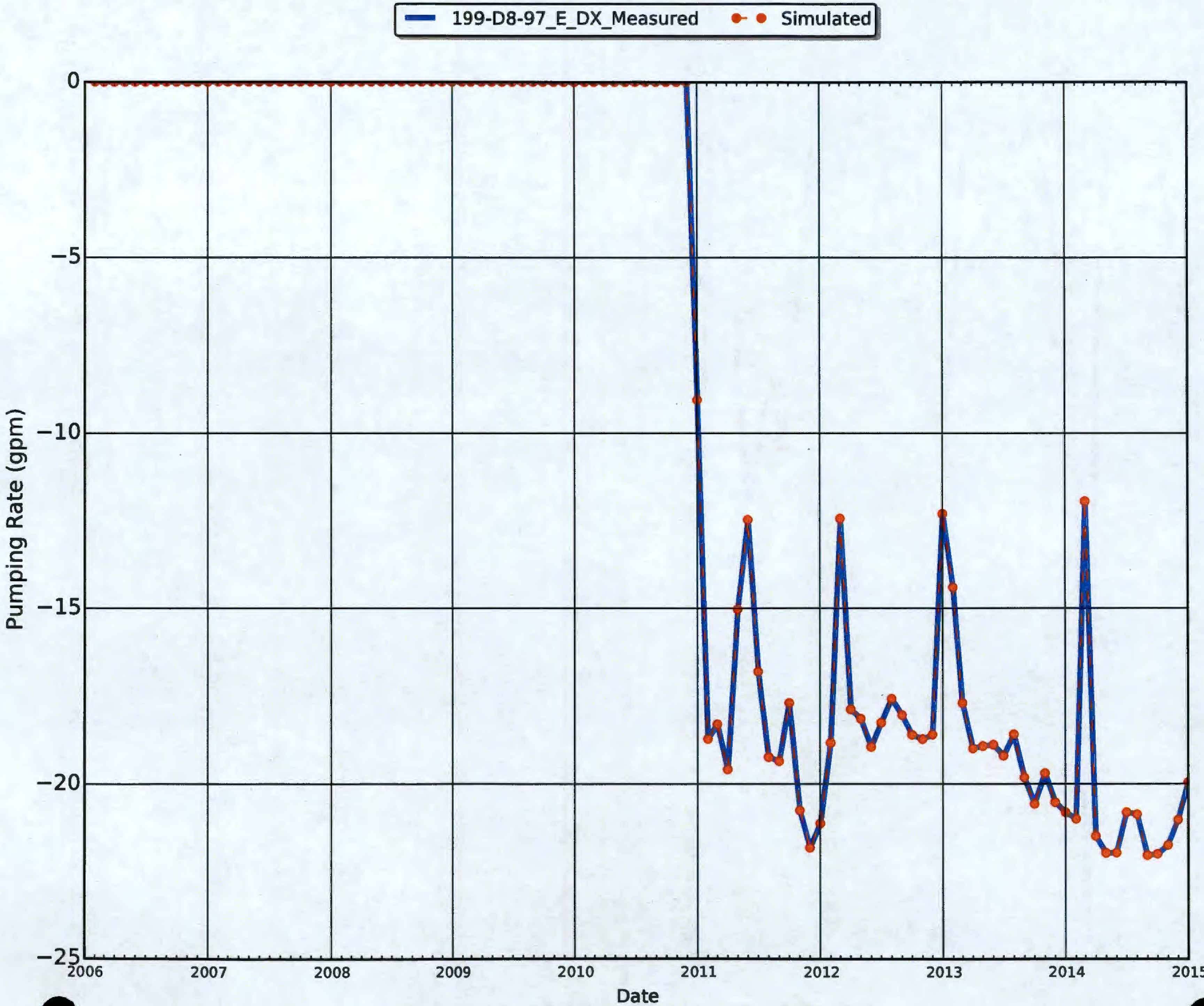


199-D8-93_I_DX_Measured
Simulated
16
14
12
10
8
6
4
2
0
−2
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D8-94_I_DX_Measured
Simulated
Pumping Rate (gpm)
12
10
8
6
4
2
0
−2
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

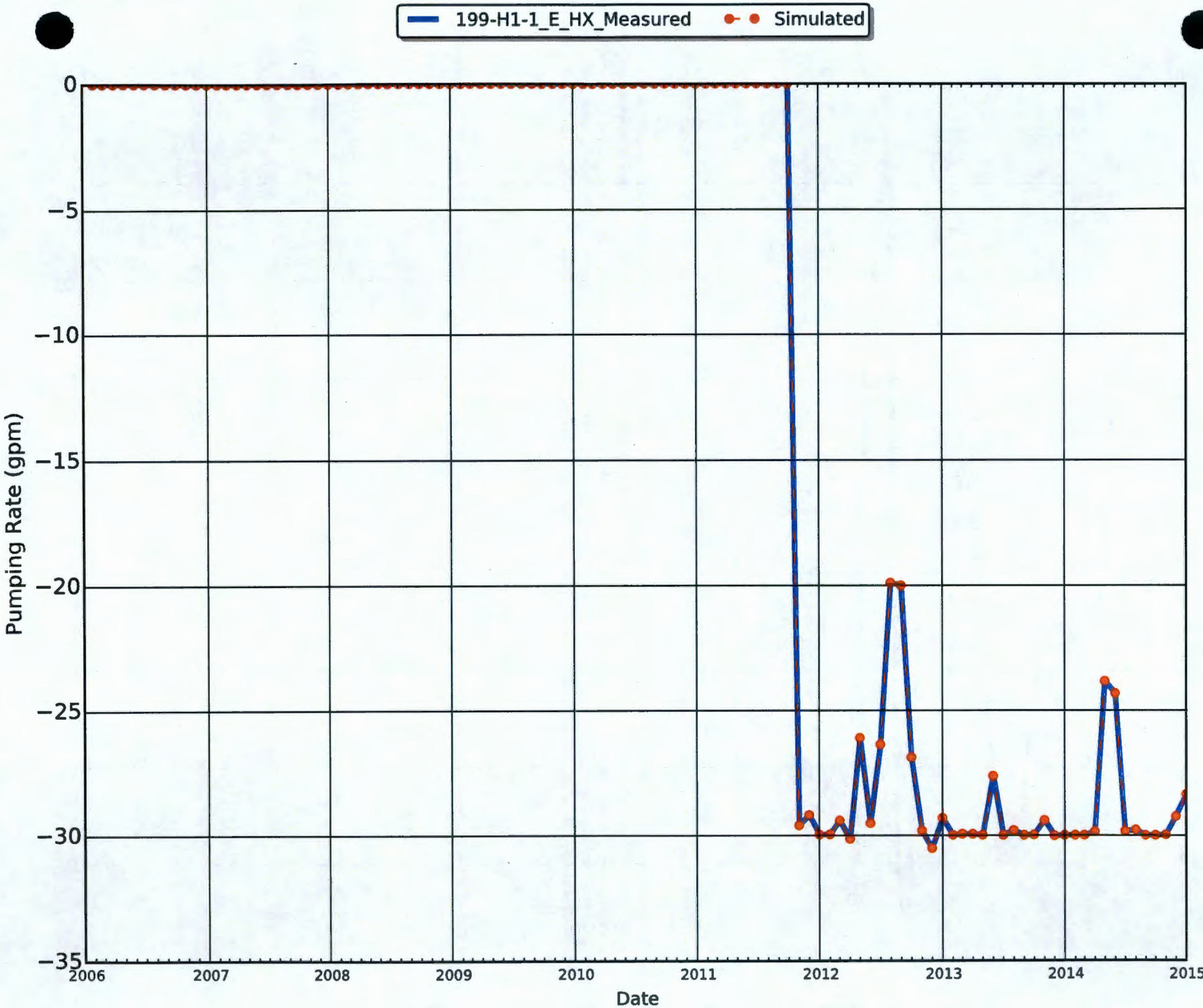

199-D8-95_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

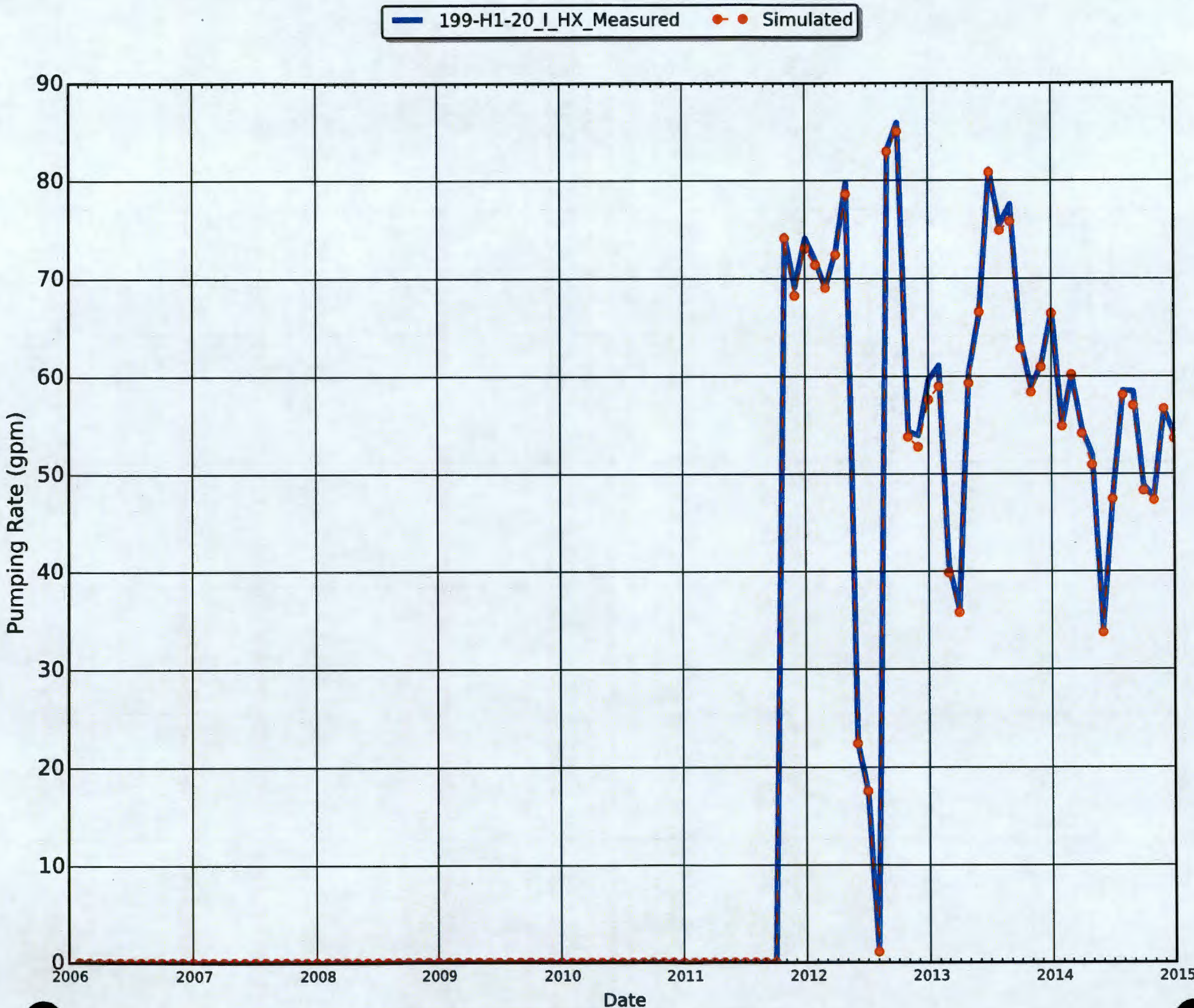

199-D8-96_E_DX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-D8-97_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

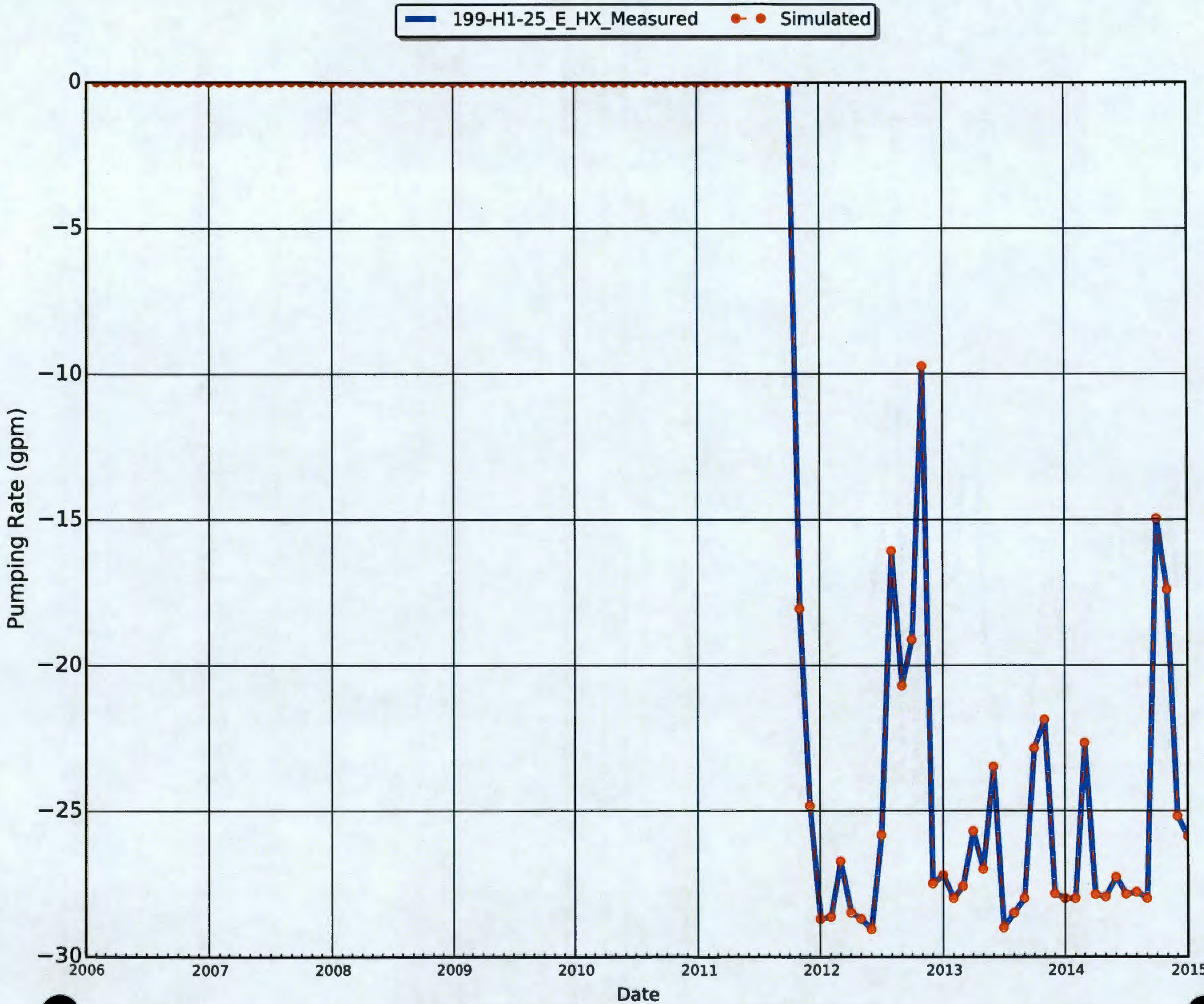

199-D8-98_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

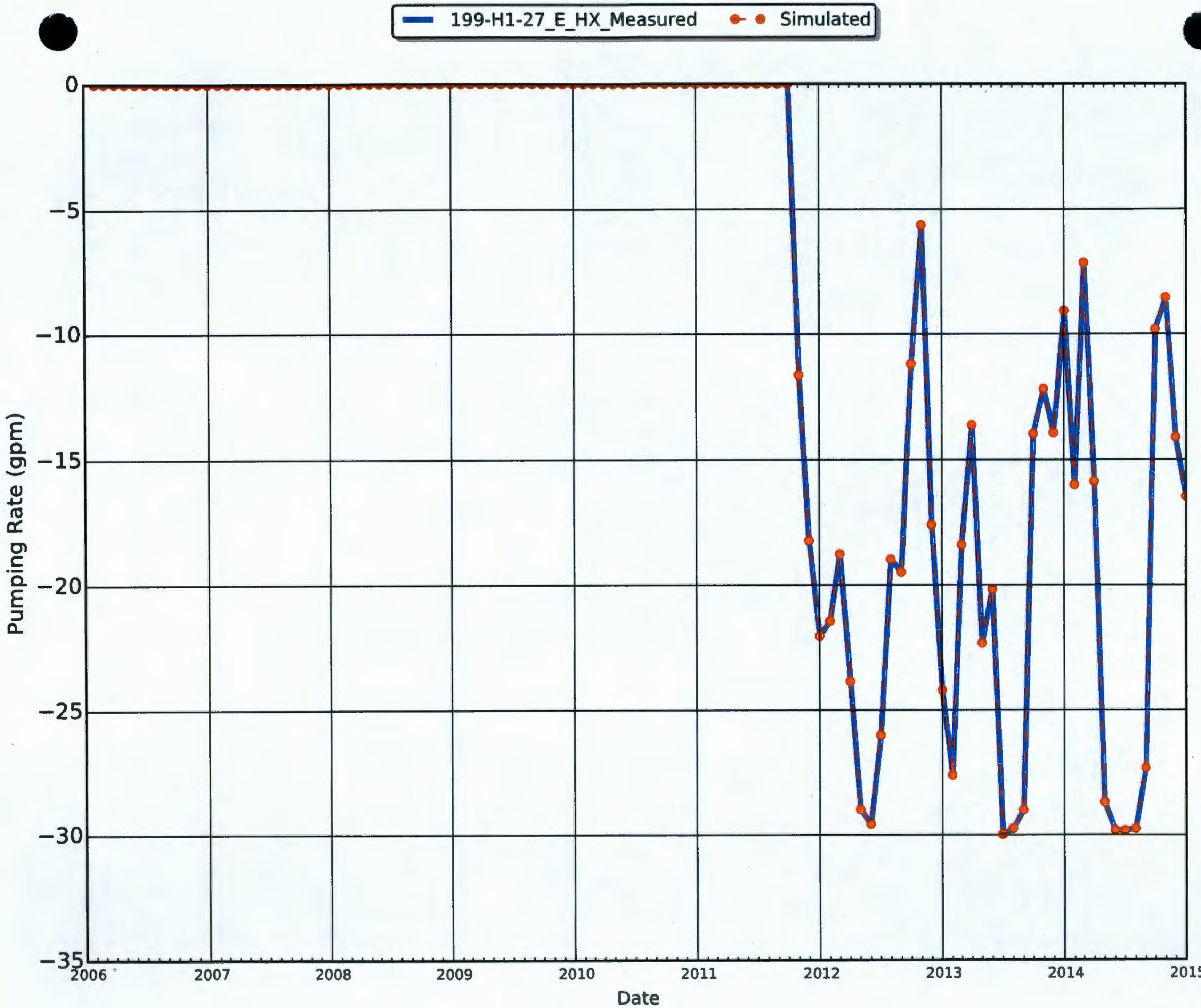

199-D8-99_I_DX_Measured
Simulated
Pumping Rate (gpm)
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-1_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
−30
−35
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

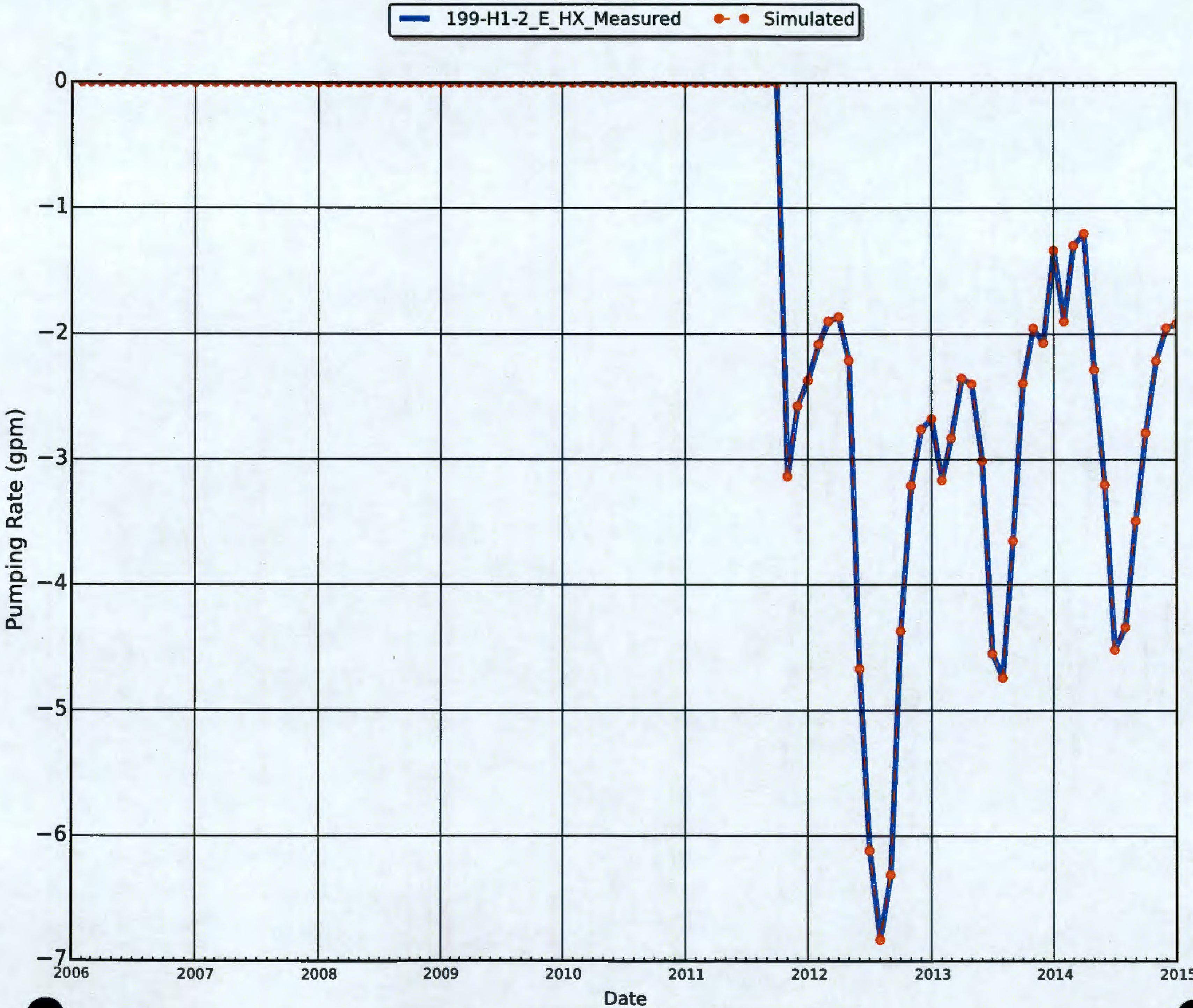

199-H1-20_I_HX_Measured
Simulated
Pumping Rate (gpm)
0
10
20
30
40
50
60
70
80
90
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-21_I_HX_Measured
Simulated
Pumping Rate (gpm)
0
20
40
60
80
100
120
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

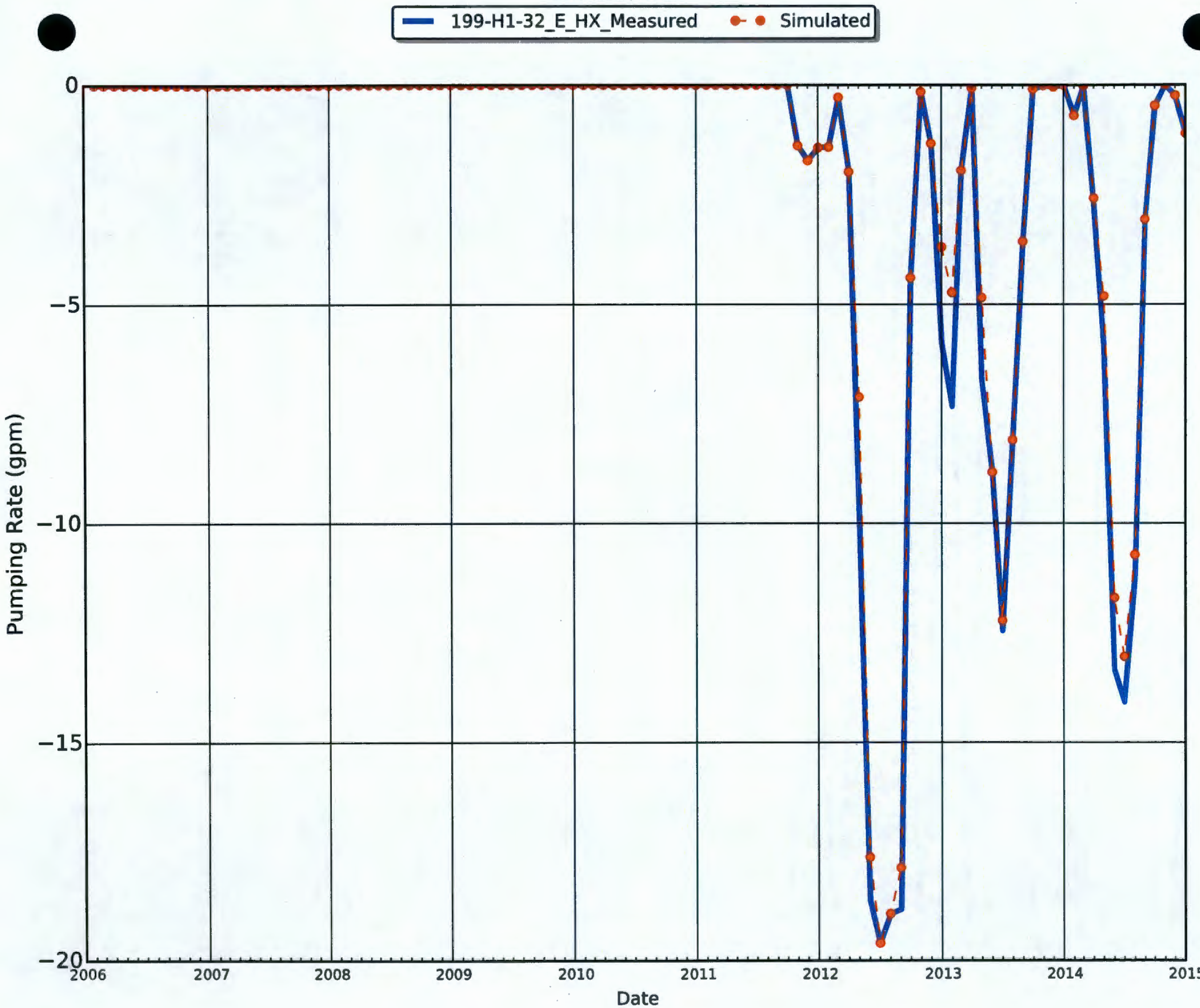

199-H1-25_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

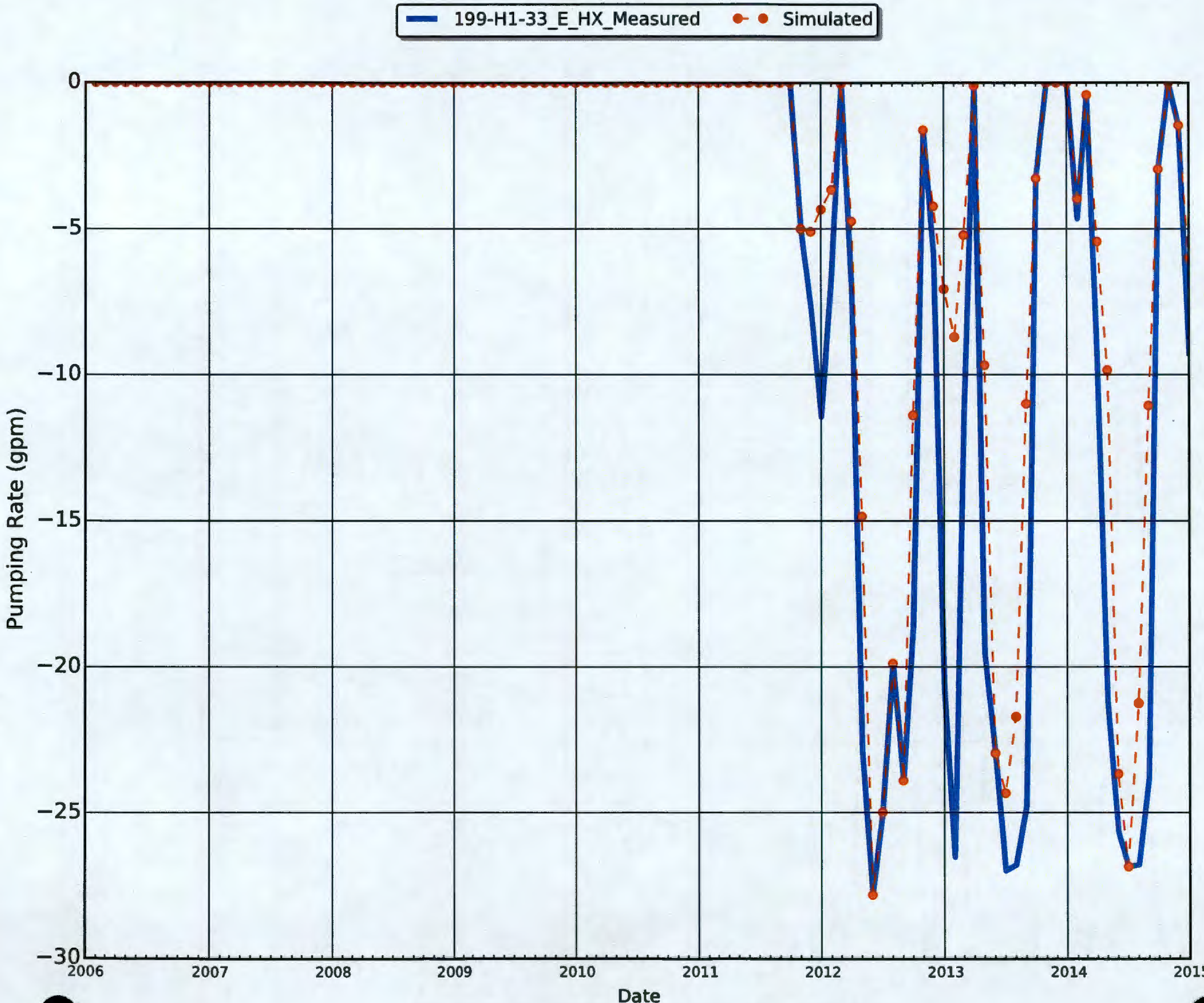


199-H1-27_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

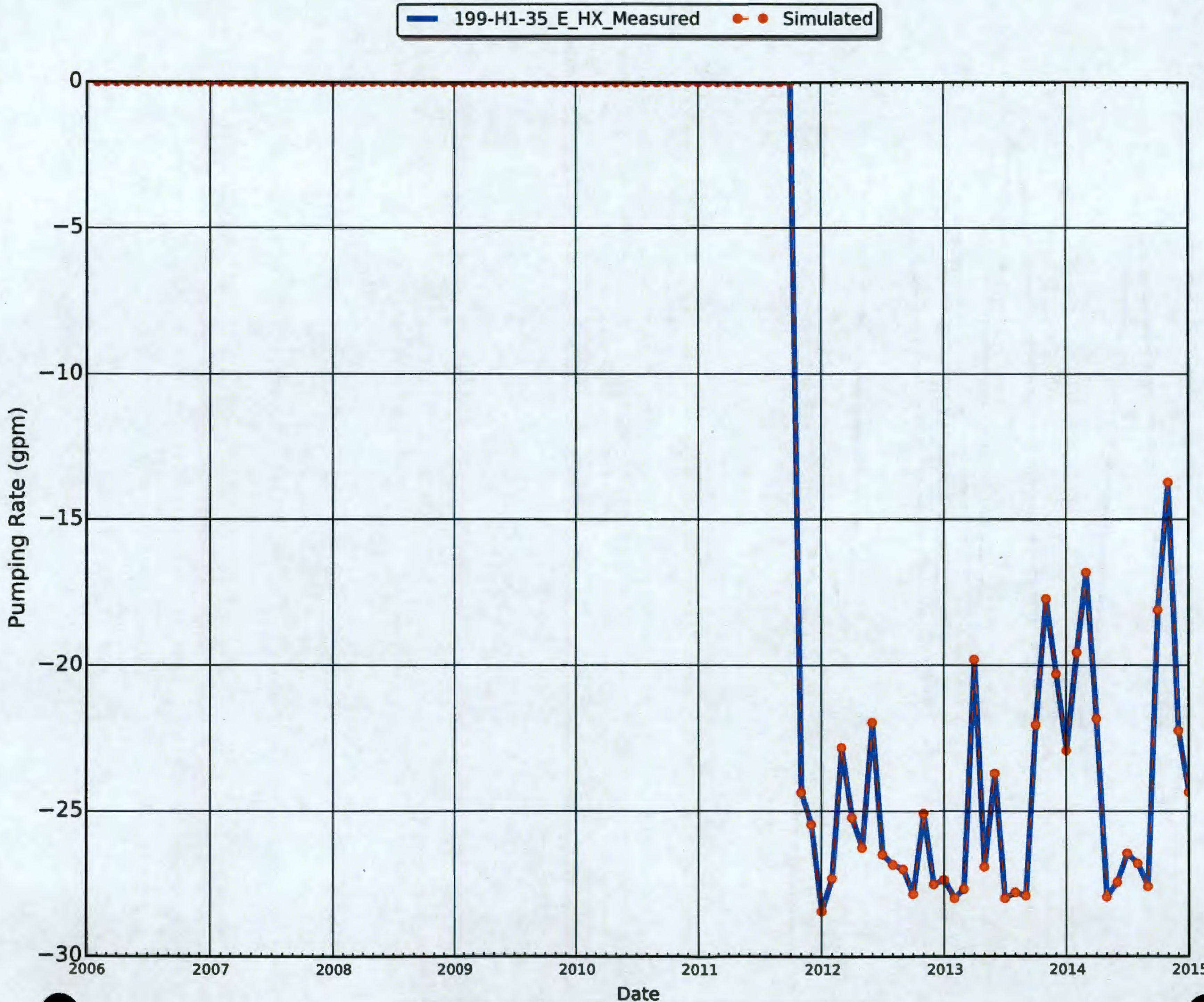


199-H1-2_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−1
−2
−3
−4
−5
−6
−7
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

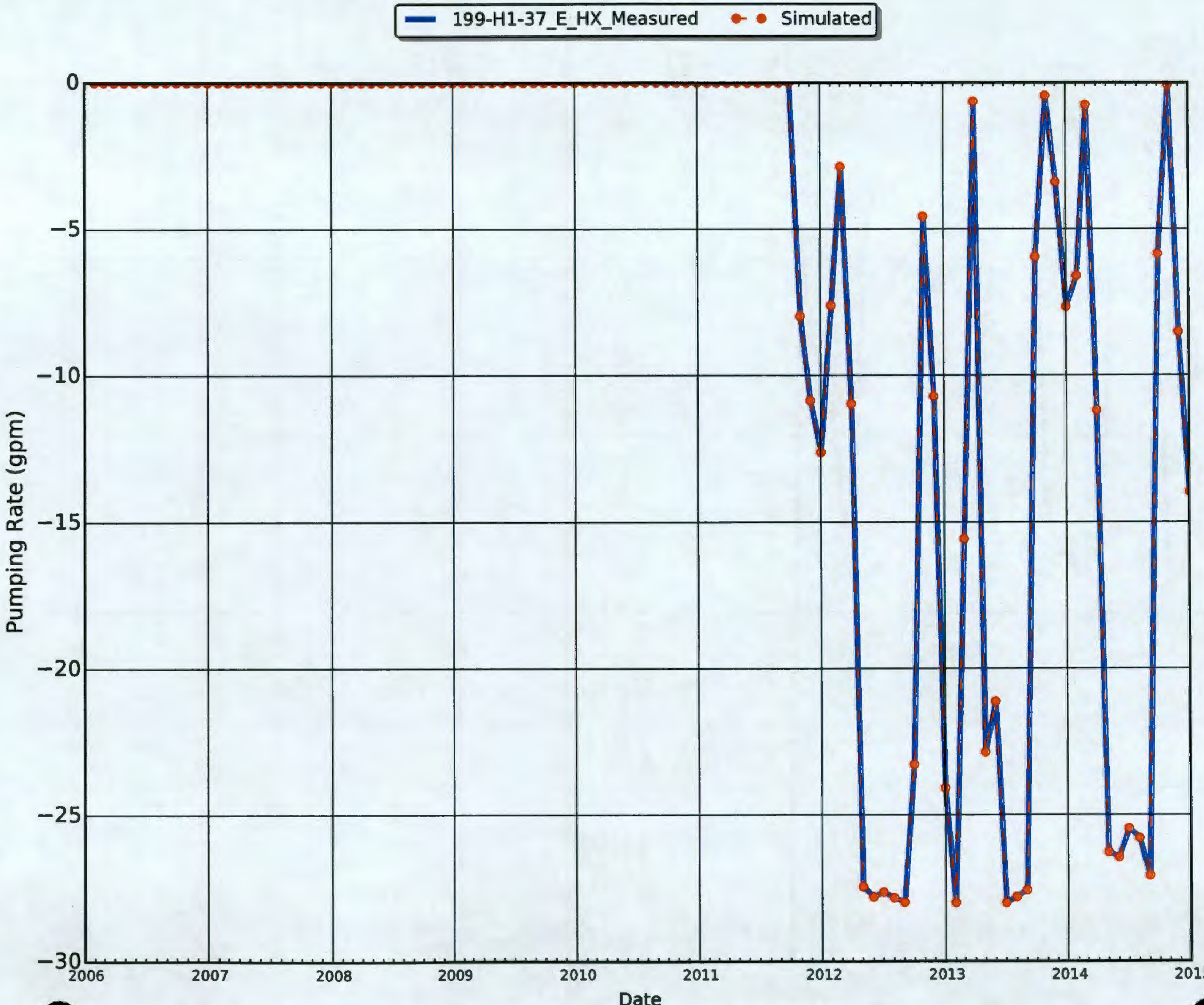

199-H1-32_E_HX_Measured
Simulated
0
−5
−10
−15
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-33_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-H1-34_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
−30
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

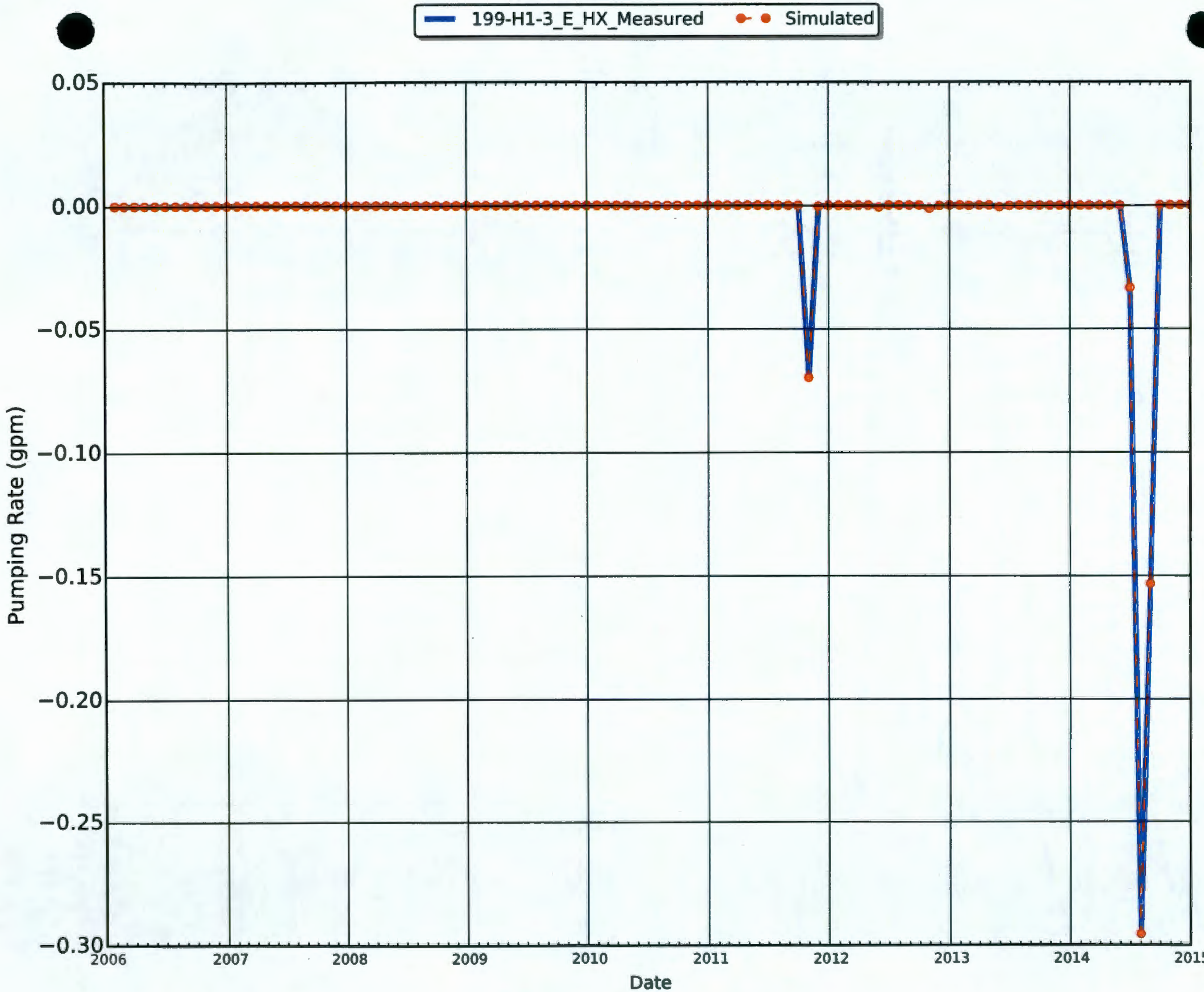

199-H1-35_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
−30
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-36_E_HX_Measured
Simulated
0
−2
−4
−6
−8
−10
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

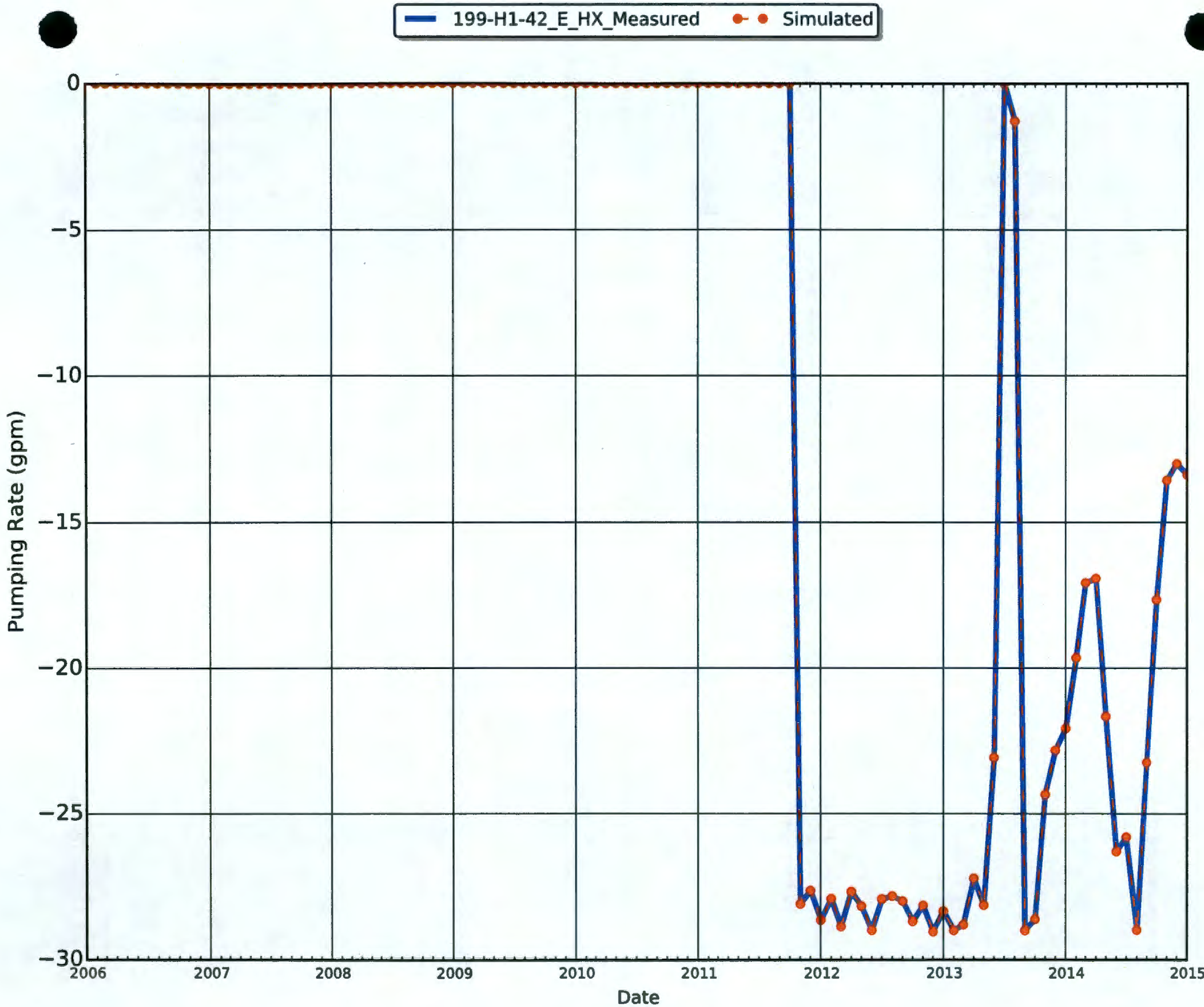

199-H1-37_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
−30
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

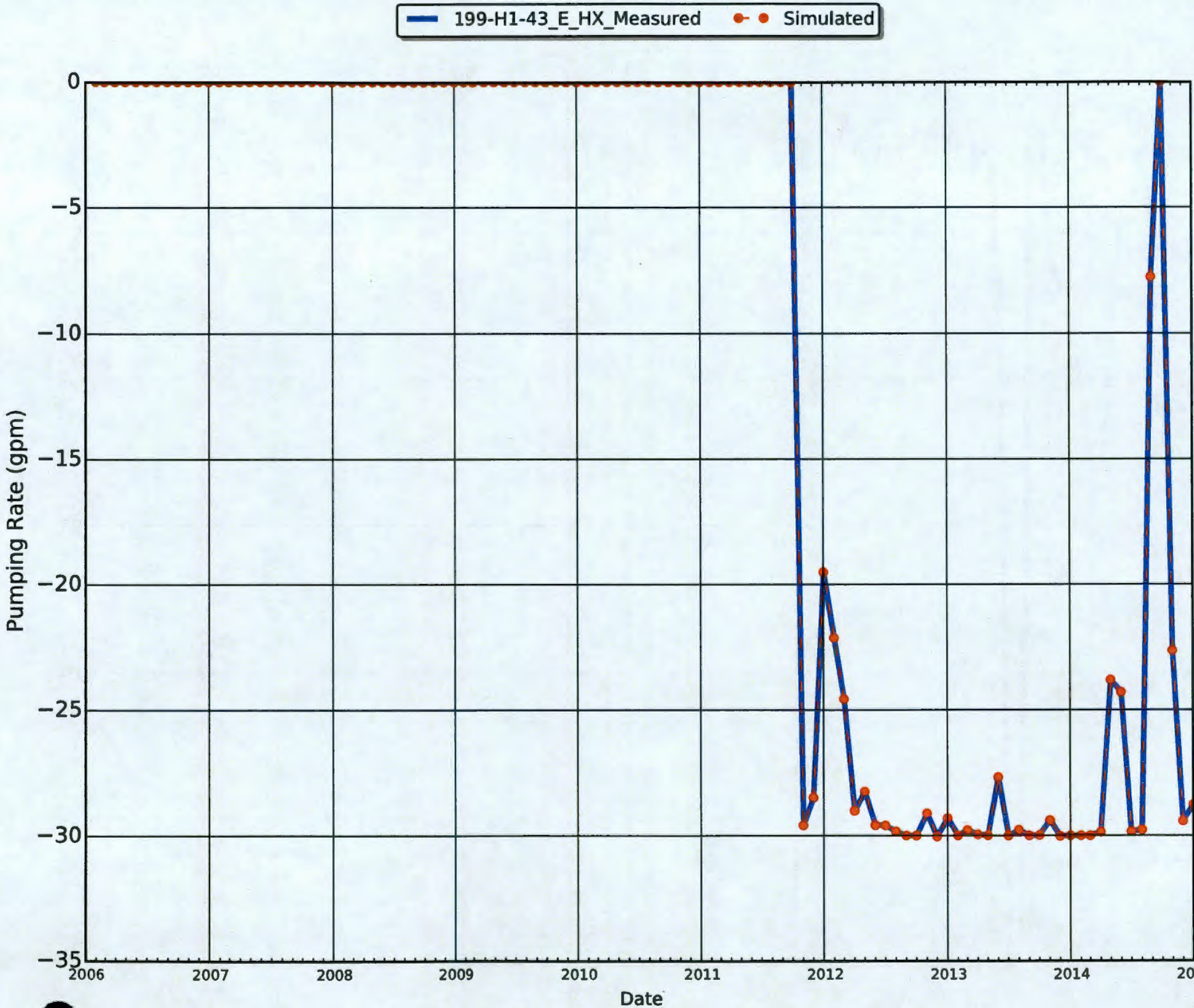

199-H1-38_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-39_E_HX_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

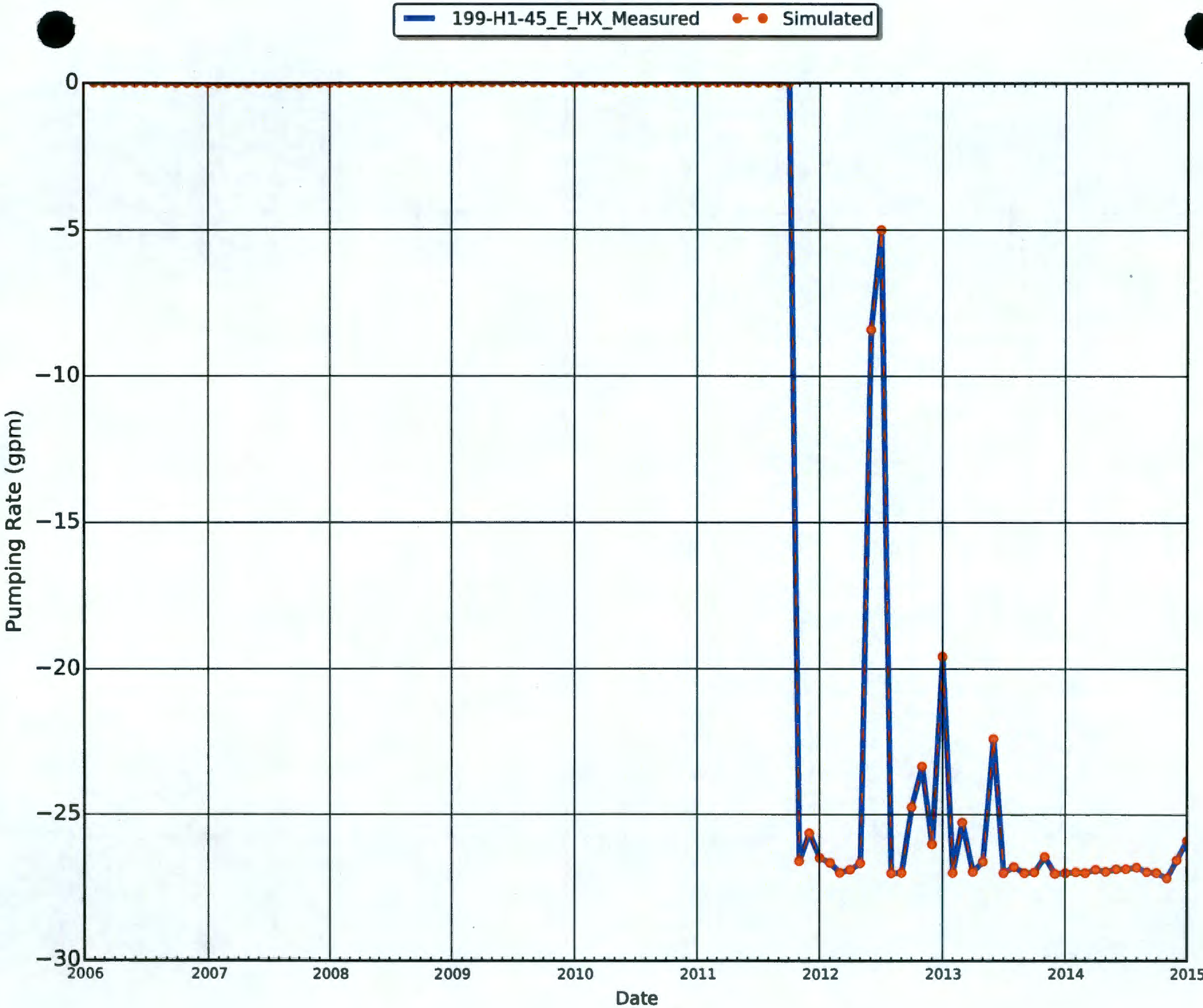

199-H1-3_E_HX_Measured
Simulated
0.05
0.00
−0.05
−0.10
−0.15
−0.20
−0.25
−0.30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-40_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

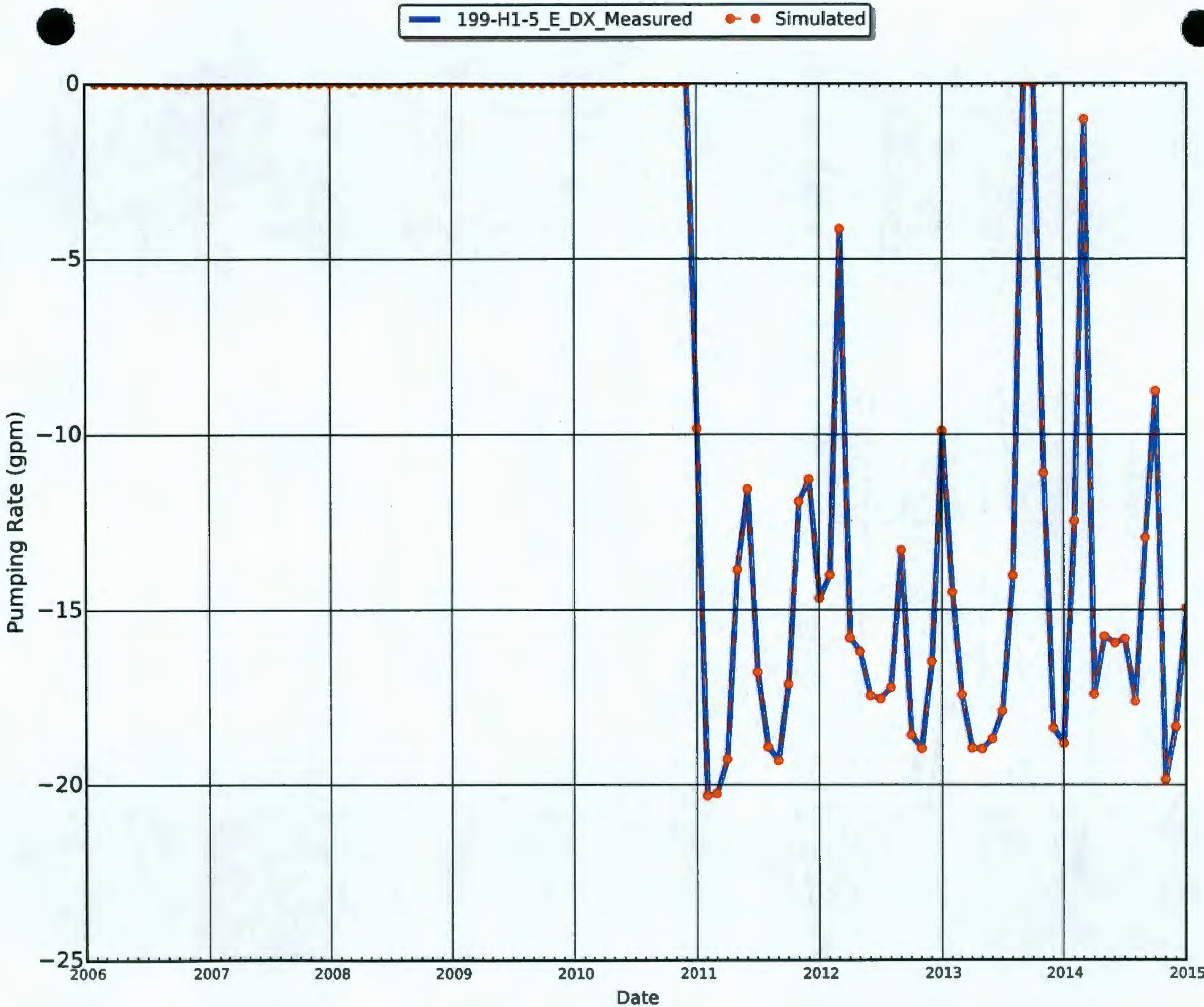

199-H1-42_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date



199-H1-43_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

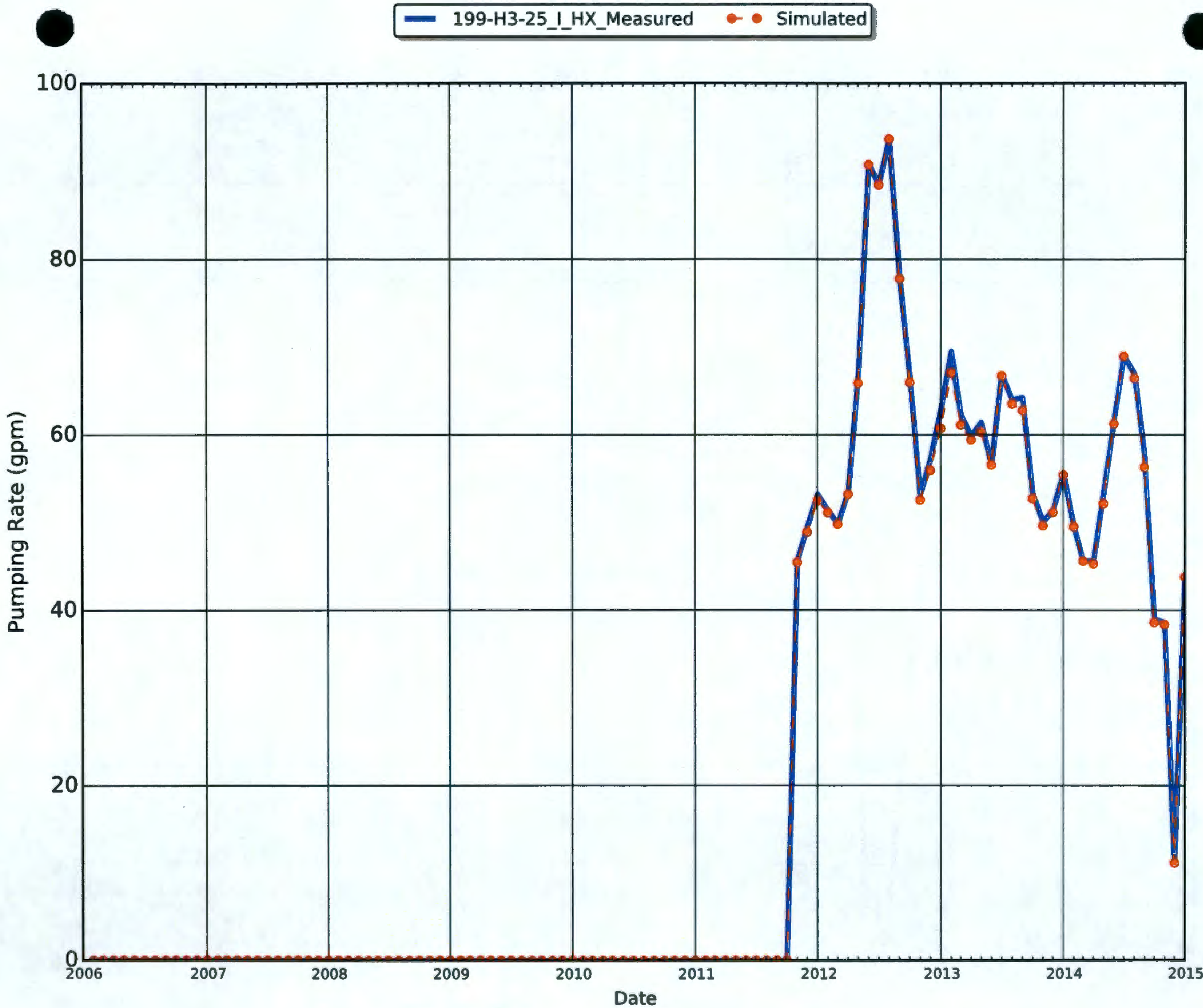

199-H1-45_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

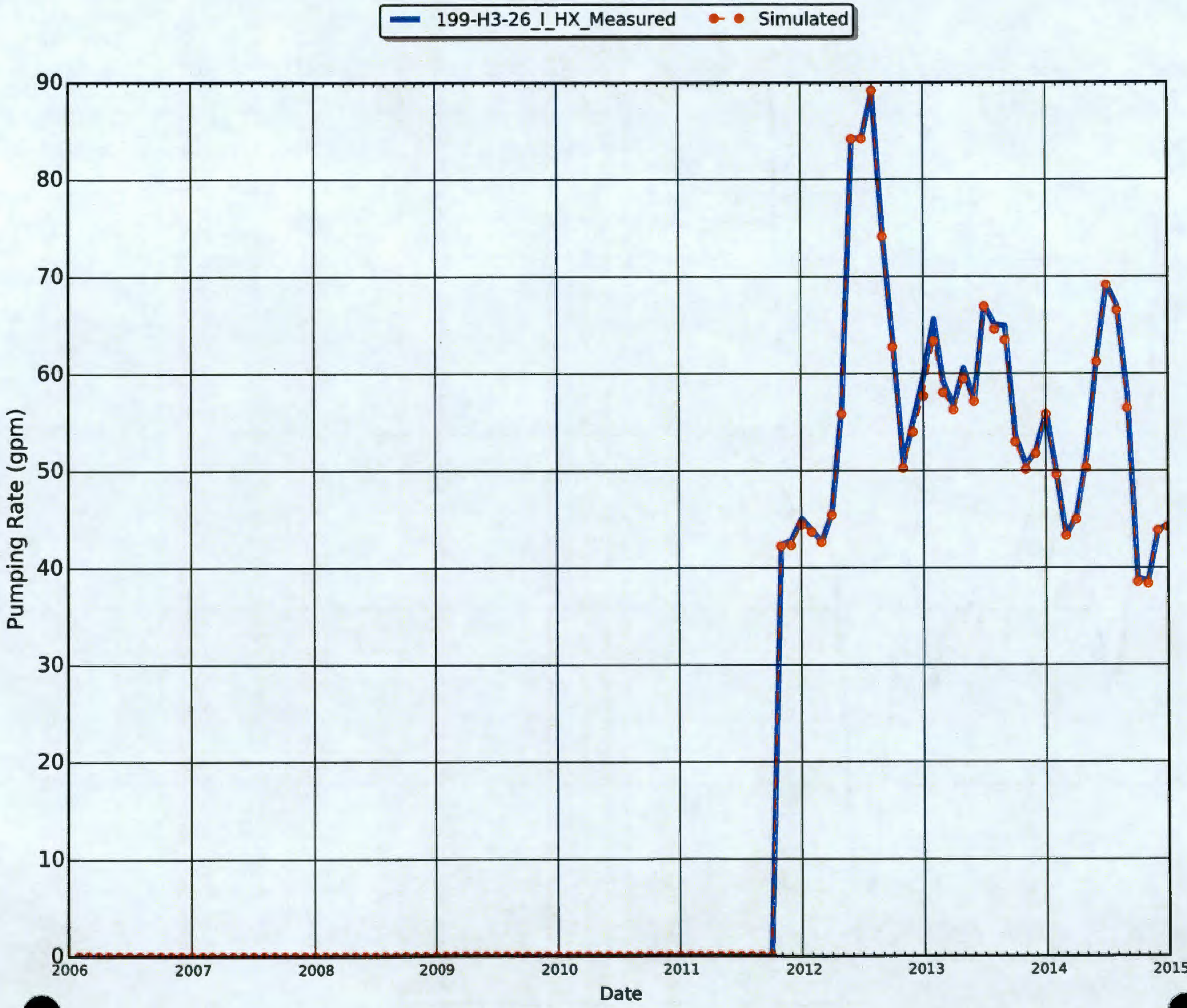
199-H1-4_E_HX_Measured
Simulated
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date



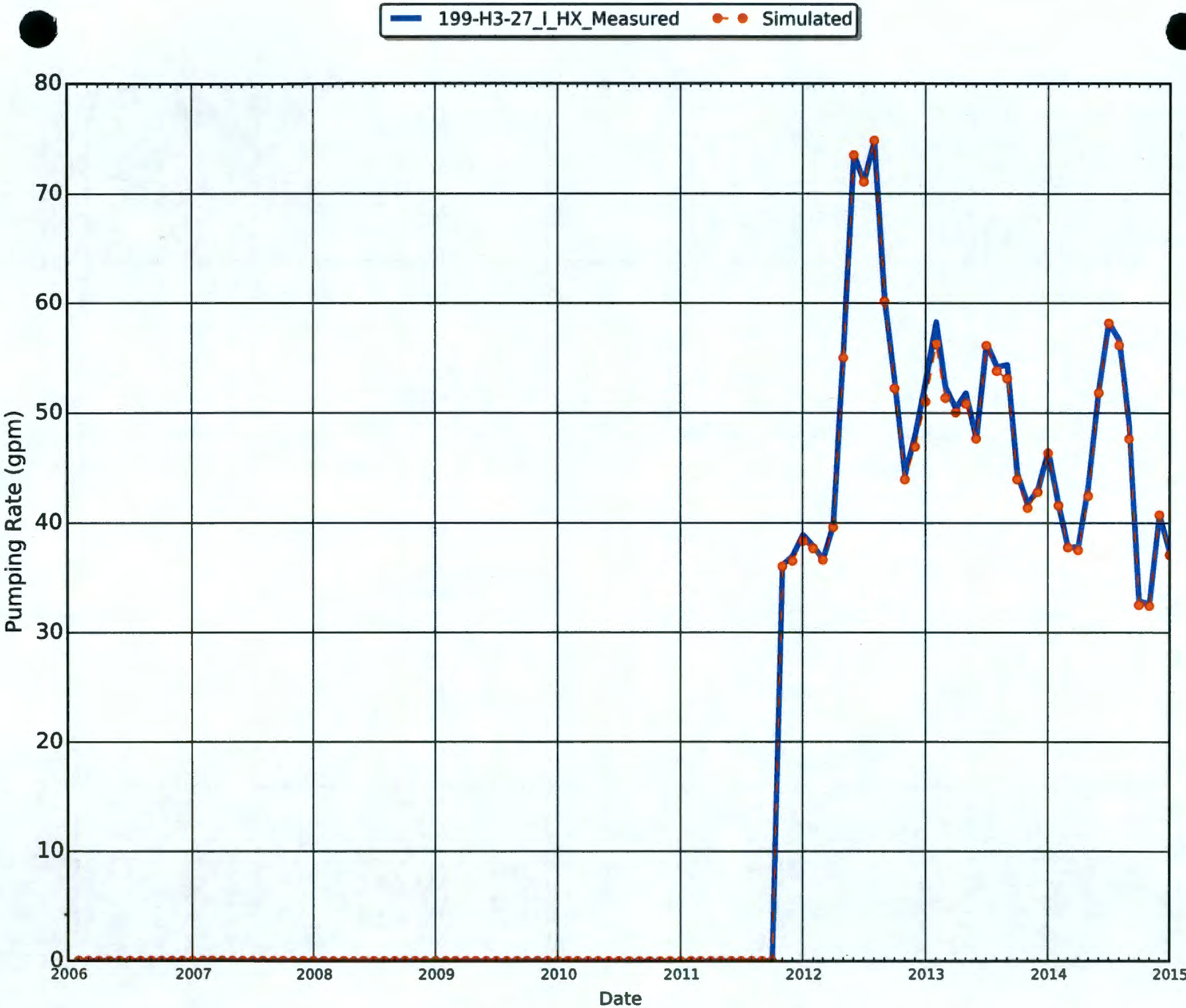
199-H1-5_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H1-6_E_HX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

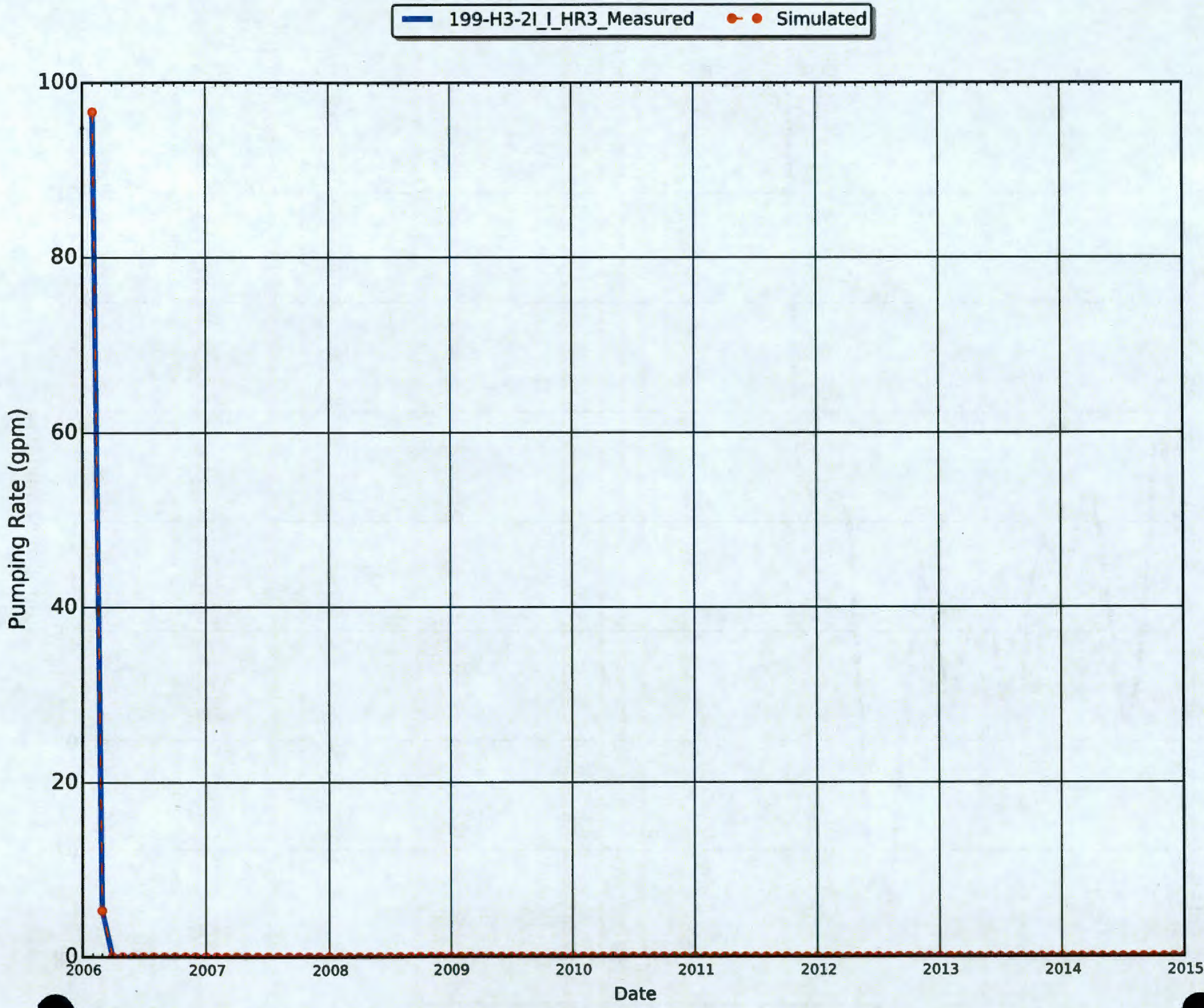

199-H3-25_I_HX_Measured
Simulated
100
80
60
40
20
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

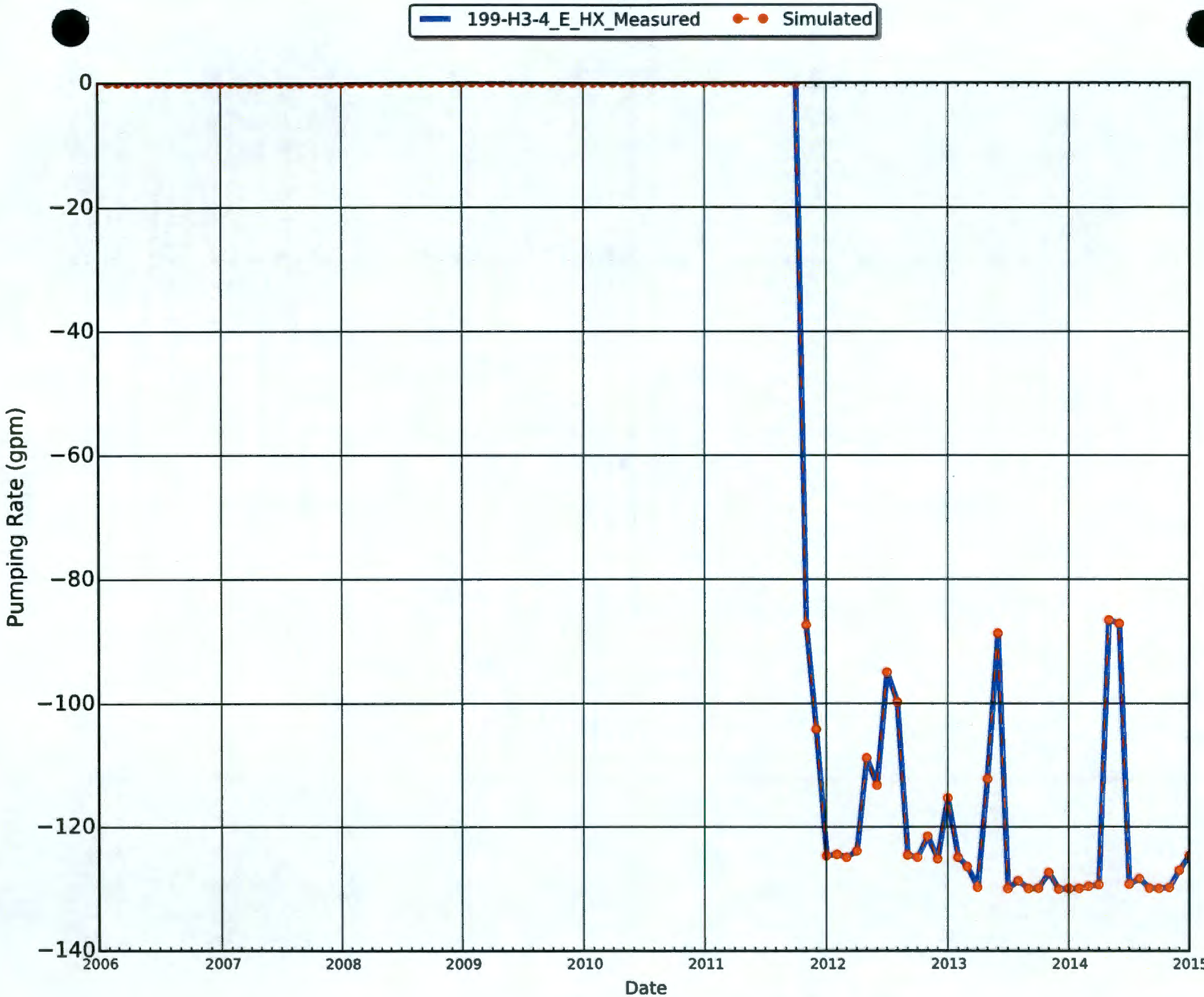


199-H3-26_I_HX_Measured
Simulated
90
80
70
60
50
40
30
20
10
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

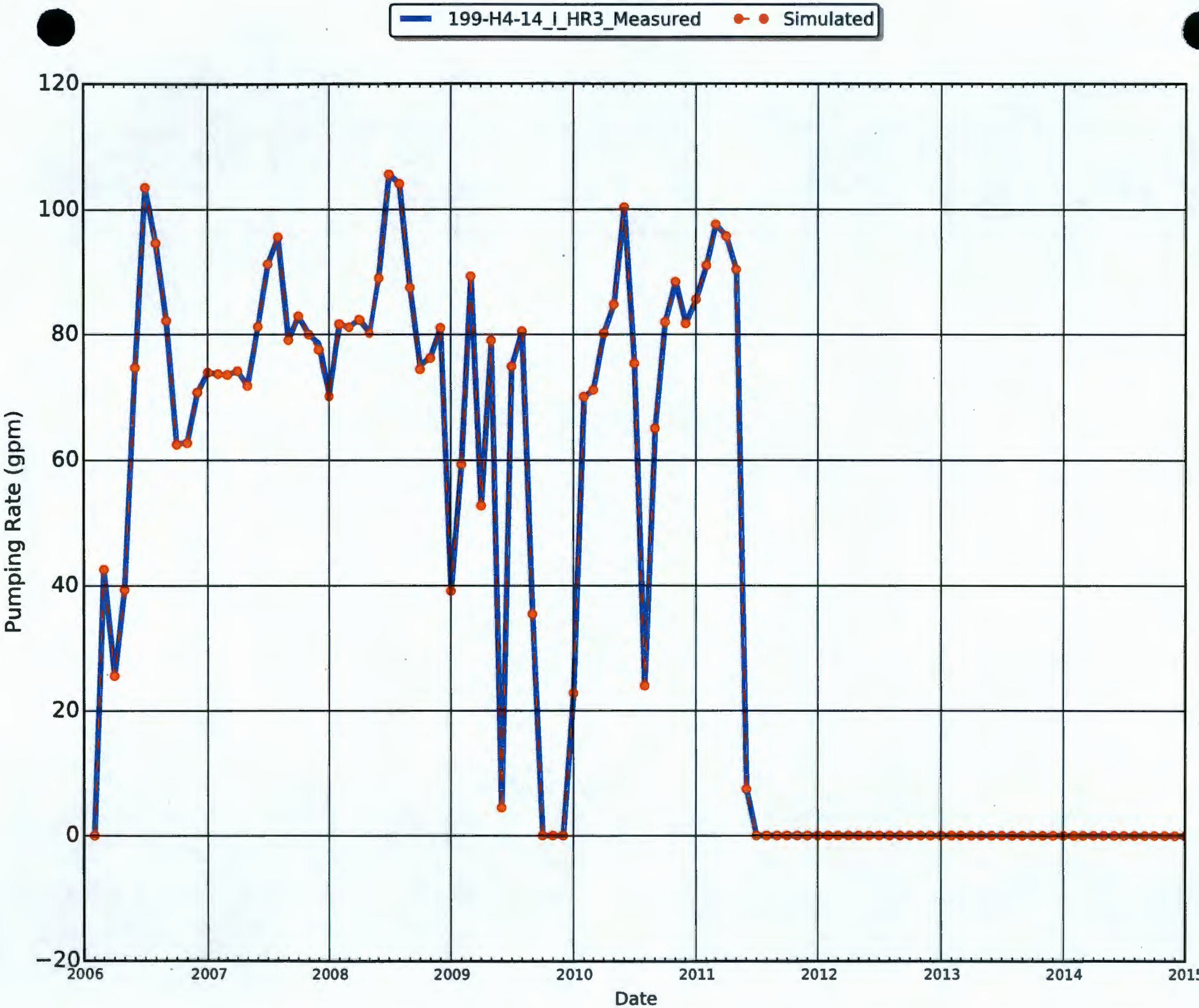


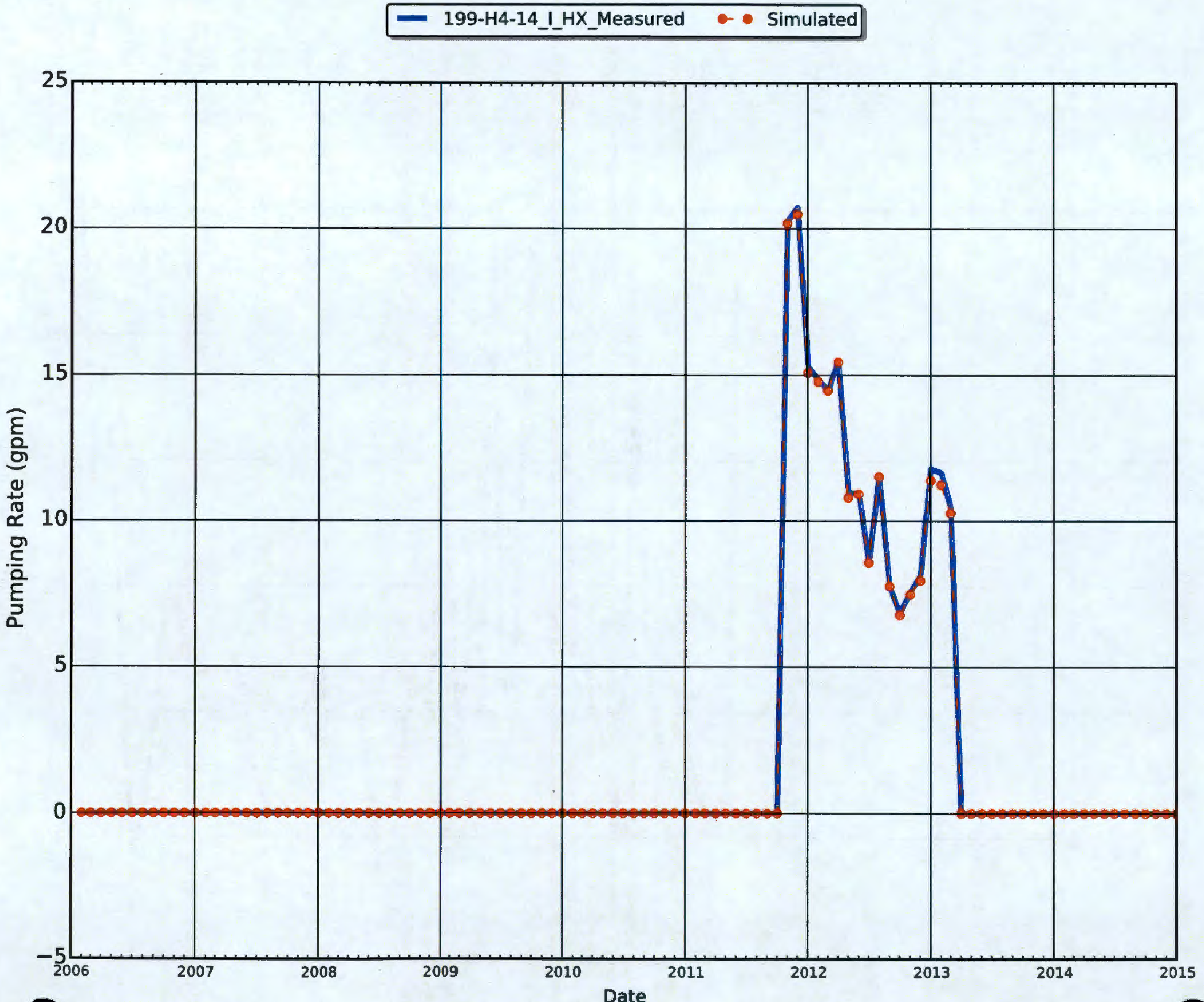
199-H3-27_I_HX_Measured
Simulated
80
70
60
50
40
30
20
10
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H3-2I_I_HR3_Measured
Simulated
100
80
60
40
20
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H3-4_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−20
−40
−60
−80
−100
−120
−140
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

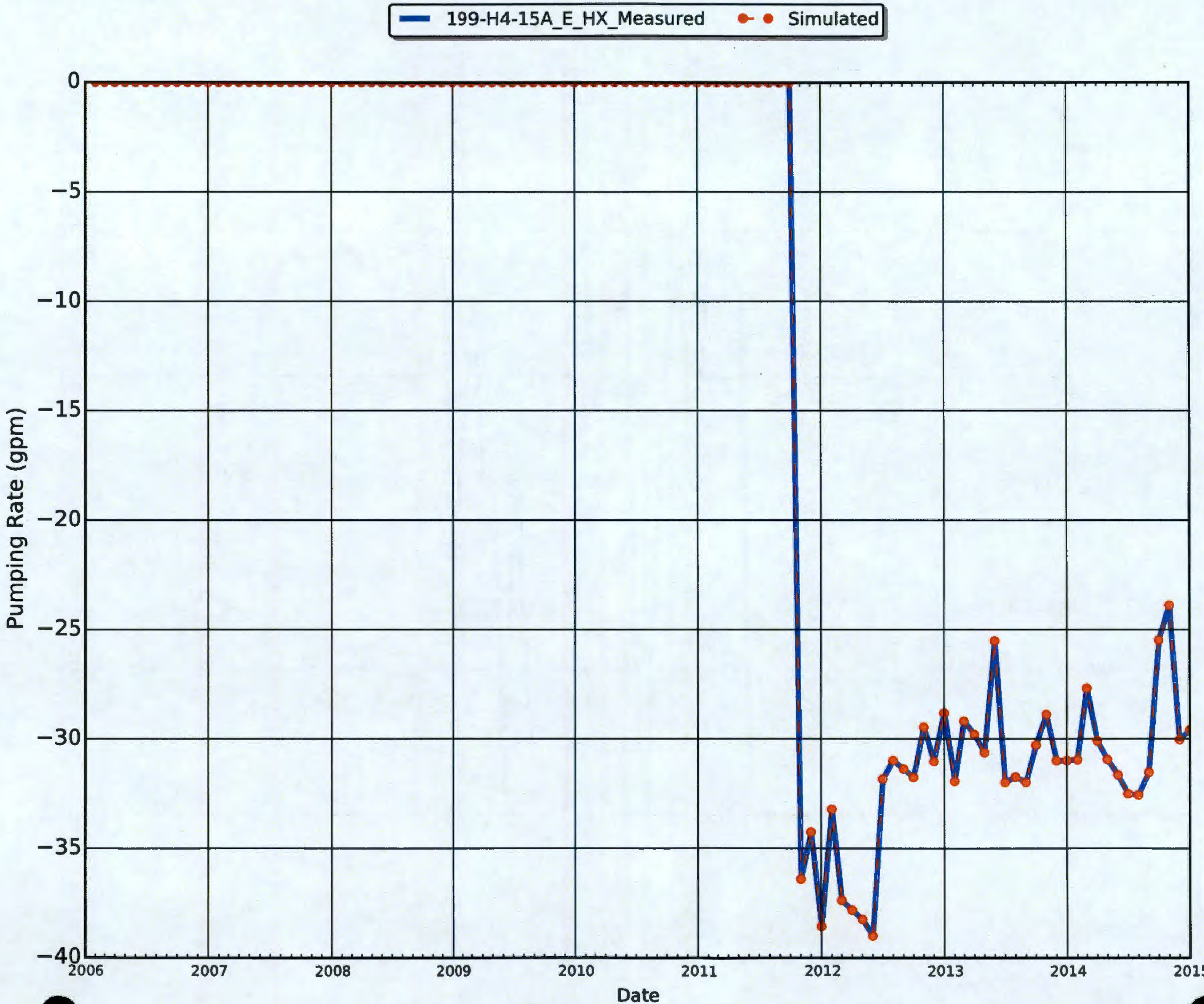
199-H4-12A_E_HR3_Measured
Simulated
Pumping Rate (gpm)
5
0
−5
−10
−15
−20
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-14_I_HR3_Measured
Simulated
120
100
80
60
40
20
0
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

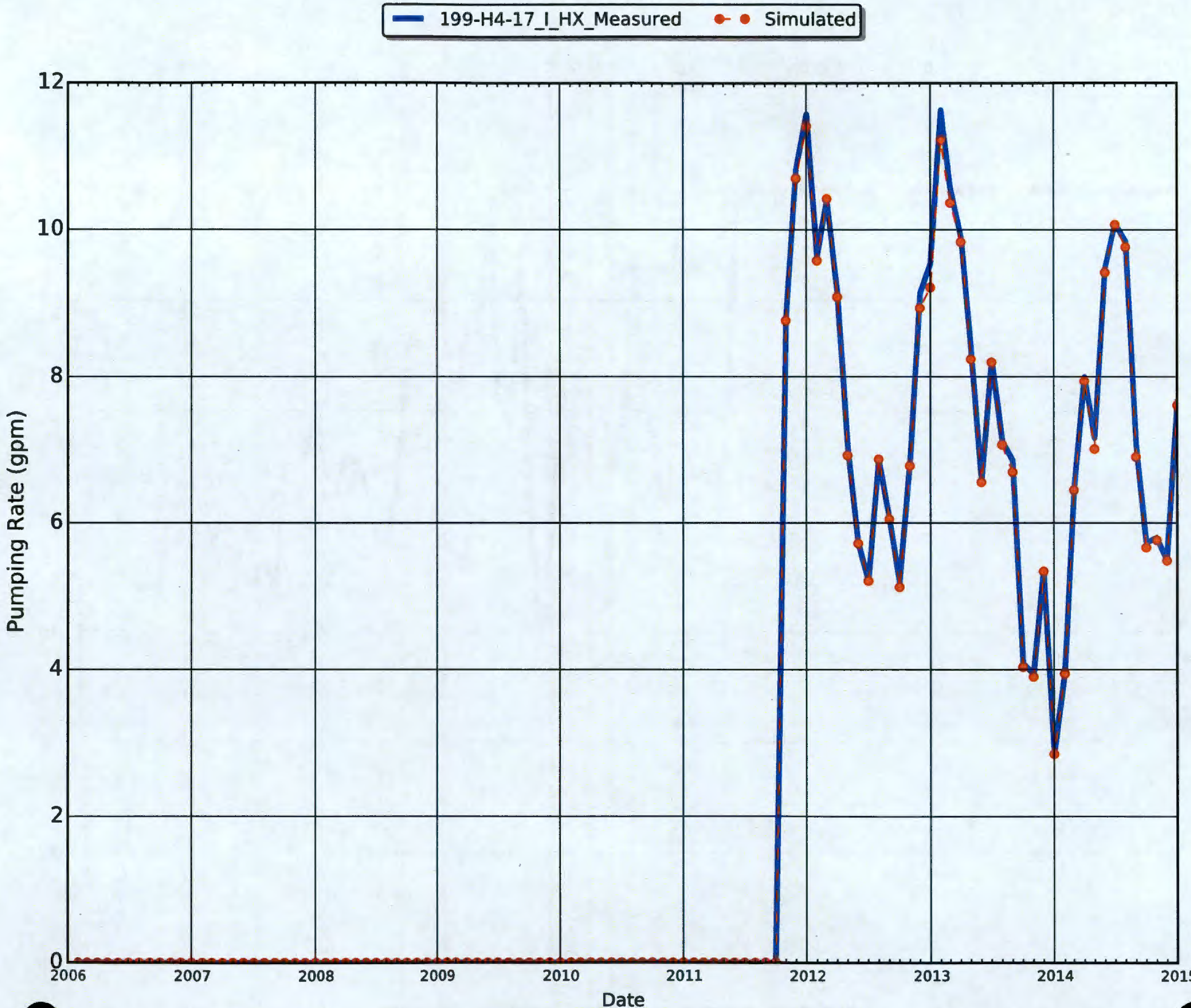


199-H4-14_I_HX_Measured
Simulated
Pumping Rate (gpm)
25
20
15
10
5
0
−5
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

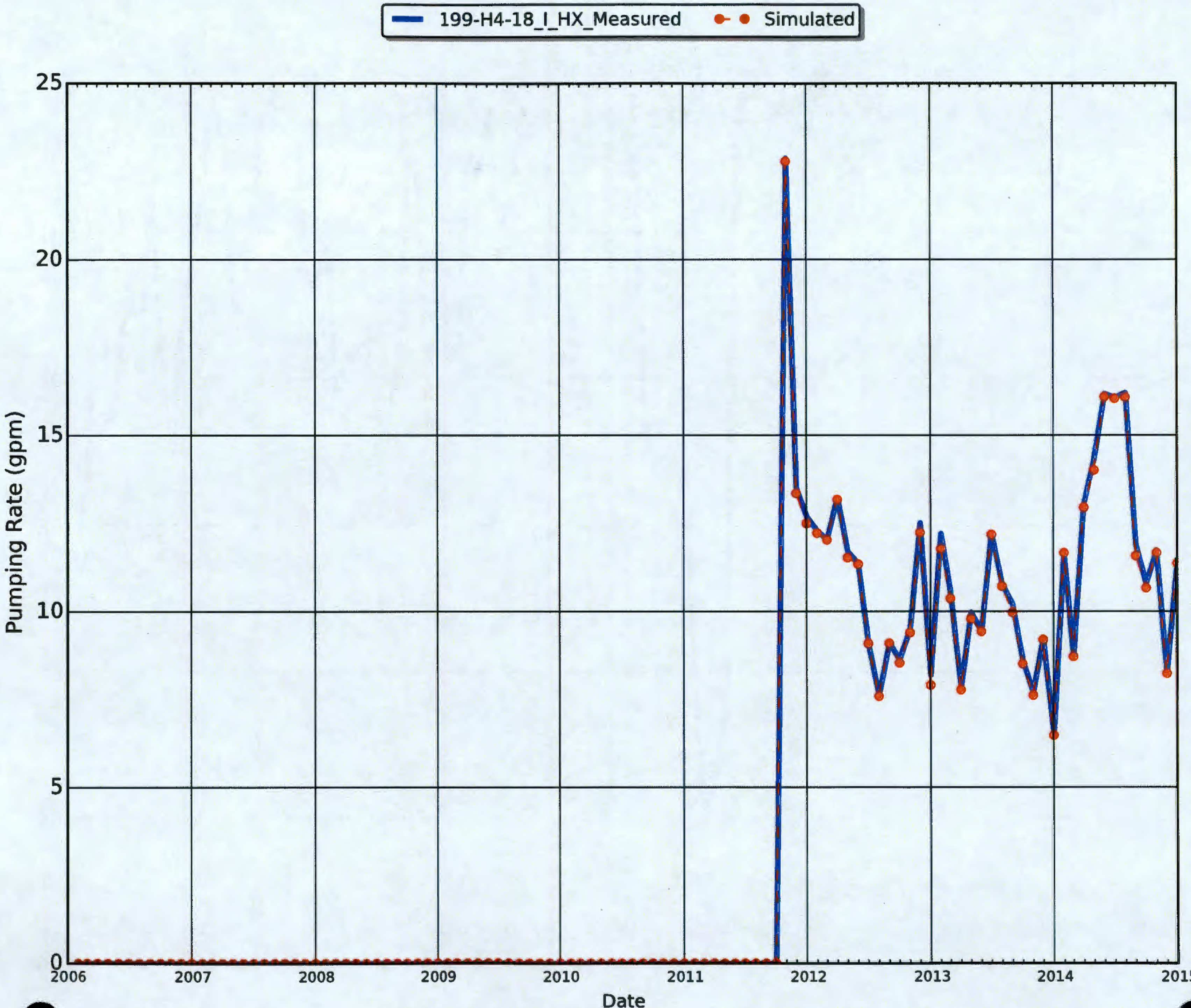

199-H4-15A_E_HR3_Measured
Simulated
5
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-15A_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
−40
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-17_I_HR3_Measured
Simulated
Pumping Rate (gpm)
140
120
100
80
60
40
20
0
−20
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-17_I_HX_Measured
Simulated
Pumping Rate (gpm)
Date
0
2
4
6
8
10
12
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

199-H4-18_I_HR3_Measured
Simulated
Pumping Rate (gpm)
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

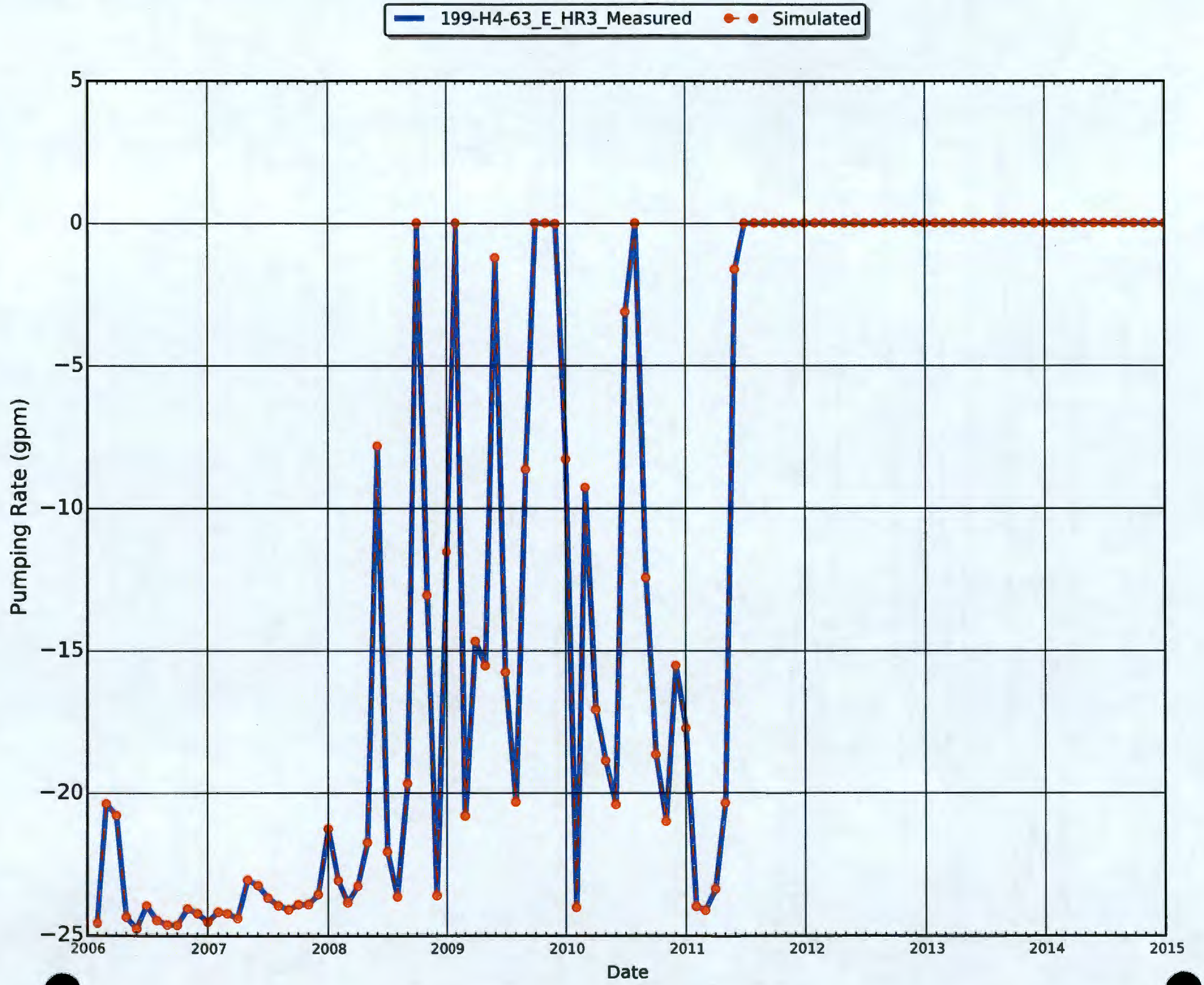


199-H4-18_I_HX_Measured
Simulated
25
20
15
10
5
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-3_E_HR3_Measured
Simulated
Pumping Rate (gpm)
2
0
−2
−4
−6
−8
−10
−12
−14
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-4_E_HR3_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-4_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
−12
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

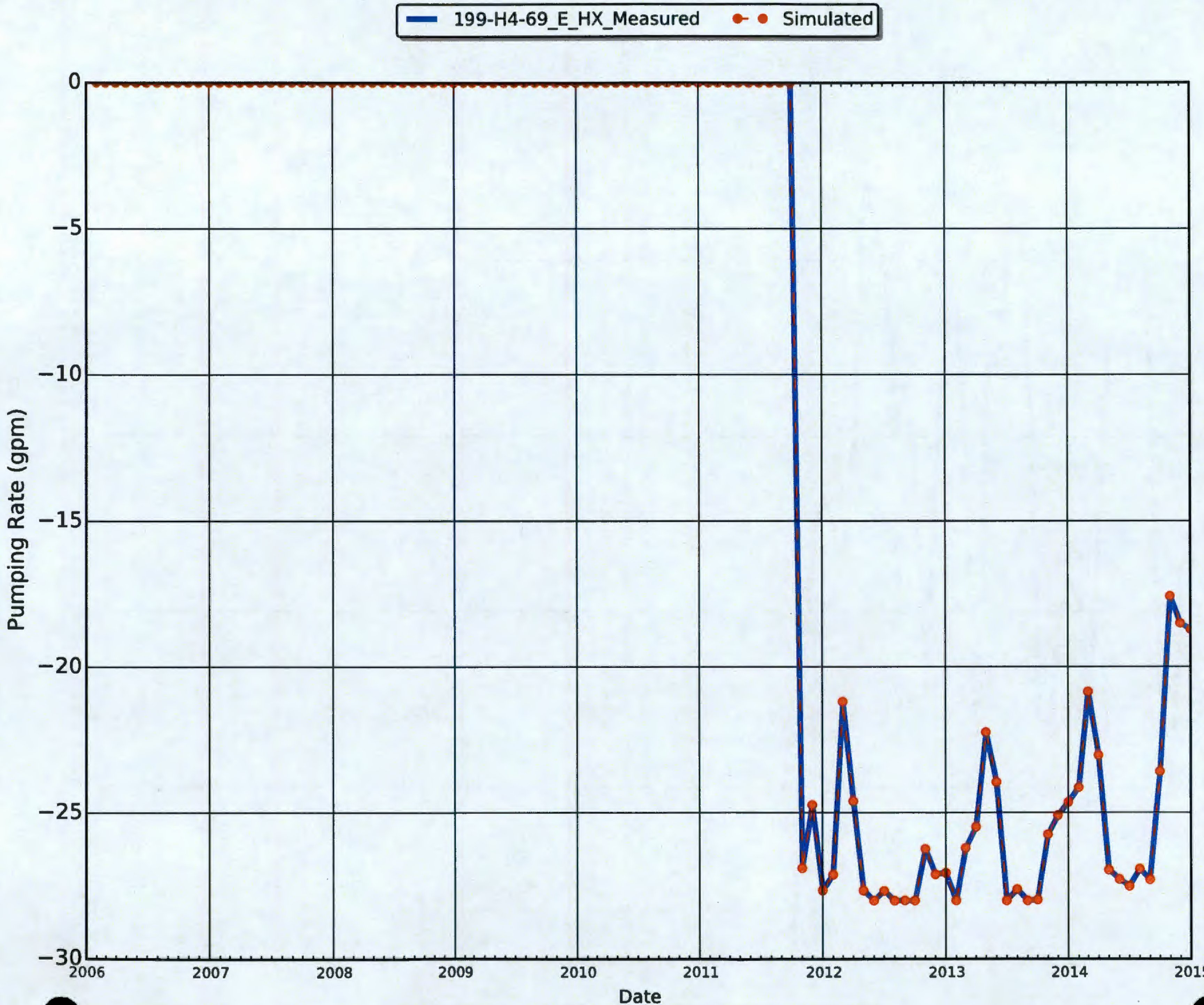


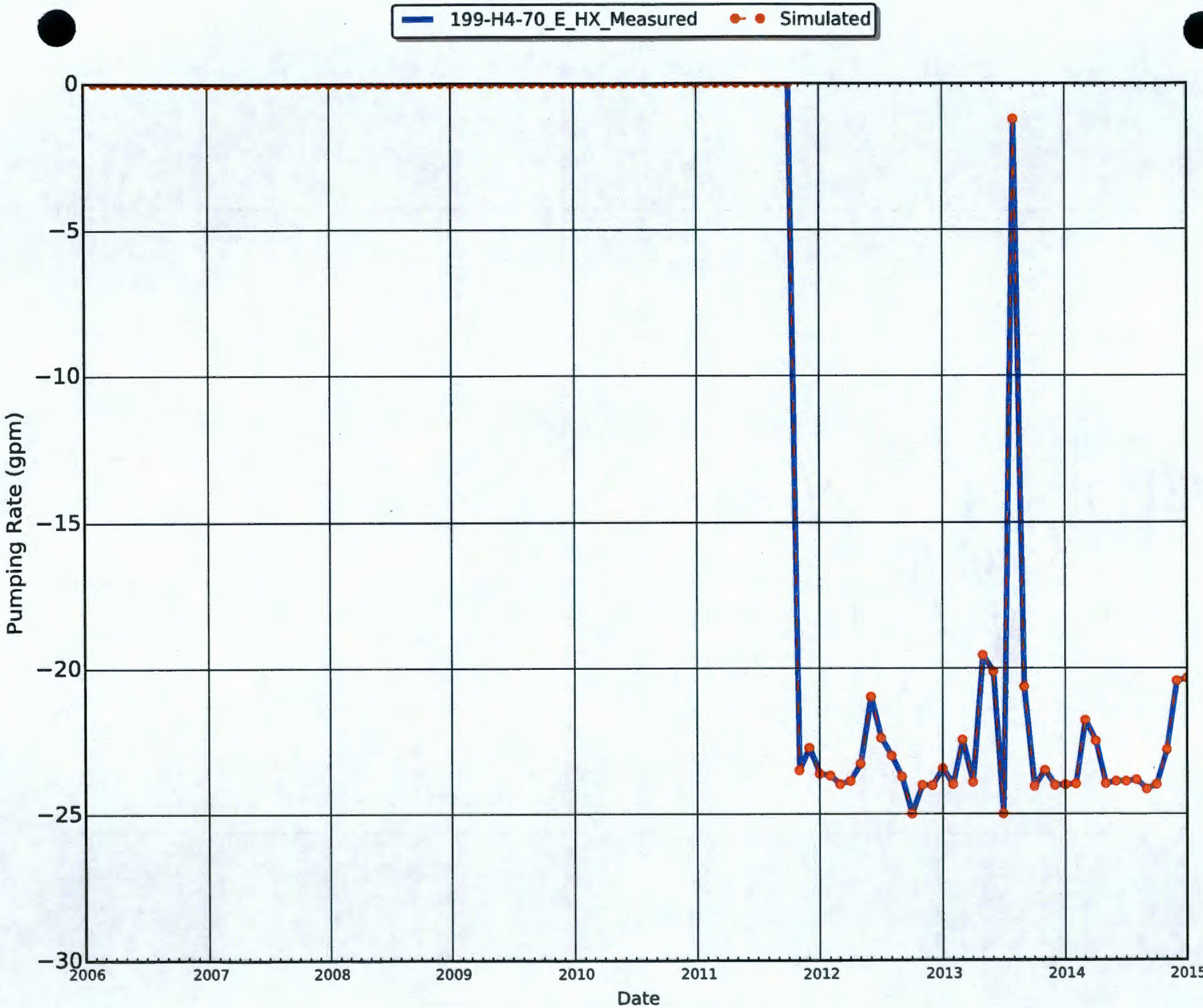
199-H4-63_E_HR3_Measured
Simulated
5
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-63_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-64_E_HR3_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-H4-64_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-69_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

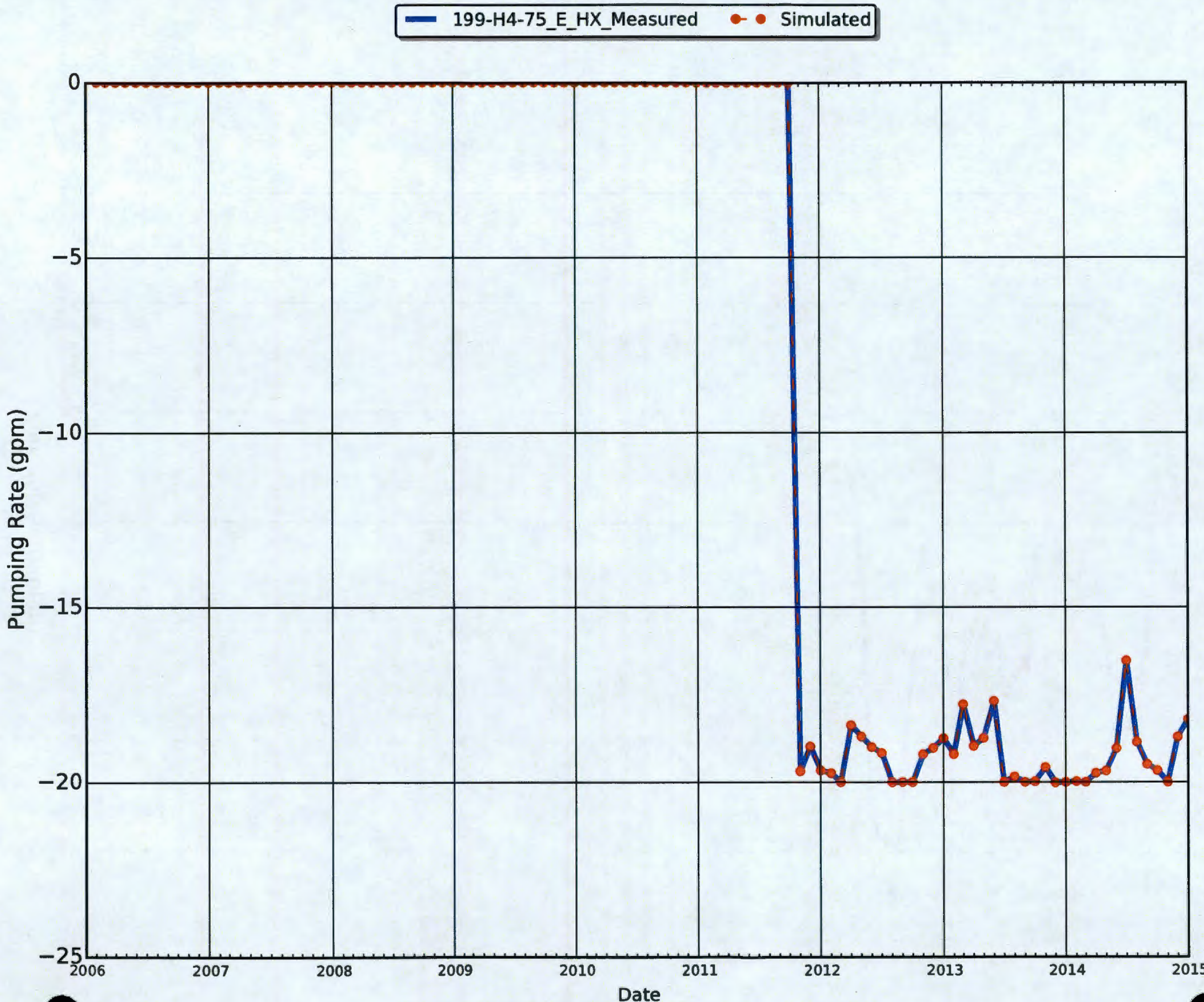

199-H4-70_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-71_I_HX_Measured
Simulated
70
60
50
40
30
20
10
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-72_I_HX_Measured
Simulated
Pumping Rate (gpm)
0
10
20
30
40
50
60
70
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-H4-73_I_HX_Measured
Simulated
Pumping Rate (gpm)
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-H4-74_I_HX_Measured
Simulated
Pumping Rate (gpm)
0
10
20
30
40
50
60
70
80
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

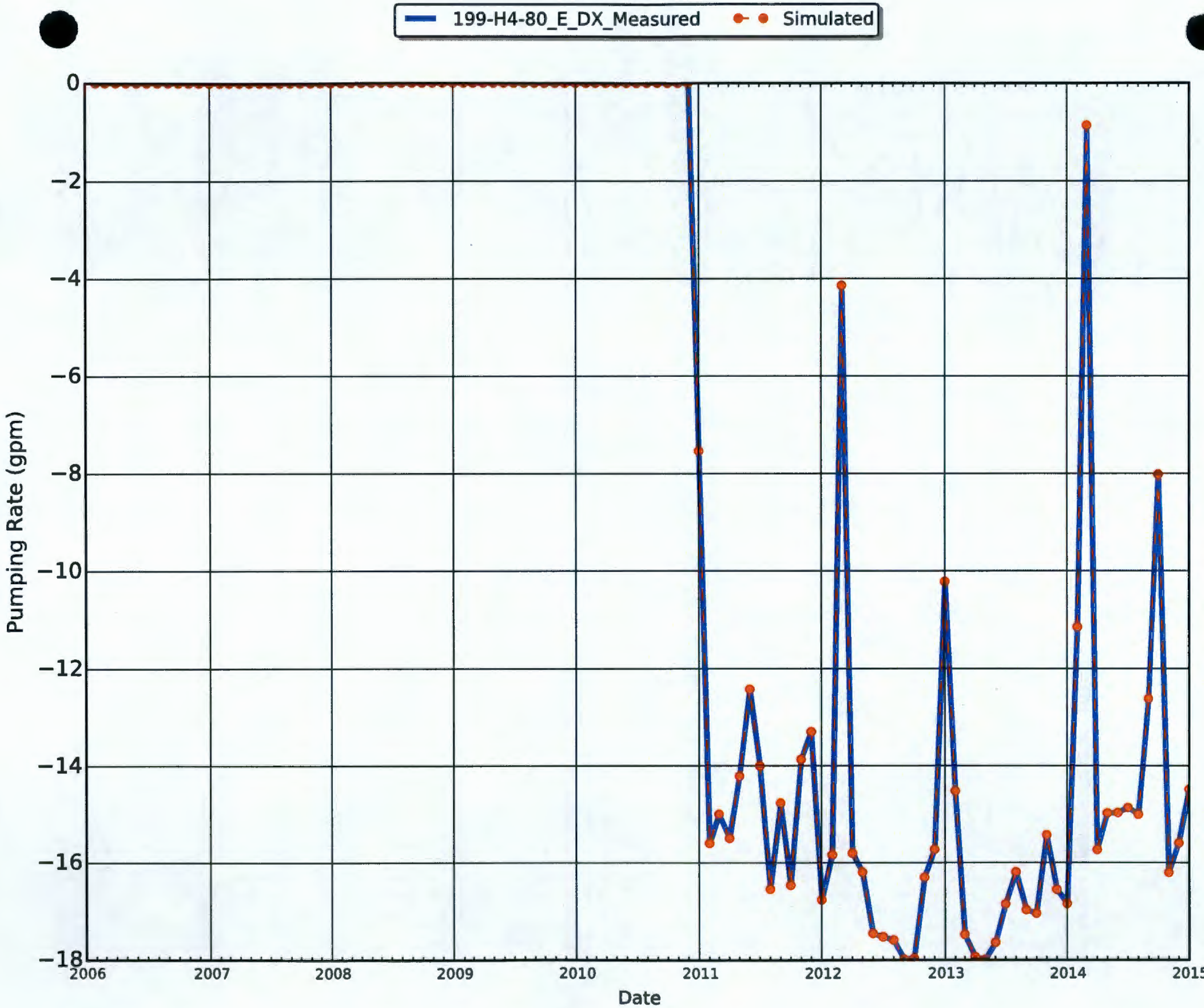

199-H4-75_E_HX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-76_E_HX_Measured
Simulated
5
0
−5
−10
−15
−20
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

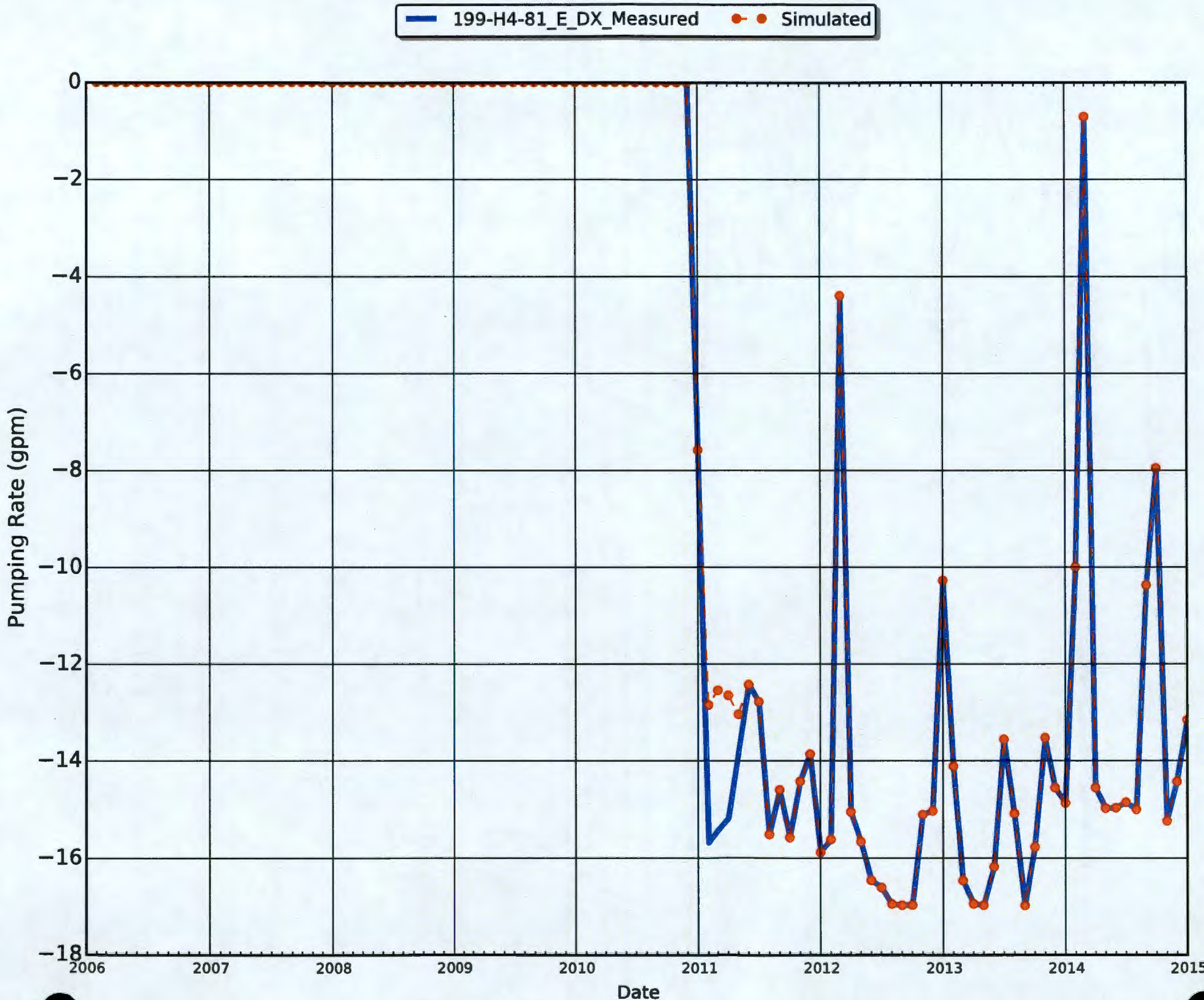
199-H4-77_E_HX_Measured
Simulated
Pumping Rate (gpm)
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-H4-78_I_HX_Measured
Simulated
Pumping Rate (gpm)
140
120
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

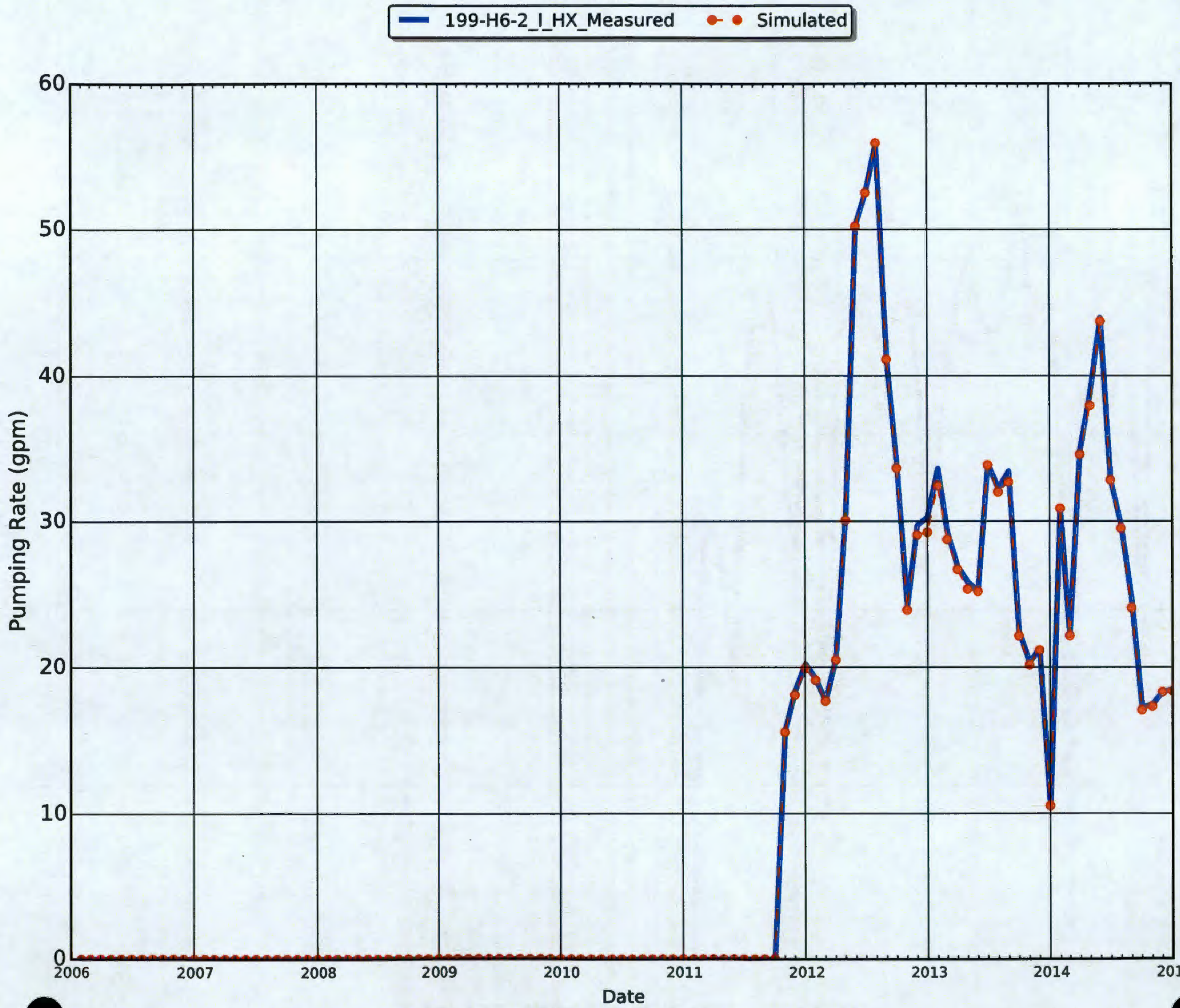
199-H4-79_I_HX_Measured
Simulated
Pumping Rate (gpm)
100
80
60
40
20
0
−20
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

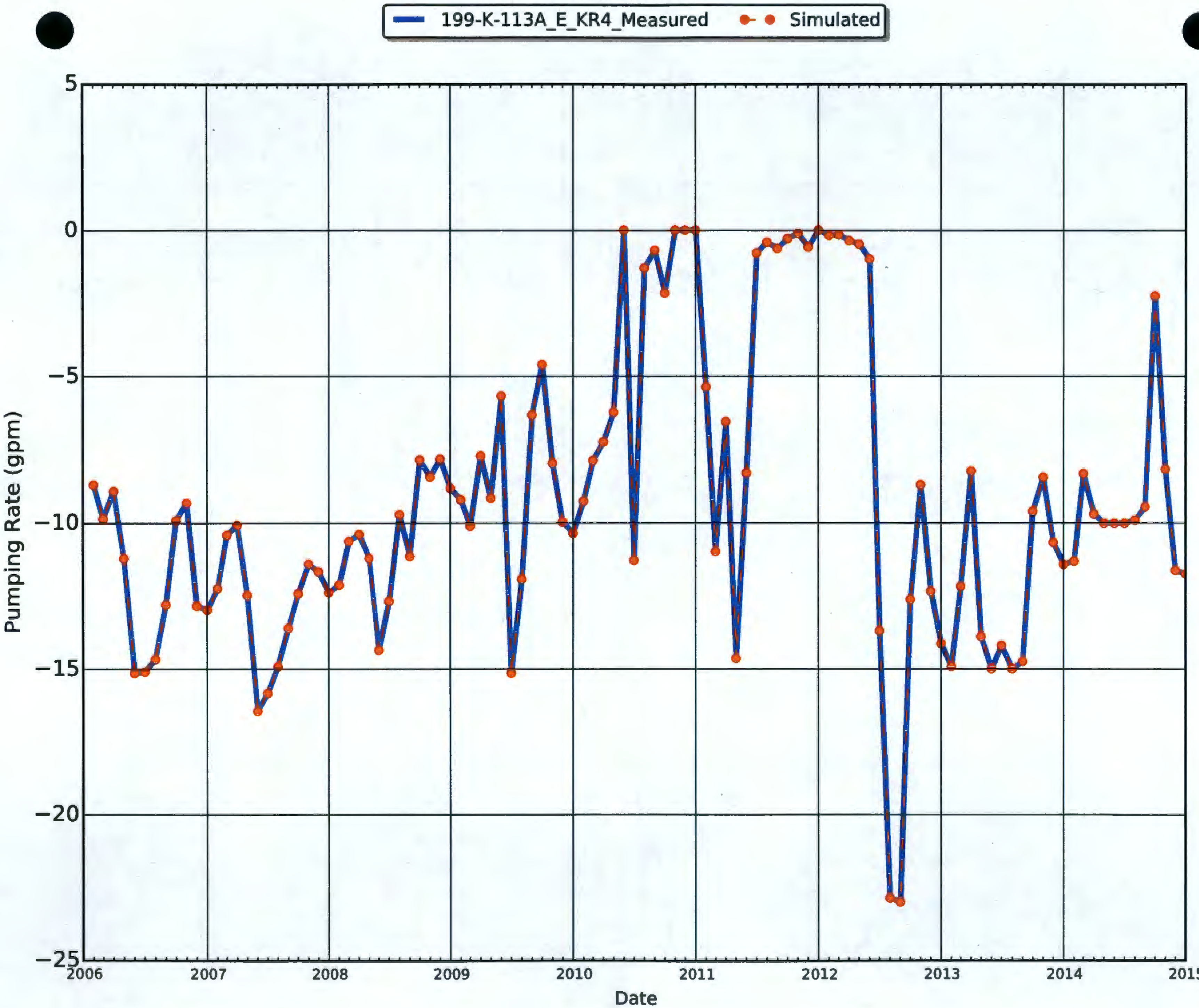


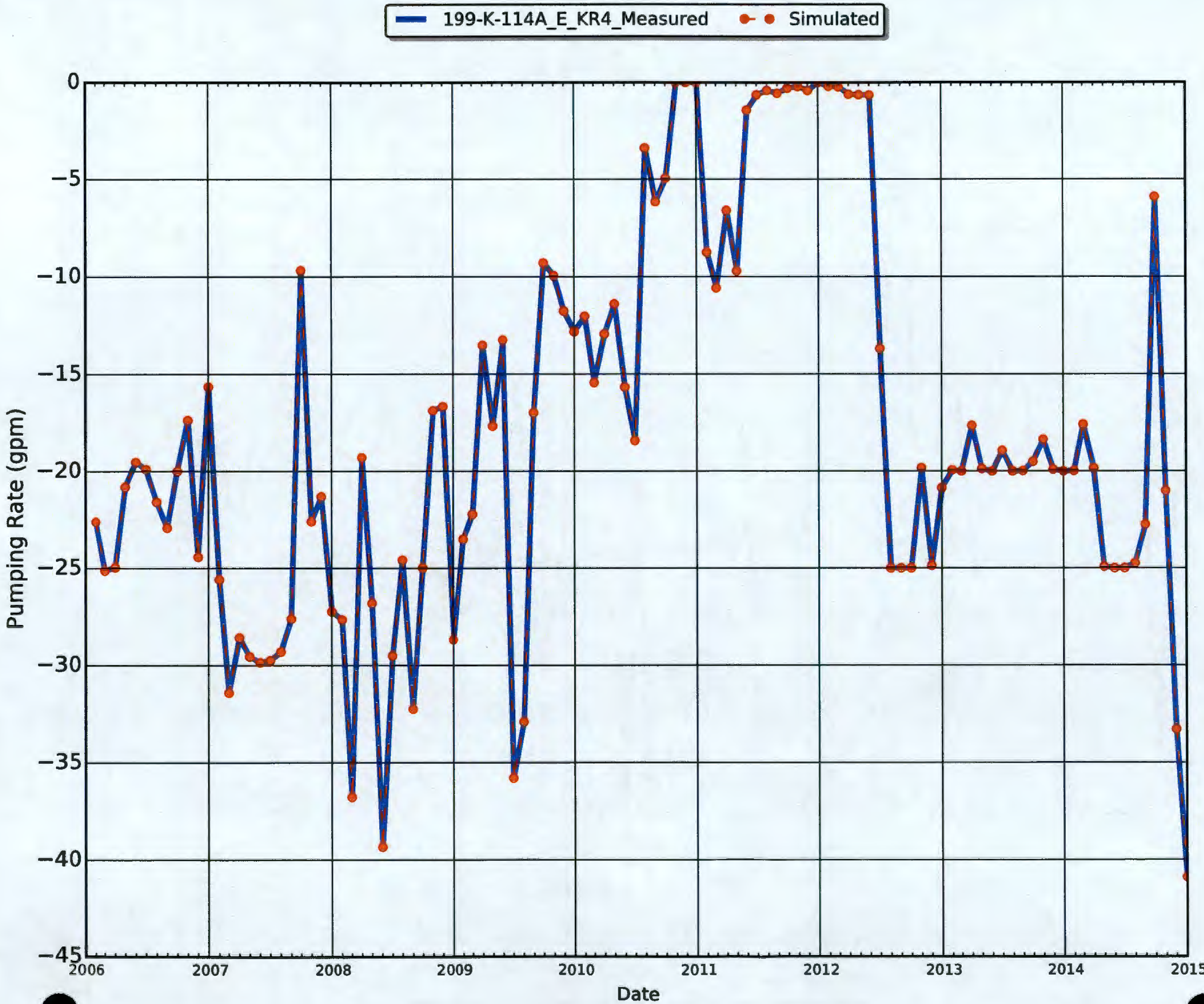
199-H4-80_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-H4-81_E_DX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

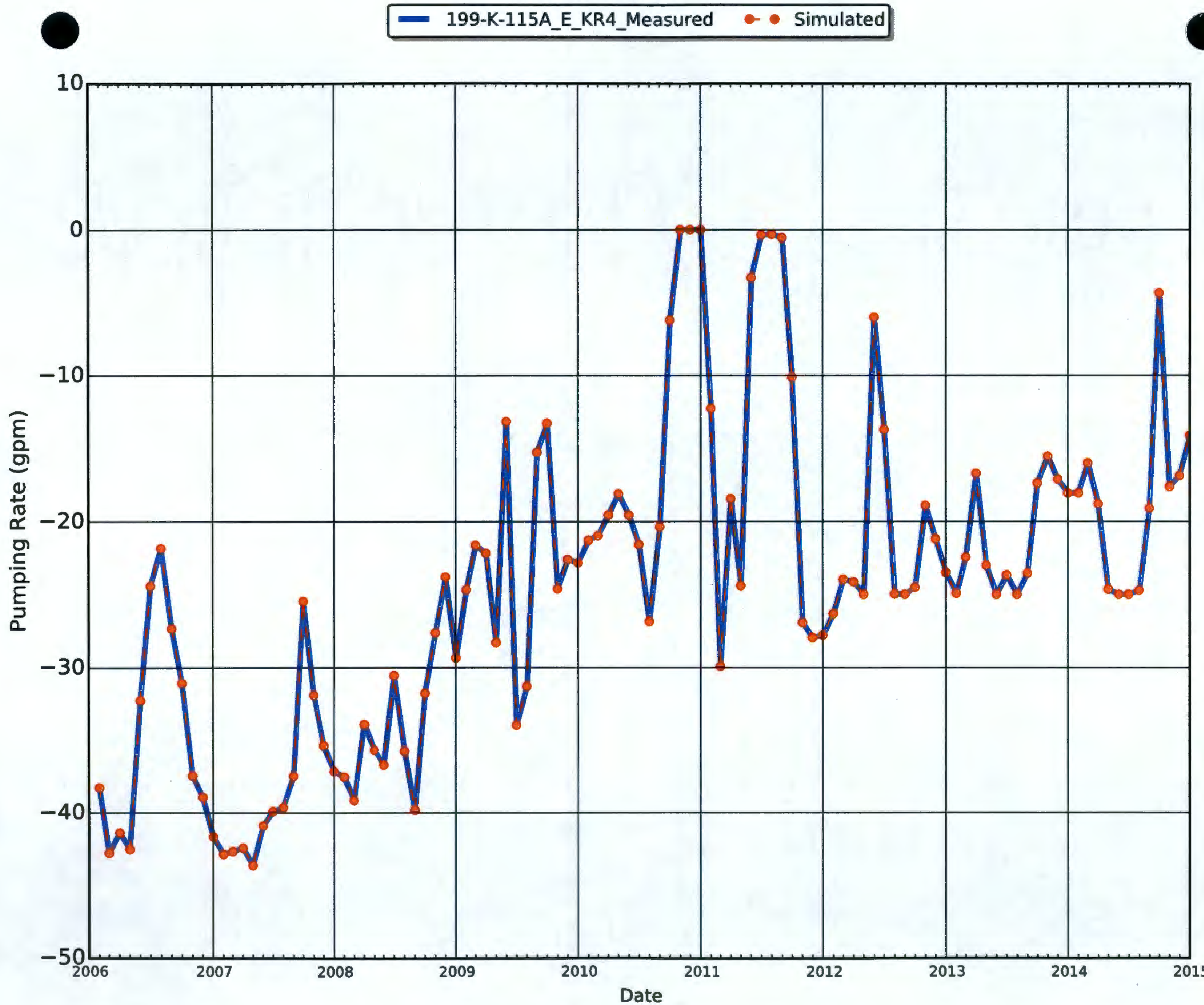
199-H4-82_E_DX_Measured
Simulated
0
−5
−10
−15
−20
−25
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

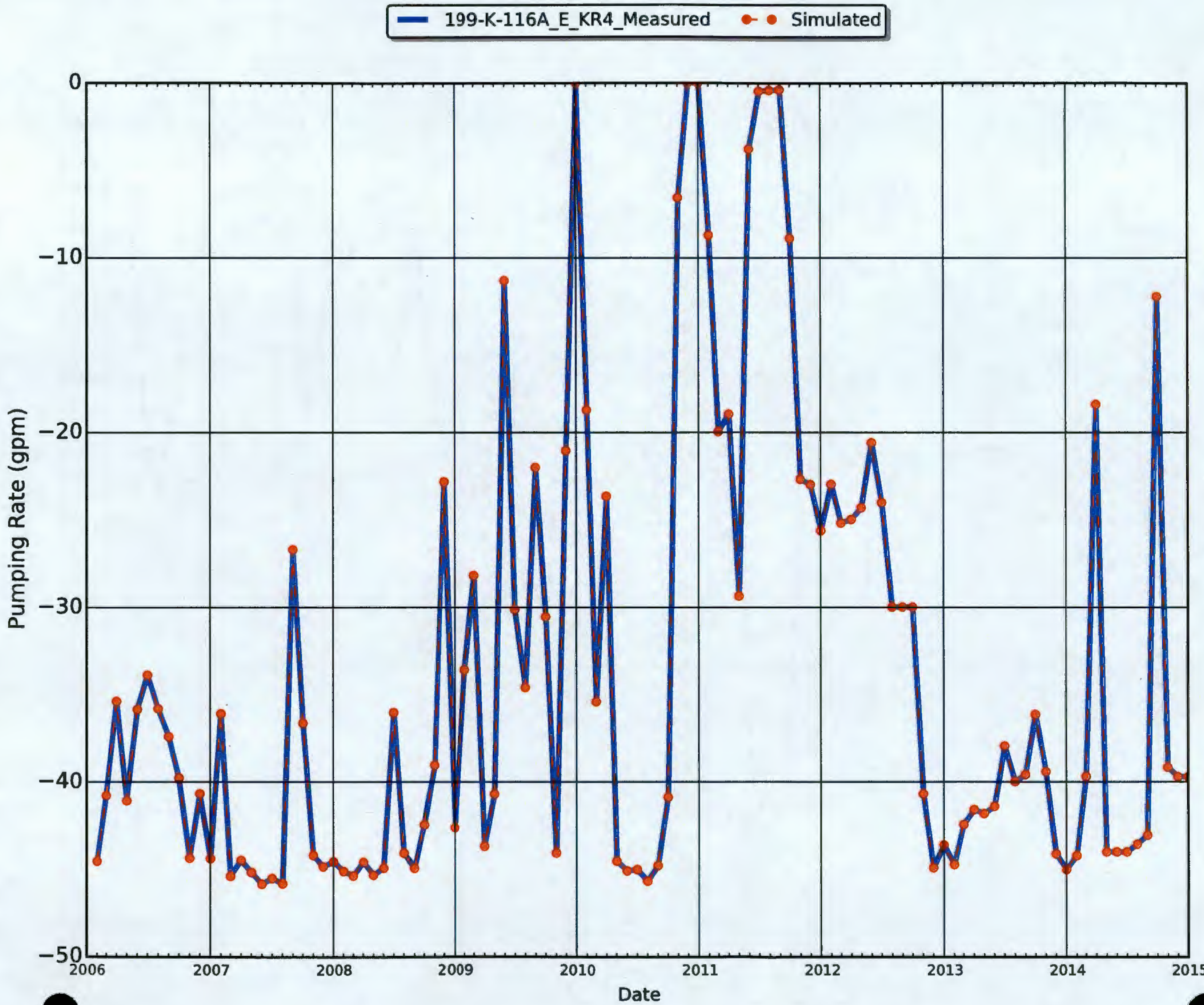

199-H6-2_I_HX_Measured
Simulated
60
50
40
30
20
10
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-113A_E_KR4_Measured
Simulated
Pumping Rate (gpm)
5
0
−5
−10
−15
−20
−25
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

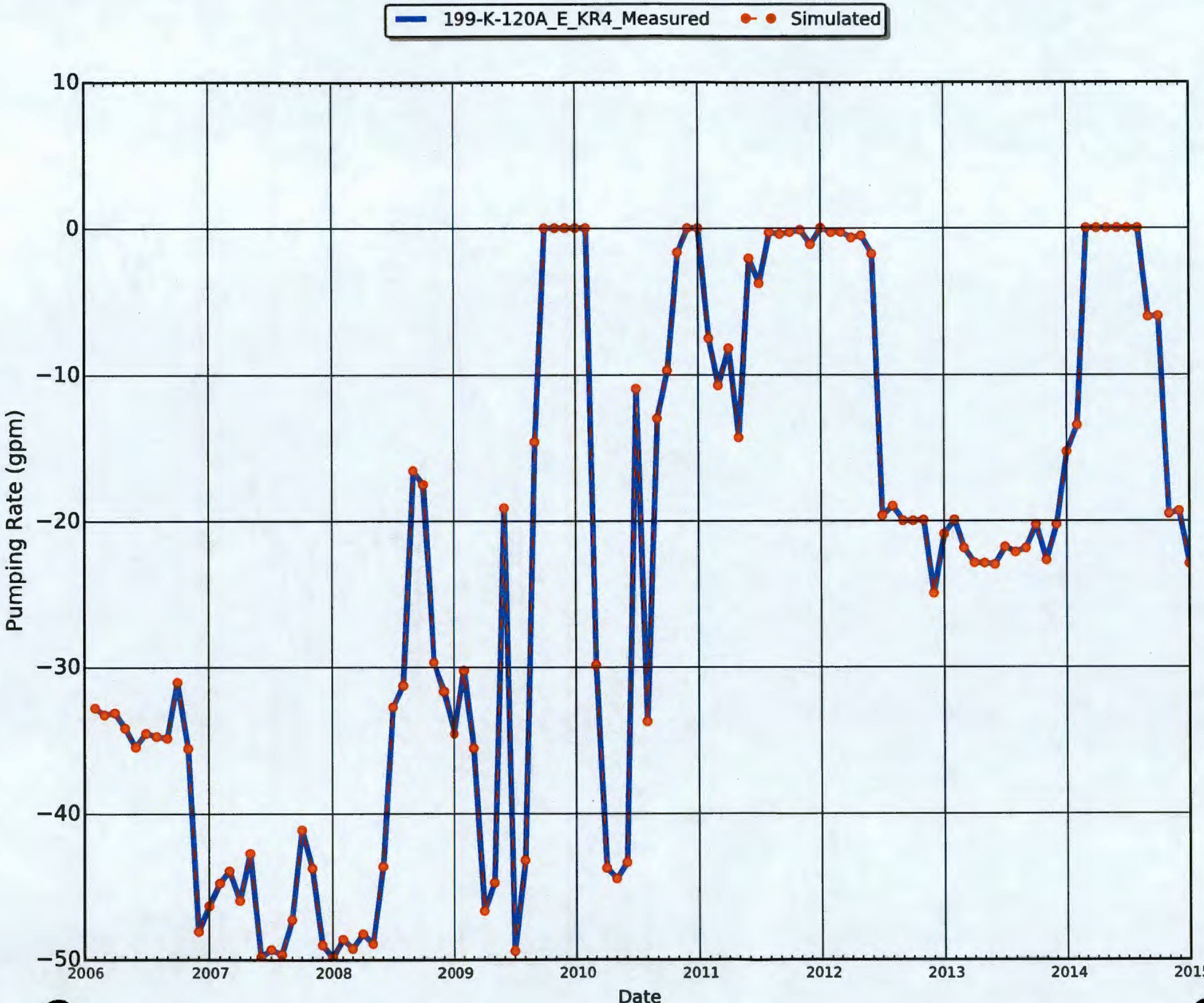


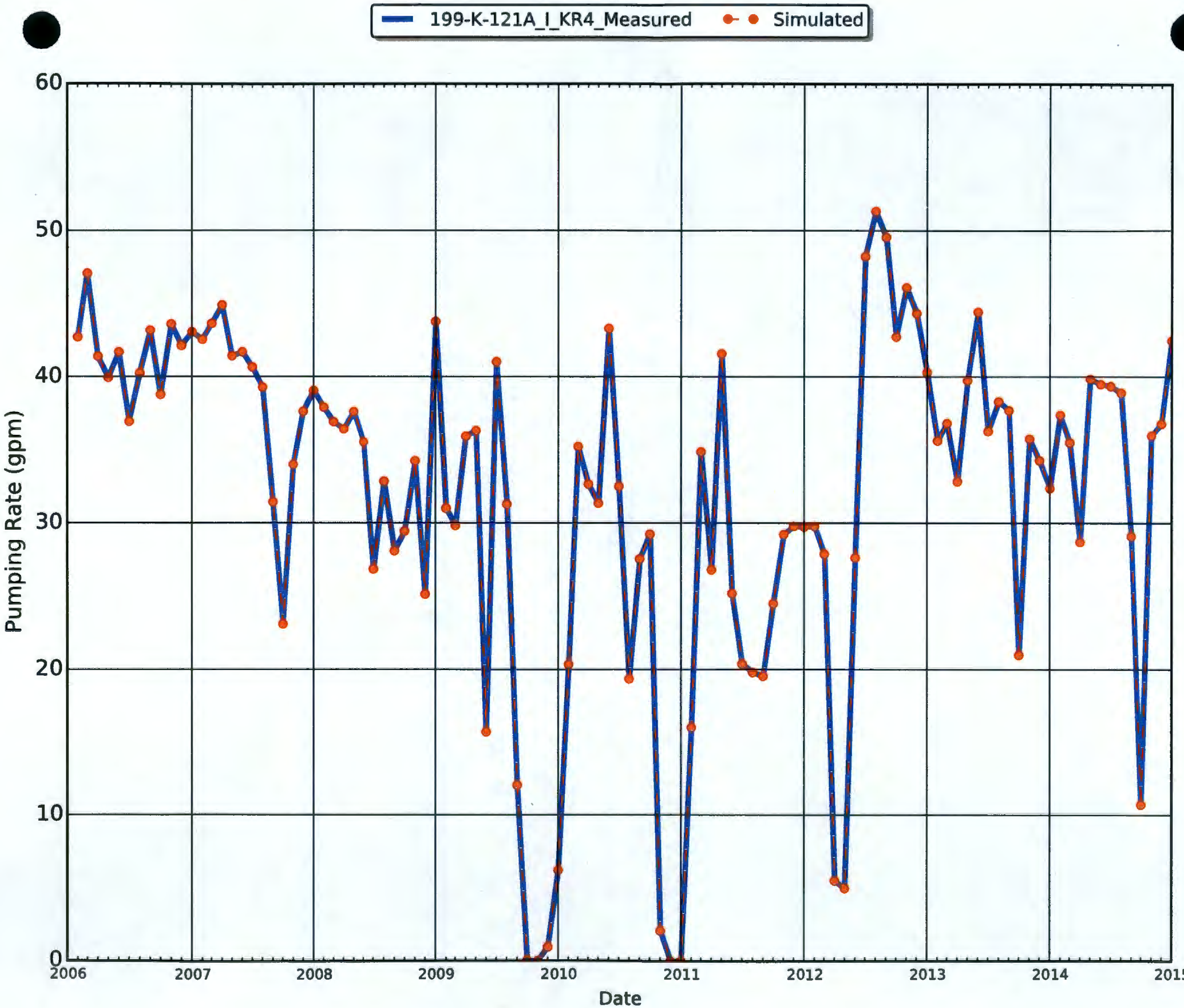
199-K-114A_E_KR4_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

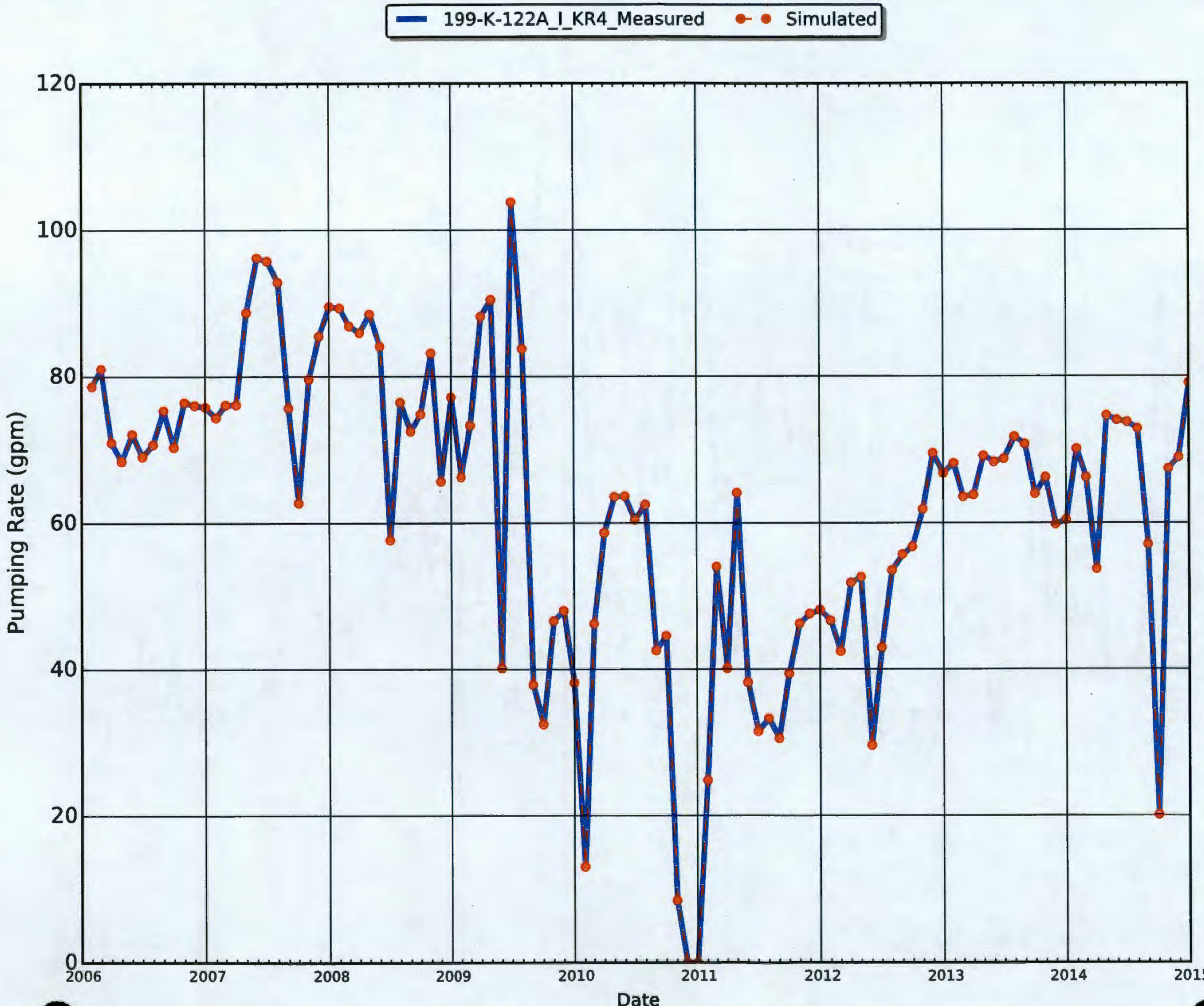

199-K-115A_E_KR4_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-116A_E_KR4_Measured
Simulated
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

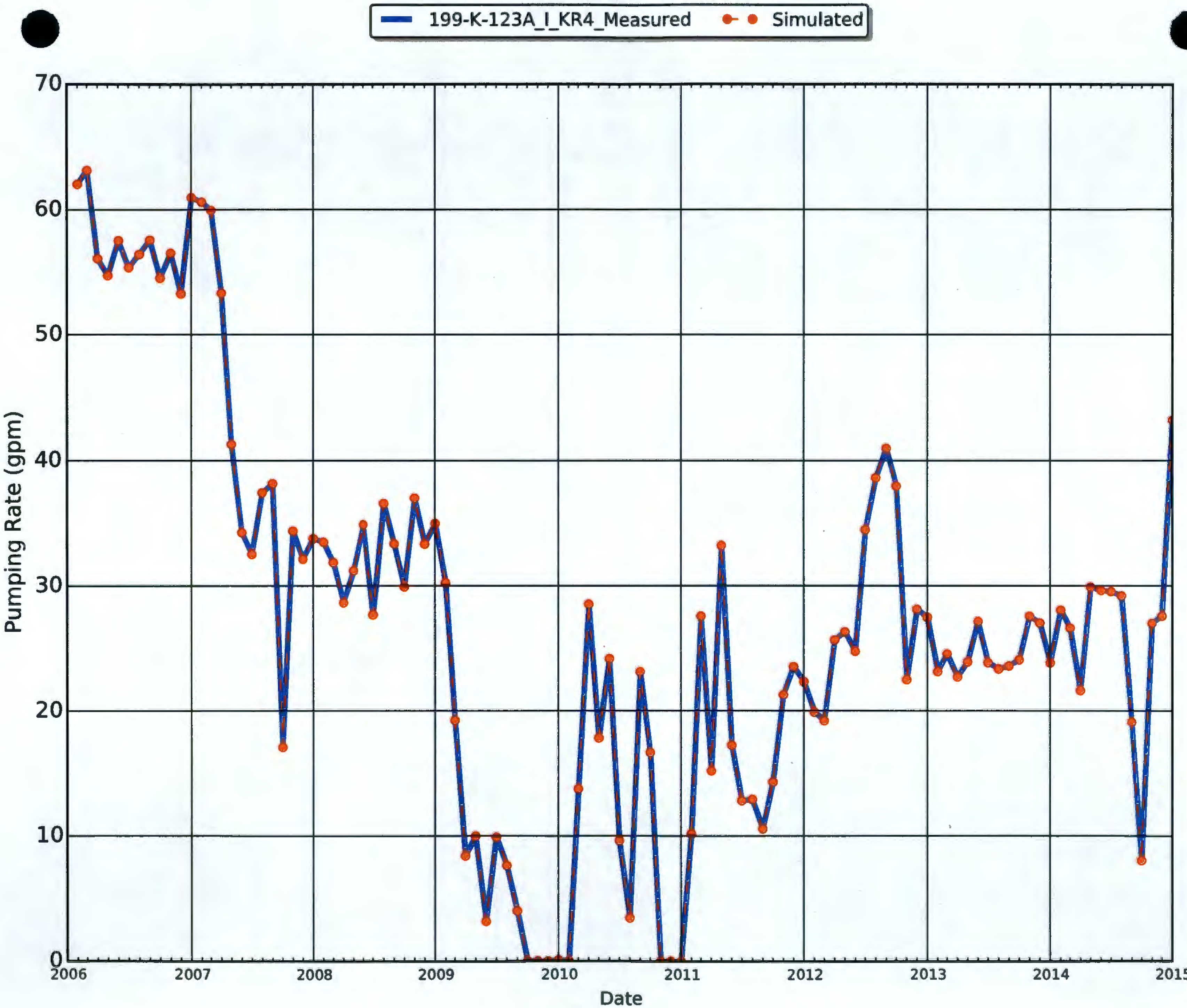
199-K-119A_E_KR4_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-120A_E_KR4_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

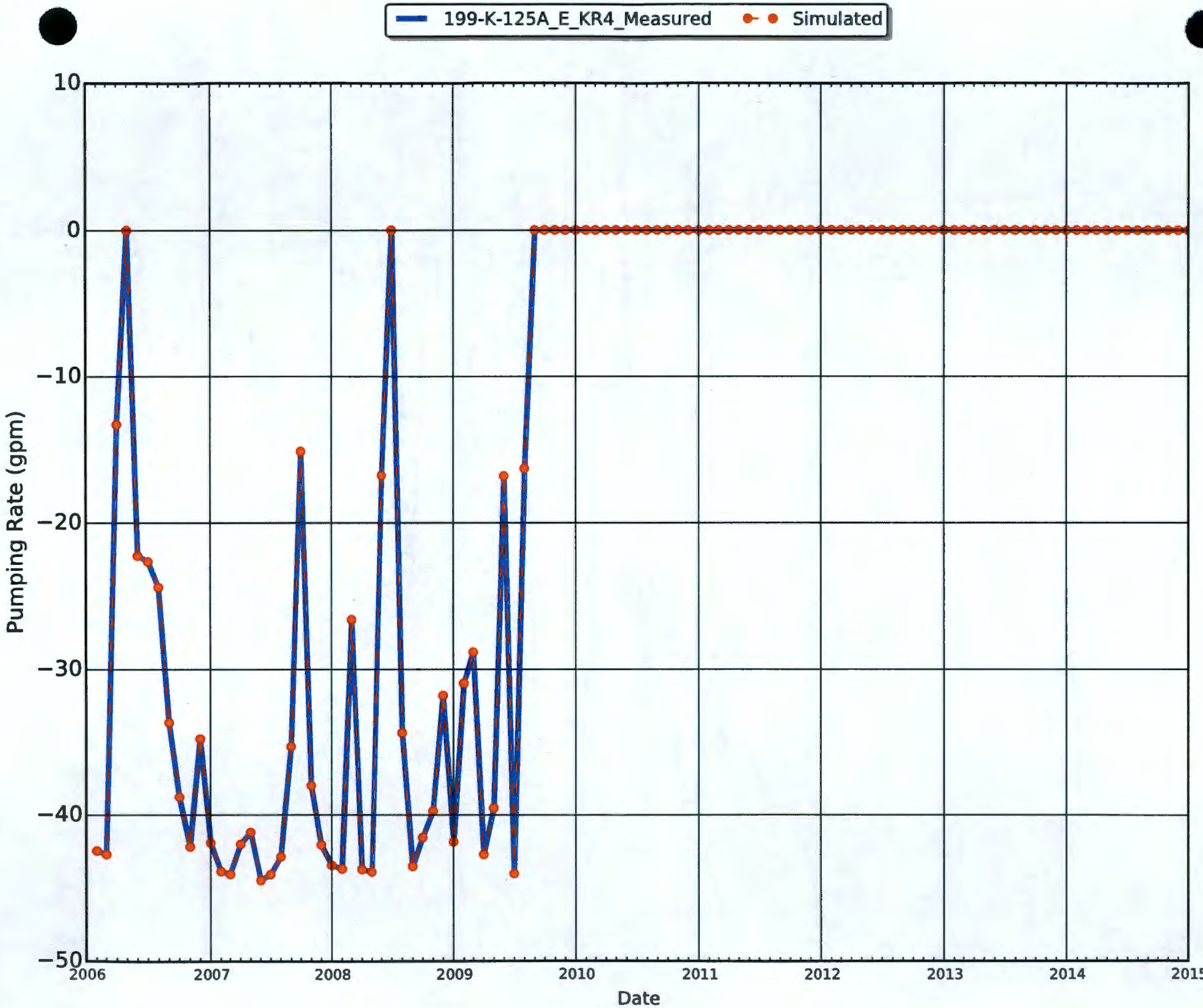

199-K-121A_I_KR4_Measured
Simulated
Pumping Rate (gpm)
Date
0
10
20
30
40
50
60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

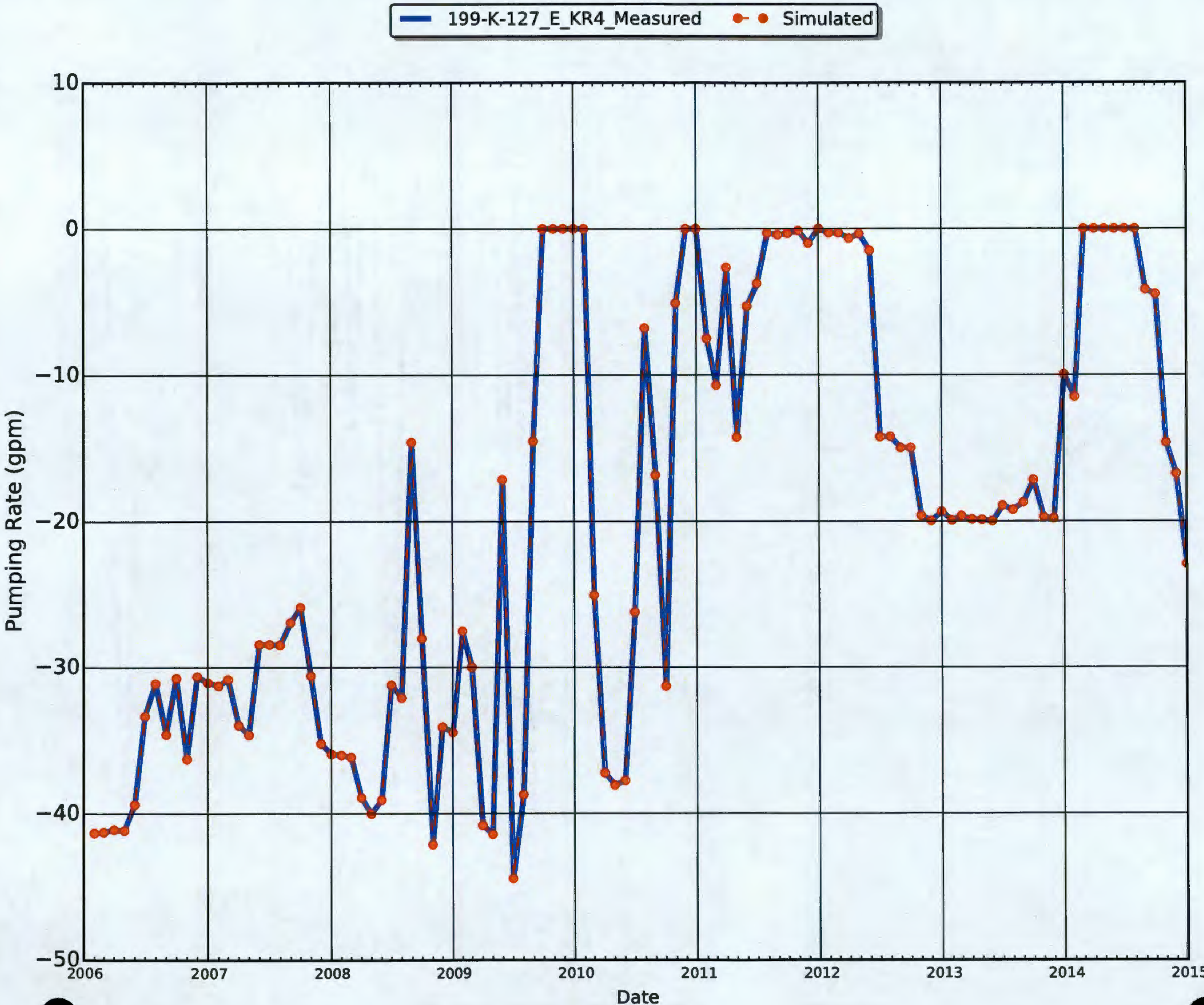


199-K-122A_I_KR4_Measured
Simulated
Pumping Rate (gpm)
0
20
40
60
80
100
120
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

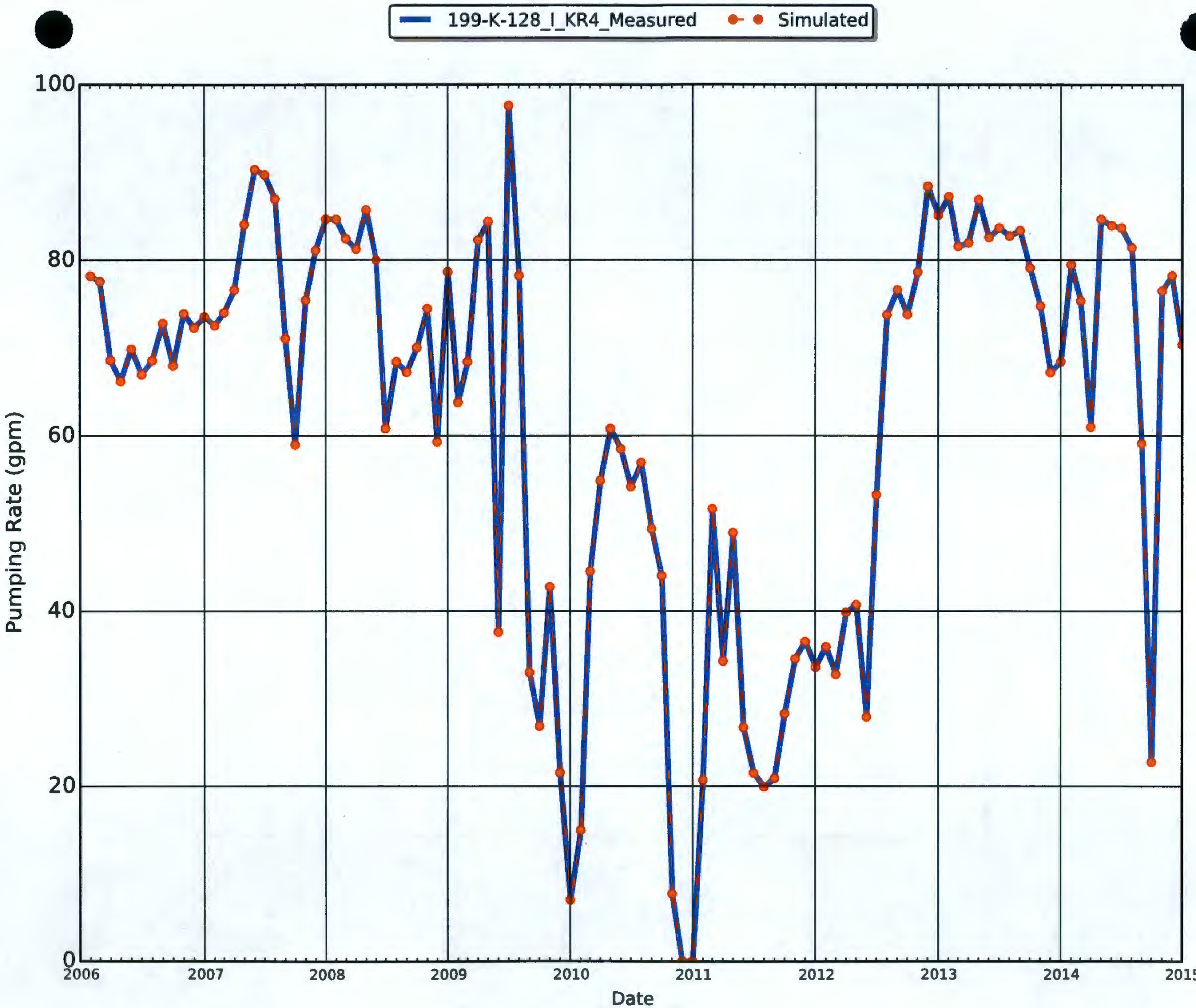

199-K-123A_I_KR4_Measured
Simulated
70
60
50
40
30
20
10
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-124A_I_KR4_Measured
Simulated
Pumping Rate (gpm)
30
25
20
15
10
5
0
−5
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-125A_E_KR4_Measured
Simulated
Pumping Rate (gpm)
10
0
−10
−20
−30
−40
−50
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

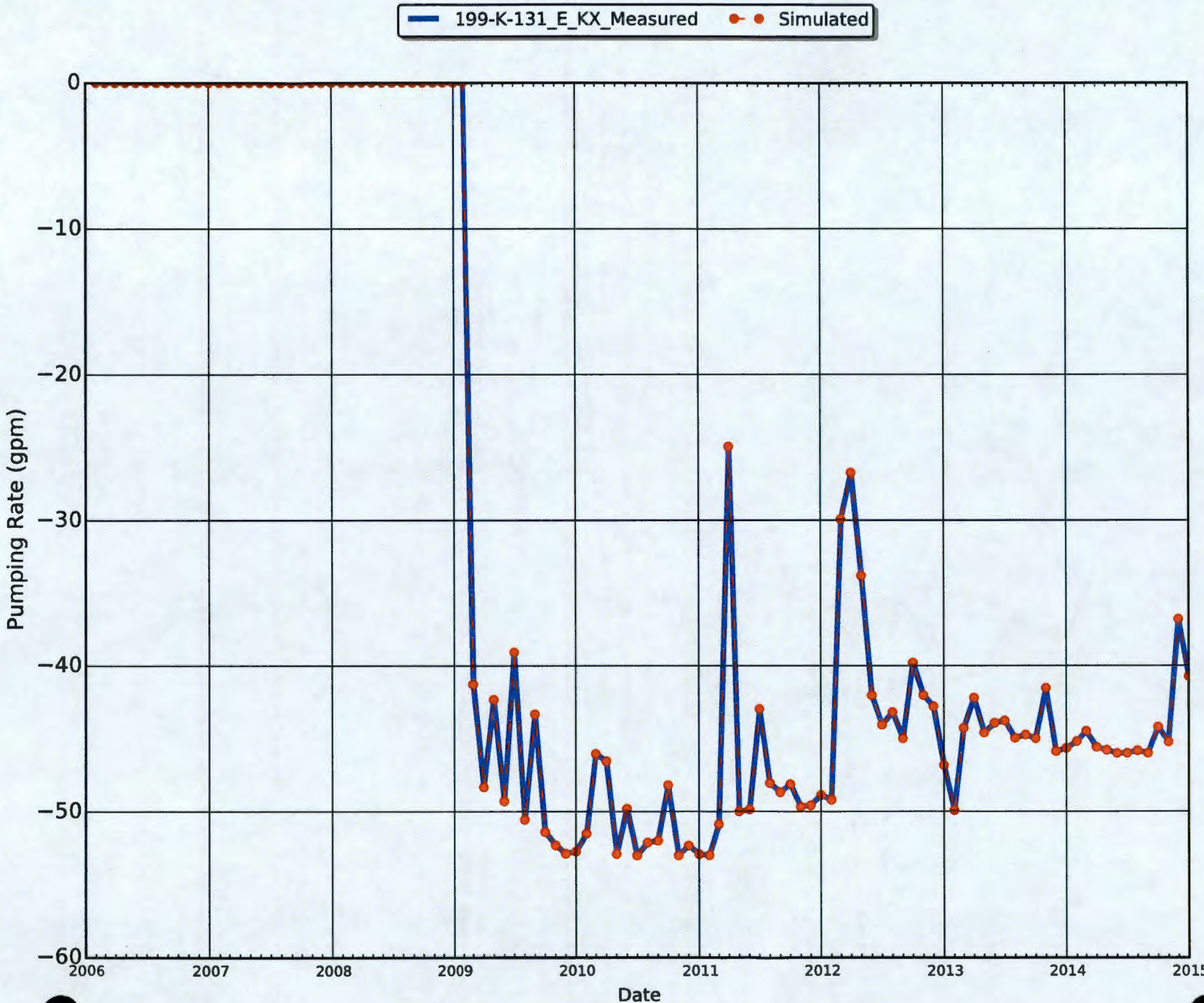


199-K-127_E_KR4_Measured
Simulated
10
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

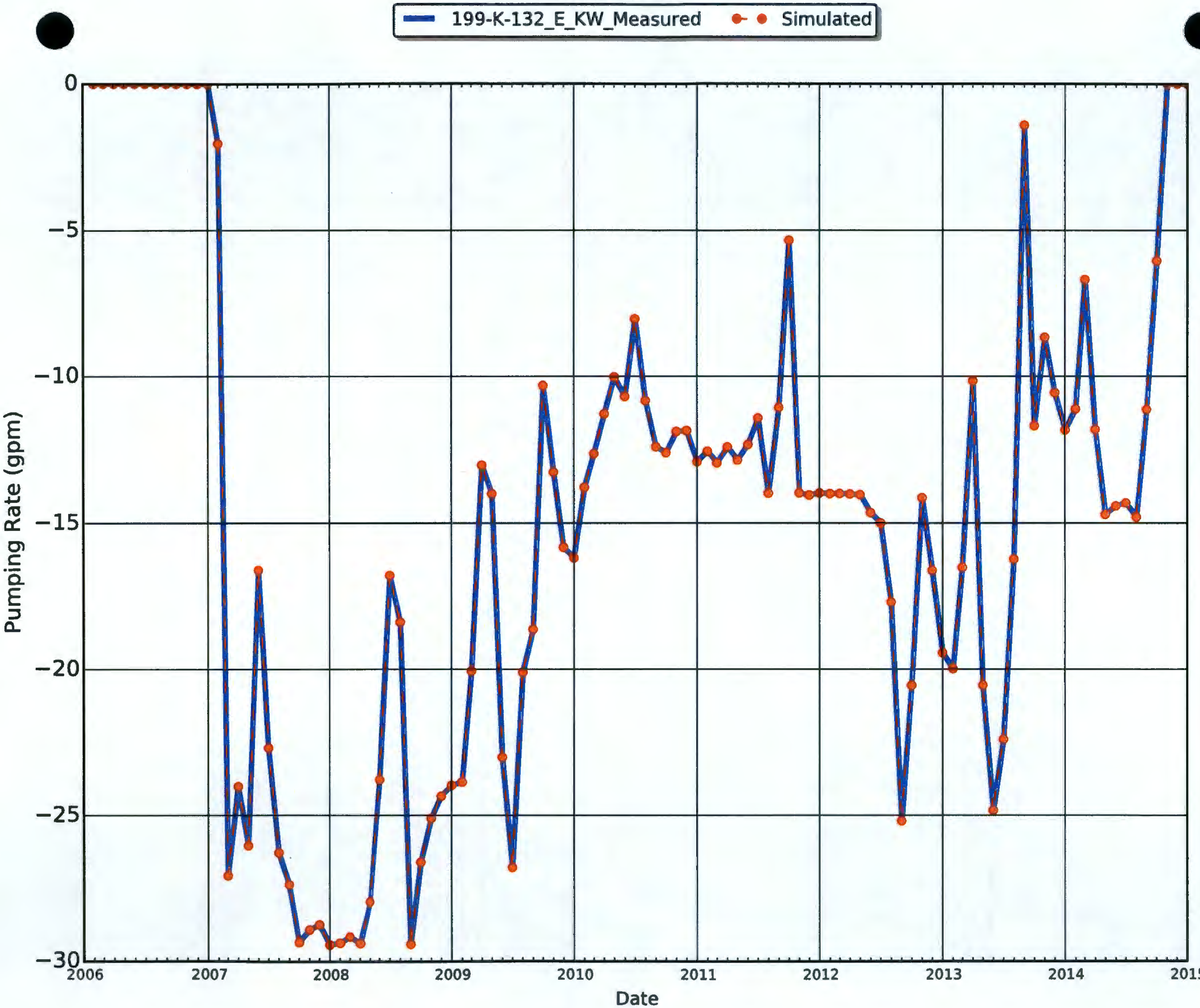

199-K-128_I_KR4_Measured
Simulated
Pumping Rate (gpm)
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-K-129_E_KR4_Measured
Simulated
Pumping Rate (gpm)
5
0
−5
−10
−15
−20
−25
−30
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-K-130_E_KX_Measured
Simulated
Pumping Rate (gpm)
0
−10
−20
−30
−40
−50
−60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date



199-K-131_E_KX_Measured
Simulated
0
−10
−20
−30
−40
−50
−60
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date



199-K-132_E_KW_Measured
Simulated
Pumping Rate (gpm)
Date
0
−5
−10
−15
−20
−25
−30
2006
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2008
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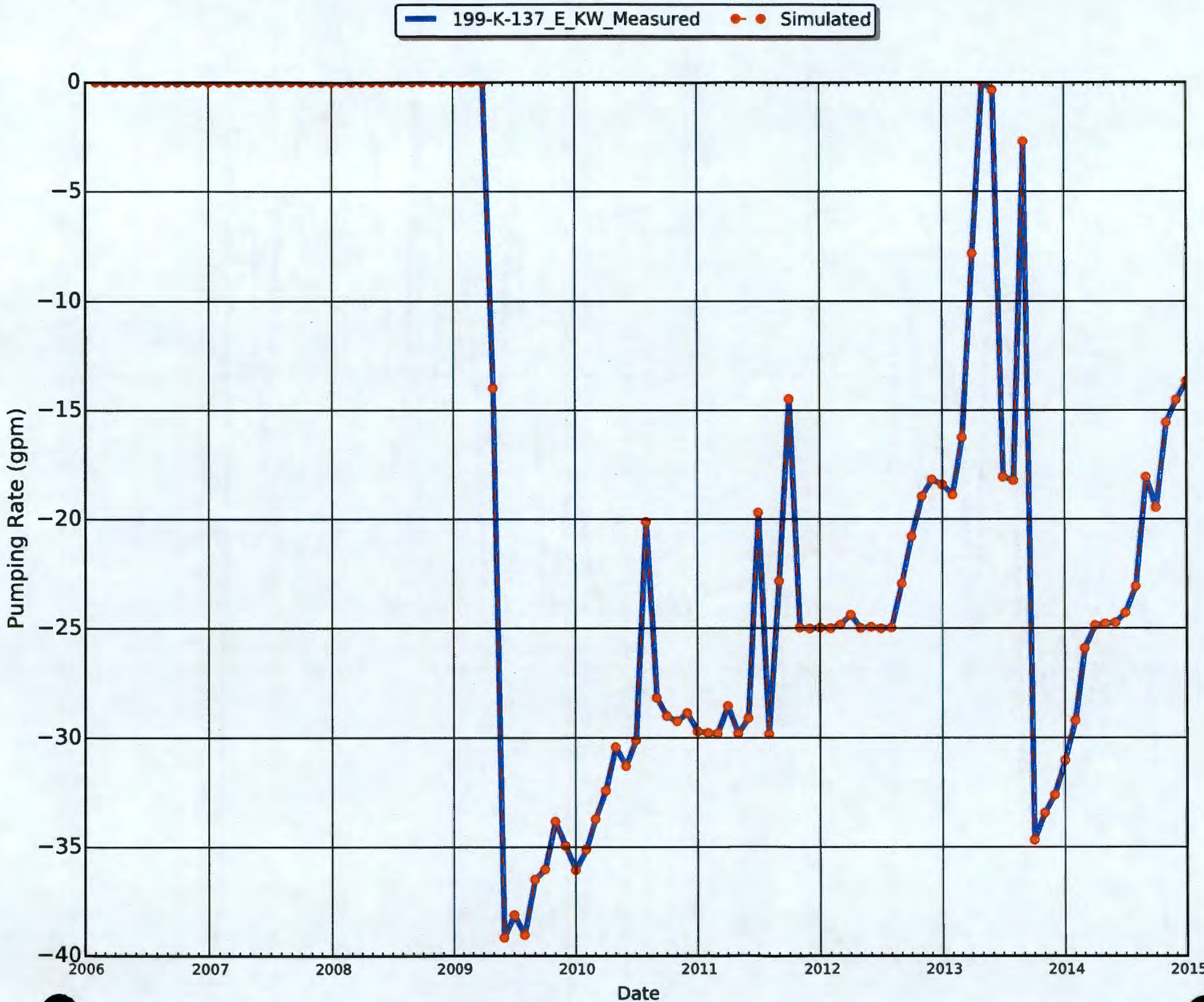
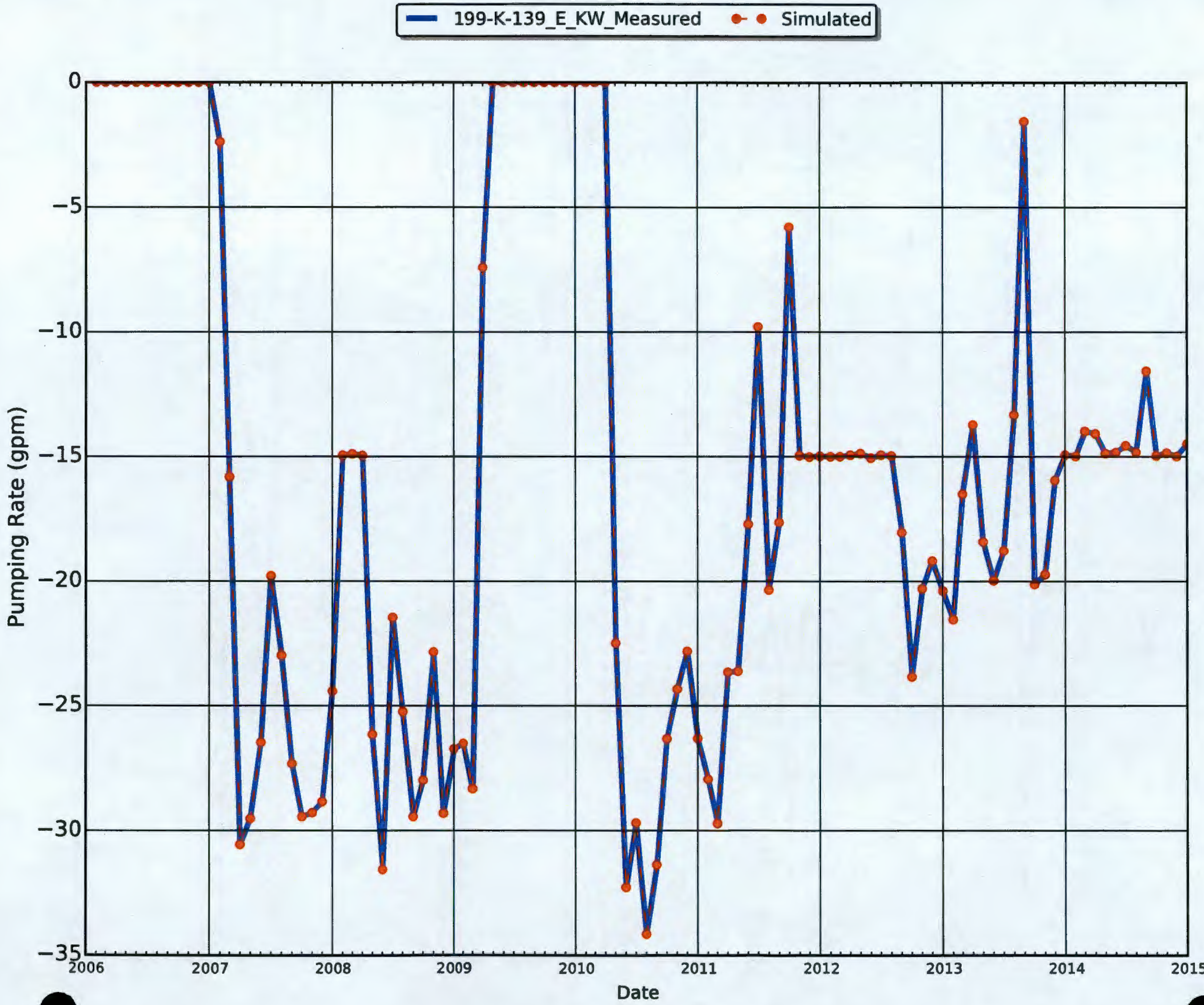
2010
2011
2012
2013
2014
2015

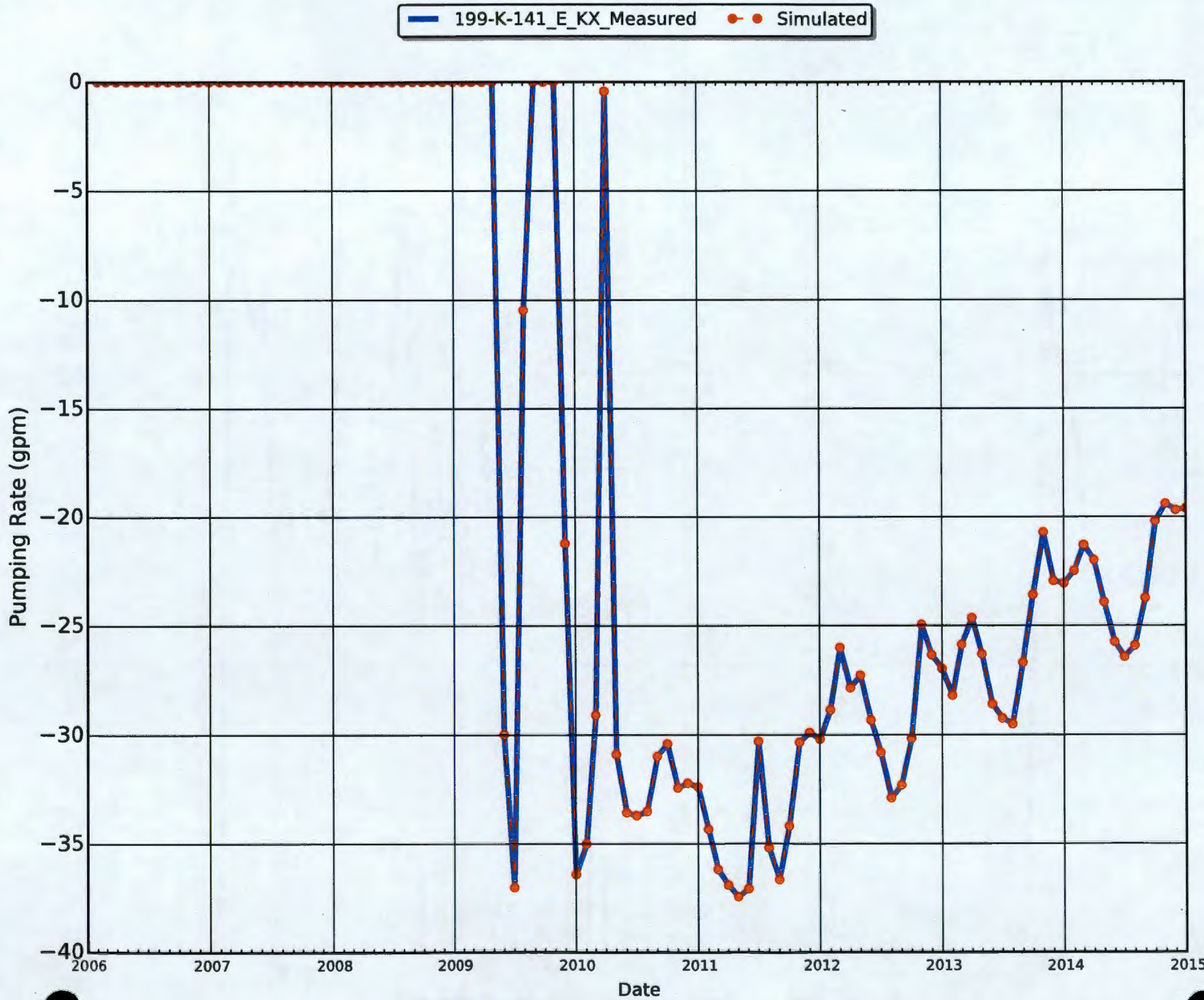


199-K-137_E_KW_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
−40
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

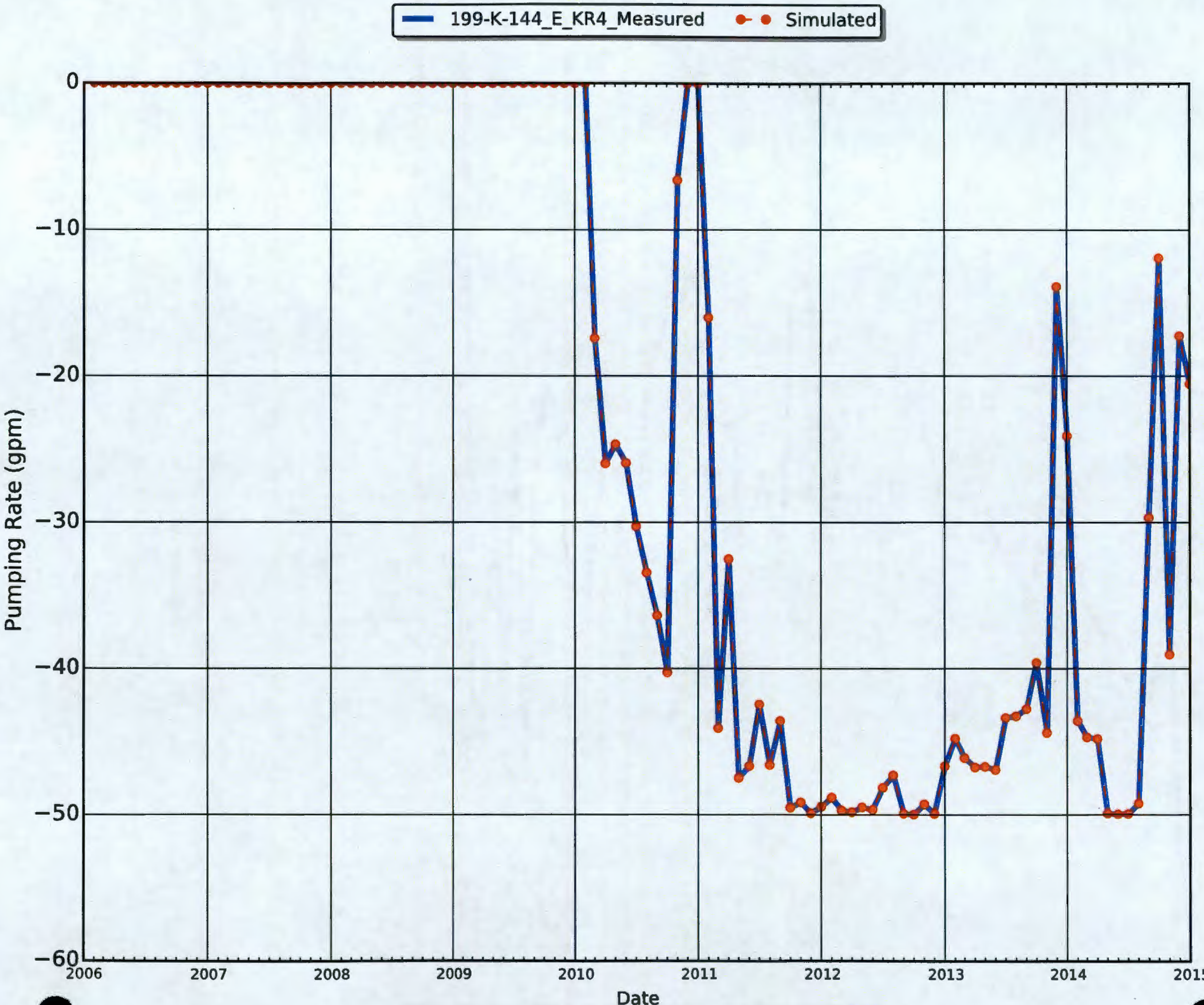

199-K-138_E_KW_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-139_E_KW_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
−35
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

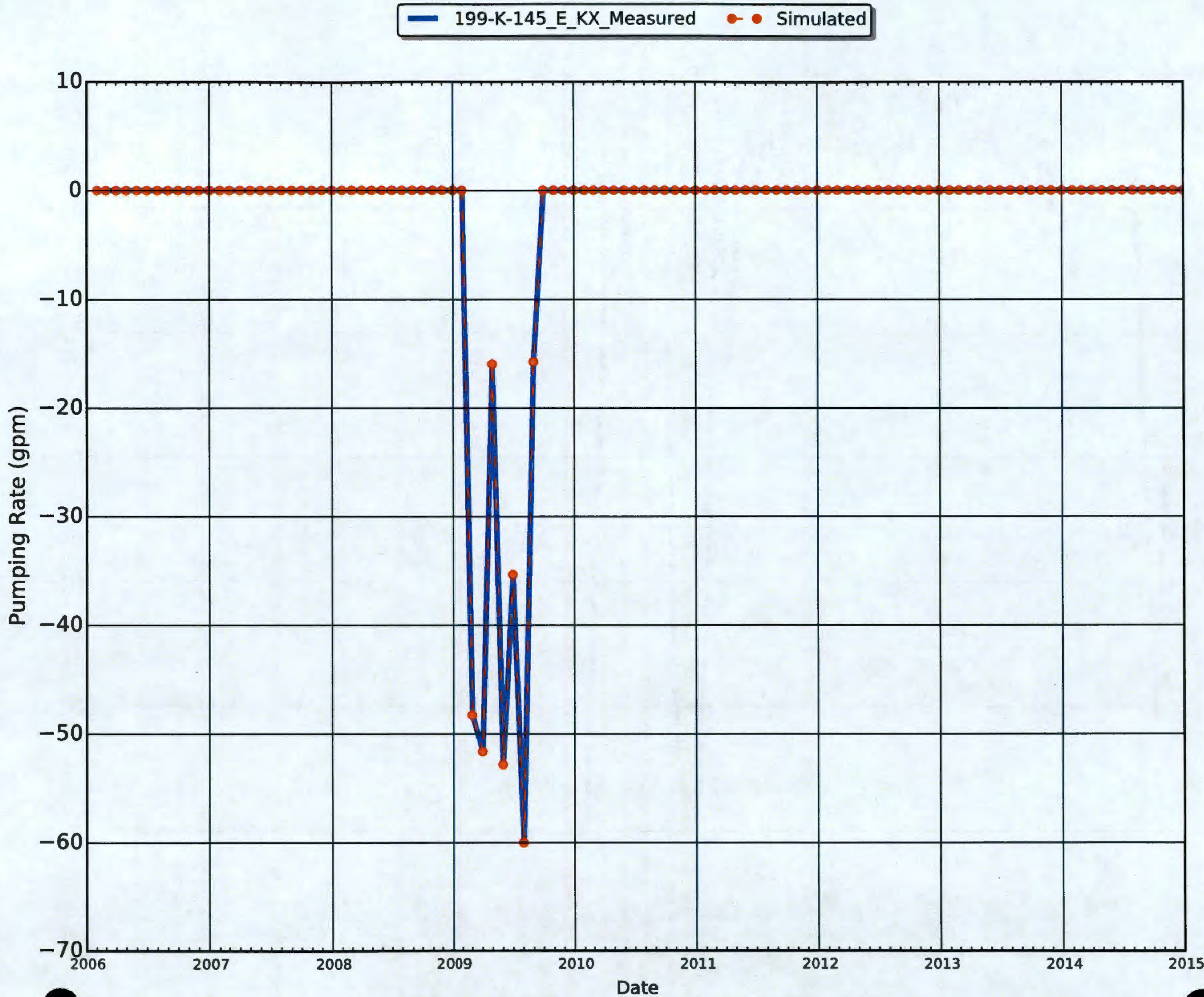
199-K-140_E_KW_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

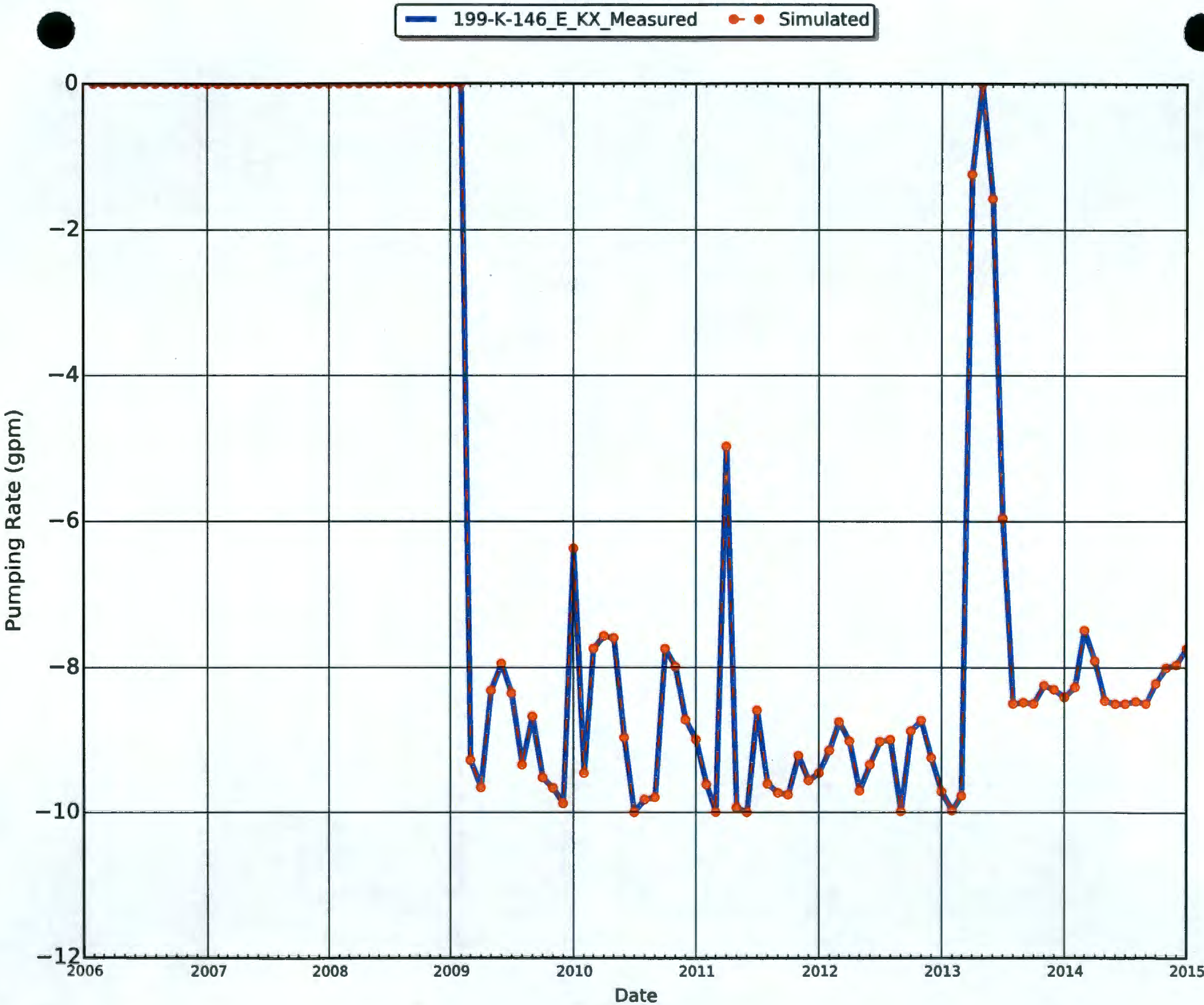

199-K-141_E_KX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
−30
−35
−40
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

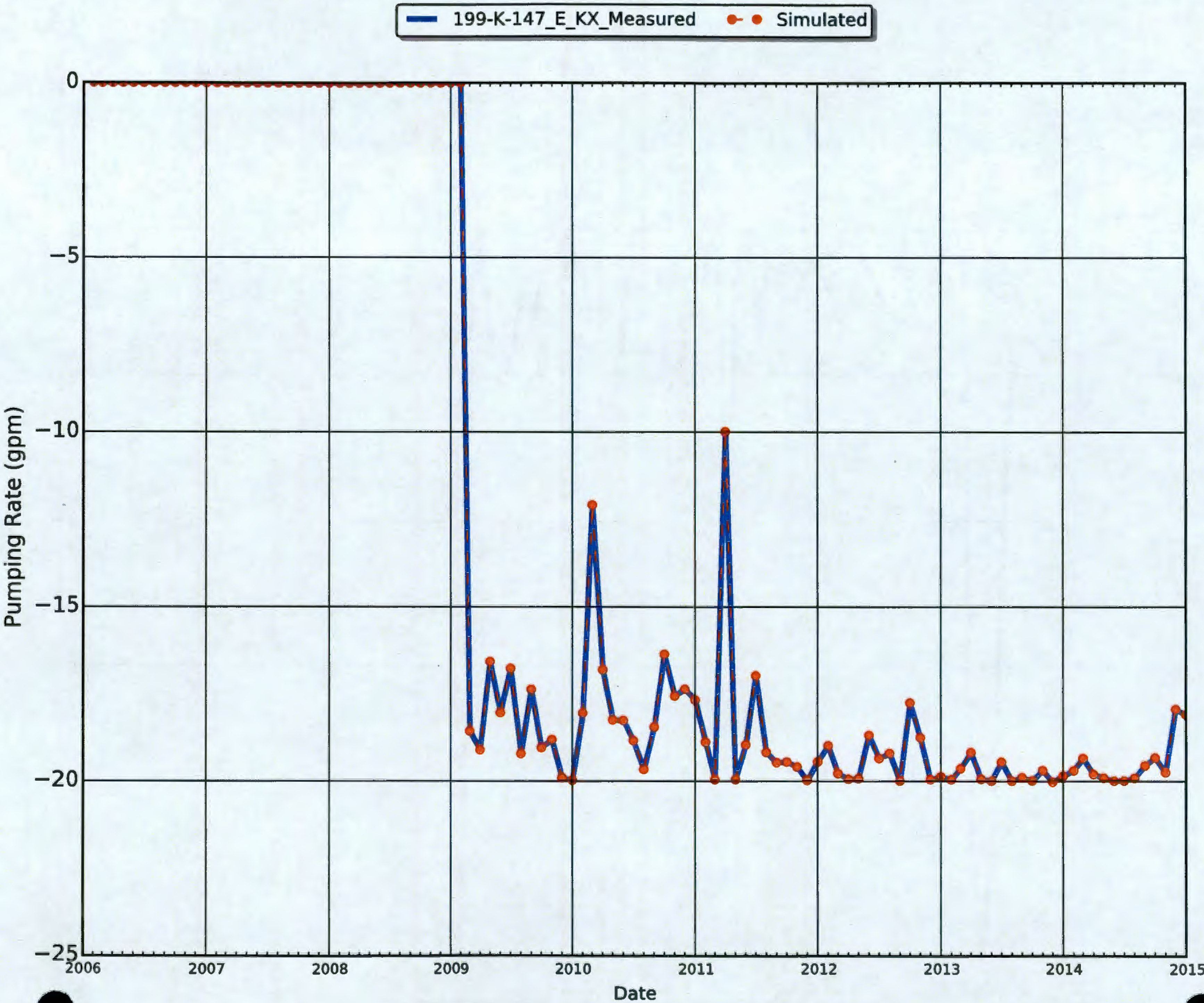

199-K-143_I_KX_Measured
Simulated
Pumping Rate (gpm)
0
10
20
30
40
50
60
Date
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


199-K-144_E_KR4_Measured
Simulated
Pumping Rate (gpm)
0
−10
−20
−30
−40
−50
−60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

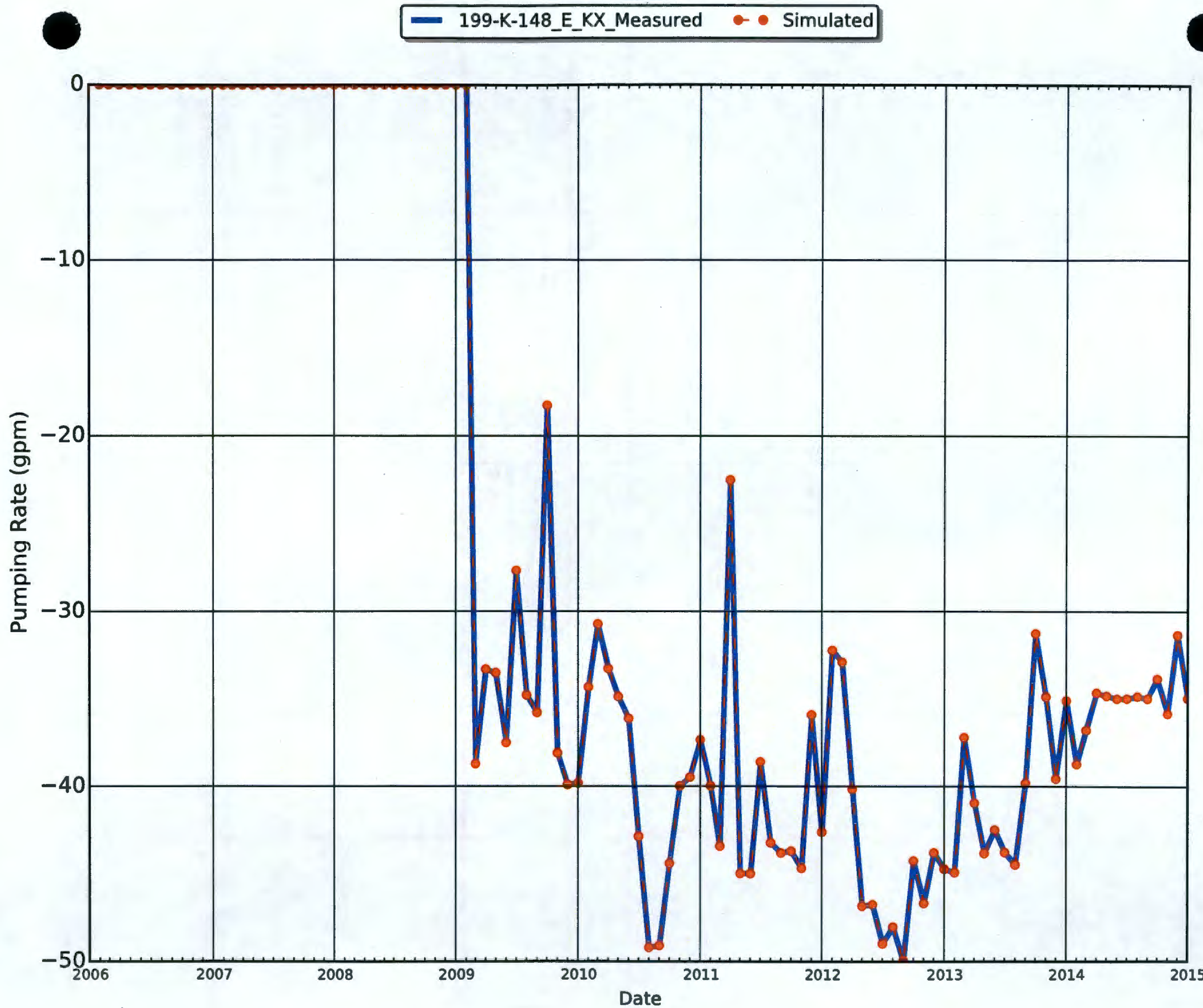

199-K-145_E_KR4_Measured
Simulated
10
0
−10
−20
−30
−40
−50
−60
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-145_E_KX_Measured
Simulated
10
0
−10
−20
−30
−40
−50
−60
−70
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

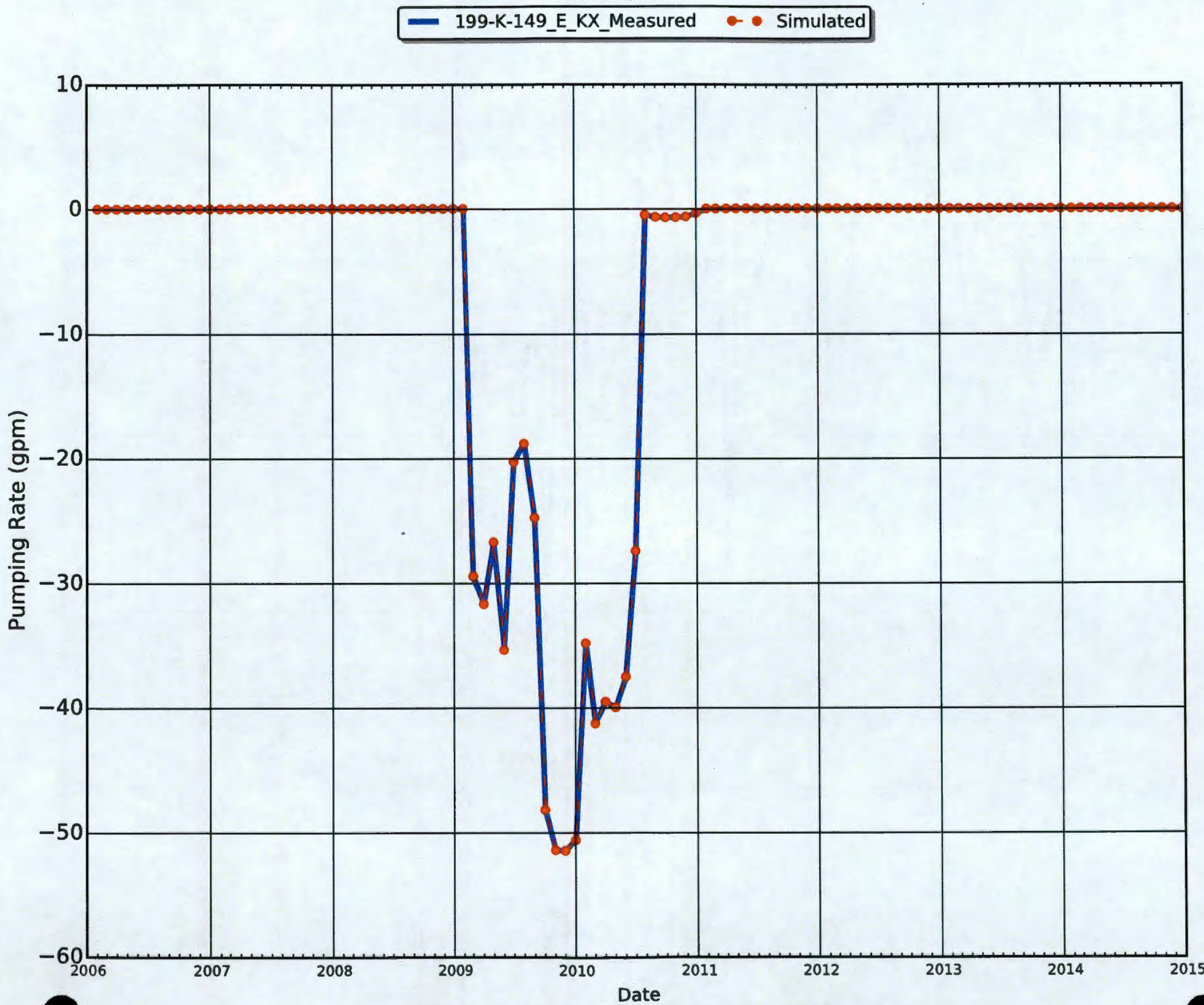

199-K-146_E_KX_Measured
Simulated
0
−2
−4
−6
−8
−10
−12
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

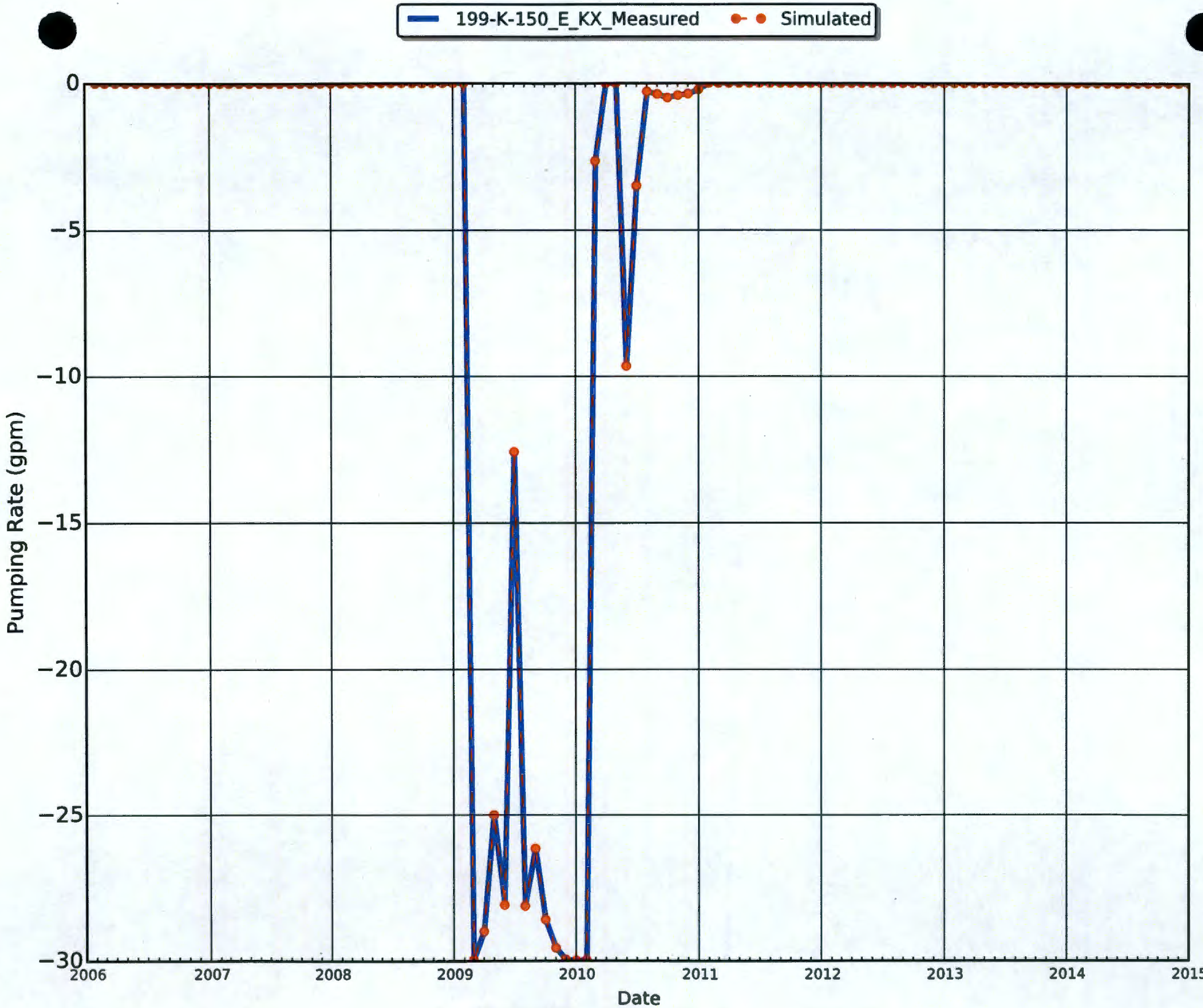


199-K-147_E_KX_Measured
Simulated
Pumping Rate (gpm)
0
−5
−10
−15
−20
−25
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

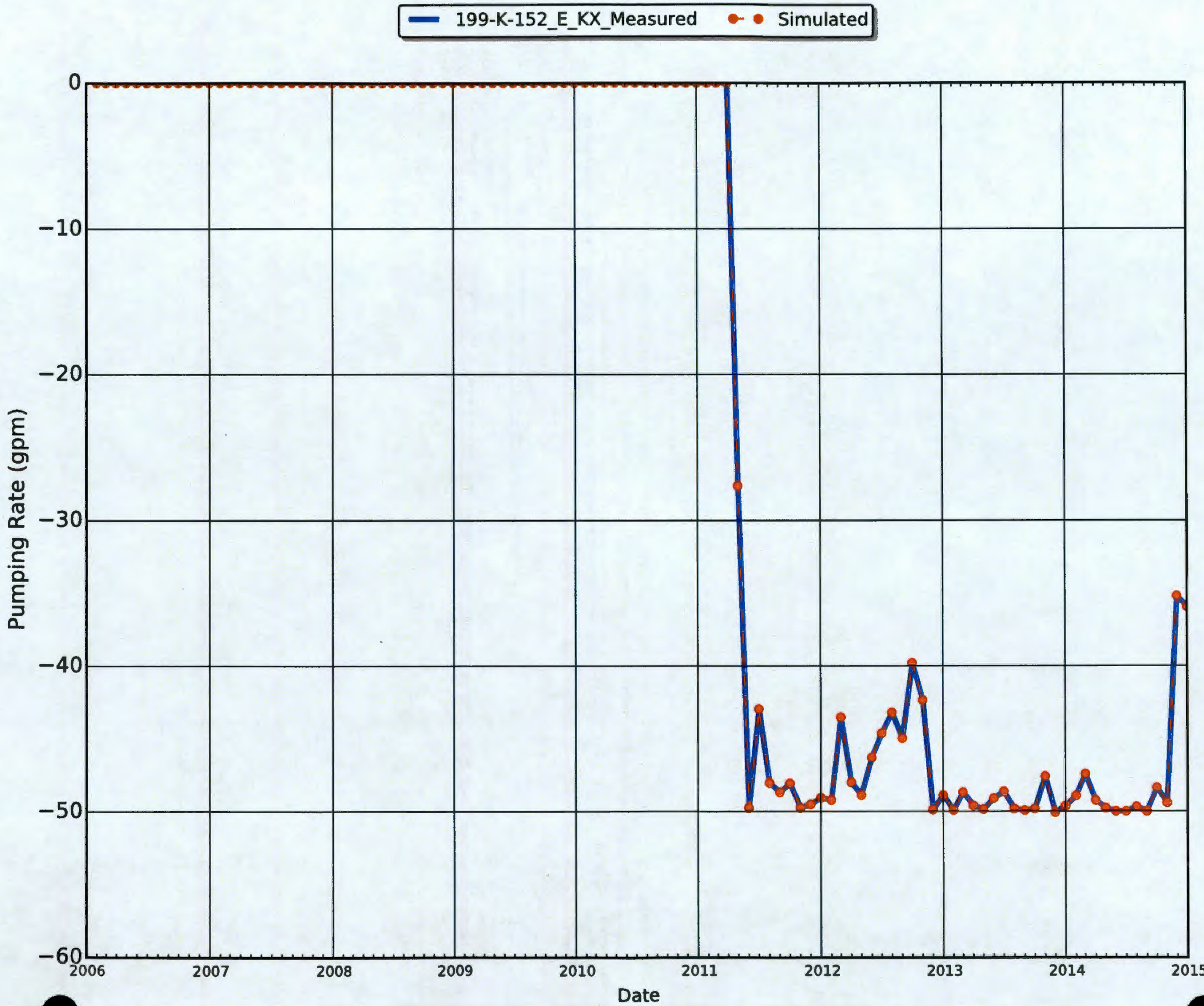


199-K-148_E_KX_Measured
Simulated
0
−10
−20
−30
−40
−50
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

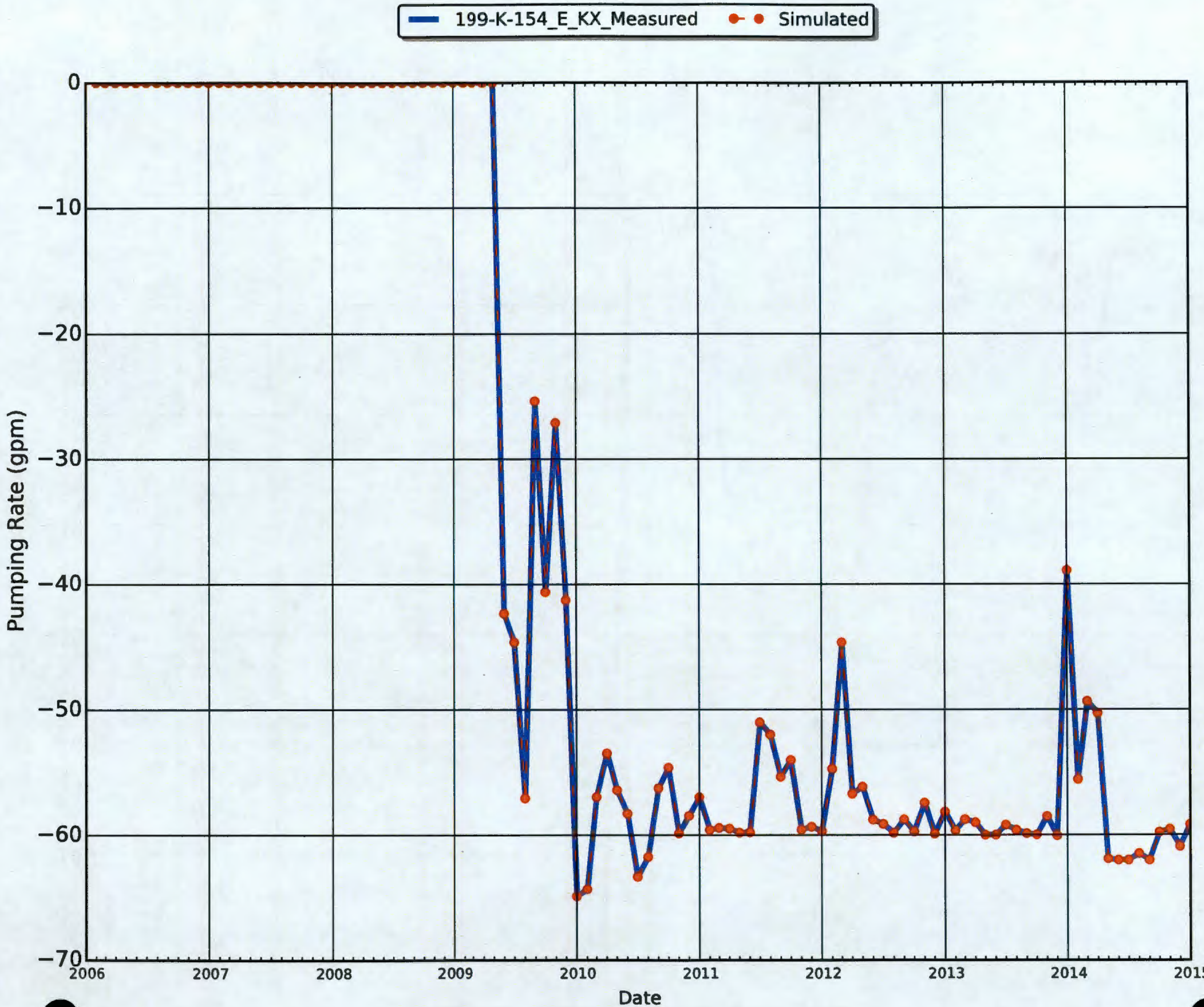

199-K-149_E_KX_Measured
Simulated
10
0
−10
−20
−30
−40
−50
−60
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date



199-K-150_E_KX_Measured
Simulated
0
−5
−10
−15
−20
−25
−30
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-152_E_KX_Measured
Simulated
Pumping Rate (gpm)
0
−10
−20
−30
−40
−50
−60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

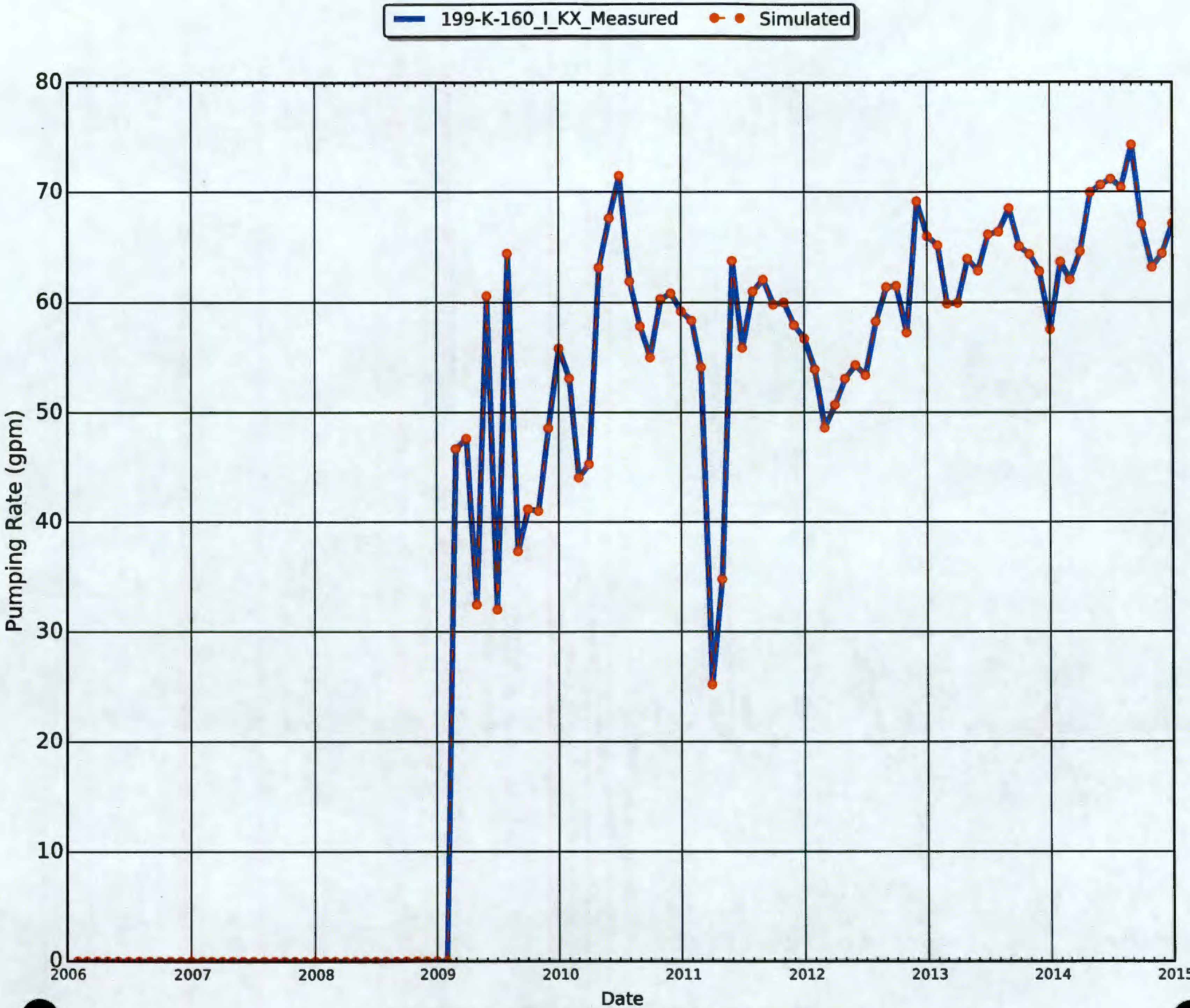

199-K-153_E_KX_Measured
Simulated
Pumping Rate (gpm)
0
−10
−20
−30
−40
−50
−60
−70
−80
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-154_E_KX_Measured
Simulated
0
−10
−20
−30
−40
−50
−60
−70
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-K-156_I_KX_Measured
Simulated
Pumping Rate (gpm)
120
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date

199-K-158_I_KW_Measured
Simulated
140
120
100
80
60
40
20
0
Pumping Rate (gpm)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date


199-K-159_I_KX_Measured
Simulated
Pumping Rate (gpm)
80
70
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Date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Date


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Pumping Rate (gpm)
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2007
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Date


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Simulated
10
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Pumping Rate (gpm)
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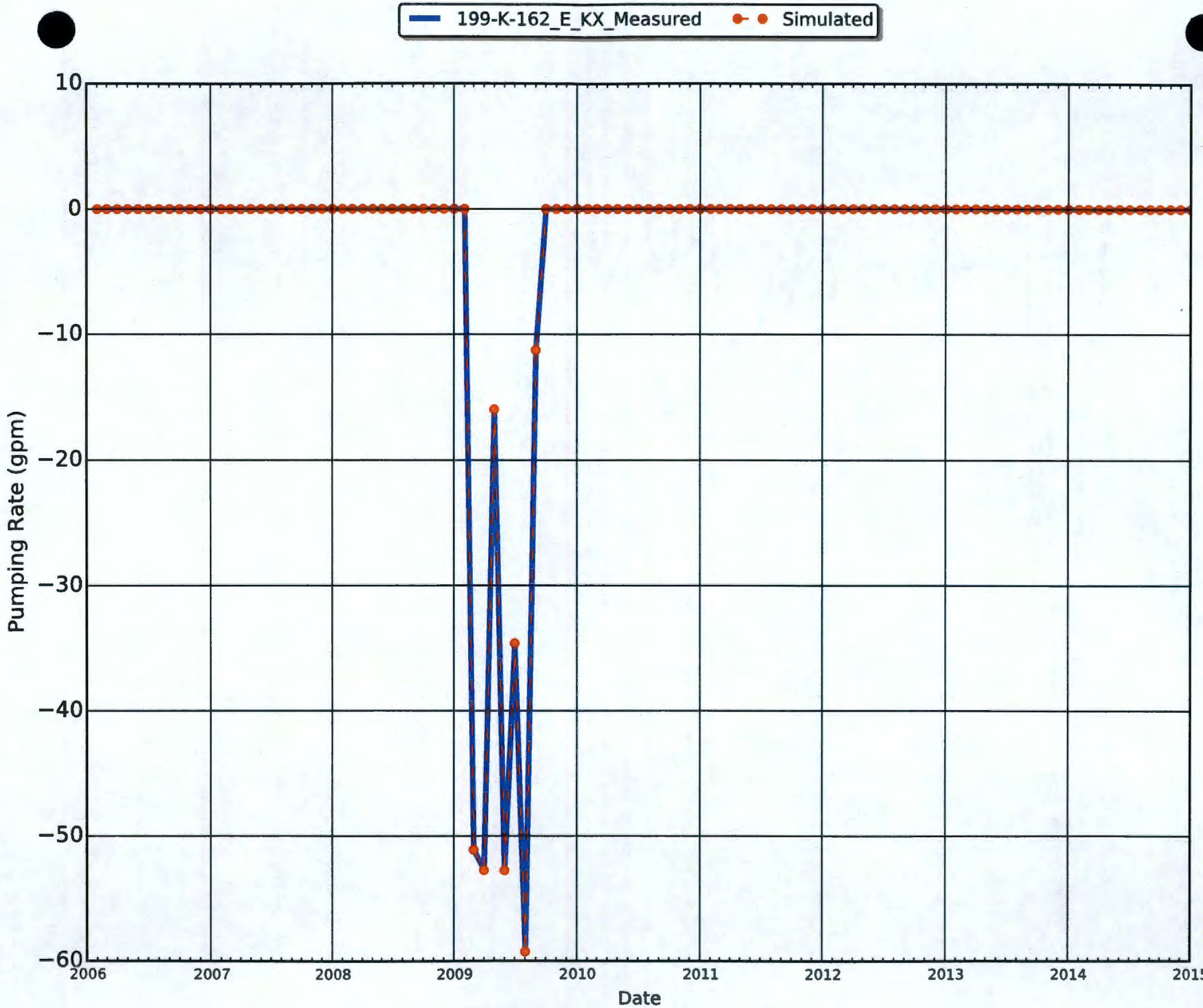
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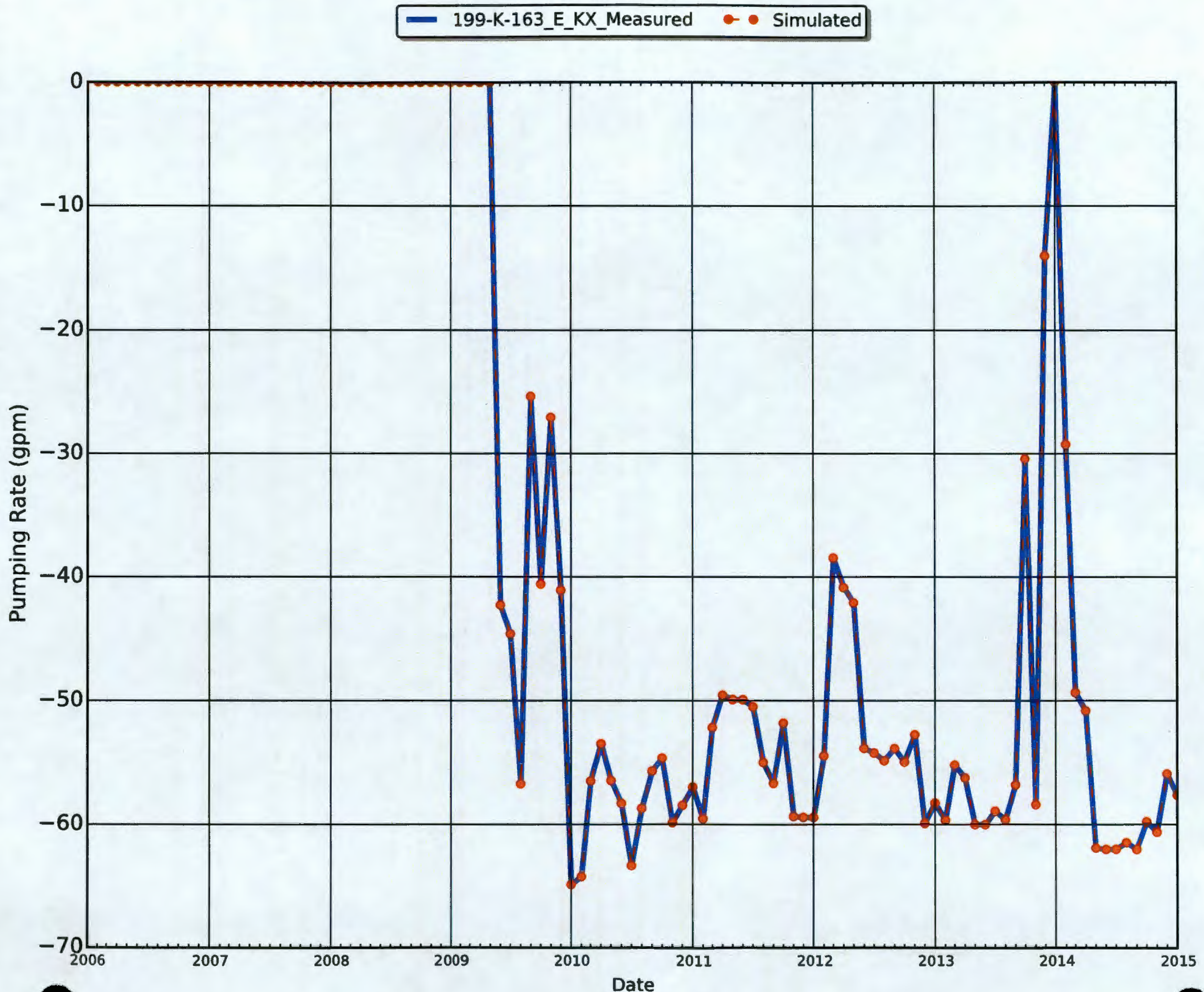
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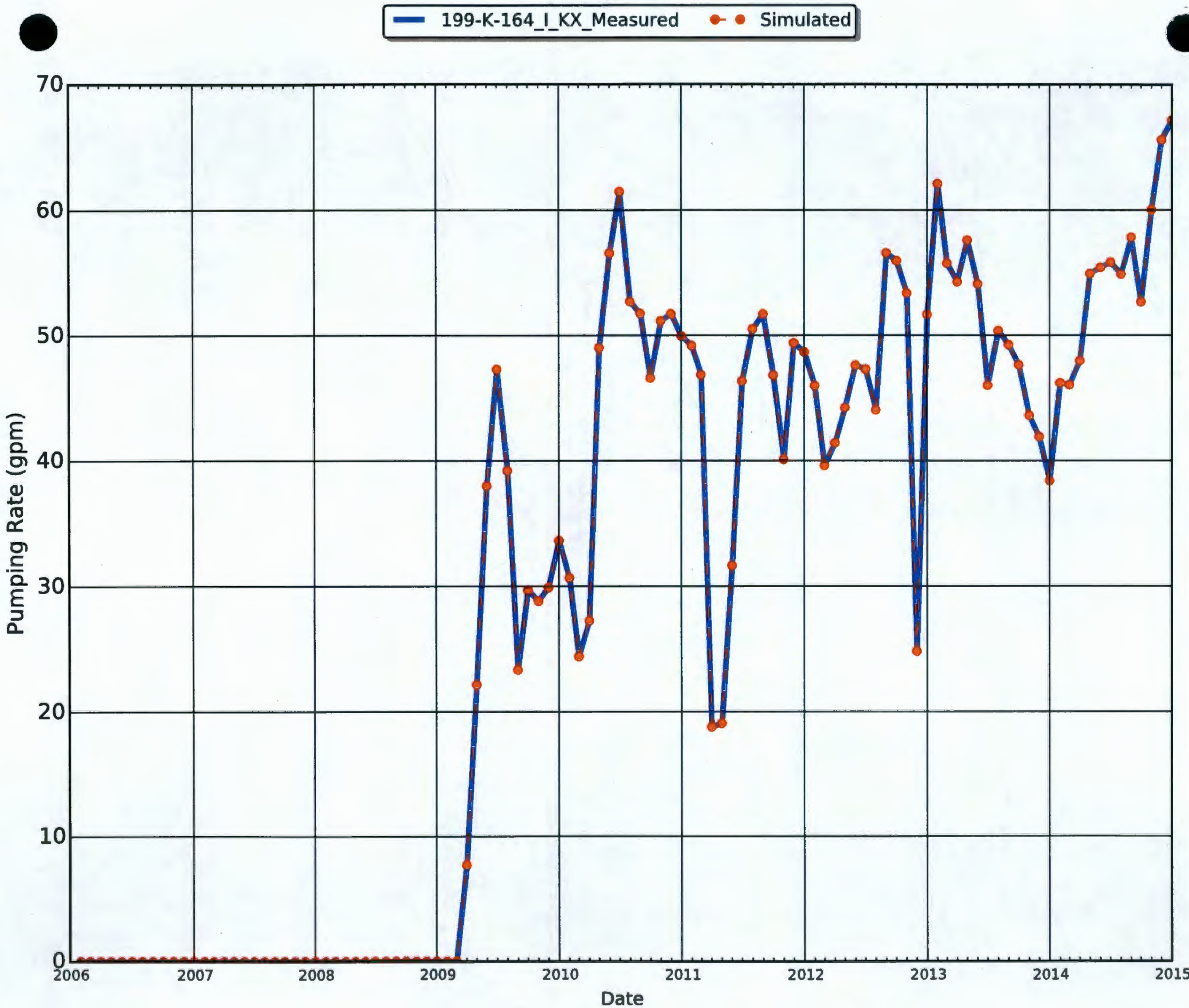
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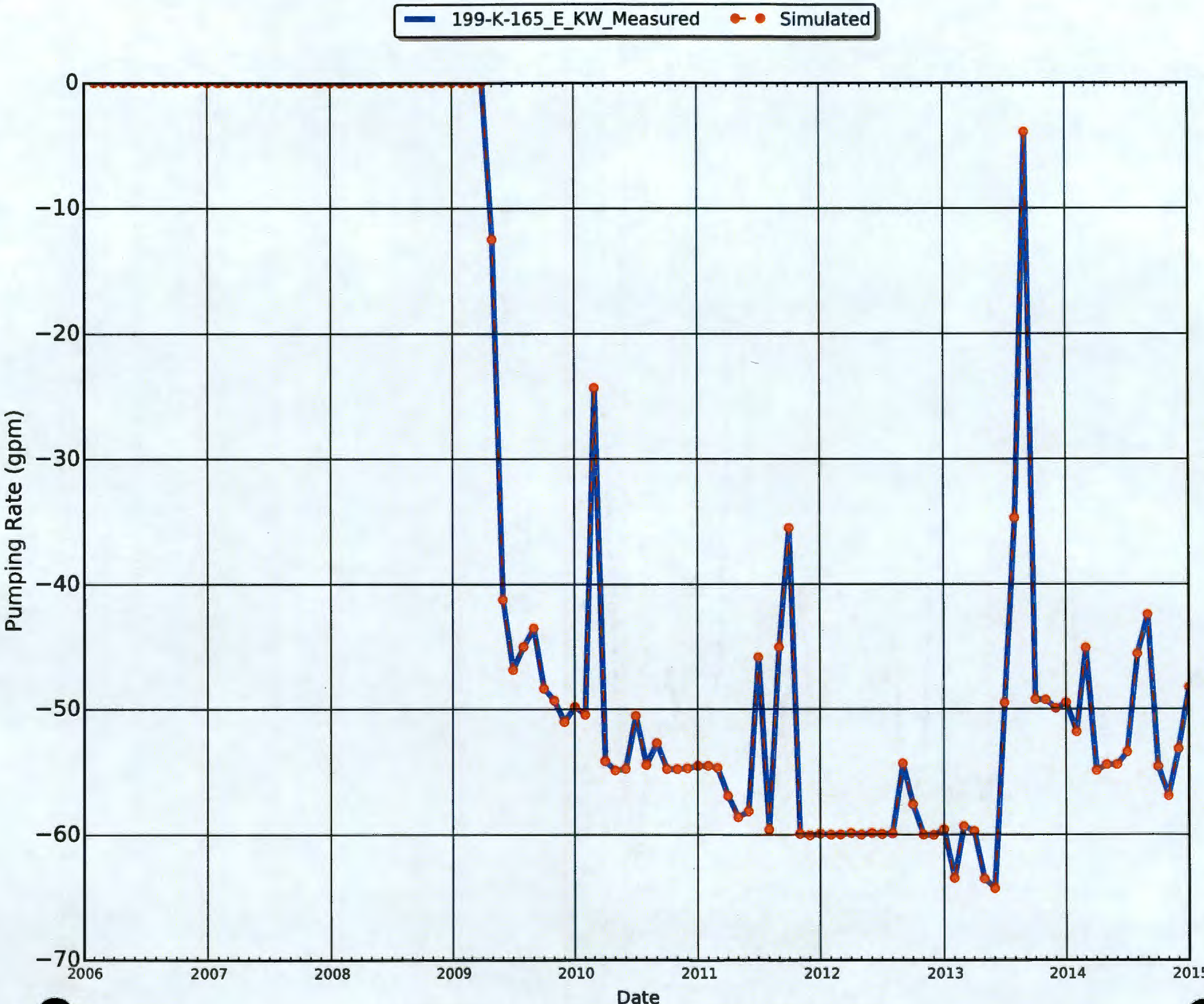
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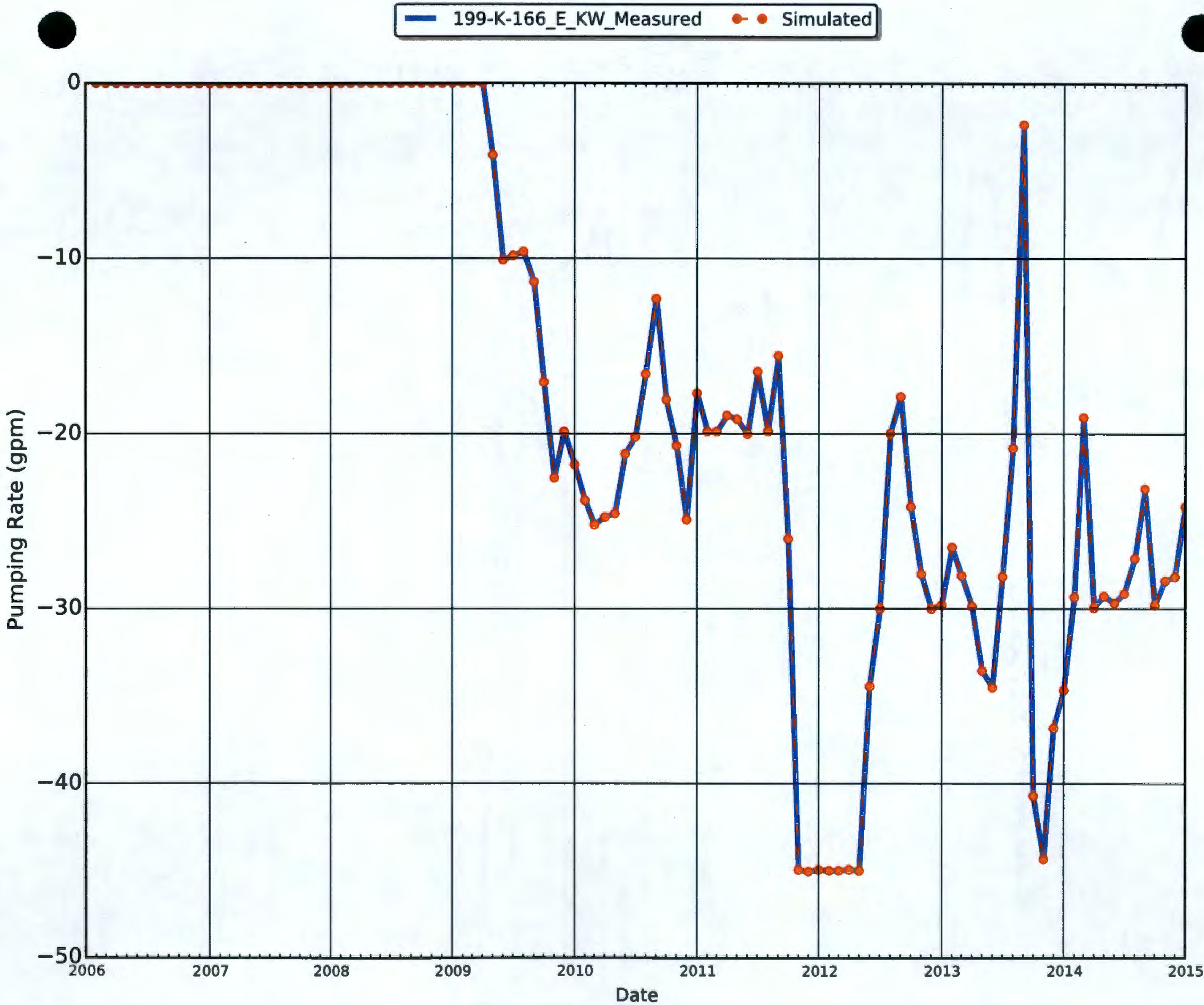

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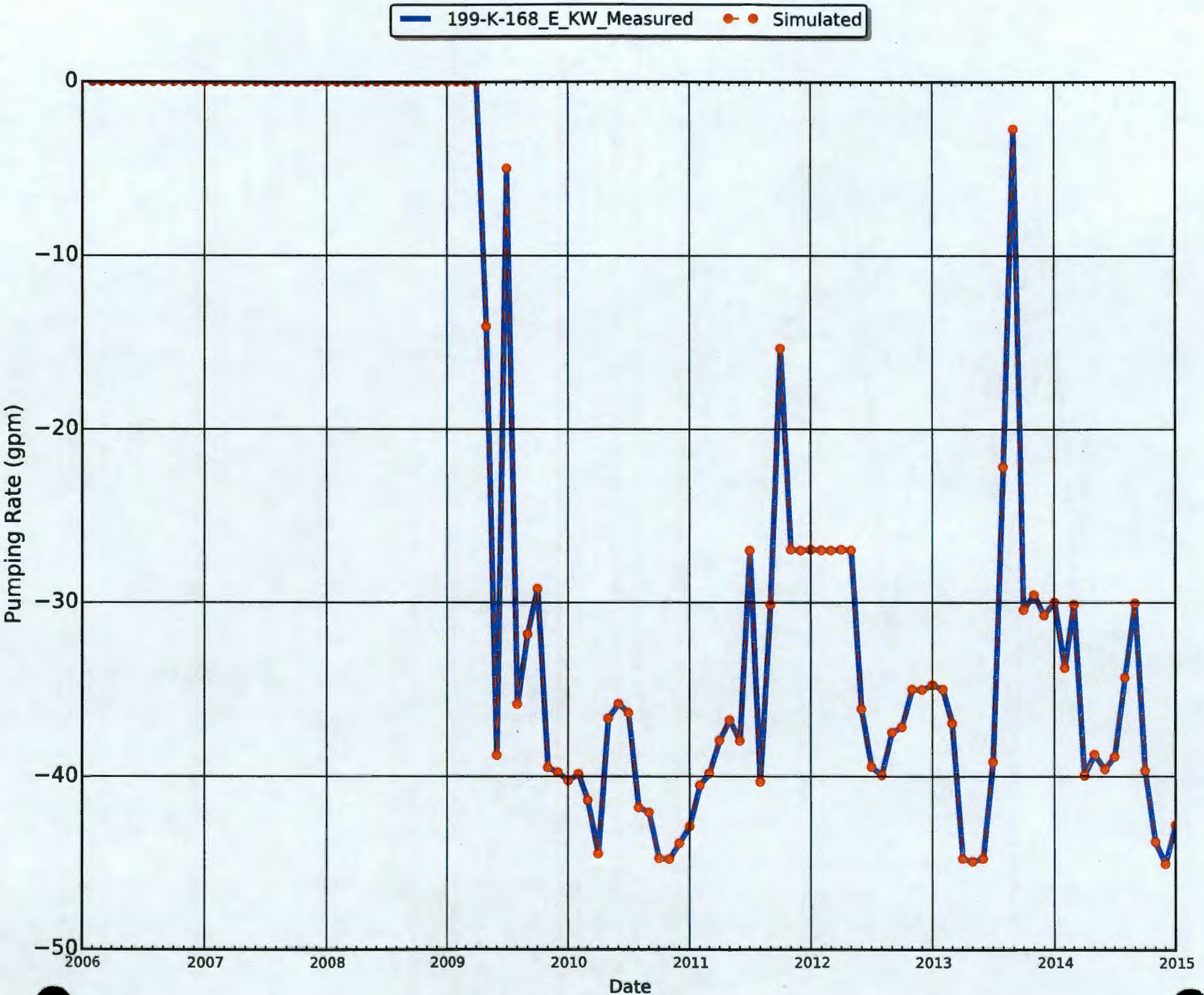
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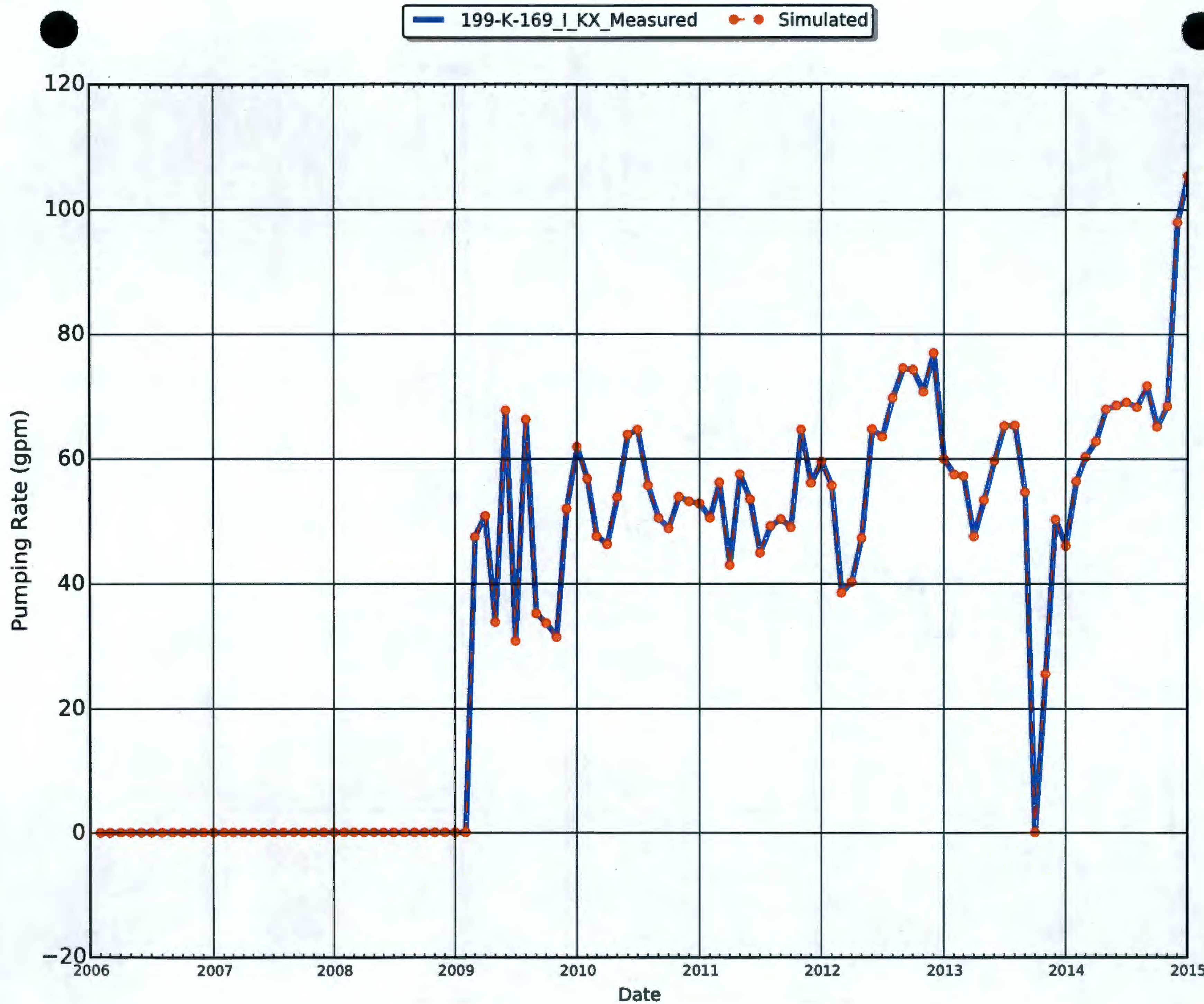
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Date


199-K-170_I_KX_Measured
Simulated
Pumping Rate (gpm)
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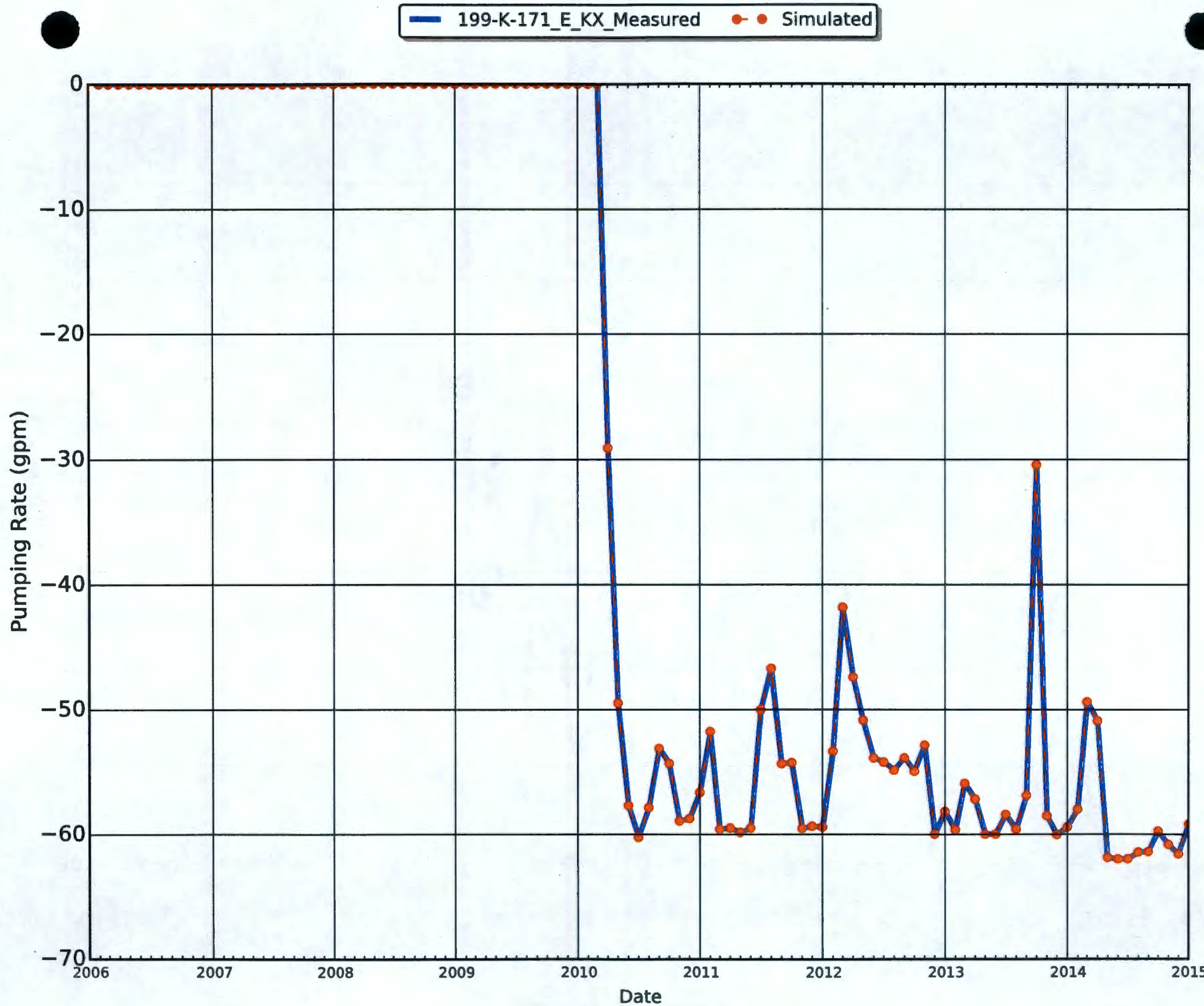

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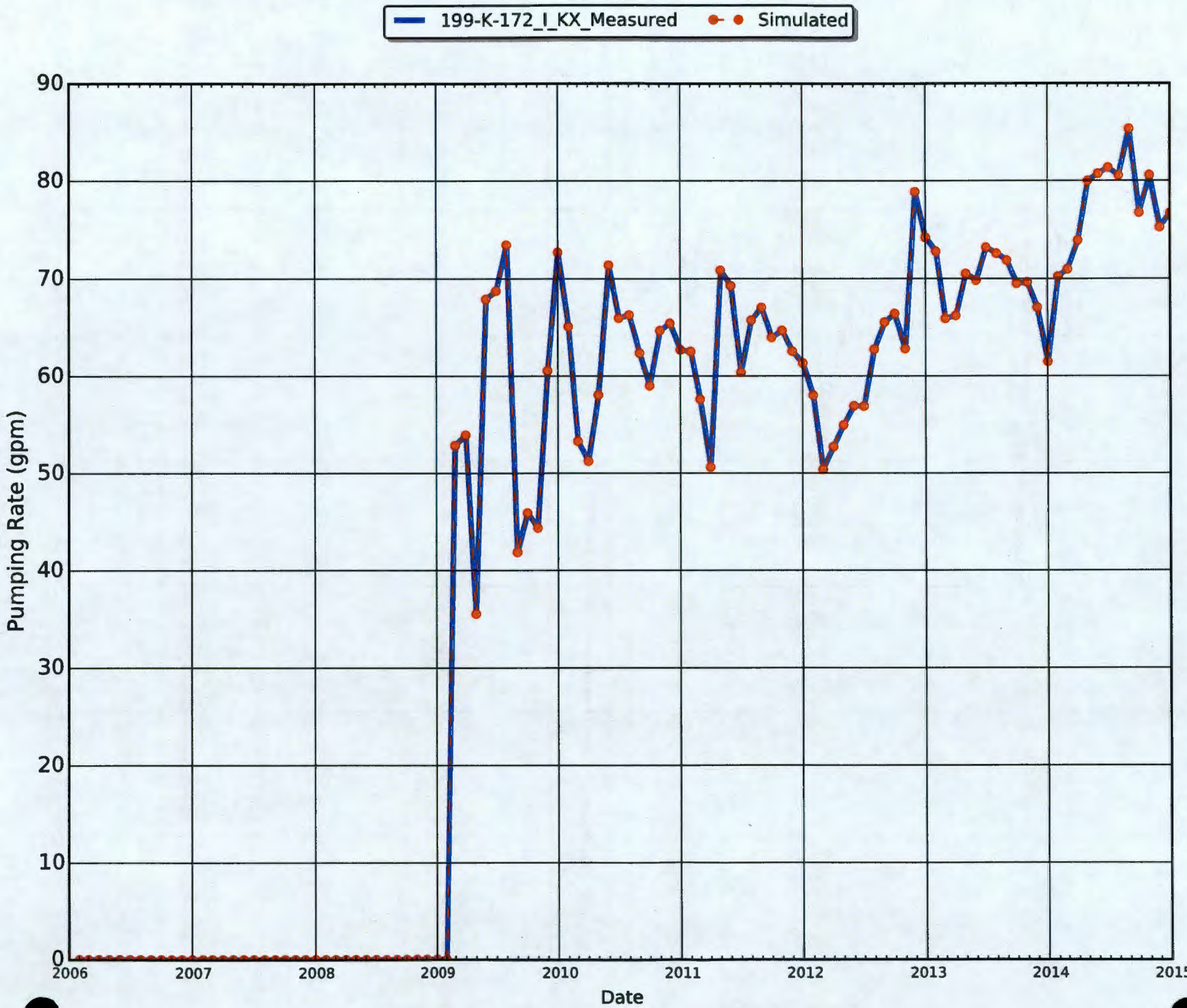
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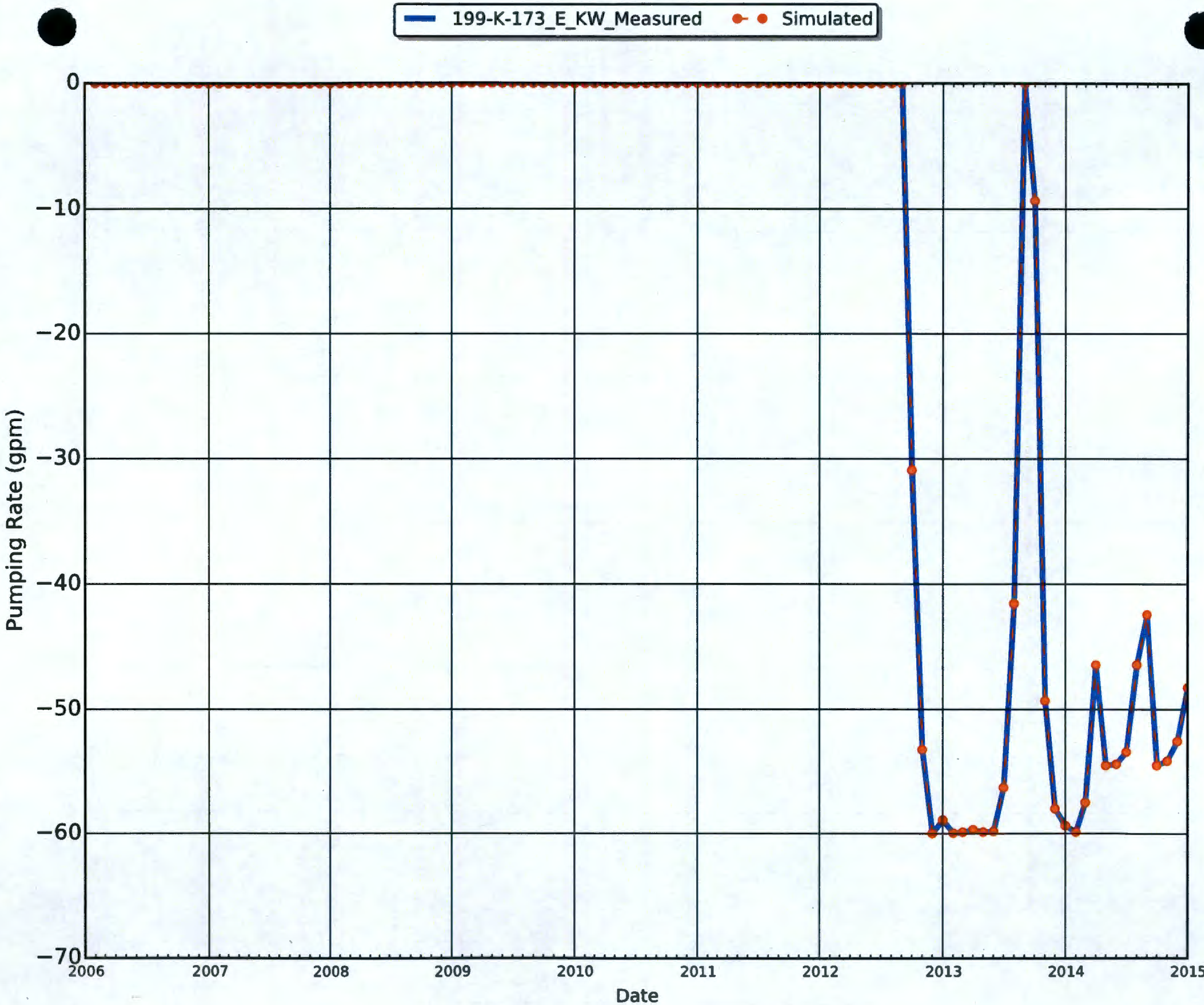

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Pumping Rate (gpm)
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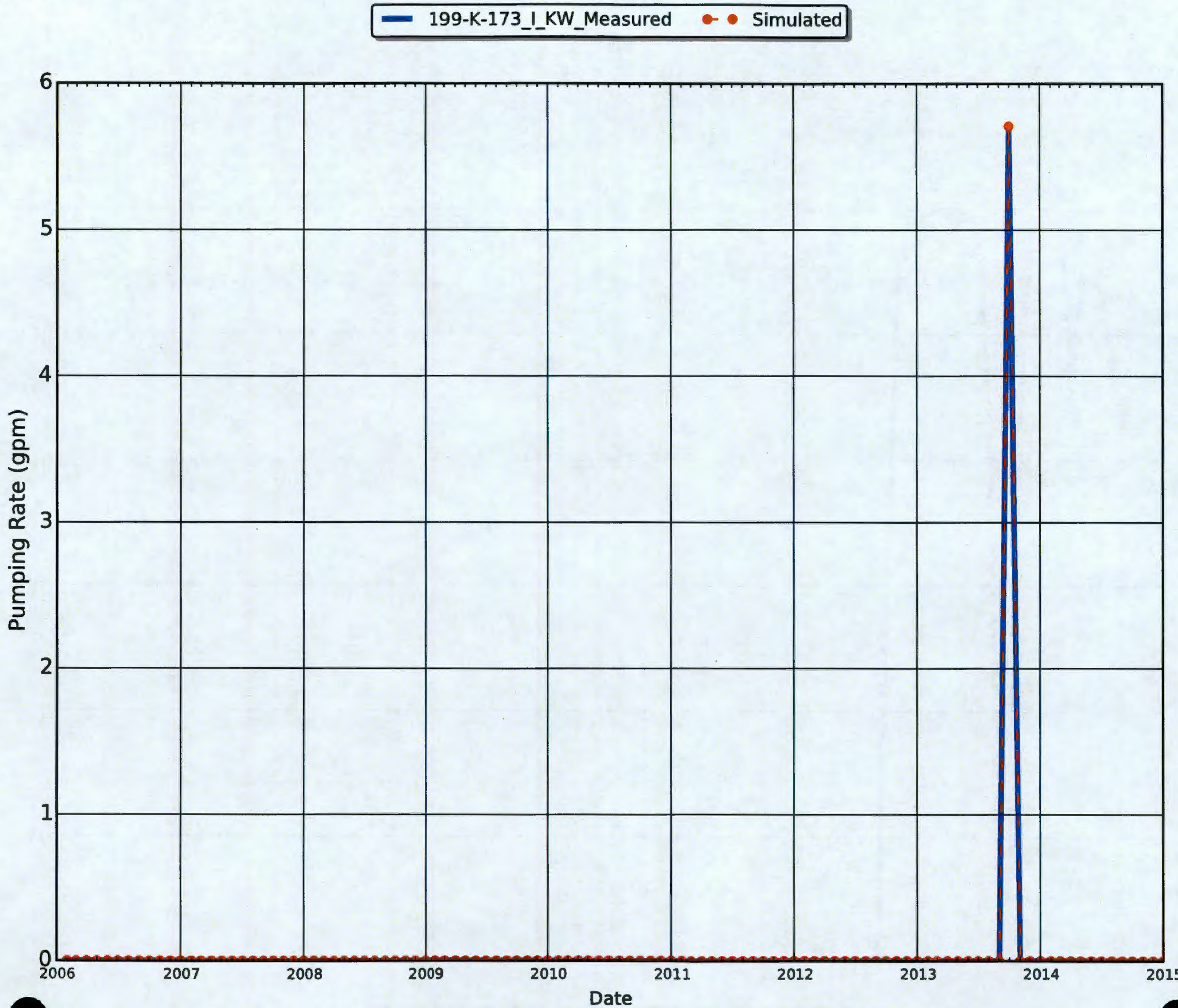
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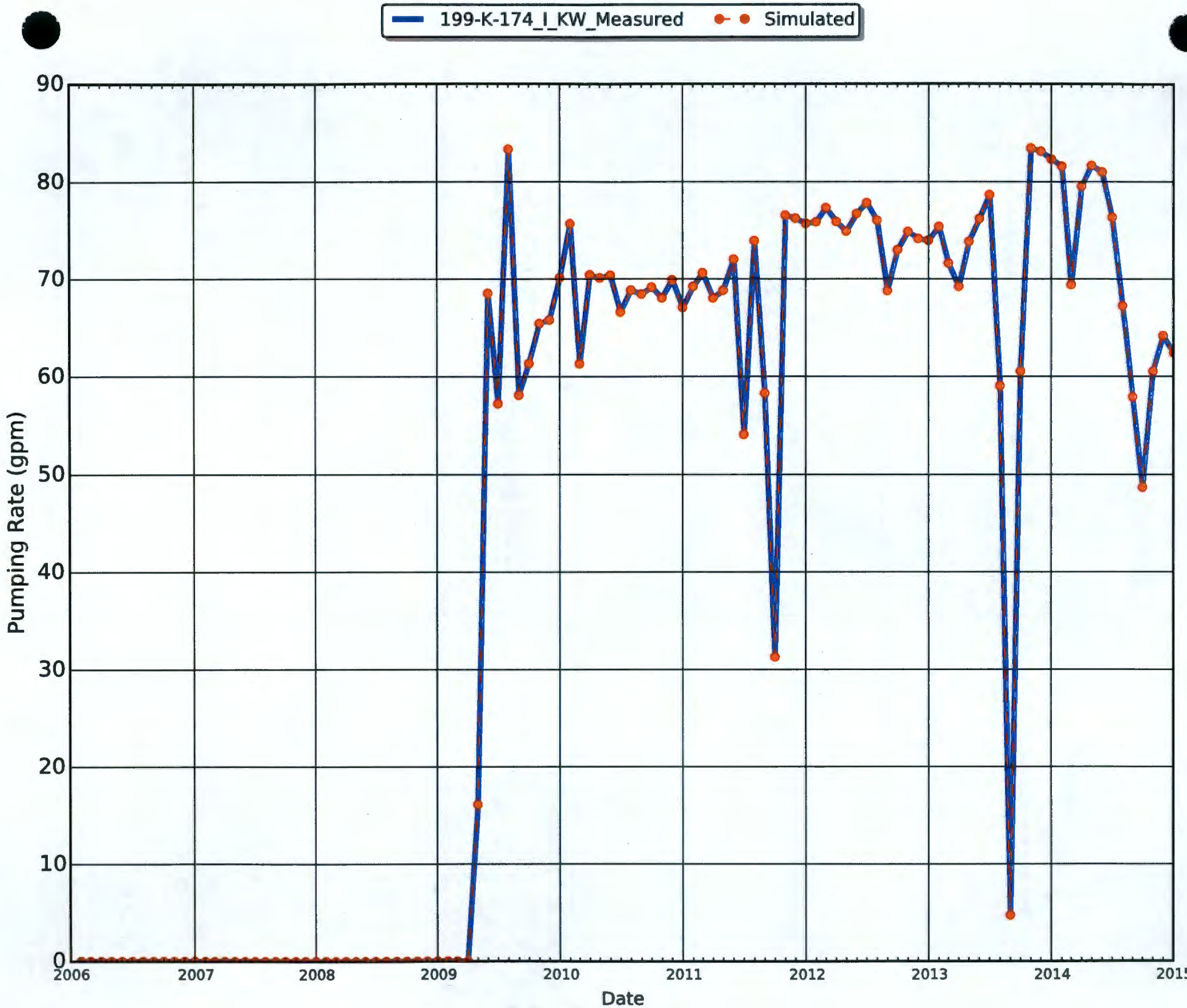
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Pumping Rate (gpm)
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Date

199-K-178_E_KX_Measured
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Pumping Rate (gpm)
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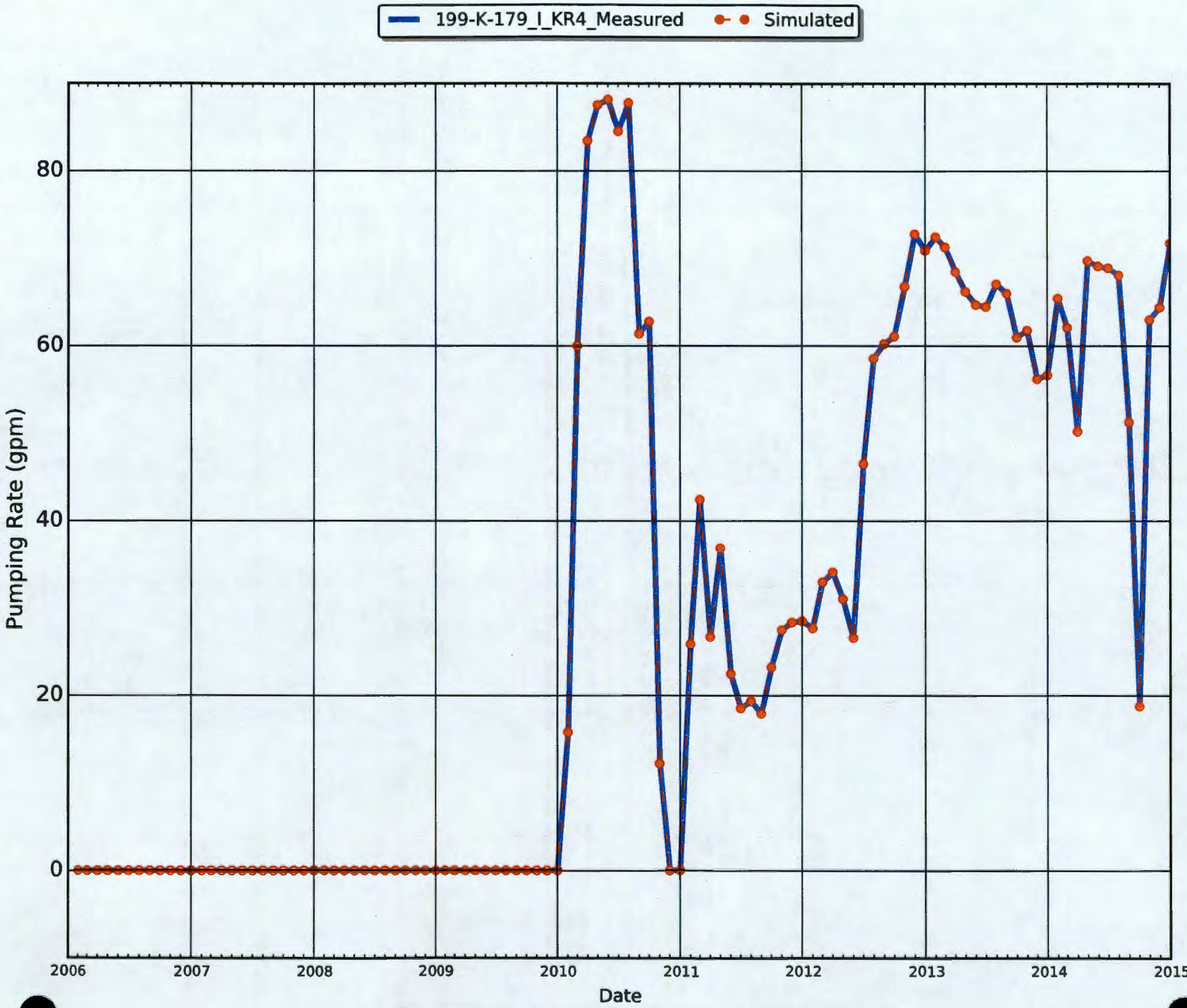
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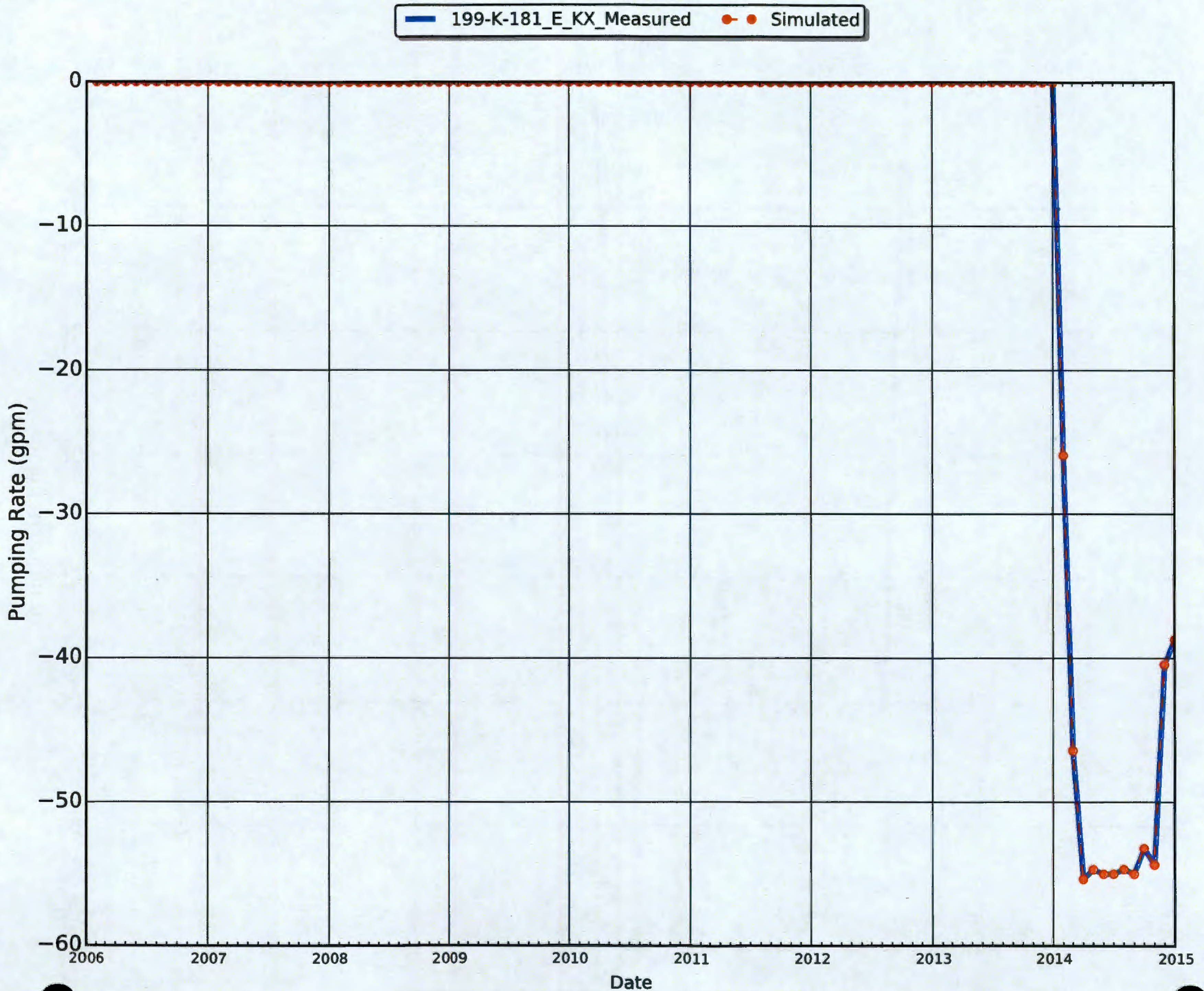
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Date


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Pumping Rate (gpm)
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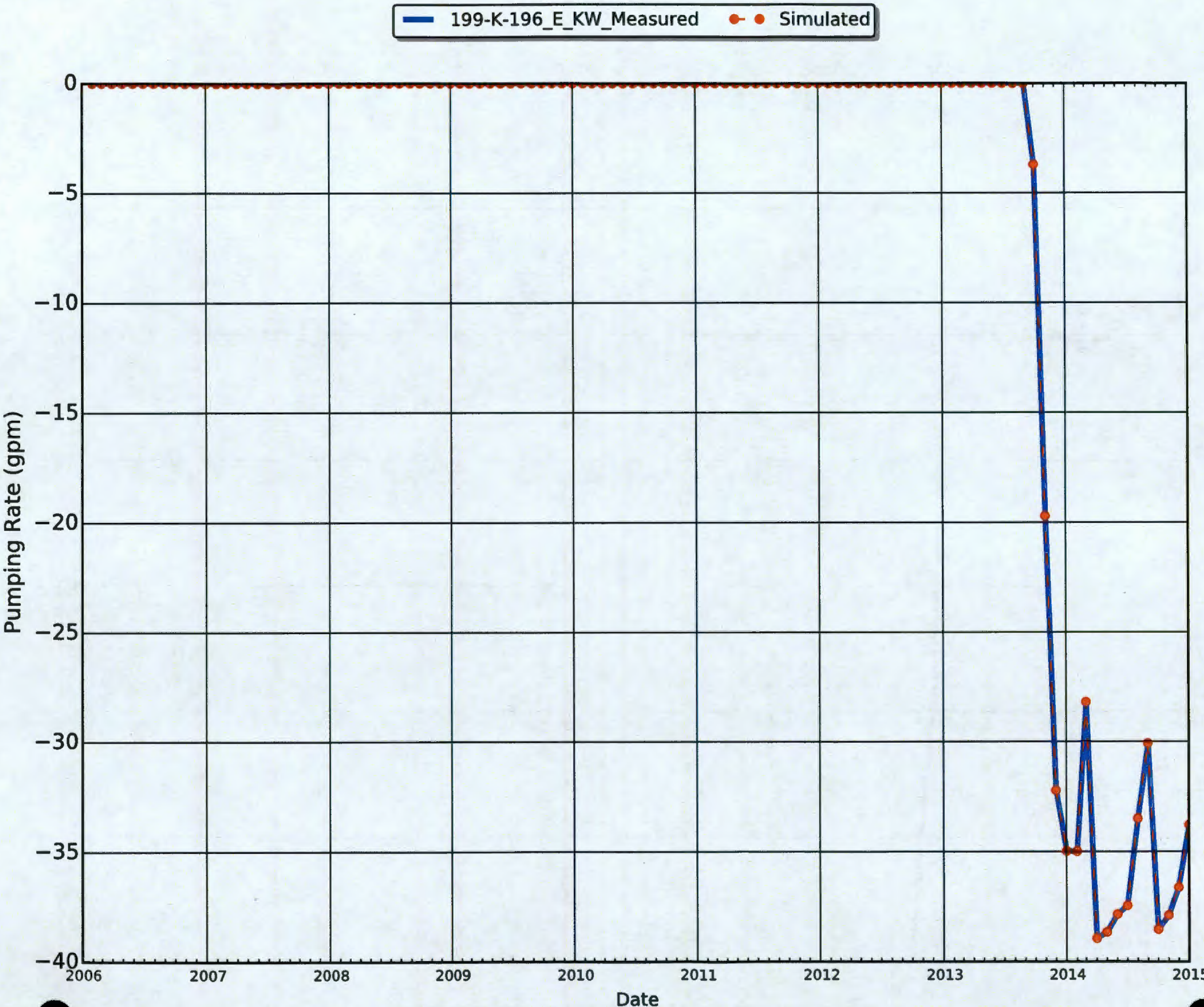

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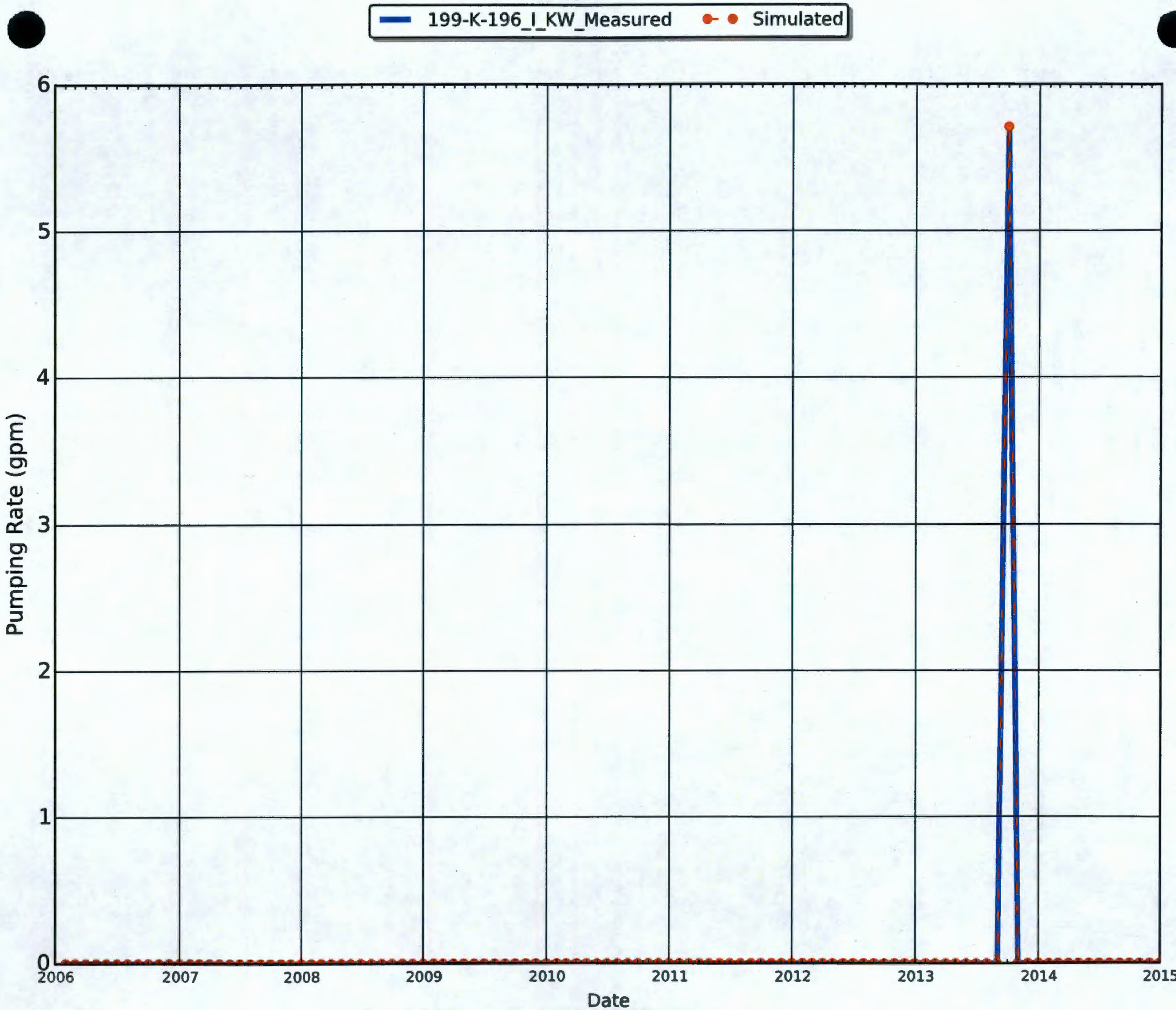

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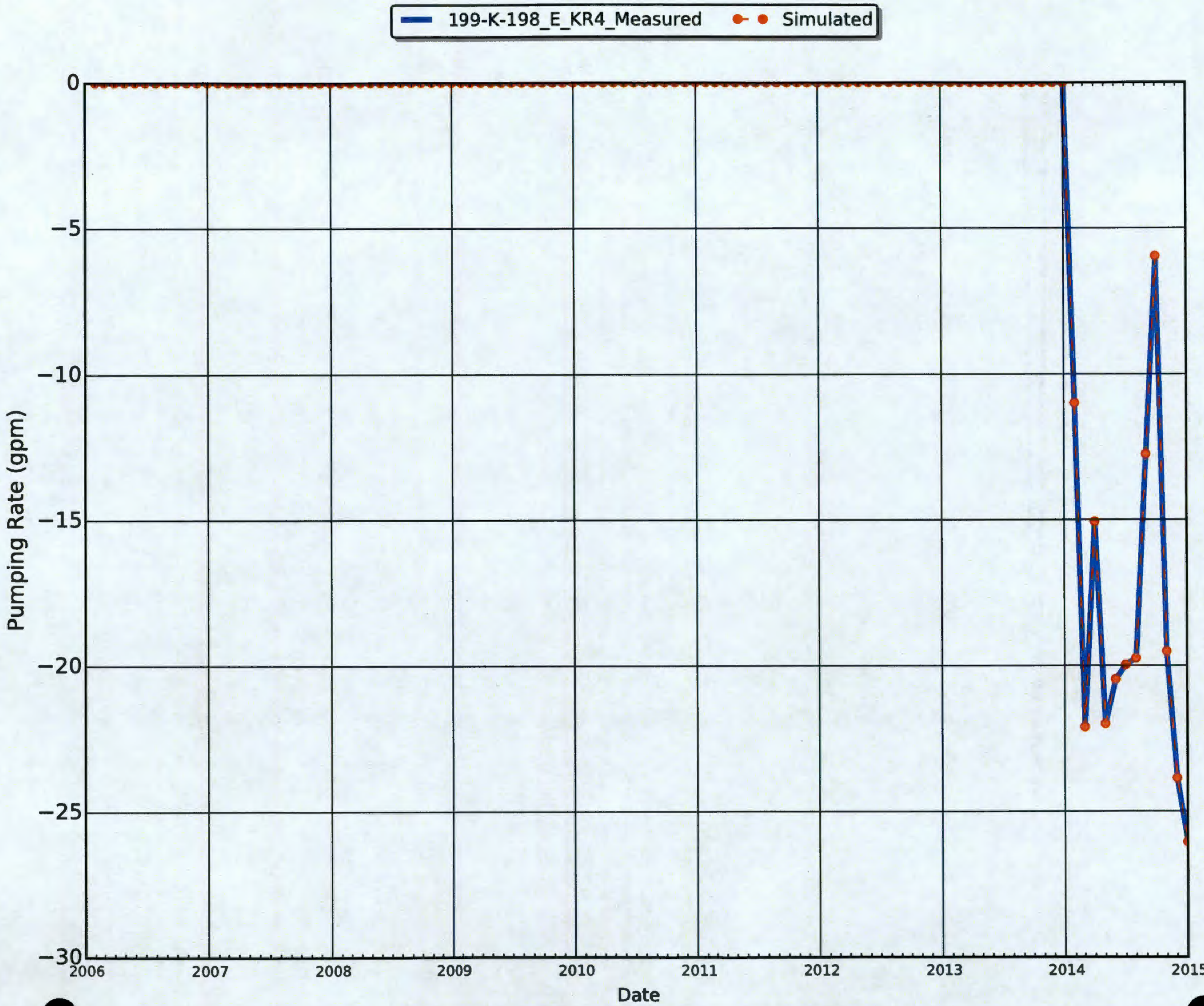
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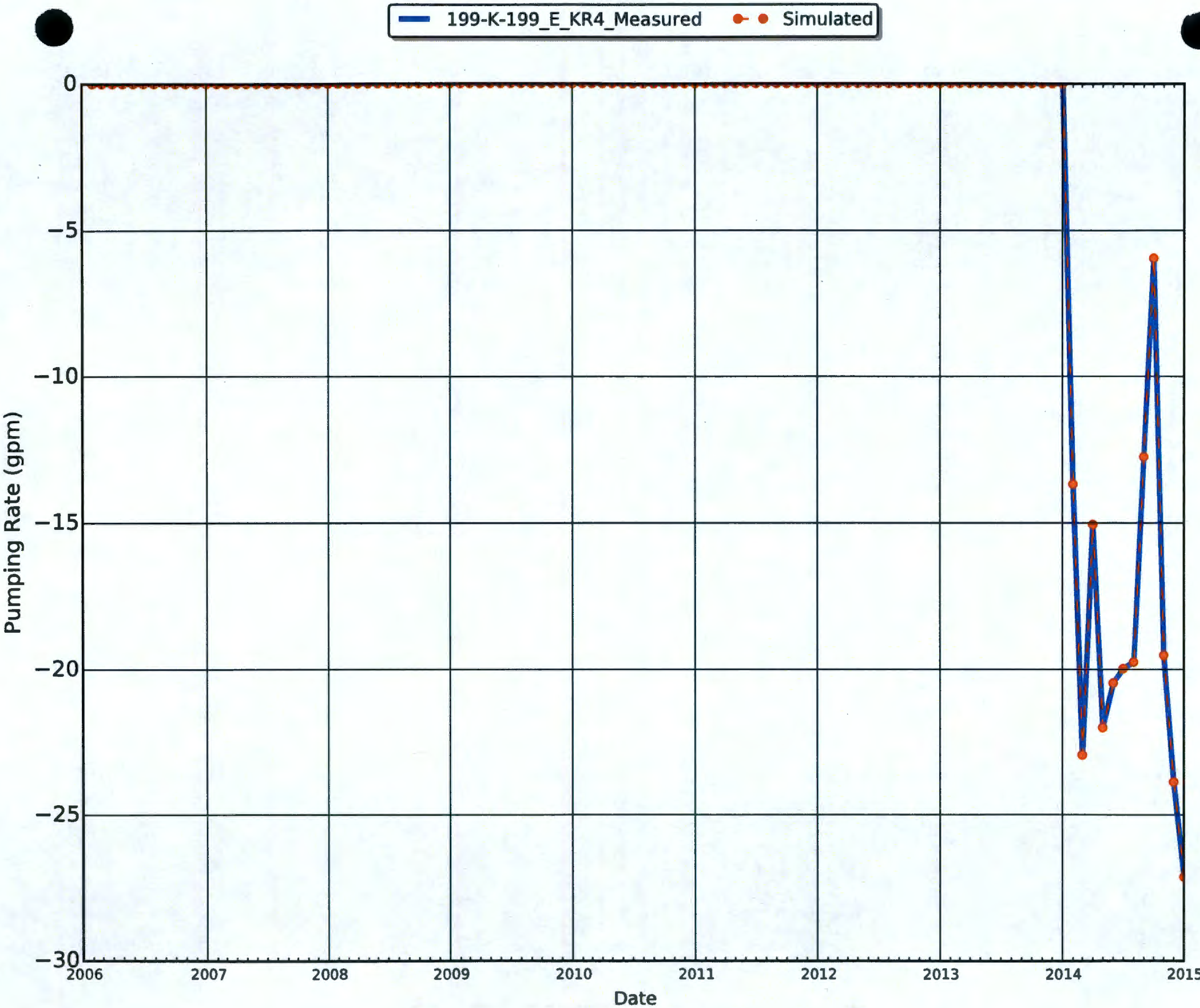
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Pumping Rate (gpm)
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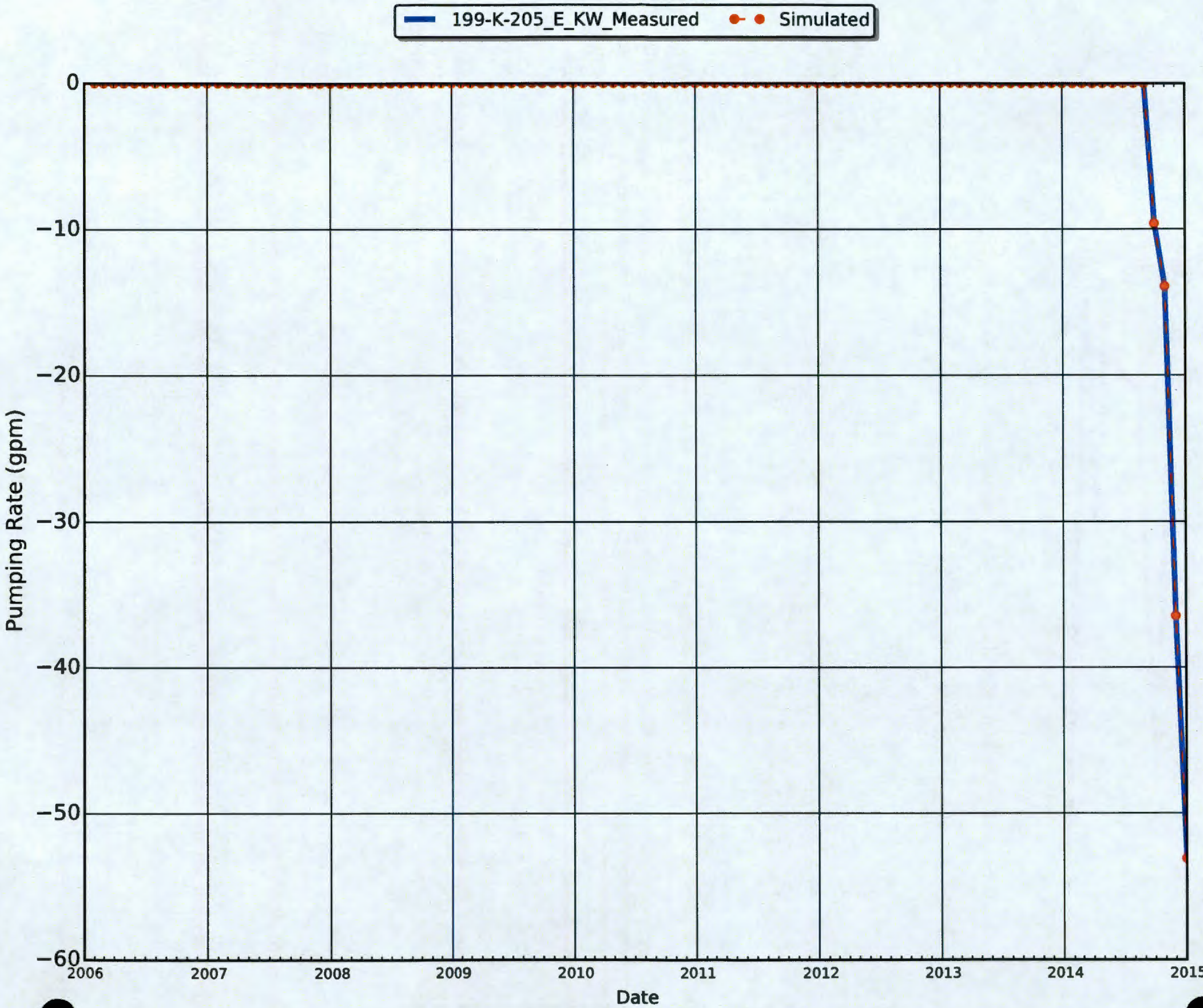
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Pumping Rate (gpm)
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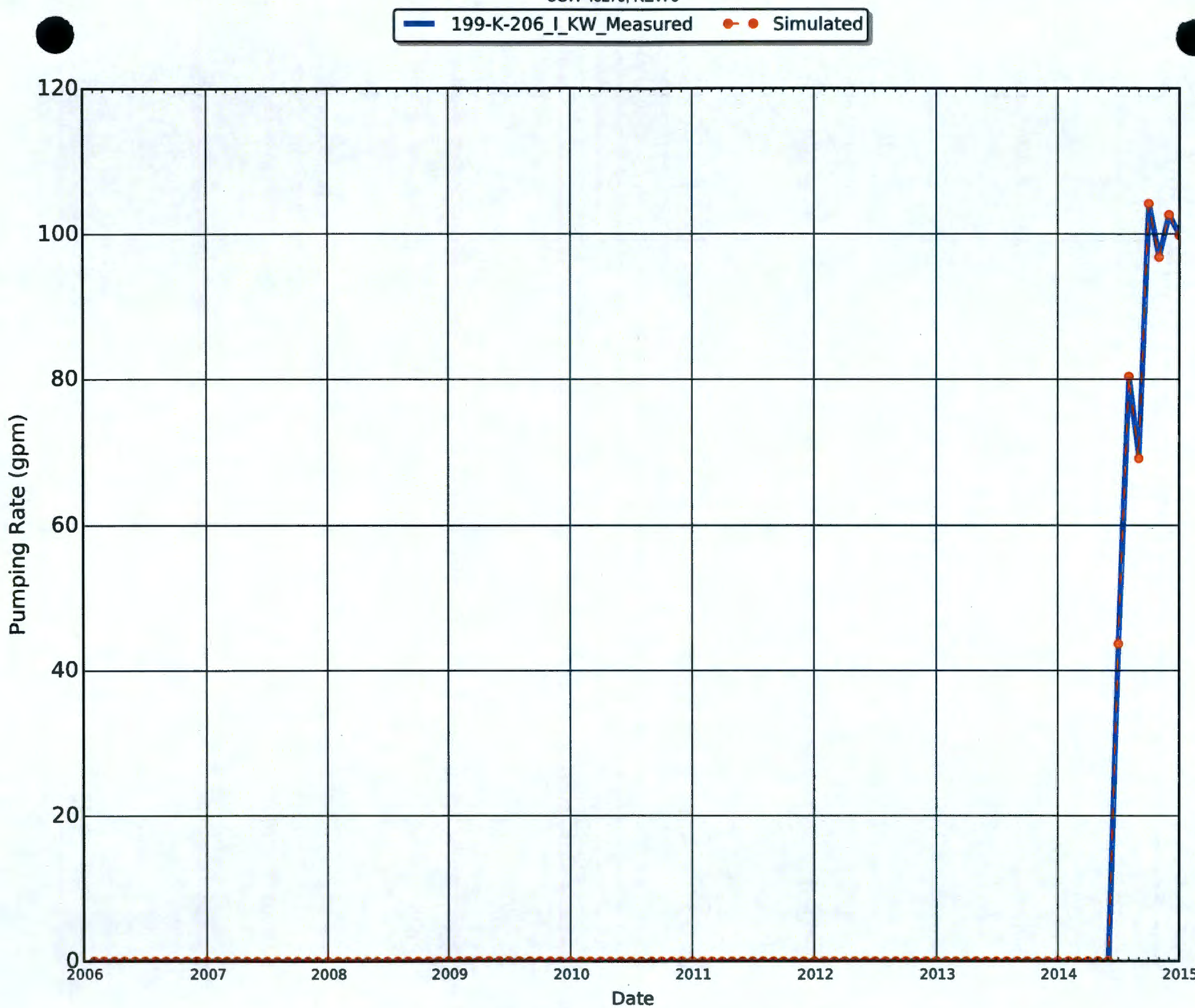
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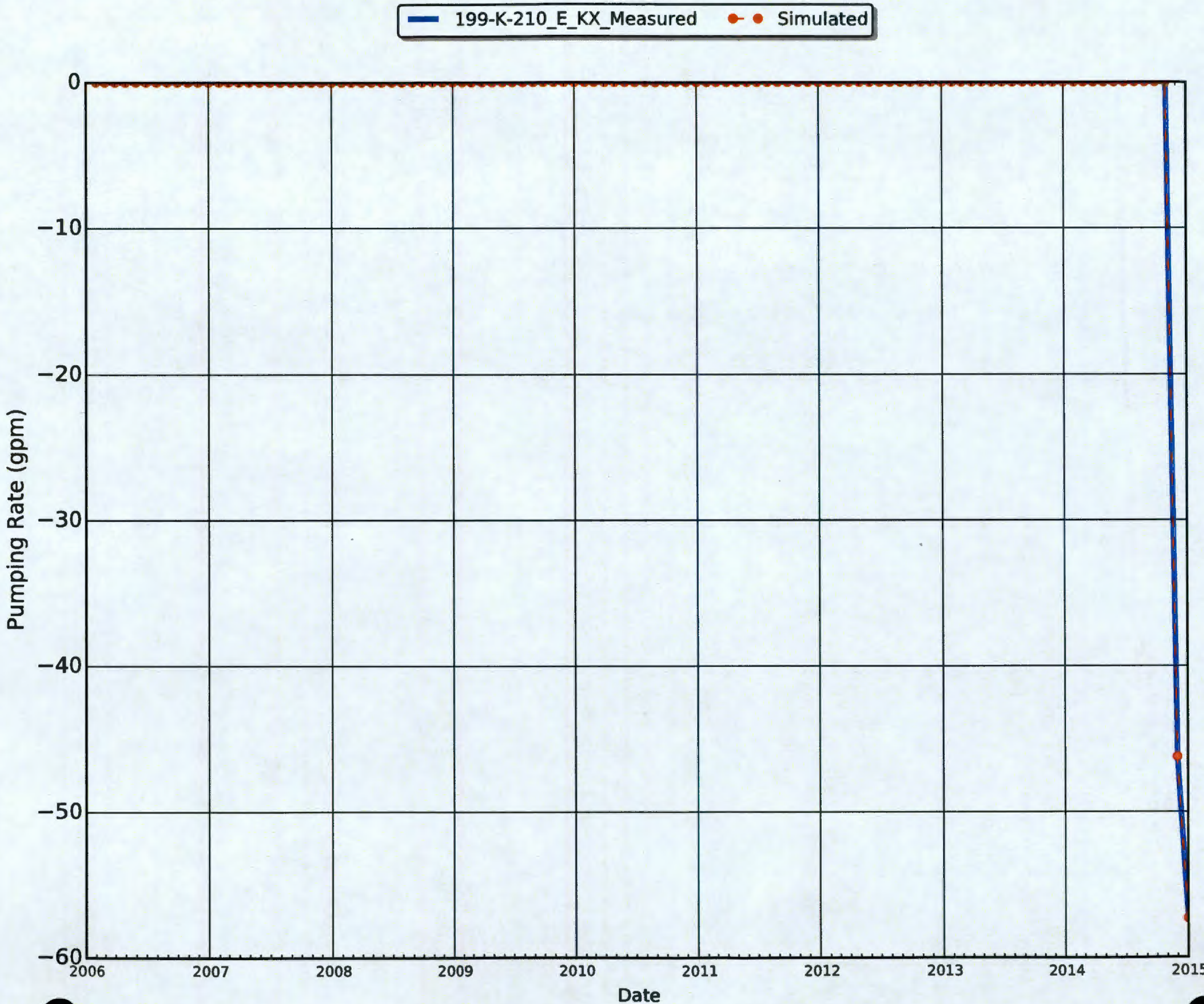
Date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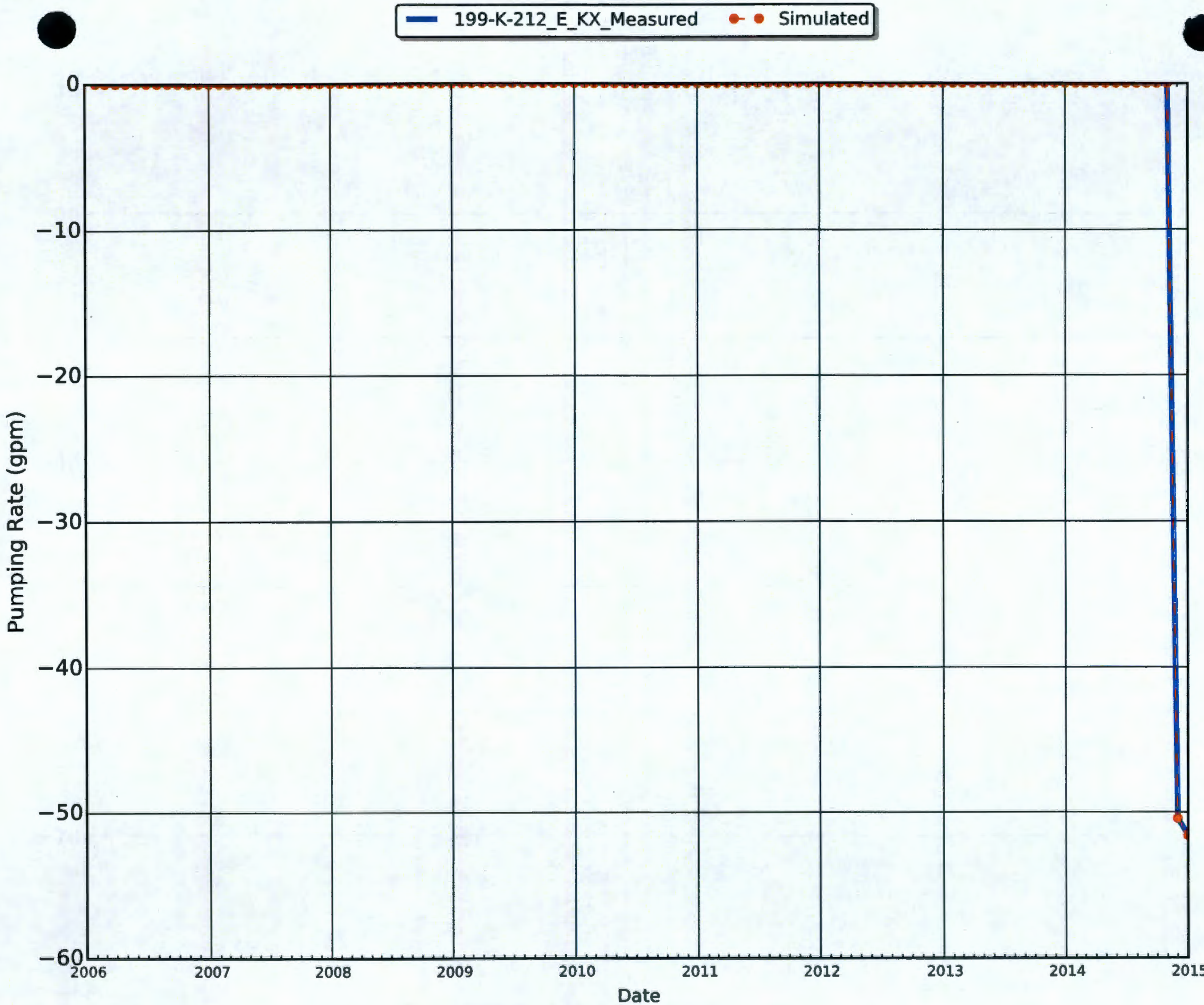
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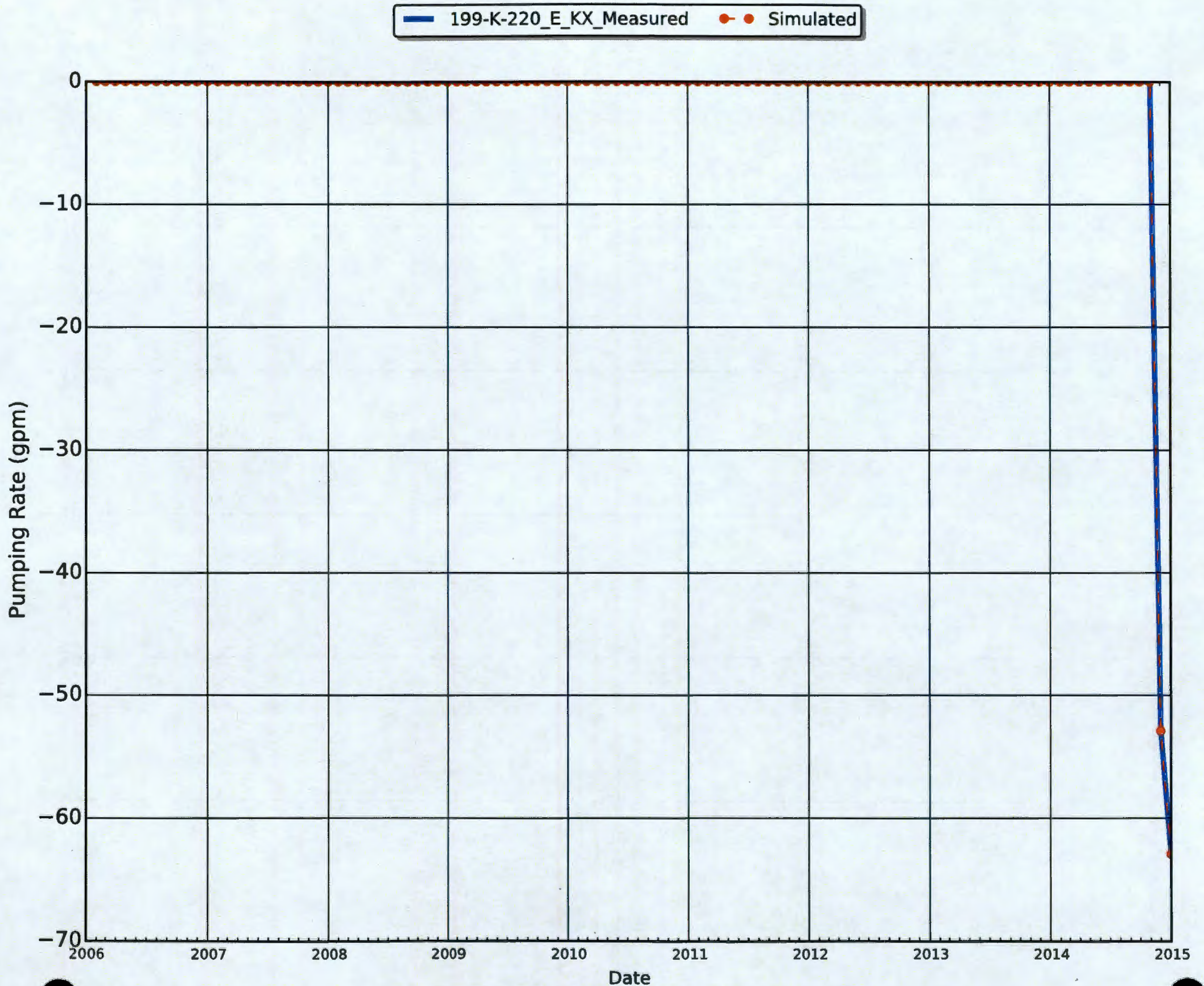
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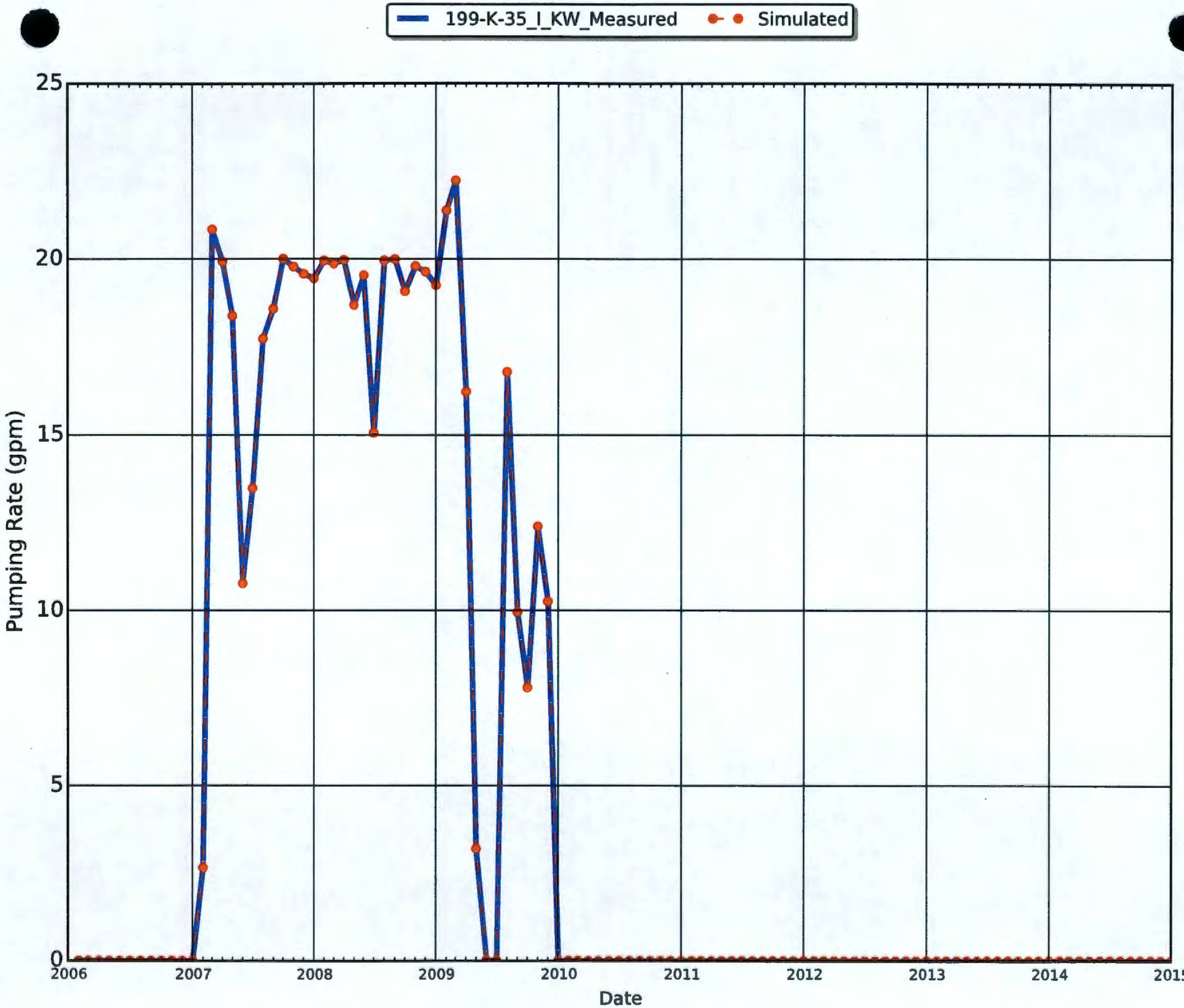
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Pumping Rate (gpm)
2006
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2015
Date

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# Appendix G

# Development and Verification of the 100 Area Two-Dimensional Pumping Optimization Model

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# Contents

# Figures



# Tables

# Terms

| | |
|---|---|
| 100AGWM | 100 Area Groundwater Model |
| 3D | three-dimensional |
| CHPRC | CH2M HILL Plateau Remediation Company |
| Cr(VI) | hexavalent chromium |
| CY | calendar year |
| GHB | general head boundary |
| HISI | Hanford Information Systems Inventory |
| LPF | layer property flow |
| OU | operable unit |
| OS | operating system |
| POM | Pumping Optimization Model |
| SSP&A | S.S. Papadopulos & Associates, Inc. |

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# G1 Background and Purpose

The 100 Area Groundwater Model (100AGWM) has been developed and calibrated to support remedy design and evaluation in the Hanford 100 Areas. 100AGWM, because of its lengthy run times, is not ideal for testing alternative pumping configurations to optimize remediation and mass recovery. Hence, a 2D version of 100AGWM was created to support pumping optimization. This model is referred to as the 100 Area Pumping Optimization Model (POM). The domain of the POM is the same as that of 100AGWM, as shown in Figure G-1. The model grid and boundary conditions are shown in Figures G-2 and G-3, respectively. The POM will be used by operable unit (OU) scientists via the INTERA Incorporated Plume Visualization Tool interface principally to evaluate the relative performance of alternative well configurations.

The development and verification of the POM are described in the subsequent sections of this appendix.

# G2 Test Scenarios

Likely future cumulative mass recovery of the pump and treat systems in the 100-HR-3 and 100-KR-4 OUs, and the fate of hexavalent chromium (Cr(VI)) in groundwater is tested under two pumping scenarios:

- *Historical*: Simulation of historical conditions from January 2006 to the end of December 2014. While the flow models simulate the entire period, particle-tracking and transport models are run to simulate calendar year (CY) 2014 conditions only.
- *Predictive*: The CY 2014 boundary conditions and pumping rates were cycled annually to simulate hypothetical conditions from 2015 to 2075. The period between January 2014 and December 2025 was simulated using monthly stress periods. A single stress period was used to simulate conditions between 2026 and 2075 to keep model run times and output file sizes at a manageable level. For the predictive case, only the flow and transport models were run; the particle-tracking model was not run.

Information on boundary conditions, pumping wells, and rates is provided in Section 3.7 of the model documentation report and in Appendix C. 100AGWM and the equivalent POM were used for simulating flow, hydraulic capture, and contaminant transport representing the two scenarios described previously. Flow and mass budgets, zones of hydraulic capture, simulated concentrations, and model run times are compared against the results from the three-dimensional (3D) 100AGWM.

# G3 Software Applications, Descriptions, Installation and Checkout, and Statements of Validity

Software use for this calculation was in accordance with PRC-PRO-IRM-309, *Controlled Software Management*.

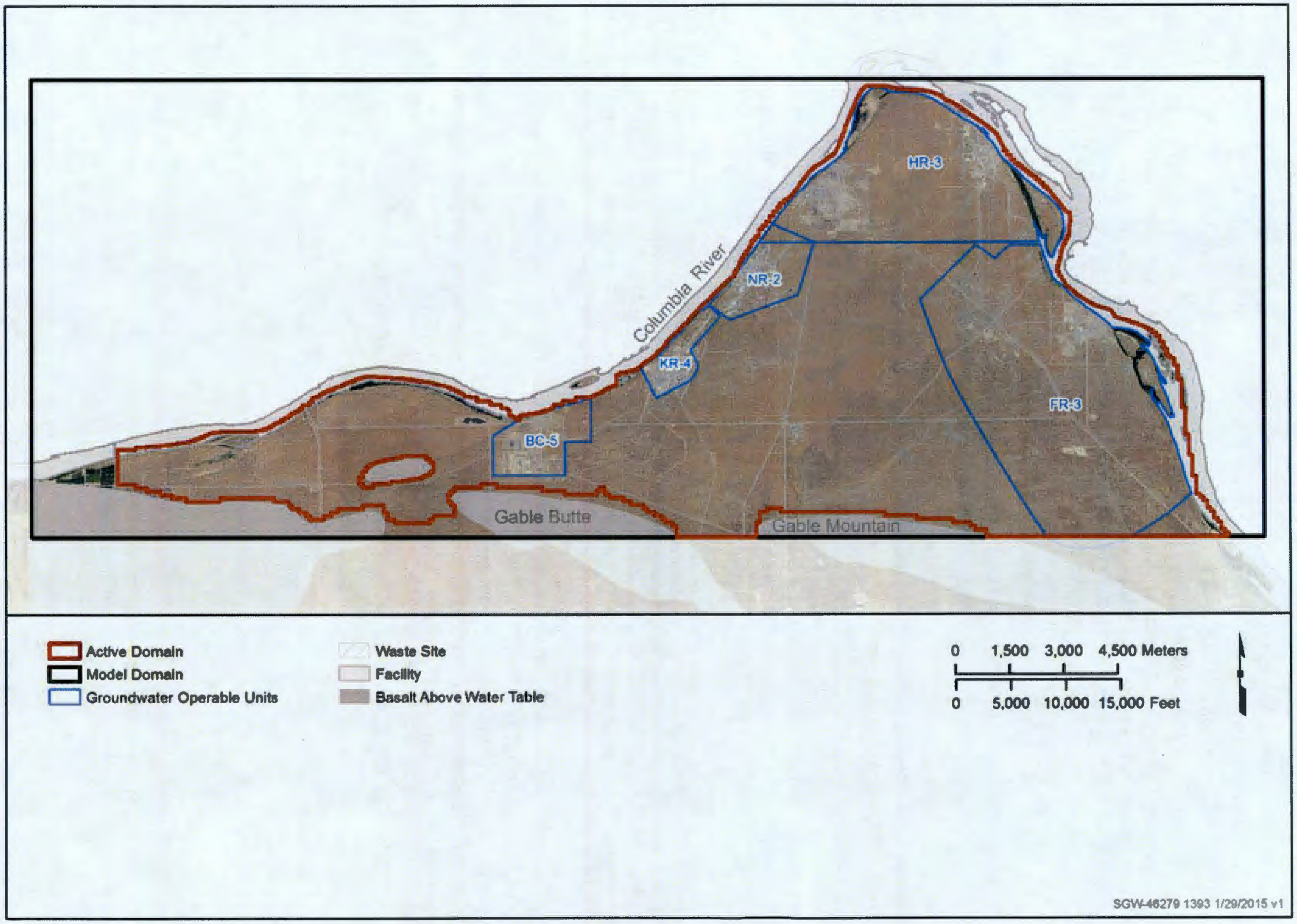


**Figure G-1. 100AGWM and POM Domain**

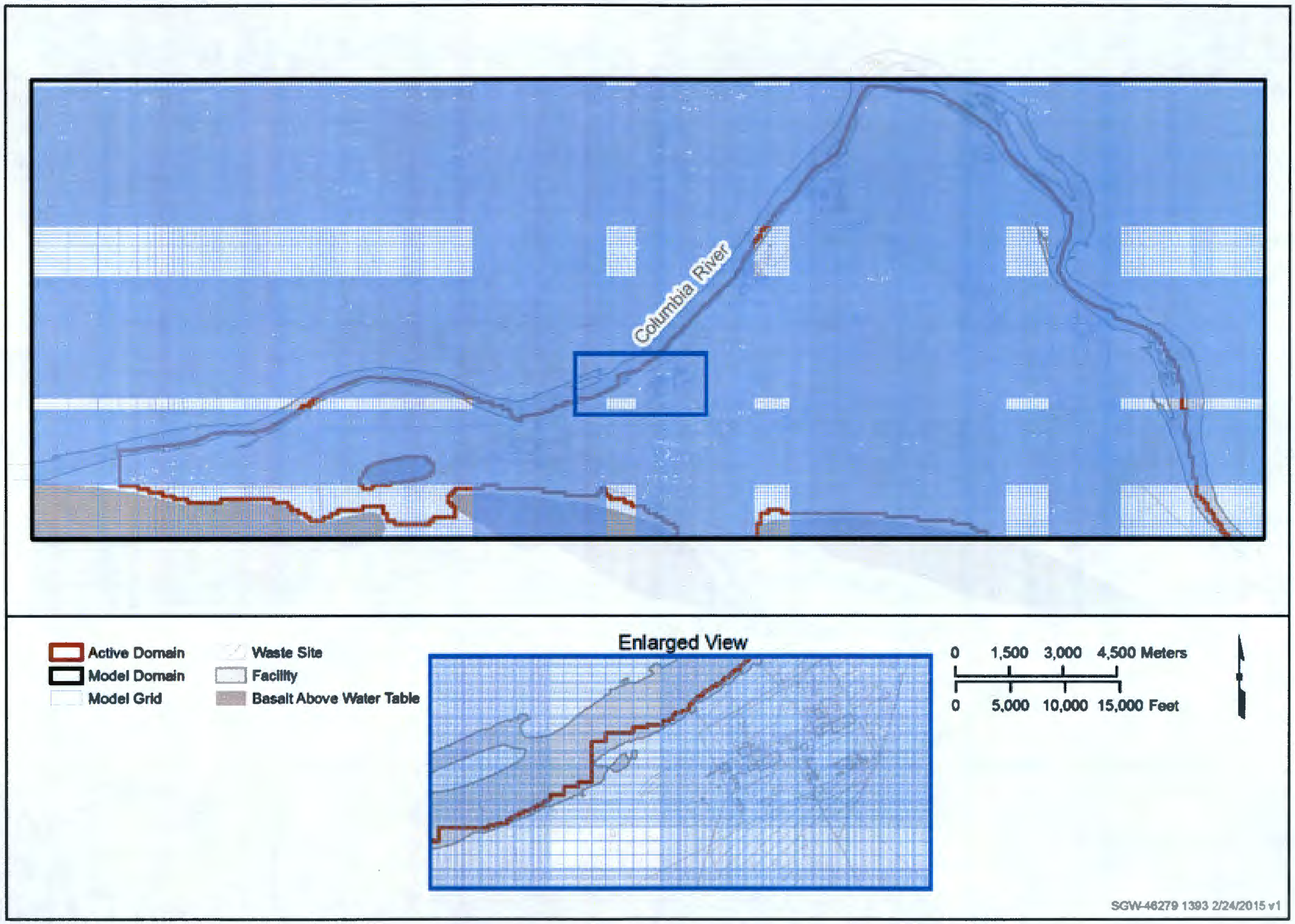


**Figure G-2. 100AGWM and POM Grid**

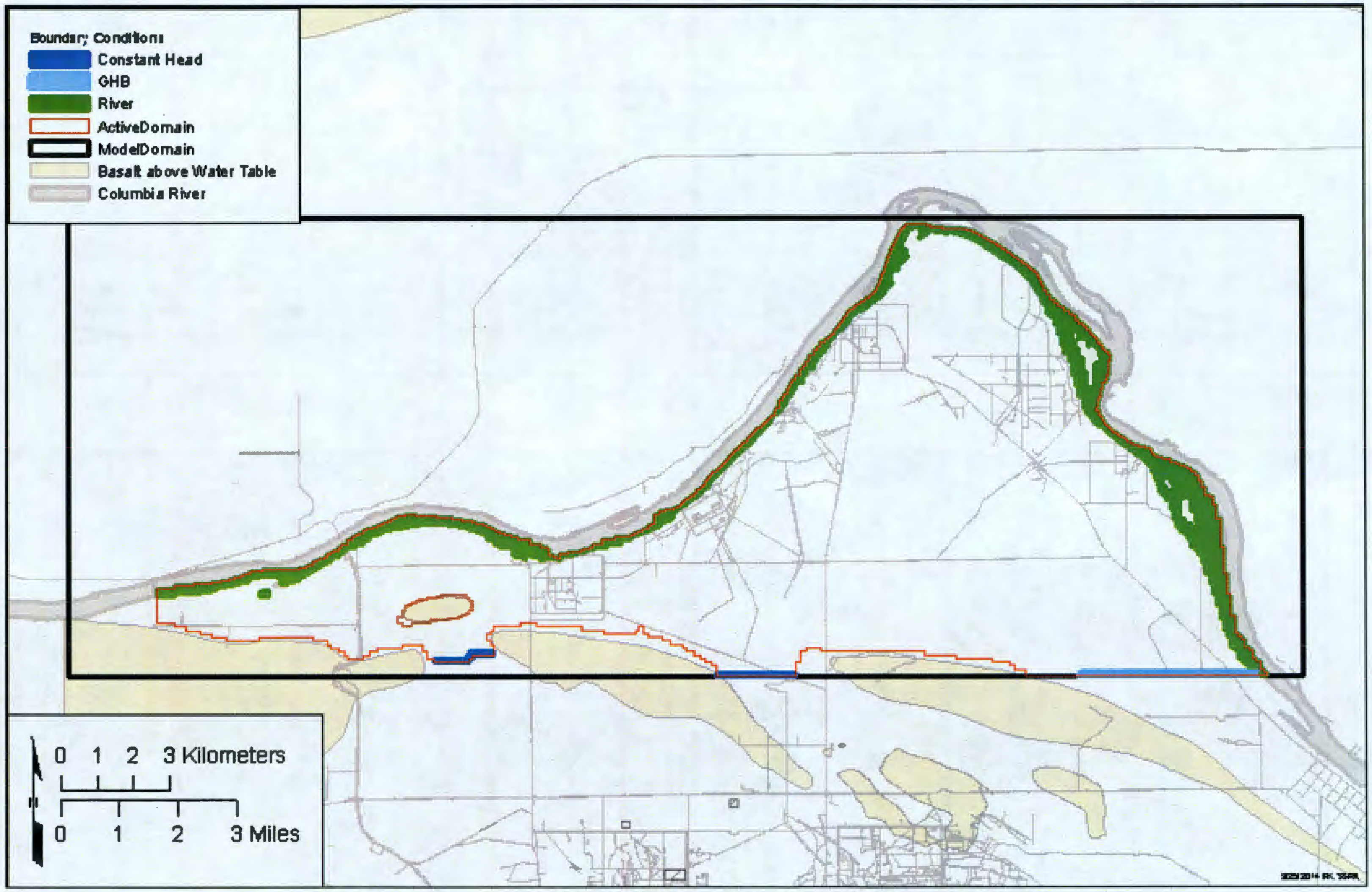


**Figure G-3. 100AGWM and POM Boundary Conditions**

## G3.1 Approved Software

The approved software used to perform calculations is managed under the following documents consistent with PRC-PRO-IRM-309:

- 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*

CHPRC-00258 distinguishes between safety software and support software based on whether the software managed calculates reportable results or provides run support, visualization, or other similar functions. Brief descriptions of the software are provided in the following subsections.

## G3.2 Descriptions

### G3.2.1 MODFLOW (Controlled Calculation Software)

- **Software title:** MODFLOW-2000 (Harbaugh, et al., 2000, *MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model—User Guide to Modularization Concepts and the Ground-Water Flow Process*); solves transient groundwater flow equations using the finite-difference discretization technique.

- **Software version:** Version 1.19.01 modified by S.S. Papadopulos and Associates, Inc. (SSP&A) to address dry cell issues and to use the Orthomin solver; approved as CH2M HILL Plateau Remediation Company (CHPRC) Build 7 using executable file "mf2k-mst-chprc07dpv.exe" compiled to default double precision for real variables and optimized for speed. The MD5 Hash for this executable file is "4E7F29DD5496D2CBA7144ADACB13DAAD".

- **Hanford Information Systems Inventory (HISI) ID number:** 2517 (Safety Software, graded Level C).

- **Workstation type and property number (from which software is run):** SSP&A, FE483.

### G3.2.2 MT3DMS (Controlled Calculation Software)

- **Software title:** MT3DMS (Zheng and Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*; Zheng, 2010, *MT3DMS v5.3: Supplemental User's Guide – Technical Report*).

- **Software version:** Version 5.3 modified by SSP&A to address dry cell issues; approved as CHPRC Build 7 using executable file "mt3d-mst-chprc07dpv.exe " compiled to default double precision for real variables and optimized for speed. The MD5 Hash for this executable file is "A09EDC957F6B19A8CD3968EA901355CB".

- **HISI ID number:** 2518 (Safety Software, graded Level C).

- **Workstation type and property number (from which software is run):** SSP&A, FE483.

### G3.2.3 MODPATH (Controlled Calculation Software)

- **Software title:** MODPATH (Pollock, 1994, *User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U. S. Geological Survey finite-difference ground-water flow model*). A particle-tracking post-processor developed for use with the MODFLOW codes evaluated the approximate directions and rates of groundwater flow and the approximate extent of hydraulic capture developed by proposed pump and treat well configurations.
- **Software version:** Version 5 modified by SSP&A to address dry cell issues; approved as CHPRC Build 6 using the SSP&A-compiled executable file "modpath_mst_build6.exe".
- **Workstation type and property number (from which software is run):** SSP&A, FE483.

## G4 POM: Construction of Flow Model

Groundwater flow is simulated with MODFLOW. The file modifications required to create an equivalent POM from the 3D 100AGWM are tabulated in Table G-1.

**Table G-1. Modifications to MODFLOW Files**

| MODFLOW File | Modification(s) |
|---|---|
| BAS | IBOUND array → Keep only layer 1.<br>Starting head → Keep only layer 1. |
| DIS | NLAY → Change 4 to 1.<br>Top and bottom elevation:<br>Top of first model layer → Top of the 1-layer model<br>Bottom of the 4th model layer → Bottom of the 1-layer model. |
| LPF | Hydraulic conductivity → Equivalent hydraulic conductivity (Equation G.1).<br>Specific storage → Keep only layer 1.<br>Specific yield → Keep only layer 1. |
| RIV | Use an equivalent river conductance (Equation G.2). |
| GHB | Include GHB cells from layer 1 only. Use an equivalent GHB conductance (Equation G.2). |
| CHD | Constant head cells are defined only in layer 1. |

## G4.1 LPF: Calculation of Equivalent Hydraulic Conductivity

Equivalent hydraulic conductivity is calculated as follows:

$$K_{eq} = \frac{\sum_{i=1}^{4} K_i B_i}{\sum_{i=1}^{4} B_i} \qquad \text{Equation G.1}$$

where:

$K_{eq}$ = is the equivalent hydraulic conductivity of a cell in the 1-layer model.

$K_i$ = is the hydraulic conductivity of the model layer i.

$B_i$ = is the saturated thickness of the model layer *i*.

## G4.2 GHB and River: Calculation of Equivalent Conductance

The equivalent general head boundary (GHB) and river conductances of the cells are calculated using the following equation:

$$Cond_{eq} = \sum_{i=1}^{4} Cond_i * index_i \qquad \text{Equation G.2}$$

where:

$Cond_{eq}$ = is the equivalent conductance of the GHB/river cell in the 1-layer model.

$Cond_i$ = is the conductance of the GHB/river cell in model layer i.

$index_i$ = is an integer with a value of 1 if there is an active GHB/river cell in model layer *i* and 0 otherwise.

## G4.3 Results and Verification

The model run times on an Intel core i7 CPU @ 3.4 GHz with a 64-bit Windows® operating system (OS) are provided in Table G-2. The POM flow model runs 11 times faster than the 100AGWM flow model.

**Table G-2. Flow Model Run Times**

| Scenario | 100AGWM Run Time | POM Run Time | Speedup (100AGWM/POM) |
|---|---|---|---|
| Historical | 105 minutes | 9 minutes | ~11 |
| Predictive | 145 minutes | 13 minutes | ~11 |

100AGWM = 100 Area Groundwater Model
POM = Pumping Optimization Model

Comparisons of the flow budgets for the historical and predictive simulations are provided in Figures G-4 and G-5, respectively. Comparisons of the cumulative water budgets for the historical and predictive simulations are provided in Figures G-6 and G-7, respectively. Both sets of comparisons show that the flow budgets for the single-layer POM match the flow budgets for the four-layer 3D 100AGWM.

® Windows is a registered trademark of Microsoft Corporation, Redmond, Washington.

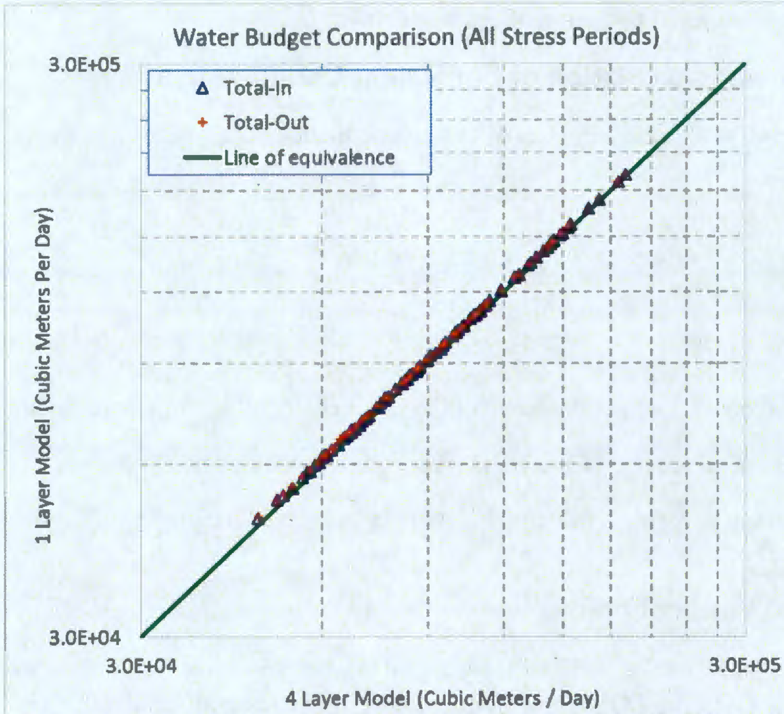


**Figure G-4. Historical Scenario (Water Budget Comparison)**

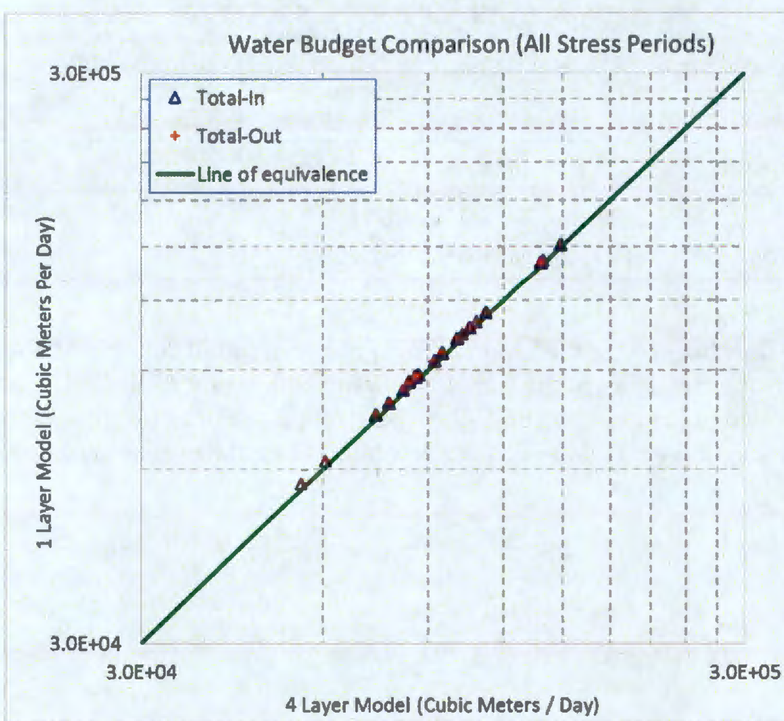


**Figure G-5. Predictive Scenario (Water Budget Comparison)**

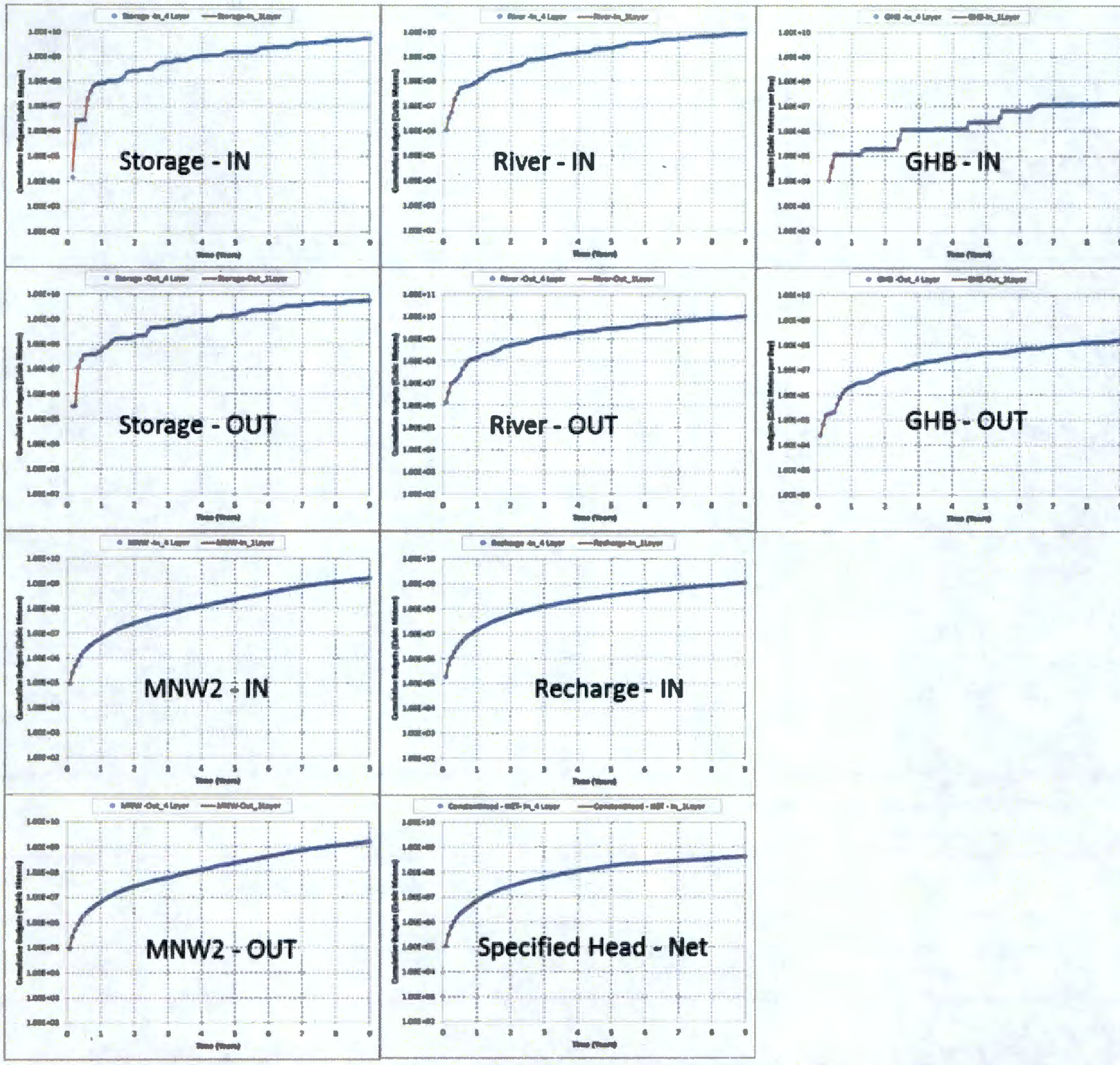


**Figure G-6. Historical Scenario (Cumulative Water Budget Comparison)**

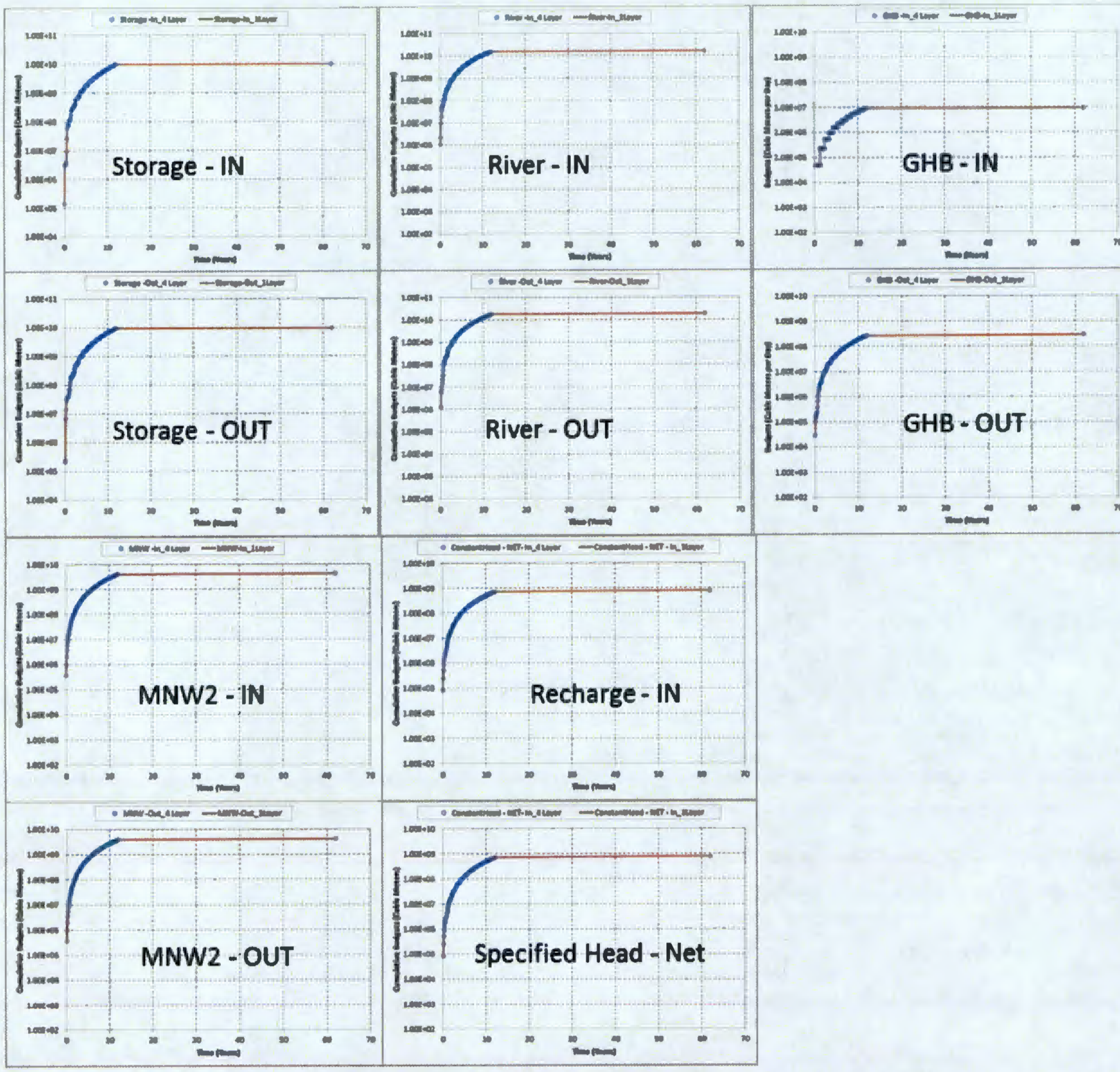


**Figure G-7. Predictive Scenario (Cumulative Water Budget Comparison)**

## G5 POM: Construction of Particle-Tracking Model

Simulated capture frequency maps (SCFMs) for the historical simulation are generated by post-processing the results of particle-tracking simulations performed with MODPATH. The methodology for generating SCFMs from particle-tracking simulations is described in Section 3.2 of SGW-42305, *Collection and Mapping of Water Levels to Assist in the Evaluation of Groundwater Pump-and-Treat Remedy Performance*. The file modifications required to create an equivalent particle-tracking model are described in Table G-3.

The results of MODPATH are post-processed to compute capture frequency. The changes required to the post-processor input files are provided in Table G-4.

**Table G-3. Modifications to MODPATH Files**

| MODPATH File | Modifications |
|---|---|
| Modpath.dat | IBOUND array → Keep only layer 1.<br>POROSITY → Keep only layer 1. |
| Modpath.nam | Update the names of the DIS, CBB, MST, and HDS files so that they reflect the names of the files used for the POM. |

POM = Pumping Optimization Model

**Table G-4. Modifications to MODPATH Post-Processor Input Files**

| File Name | Modification |
|---|---|
| CaptureLocationCodes_OnlyWells.txt | Update the number of wells to be the total number of wells in the 1-model layer only. Move all wells to model layer 1. |
| ReadEND_WriteCapture_H_L1_CapEff.IN | Update the name of the DIS file if it has been changed. |
| ReadEND_WriteCapture_K_L1_CapEff.IN | Update the name of the DIS file if it has been changed. |

## G5.1 POM: Verification of Hydraulic Capture Model

The run times for the particle-tracking model on an Intel core i7 CPU @ 3.4 GHz with a 64-bit Windows OS are provided in Table G-5.

**Table G-5. Run Times for Particle-Tracking Model**

| Scenario | 100AGWM Run Time | POM Run Time | Speedup |
|---|---|---|---|
| Full-Year Capture (2014) | 70 minutes | 26 minutes | 2.7 |

100AGWM = 100 Area Groundwater Model
POM = Pumping Optimization Model

The hydraulic capture maps for the 100-HR-3 and 100-KR-4 OUs are compared in Figures G-8 and G-9, respectively. For each OU, the capture maps from the POM are compared against the capture maps in the top and bottom layers of 100AGWM and also against the interpolated capture frequency map for 2014 (ECF-Hanford-15-0001, *Description of Groundwater Modeling Calculations and Assessment of the River Protection Objective for the Calendar Year 2014 (CY2014) 100 Areas Pump-and-Treat Report*).
The comparisons show that the results of the POM agree reasonably with the results of the 3D 100AGWM. The POM particle-tracking model runs nearly three times faster than the 3D 100AGWM particle-tracking model.

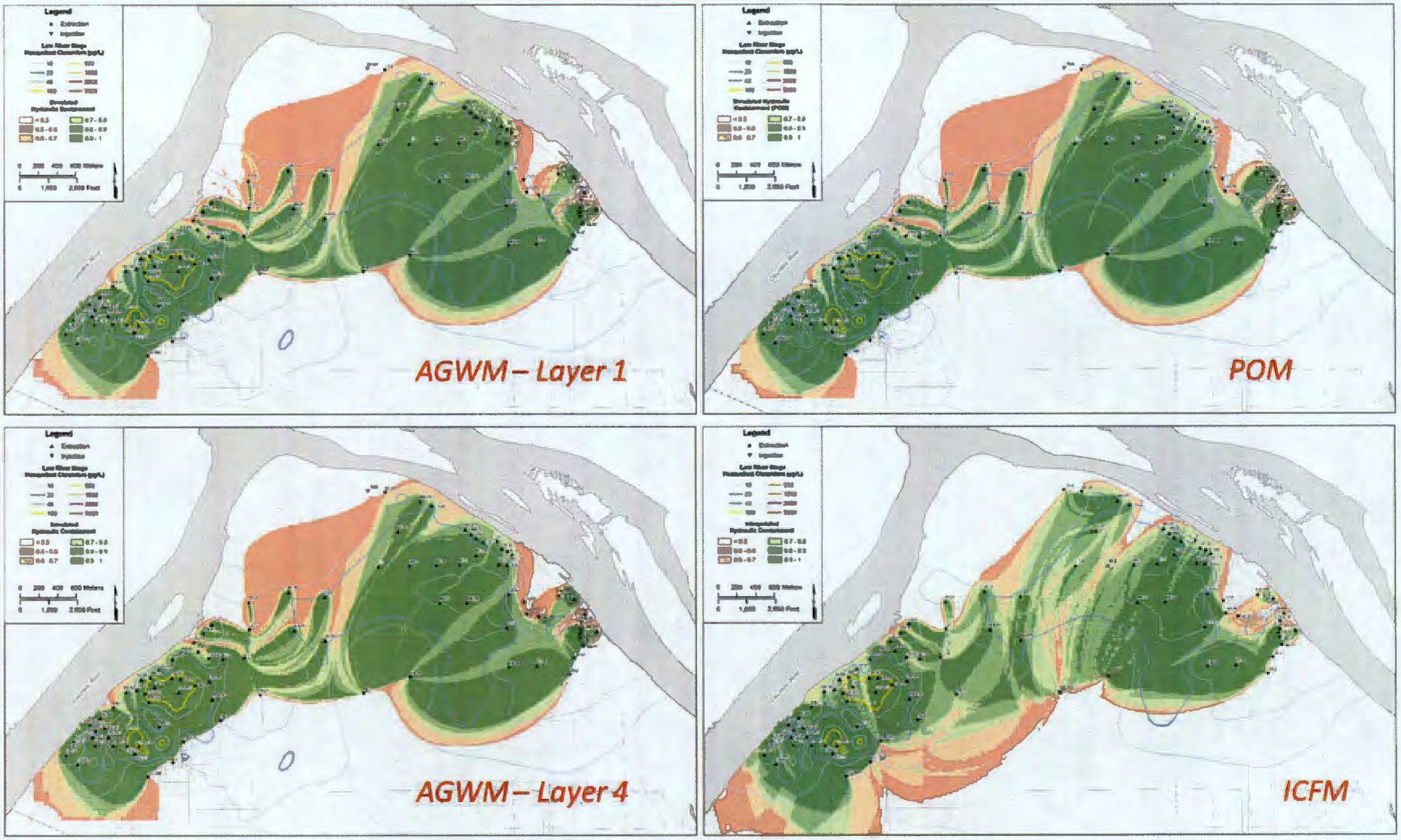


**Figure G-8. Comparison of Capture Frequency Maps for the 100-HR-3 OU**


**Figure G-9. Comparison of Capture Frequency Maps for the 100-KR-4 OU**

## G6 POM: Construction of Contaminant Transport Model

Migration of the Cr(VI) plume in response to groundwater flow patterns and extraction and injection well operations in the 100-HR-3 and 100-KR-4 OUs is simulated with the 3D 100AGWM for the historical (CY 2014) and predictive scenarios using MT3DMS. Equivalent POM transport models are constructed from the existing 100AGWM transport models. The file modifications required to create an equivalent POM from the 3D 100AGWM are provided in Table G-6.

**Table G-6. Modifications to MT3DMS Files**

| Transport File | Change |
|---|---|
| BTN | NLAY → Change 4 to 1.<br>Delta Z → Update them to be the total delta Z of 4-model layers.<br>POROSITY → Keep only layer 1.<br>ICBUND array → Keep only layer 1.<br>Initial concentration → Keep only layer 1. |
| RCT | DENSITY → Keep only layer 1.<br>PRSITY2 → Keep only layer 1.<br>Initial concentration → Keep only layer 1.<br>SRCONC for component 1 → Keep only layer 1.<br>SP1 for component 1 → Keep only layer 1.<br>SP2 for component 1 → Keep only layer 1. |
| NAM | Make sure it has the correct FTL file name. |

### G6.1 Transport Model Verification

The model run times on an Intel core i7 CPU @ 3.4 GHz with a 64-bit Windows OS are provided in Table G-7. The POM runs seven times faster than the 100AGWM.

**Table G-7. Transport Model Run Times**

| Scenario | 100AGWM Run Time | POM Run Time | Speedup |
|---|---|---|---|
| Historical | 20 minutes | 3 minutes | ~7 |
| Predictive | 282 minutes | 36 minutes | ~8 |

100AGWM = 100 Area Groundwater Model
POM = Pumping Optimization Model

The cumulative mass budgets for the historical and predictive scenarios are compared in Figures G-10 and G-11, respectively. There is good agreement between the POM and 100AGWM in the historical scenario. For the predictive scenario, there is good agreement until 5,000 days (~14 years or CY 2028) into the simulation. After this period, the results of the POM deviate from 100AGWM. A possible reason for this discrepancy could be the 50-year stress period from 2026 to 2075. For the purposes of evaluating model performance before CY 2028, the POM would be adequate.

As an additional check, the simulated plumes from 100AGWM and the POM at the end of CY 2014 for the historical scenario are compared for the 100-HR-3 and 100-KR-4 OUs in Figures G-12 and G-13, respectively. Similarly, the simulated plumes from 100AGWM and the POM at the end of CY 2025 for the predictive scenario are compared for the 100-HR-3 and 100-KR-4 OUs in Figures G-14 and G-15, respectively. In each of these figures, simulated concentrations from 100AGWM are shown on the left, and those from the POM are shown on the right. Two sets of results are displayed from 100AGWM. Average concentrations across all the model layers in 100AGWM are shown in the top-left panel, whereas the concentrations from layer 4, the bottom-most layer, are shown in the bottom-left panel. In general, there is good agreement between 100AGWM and the POM in the historical scenario. For the predictive scenario, there is good agreement between the two models on the outline of the plume. However, the POM tends to underestimate higher concentrations, especially in the 100-HR-3 OU.

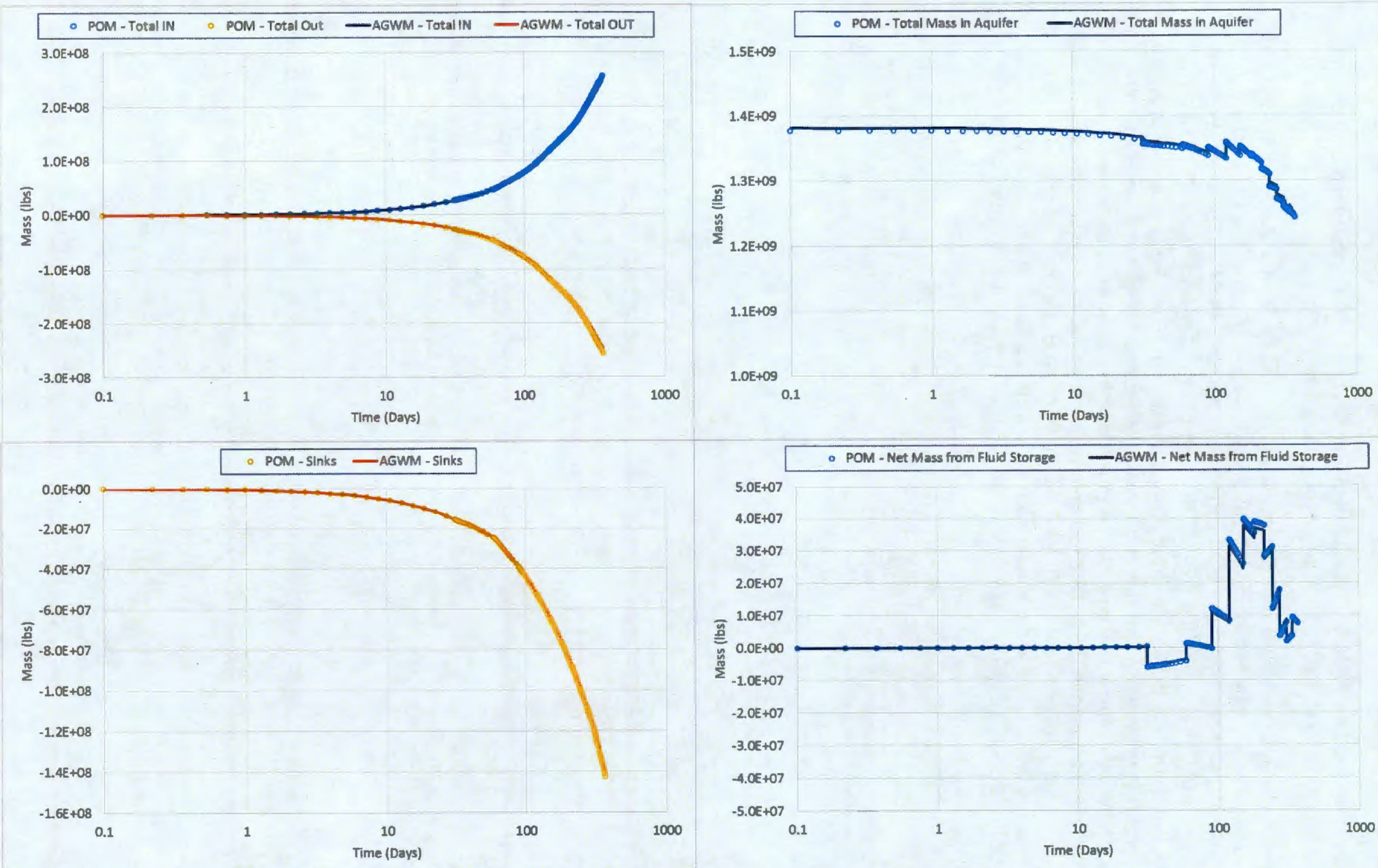


**Figure G-10. Historical Scenario: Comparison of Cumulative Mass Budgets**

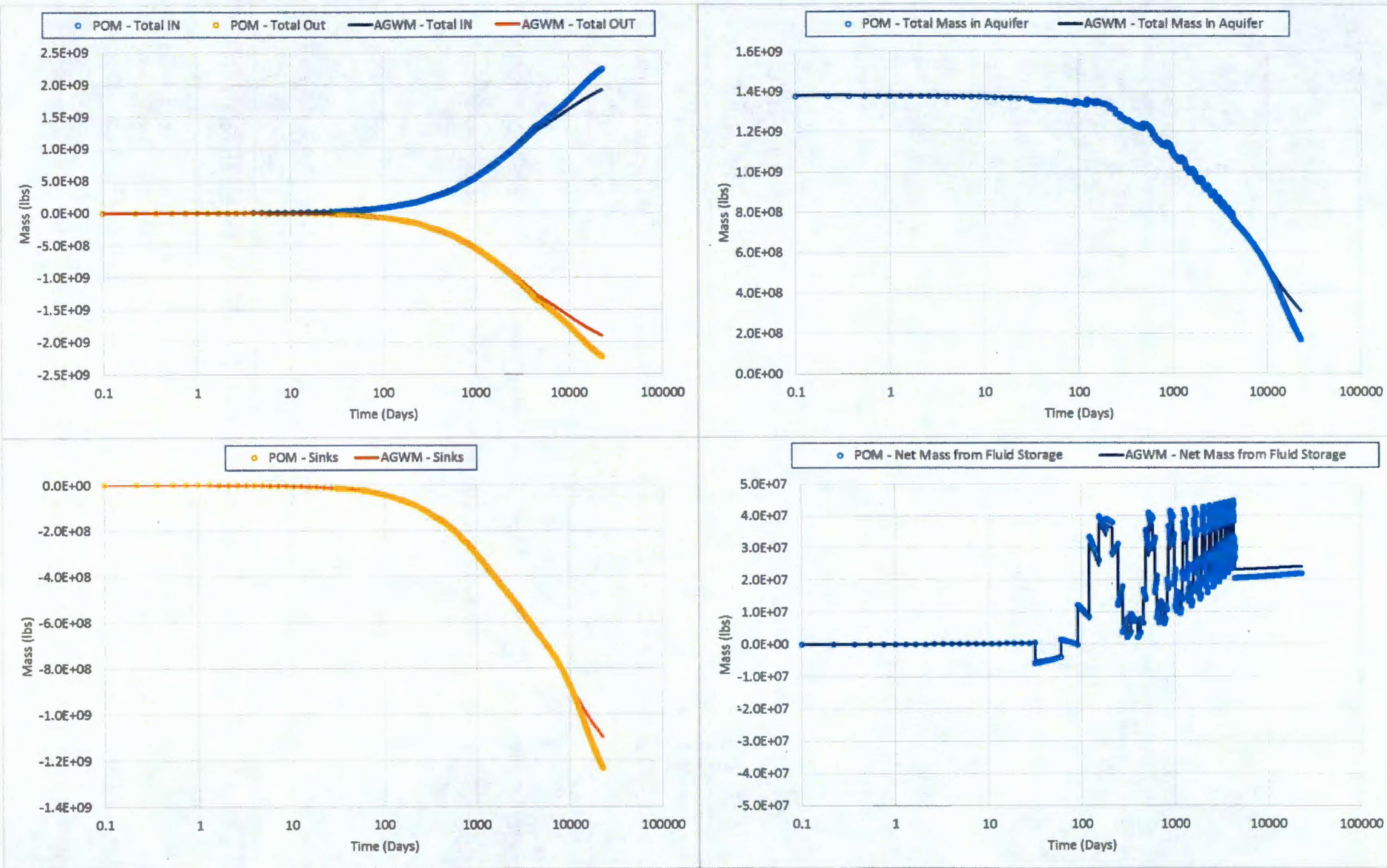


**Figure G-11. Predictive Scenario: Comparison of Cumulative Mass Budgets**

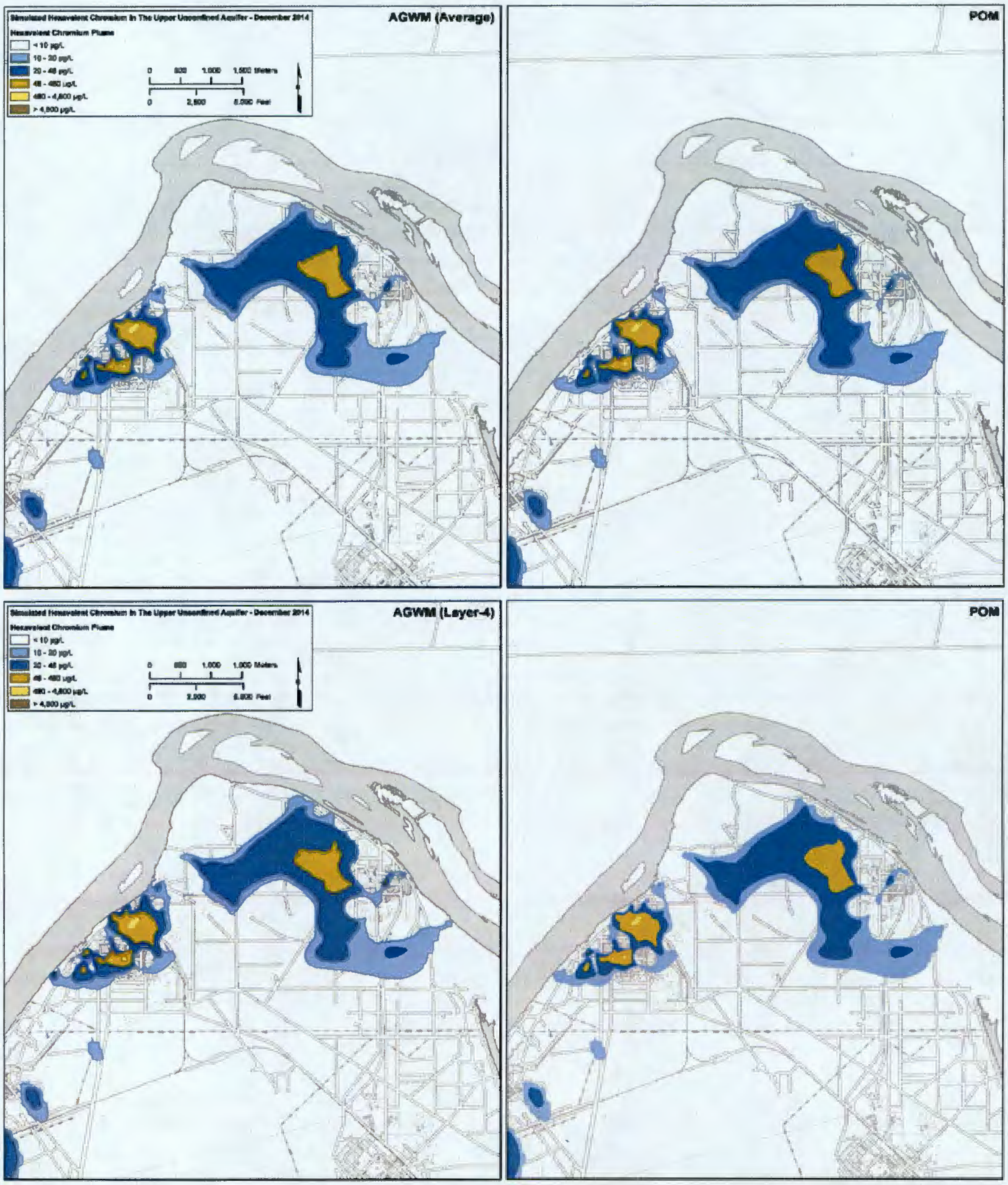


**Figure G-12. Historical Scenario: 100-HR-3 OU – Simulated Cr(VI) Concentrations at the End of CY 2014**

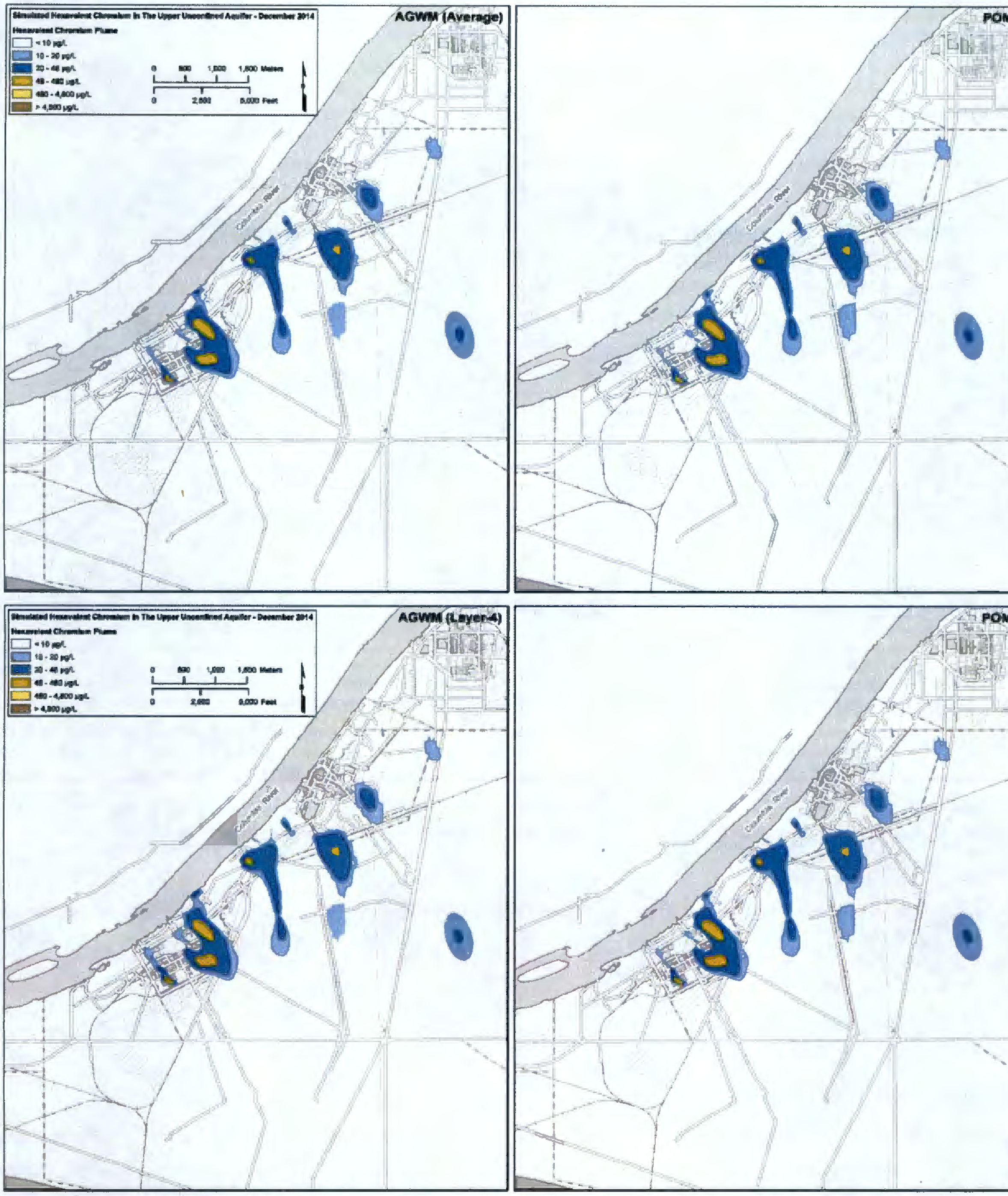


**Figure G-13. Historical Scenario: 100-KR-4 OU – Simulated Cr(VI) Concentrations at the End of CY 2014**

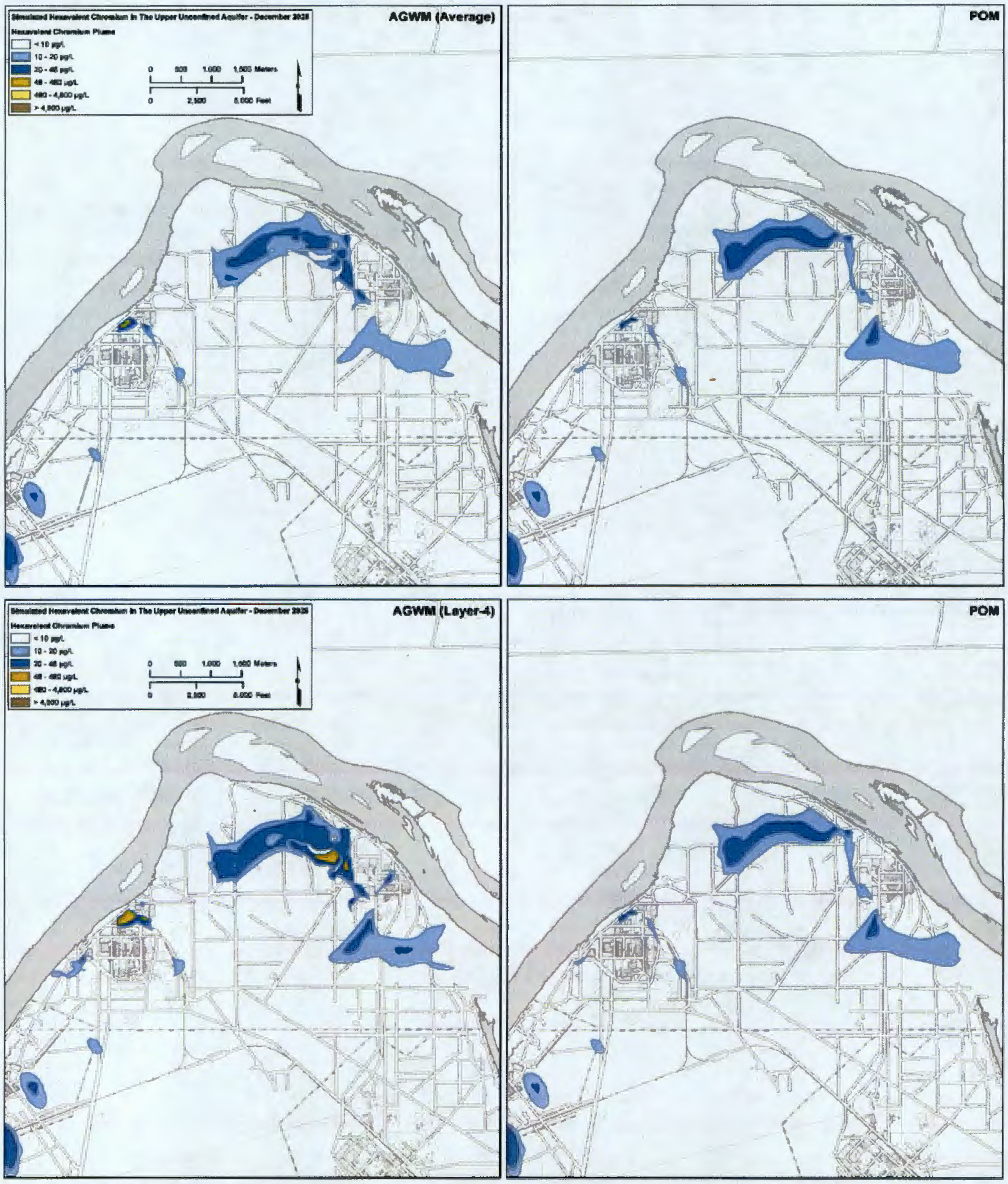


**Figure G-14. Predictive Scenario: 100-HR-3 OU – Simulated Cr(VI) Concentrations at the End of CY 2025**

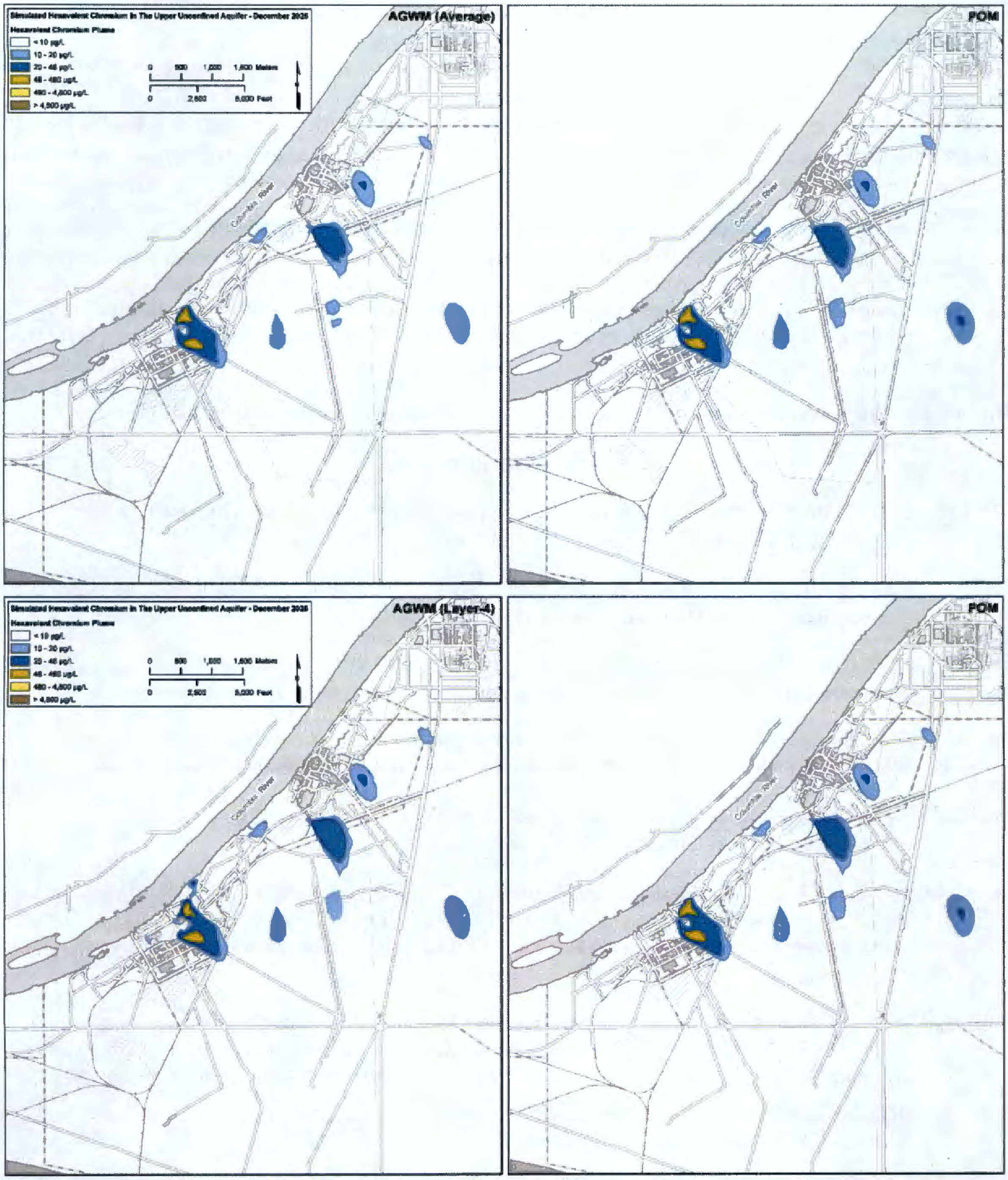


**Figure G-15. Predictive Scenario: 100-KR-4 OU – Simulated Cr(VI) Concentrations at the End of CY 2025**

## G7 Conclusions

Conversion of the four-layer 3D 100AGWM to an equivalent one-layer POM results in substantial speedup in the flow, particle-tracking, and transport simulations without giving rise to significant differences in the results. Therefore, the POM can be used in a framework where there is a need to rapidly evaluate multiple alternative pumping configurations with respect to mass recovery. There are some small differences between the results of the POM and the 3D 100AGWM model that, therefore, generate the following recommendations:

- Use the POM to rapidly assess alternative pumping configurations.
- Use 100AGWM to generate and verify the results from the final version of effective alternative(s) identified with the POM. In all cases, finalized configurations will be based on simulations performed using the 3D 100AGWM.

The proposed approach represents an appropriate compromise between speed and accuracy.

## G8 References

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CHPRC-00258, 2015, *MODFLOW and Related Codes Software Management Plan*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-00259, 2014, *MODFLOW and Related Codes Software Test Plan*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-00260, 2015, *MODFLOW and Related Codes Requirements Traceability Matrix*, Rev. 6, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-00261, 2015, *MODFLOW and Related Codes Acceptance Test Report*, Rev. 6, CH2M HILL Plateau Remediation Company, Richland, Washington.

ECF-Hanford-15-0001, 2015, *Description of Groundwater Modeling Calculations and Assessment of the River Protection Objective for the Calendar Year 2014 (CY2014) 100 Areas Pump-and-Treat Report*, Rev. 0 (in publication), CH2M HILL Plateau Remediation Company, Richland, Washington.

Harbaugh, Arlen W., Edward R. Banta, Mary C. Hill, and Michael G. McDonald, 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: http://water.usgs.gov/nrp/gwsoftware/modflow2000/ofr00-92.pdf.

Pollock, David W., 1994, *User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U. S. Geological Survey finite-difference ground-water flow model*, Open-File Report 94-464, U.S. Geological Survey, Reston, Virginia. Available at: http://pubs.er.usgs.gov/publication/ofr94464.

PRC-PRO-IRM-309, 2014, *Controlled Software Management*, Revision 5, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

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Zheng, Chunmiao, 2010, *MT3DMS v5.3 Supplemental User's Guide*, Technical Report, Department of Geological Sciences, University of Alabama, Tuscaloosa, Alabama. Available at: http://hydro.geo.ua.edu/mt3d/mt3dms_v5_supplemental.pdf.

Zheng, Chunmiao and P. Patrick Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*, Contract Report SERDP-99-1, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. Available at: http://hydro.geo.ua.edu/mt3d/mt3dmanual.pdf.

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# Appendix H

# Software Installation and Checkout Forms

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# 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 7

**EXECUTABLE INFORMATION:**

2. Executable Name (include path):

Following executable files in directory: _E:\Projects\1393-Hanford\MODFLOW-CHPRC-Build-7-distribution\bin-windows

| MD5 Signature (unique ID) | Executable File Name | |
|---|---|---|
| 919F74196F5FB5BF0364FC373011B507 | mf2k-chprc07dpl.exe | MODFLOW-2000 double precision |
| EAF037703ADD2C62CDD9CBC47468D2F6 | mf2k-chprc07spl.exe | MODFLOW-2000 single precision |
| 4E7F29DD5496D2CBA7144ADACB13DAAD | mf2k-mst-chprc07dpv.exe | MODFLOW-2000-MST single prec |
| CEB80288C616E0552E4CE5A2D4719387 | mf2k-mst-chprc07spv.exe | MODFLOW-2000-MST double prec |
| ECA9828530B68D2D7C34078C019D5D0C | mt3d-chprc07dpl.exe | MT3DMS double precision |
| 0920CC235862665D9400A3FC80F682DD | mt3d-chprc07spl.exe | MT3DMS single precision |
| A09EDC957F6B19A8CD3968EA901355CB | mt3d-mst-chprc07dpv.exe | MT3DMS-MST double precision |
| 8BF16F4DD26D0965CFB16A14F2F4A60D | mt3d-mst-chprc07spv.exe | MT3DMS-MST single precision |

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

**COMPILATION INFORMATION:**

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

BEN-PC (FE483)

5. Operating System (include version number):

WINDOWS 8.1 PRO

**INSTALLATION AND CHECKOUT INFORMATION:**

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

BEN-PC (FE483)

7. Operating System (include version number):

WINDOWS 8.1 PRO

8. Open Problem Report? (●) No ( ) Yes PR/CR No.

**TEST CASE INFORMATION:**

9. Directory/Path:

E:\Projects\1393-Hanford\MODFLOW-CHPRC-Build-7-distribution\test-windows

10. Procedure(s):

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

11. Libraries:

N/A (static linking)

12. Input Files:

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


A-6005-149 (REV 0)

## CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: MODFLOW and Related Codes    Software Version No.: Bld 7

13. Output Files:

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

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:

```
MODFLOW, MODFLOW-MST, and MT3DMS-MST Installation Testing Log
Eight instances of /FC: no differences encountered/ in log below indicates
that all installation tests were successful.
Ben-PC
Tue 03/31/2015
03:48 PM

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered

---------- TESTRESULTS.LOG
FC: no differences encountered
```

16. Test Performed By: Prashanth Khambhammettu

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

18. Disposition (include HISI update):

Prepared By:

| 19. _______________ | WE Nichols | _______________ |
|---|---|---|
| Software Owner (Signature) | Print | Date |

## CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: MODFLOW and Related Codes Software Version No.: Bld 7

20. Test Personnel:

| Sign | Print | Date |
|---|---|---|
| [signature] | PRASHANTH KHAMBHAMMETTU | 3/31/2015 |
| | | |
| | | |

Approved By:

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



A-6005-149 (REV 0)

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