LAW QUARRY EXTENSION

MAXIMUM PREDICTED WATER TABLE REPORT

WATERFORD SAND & GRAVEL LTD.

WSP PROJECT NO.: 111-53023-06
DATE: MARCH 2022

SUITE 700
55 KING STREET
ST. CATHARINES, ON, CANADA L2R 3H5

T: +1 905 687-1771
F: +1 905 687-1773
wsp.com

March 07, 2022

Mr. Ed Lamb
Waterford Sand & Gravel Ltd.
70 Ewart Avenue, R. R. #8
Brantford, ON N3T 5M1

Subject: **Law Quarry Extension**
Maximum Water Table Report
WSP Project No. 111-53023-06

Dear Mr. Lamb:

We are pleased to provide the Maximum Predicted Water Table Report in support of the Waterford Sand & Gravel Ltd. (Waterford) Law Quarry Extension (Site). This report provides an interpretation of the water level monitoring data collected to date and the maximum predicted water table at the Site.

We trust that this report satisfies your requirements.

Yours truly,
WSP Canada Inc.

Kevin Fitzpatrick

Kevin Fitzpatrick, P.Eng.
Senior Project Engineer

Suite 700
55 King Street
St. Catharines, ON, Canada L2R 3H5

T: +1 905 687-1771
F: +1 905 687-1773
wsp.com

SIGNATURES

Rebecca Warrack, P.Eng.
Project Engineer, Environment

Leigh Davis, M.A.Sc., P.Eng.
Project Engineer, Environment

Kevin Fitzpatrick, P.Eng.
Senior Project Engineer

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1 INTRODUCTION

1.1 BACKGROUND

The existing Law Quarry is located in parts of Lots 3, 4, 5 and 6, Concession 2, Wainfleet Township, Regional Municipality of Niagara, and owned and operated by Waterford. The existing quarry is located approximately 3 kilometers west of the City of Port Colborne. A Site Plan showing the existing area of extraction, sump location and monitoring well network is provided in **Figure 1**.

Additional lands to the west of the existing quarry have been acquired by Waterford over time for the proposed quarry extension (Site). Like the existing quarry, the Site will be developed below the natural groundwater table and will be dewatered to maintain dry working conditions. Therefore, Waterford is required to obtain a Category 2 Class "A" below-water Quarry licence for the Site under the Aggregate Resources Act (ARA) and to apply for amendments to the Niagara Region Official Plan, Township of Wainfleet Official Plan and the Township Zoning By-Law.

WSP Canada Inc. (WSP) was retained by Waterford to provide hydrogeologic services, including the completion of this Maximum Predicted Water Table Report in support of the Site licence application.

1.2 EVALUATION REQUIREMENTS

In the Aggregate Resources of Ontario Provincial Standards (Ministry of Natural Resources and Forestry (MNRF), August 2020), Part 2.1 outlines the following requirements for the Maximum Predicted Water Table Report for a Class A quarry below groundwater:

> *A report must be prepared that details how the maximum predicted water table is identified in metres above sea level, relative to the proposed depth of excavation at the site.*
>
> *The maximum predicted water table shall be determined by monitoring the ground water table at the site for a minimum of one (1) year to account for seasonal variations and influences due to precipitation, unless alternative information already exists (e.g. previous hydrogeological study, existing well data) to support a determination of the maximum predicted water table by a qualified person.*
>
> *An alternative method may be used for sites determining the maximum water table in Precambrian rocks of the Canadian Shield where it is difficult to determine the elevation of the water table. In such cases, the maximum predicted water table may be assumed at an elevation (metres above sea level) that is a minimum of 2.5 metres below the deepest sump or pond on the site, provided a qualified person develops and oversees a drilling and monitoring program to determine if the ground water table would be intercepted at the assumed maximum predicted water table.*
>
> *The number of drill holes and seasonal monitoring frequency shall be determined by a qualified person based on site conditions.*

This report addresses the requirements of the Maximum Predicted Water Table report for the proposed quarry extension.

1.3 STUDY METHODOLOGY

1.3.1 DRILLING PROGRAMS

Boreholes were advanced during two separate drilling programs at the Site. The locations of all boreholes and shallow drivepoints are shown in the Site Plan, **Figure 1**.

Prior to the current study, in 2004, Gartner Lee Limited (GLL) advanced ten (10) boreholes as part of the east quarry extension license application. In each borehole, 51 mm diameter PVC monitors were installed in the more hydraulically conductive zones based on the results of packer testing in the bedrock. The details of the drilling program are included in the Hydrogeological Assessment for Below Water Extraction, Law Quarry Eastern Extension, Township of Wainfleet, Region of Niagara report (GLL, 2005). Boreholes installed during the 2004 drilling program are described as GLL-1 to GLL-10 in this report. It is noted that the two (2) monitoring wells at GLL-11 were installed in 2005 after the initial drilling program and GLL-2 was abandoned in 2013 as the quarry face advanced east.

The 2004 GLL wells were completed in various hydraulically conductive zones identified through packer testing as follows:

- ➔ GLL-1 was screened across the Bois Blanc Formation, the Springvale member of the Bois Blanc Formation, and the Akron member of the Bertie Formation.
- ➔ GLL-3 was screened across the Williamsville, Scajaquada and Falkirk members of the Bertie Formation.
- ➔ GLL-4 was screened within the Bois Blanc Formation.
- ➔ GLL-5 was screened across the Falkirk and Oatka members of the Bertie Formation.
- ➔ GLL-6 was screened across the Williamsville, Scajaquada and Falkirk members of the Bertie Formation.
- ➔ GLL-7 was screened across the Akron, Williamsville and Scajaquada members of the Bertie Formation.
- ➔ GLL-8 was screened across the Falkirk and Oatka members of the Bertie Formation.
- ➔ GLL-9 was screened across the Bois Blanc Formation, the Springvale member of the Bois Blanc Formation and the Akron and Williamsville members of the Bertie Formation.
- ➔ GLL-10 was installed across the Springvale member of the Bois Blanc Formation and the Akron, Williamsville and Scajaquada members of the Bertie Formation.

Borehole logs for GLL-11 were not available; as such, field-measured depths were used to interpret the stratigraphy screened.

In the autumn of 2017 and summer of 2018, WSP completed a drilling program at the Site in order to establish a more suitable groundwater monitoring network for predicting impacts within the deeper bedrock units. A total of fourteen (14) monitoring wells were installed at seven (7) existing well nests (GLL-1, GLL-4, GLL-5, GLL-6, GLL-9, GLL-10 and GLL-11). An additional two (2) monitoring wells were installed at well nest MW12 located south of GLL-8 adjacent to Highway 3. Typically, each well nest consists of two to three wells screened within the following intervals (from deepest to shallowest):

- ➔ Monitoring well designation 'I' corresponds to well screens installed 4.6 – 6.1 metres into the Salina Formation, referenced as deep Salina Formation wells. These wells correspond to depths below the proposed quarry floor.
- ➔ Monitoring well designation 'II' corresponds well screens installed at the contact between the Oatka Member of the Bertie Formation and the Salina Formation. It is noted that MW11-1 was also installed across the Oatka and Salina contact.
- ➔ Monitoring well designation 'III' corresponds to the Falkirk member of the Bertie Formation. The base of the Falkirk member is equivalent to the proposed final quarry floor depth (excavation will not occur into the underlying Oatka member as the rock quality is not acceptable for construction aggregate).

Both the initial and supplemental drilling programs undertaken as part of the current study were completed by Noll Drilling of Breslau, Ontario. Boreholes advanced through the overburden were completed with hollow-stem augers (108 mm inner diameter) to allow measurement of in-situ geotechnical parameters and detailed soil logging. Bedrock coring was completed with an HQ (64 mm diameter) diamond drill bit. The deepest boreholes in each well nest were continuously cored from the bedrock surface to the final depth of the borehole, typically into the Salina Formation. Rock core was placed into core boxes and stored at the Site for review by a senior geological engineer. Descriptions included stratigraphy, percent recovery and rock quality designation (RQD).

Monitoring wells were constructed of 51 mm diameter PVC riser pipe and a slot 10 well screen of varying lengths depending on the interval screened. The borehole annulus around the screen was filled with number 2 silica sand to a nominal height above the screen to provide a filter pack. The remainder of the borehole annulus was sealed with bentonite pellets and / or grout. A lockable protective steel casing was cemented in place at the surface to provide a surface seal. Dedicated inertial lift sampling equipment (Waterra) was installed and the wells were developed to set the filter pack. Cluster MECP well records were submitted for the separate drilling programs.

All of the available wells included in the current monitoring network were surveyed by WSP to establish ground surface and top of pipe elevations to a geodetic datum and UTM location coordinates.

1.3.2 GROUNDWATER MONITORING

The baseline groundwater monitoring program completed for this study consisted of the following:

- ➔ Continuous groundwater level monitoring using dataloggers installed at six (6) shallow bedrock aquifer wells, nine (9) Falkirk member wells, eight (8) Oatka / Salina contact wells, and three (3) deep Salina wells included in the monitoring network. Loggers were programmed to collect data every four (4) hours. One barologger was installed at nest MW4 to correct for atmospheric pressure changes over time.
- ➔ Periodic manual water level measurements at each location were made over the course of the baseline monitoring period, generally occurring on a quarterly basis. The manual measurements were used to confirm the datalogger water levels. The manual water levels were measured with an electric contact gauge (Water Level Tape).

2 BASELINE GROUNDWATER ELEVATION DATA

The bedrock units relevant to this study have been divided into four hydrostratigraphic units based on the regional groundwater setting interpretation. The upper-most aquifer is referred to as the shallow bedrock aquifer.

The shallow bedrock aquifer consists of the Bois Blanc Formation and upper Bertie Formation bedrock. The maximum water table at the Site is inferred to occur within this hydrostratigraphic unit. There are seven wells which are inferred to be completed in the shallow bedrock aquifer.

Water level hydrographs are included in **Figures E-1 through E-15**. Water level data from the GLL-series of wells is available starting 2004 and the wells installed as part of this study have data starting 2018.

Based on electronic water level monitoring, there appears to be a muted response to precipitation events within the shallow bedrock aquifer, on the order of a maximum of 0.5 m. Minor seasonal fluctuations are observed in the shallow bedrock aquifer wells. In general, the water levels increase in the spring following snow melt and several large precipitation events. Typically, the lowest water levels observed in the shallow bedrock aquifer are in the late summer / early autumn. Most of the wells exhibit seasonal variation on the order of 1 m to 2 m between the spring and late summer.

The average shallow bedrock aquifer water table elevation in April 2019 is shown in **Figure 2**. The water level from GLL-4 has not been included in the figure. According to the borehole log for GLL-4, this well is screened entirely in the Bois Blanc Formation limestone, whereas the other shallow bedrock aquifer wells are screened between the Bois Blanc Formation limestone, the Springvale Sandstone and the Akron / Williamsville members of the Bertie Formation bedrock. Groundwater flow in the shallow bedrock aquifer is generally eastward to southeast in the vicinity of the Site.

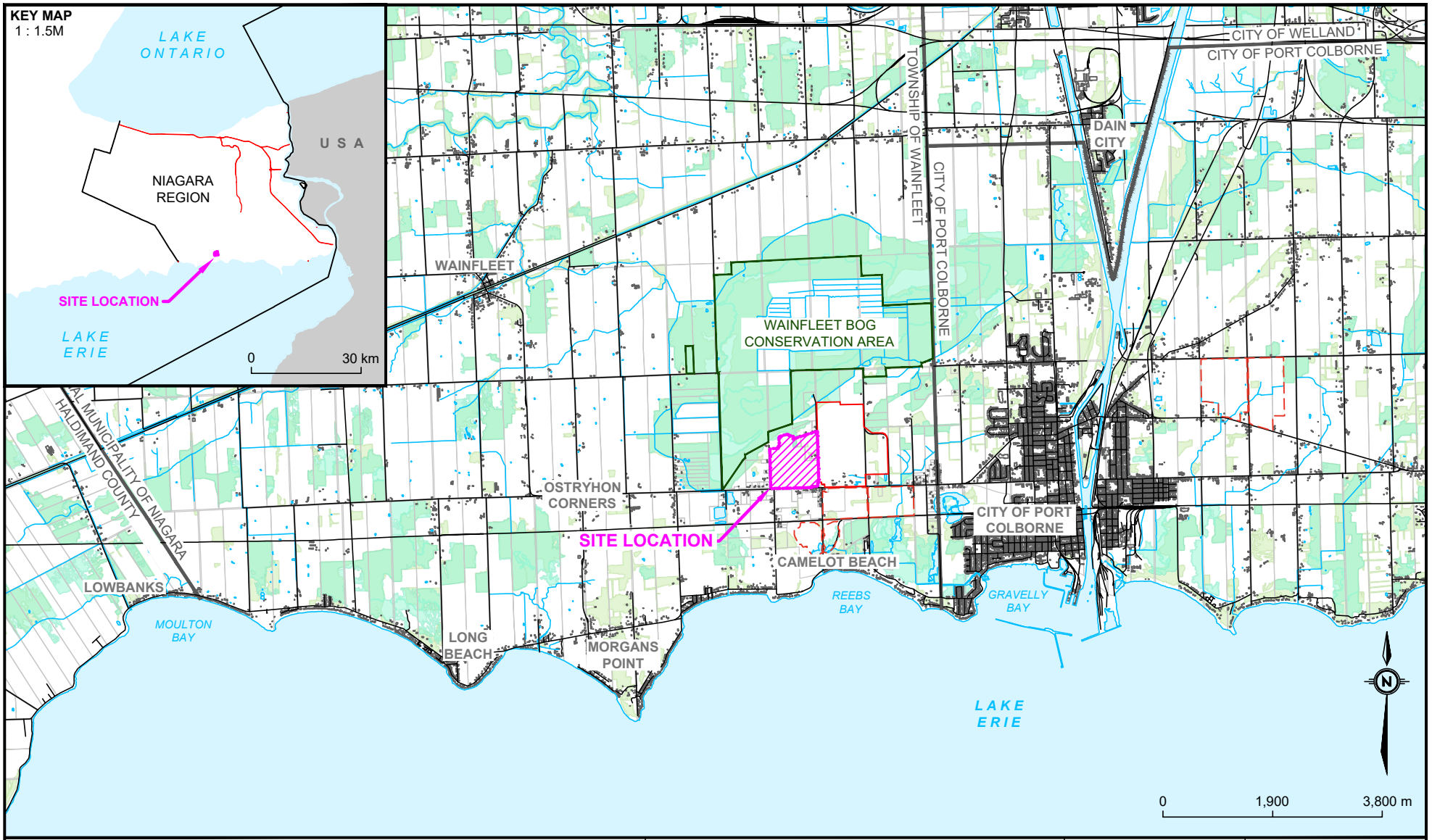
The maximum shallow bedrock aquifer groundwater elevations within the Site boundary are consistently observed at GLL-9, in the western portion of the Site adjacent to Graybiel Road. Based on the hydrograph shown on **Figure E-8**, the maximum groundwater elevation at GLL-9 observed during the baseline monitoring period is about 183.0 masl.

3 SUMMARY OF FINDINGS

The following is a summary of the key findings of the Maximum Predicted Water Table report for the proposed Law Quarry Extension Class A License (Quarry Below Groundwater) application.

- ➔ The proposed quarry extension will be developed below the natural groundwater table up to a maximum depth of approximately 20 m below ground surface (approximately 165 masl), corresponding to the base of the Bertie Formation, Falkirk member dolostone.
- ➔ The maximum water table at the Site is inferred to occur within the shallow bedrock aquifer. The maximum shallow bedrock aquifer groundwater elevations within the Site boundary are consistently observed at GLL-9, in the western portion of the Site adjacent to Graybiel Road. The maximum groundwater elevation at GLL-9 observed during the baseline monitoring period is about 183.0 masl.

FIGURES



SITE LOCATION MAP

LEVEL 2 WATER STUDY REPORT
LAW QUARRY EXTENSION
WAINFLEET, ON
For Waterford Sand & Gravel Ltd.

DATE:	DECEMBER 2021
PROJECT:	111-53023-06
DRAWN BY:	JLD
SCALE:	1 : 95,000
FIGURE No:	1

wsp

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LEGEND

- PROPOSED WEST EXTENSION
- PROPOSED LIMIT OF EXTRACTION
- EXISTING QUARRY LICENCE
- APPROXIMATE LAND PARCEL
- REEB QUARRY LICENCE
- WAINFLEET BOG CONSERVATION AREA
- WOODLOT
- WETLAND
- PERMANENT STREAM
- INTERMITTENT STREAM
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- GLL-3 MONITORING WELL NEST LOCATION AND DESIGNATION
- MP2 MINI-PIEZOMETER LOCATION AND DESIGNATION
- PW PUMPING WELL
- PRIVATE WATER WELL
- APPROXIMATE WORKING FACE
- A CROSS SECTION LOCATION

0 200 400 m

SITE PLAN

LEVEL 2 WATER STUDY REPORT
LAW QUARRY EXTENSION
WAINFLEET, ON
For Waterford Sand & Gravel Ltd.

DATE: DECEMBER 2021	
PROJECT: 111-53023-06	
SCALE: 1 : 10,000	
DRAWN BY: JLD	FIGURE No: 2

55 KING STREET, SUITE 700
ST. CATHARINES, ON L2R 3H5
T 905-687-1771 | F 905-687-1773 | www.wsp.com

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APPENDIX

E WATER LEVEL DATA

Figure E-1 Groundwater Hydrograph

Well Nest 1

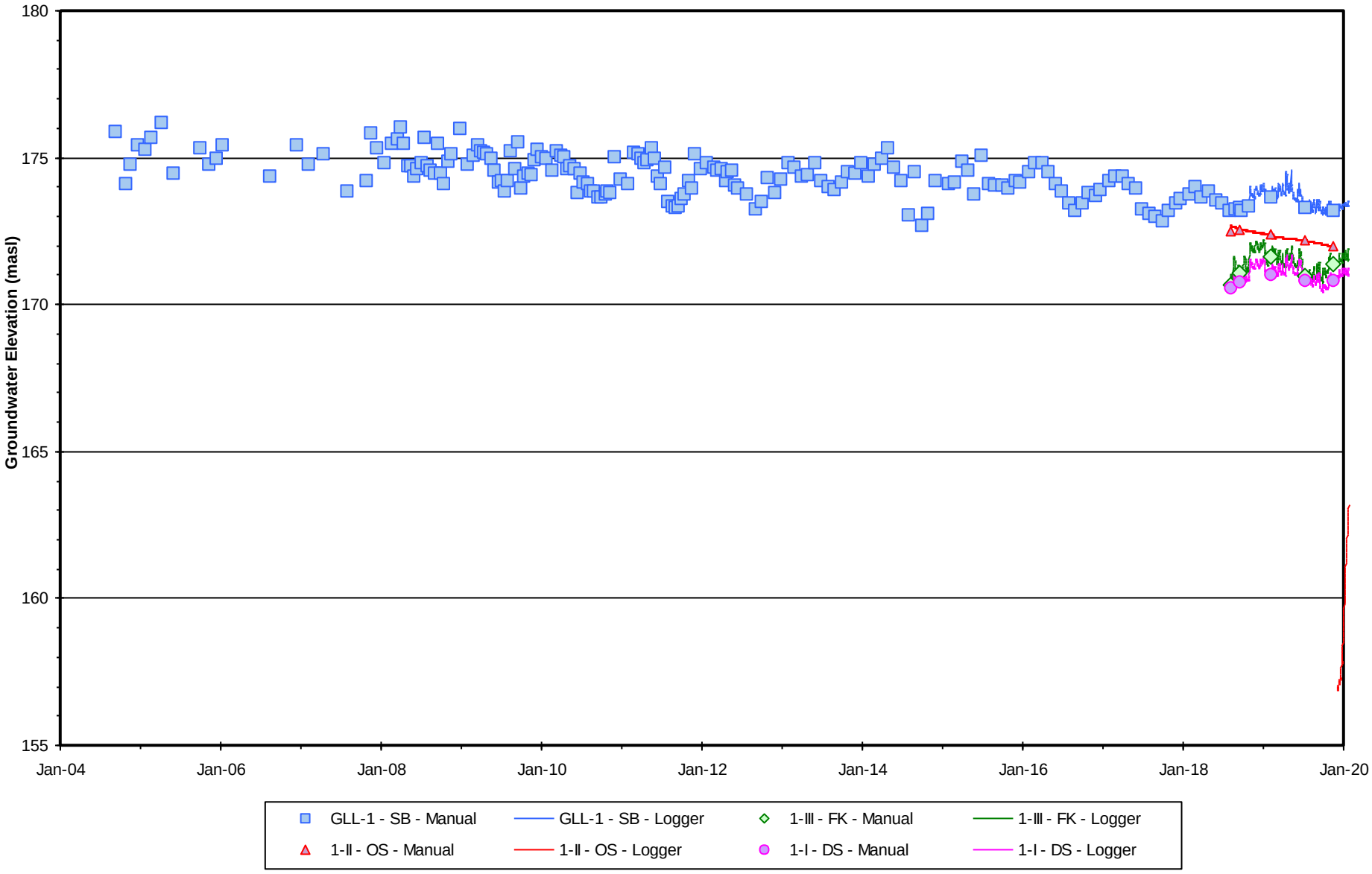

Figure E-2 Groundwater Hydrograph

Well Nest 3

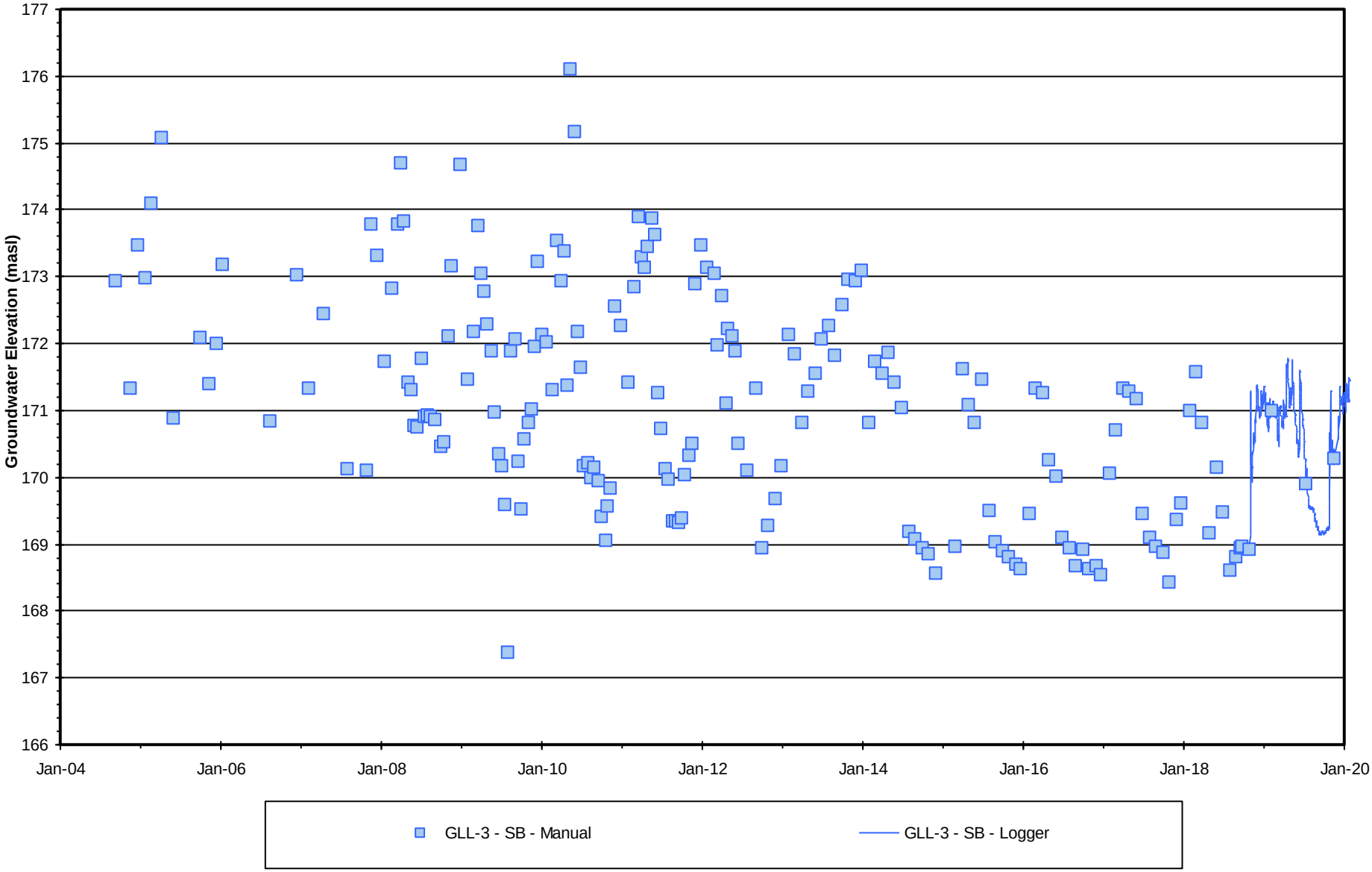

Figure E-3 Groundwater Hydrograph

Well Nest 4

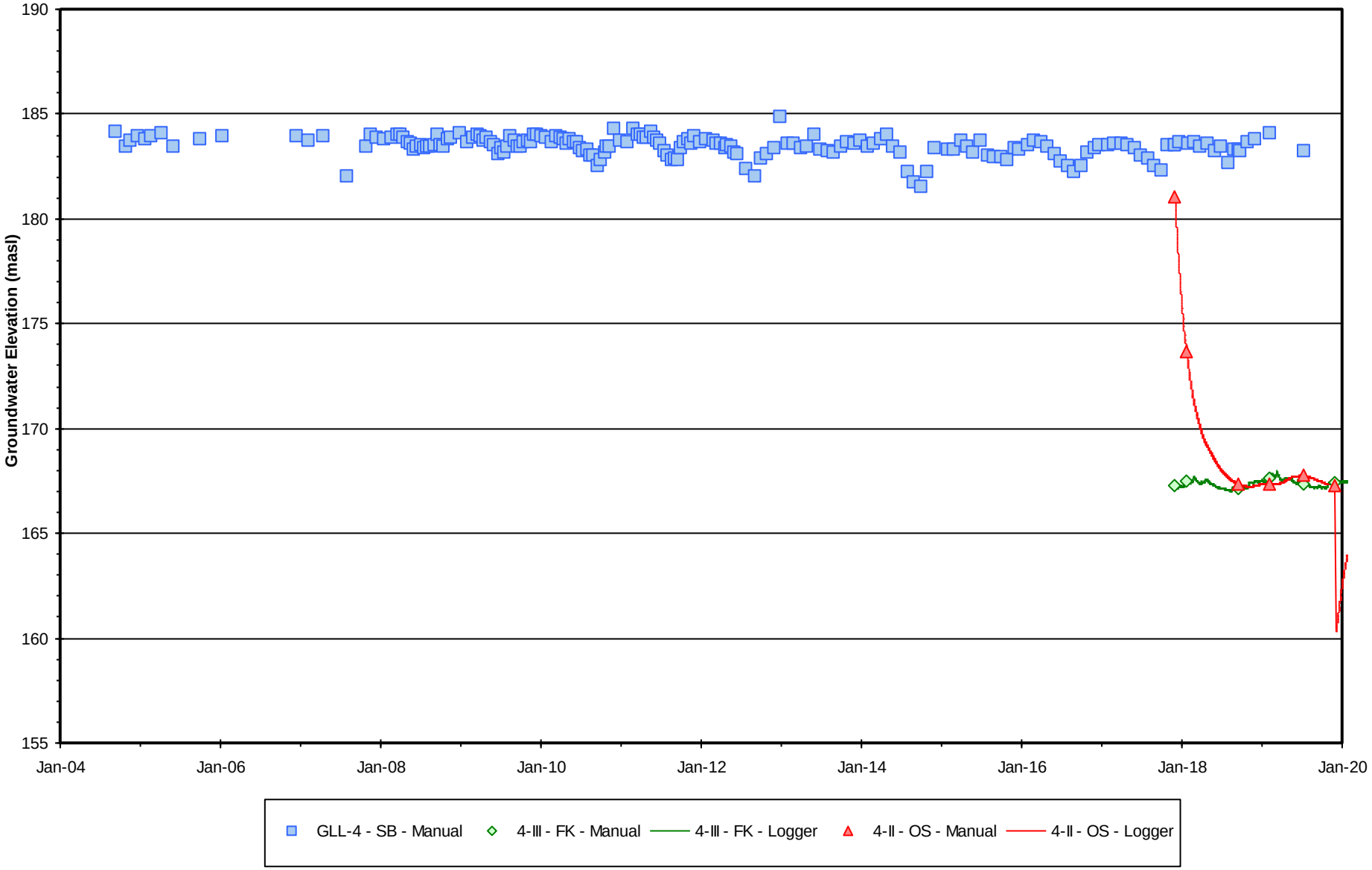

Figure E-4 Groundwater Hydrograph

Well Nest 5

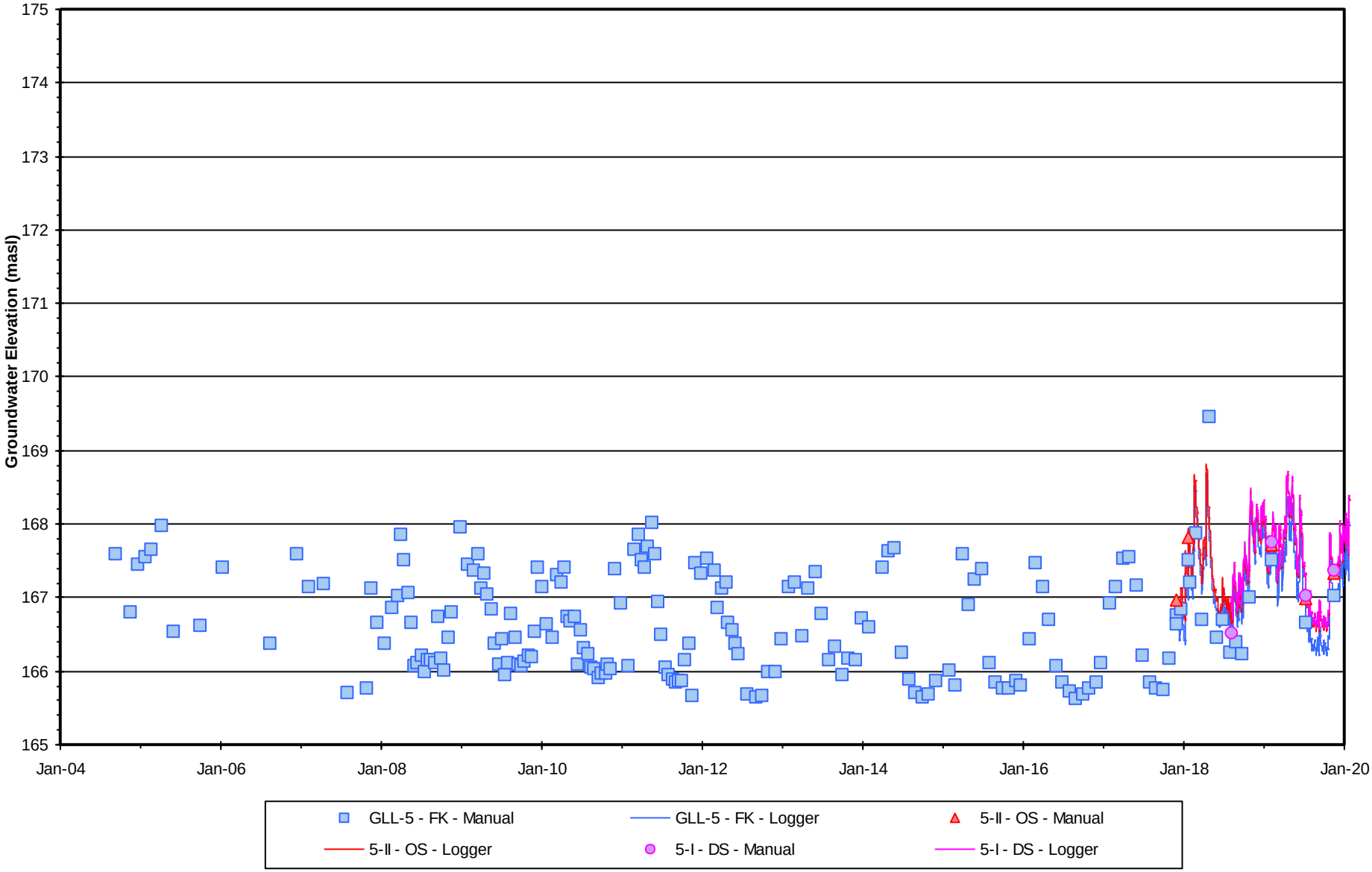

Figure E-5 Groundwater Hydrograph

Well Nest 6

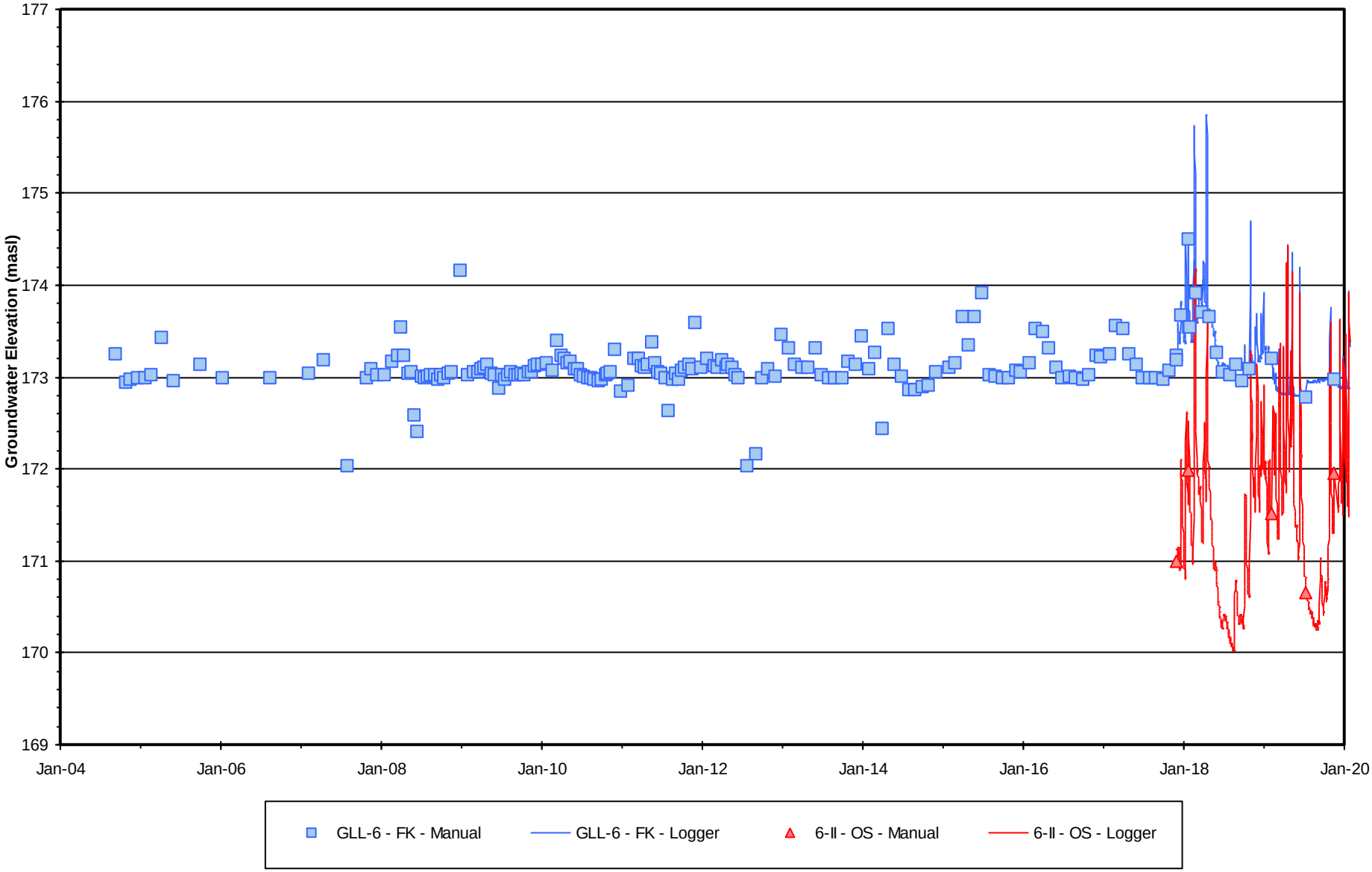

Figure E-6 Groundwater Hydrograph

Well Nest 7

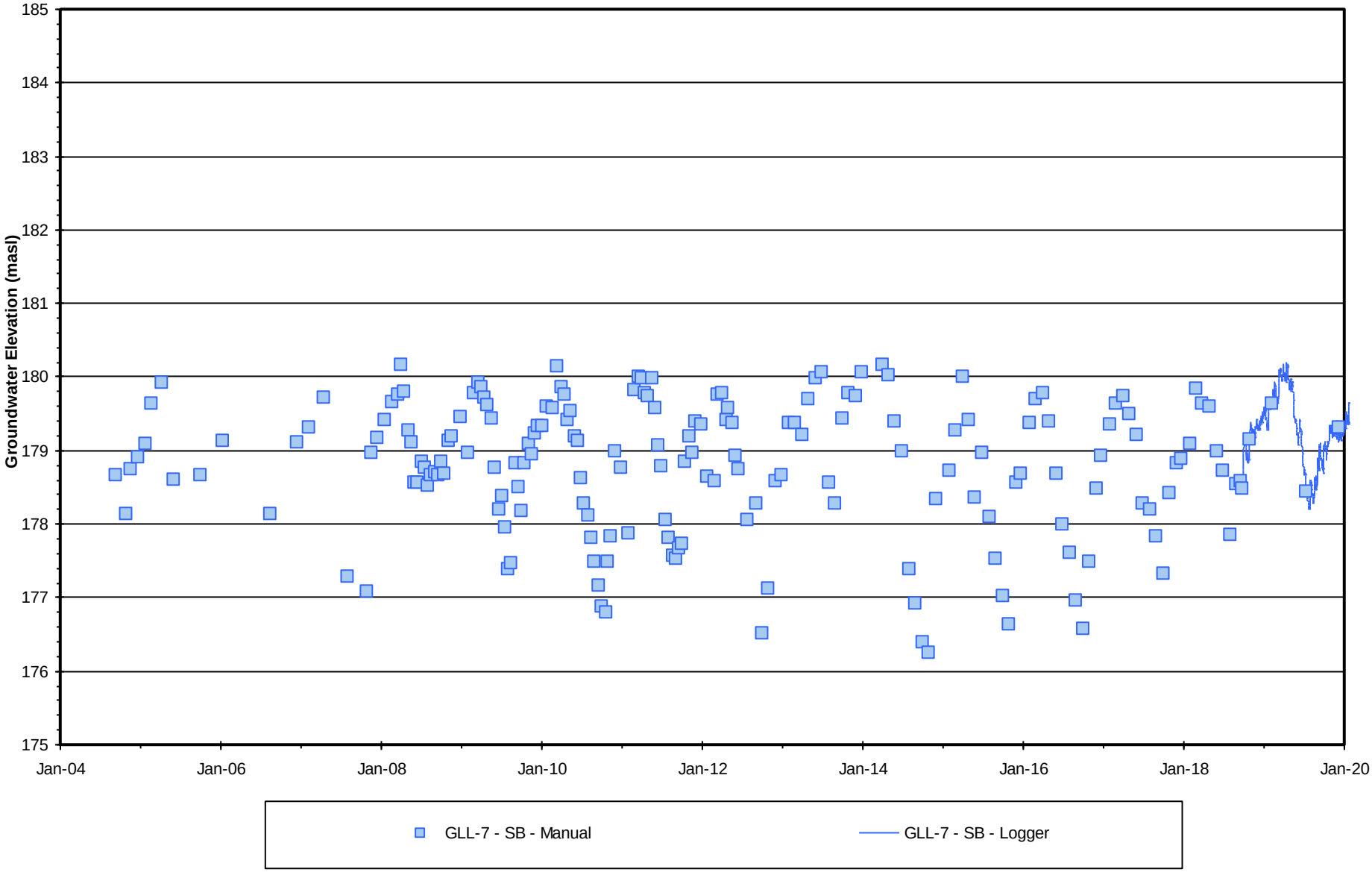

Figure E-7 Groundwater Hydrograph

Well Nest 8

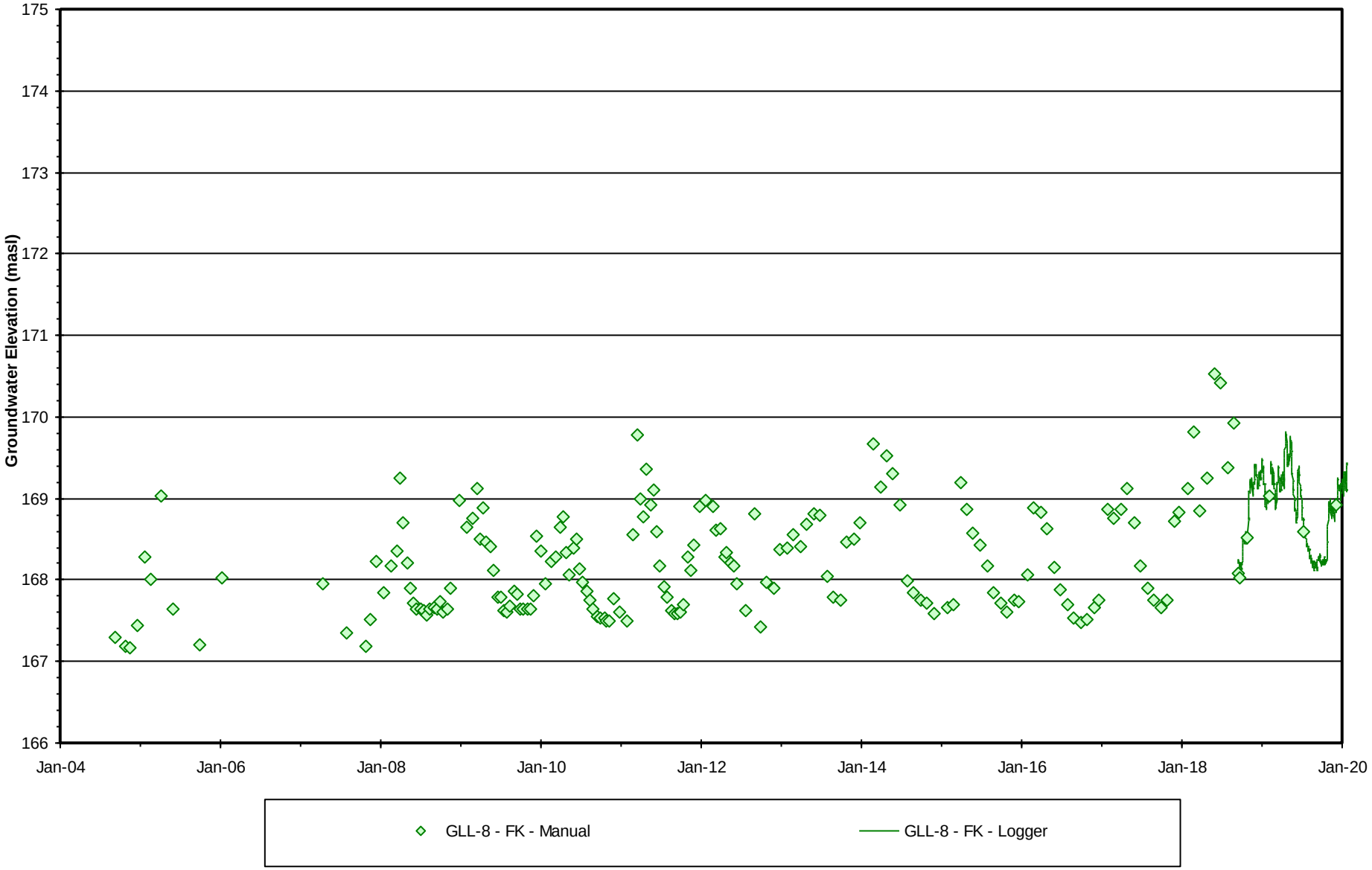

Figure E-8 Groundwater Hydrograph

Well Nest 9

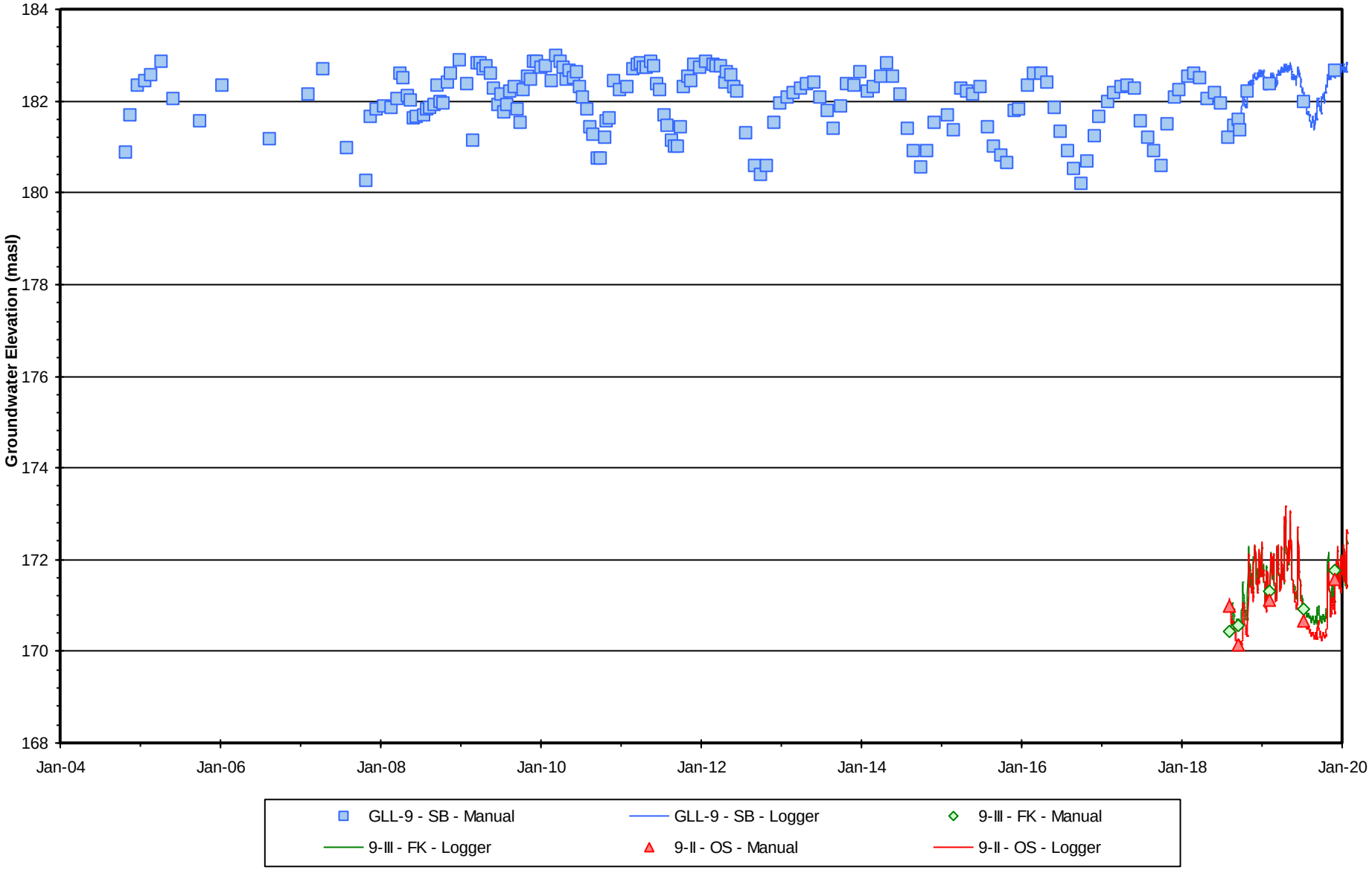

Figure E-9 Groundwater Hydrograph

Well Nest 10

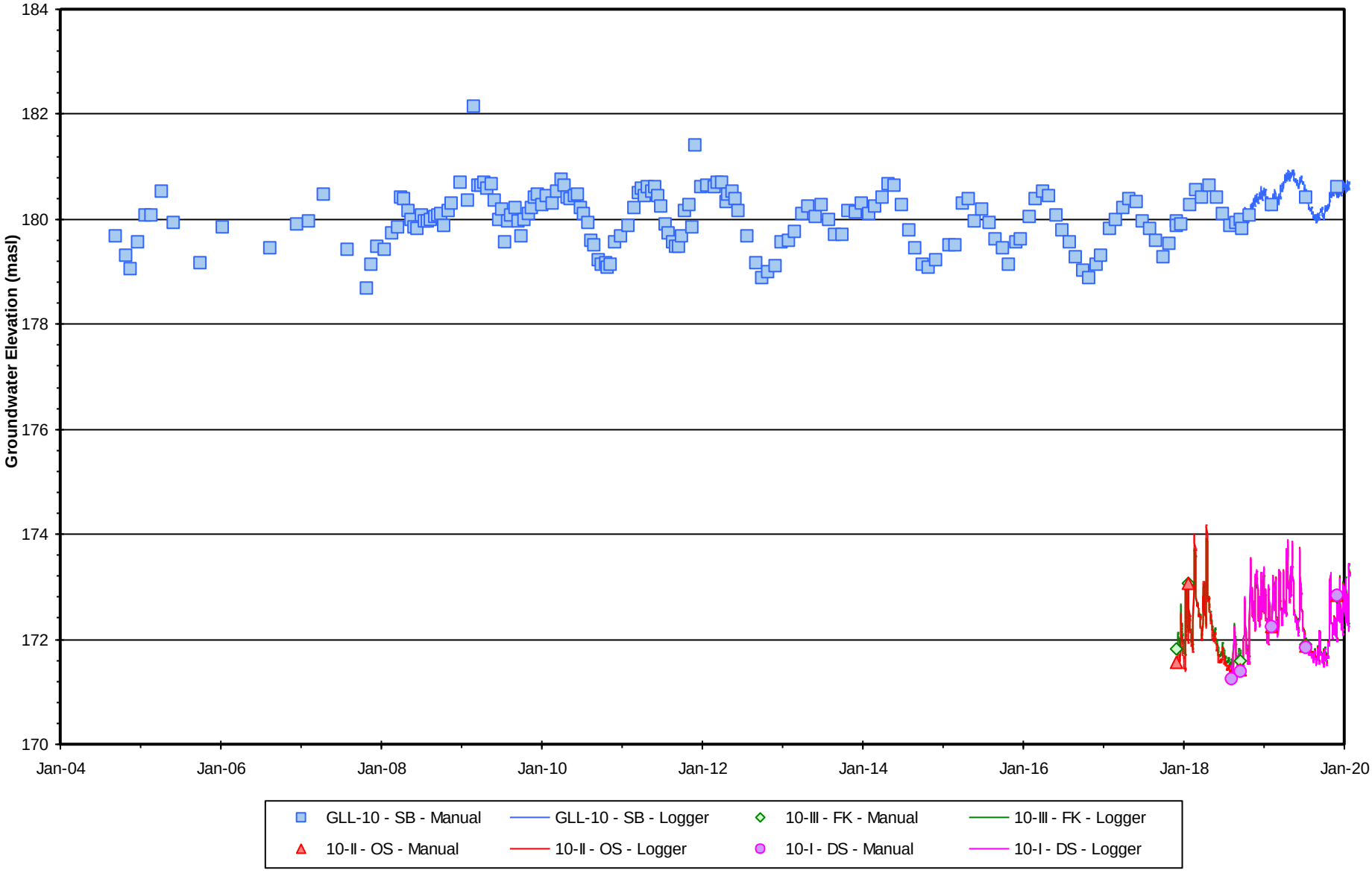

Figure E-10 Groundwater Hydrograph

Well Nest 11

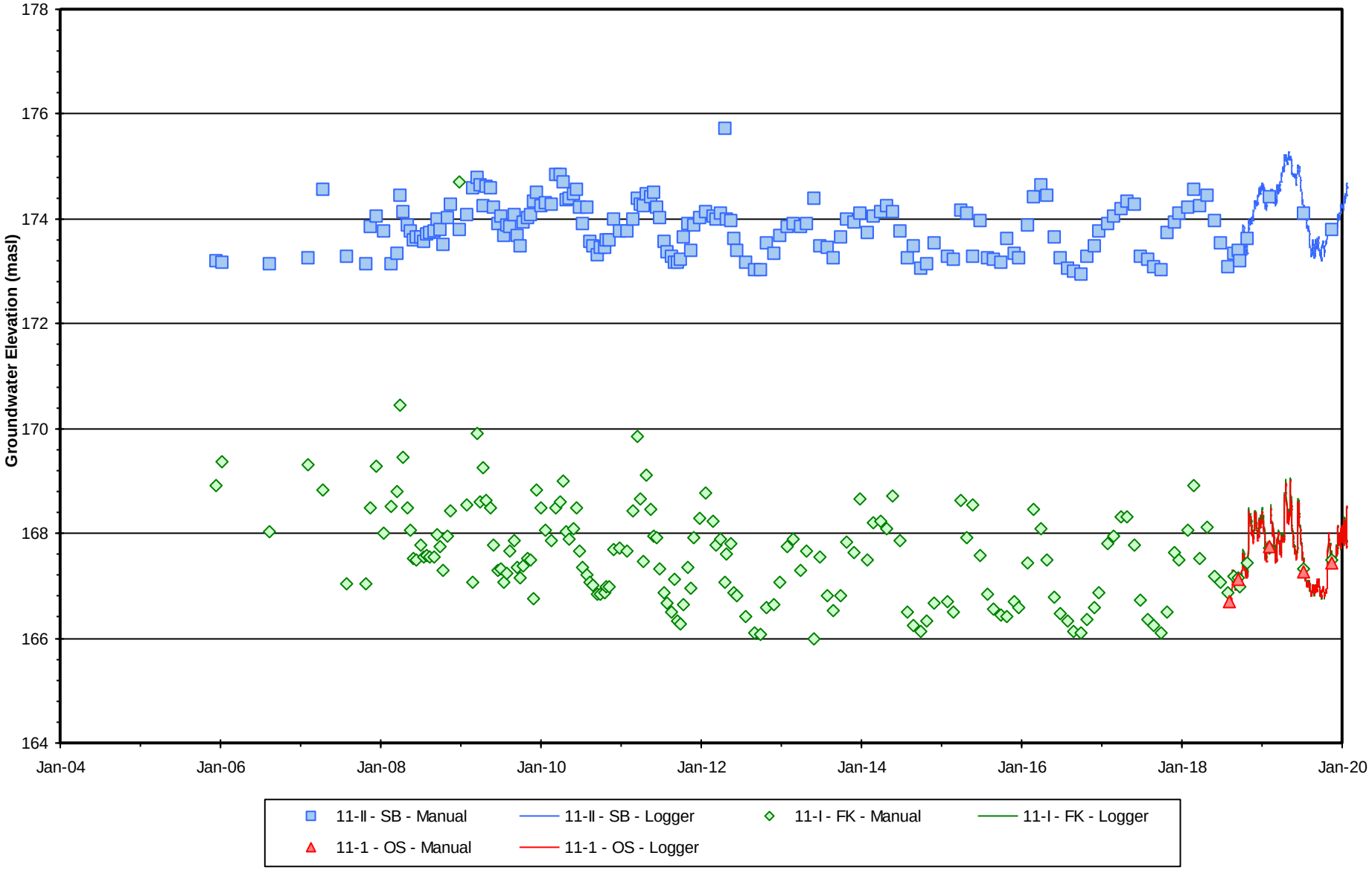

Figure E-11 Groundwater Hydrograph

Well Nest 12

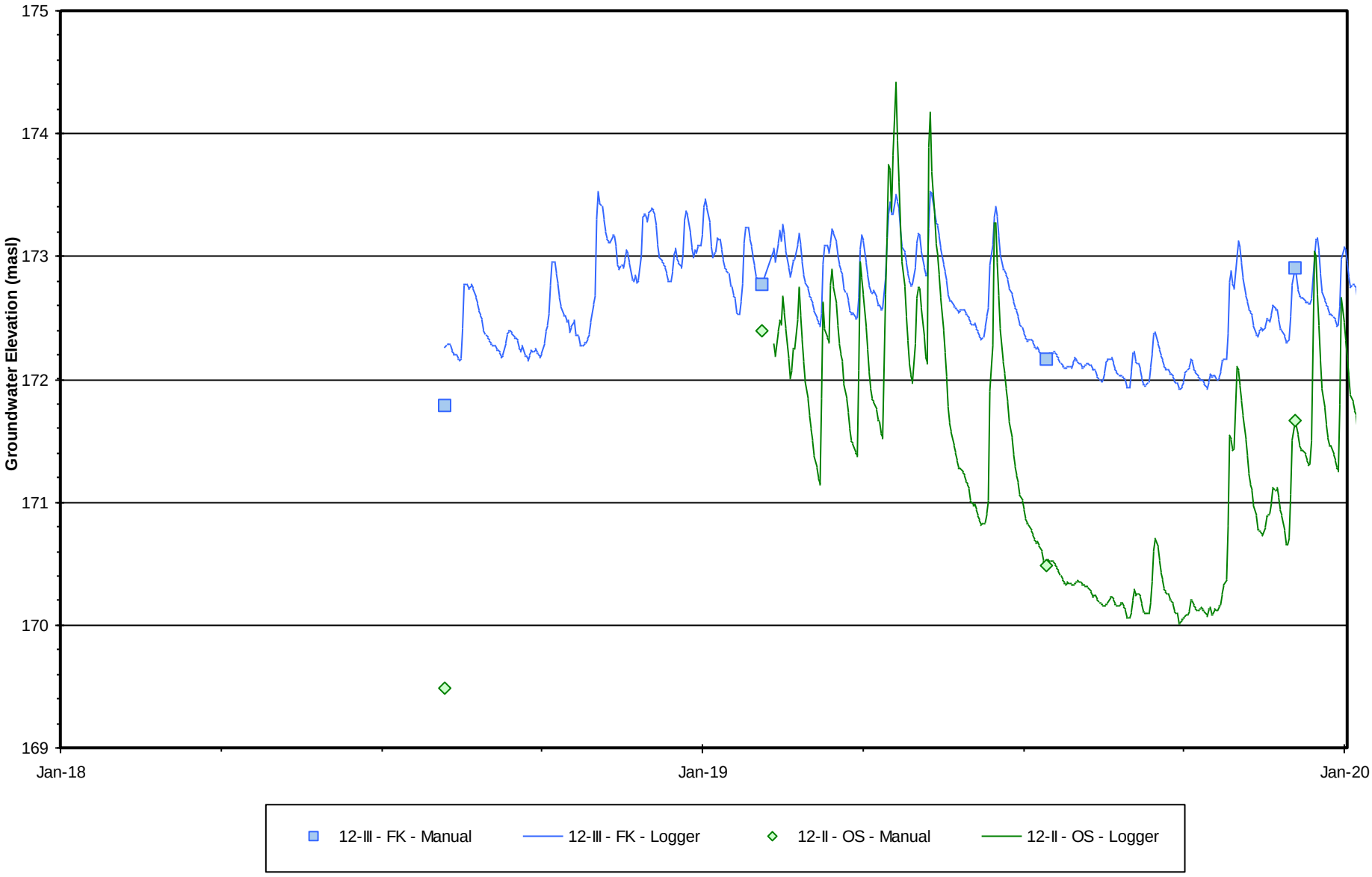

Figure E-12 Groundwater Hydrograph

Pumping Well

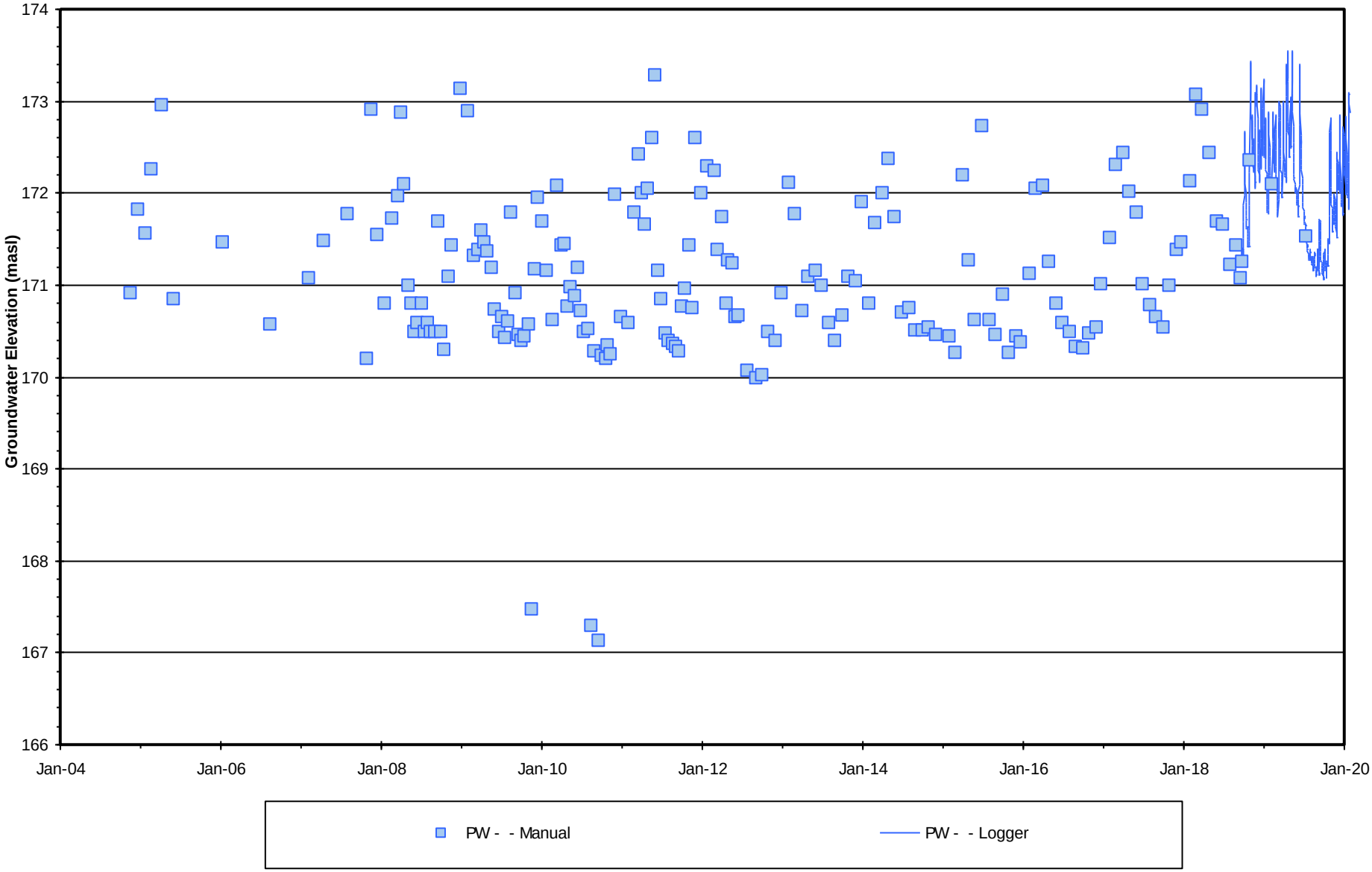

Figure E-13 Groundwater Hydrograph

20246 Youngs Road

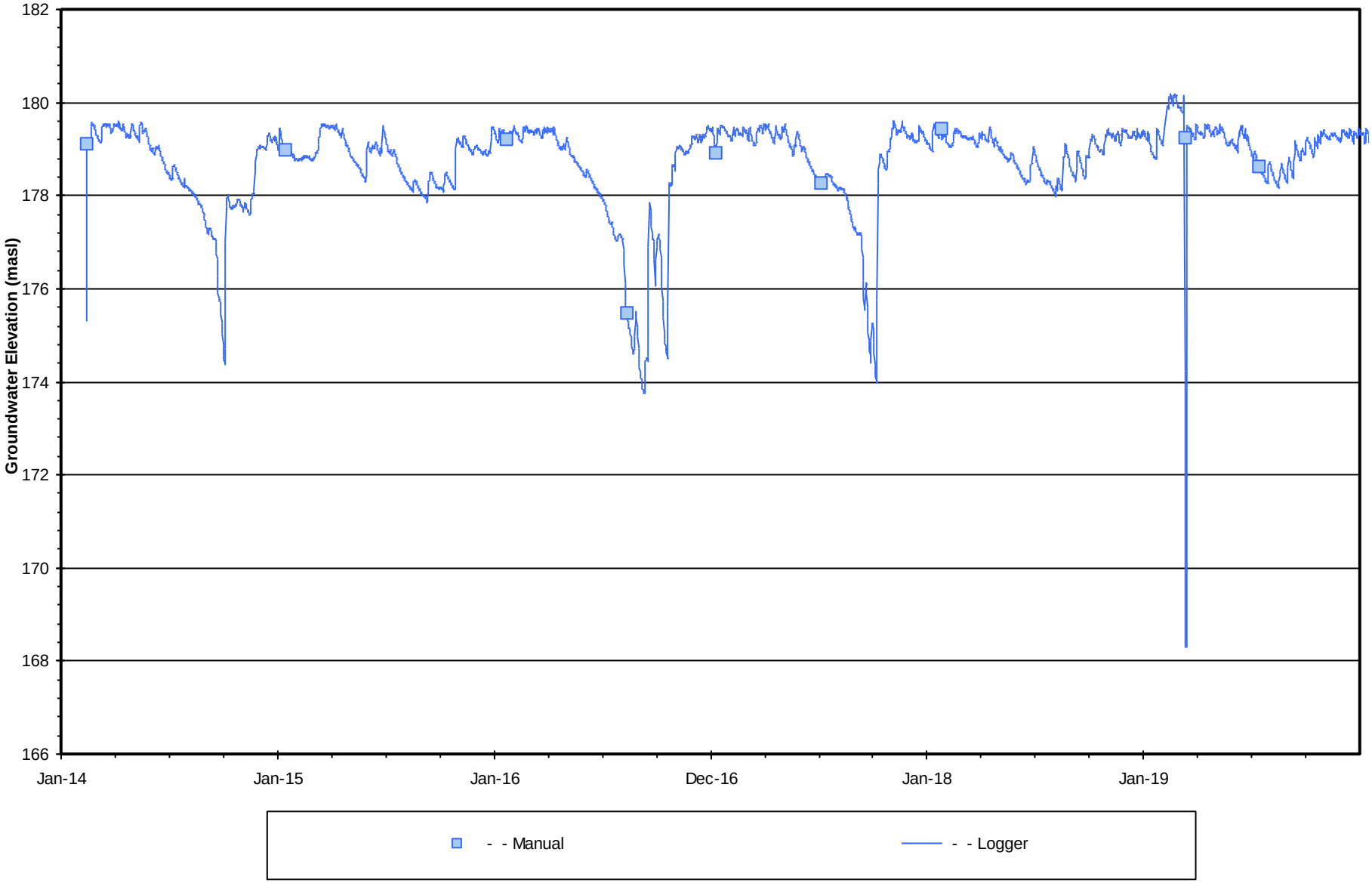

Figure E-14 Groundwater Hydrograph

722 Highway 3