Appendix 3: Cooperage Well Pumping Test Report

URS

Cooperage Well Pumping Test Report

Diageo St James' Gate Brewery (IPPC licence P0301-02)

28 March 2014 FINAL

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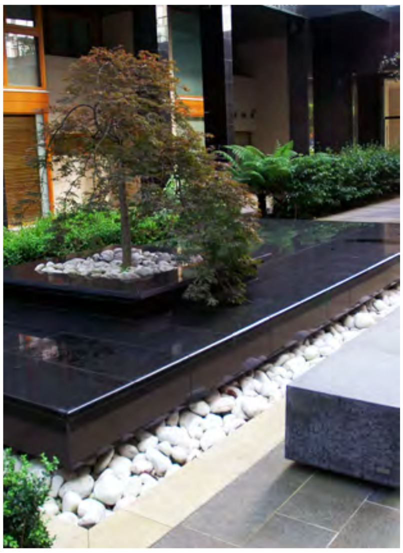
Prepared for:
Diageo Ireland

UNITED KINGDOM & IRELAND



REVISION SCHEDULE

Rev	Date	Details	Prepared by	Reviewed by	Approved by
1	28 March 2014	Draft Report	N D Mackenzie & P Johnston Principal Hydrogeologists	Eilis Linehan Senior Environmental Scientist Sinead Fitzpatrick Principal Environmental Scientist	Kevin Forde Principal Hydrogeologist
2	28 March 2014	Final Report	N D Mackenzie & P Johnston Principal Hydrogeologists	Eilis Linehan Senior Environmental Scientist Sinead Fitzpatrick Principal Environmental Scientist	Kevin Forde Principal Hydrogeologist

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EXECUTIVE SUMMARY

URS Ireland Limited (URS) was commissioned by Diageo Ireland (Diageo) in December 2013, to undertake a pumping test on the disused on-site Cooperage Well at St. James' Gate Brewery, Dublin. This work follows on from an assessment of the potential impact of abstracting from this well on controlled waters (surface water and groundwater) which was undertaken in March 2013[1].

Background

The pumping test was completed because Diageo is seeking to reduce its reliance on a mains water supply to the brewery, and to replace this with well supply.

The test was also completed in order to fulfil the requirements of Section 6.14.3 of the sites IPPC licence P0301-02, which indicates:

"The licensee shall carry out an investigation of the impact of the proposed abstraction from the Cooperage Well on-site prior to the commencement of abstraction (other than for the purpose of testing and evaluation). All potential impacts from the groundwater abstraction should be considered, in particular the potential impacts of the abstraction on the flow in the nearby rivers. The scope of the investigation shall be agreed by the Agency prior to implementation and shall include details concerning future water requirements/plan. Abstraction shall only commence subject to the agreement of the agency"

The March 2013 assessment of impact of abstracting was based on historic and recent information collected at the site. However, in order to fully address the above, it was recommended that a long term pumping test be completed to understand the impact – the pumping test could not be undertaken in March 2013 due to difficulties in discharging the large volumes of groundwater that would be generated during the test (a water treatment plant has since been constructed and commissioned at the site).

Summary and Findings

A pumping test was undertaken of the Cooperage Well in St James' Gate Brewery, Dublin 8 in January-February 2014. The findings from the test are provided below:

- Near steady state conditions were achieved at the Cooperage Well after 13 days of pumping at $100m^3/hr$. It is therefore concluded that this rate of pumping would be sustainable in the longer term from this well;
- The constant rate abstraction of $100m^3/hr$ accounts for 2% of the low flow for the River Liffey. The impact of the abstraction at the Cooperage Well on the flow of the River Liffey is assessed to be low. The impact of the abstraction on the water quality of the River Liffey is also considered negligible.
- The River Cammock close to the site is lined and potential impacts of abstraction on flows and quality are assessed as negligible;
- The cone of depression is anticipated to have reached the River Liffey within days of pumping. This did not result in any intrusion of saline estuarine water into the gravel aquifer.
- Insignificant changes in water level seen in the monitoring wells at the St James' Gate Brewery would indicate that the gravel aquifer is highly permeable. Predicted drawdowns beneath the River Liffey are small and unlikely to result in significant changes to flow within the river; and

[1] URS Ireland Limited (2013) *Impact Assessment on Controlled Waters",* report ref. 46402058, Issue 2, dated 19 March 2013.

- The risk of adverse impact on Water Framework Directive status or other groundwater abstractors is considered to be low.

It is noted that it would be possible to pump at a higher rate from the Cooperage Well than the 100 m^3/hr tested by the pumping test, given the permeability of the gravels. Historical data indicates that abstraction rates of 200-250 m^3/hour were sustained for periods of several months at times, albeit with significantly higher drawdowns and with no assessment of any impacts on water quality. Therefore, it is not known what effect pumping at higher rates would have on water quality of the gravel aquifer, in terms of saline intrusion. Therefore, electrical conductivity (EC) monitoring of the surrounding wells should be completed if a higher pumping rate is required, in order to monitor if any saline intrusion takes place.

Recommendations

It is recommended that:

- The Cooperage Well is monitored further (water levels and water quality) during periods of supply to site, on a biannual basis; and

- An inspection of the Cooperage Well should be carried out every five year to confirm that its condition has not altered in the preceding years.

1 INTRODUCTION

URS Ireland Limited (URS) was commissioned by Diageo Ireland (Diageo) in December 2013, to undertake a pumping test on the disused on-site Cooperage Well at St. James' Gate Brewery, Dublin. This work follows on from an assessment of the potential impact of abstracting from this well on controlled waters (surface water and groundwater) which was undertaken in March 2013[2].

1.1 Background

The pumping test was completed because Diageo is seeking to reduce its reliance on a mains water supply to the brewery, and to replace this with well supply.

The test was also completed in order to fulfil the requirements of Section 6.14.3 of the sites IPPC licence P0301-02, which indicates:

> *"The licensee shall carry out an investigation of the impact of the proposed abstraction from the Cooperage Well on-site prior to the commencement of abstraction (other than for the purpose of testing and evaluation). All potential impacts from the groundwater abstraction should be considered, in particular the potential impacts of the abstraction on the flow in the nearby rivers. The scope of the investigation shall be agreed by the Agency prior to implementation and shall include details concerning future water requirements/plan. Abstraction shall only commence subject to the agreement of the agency"*

The potential impact of abstracting was based on historic and recent information collected at the site. However, in order to fully address the above, it was recommended that a long term pumping test be completed to understand the impact – such a pumping test could not be undertaken in March 2013 due to regulatory and volumetric difficulties in discharging the large volumes of groundwater that would be generated during the test either to municipal drains or to the River Liffey (a water treatment plant has since been constructed and commissioned at the site).

1.2 Location

The site is located at the St James' Gate Brewery, Dublin 8 (the site). The location of the Cooperage Well is shown in Figure 1.

1.3 Scope of Study

The scope of the study included the following:

- Review of baseline data collected from wells in the area since 2006;
- Completion of a step test on the Cooperage Well, including measurement of groundwater levels and quality in surrounding wells; and
- Completion of a constant rate and a recovery test on the Cooperage Well, including measurement of groundwater levels and quality in surrounding wells.

[2] URS Ireland Limited (2013) *Impact Assessment on Controlled Waters",* report ref. 46402058, Issue 2, dated 19 March 2013.

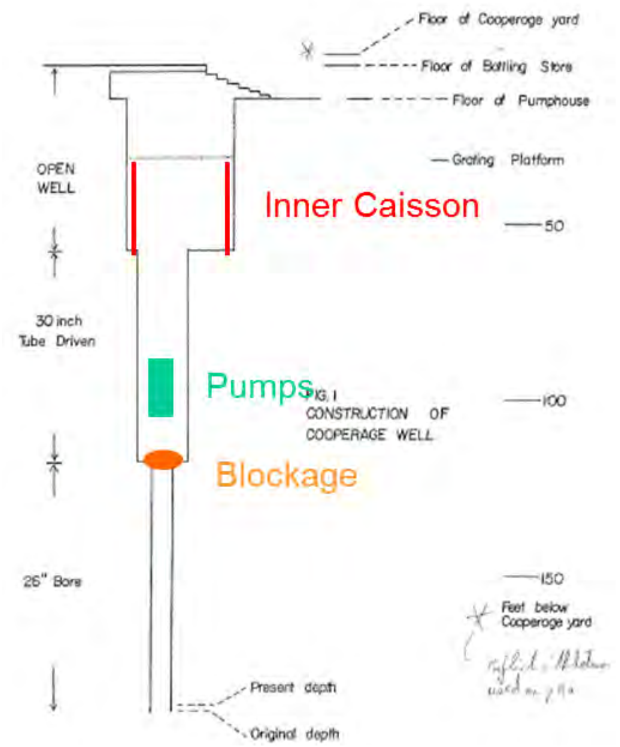
The water level, electrical conductivity (EC) and temperature data was collected using in-situ Level-Conductivity-Temperature (LCT) probes that were placed in each well for the duration of the tests.

The assessment was completed by URS Hydrogeological teams in Ireland and the UK. The key skills of this team include groundwater resource assessment, catchment and aquifer management, groundwater quality and remediation, impact assessment and groundwater control and dewatering. The UK team is headed by Jane Sladen who is a Hydrogeologist and Chartered Civil Engineer with over 20 years' experience in groundwater hydrology. Her expertise includes groundwater resource assessment, wellfield management, groundwater quality evaluation and pollution control, groundwater control and quarry, mine and construction site dewatering. She has been involved with projects addressing the requirements of the Water Framework Directive, Habitats Directive and other legislation, and has worked on low flow river augmentation and groundwater flooding projects.

1.4 Construction of Cooperage Well

The Cooperage Well was most probably constructed in three stages, as follows;

- 1880 - 3.1 m diameter well to 17.1 metres - inner and outer cast-iron caissons - narrower inner caisson below grating at approximately 3 metres (shown in red in drawing below);
- 1902 – 292 mm diameter tube was driven down below the dug well and proved increased supply available from the deeper strata (not shown); and
- 1903 - 762 mm diameter tube to 35.36 m and 660mm diameter bored well below to 56.99 metres below the former Cooperage yard floor level (this level is unknown and is not equivalent to the current Export Warehouse floor level).



(URS, 2011a)

The floor level of the current Export Warehouse has recently been levelled in to Ordnance Datum (OD) and is at an absolute level of 5.45 m above OD (m aOD). From this level, the base of Cooperage Well is at approximately -51 m aOD.

URS' Downhole CCTV and Geophysical testing (Natural Gamma log) also indicated the top of bedrock (see Section 2.1) at 24 m below the Export Warehouse floor level or approximately -18 m aOD (URS, 2011a).

1.5 Sources of Information

The following sources of information were used in the preparation of this report;

- Minerex Limited (1982) "Potential of the Cooperage Well at Victoria Quay, Dublin", dated 25th June 1982, Minerex Ref. 205-39;
- O'Neill Groundwater Engineering (2001) Cooperage Well Report, dated 30th July 2001;
- URS (2010) Diageo St James' Gate Cooperage Well, Assessment of the Development Potential of the Old Cooperage Well, dated 10th June 2010, Draft Issue No. 1 03082242/;
- URS (2011a) Diageo St James' Gate Cooperage Well, Downhole CCTV & Geophysical Testing, MS Powerpoint presentation, dated 17th November 2011;

- URS (2011b) Diageo St James' Gate Cooperage Well, Geophysical and CCTV survey of Cooperage Well, dated 7th December 2011, Draft Issue No.1 46402057/;
- URS (2012) Cooperage Well Preliminary Risk Assessment, Issue No. 3 46402058, dated 24 October 2012;
- Groundwater level monitoring data from St James' Gate Brewery site, November 2012 to January 2013 and December 2013 to February 2014;
- Groundwater quality monitoring data from St James' Gate Brewery boreholes since 2006 (including the period of the 2014 pumping test);
- Marine Institute (2014) Digital Data Surface water levels and flow information for the River Liffey and Cammock River, December 2013 to February 2014; and
- Met Eireann (2014) Hourly rainfall data from the Phoenix Park December 2013 to February 2014.

In addition, publically available sources, principally from Environmental Protection Agency (EPA), Geological Survey of Ireland (GSI) (www.gsi.ie) and the Water Framework Directive in Ireland website (www.wfdireland.ie), have been used.

2 BASELINE DATA

2.1 Groundwater levels

The location of the various on-site groundwater monitoring wells is shown in Figure 1. The datum levels for these different boreholes are given in Table 1.

Table 1: Water Level Datum - St James' Gate Brewery

Well locations	Level (m above OD)	Datum description
Cooperage Well	5.427	Top of temporary casing tube to house measurement probe[3]
MW6	3.217	Top of casing
MW9	4.877	Top of casing
MW13	2.979	Top of casing
MW14a	6.192	Top of casing
MW23	5.327	Top of casing

The topographic elevations of borehole were re-surveyed in to OD on 19 January 2014.

The approximate distances of the following boreholes from the River Liffey are:

- MW6 is 30m;
- MW13 is 40m;
- MW23 is 80m;
- MW9 is 100m;
- MW14a is 110m;
- Cooperage Well is 120m; and
- MW8b is 160m.

The average water levels recorded in these boreholes running up to the start of the test (8 – 13 January 2014) and during the pumping tests are presented in Figure 2.

2.2 Groundwater Quality

Figure 3 and Table 2 below shows the pH and EC recorded in the boreholes during two tidal cycles in 2013 - 22 July and 6 August. The wells monitored during these tidal cycles were the Cooperage Well, MW13, MW06 and MW14a.

[3] The in-situ water level/temperature/conductivity probe was placed in the Cooperage Well inside a 50mm diameter plastic tube (16 m length) and securely anchored at surface, in order to avoid water turbulence during pumping.

Table 2: Water Quality Baseline - St James' Gate Brewery

Location	Parameter	High Tide - 22/07/13	Low Tide - 22/07/13	High Tide - 06/08/13	Low Tide - 06/08/13
Cooperage Well	**Time**	11.20	16.45	12.00	17.00
	Temperature (°C)	14.40	14.5	14.80	15.10
	pH	7.03	7.31	6.83	7.25
	EC (µS/cm)	1,158	1,171	775	771
	Comments	Clear, NEC, readings taken from grab sample	Clear, NEC, readings taken from grab sample	Clear, NEC, readings taken from grab sample	Clear, NEC, readings taken from grab sample
MW13	**Time**	11.35	17.20	12.15	18.00
	Temperature (°C)	14.10	14.0	14.80	14.80
	pH	6.98	7.31	7.07	7.14
	EC (µS/cm)	1,999	2,525	1,914	2,714
	Comments	High turbidity, red in colour, NEC	High turbidity, red in colour, NEC	Moderate to high, turbidity, red in colour, NEC	Moderate to high, turbidity, red in colour, NEC
MW06	**Time**	12.05	17.05	12.25	17.45
	Temperature (°C)	15.04	15.40	15.50	16.40
	pH	7.56	7.90	7.7	7.67
	EC (µS/cm)	1,254	1,246	1,270	1,245
	Comments	Low to moderate turbidity Slightly brown in colour NEC	Low to moderate turbidity Slightly brown in colour NEC	Moderate to high turbidity, red in colour NEC	High turbidity, red in colour, NEC
MW14a	**Time**	12.15	16.55	13.00	17.30
	Temperature (°C)	14.00	14.10	13.70	15.50
	pH	8.86	8.48	8.58	8.58
	EC (µS/cm)	821	830	129.2	133.4
	Comments	Poor recharge; approximately 3 litres purged. High turbidity, sandy/silty brown water.	Poor recharge; approximately 3 litres purged. High turbidity, sandy/silty brown water.	Poor recharge; approximately 4 litres purged. High turbidity, sandy/silty brown water.	Poor recharge; approximately 4 litres purged. High turbidity, sandy/silty brown water.

The main observations from this data are as follows;

- The data shows very little variation between high and low tide in terms of pH and temperature;
- There was a slight variation in EC readings between high and low tide in some of the wells;

- The groundwater at MW14a near the Cammock River had a low EC reading indicating no tidal influence at this location; and

- The elevated EC reading in MW13 is likely to be due to the presence of iron in the groundwater as evidenced by the red colouration of the water observed during groundwater monitoring - the explanation for this feature is most probably due to the water in this borehole having been confined by peat (identified in the drilling log for this well) and becoming anoxic i.e. reduced conditions and with iron being present in the Fe^{2+} form. By drilling through the peat layer, air is introduced into the system and the iron gets converted to Fe^{3+} form ('red' ochre material). The presence of high amounts of iron in suspension may affect the EC readings seen in this monitoring well during the pump test.

The EC was also recorded in these boreholes in advance of the pumping tests (8 – 14 January 2014) and is provided in Figure 3. The average daily EC observed between 8 and 13 January 2014 was within the range of conductivities observed during the tidal cycles on 22 July 2013 and 6 August 2013 (both sets of EC data are shown in Figure 3).

Table 3: Electrical Conductivity Readings – Cooperage Well, St. James' Gate Brewery

Date	Average Daily EC (µS/cm)
08/01/14 (part day)	985
09/01/14	985
10/01/14	990
11/01/14	1,005
12/01/14	1,018
13/01/14	1,021

3 HISTORIC PUMPING TESTS

The Cooperage Well has been test pumped on a number of occasions in the past. A summary from two reports prepared by Minerex (1982) and O'Neill Groundwater Engineering (2001) containing details of historic pumping tests is provided below:

- **Minerex (1982)** – A step test (6 hours) and constant rate test (3 days) was undertaken in 1981-82. The step test was undertaken at two rates; 136-272 m^3/hr and 272-408 m^3/hr on 6 October 1981. Each step was run for approximately 3 hours. The drawdown for each step after 150 minutes was 1.26m and 2.45m respectively. The rate of 136 m^3/hr was chosen for the constant rate pumping test (3 days). This took place between 23 March and 26 March 1982. There was some influence from the storage of Cooperage Well on the early stage results, but by the end of the test, well levels were declining at a rate of 1.2m per log cycle (i.e. between day 3 and day 30).

- **O'Neill Groundwater Engineering (2001)** – An operational test was undertaken on 27th April 2001, along with CCTV borehole monitoring. The maximum and minimum water levels in the Cooperage Well were recorded over an 84 minute period. The drawdown observed over this period was 1.23m with a pumping rate of 273 m^3/hr. The Specific Capacity (defined as the rate of discharge of a well per unit drawdown, expressed as m^3/d/m or m^2/d) was calculated as 5,321 m^2/d.

4 URS PUMPING TEST 2014

4.1 Objectives

The objectives of the pumping test were to:

- Evaluate hydrogeological conditions and maximum well capacity of the gravel aquifer;
- Further refinement of the site hydrogeology conceptual model in order to inform the impacts on the River Liffey; and
- Determine whether the operation of the Cooperage Well causes saline intrusion into the gravel aquifer.

4.2 Pump Test Analysis

The step, constant rate and recovery test time/drawdown data was analysed using Aquifer Win32. The software was developed by Environmental Simulations International, UK and is the preferred package used by the UK Environment Agency.

Step Test

URS carried out a calibration test on 13 January 2014, followed by a step test on the 15 January 2014. The specification used is provided in Appendix A.1.

During the step test, there were four 100 minute steps:

- Step 1 – 10:10 (70 m^3/hr)
- Step 2 – 11:50 (100 m^3/hr)
- Step 3 – 13:30 (130 m^3/hr)
- Step 4 – 15:10 (170 m^3/hr)

The step test was completed at 16:55 and the Cooperage Well was allowed to recover for 16 hours.

The flow rates were recorded using a sonic flow meter installed between the Cooperage Well and the treatment plant.

The results of the step test are presented in Figure 4. The cumulative drawdown in the test well over the test period was approximately 1m. Figure 5 shows the specific capacity versus drawdown plot for the Cooperage Well and indicates that a well yield of 100 m^3/hr is a sustainable abstraction rate. The specific capacity of the Cooperage Well is estimated to be 150m^2/hr, or 3,600m^2/d. This is somewhat lower than the previous estimate of 5,321m^2/d (see Section 3).

The drawdown vs. time data of the three steps within the step test was analysed. The transmissivity and well efficiency were determined using the Eden and Hazel method. The drawdown is accounted for by head loss within the formation and head loss due to the well. The drawdown is related to the formation head loss and well losses by the following expression:

$$s = aQ + bH + CQ^2$$

Where s is the drawdown [m]

Q is the abstraction rate [m^3/d]

a is a formation coefficient [d/m^2]

b is a formation coefficient [d/m^2]

C is the non-linear well loss coefficient [d^2/m^5]

H is a parameter which is related to the sum of Q and log time [d/m^3xlog(d)]

The transmissivity and turbulent head loss constants are as follows:

Transmissivty, T = 2608 m^2/d

Turbulent head loss, C = 5.7×10^{-8} d^2/m^5

Parameter, a = -3×10^{-4} d/m^2

Parameter, b = 7×10^{-5} d/m^2

The estimated head loss due to non-linear effects is given by CQ^2. At a pumping rate of 170m^3/hr, and a drawdown of 1.2m, the non-linear head loss is estimated to be 0.95m or 79% of the drawdown. This is a similar non-linear head loss calculated by Minerex (1982), which estimated 67% at a pumping rate of 136m^3/hr. The poor efficiency is likely to be due to the presence of the caisson, which may act as a barrier to groundwater flow. The well efficiency has no bearing on the study, but will provide a useful baseline for well performance over time.

Constant Rate Test

During the constant rate test, the Cooperate well was pumped at a flow rate of 100 m^3/hr for a period of thirteen days. The results of this test are presented in Figures 6 to 11.

After thirteen days of pumping a near steady state was reached. A drawdown of approximately 1.6m was measured in the Cooperage Well. Drawdowns of 1m, 0.6m, 0.9m, 1m and 0.8m were measured in monitoring wells MW6, MW9, MW13, MW14a and MW23, respectively. A peak in rainfall was noted at the beginning of the test with a decline in rainfall during the test. Recovery to pre-test levels was not achieved and drawdowns are likely in part to be due to reductions in rainfall as the test proceeded. If the recovery levels are taken as rest level then drawdowns are 1.3m in the Cooperage Well and 0.2m - 0.4m in the monitoring wells.

The response in groundwater levels to pumping is similar in all wells, which indicates that the water table during pumping is relatively flat and that the gravels have a high permeability. However, the drawdown in MW6 and MW13 could also be affected by the presence of the river wall. The river wall may act as a barrier to flow increasing the drawdown in these wells.

MW14a shows the clearest relationship between rainfall and groundwater level with the changes in EC corresponding with peaks in rainfall level. However, the variations in EC are small and vary between 80µs/cm and 160µs/cm.

Tidal influence can be clearly seen in MW6, MW9, MW13 and MW23. However, the fluctuations are less than 0.1m. This is compared with a tidal range in the River Liffey of 1.5-

2.5m, again suggesting limited hydraulic connectivity to the river. There is a small increase in the EC within MW6 during the pumping test, indicating that there is at least partial interaction between the gravel aquifer and the River Liffey. The high EC within MW13 is consistent with previous observations made (see Section 2.2), and is likely to be as a result of the oxidation of iron. As expected, the groundwater level within MW13 responded in a similar way to water levels in MW6.

After thirteen days of pumping the EC levels in MW9 and MW23 do not show signs of saline intrusion. There is a small increase in the EC within MW6, however, the increase is only approximately 300µs/cm, and not a sufficient rise to indicate that saline intrusion is occurring.

The Neuman, Theis and Cooper-Jacob methods for an unconfined aquifer were used to estimate the transmissivity and storativity of the gravel aquifer. The transmissivity and storativity are reported in Table 4 below. The transmissivity ranges between 414m^2/d and 864m^2/d, and the storage coefficient between $5x10^{-5}$ and 0.063. The curve matches are presented in Appendix A.2.

Table 4: Aquifer Properties based on Constant Rate Test – St James' Gate Brewery

Well	Cooper & Jacob, 1946 (Straight Line Method)		Theis, 1935 (unconfined approximation)		Neuman, 1972 (unconfined aquifer)	
	Transmissivity (m^2/d)	Storage Coefficient	Transmissivity (m^2/d)	Storage Coefficient	Transmissivity (m^2/d)	Storage Coefficient
Cooperage Well	464		432		432	
MW6	656	0.026	572	0.037	527	0.013
MW9	857	0.024	864	0.026	785	0.011
MW13	414	0.058	435	0.068	464	0.015
MW14a	418	0.073	482	0.069	466	0.00008
MW23	745	0.051	645	0.068	511	0.075

Groundwater quality sampling was undertaken in the Cooperage Well five times during day 1 and on days 2, 3, 6, 8, 10, 12 and 13. The results are presented in Table 5 below. With the exception of manganese, all determinands show little variation during the constant rate test. The manganese concentrations in the Cooperage Well approximately doubled during the test. Groundwater sampling results from the Cooperage Well and EC monitoring in the nearby monitoring wells during the test indicate that saline intrusion from the River Liffey to the gravel aquifer is unlikely to occur to any significant extent at an extraction rate of 100m^3/day.

Table 5: Selected Water Quality Parameters from the Cooperage Well – St James' Gate Brewery

COOPERAGE WELL				
Parameter	**End of day (EoD) 1**	**EoD8**	**EoD10**	**EoD13**
EC@20°C (µS/cm)	1,170	1,113	1,133	1,148
pH	7.93	7.81	7.27	7.51
Temperature °C	13.4	13.2	13.4	13.5
Alkalinity as CaCO3 (mg/l CaCO3)	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	285	306	300	309

COOPERAGE WELL				
Parameter	**End of day (EoD) 1**	**EoD8**	**EoD10**	**EoD13**
(mg/l)				
Chloride (mg/l Cl)	98.8	93.9	93.5	93.9
Fluoride (mg/l Fl)	<0.3	<0.3	<0.3	<0.3
Sulphate mg/l	119.67	112.31	109.4	106.12
Nitrate (mg/l N)	33.1	25.4	24.6	23.6
Nitrite (mg/l N)	<0.02	<0.02	<0.02	<0.02
ortho-Phosphate (mg/l P)	0.04	<0.03	<0.03	<0.03
Ammoniacal Nitrogen as N (mg/l N)	0.17	0.2	0.22	0.24
Dissolved Calcium (mg/l)	131	123.3	120.6	116.9
Dissolved Iron (µg/l)	<20	<20	<20	<20
Dissolved Magnesium (mg/l)	17.8	17	16.8	17.3
Dissolved Manganese (µg/l)	167	295	301	309
Dissolved Potassium (mg/l)	8.3	8.2	7.9	7.9
Dissolved Sodium (mg/l)	90.1	91.1	96	96.2
Total Iron (mg/l)	<20	<20	<20	<20
Total Manganese (mg/l)	185	297	307	316
Turbidity NTU	0.3	0.7	0.9	0.9

Groundwater quality data collected during the pumping test is summarised in Appendix A.3. Laboratory reports are provided in Appendix B.

Recovery Test

The results of the recovery test are presented in Figures 6 to 11. The recovery groundwater levels are lower than the pre-test level. This is likely to be due to the peak rainfall level at the beginning of the constant rate test.

The transmissivities for the Cooperage Well and monitoring wells are presented in Table 6 below and range between 688m^2/d and 3,320m^2/d. The transmissivities estimated from the recovery test are higher than the transmissivities determined from the constant rate test (414m^2/d to 864m^2/d), but are in a similar order of magnitude.

Table 6: Aquifer Properties from Recovery Test – St James' Gate Brewery

Well	Theis, 1946 (Recovery) Transmissivity (m^2/d)
Cooperage Well	781
MW6	1,217
MW9	3,320
MW13	1,379
MW14a	688

Well	Theis, 1946 (Recovery) Transmissivity (m^2/d)
MW23	1,559

4.3 Predicted Drawdown at River Liffey

The drawdowns measured within monitoring wells MW6, MW8b, MW9, MW13, MW14a and MW23, as shown in Figures 6 - 11, are in the same order of magnitude. The flat water table during pumping indicates that the gravel is highly permeable. Pumping test analysis gave a transmissivity range of between $414m^2/d$ and $3,320m^2/d$, with an average of $869m^2/d$, at these monitoring wells.

Evidence from CCTV survey (O'Neill, 2001) of the Cooperage Well indicates that the Cooperage Well primarily abstracts water from the gravel aquifer. Assuming that all flow is within the gravel aquifer, the saturated aquifer thickness has been estimated from borehole logs and the pre-constant rate water level in the Cooperage Well. A saturated aquifer thickness of the gravel aquifer is estimated to be 17m. Based on the transmissivity range estimated from the pumping test and the saturated aquifer thickness, then the hydraulic conductivity of the gravel aquifer is likely to be in the range 24m/d and 195m/d (with an average of 51m/day).

Using the Dupuit-Thiem equation it is possible to estimate the drawdown at the River Liffey under steady state conditions. The Dupuit-Thiem equation is given as:

$$Q = \pi K \frac{\left(h_2^2 - h_1^2\right)}{2.3\log\left(\frac{r_2}{r_1}\right)}$$

Where Q is discharge [m^3/d]

K is hydraulic conductivity [m/d]

r is radius [m]

h is hydraulic head [m]

The permeability of the gravel formation can be estimated by using the discharge rate of $100m^3/hr$, or $2,400m^3/d$, and drawdowns at each well. Radius r_1 is set to be the radius of Cooperage Well (1.5m), at which the drawdown is 1.28m and the hydraulic head at the pumping well is therefore 15.72m. Radius r_2 is set as the distance to each monitoring well. The hydraulic heads, h2, and modelled permeabilities for each monitoring well are presented in Table 7.

Table 7: Model Parameters and Estimated Permeabilities for Monitoring Wells – St James' Gate Brewery

MODEL PARAMETERS

Monitoring Well	Modelled Permeability m/d	h1 m	h2 m	r1 m	r2 m	Q m^3/d
MW6	135	15.72	16.52	1.5	147	2,400
MW9	110	15.72	16.86	1.5	293	2,400
MW13	130	15.72	16.58	1.5	164	2,400
MW14a	145	15.72	16.44	1.5	112	2,400
MW23	120	15.72	16.62	1.5	160	2,400

The modelled permeability of the gravel aquifer ranges between 110m/d and 145m/d. The modelled permeability lies within the range calculated from the pumping test (permeability = transmissivity/aquifer saturated thickness). Applying this permeability range, the predicted drawdown at the River Liffey is estimated to be between 0.2m and 0.5m.

4.4 Predicted Impact on Surface water

The pumping test carried out at an abstraction rate of 100 m^3/hr indicates that this yield is sustainable in the long term.

Comparing flow rate at the Cooperage Well with river flow measurements, 100 m^3/hr represents approximately 2% of 95% flow for the River Liffey. As the proposed abstraction rate is only 2% of this low flow rate of the River Liffey, the impact of the abstraction on river flows is considered to be low. Moreover, the pumping test indicates that the interaction between the River Liffey and the gravel aquifer is limited, as evidenced by the response to pumping in MW6 and MW14a compared with the other monitoring wells, the absence of significant salinity increases in monitoring wells close to the Liffey during the test and the small predicted drawdown at the River Liffey. The abstraction is therefore predicted to have a negligible effect on the water quality of the River Liffey.

The River Cammock is culverted within the vicinity of the site and interaction with groundwater will not take place. This is evidenced by monitoring well MW14a showing a similar response to pumping as MW23 and MW9 located furthest away from the River Cammock. Abstraction at the Cooperage well is predicted to have a negligible effect on the flows and the water quality of the River Cammock due to the presence of the culvert, though the ribbon gravels around the Cammock may provide some flow towards the Cooperage Well.

4.5 Predicted Impact on Groundwater

The constant rate pumping test undertaken by URS achieved near steady state conditions after 13 days of pumping.

The abstraction has resulted in relatively small and insignificant effects on the groundwater levels and flows within the gravel aquifer. In particular, the steady state drawdowns below the River Liffey are only estimated to be between 0.3m to 0.5m.

The cone of depression is anticipated to have reached the River Liffey within days of pumping. This did not result in any intrusion of saline estuarine water into the gravel aquifer, as observed in the monitoring wells on the St James' Gate Brewery site.

Finally, it is noted that there are no other groundwater users within the immediate vicinity of the abstraction well.

It is noted that it would be possible to pump at a higher rate from the Cooperage Well than the 100 m^3/hr tested by the pumping test, given the permeability of the gravels. Historical data indicates that abstraction rates of 200-250 m^3/hour were sustained for periods of several months at times, albeit with significantly higher drawdowns and with no assessment of any impacts on water quality. Therefore, it is not known what effect pumping at higher rates would have on water quality of the gravel aquifer, in terms of saline intrusion. Therefore, EC monitoring of the surrounding wells should be completed if a higher pumping rate is required, in order to monitor if any saline intrusion takes place.

5 FINDINGS AND RECOMMENDATIONS

5.1 Findings

- A pumping test was undertaken of the Cooperage Well in St James' Gate Brewery, Dublin 8 in January-February 2014;
- Near steady state conditions were achieved at the Cooperage Well after 13 days of pumping at 100m^3/hr. It is therefore concluded that this rate of pumping would be sustainable in the longer term from this well;
- The constant rate abstraction of 100m^3/hr accounts for 2% of the low flow for the River Liffey. The impact of the abstraction at the Cooperage Well on the flow of the River Liffey is assessed to be low. The impact of the abstraction on the water quality of the River Liffey is also considered negligible. The River Cammock close to the site is lined and potential impacts of abstraction on flows and quality are assessed as negligible;
- The cone of depression is anticipated to have reached the River Liffey within days of pumping. This did not result in any intrusion of saline estuarine water into the gravel aquifer;
- The insignificant changes in water level seen in the monitoring wells at the St James' Gate Brewery would indicate that the gravel aquifer is highly permeable. Predicted drawdowns beneath the River Liffey are small and unlikely to result in significant changes to flow within the river; and
- The risk of adverse impact on Water Framework Directive status or other groundwater abstractors is considered to be low.

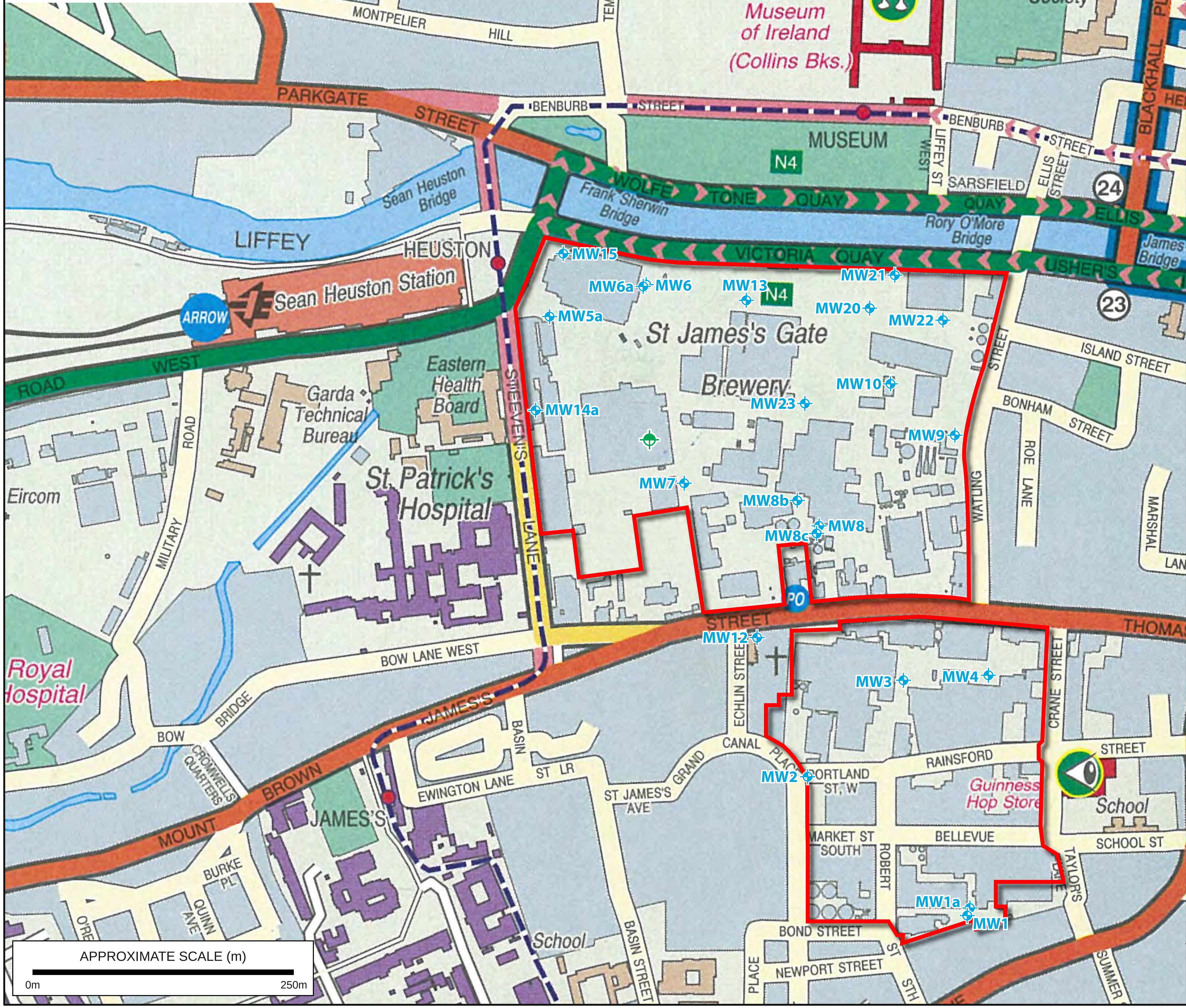
5.2 Recommendations

It is recommended that:

- The Cooperage Well is monitored further (water levels and water quality) during periods of supply to site, on a biannual basis; and
- An inspection of the Cooperage Well should be carried out every five year to confirm that its condition has not altered in the preceding years.

FIGURES

PRIVATE AND CONFIDENTIAL



NOTES

- Site Boundary
- Cooperage Well
- IPPC Groundwater Monitoring Well

Fig 1

URS

410/411 Q House, 76 Furze Road, Sandyford, Dublin 18.
Tel: +353 (1) 293 3200 Fax: +353 (1) 293 3201

CLIENT

DIAGEO IRELAND

PROJECT

IMPACT ASSESSMENT OF CONTROLLED WATERS

DRAWING TITLE

FIGURE 1 _ IPPC GROUNDWATER MONITORING WELL LOCATIONS

DRAWN	TRACED	CHECKED	APPROVED	DATE
SML		SF	SF/DUB	FEB 2013
SCALE	DRG NO.			REV
AS SHOWN	46402058			

Fig 2

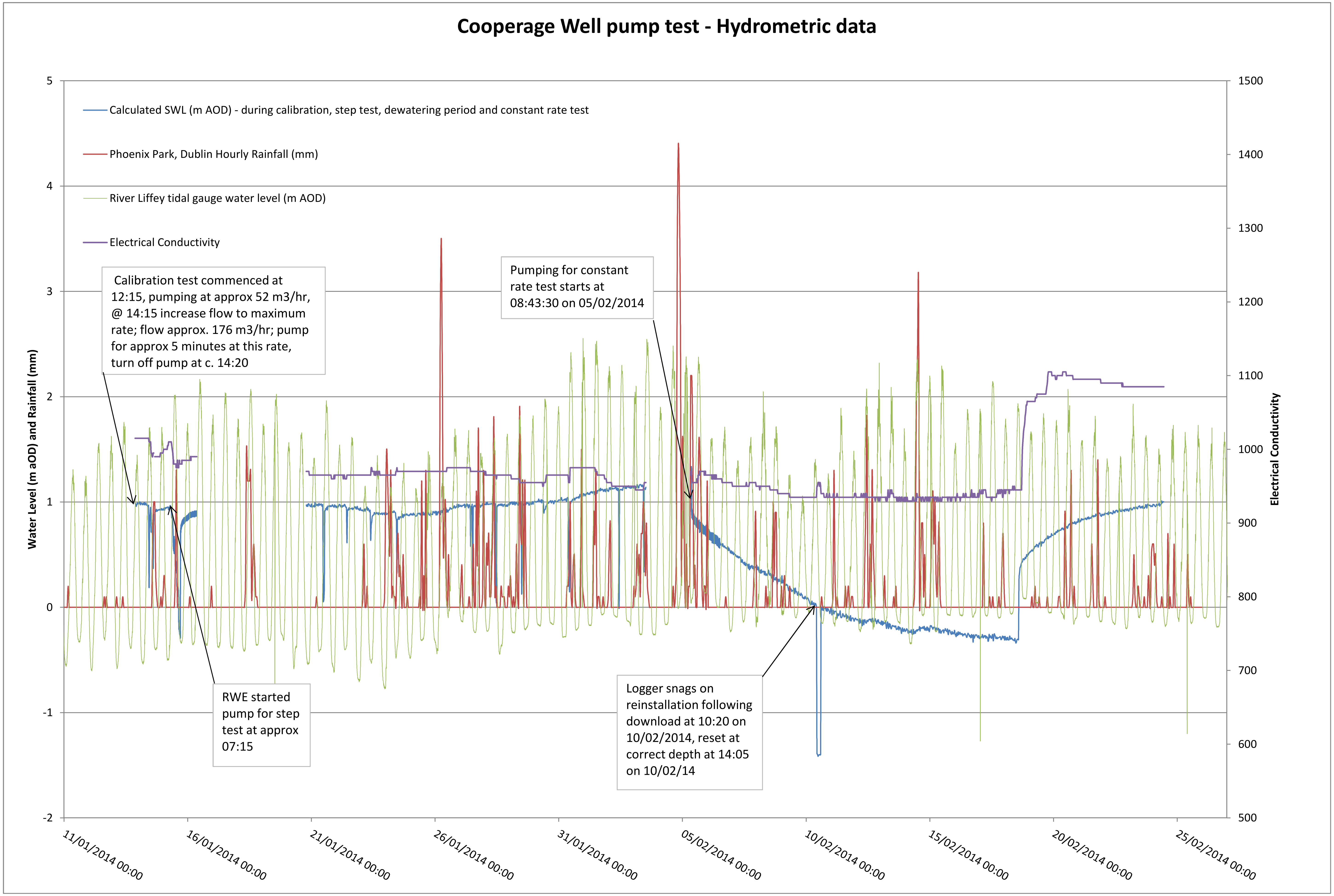
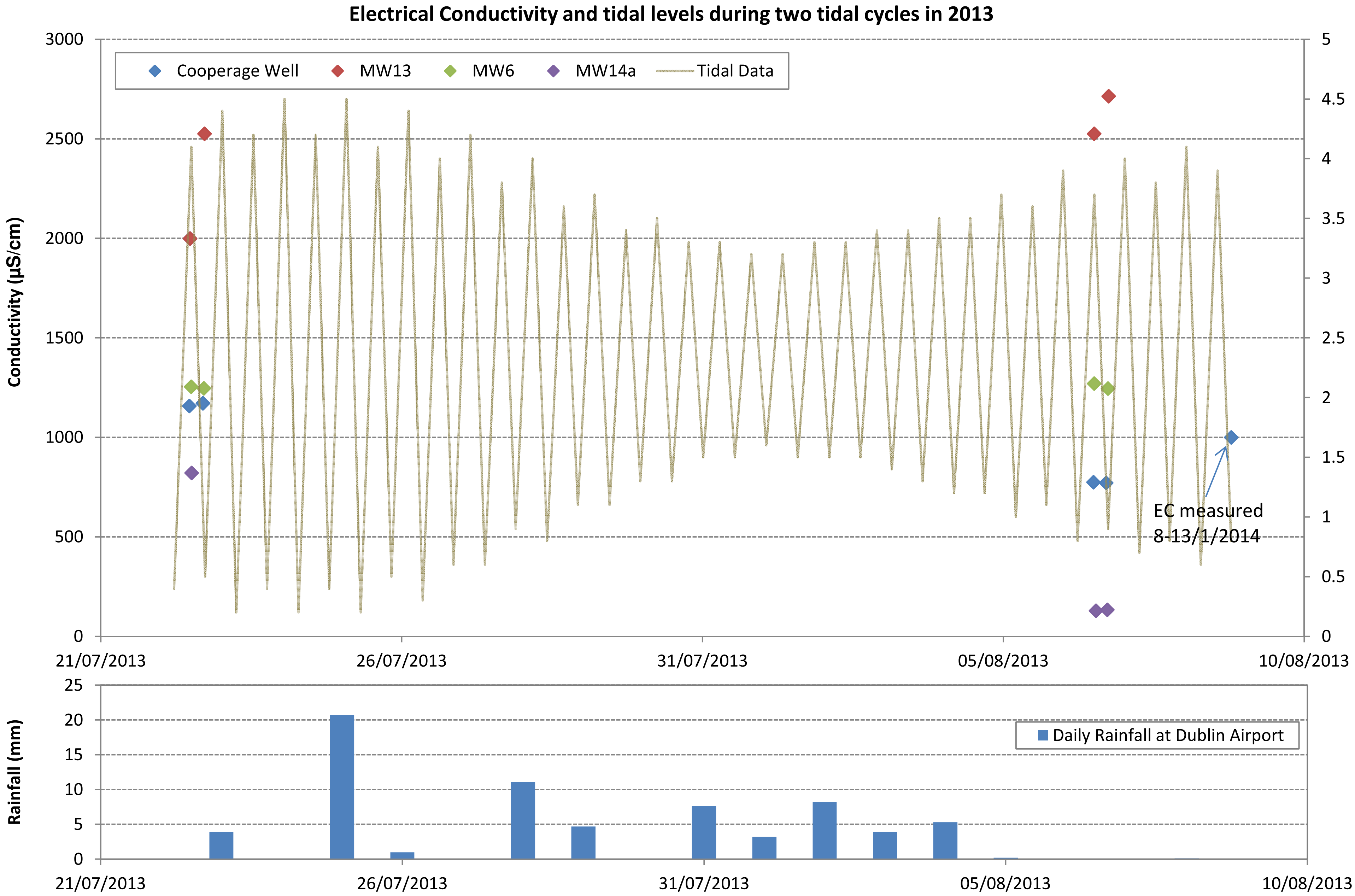
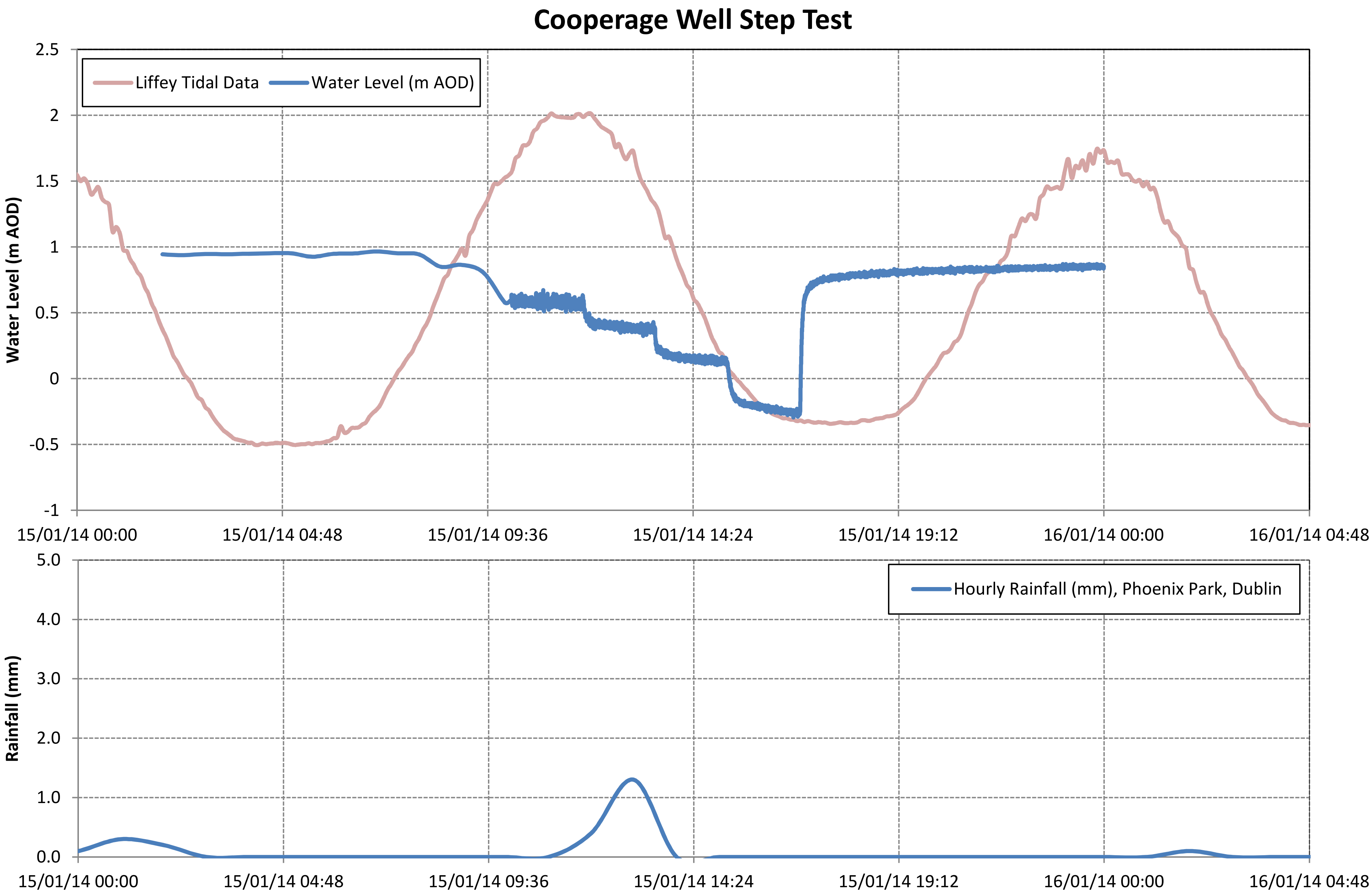

Cooperage Well pump test - Hydrometric data
Calculated SWL (m AOD) - during calibration, step test, dewatering period and constant rate test
Phoenix Park, Dublin Hourly Rainfall (mm)
River Liffey tidal gauge water level (m AOD)
Electrical Conductivity
Calibration test commenced at 12:15, pumping at approx 52 m3/hr, @ 14:15 increase flow to maximum rate; flow approx. 176 m3/hr; pump for approx 5 minutes at this rate, turn off pump at c. 14:20
Pumping for constant rate test starts at 08:43:30 on 05/02/2014
RWE started pump for step test at approx 07:15
Logger snags on reinstallation following download at 10:20 on 10/02/2014, reset at correct depth at 14:05 on 10/02/14
Water Level (m aOD) and Rainfall (mm)
Electrical Conductivity
5
4
3
2
1
0
-1
-2
1500
1400
1300
1200
1100
1000
900
800
700
600
500
11/01/2014 00:00
16/01/2014 00:00
21/01/2014 00:00
26/01/2014 00:00
31/01/2014 00:00
05/02/2014 00:00
10/02/2014 00:00
15/02/2014 00:00
20/02/2014 00:00
25/02/2014 00:00

Fig 3



Electrical Conductivity and tidal levels during two tidal cycles in 2013
Cooperage Well
MW13
MW6
MW14a
Tidal Data
Conductivity (µS/cm)
Tdie Level
EC measured 8-13/1/2014
3000
2500
2000
1500
1000
500
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
21/07/2013
26/07/2013
31/07/2013
05/08/2013
10/08/2013
Rainfall (mm)
Daily Rainfall at Dublin Airport
25
20
15
10
5
0
21/07/2013
26/07/2013
31/07/2013
05/08/2013
10/08/2013

Fig 4



Cooperage Well Step Test
Liffey Tidal Data
Water Level (m AOD)
Water Level (m AOD)
2.5
2
1.5
1
0.5
0
-0.5
-1
15/01/14 00:00
15/01/14 04:48
15/01/14 09:36
15/01/14 14:24
15/01/14 19:12
16/01/14 00:00
16/01/14 04:48
Hourly Rainfall (mm), Phoenix Park, Dublin
Rainfall (mm)
5.0
4.0
3.0
2.0
1.0
0.0
15/01/14 00:00
15/01/14 04:48
15/01/14 09:36
15/01/14 14:24
15/01/14 19:12
16/01/14 00:00
16/01/14 04:48

Fig 5

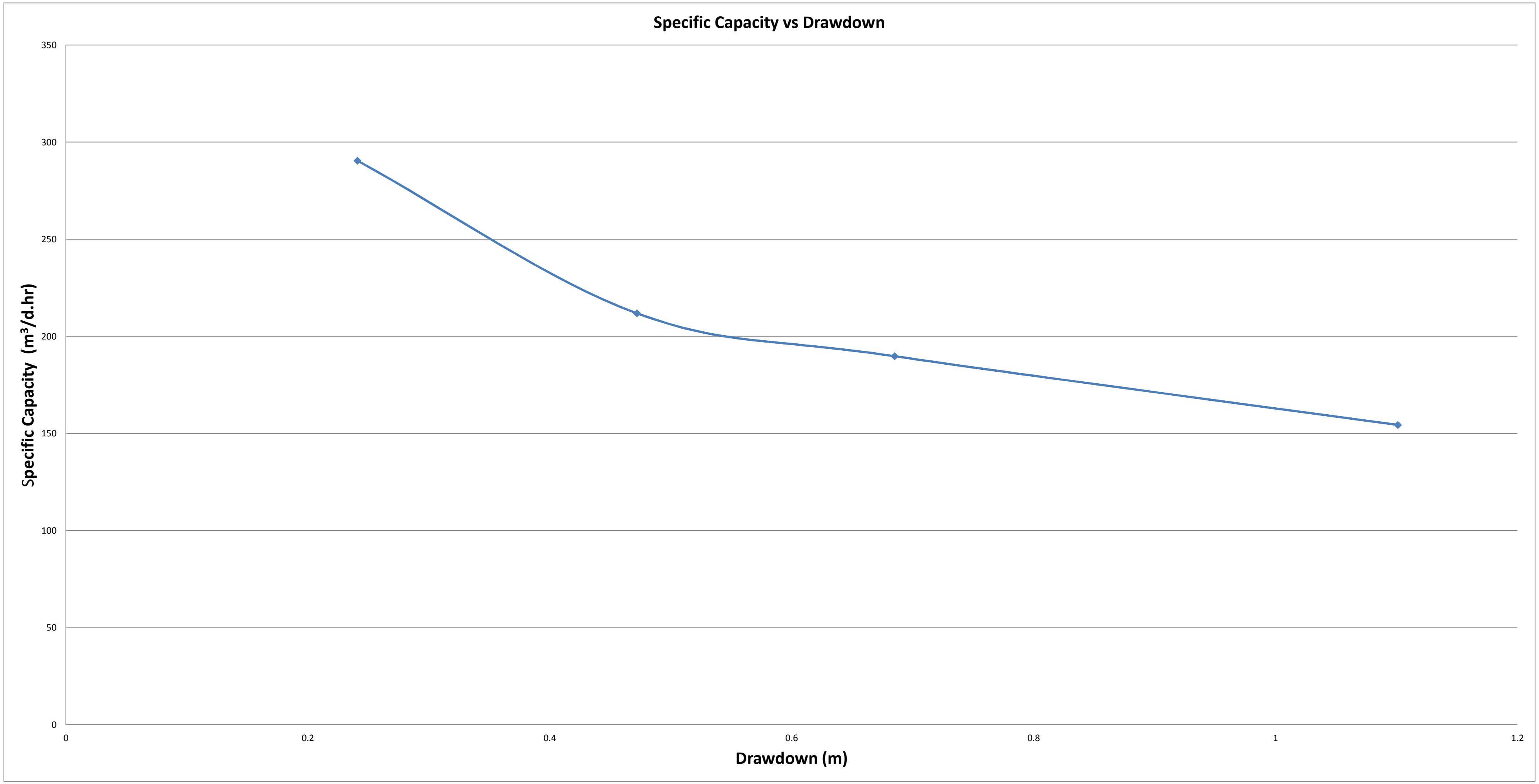

Specific Capacity vs Drawdown
Specific Capacity (m³/d.hr)
350
300
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
Drawdown (m)

Fig 6

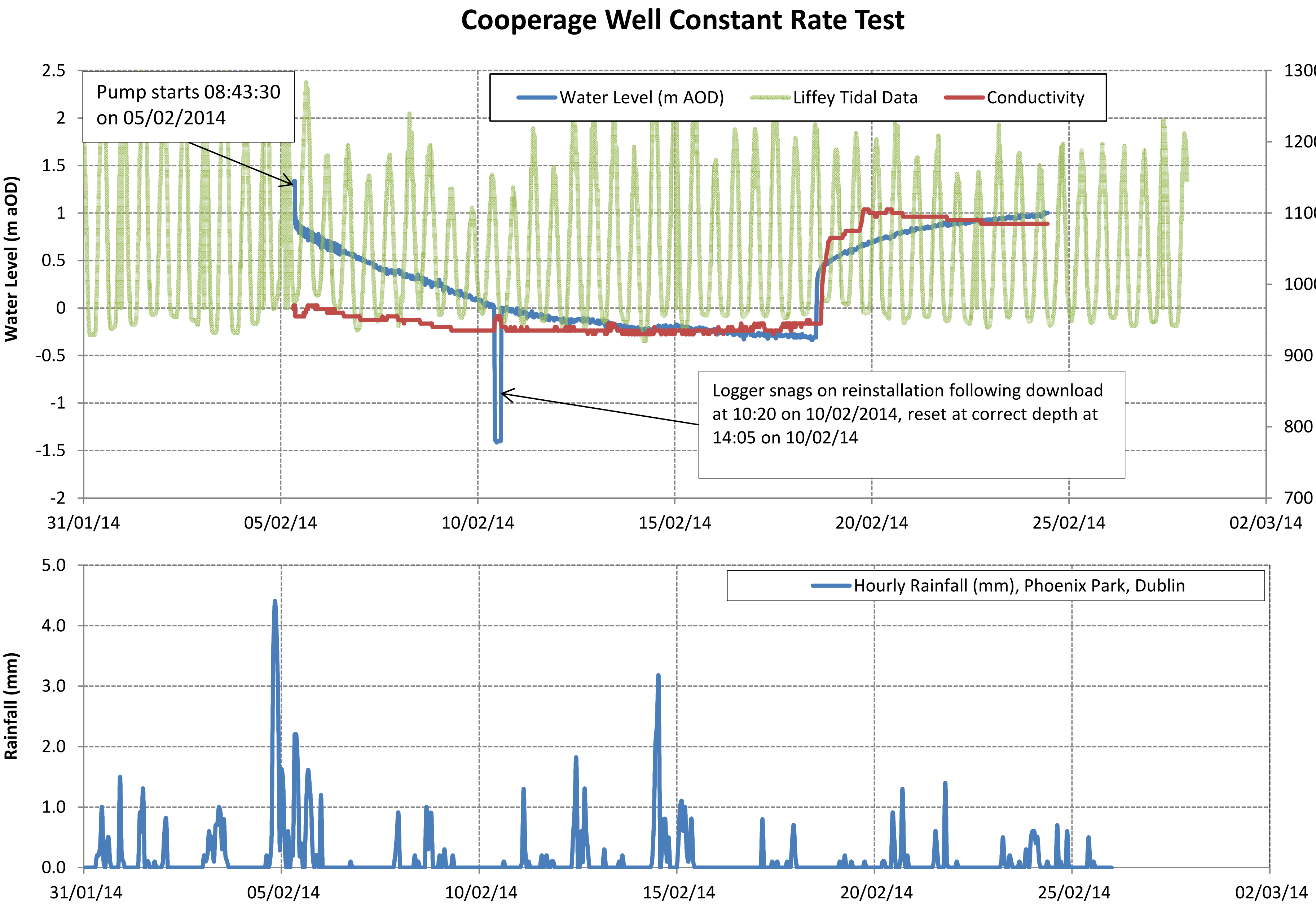
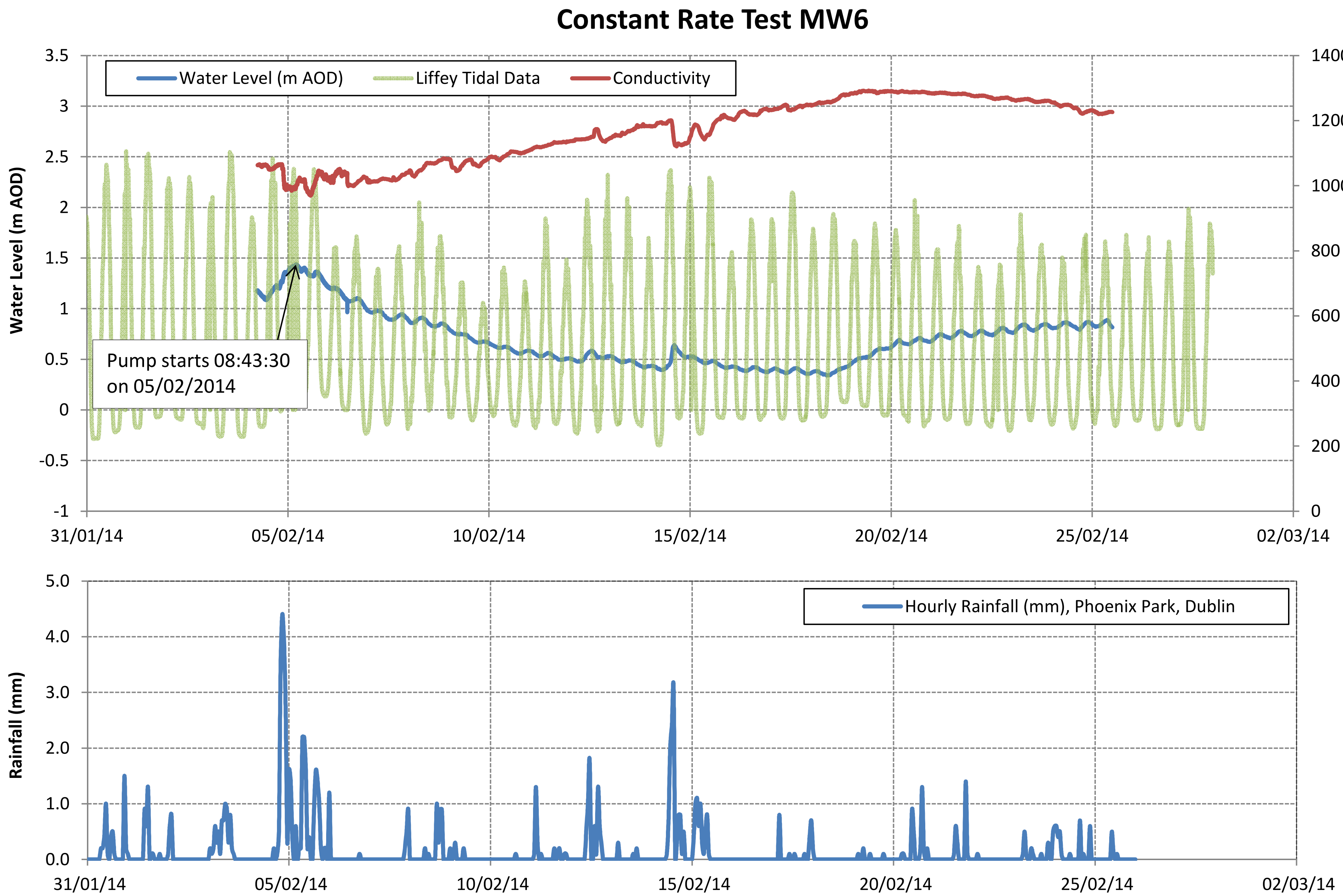
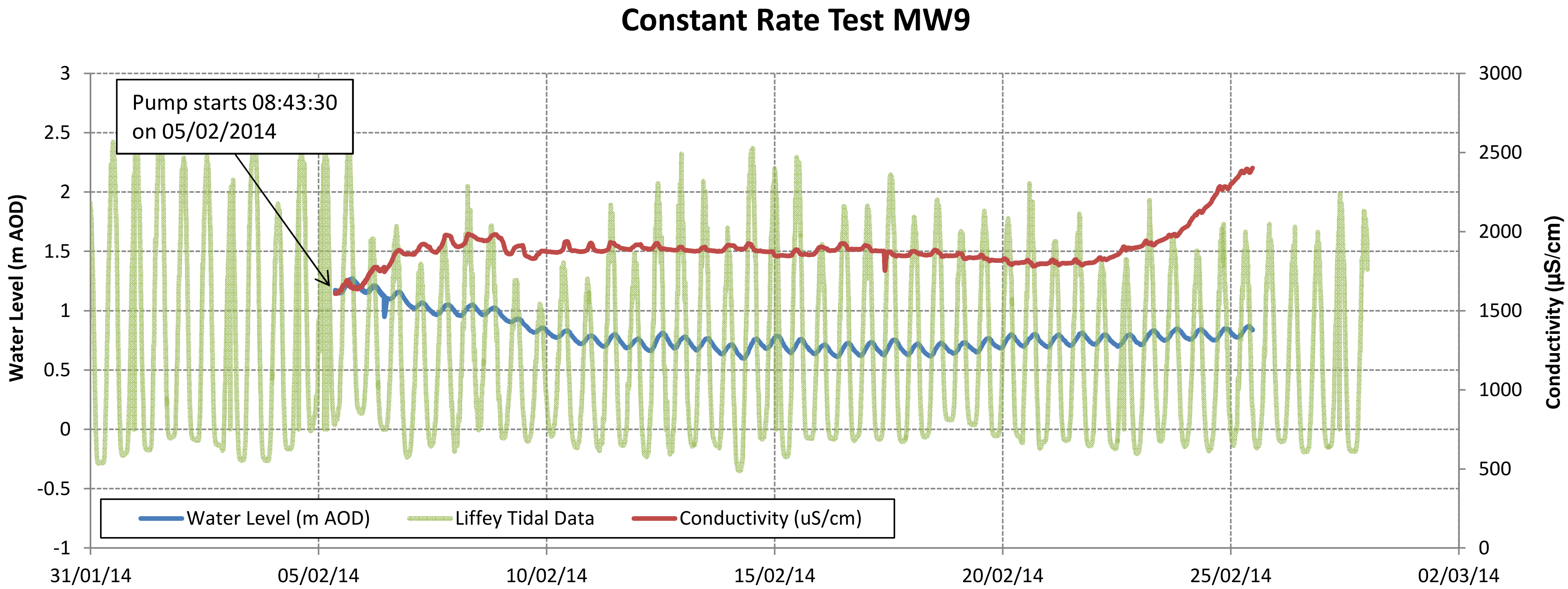

Cooperage Well Constant Rate Test
Pump starts 08:43:30 on 05/02/2014
Water Level (m AOD)
Liffey Tidal Data
Conductivity
Logger snags on reinstallation following download at 10:20 on 10/02/2014, reset at correct depth at 14:05 on 10/02/14
Water Level (m aOD)
Conductivity (µS/cm)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1300
1200
1100
1000
900
800
700
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14
Hourly Rainfall (mm), Phoenix Park, Dublin
Rainfall (mm)
5.0
4.0
3.0
2.0
1.0
0.0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14

Fig 7

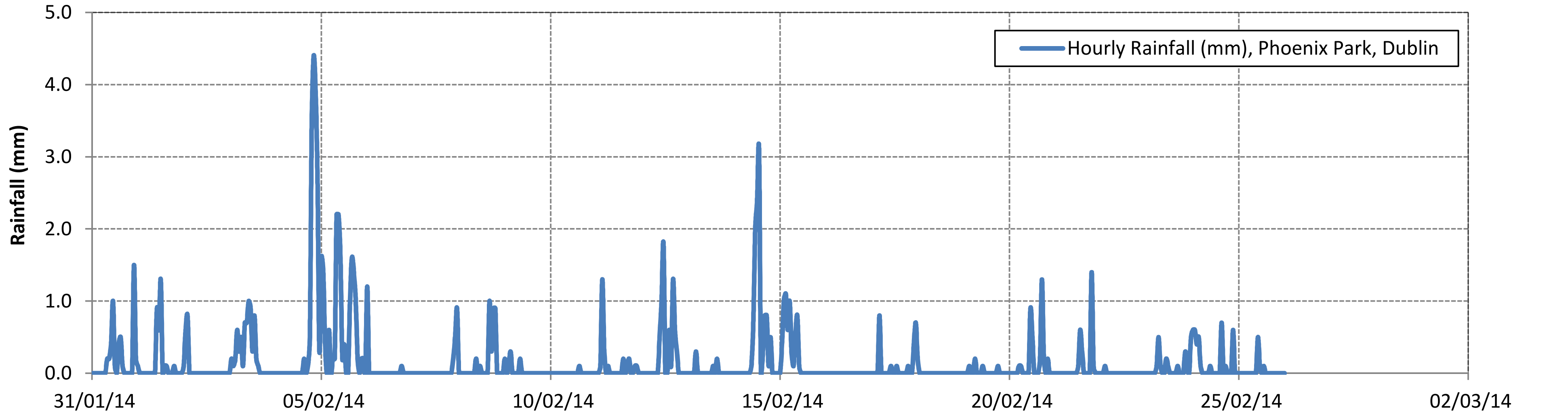


Constant Rate Test MW6
Water Level (m AOD)
Liffey Tidal Data
Conductivity
Pump starts 08:43:30 on 05/02/2014
Water Level (m AOD)
Conductivity (µS/cm)
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
1400
1200
1000
800
600
400
200
0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14
Hourly Rainfall (mm), Phoenix Park, Dublin
Rainfall (mm)
5.0
4.0
3.0
2.0
1.0
0.0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14

Fig 8



Constant Rate Test MW9
Pump starts 08:43:30 on 05/02/2014
Water Level (m AOD)
Conductivity (µS/cm)
Water Level (m AOD)
Liffey Tidal Data
Conductivity (uS/cm)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
3000
2500
2000
1500
1000
500
0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14



Rainfall (mm)
Hourly Rainfall (mm), Phoenix Park, Dublin
5.0
4.0
3.0
2.0
1.0
0.0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14

Fig 9

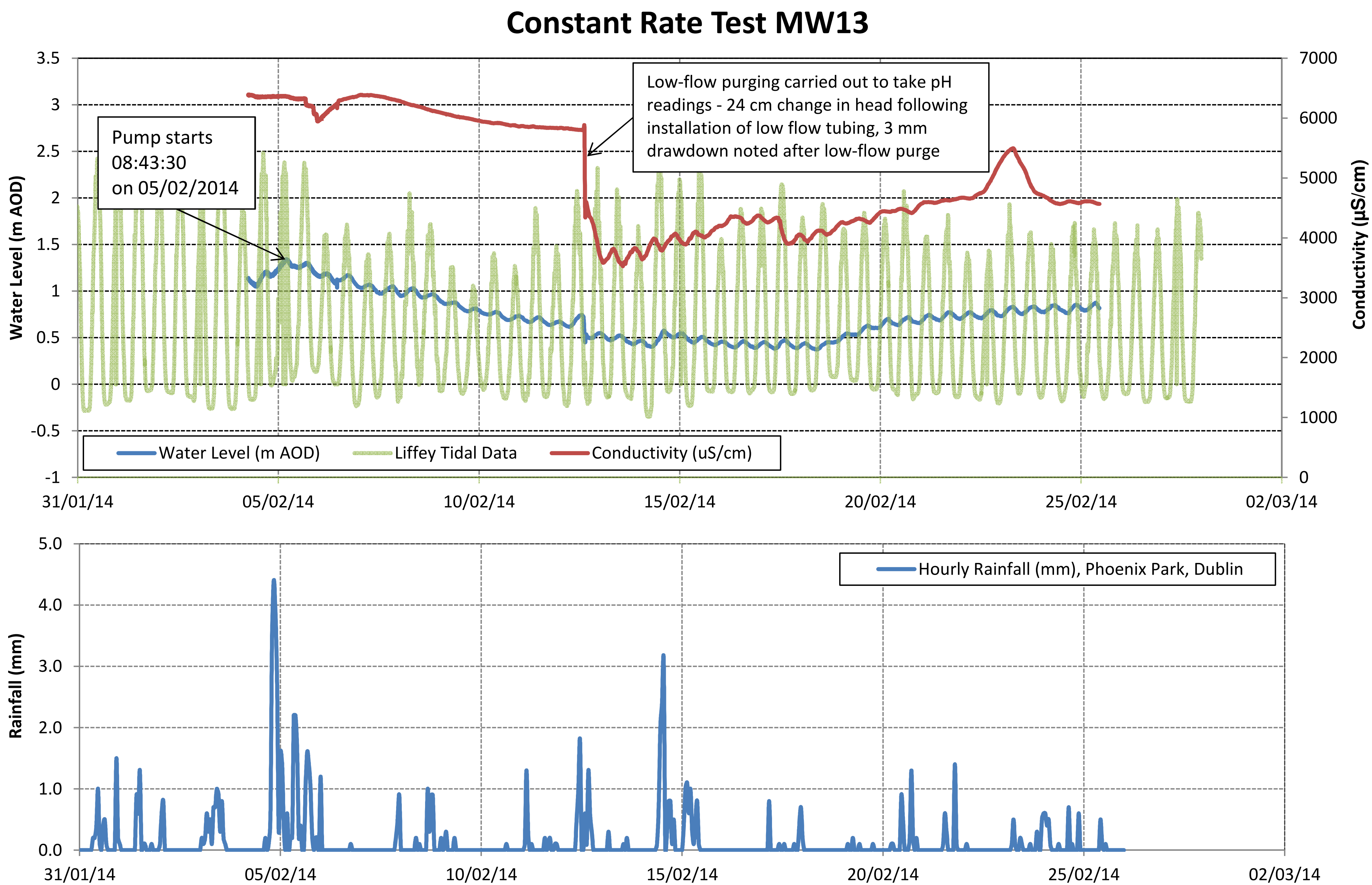

Constant Rate Test MW13
Pump starts
08:43:30
on 05/02/2014
Low-flow purging carried out to take pH readings - 24 cm change in head following installation of low flow tubing, 3 mm drawdown noted after low-flow purge
Water Level (m AOD)
Conductivity (µS/cm)
Water Level (m AOD)
Liffey Tidal Data
Conductivity (uS/cm)
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
7000
6000
5000
4000
3000
2000
1000
0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14
Rainfall (mm)
Hourly Rainfall (mm), Phoenix Park, Dublin
5.0
4.0
3.0
2.0
1.0
0.0
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14

Fig 10

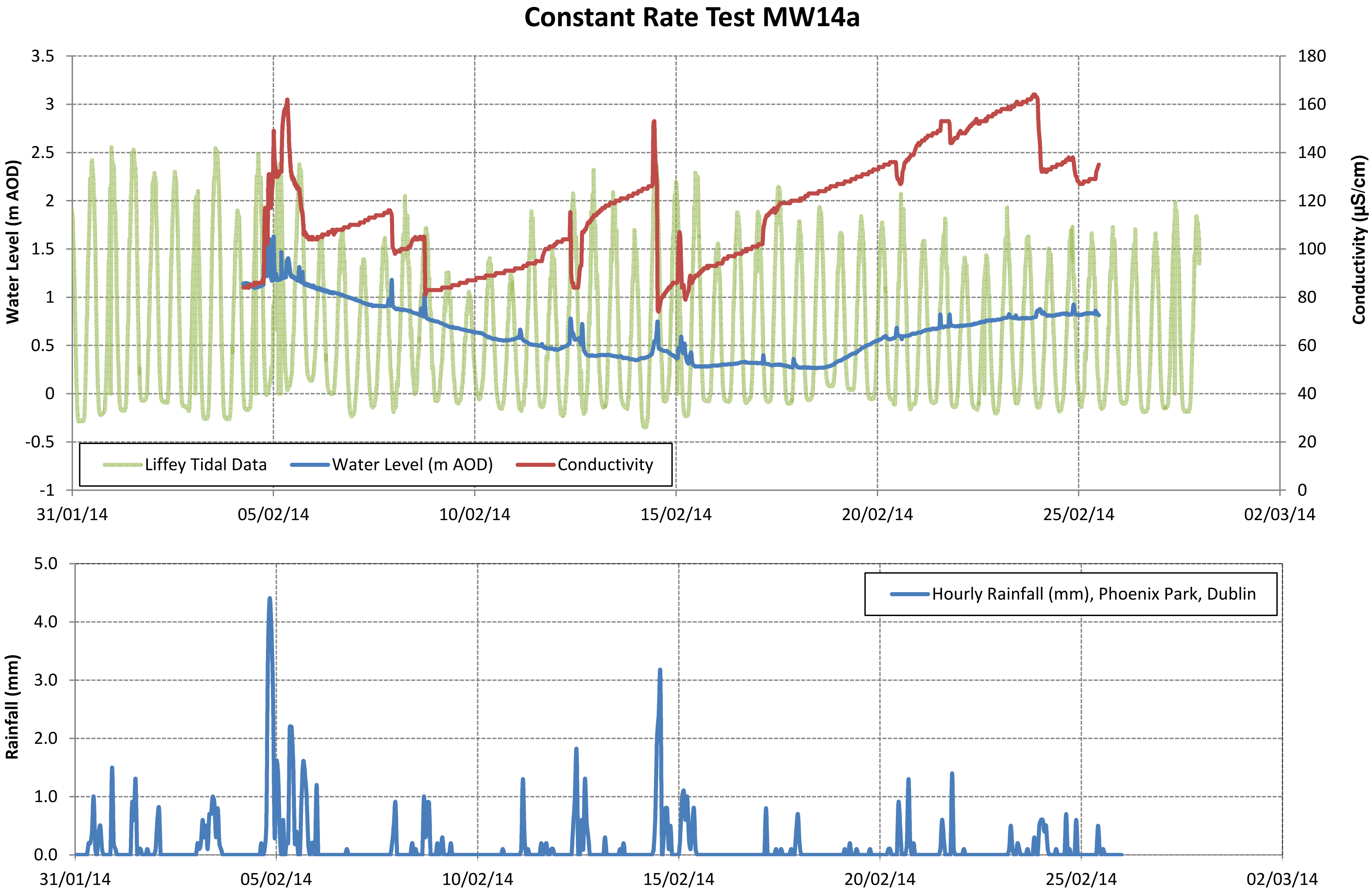
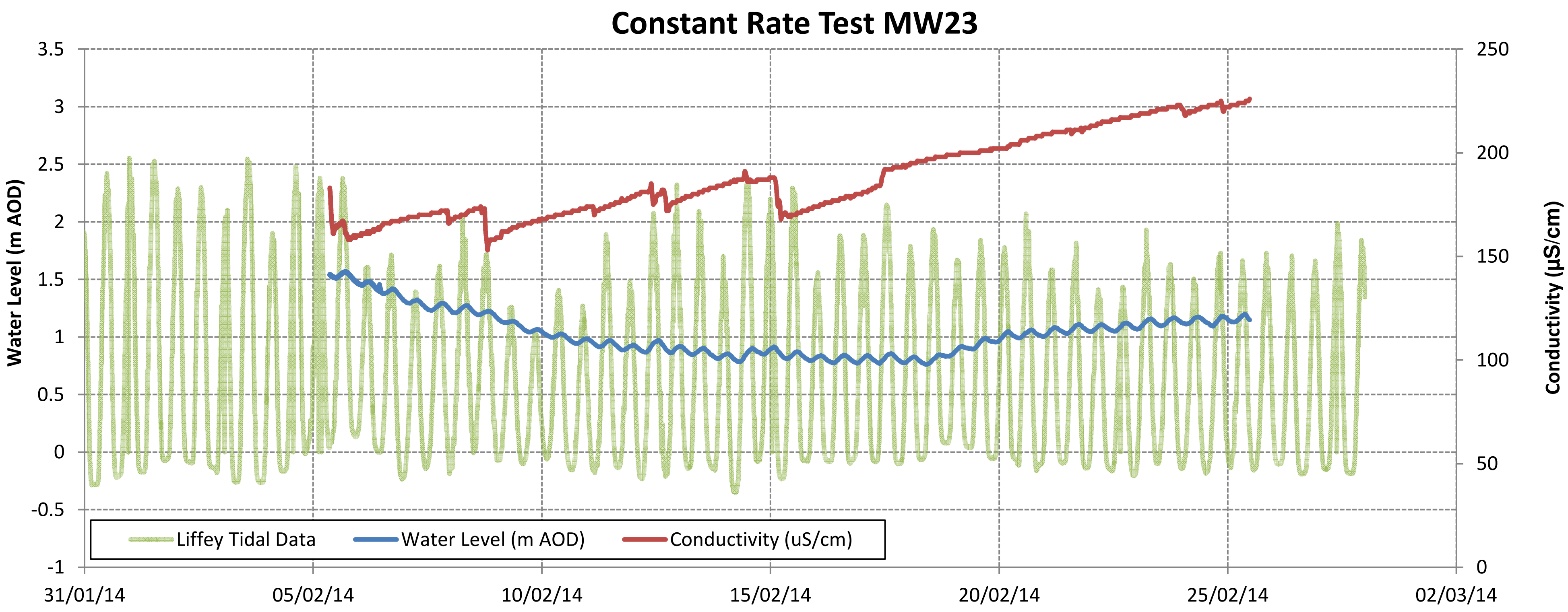
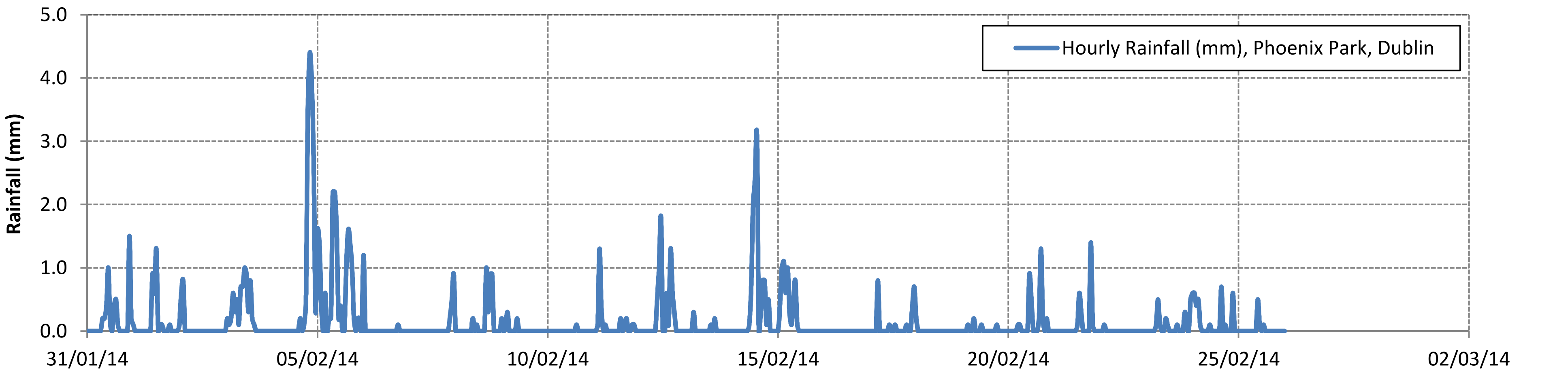

Constant Rate Test MW14a
Water Level (m AOD)
Conductivity (µS/cm)
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
180
160
140
120
100
80
60
40
20
0
Liffey Tidal Data
Water Level (m AOD)
Conductivity
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14
Rainfall (mm)
5.0
4.0
3.0
2.0
1.0
0.0
Hourly Rainfall (mm), Phoenix Park, Dublin
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14

Fig 11



Constant Rate Test MW23
Water Level (m AOD)
Conductivity (µS/cm)
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
250
200
150
100
50
0
Liffey Tidal Data
Water Level (m AOD)
Conductivity (uS/cm)
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14



Rainfall (mm)
5.0
4.0
3.0
2.0
1.0
0.0
Hourly Rainfall (mm), Phoenix Park, Dublin
31/01/14
05/02/14
10/02/14
15/02/14
20/02/14
25/02/14
02/03/14

APPENDIX A 1 SPECIFICATION FOR PUMP TESTING OF COOPERAGE WELL
2 AQUIFER TEST FIGURES
3 GROUNDWATER QUALITY SUMMARY TABLE

Diageo, Dublin

Specification for Pump Testing of Cooperage Well

1 Introduction

1.1 Purpose

This document provides a specification for the test pumping at Diageo, Dublin. The test pumping is intended to:

- determine the transmissivity and storativity of the Gravel;
- evaluate the sustainable abstraction rate of Cooperage Well; and
- determine the interaction of the cone of depression created by Cooperage Well and the River Liffey.

As currently understood, the site conditions of geology, hydrogeology and aquifer properties are described, followed by a detailed specification for the proposed works.

The site geology comprises Made Ground, overlying Gravel and Limestone.

1.2 Scope of works

This specification provides details of a pumping test designed to determine the hydraulic properties of the Gravel formation beneath the site and to assess the interaction between the cone of depression and the River Liffey boundary.

The scope of works for the monitoring and testing programme include:

- Undertake pre-test monitoring;
- Conduct calibration test;
- Conduct step tests;
- Conduct constant rate test;
- Conduct recovery test; and
- Undertake post-test monitoring.

The objectives of the study are to address the following aspects:

- Hydrogeological conditions and maximum well capacity of the Gravel.
- Further refinement of the site hydrogeology conceptual model in order to inform the impacts on the River Liffey.

- Determine whether the operation of Cooperage Well causes saline intrusion into the Gravel aquifer.

All water quality and groundwater level monitoring will be undertaken by URS. Where URS has responsibility for monitoring they are clearly stated. All other activities are the responsibility of the contractor. Engineer refers to a representative of URS.

1.3 Site Conditions

1.3.1 Geology

Based on geotechnical investigation boreholes drilled in February 2006 the geology is comprised of sand and gravels to about 20m, or -18m AOD, which is immediately underlain by the limestone bedrock.

The materials encountered during the site investigation comprise:

- Made Ground
- Alluvium (including Peat)
- Sands
- Gravels
- Limestone

1.3.2 Hydrogeology

There is likely to be good hydraulic continuity between the River Liffey and the gravel deposits. The Gravel aquifer is likely to be in hydraulic continuity with the underlying Limestone. The groundwater level is approximately 3m below the ground surface or 0.5 metres above ordnance datum (m AOD).

2 Specification - Pump Testing

2.1 Pumping Test

The purpose of the test pumping is to inform the impacts of the operation of Cooperage Well on the River Liffey and groundwater quality of the Gravel aquifer.

All procedures and equipment shall comply with the British Standard Code of Practice for test pumping of boreholes unless otherwise stated (BS ISO 14686: 2003).

The well head shall include flow control valves and pressure gauges, which shall be in good working order and approved by the Engineer prior to installation. One stainless steel sample tap shall be included in the well head.

The abstraction borehole will be fitted with a dipping access tube (of sufficient size to house a pressure transducer) and securely anchored at surface. The position of this dipping access tube shall not be changed during the test pumping unless prior permission is obtained from the Engineer.

The measurement of discharge rate shall be by both a metering device installed in the delivery pipe. A continuous record of pumped discharge shall be maintained by the Contractor for both flow measuring devices.

2.1.1 Test Pumping Programme

The pumping test shall comprise:

- Calibration Test
- Groundwater Monitoring
- Step test
- Constant rate test
- Recovery test

2.1.2 Calibration Test

A calibration test shall be carried out before commencement of the step test and shall involve a period of pumping during which the flow control valve is calibrated and all equipment checked. Calibration tests are not required between the step and constant rate test. The duration of pumping is expected to be no more than 2 hours or as directed by the Engineer. A rest period of 12 hours to achieve substantial recovery of water levels shall follow calibration testing as directed by the Engineer.

2.1.3 Interruptions during Test Pumping

Should interruptions occur to any of the pumping tests the failed test shall be repeated in full after a suitable waiting period for recovery to be decided by the Engineer.

2.1.4 Dippers and Stop watches

URS shall ensure a sufficient number of well dippers /and or data loggers to undertake the monitoring of water levels required by the specification. Dippers shall have a minimum length of tape of 30m with centimetre and metre graduations. . Manually dipped water level measurements shall be taken at the beginning and at the end of each test cycle (Table 3). In addition to monitoring groundwater level the dippers shall monitor electrical conductivity and temperature. The electrical conductivity and temperature shall be measured for each cycle of the test (see Tables 4-5) and at the same time and frequency as the test being undertaken.

2.1.5 Barometric Pressure and Tide Level

The barometric pressure and tide level shall be measured for each cycle of the test (see Tables 4-5) and at the same time and frequency as the test being undertaken. The tide level should be measured to the same datum, time and frequency as the groundwater level measurements.

2.1.6 Pre and Post-pumping procedure

URS shall measure the rest groundwater levels in MW6, MW7, MW9, MW13, MW14 and MW23 for a period of (at a minimum) 7 days prior to and 7 days post calibration, step, constant, and recovery test using pressure transducers. The frequency of measurement shall be every 30 minutes. The wells shall be dipped manually at the beginning and end of the monitoring periods.

2.1.7 Groundwater Level/ Water Quality Monitoring Locations

The following table provides the locations of boreholes to be monitored for groundwater level, electrical conductivity and temperature during the tests. Loggers shall be installed in all specified boreholes prior to the commencement of works.

Monitoring wells MW7, MW9 and MW23 are in addition to that presented in the proposal. MW7 and MW23 are required to monitor intermediate response and to enable the calculation of transmissivity and storativity. MW9 is required as a control borehole to enable the effects of the tide to be removed from groundwater level monitoring.

Table 3 Monitoring Locations (See Figure 1)

Borehole Location	Monitoring Method During each Test Cycle				
	Pre-Monitoring	Step Test	Constant Rate Test	Recover Test	Post-Monitoring
MW6	Logger	logger	logger	Logger	logger

Borehole Location	Monitoring Method During each Test Cycle				
MW7	Logger	logger	logger	Logger	logger
MW9	Logger	logger	logger	Logger	logger
MW13	Logger	logger	logger	Logger	logger
MW14	Logger	logger	logger	Logger	logger
MW23	Logger	logger	logger	Logger	logger

2.1.8 Step Test

The Step Drawdown Test shall consist of 4 steps at 100 minutes each with increasing rates of discharge with rates of 50, 100, 150, and 200m^3/hr. The water level in the test well and in observation wells shall be monitored using the monitoring frequency outlined in Table 4. The control valve shall be adjusted for each step in accordance with the settings defined during the Calibration Test.

The step test shall be undertaken consecutively with a rest period of at least 12 hours at the end of the test to achieve full recovery of the water level in the borehole, as directed by the Engineer.

Table 4. Groundwater monitoring frequency

Time	Readings
Prior to start	Once
0 – 5 min	Every 10 sec
5 – 10 min	Every 30 sec
10 – 100 min	Every 5 min
Recovery	Frequency as above for as long as recovery lasts

2.1.9 Constant Rate test

The Constant Rate test shall be conducted at a constant pumping rate for a period of 10 days. The actual rate and duration will be decided by the Engineer. The duration will depend upon the criteria being to reach steady state conditions, i.e. a steady groundwater level equivalent to a steady pumping rate.

The rate of discharge shall be monitored and maintained at a constant level throughout the test. The rate of discharge shall be constant to an accuracy of five percent. The water level in the test well and in observation wells shall be monitored using the monitoring frequency outlined in Table 5.

On cessation of pumping, water level recovery shall be monitored for a period of at least 12 hours using the monitoring frequency outlined in Table 5. If at this time, the level has not reached rest level as measured at the start of the test, then monitoring shall continue until this is achieved or as directed by the Engineer.

Table 5. Groundwater monitoring frequency

Time	Readings
Prior to start	Once
0 – 5 min	Every 10 sec
5 - 10 min	Every 30 sec
10 – 60 min	Every 5 min
60 – 240 min	Every 15 min
240 – 480 min	Every 30 min
480 min to completion	Every hour (by Logger)
Recovery	Frequency as above for as long as recovery lasts

2.1.10 Test pumps and ancillary equipment

1. The Contractor shall provide two test pumps (one duty within the abstraction well, and one standby, but maintained on site) of a type and dimensions such that it can be accommodated within the inside diameter casing. The clearance between the pump to be installed and the casing shall be such that it allows the installation of the 'dip access tube' for the accurate measurement of water levels.

2. The attention of the Contractor is drawn to the following requirements:
   - The pump shall be of sufficient size to allow discharges up to $200m^3$/hr.
   - A non-return valve shall be fitted below the test pump.
   - An approved valve shall be provided in the discharge pipework to permit flow control.

- An approved pressure gauge shall be installed upstream of the flow control valve.

2.1.11 Disposal of discharged waters

1. The Contractor shall ensure that all pipelines where required are watertight and sufficient for any discharges to be pumped. The diameter of the pipe shall be of sufficient size to allow the discharge of $200m^3/hr$. The contractor shall be responsible for the discharge and all necessary permits.

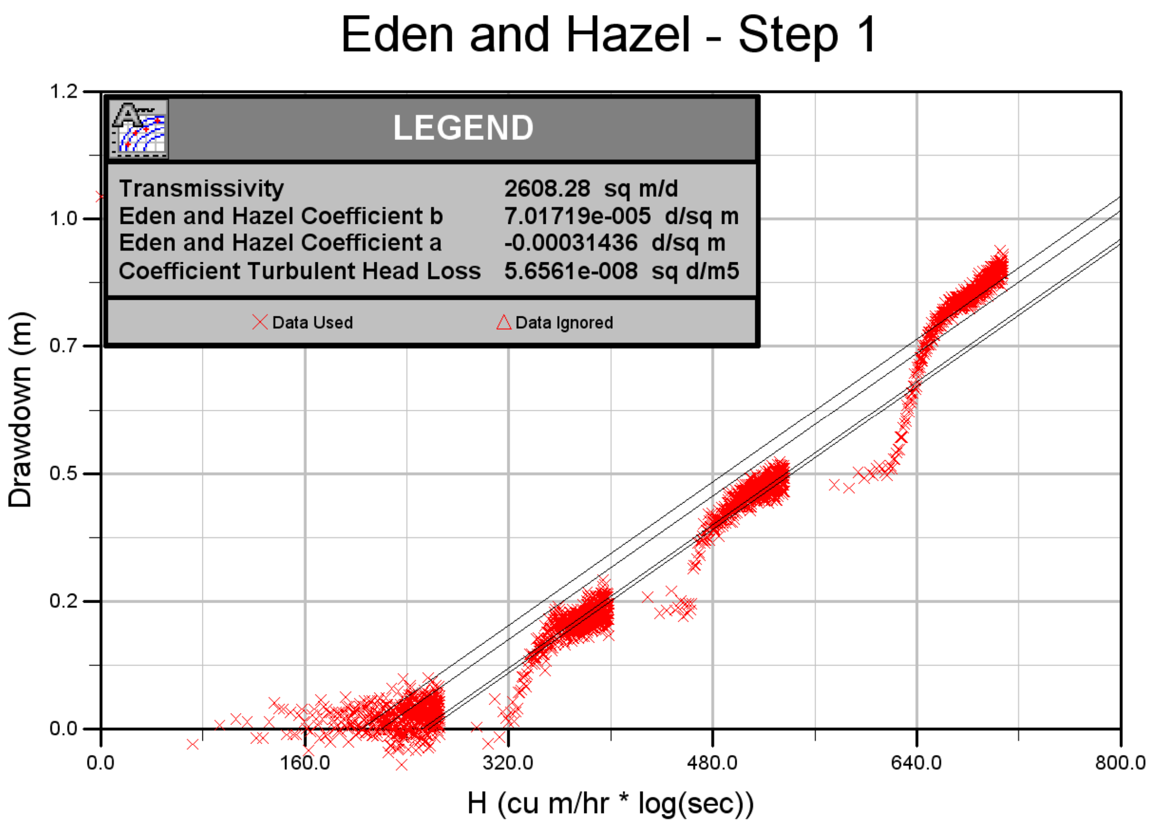
2.1.12 Factual Report - Requirements

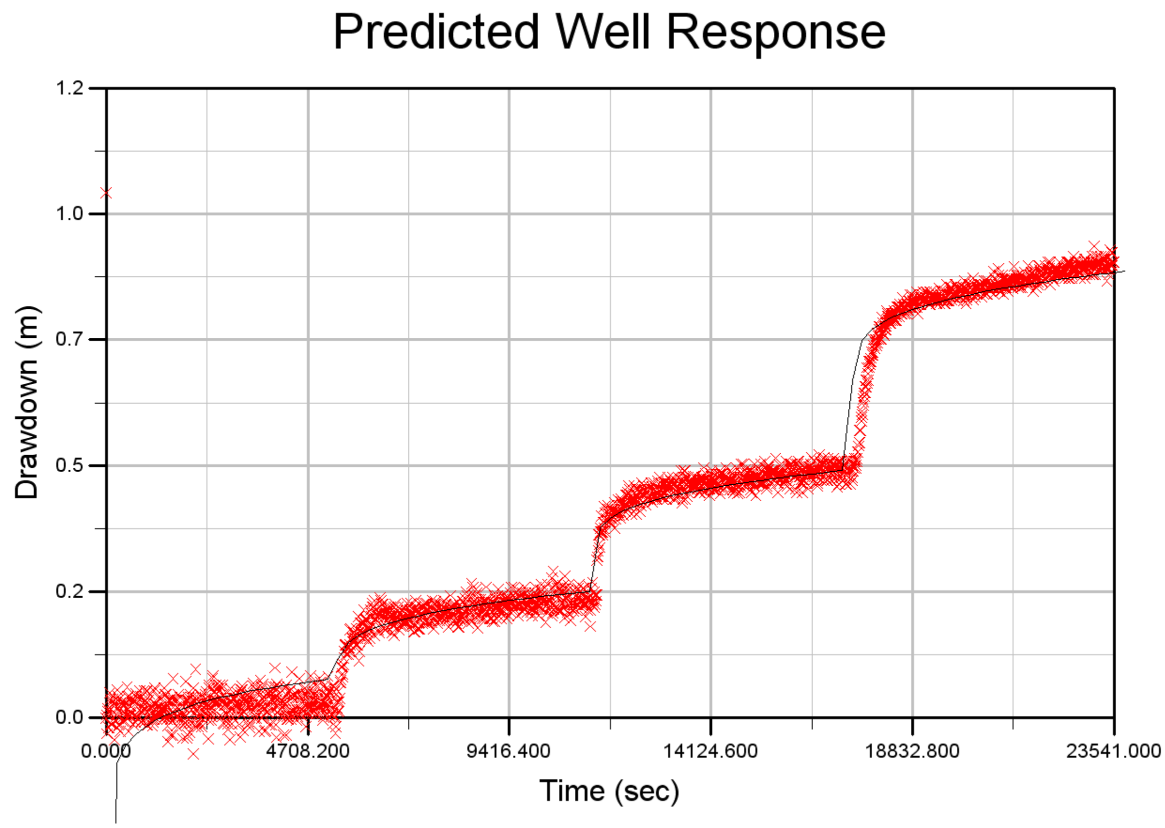
URS/Contractor shall include

- Date of test, location and pumping test operational diagram.
- Drawdown measurements, time of measurement and flow rate.
- Background data, including tidal information
- Any interruptions to pump operation;
- As stated in Section 2.1.5 the barometric pressure and tide level shall be measured and reported for each cycle of the test , starting at the same time (preferably on the hour or half hour) and at the same frequency as the test being undertaken;
- All reference points (datums) for tide level and groundwater level measurement.

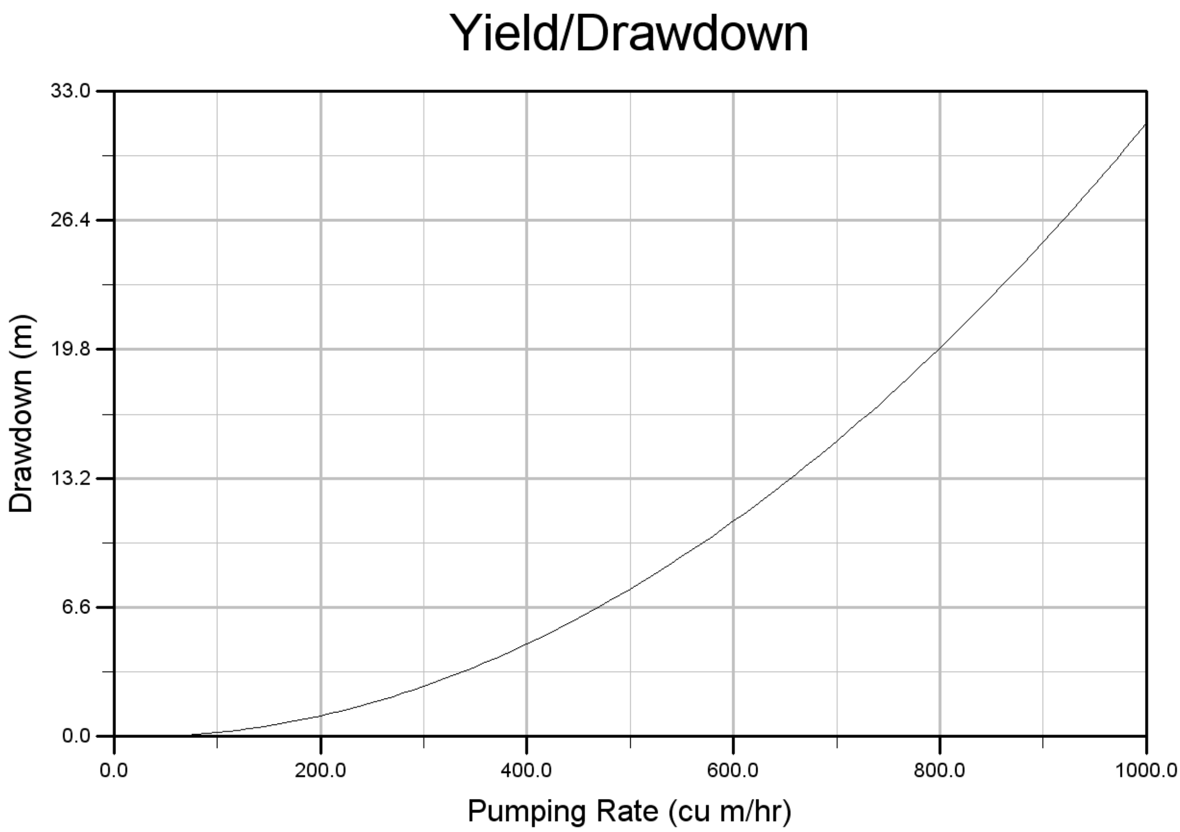
It is critical for the analysis of the collected information that all data are collected to the same relative datum, time and frequency, i.e. all measurements on a frequency of 30 minutes start on the hour or at 30 minutes past the hour. All groundwater level observations, barometric and tidal data recorded during the pump test shall be made available in an Excel format, to be agreed with the Engineer.

Cooperage Well Step Test





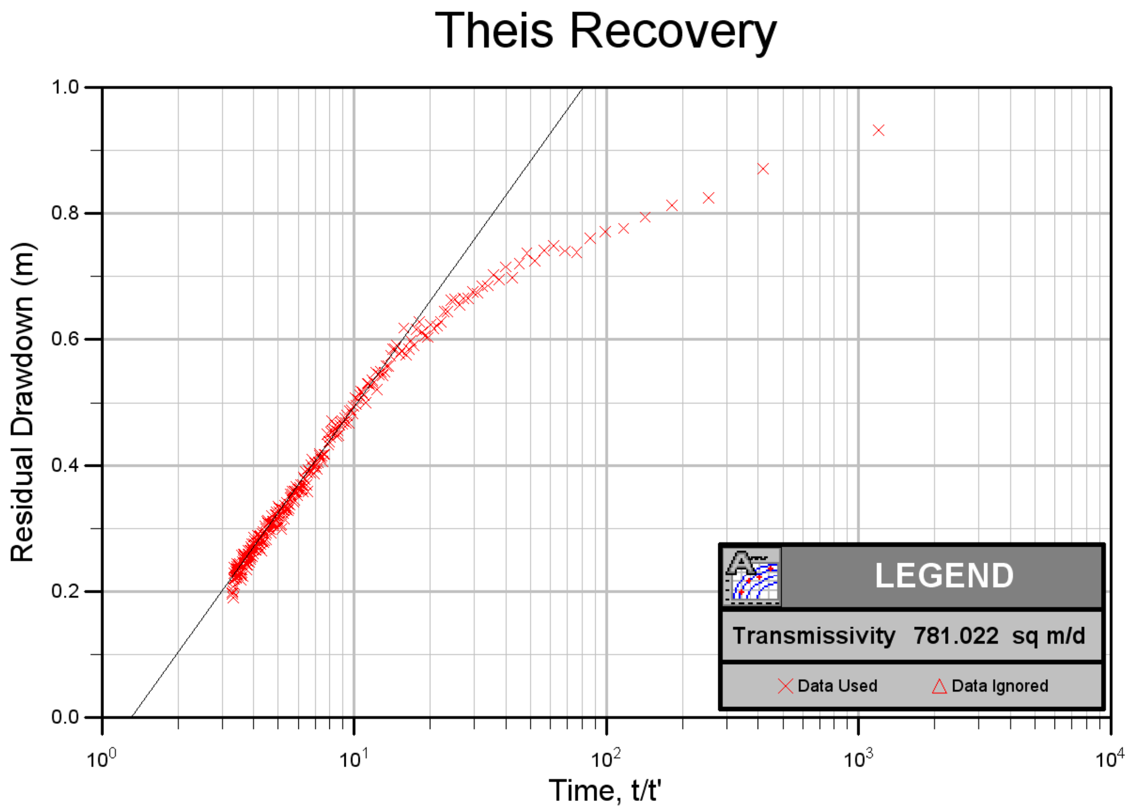
Predicted Well Response
Drawdown (m)
1.2
1.0
0.7
0.5
0.2
0.0
0.000
4708.200
9416.400
14124.600
18832.800
23541.000
Time (sec)

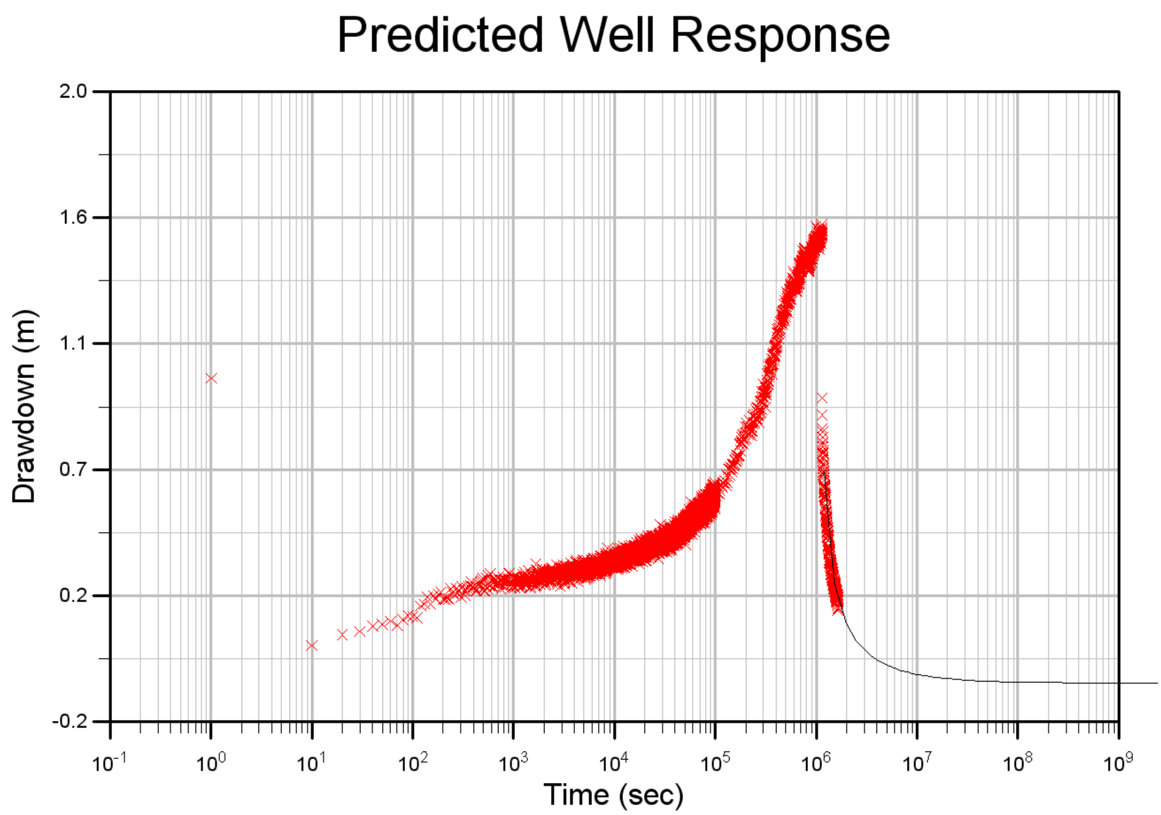


Yield/Drawdown
Drawdown (m)
33.0
26.4
19.8
13.2
6.6
0.0
0.0
200.0
400.0
600.0
800.0
1000.0
Pumping Rate (cu m/hr)

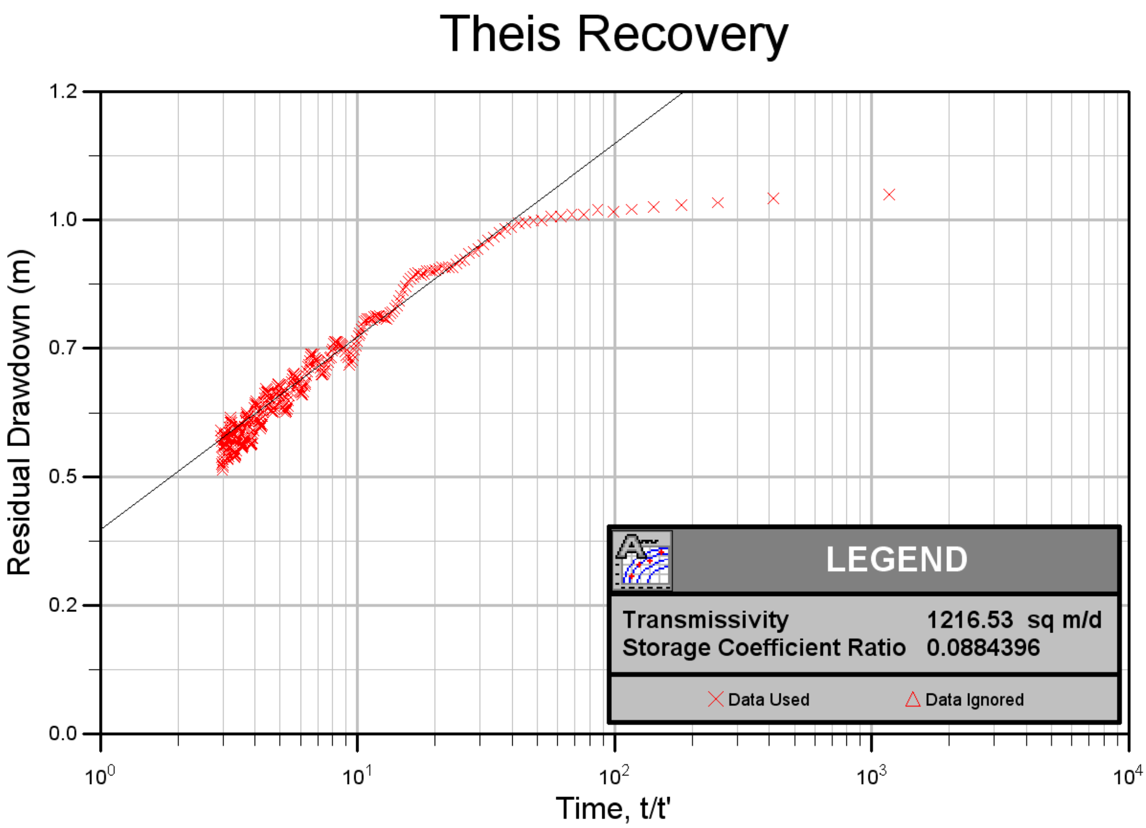
Recovery Analysis

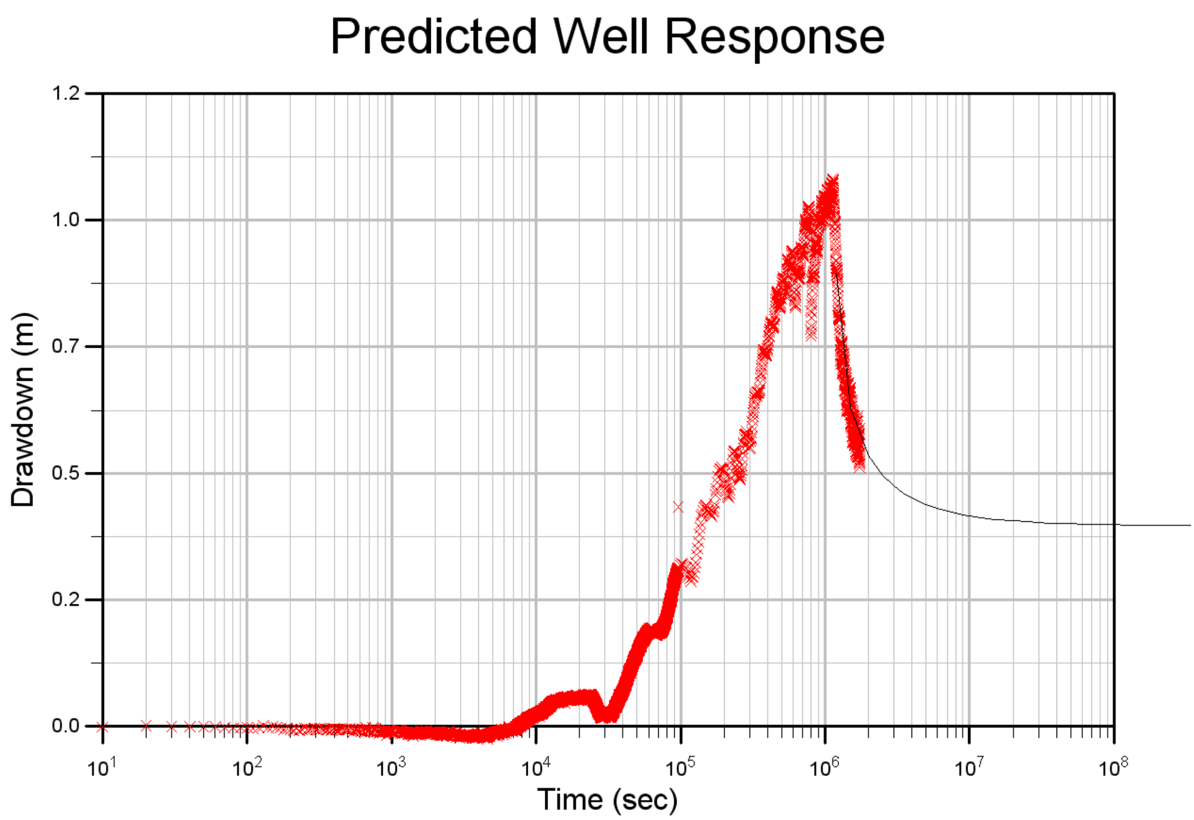
Cooperage Well



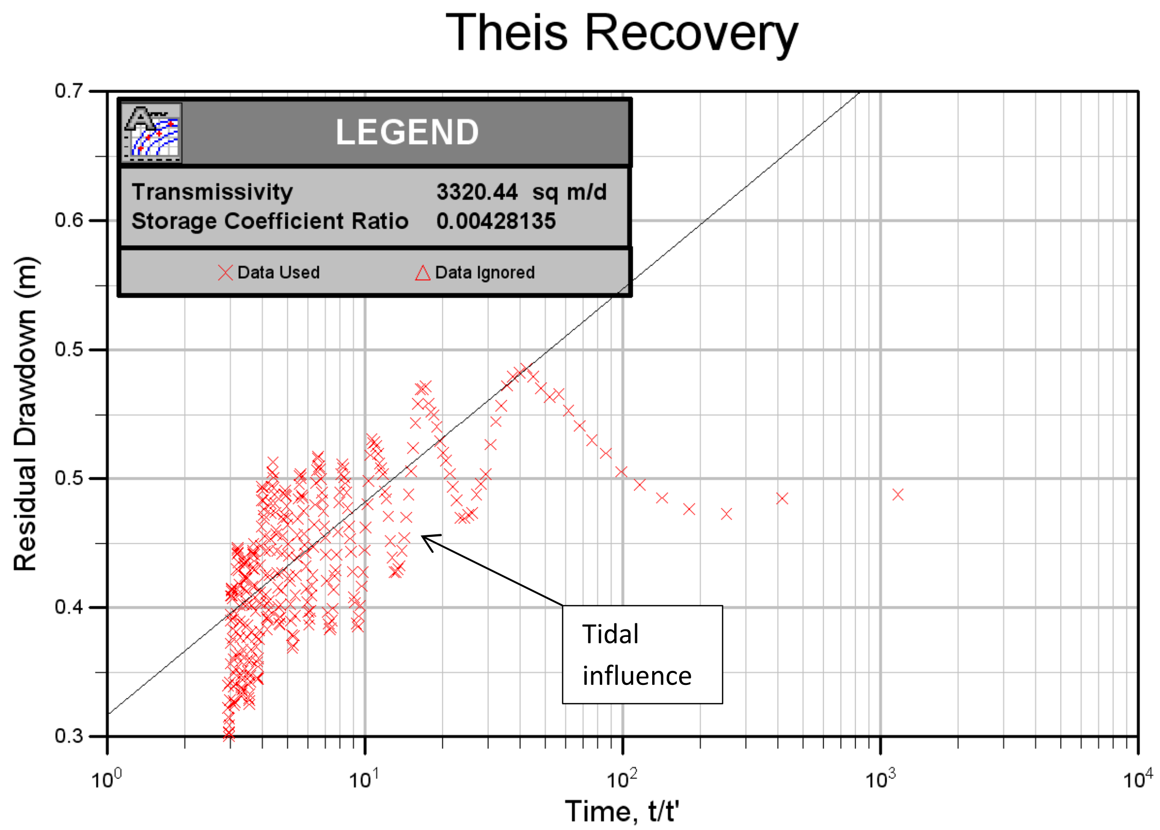


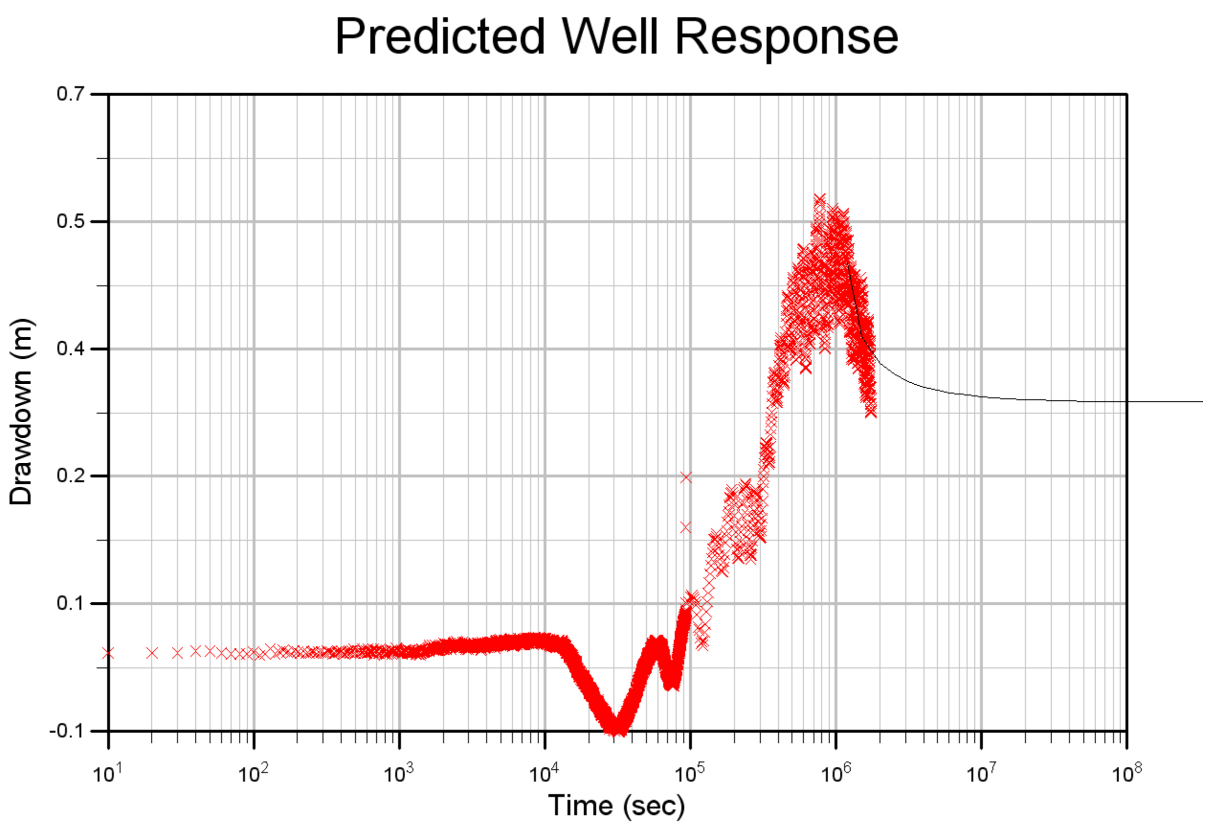
Monitoring Well 6



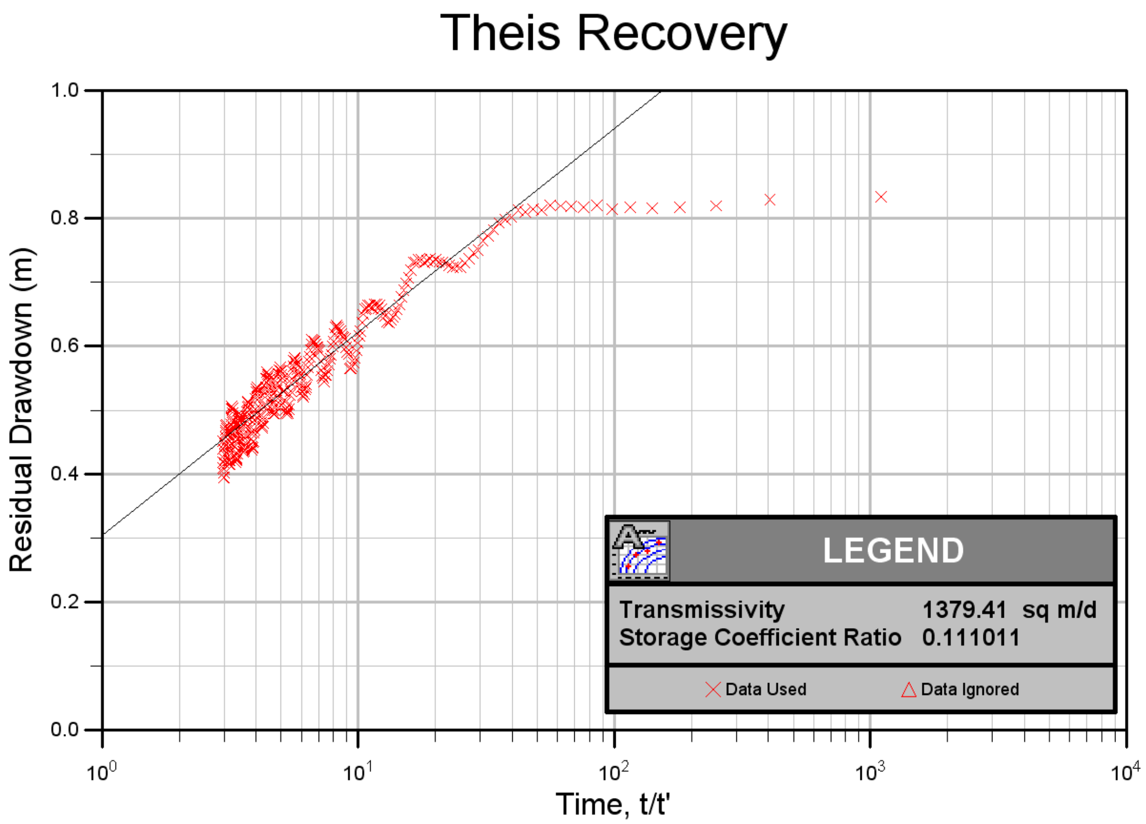


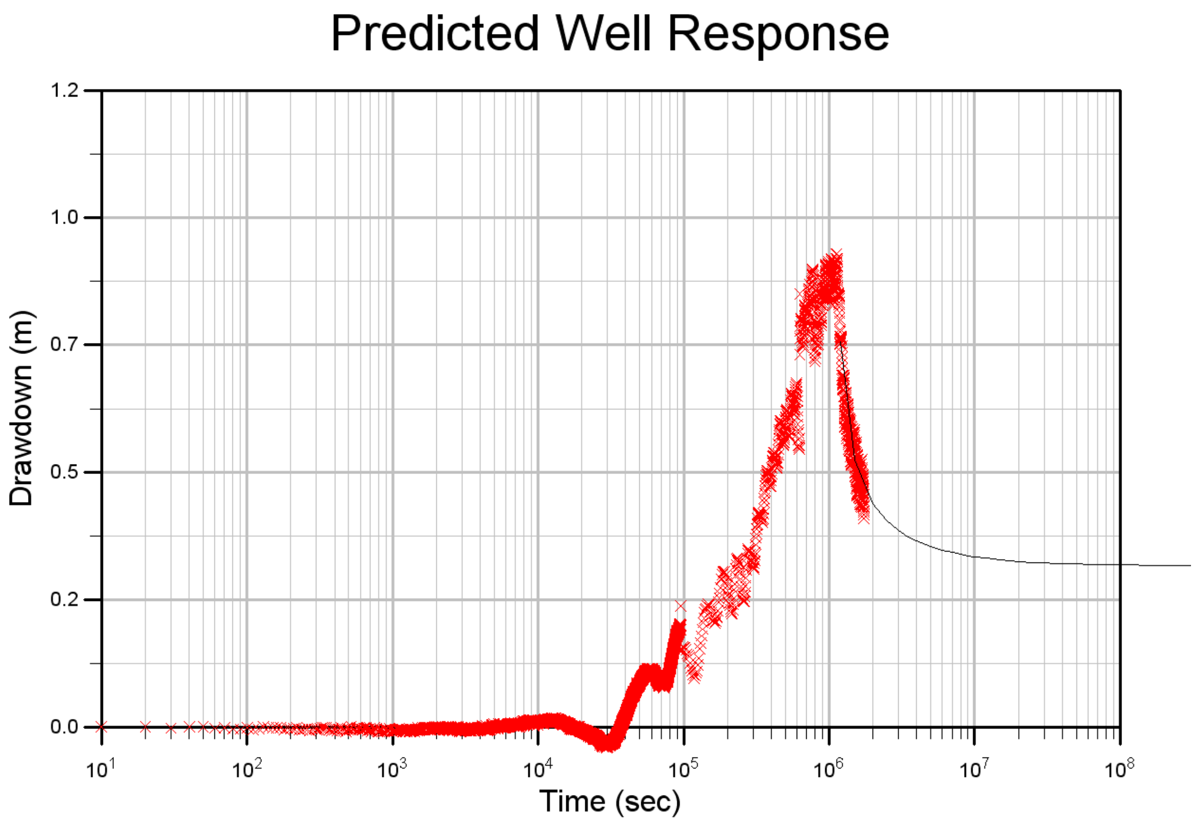
Monitoring Well 9



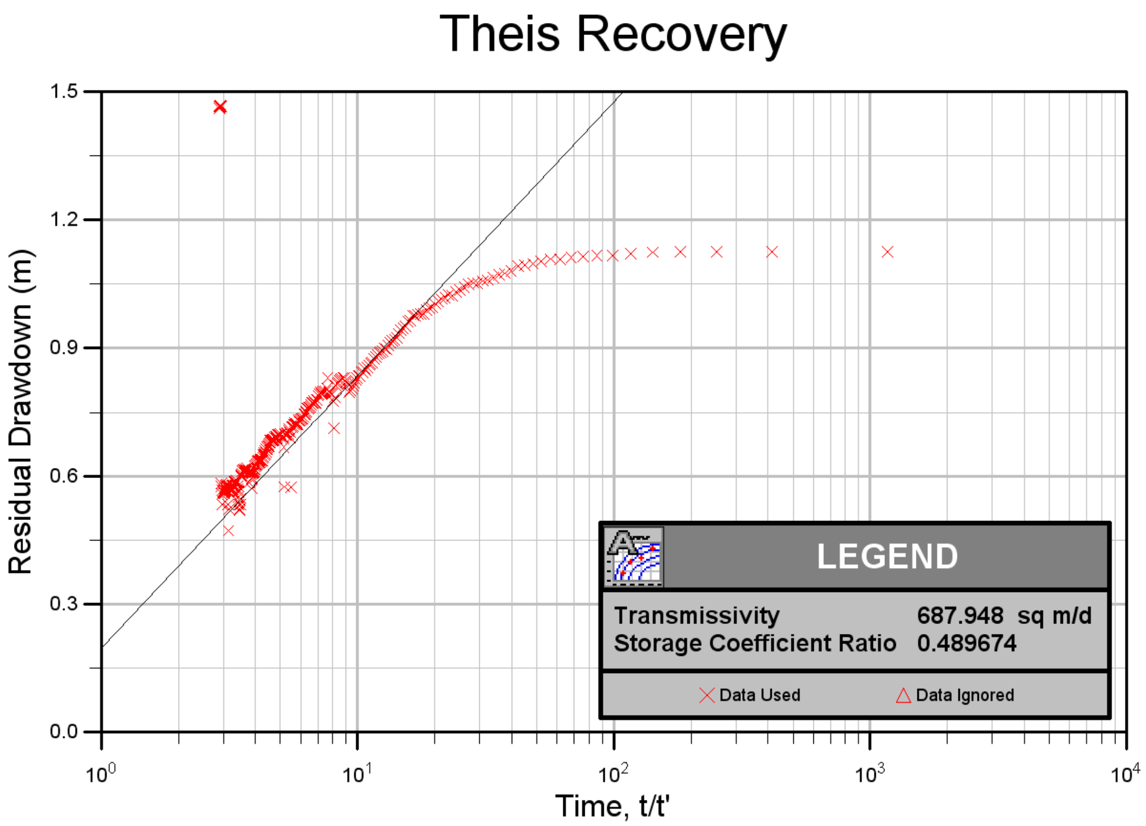


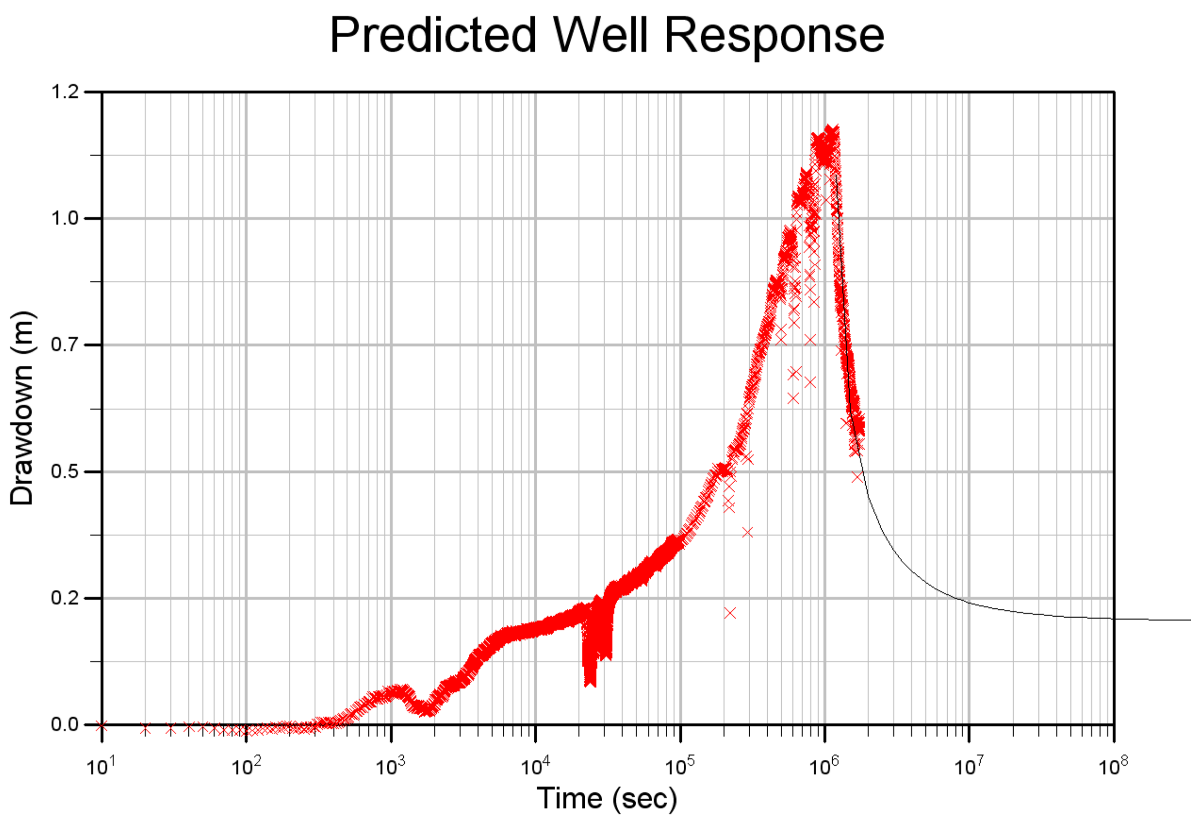
Monitoring Well 13



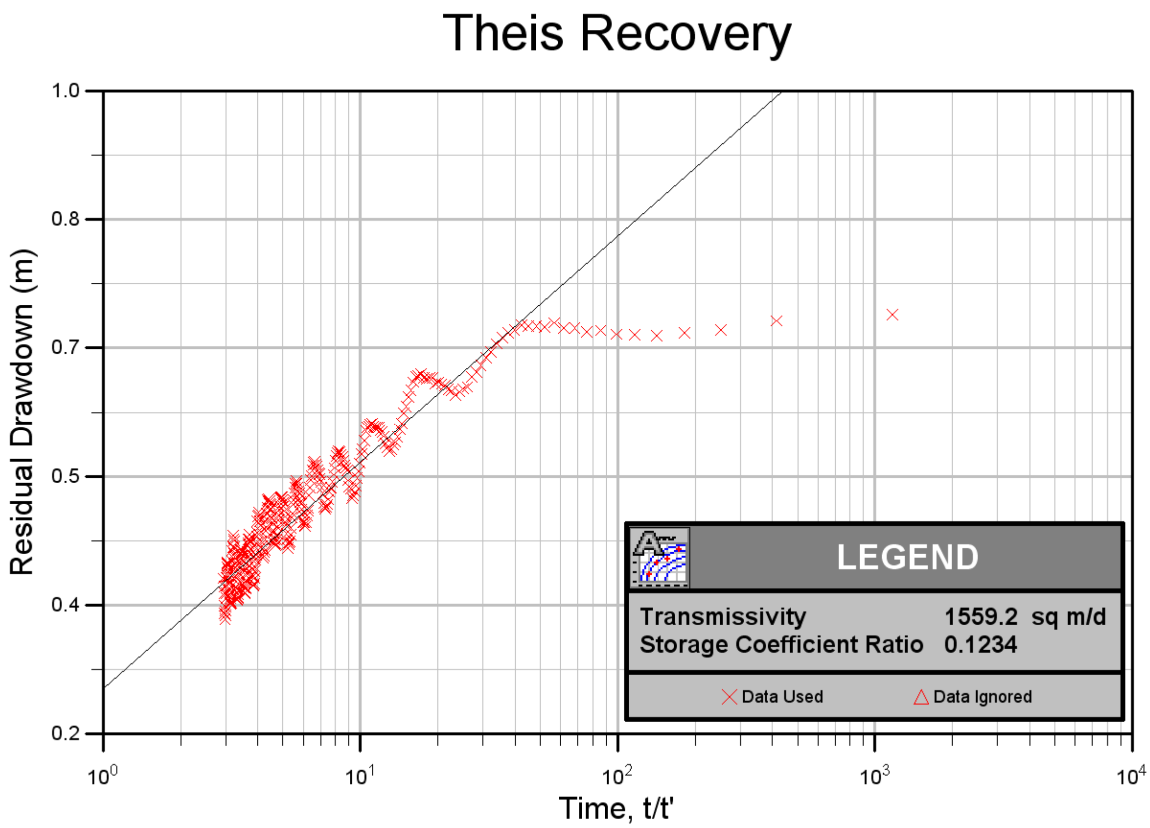


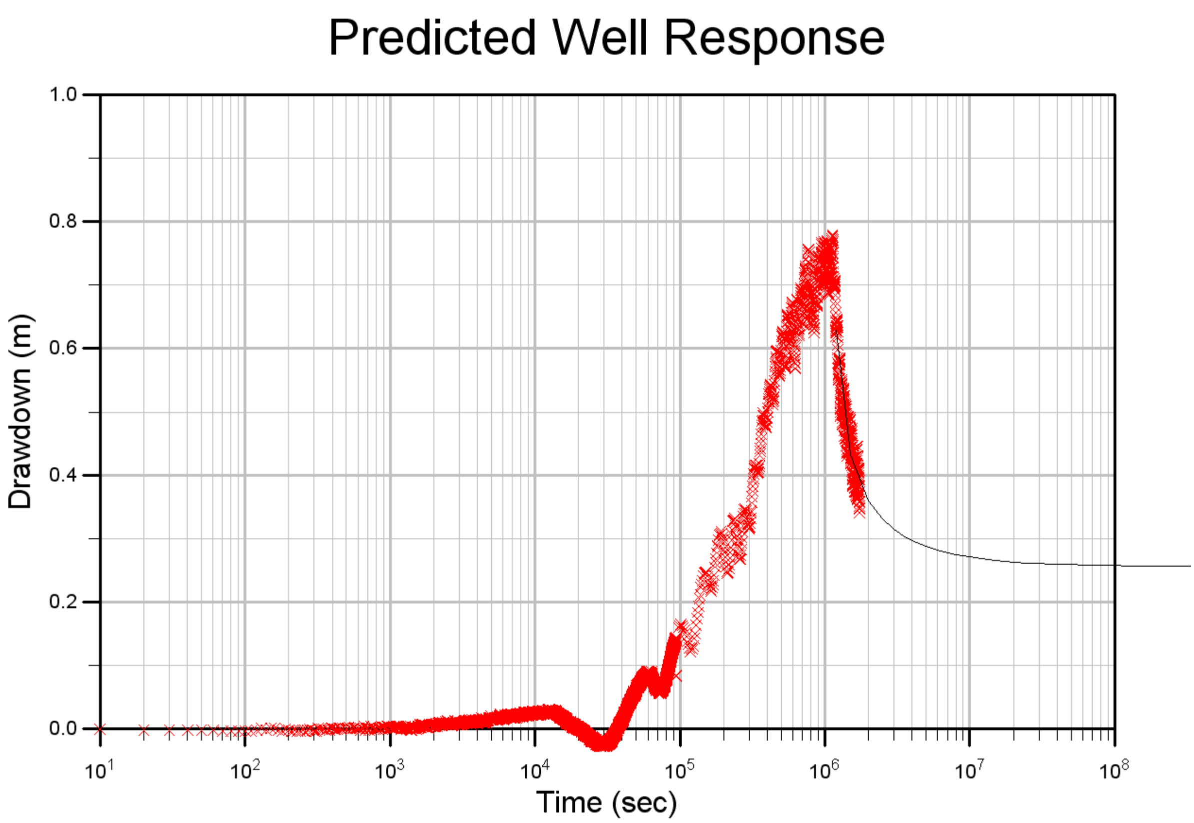
Monitoring Well 14a





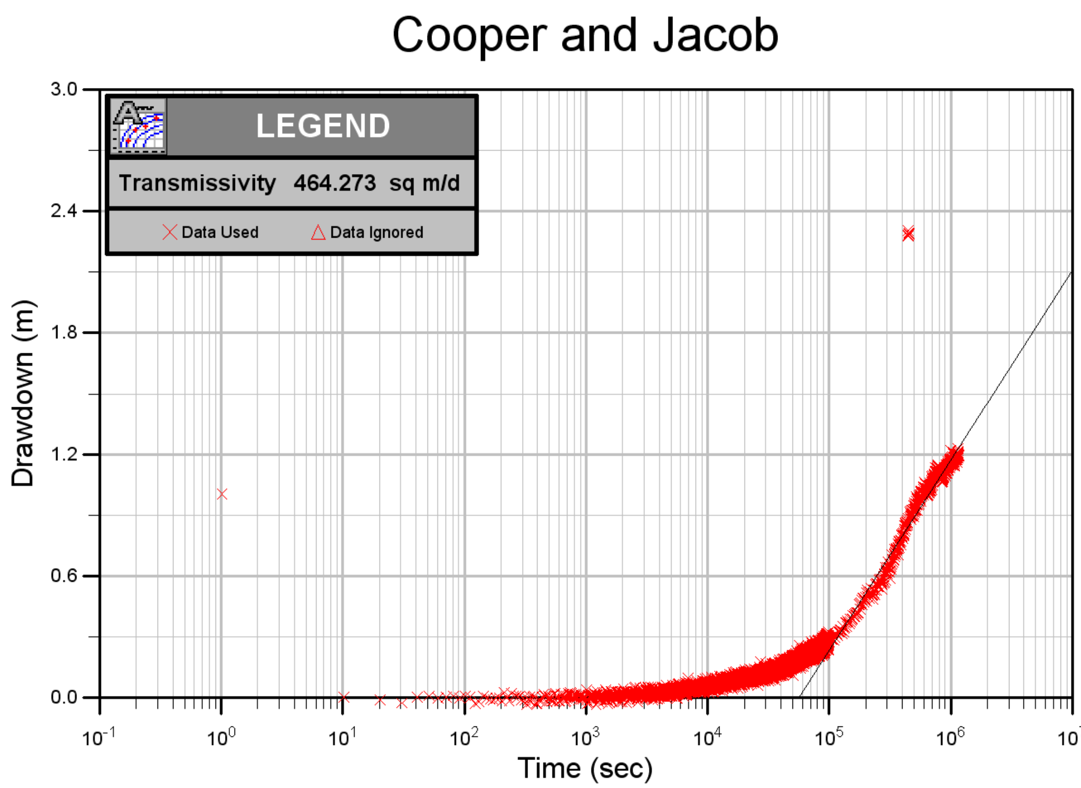
Monitoring Well 23



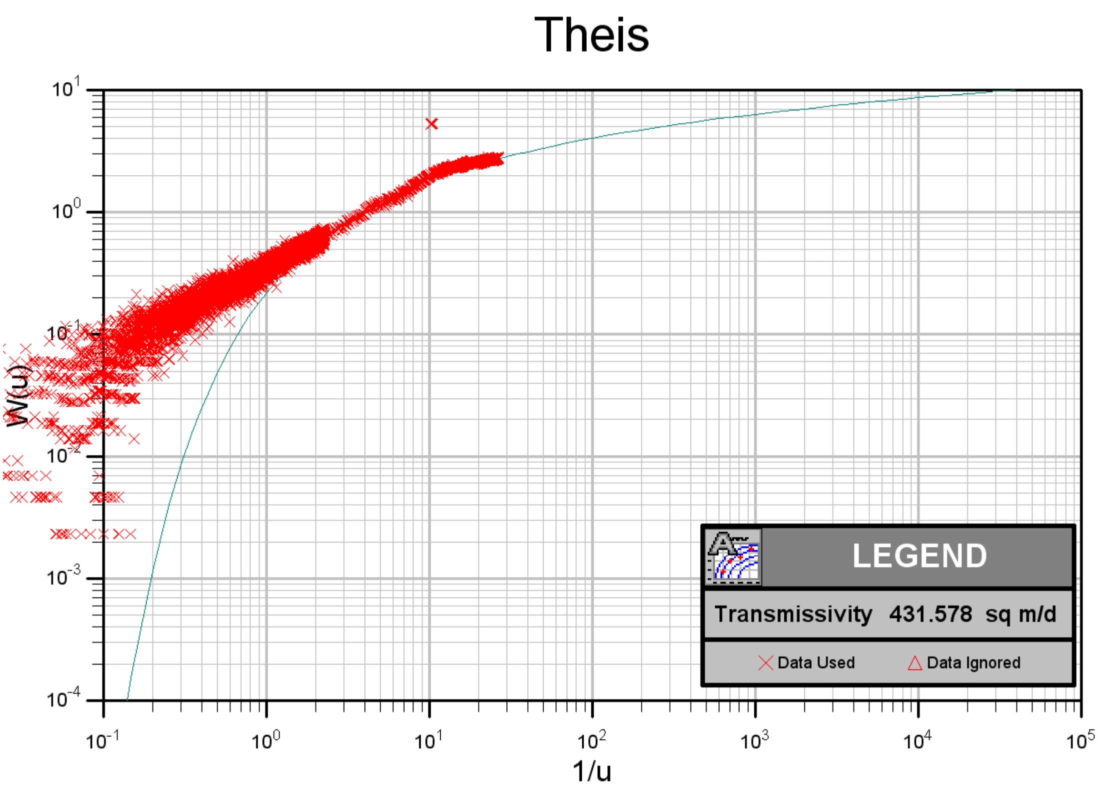


Constant Rate Test

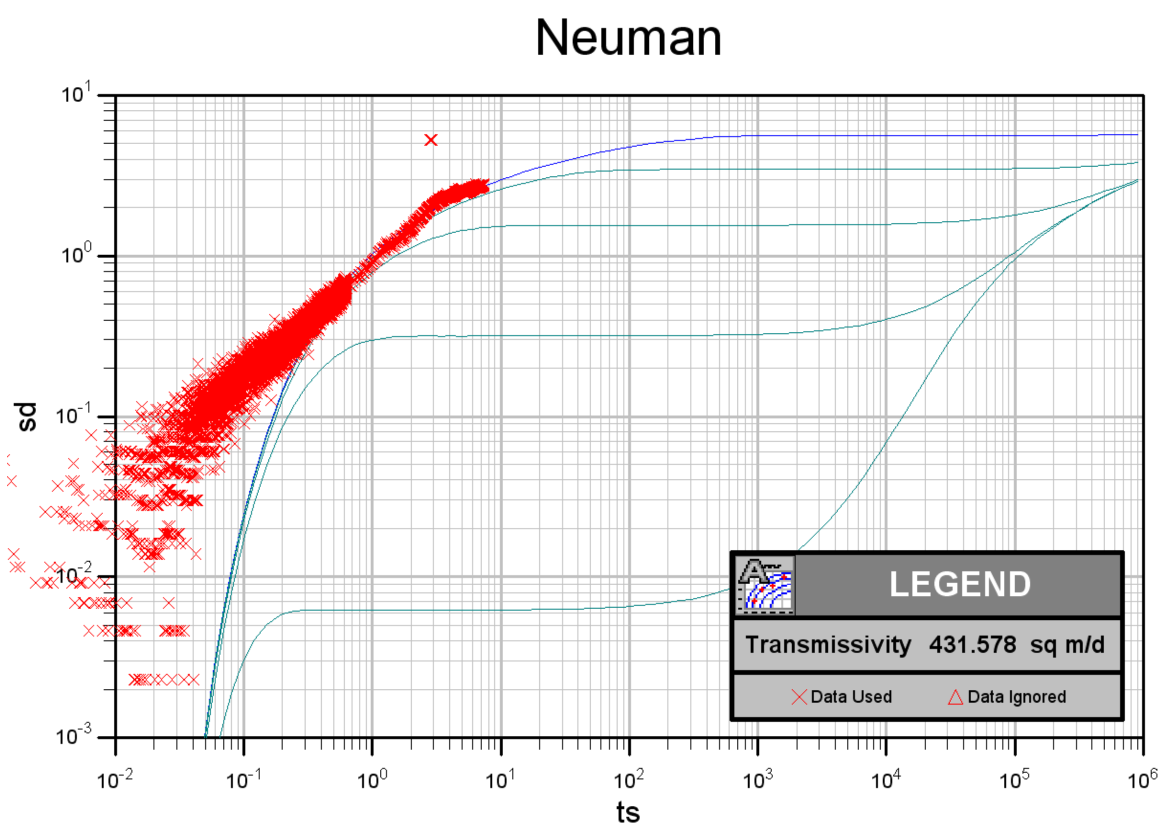
Cooperage Well – Cooper & Jacob, 1946 (Straight Line Method)



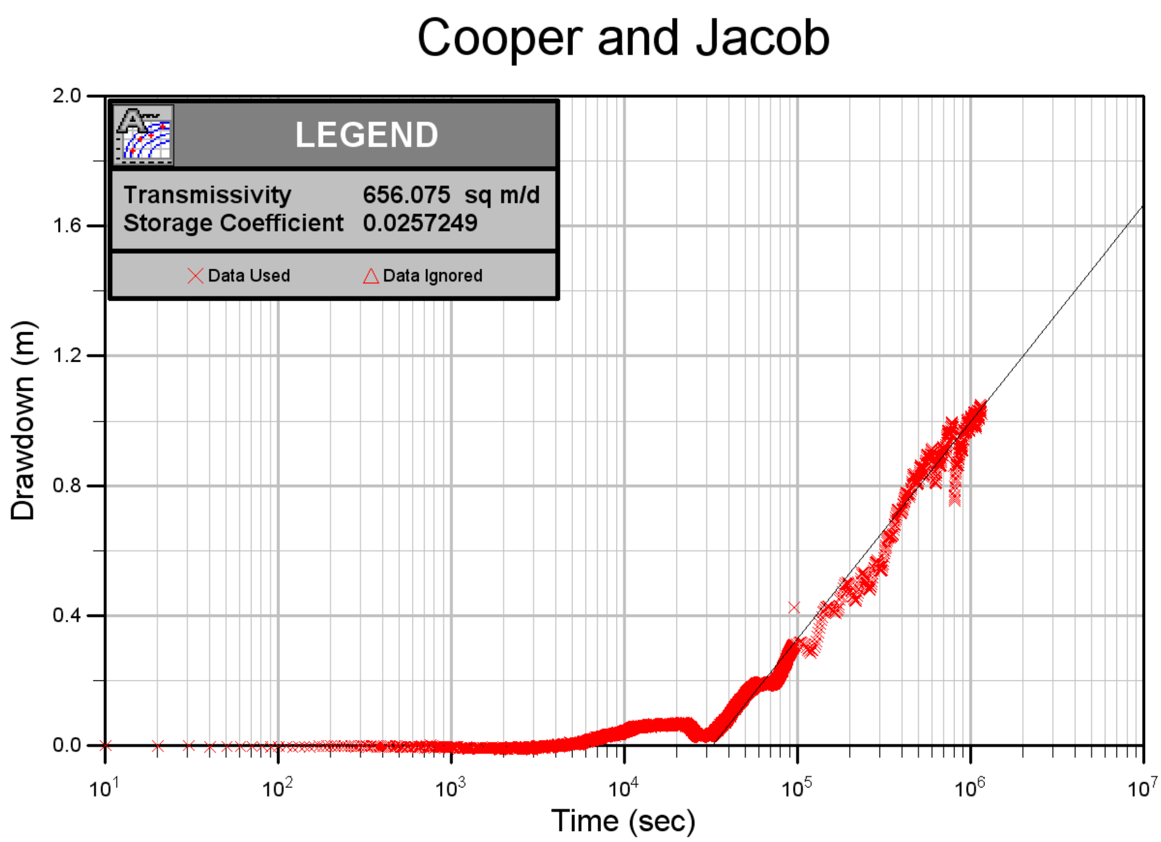
Cooperage Well – Theis, 1935 (unconfined approximation)



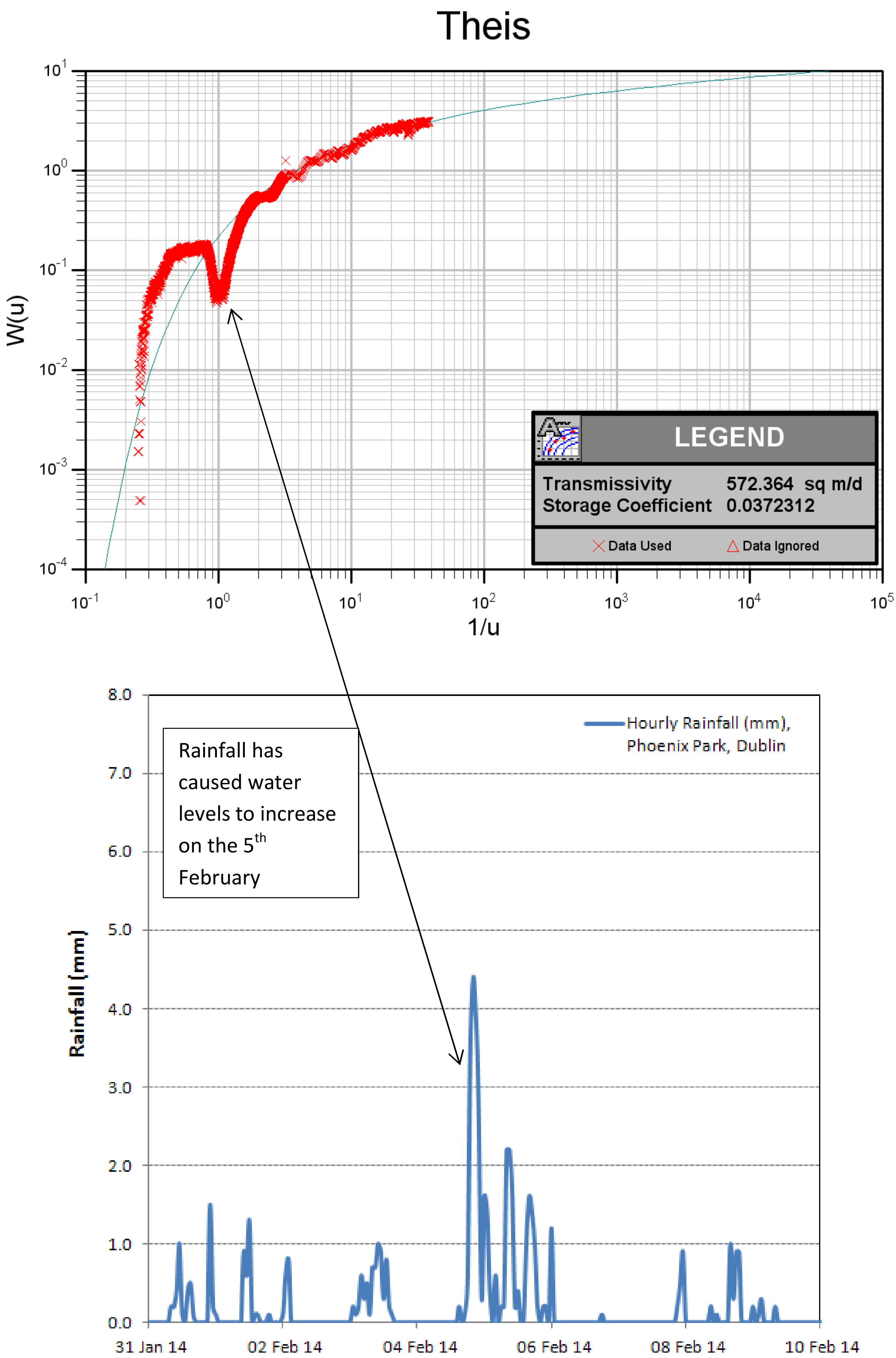
Cooperage Well – Neuman, 1972 (unconfined aquifer)



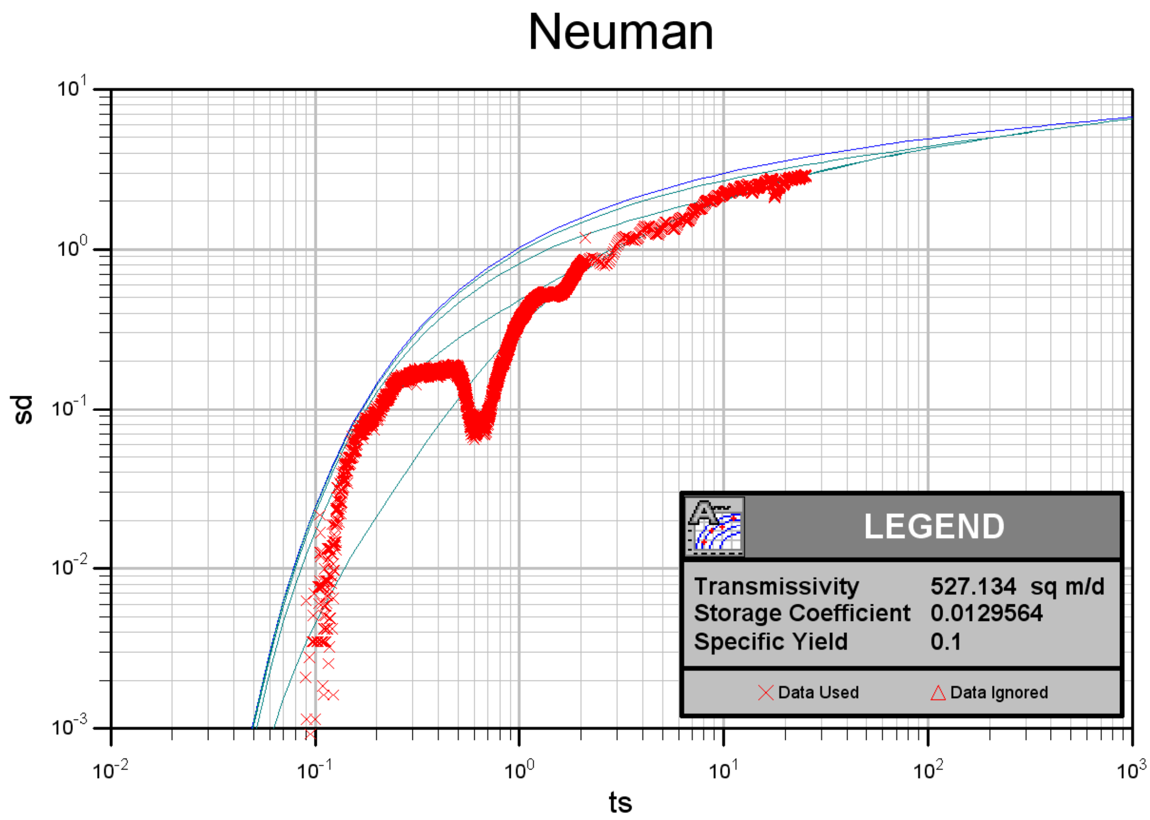
Monitoring Well 6 – Cooper & Jacob, 1946 (Straight Line Method)



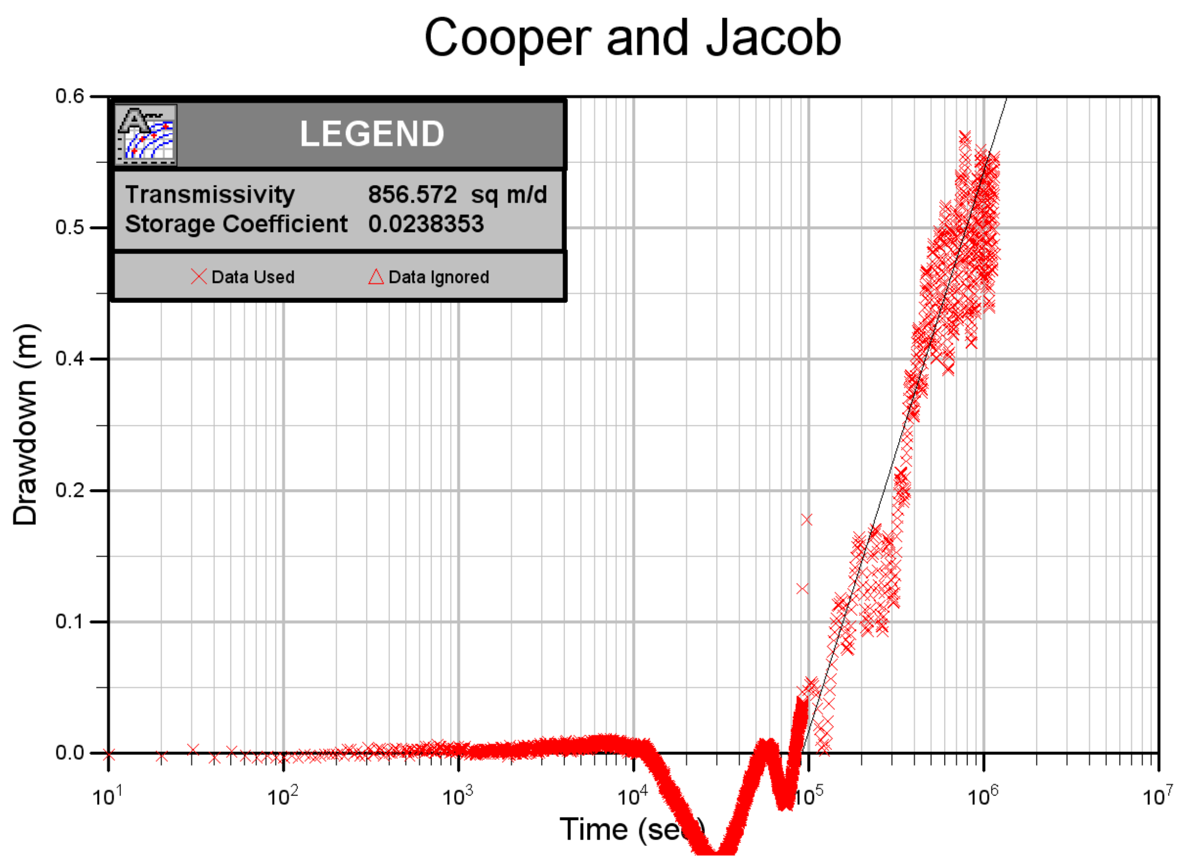
Monitoring Well 6 – Theis, 1935 (unconfined approximation)



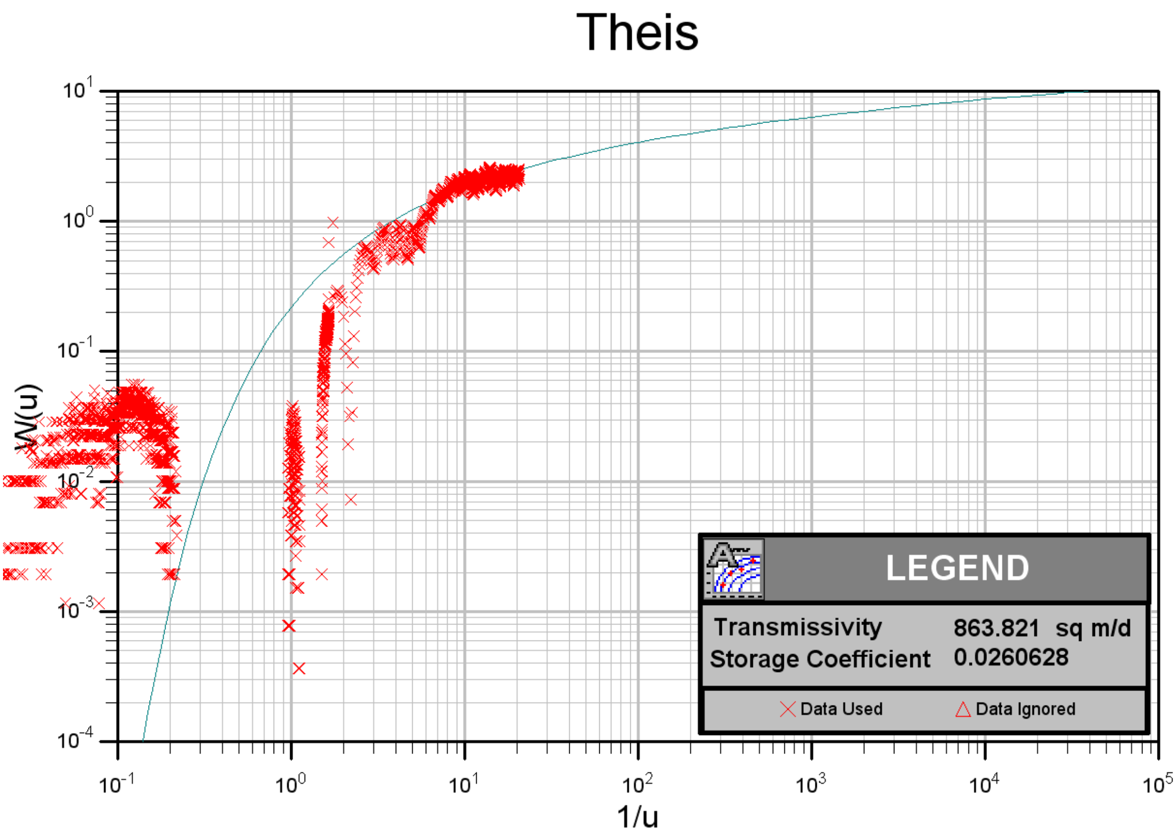
Monitoring Well 6 – Neuman, 1972 (unconfined aquifer)



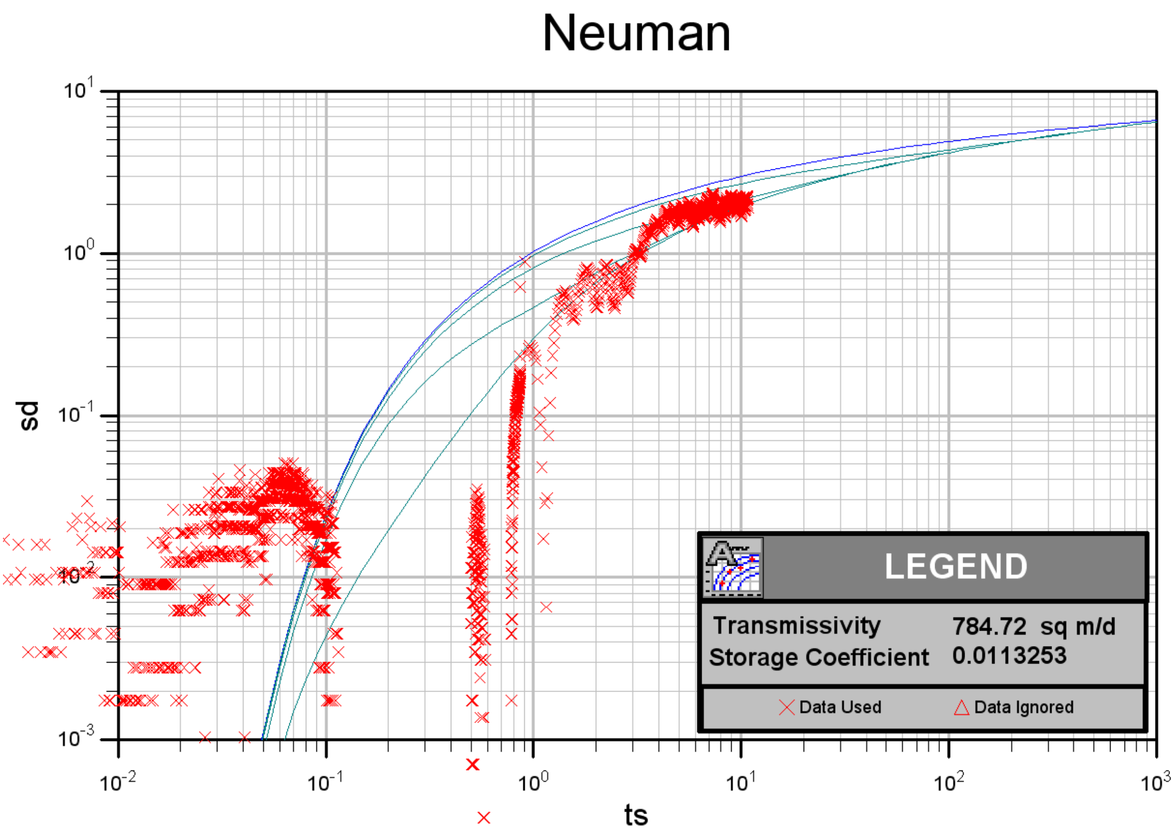
Monitoring Well 9 – Cooper & Jacob, 1946 (Straight Line Method)



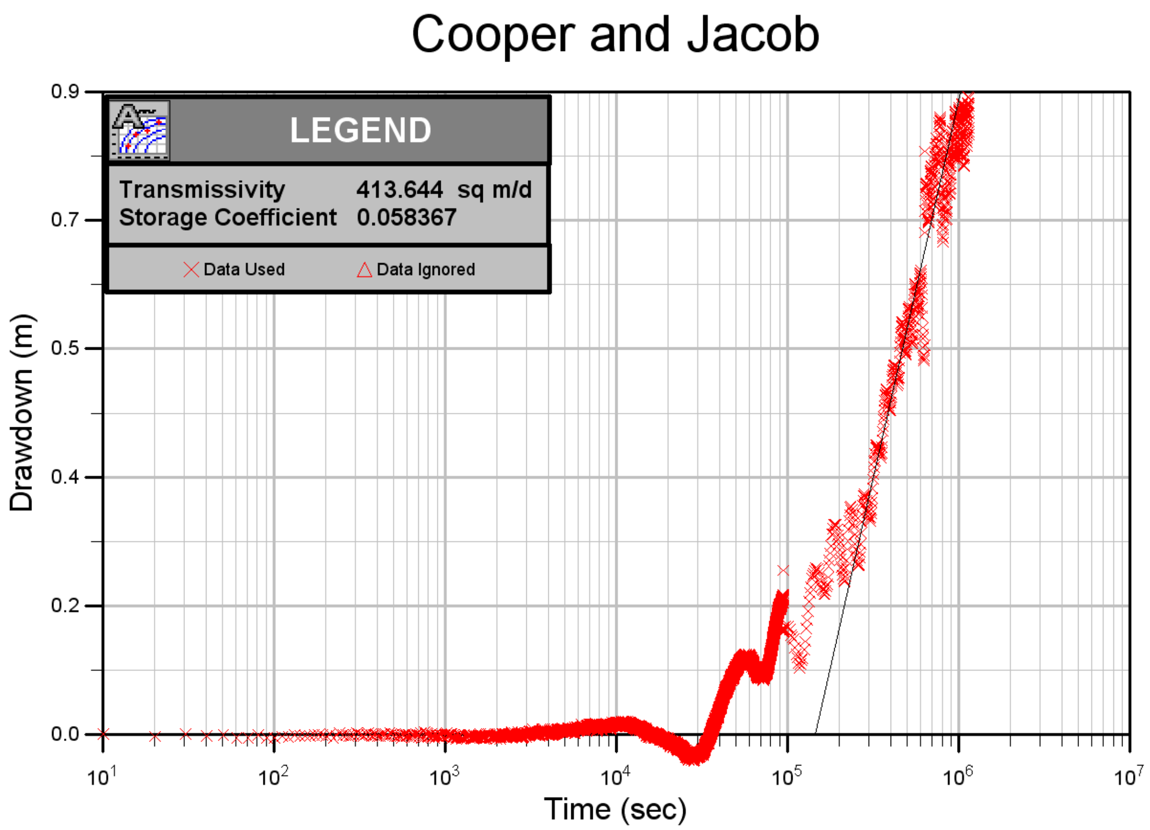
Monitoring Well 9 – Theis, 1935 (unconfined approximation)



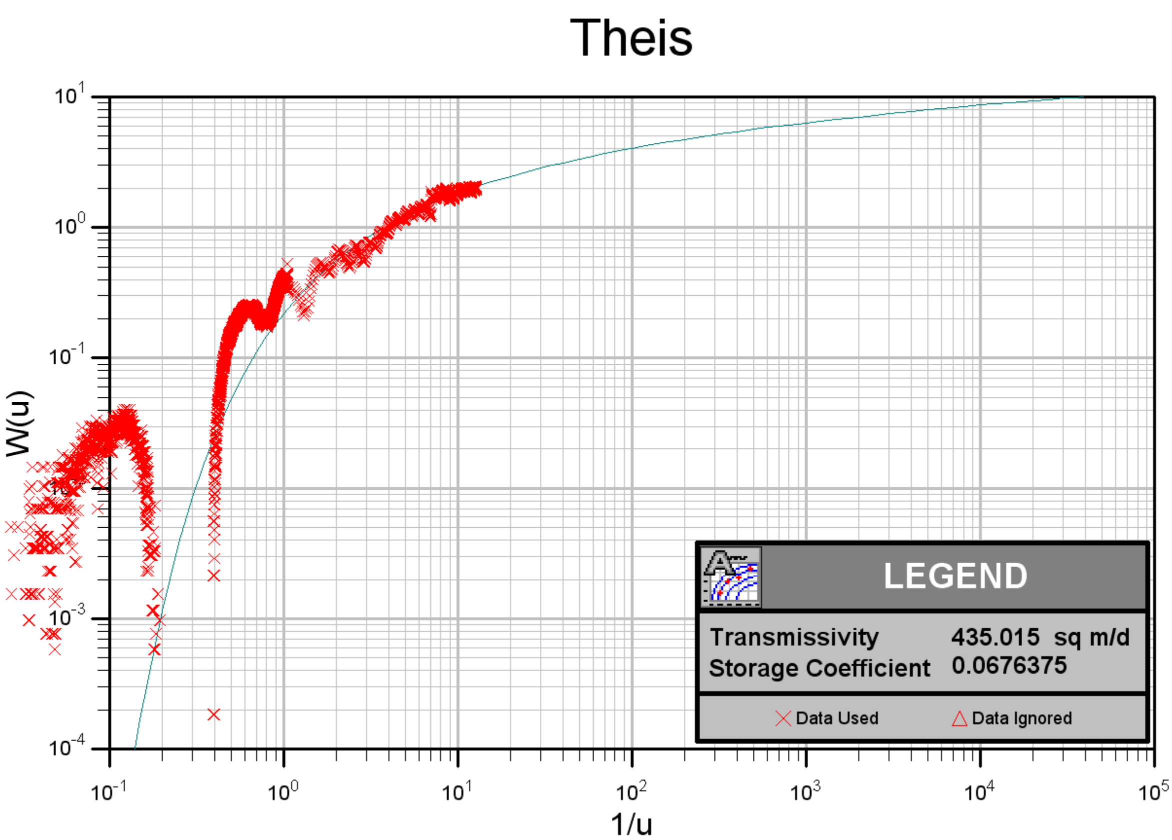
Monitoring Well 9 – Neuman, 1972 (unconfined aquifer)



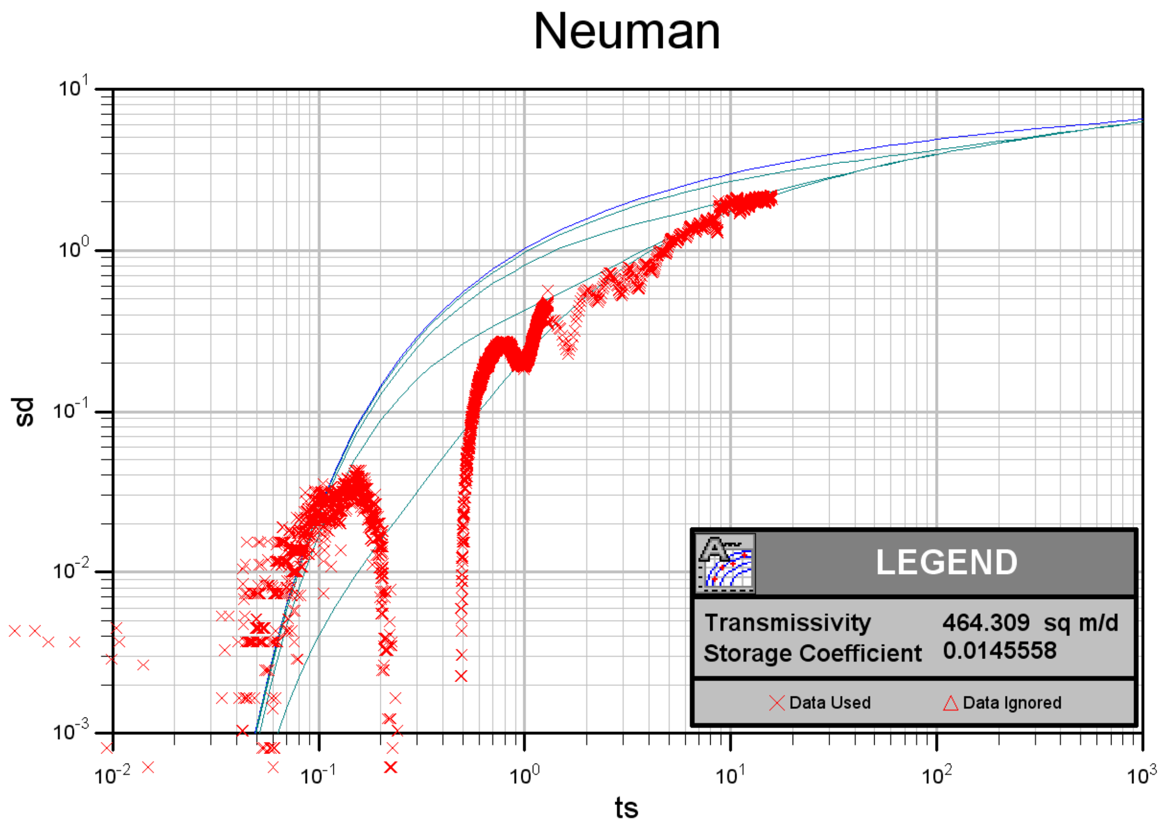
Monitoring Well 13 – Cooper & Jacob, 1946 (Straight Line Method)



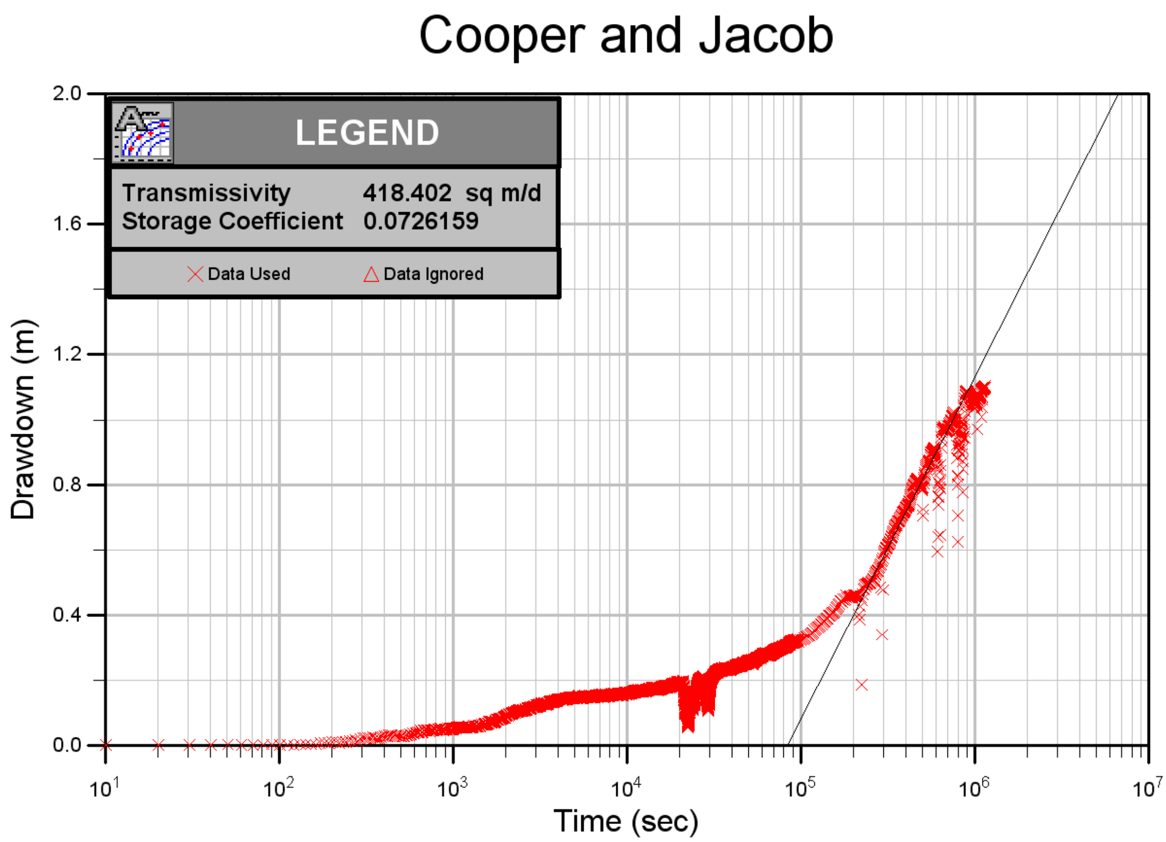
Monitoring Well 13 – Theis, 1935 (unconfined approximation)



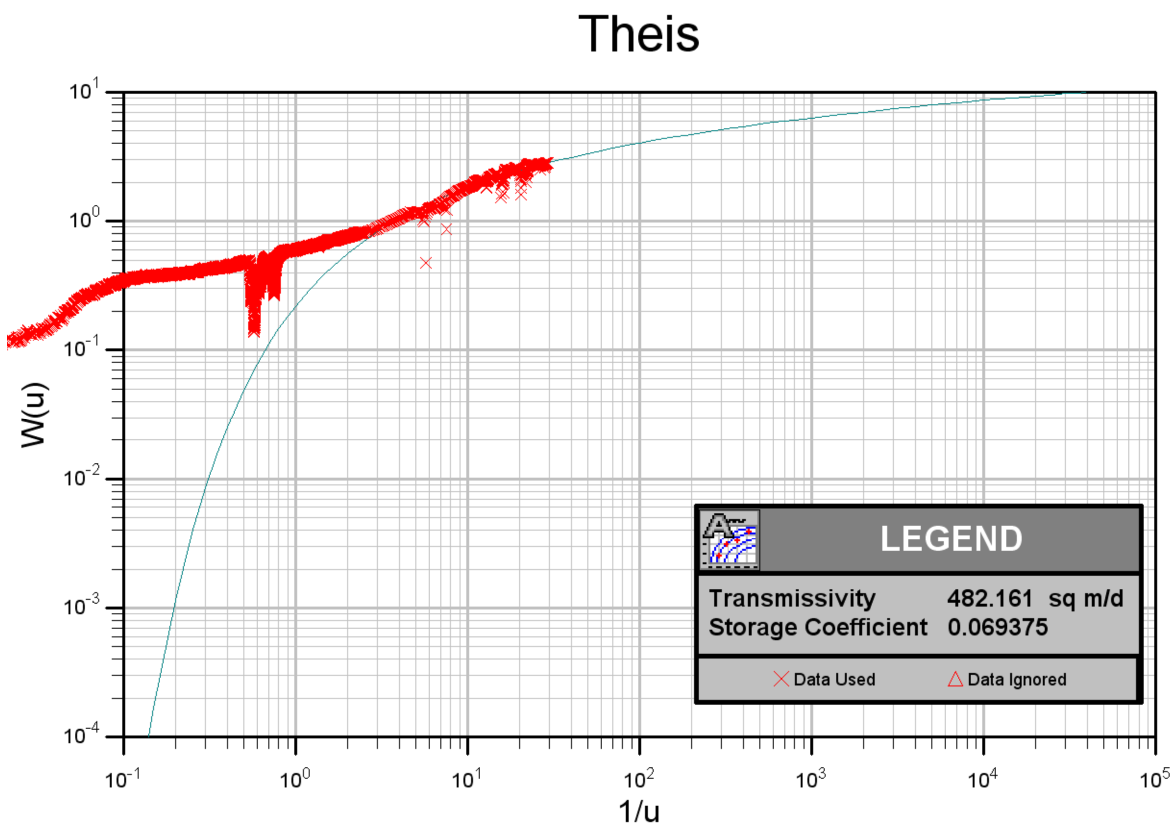
Monitoring Well 13 – Neuman, 1972 (unconfined aquifer)



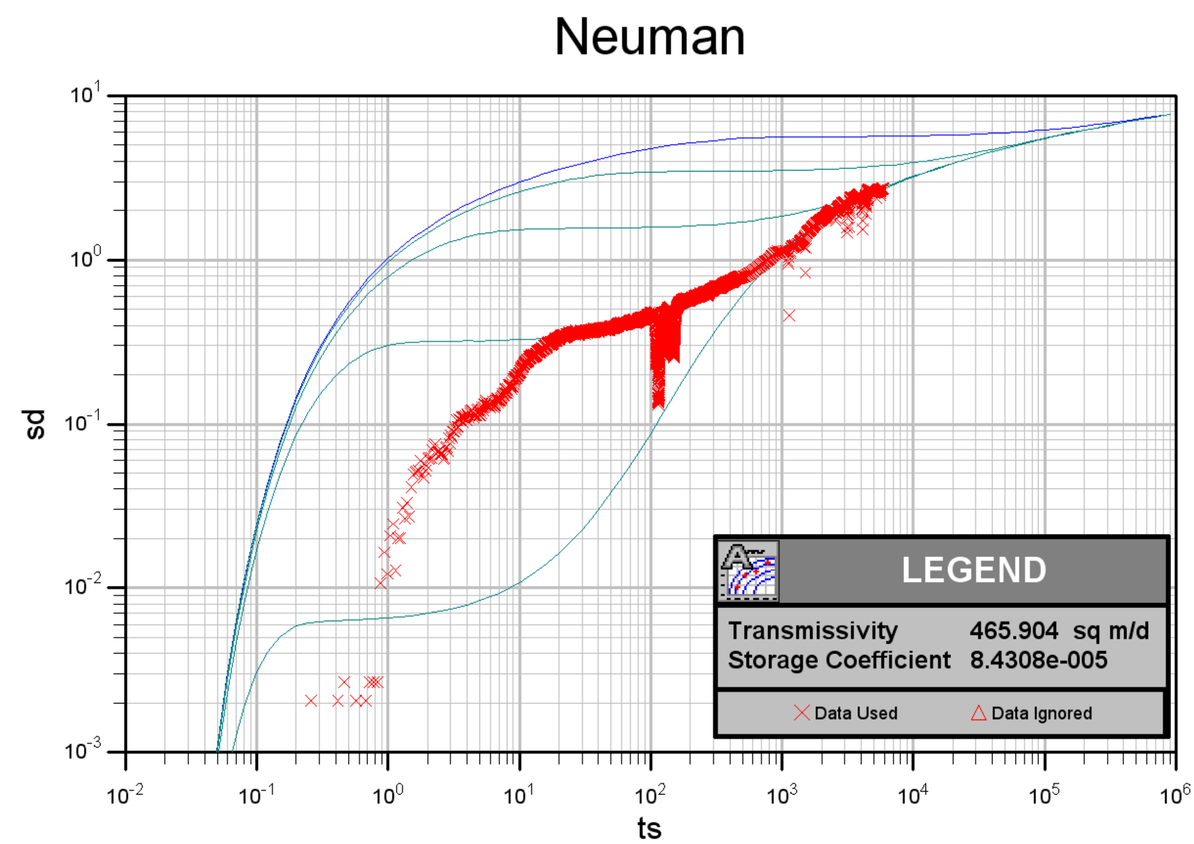
Monitoring Well 14a – Cooper & Jacob, 1946 (Straight Line Method)



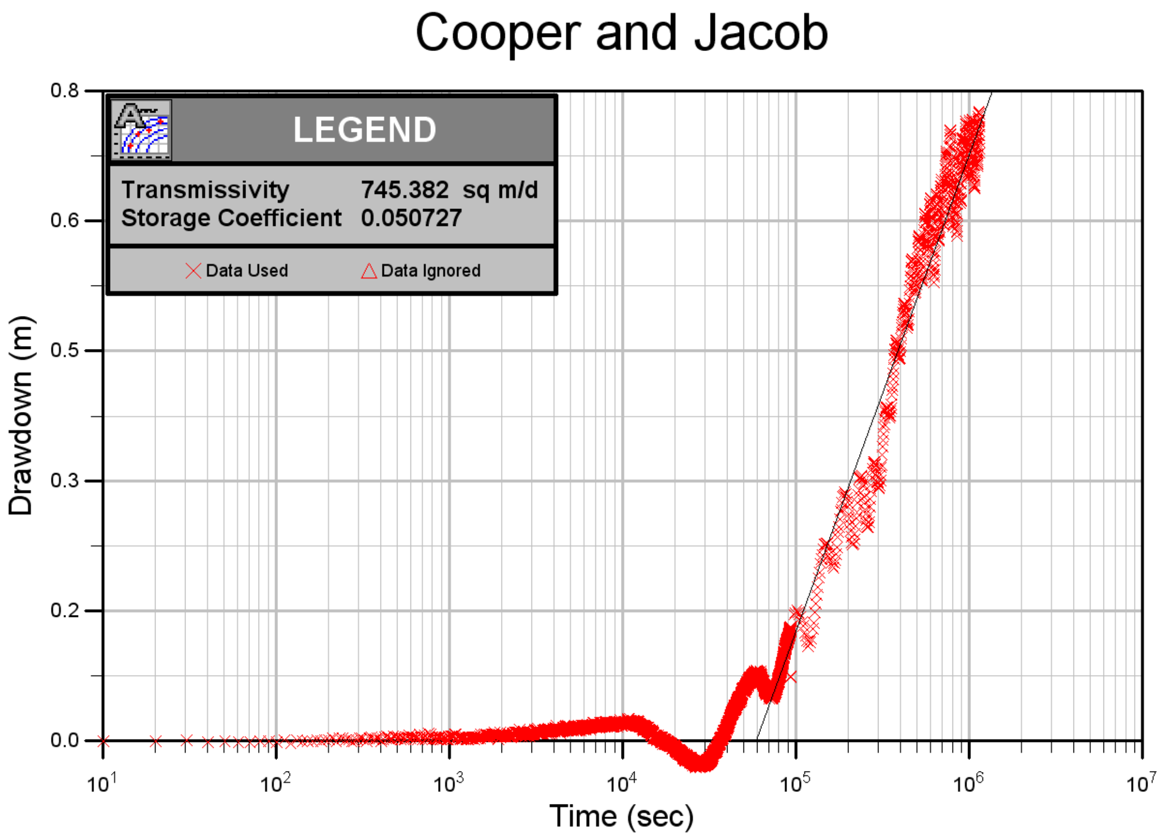
Monitoring Well 14a – Theis, 1935 (unconfined approximation)



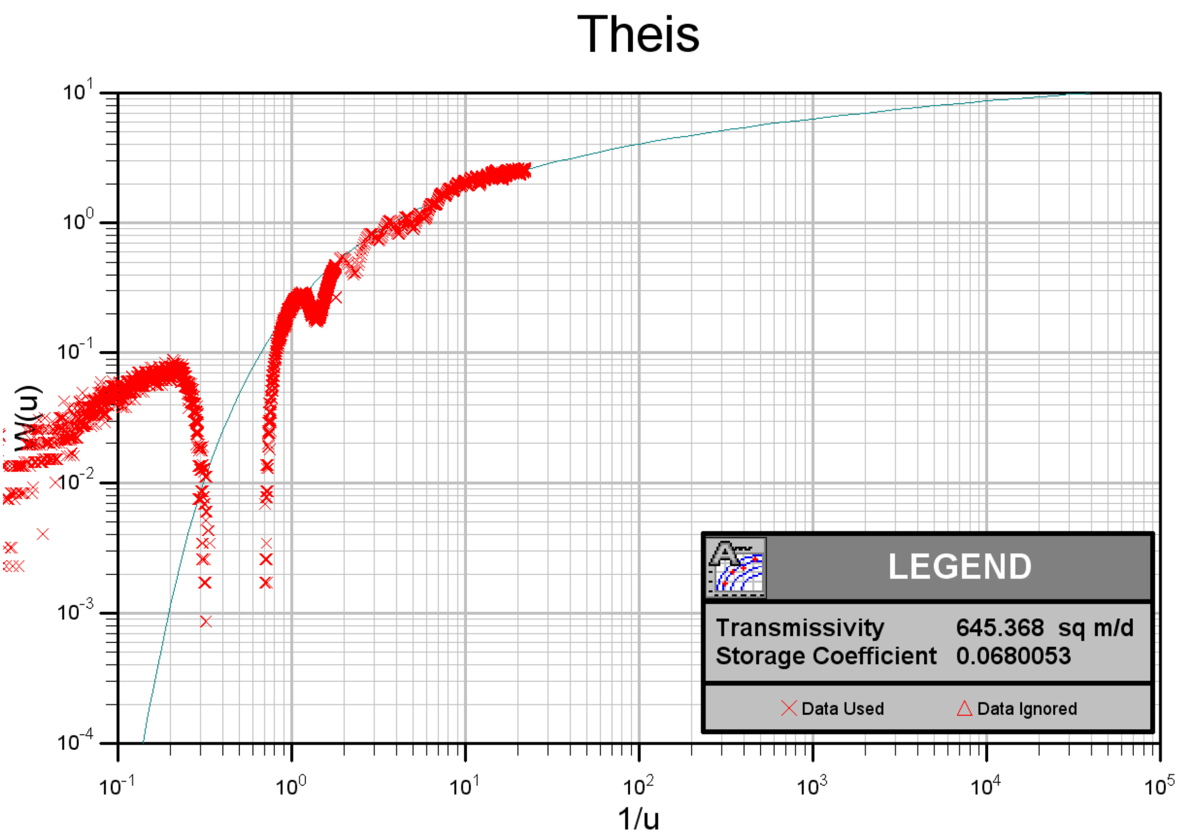
Monitoring Well 14a – Neuman, 1972 (unconfined aquifer)



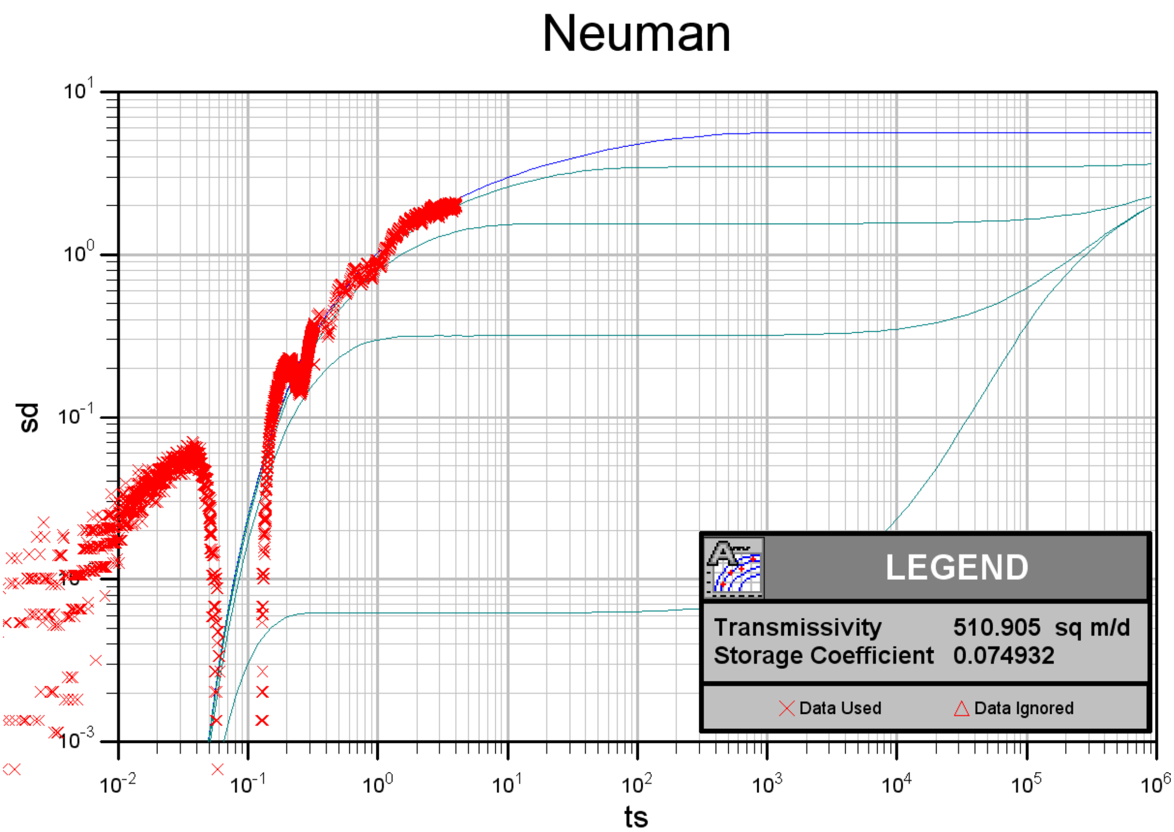
Monitoring Well 23 – Cooper & Jacob, 1946 (Straight Line Method)



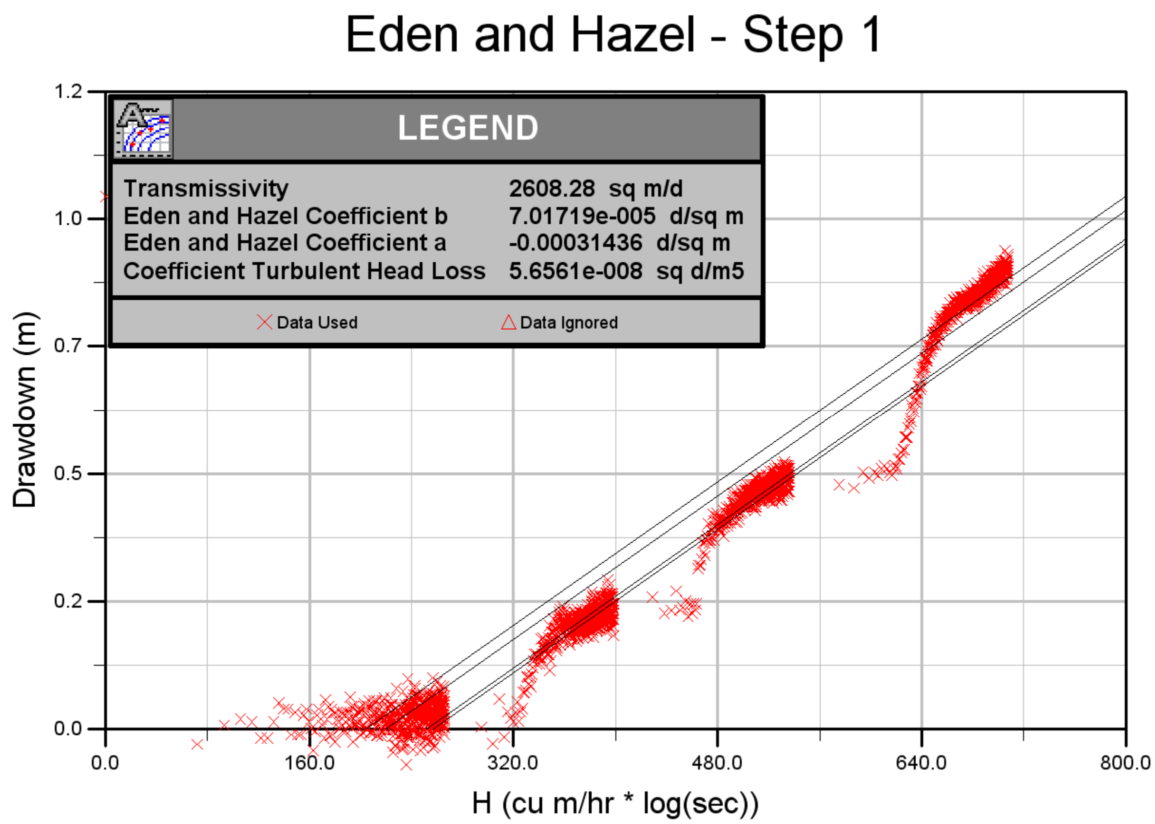
Monitoring Well 23 – Theis, 1935 (unconfined approximation)

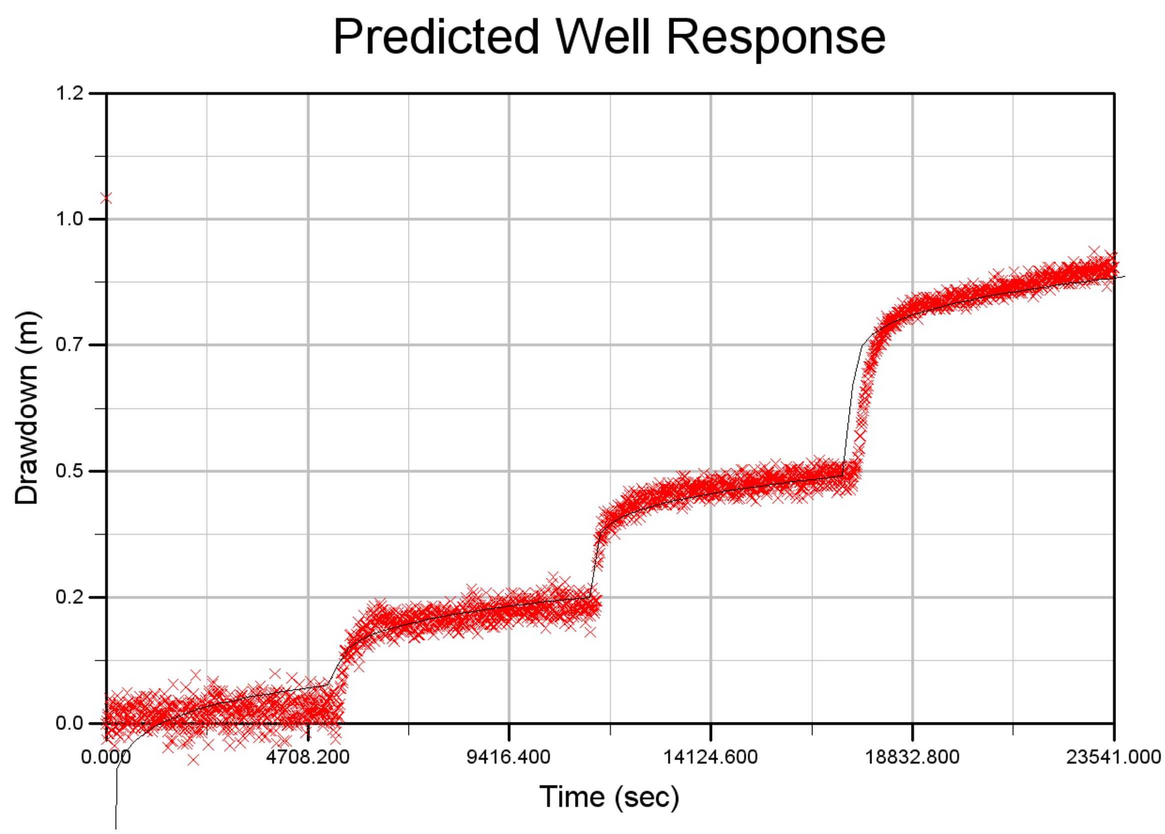


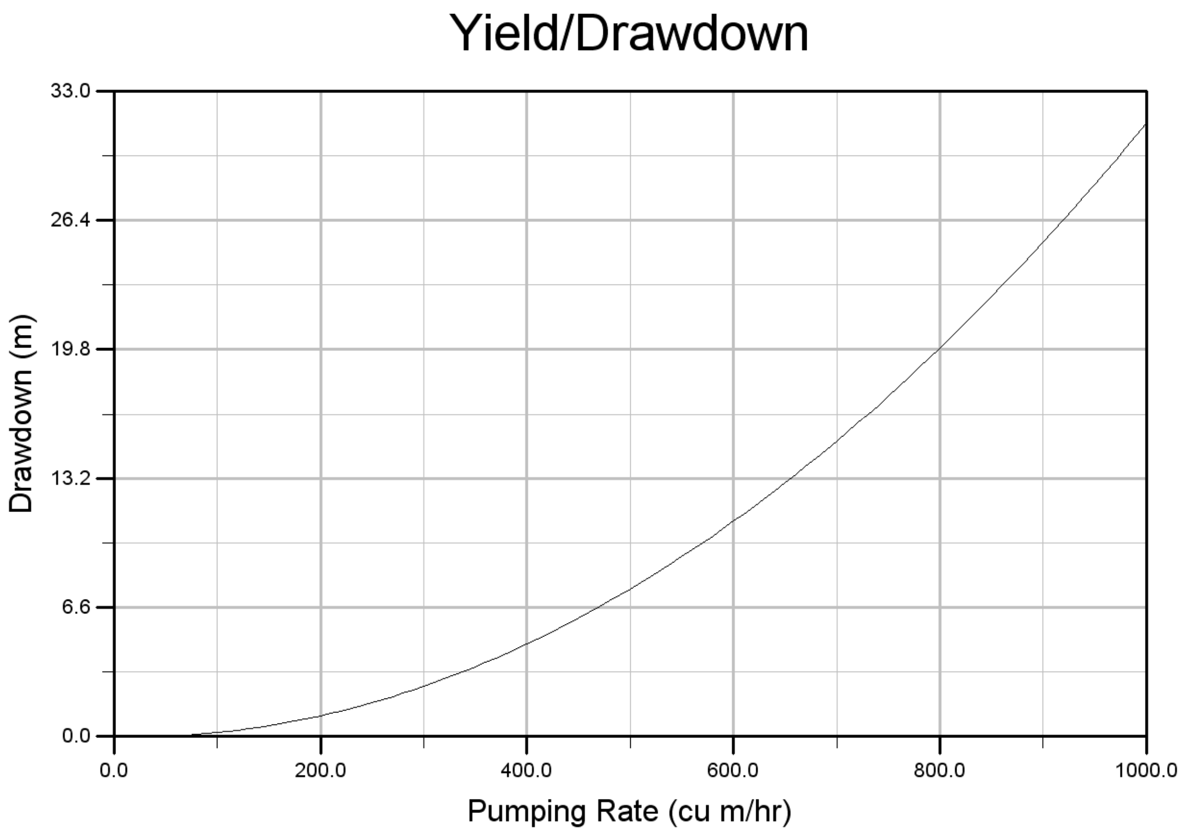
Monitoring Well 23 – Neuman, 1972 (unconfined aquifer)



Cooperage Well Step Test

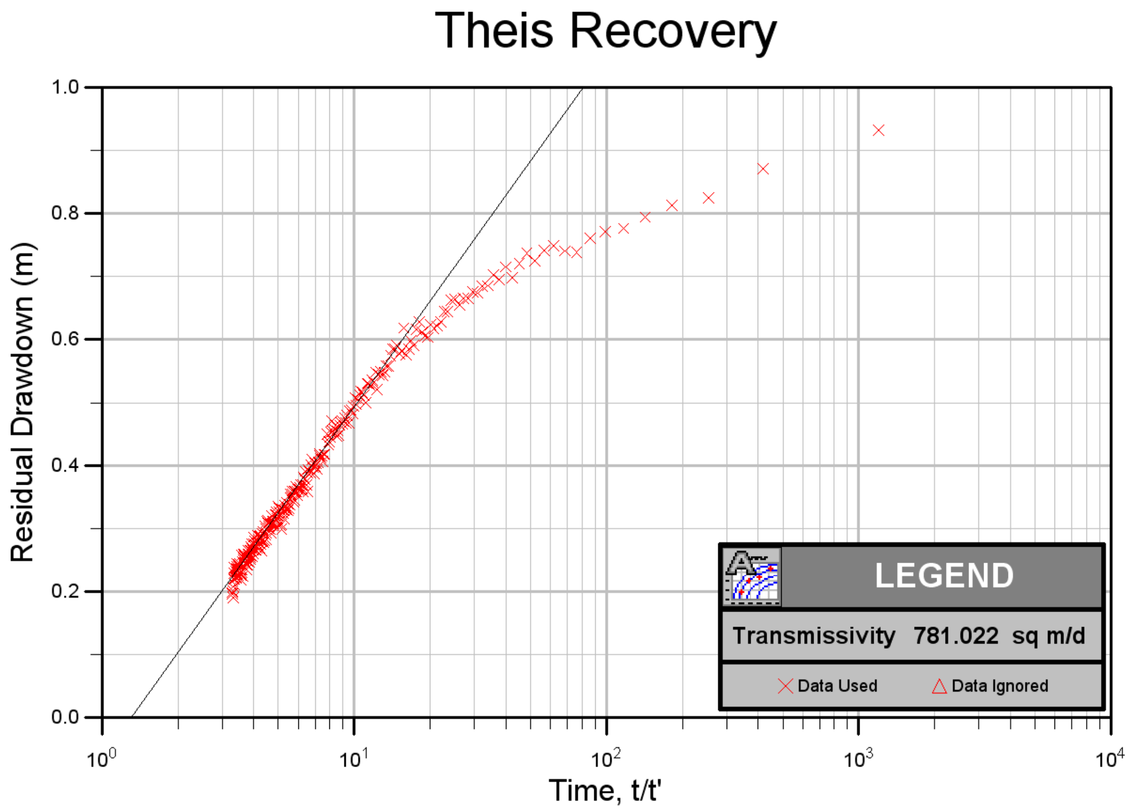


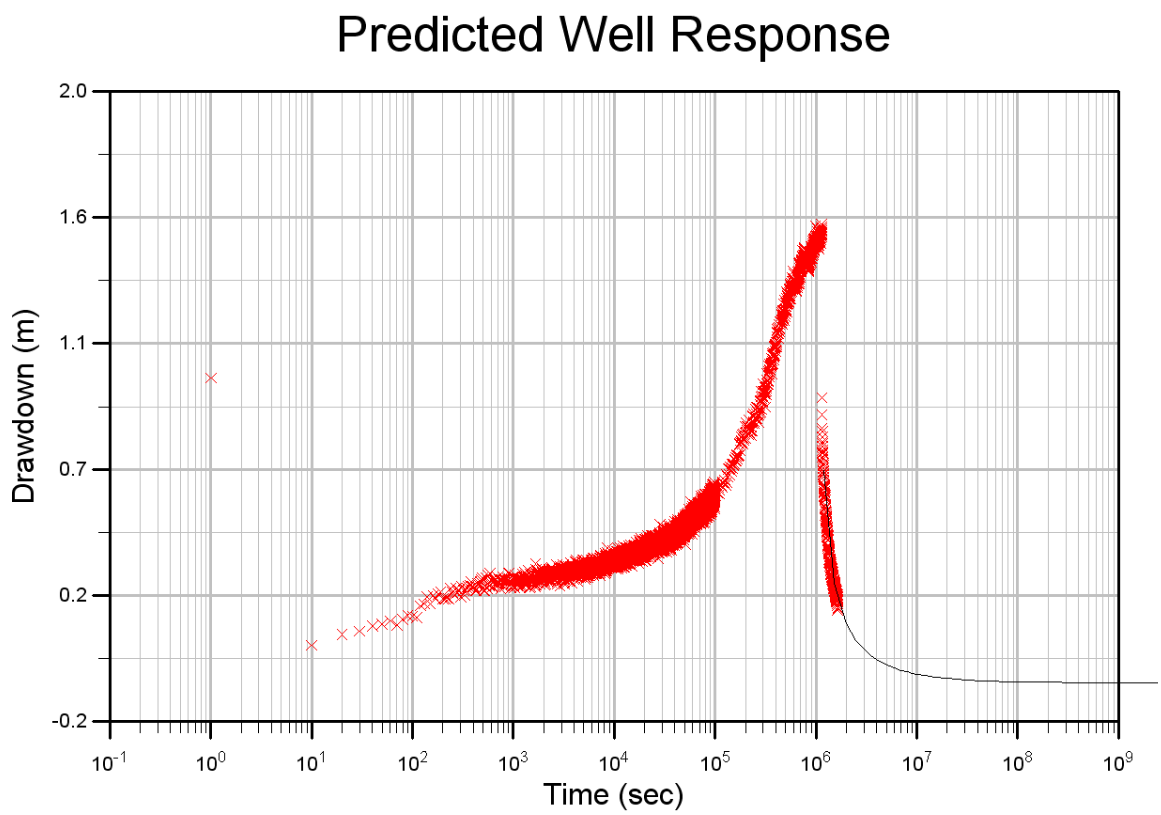

Predicted Well Response
Drawdown (m)
1.2
1.0
0.7
0.5
0.2
0.0
0.000
4708.200
9416.400
14124.600
18832.800
23541.000
Time (sec)


Yield/Drawdown
Drawdown (m)
33.0
26.4
19.8
13.2
6.6
0.0
0.0
200.0
400.0
600.0
800.0
1000.0
Pumping Rate (cu m/hr)

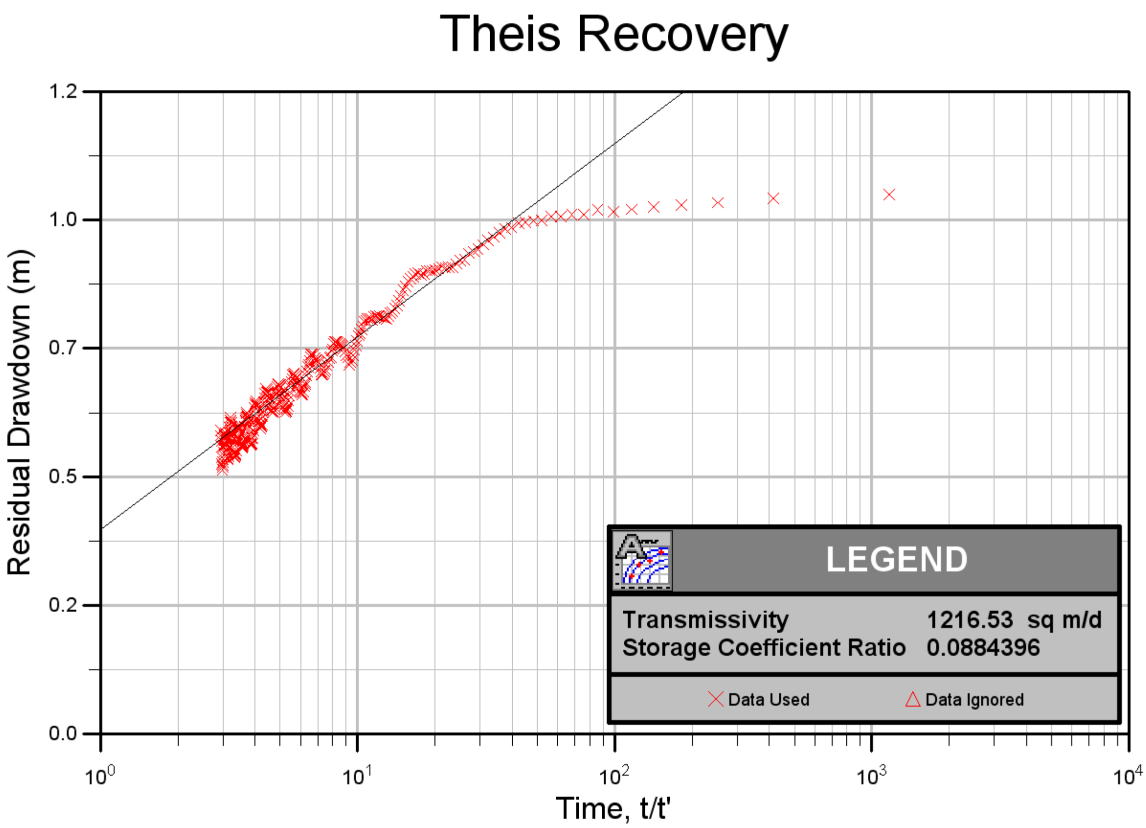
Recovery Analysis

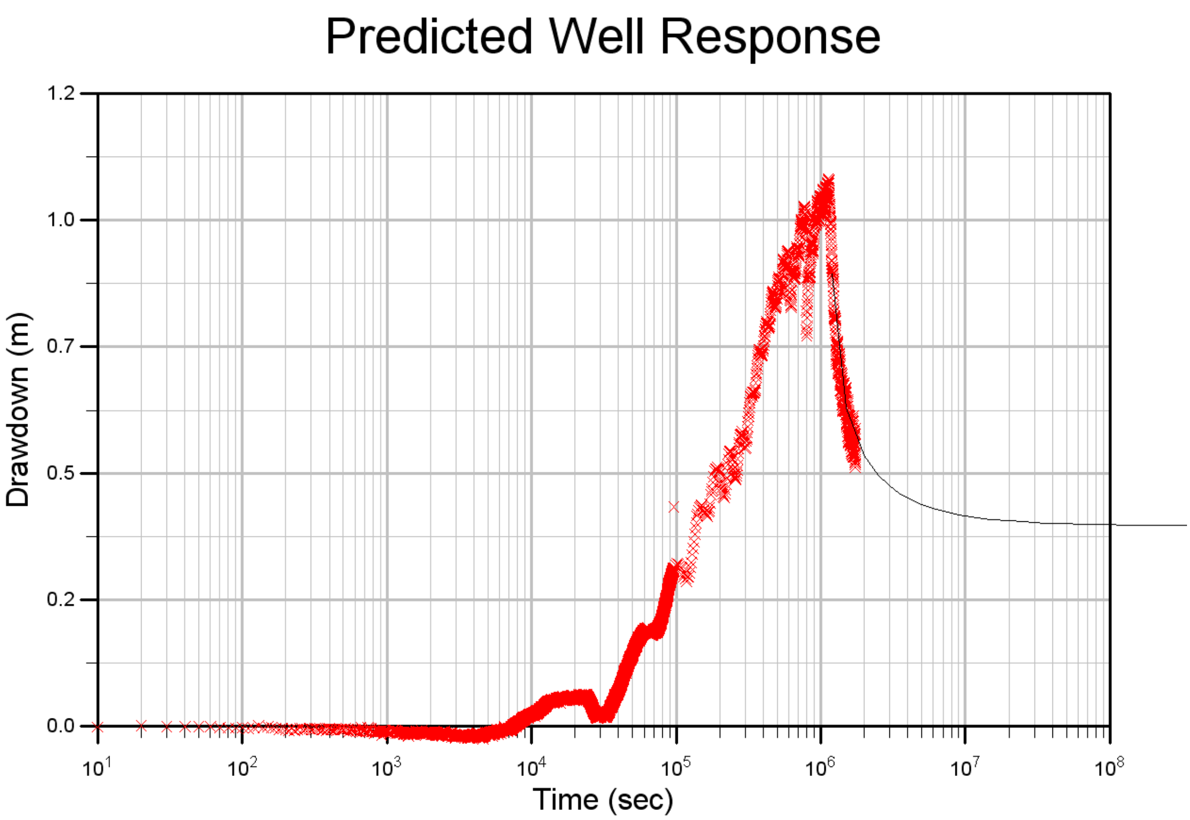
Cooperage Well



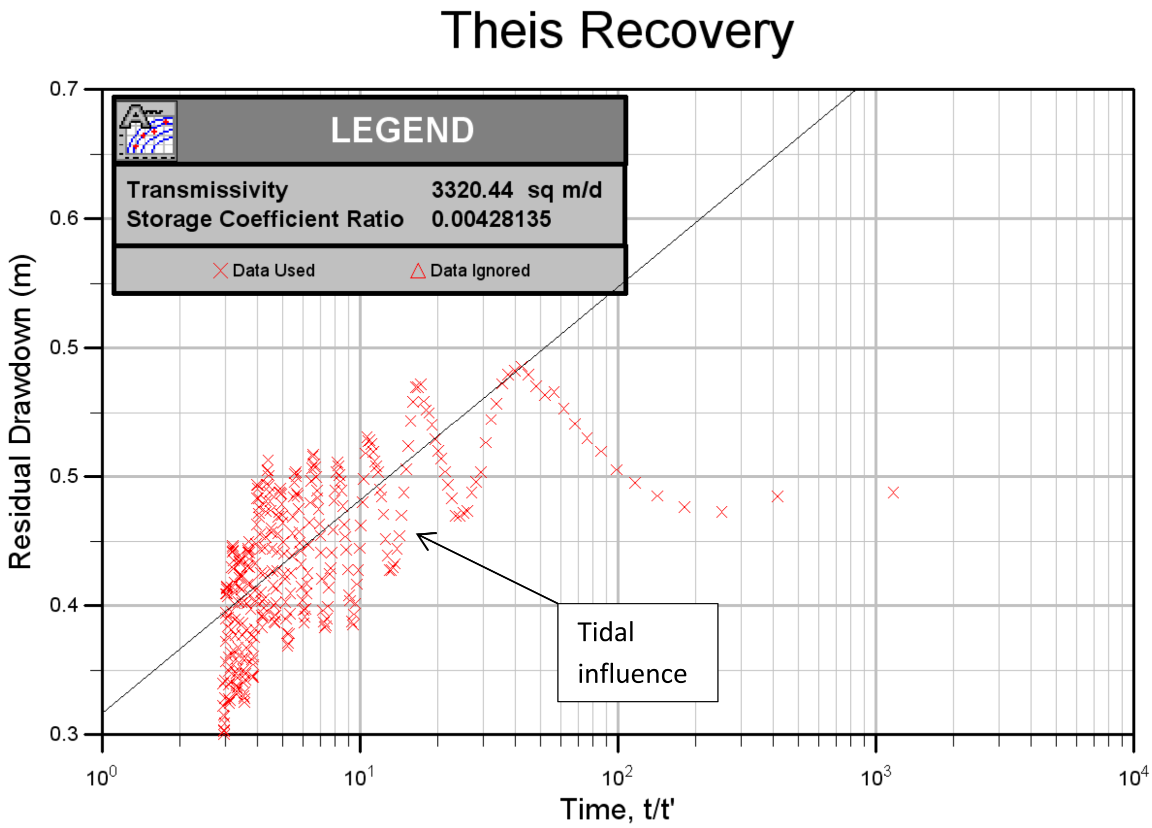


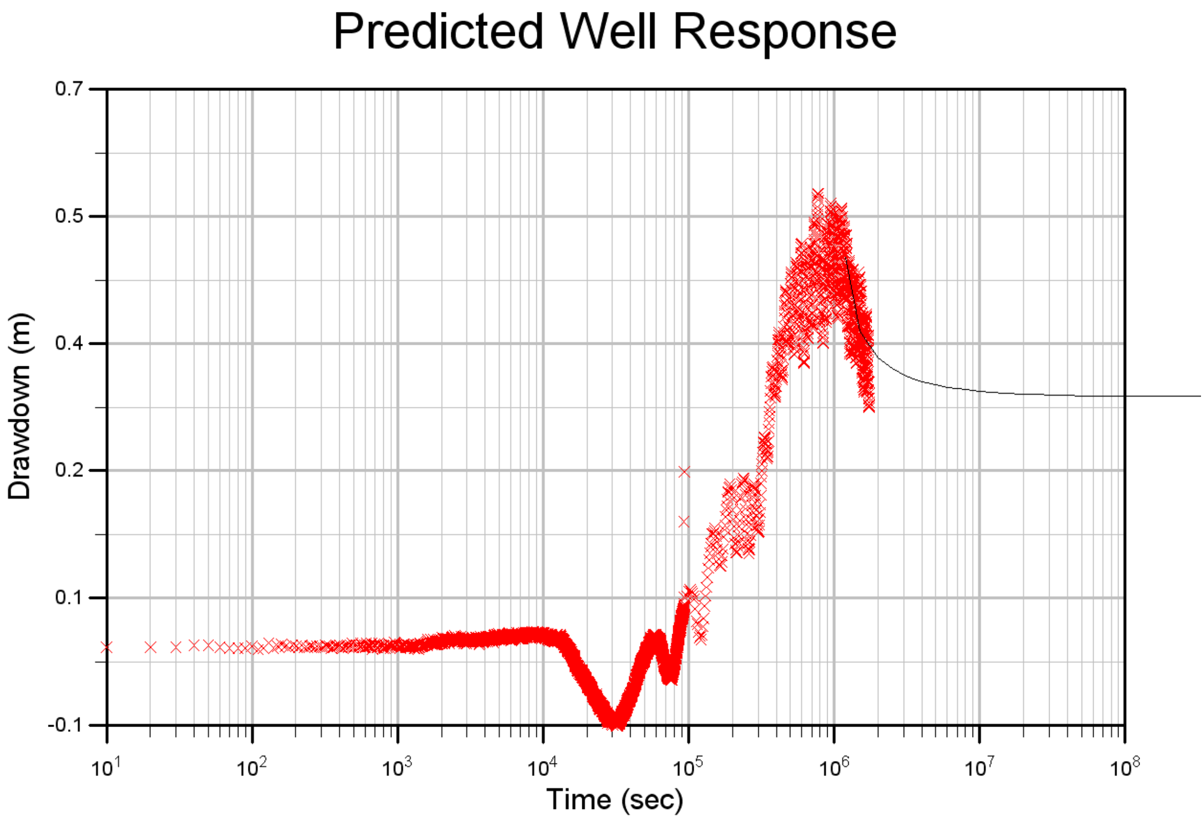
Monitoring Well 6



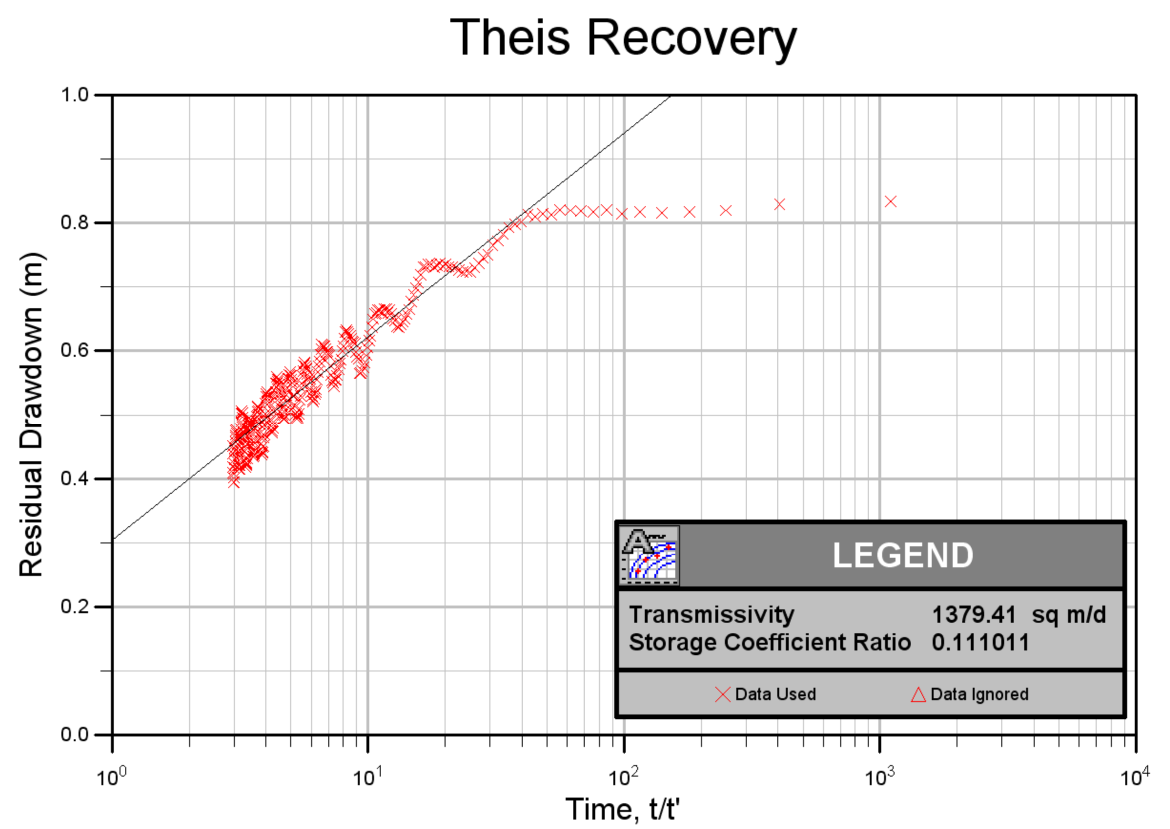


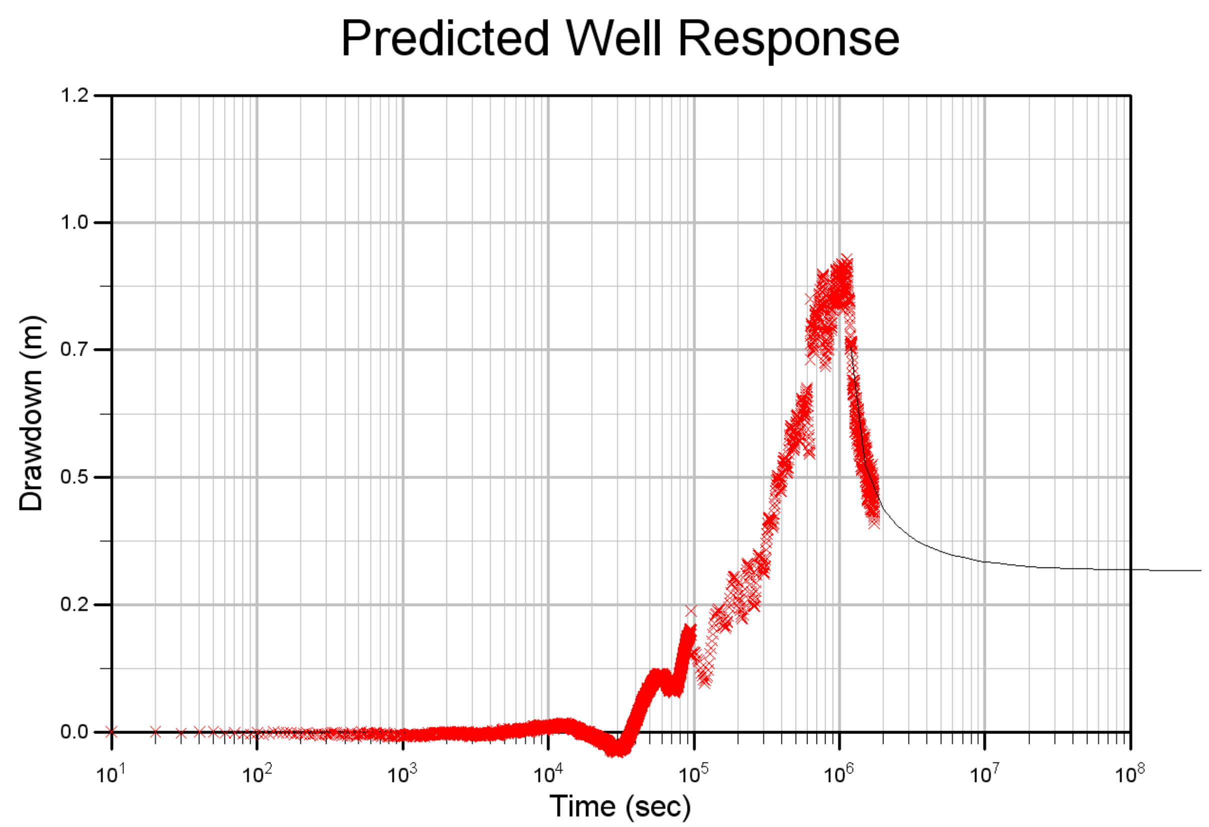
Monitoring Well 9



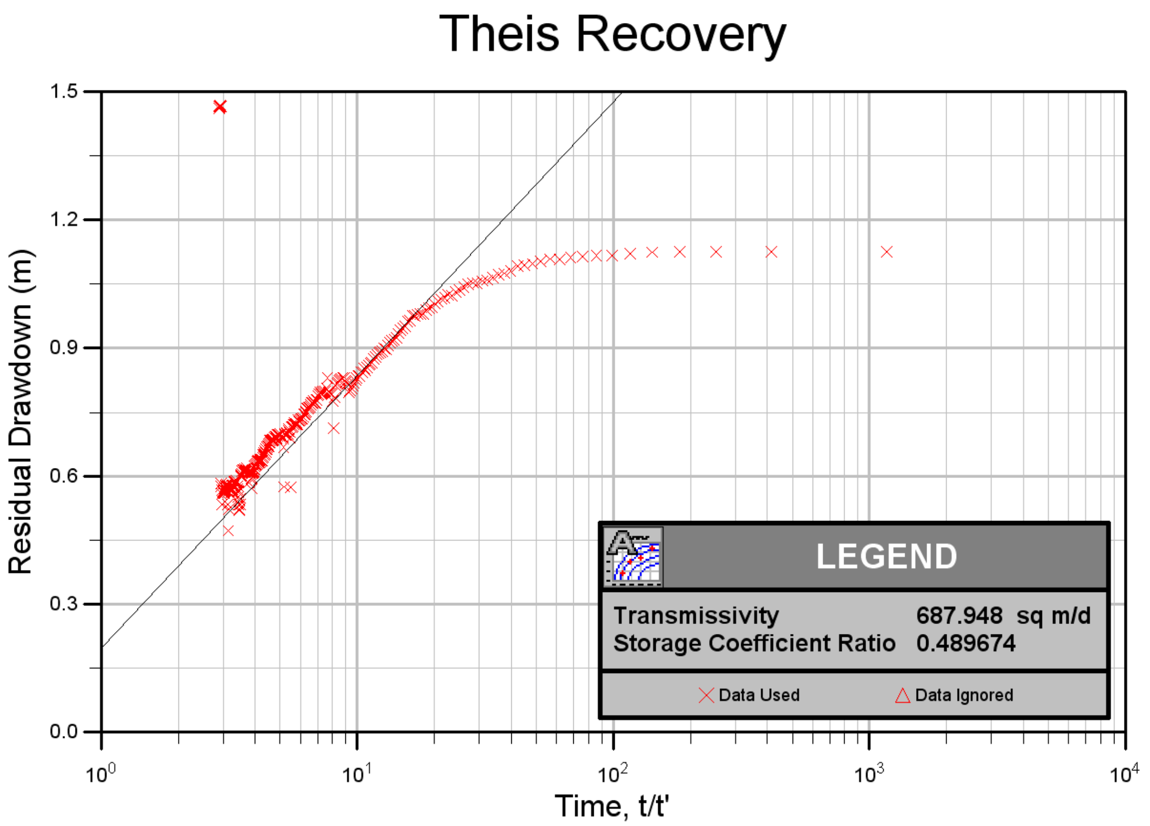


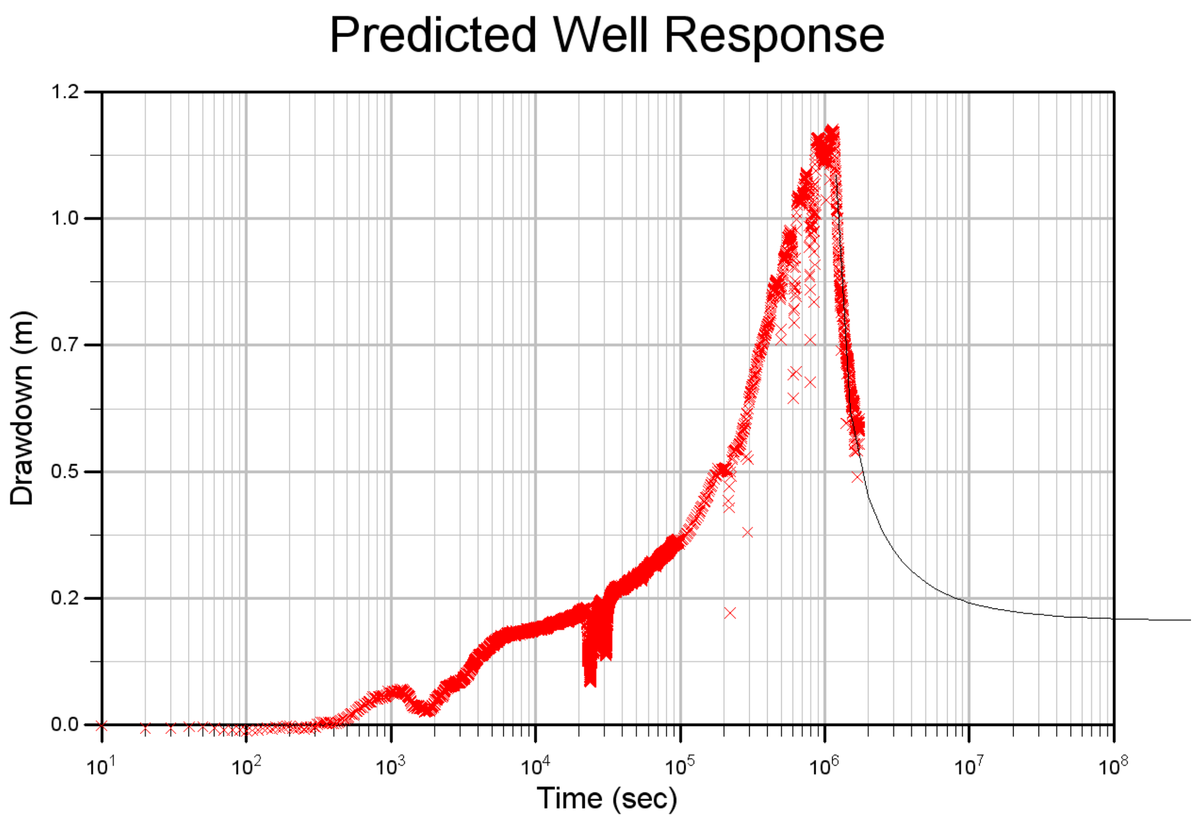
Monitoring Well 13



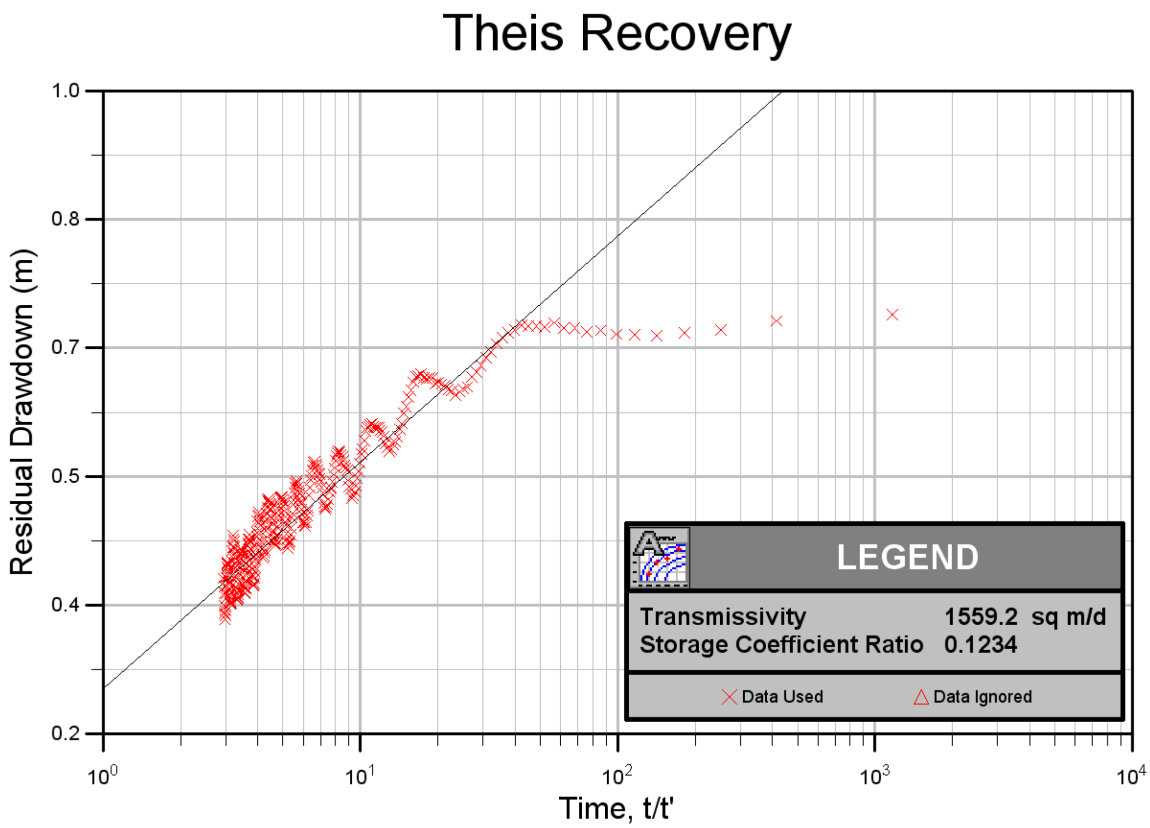


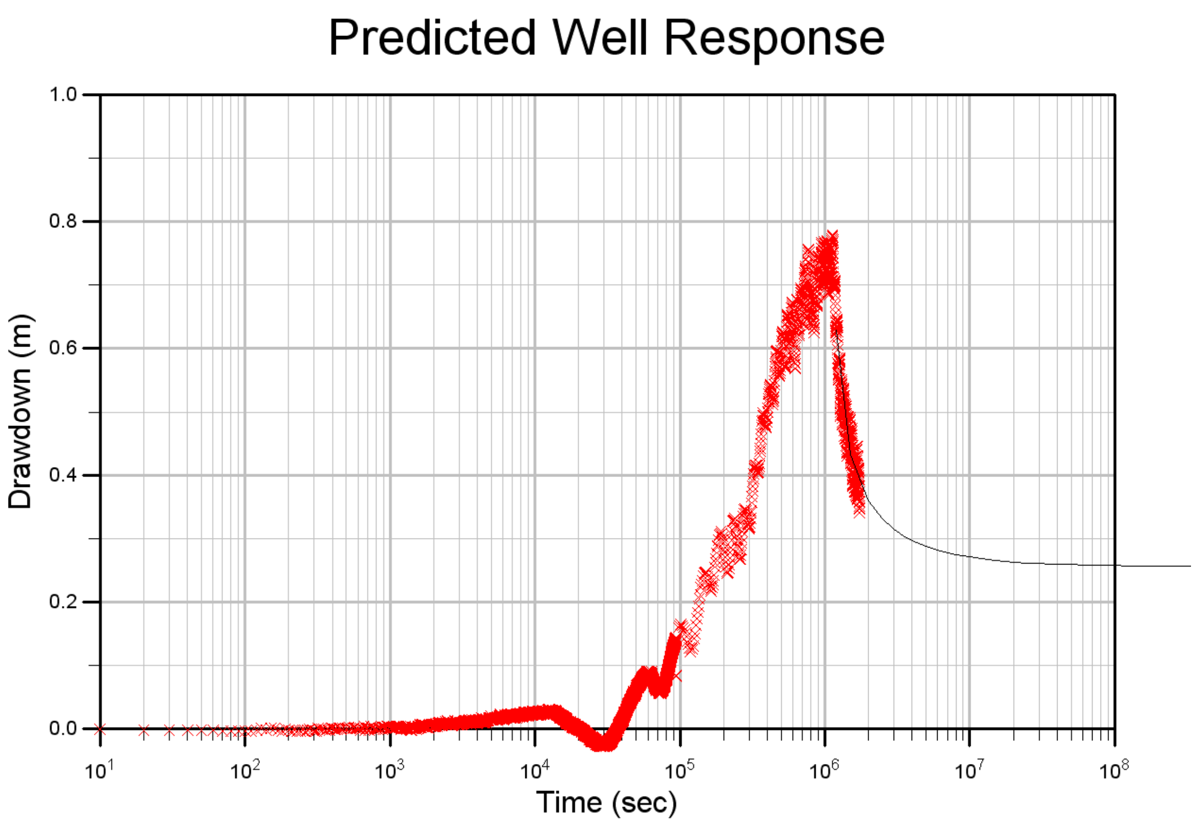
Monitoring Well 14a





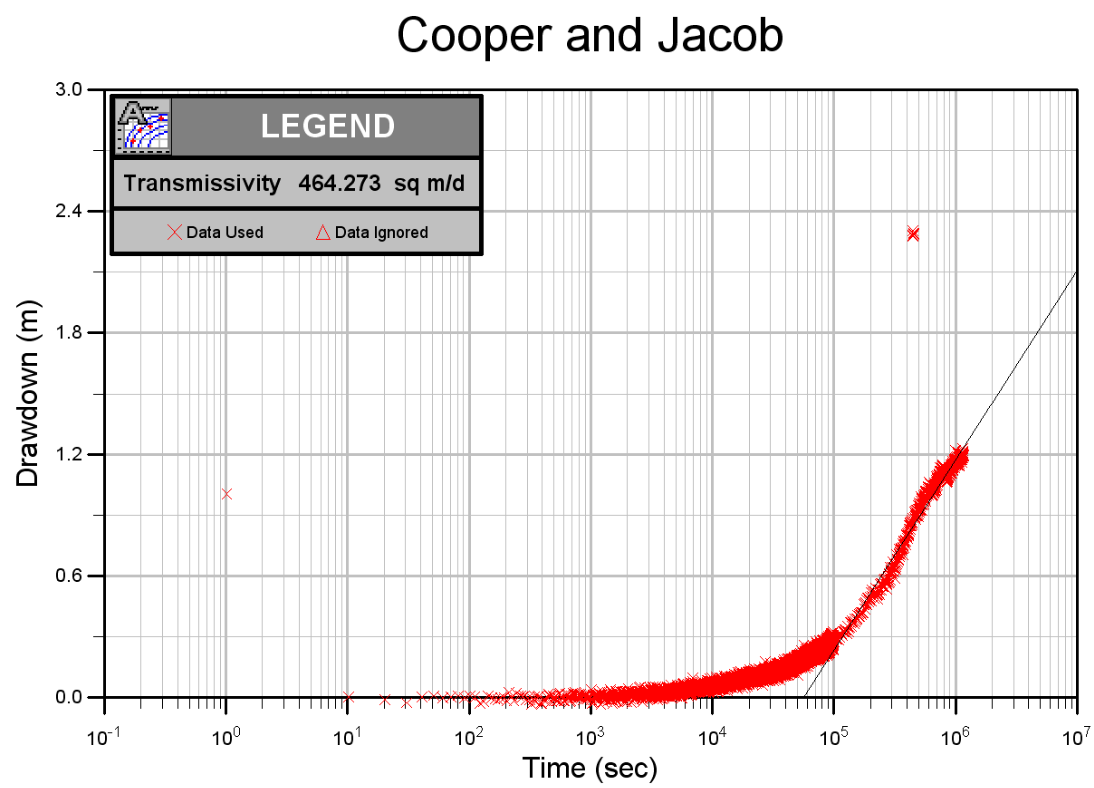
Monitoring Well 23



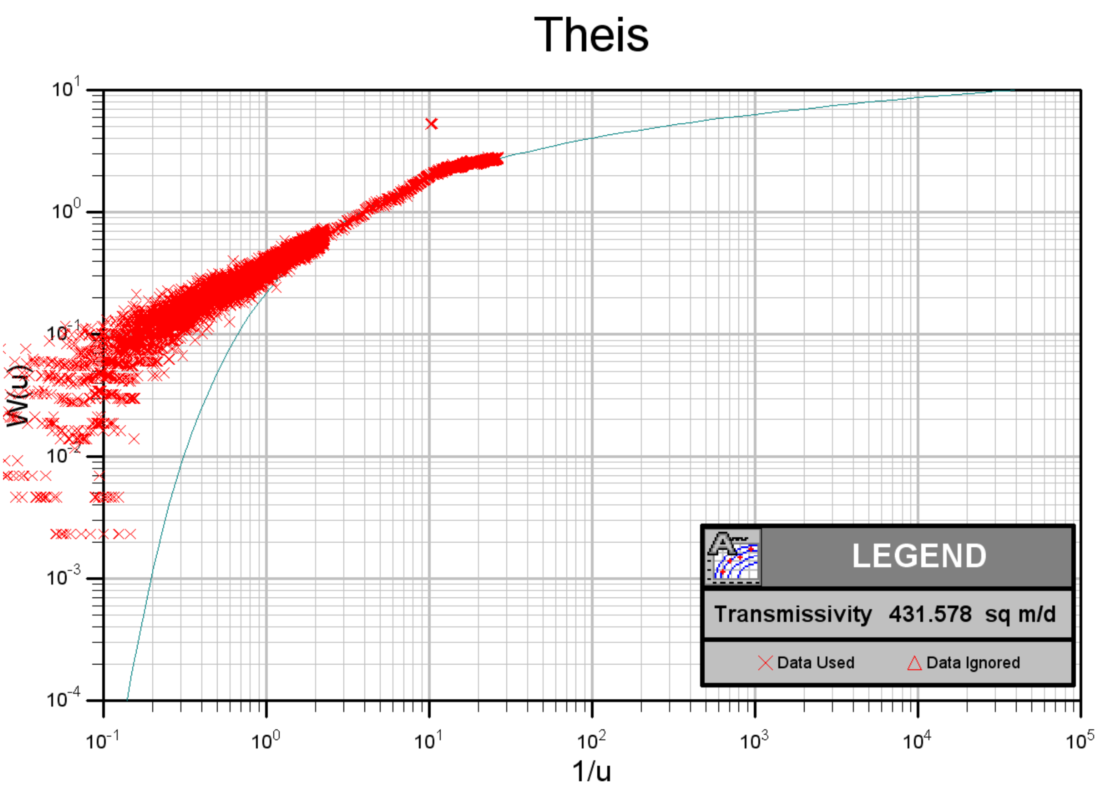


Constant Rate Test

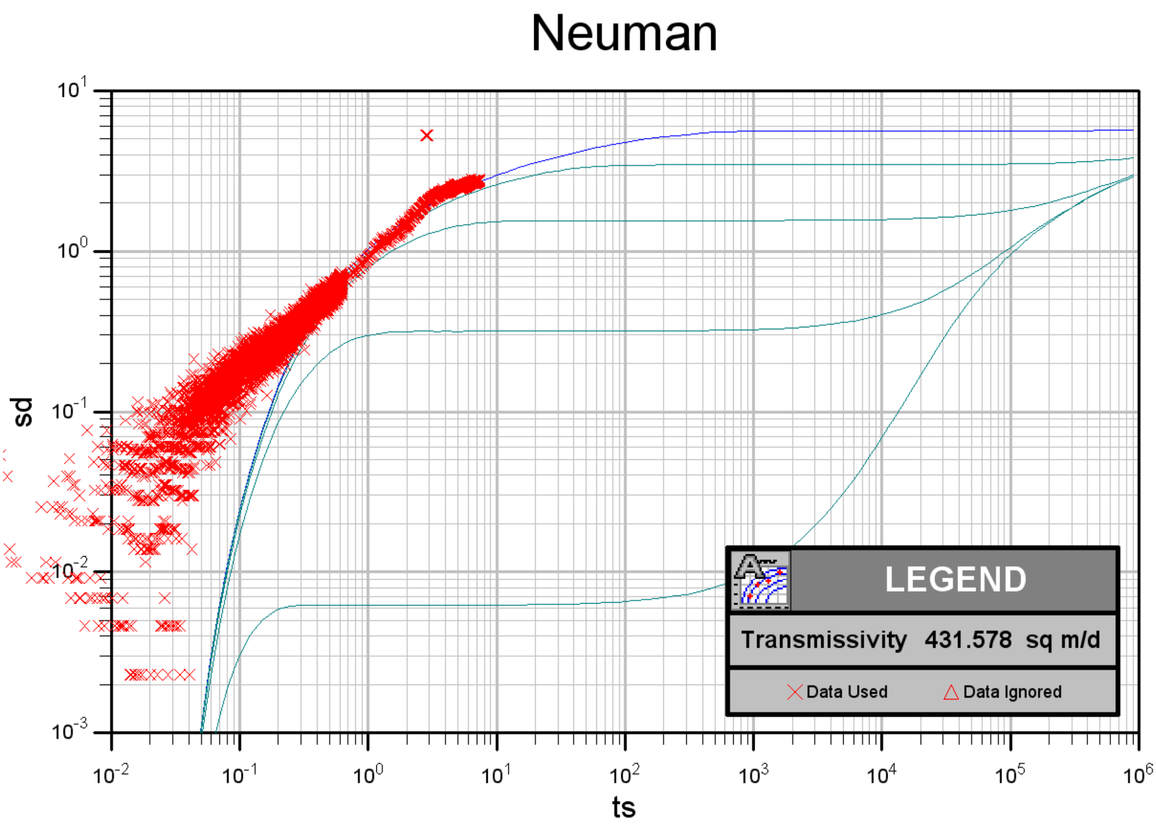
Cooperage Well – Cooper & Jacob, 1946 (Straight Line Method)



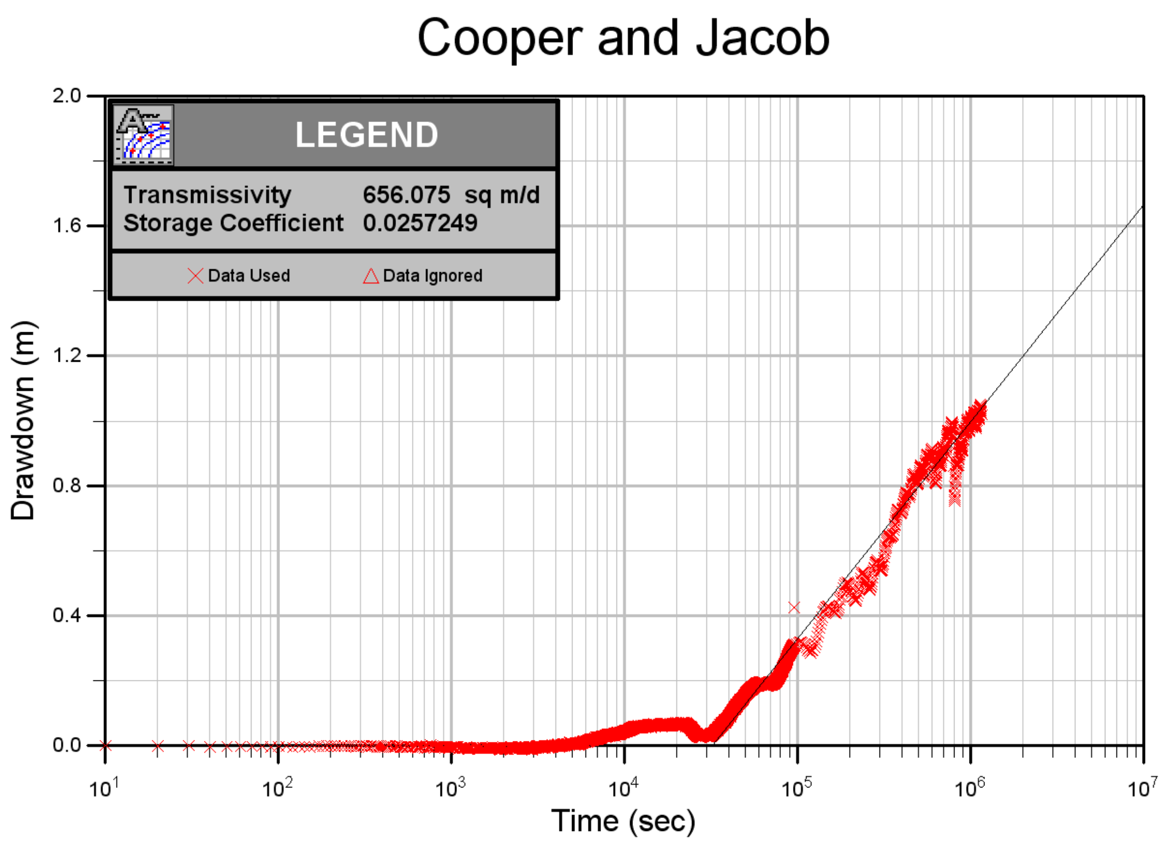
Cooperage Well – Theis, 1935 (unconfined approximation)



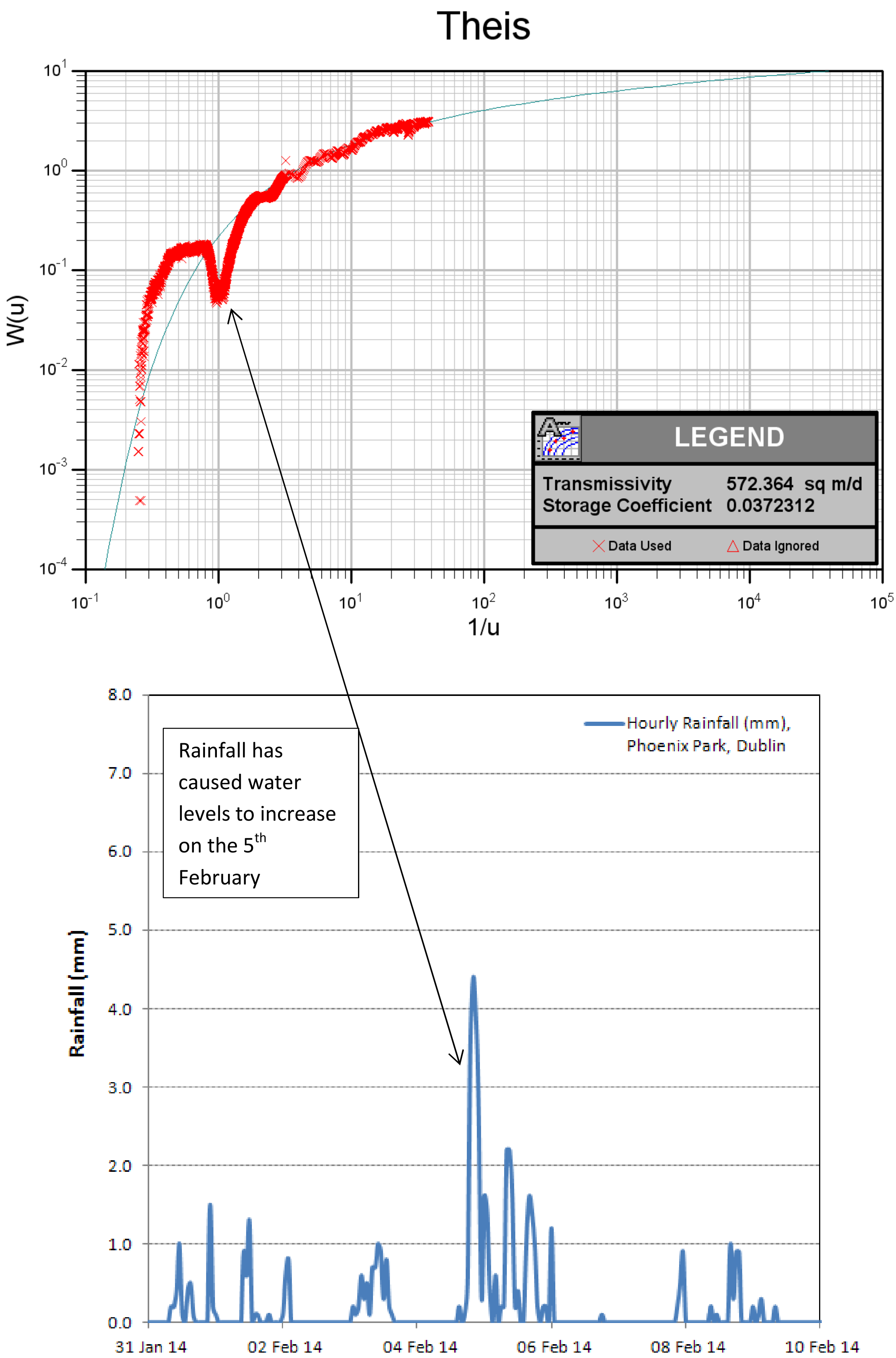
Cooperage Well – Neuman, 1972 (unconfined aquifer)



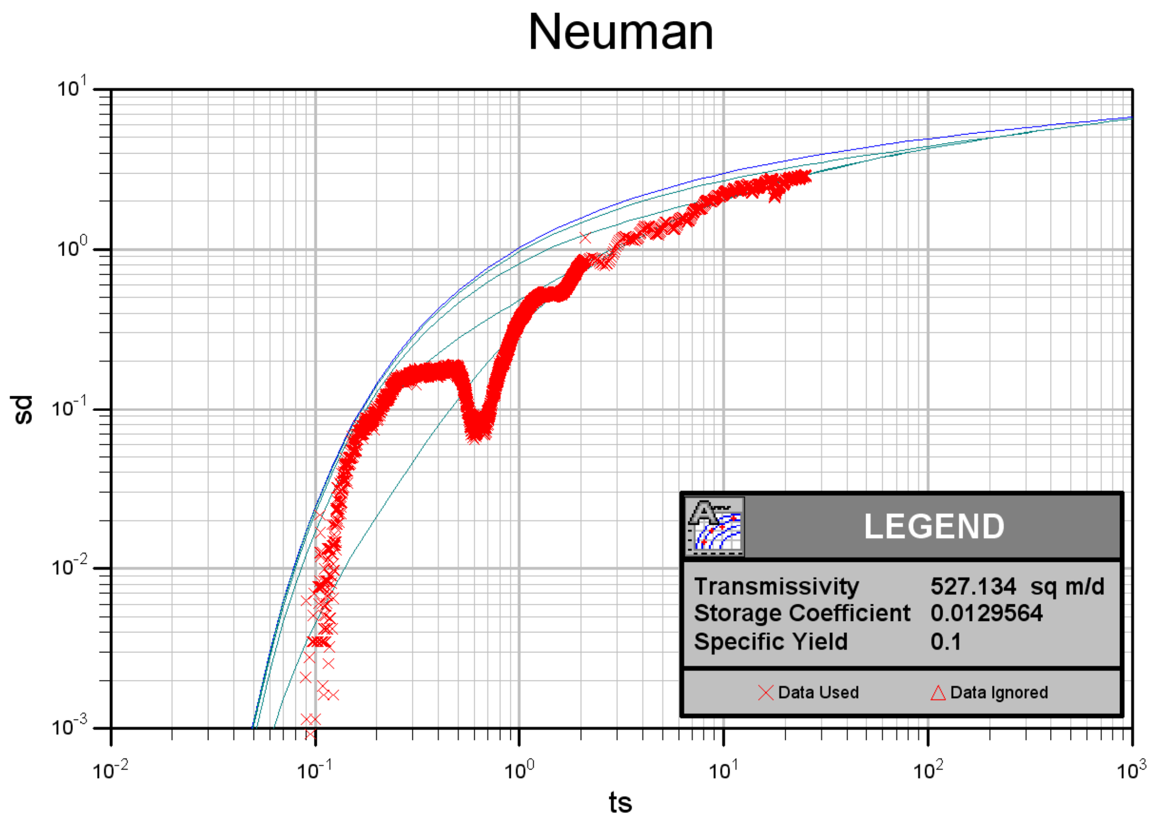
Monitoring Well 6 – Cooper & Jacob, 1946 (Straight Line Method)



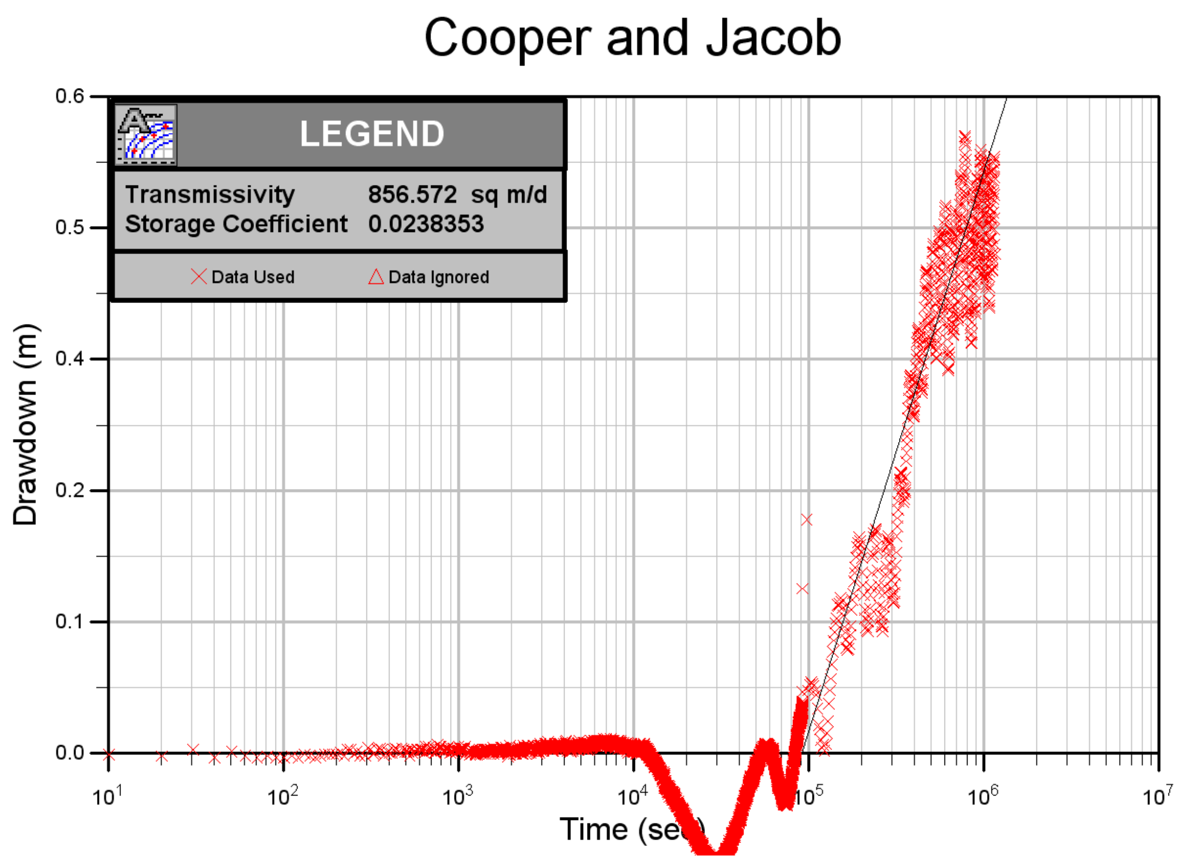
Monitoring Well 6 – Theis, 1935 (unconfined approximation)



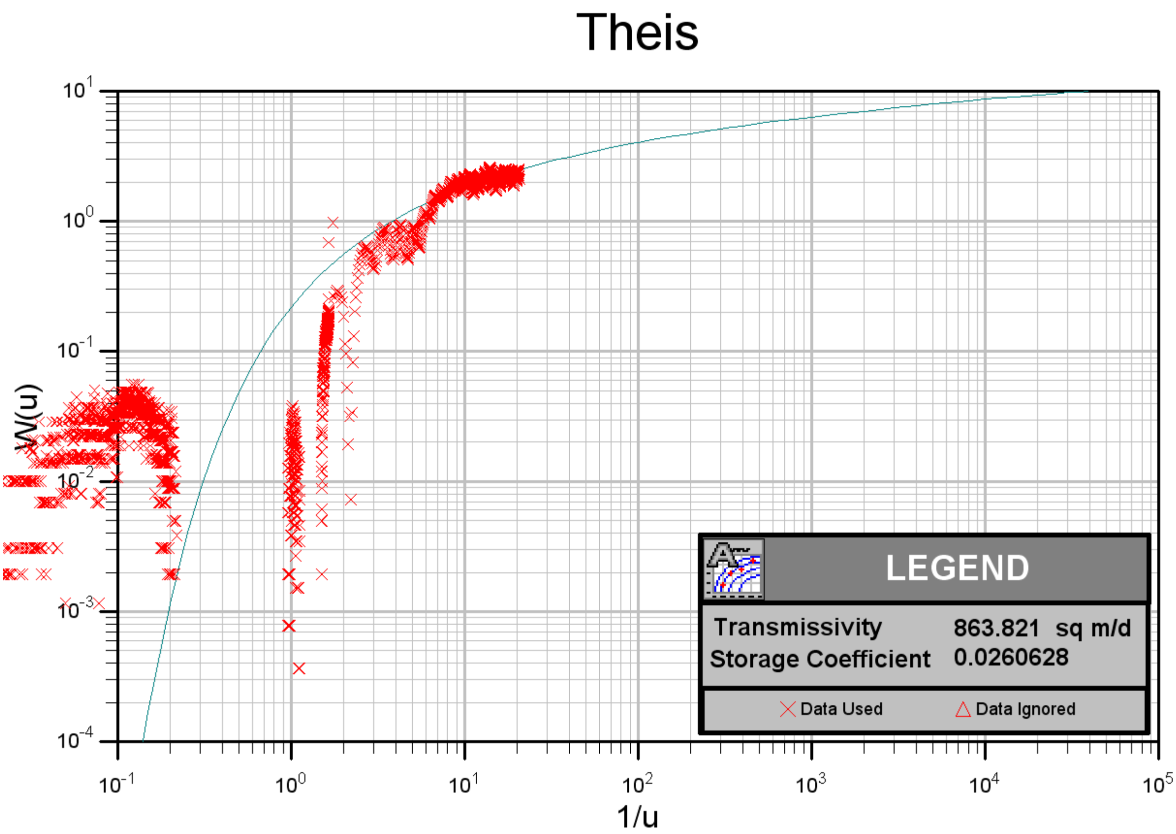
Monitoring Well 6 – Neuman, 1972 (unconfined aquifer)



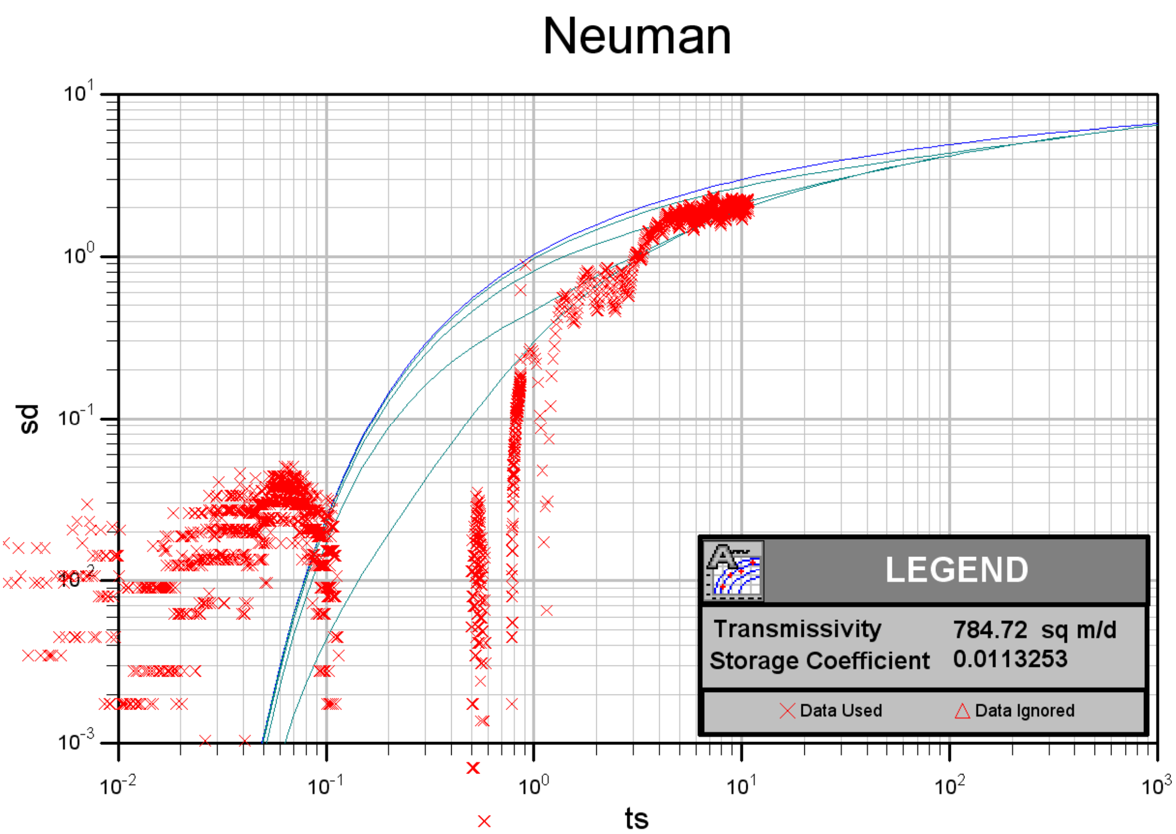
Monitoring Well 9 – Cooper & Jacob, 1946 (Straight Line Method)



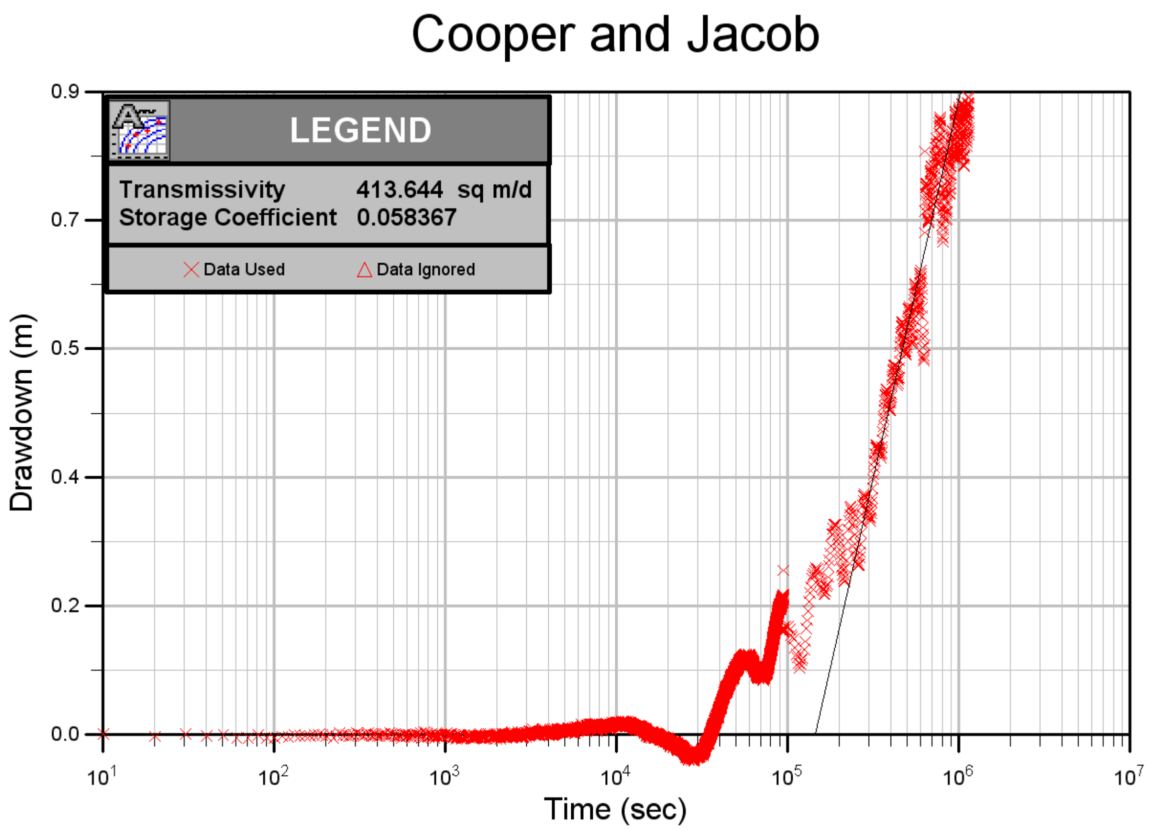
Monitoring Well 9 – Theis, 1935 (unconfined approximation)



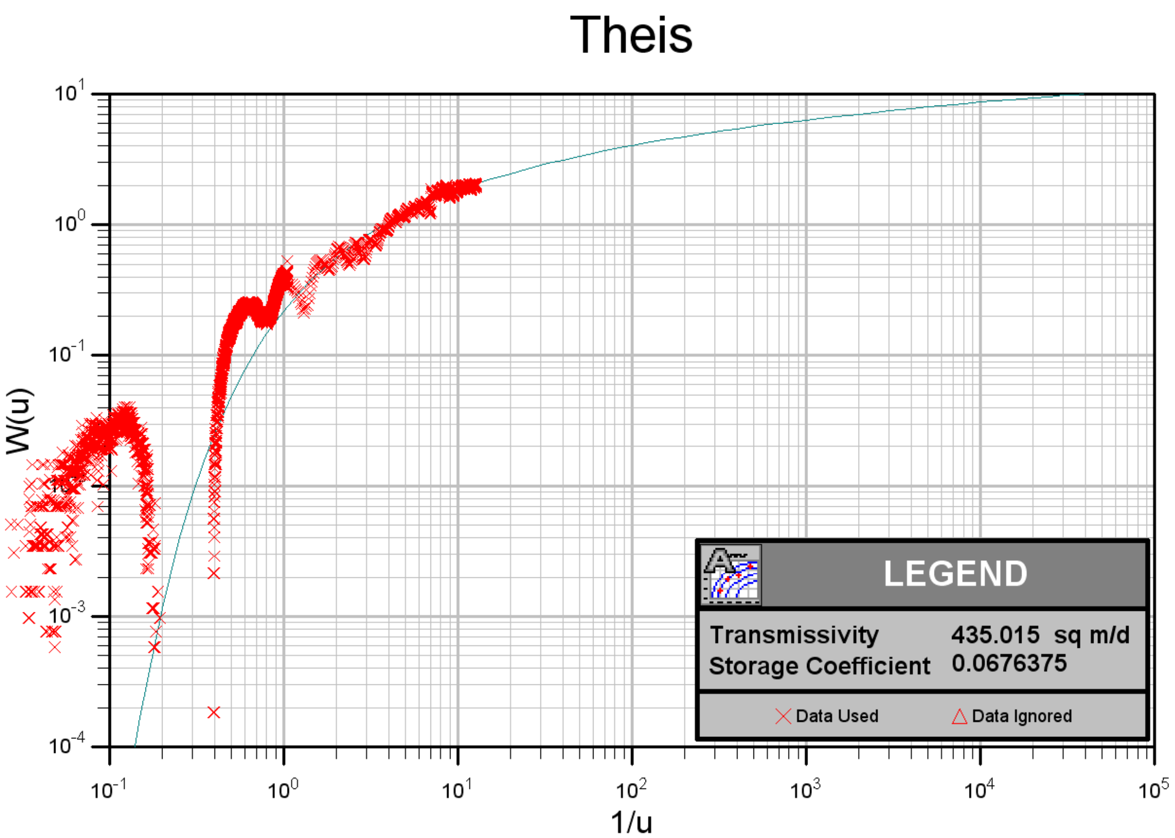
Monitoring Well 9 – Neuman, 1972 (unconfined aquifer)



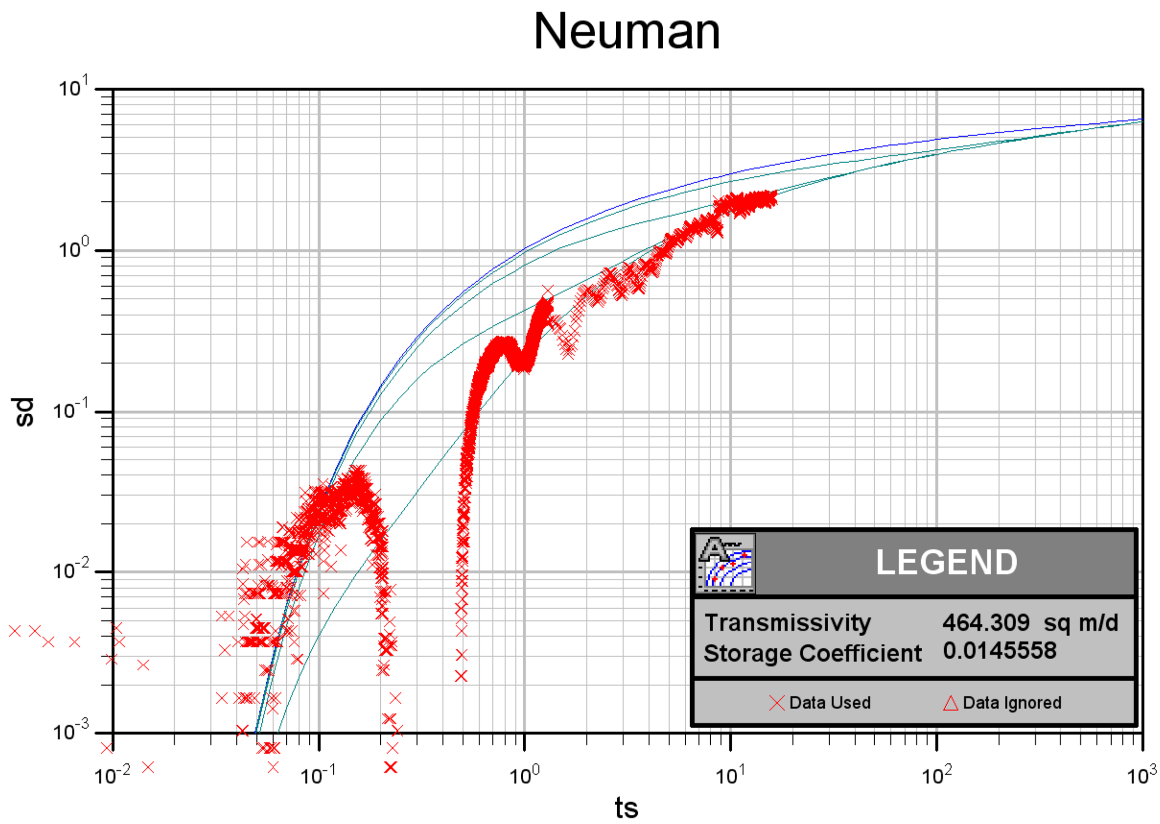
Monitoring Well 13 – Cooper & Jacob, 1946 (Straight Line Method)



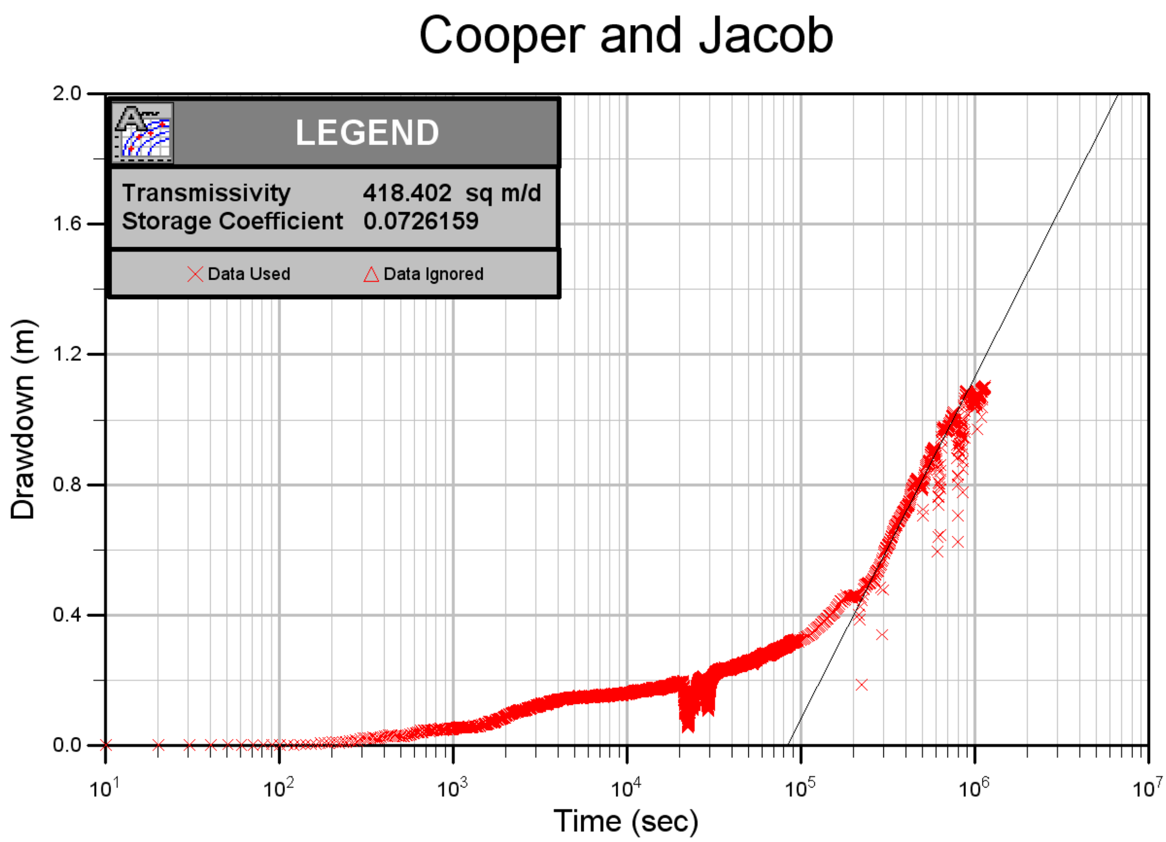
Monitoring Well 13 – Theis, 1935 (unconfined approximation)



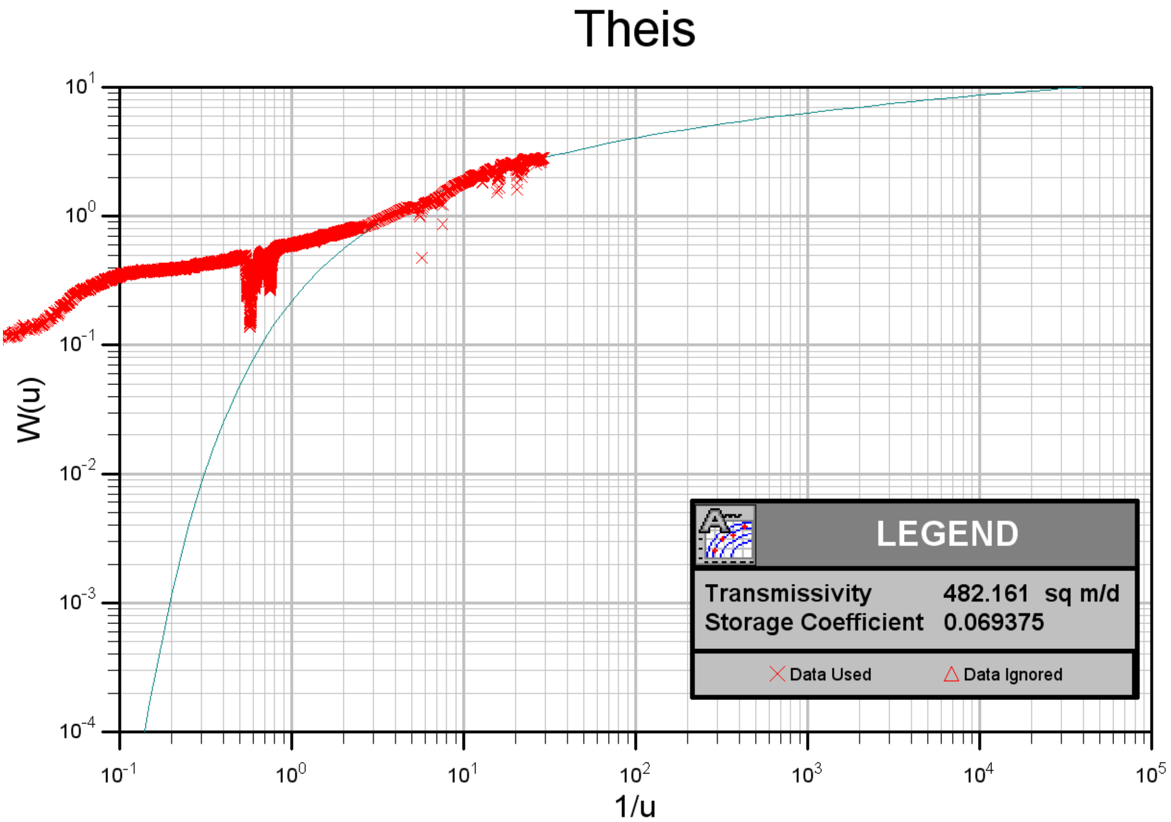
Monitoring Well 13 – Neuman, 1972 (unconfined aquifer)



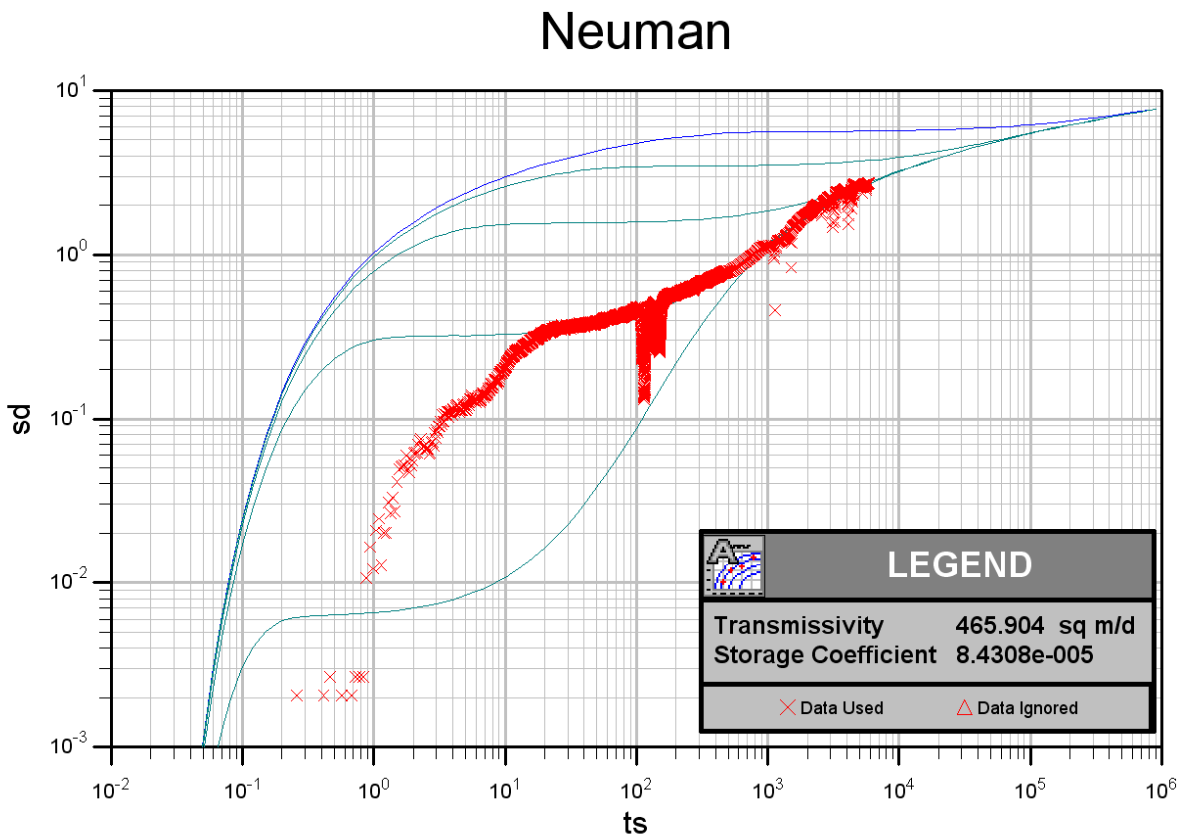
Monitoring Well 14a – Cooper & Jacob, 1946 (Straight Line Method)



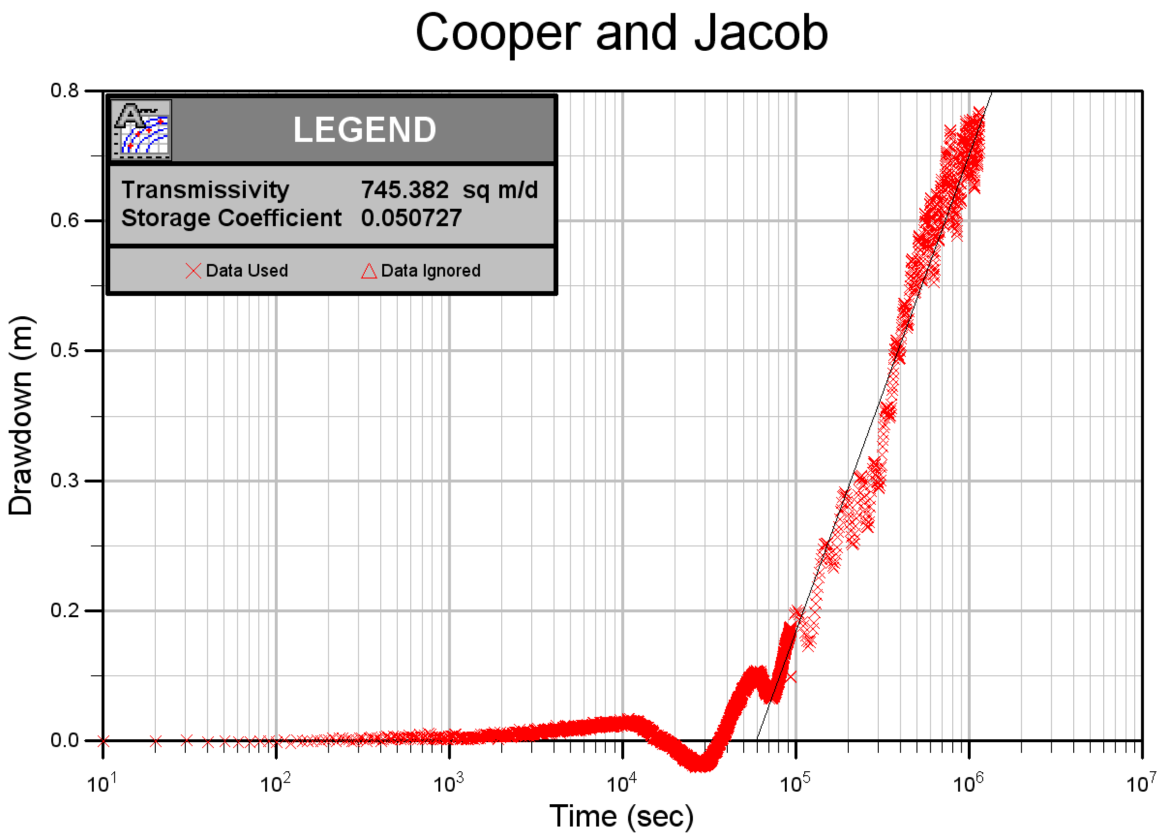
Monitoring Well 14a – Theis, 1935 (unconfined approximation)



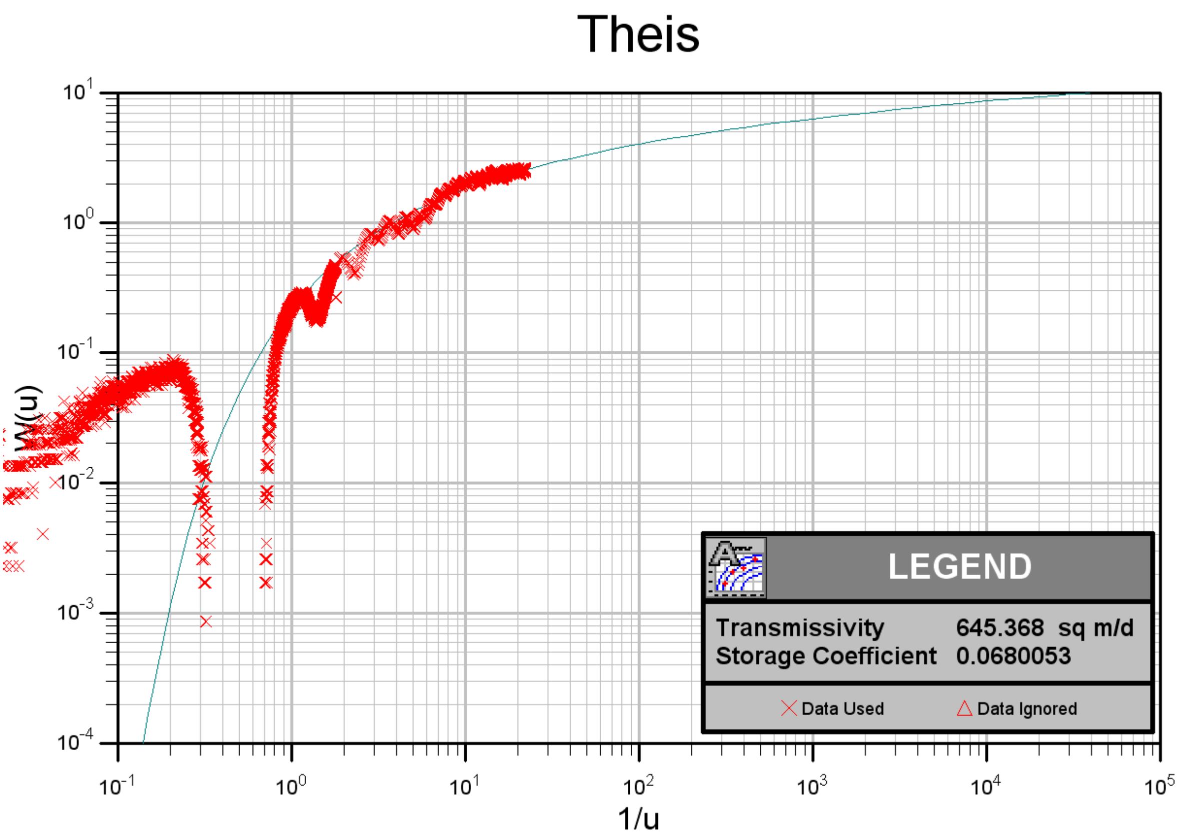
Monitoring Well 14a – Neuman, 1972 (unconfined aquifer)



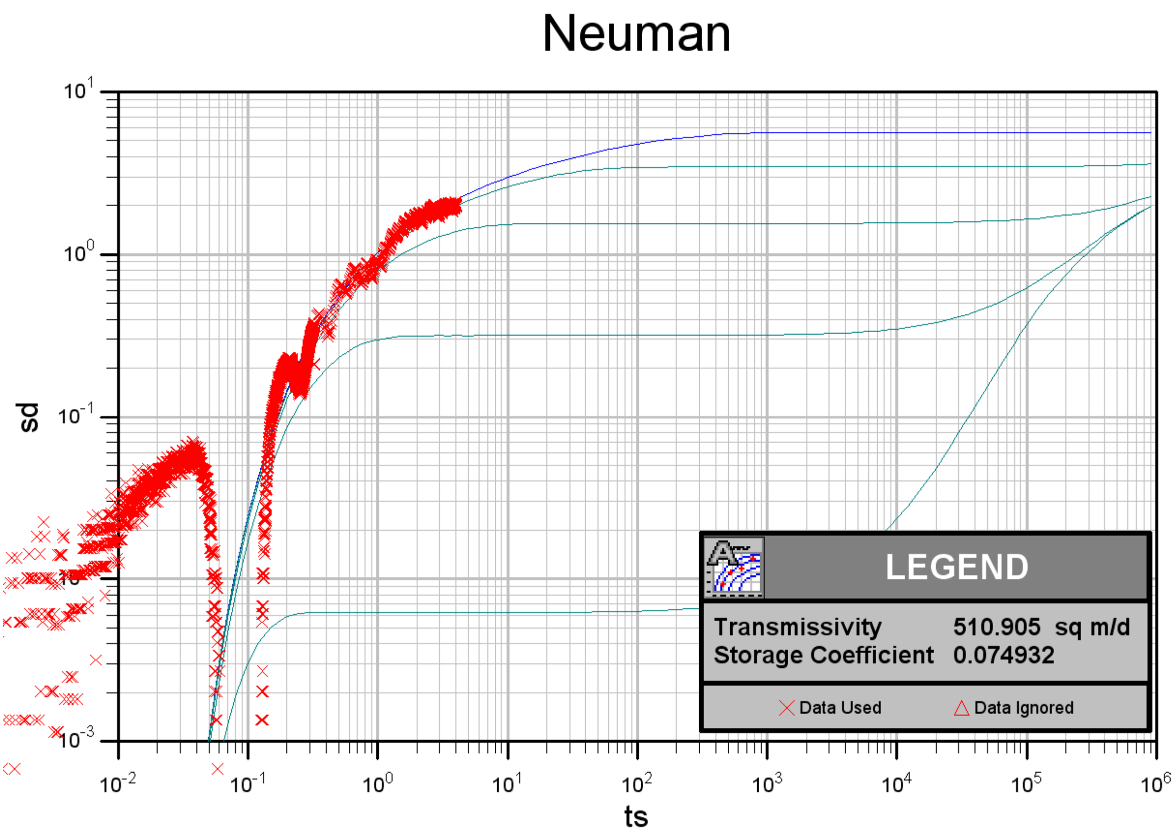
Monitoring Well 23 – Cooper & Jacob, 1946 (Straight Line Method)



Monitoring Well 23 – Theis, 1935 (unconfined approximation)



Monitoring Well 23 – Neuman, 1972 (unconfined aquifer)



App A.3

Cooperage Well WQA data from step test and constant rate test		15/01/2014 - Step Test					07/02/2014 - Constant Rate Test		10/02/2014 - PT, CRT QA/QC	12/02/2014 - Pump Test, Constant Rate Test			WQS (2007 EC drinking water standards)
										Day 8	Day 12	Day 13	
Determinand	**Units**	Sample 1	Sample 2	Sample 3	Sample 4	Duplicate	12:15	16:15		16:40	10:30	12:20	
Dissolved Calcium #	mg/l	135.2	135.3	138.5	135.2	132.7	122.7	131	124.1	123.3	120.6	116.9	
Total Dissolved Iron #	ug/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	200
Dissolved Magnesium #	mg/l	17.7	18	18.3	18	17.5	17.4	17.8	16.8	17	16.8	17.3	
Dissolved Manganese #	ug/l	96	124	157	194	153	260	167	238	295	301	309	50
Dissolved Potassium #	mg/l	8.4	8.2	8.4	8.2	8.4	7.9	8.3	8	8.2	7.9	7.9	
Dissolved Sodium #	mg/l	89.7	92.1	95.2	94.9	91.7	94.7	90.1	89.5	91.1	96	96.2	200
Total Iron	ug/l	28	<20	<20	63	<20	<20	<20	<20	<20	<20	<20	200
Total Manganese	ug/l	98	125	165	198	165	261	185	253	297	307	316	50
Fluoride	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2
Sulphate #	mg/l	132.76	132.3	133.43	131.95	134.07	112.21	119.67	116.28	112.31	109.4	106.12	250
Chloride #	mg/l	96.8	101.3	101	94	98.8	96.6	98.8	94.5	93.9	93.5	93.9	250
Nitrate as NO3 #	mg/l	32.9	31.4	30.3	29.4	30.1	29	33.1	26.1	25.4	24.6	23.6	50
Nitrite as NO2 #	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1
Ortho Phosphate as PO4	mg/l	0.03	0.04	0.05	0.04	<0.03	0.04	0.04	0.04	<0.03	<0.03	<0.03	
Ammoniacal Nitrogen as N #	mg/l	0.11	0.13	0.14	0.16	0.14	0.2	0.17	0.19	0.2	0.22	0.24	
Carbonate Alkalinity as CaCO3	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	mg/l	328	314	326	321	328	334	285	307	306	300	309	
Enterococci*	CFU/100ml	2	<1	<1	<1	1							0
Escherichia Coli*	CFU/100ml	1	1	1	<1	1							0
Turbidity	NTU	0.4	0.2	0.3	0.2	0.2	0.5	0.3	0.8	0.7	0.9	0.9	

APPENDIX B LABORATORY TEST REPORTS

Jones Environmental Laboratory

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

URS
410/411 Q House
76 Furze Road
Sandyford
Dublin 18
Ireland

Attention :	Sinead Fitzpatrick
Date :	24th January, 2014
Your reference :	CWPT
Our reference :	Test Report 14/1884 Batch 1
Location :	SJG
Date samples received :	17th January, 2014
Status :	Final report
Issue :	1

Five samples were received for analysis on 17th January, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Kim Mills
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Jones Environmental Laboratory

Client Name:	URS	**Report :**	**Liquid**
Reference:	CWPT		
Location:	SJG		
Contact:	Sinead Fitzpatrick	**Liquids/products:**	V=40ml vial, G=glass bottle, P=plastic bottle
JE Job No.:	14/1884		H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-3	4-6	7-9	10-12	13-15	LOD	Units	Method No.
Sample ID	CWPT_ST1	CWPT_ST2	CWPT_ST3	CWPT_ST4	CWPT_ST_DUP			
Depth								
COC No / misc								
Containers	H HN P	H HN P	H HN P	H HN P	H HN P			
Sample Date	15/01/2014	15/01/2014	15/01/2014	15/01/2014	15/01/2014			
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water			
Batch Number	1	1	1	1	1			
Date of Receipt	17/01/2014	17/01/2014	17/01/2014	17/01/2014	17/01/2014			
Dissolved Calcium #	135.2	135.3	138.5	135.2	132.7	<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	<20	<20	<20	<20	<20	<20	ug/l	TM30/PM14
Dissolved Magnesium #	17.7	18.0	18.3	18.0	17.5	<0.1	mg/l	TM30/PM14
Dissolved Manganese #	96	124	157	194	153	<2	ug/l	TM30/PM14
Dissolved Potassium #	8.4	8.2	8.4	8.2	8.4	<0.1	mg/l	TM30/PM14
Dissolved Sodium #	89.7	92.1	95.2	94.9	91.7	<0.1	mg/l	TM30/PM14
Total Iron	28	<20	<20	63	<20	<20	ug/l	TM30/PM14
Total Manganese	98	125	165	198	165	<2	ug/l	TM30/PM14
Fluoride	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	mg/l	TM27/PM0
Sulphate #	132.76	132.30	133.43	131.95	134.07	<0.05	mg/l	TM38/PM0
Chloride #	96.8	101.3	101.0	94.0	98.8	<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	32.9	31.4	30.3	29.4	30.1	<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4	0.03	0.04	0.05	0.04	<0.03	<0.03	mg/l	TM38/PM0
Ammoniacal Nitrogen as N #	0.11	0.13	0.14	0.16	0.14	<0.03	mg/l	TM38/PM0
Carbonate Alkalinity as CaCO3	<1	<1	<1	<1	<1	<1	mg/l	TM75/PM0
Bicarbonate Alkalinity as CaCO3	328	314	326	321	328	<1	mg/l	TM75/PM0
Enterococci*	2	<1	<1	<1	1		CFU/100ml	Subcontracted
Escherichia Coli*	1	1	1	<1	1		CFU/100ml	Subcontracted
Turbidity	0.4	0.2	0.3	0.2	0.2	<0.1	NTU	TM34/PM0

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Client Name: URS

Reference: CWPT

Location: SJG

Contact: Sinead Fitzpatrick

Matrix : Liquid

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/1884

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

NOTE

Data is only accredited when all the requirements of our Quality System have been met. In certain circumstances where the requirements have not been met, the laboratory may issue the data in an interim report but will remove the accreditation, in this instance results should be considered indicative only. Where possible samples will be re-extracted and a final report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance.
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
OC	Outside Calibration Range
NFD	No Fibres Detected

JE Job No: 14/1884

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM27	In-House method based on USEPA 9056. Analysis of samples using a Dionex Ion-Chromatograph instrument.	PM0	No preparation is required.				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM75	Alkalinity by Metrohm	PM0	No preparation is required.				
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

URS
410/411 Q House
76 Furze Road
Sandyford
Dublin 18
Ireland

Attention :	Sinead Fitzpatrick
Date :	20th February, 2014
Your reference :	47092620
Our reference :	Test Report 14/2629 Batch 1
Location :	SJG
Date samples received :	7th February, 2014
Status :	Final report
Issue :	2

Seven samples were received for analysis on 7th February, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Paul Lee-Boden BSc
Project Manager

Bob Millward BSc FRSC
Principal Chemist

Jones Environmental Laboratory

Client Name:	URS	**Report :**	**Liquid**
Reference:	47092620		
Location:	SJG		
Contact:	Sinead Fitzpatrick	**Liquids/products:**	V=40ml vial, G=glass bottle, P=plastic bottle
JE Job No.:	14/2629		$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21				LOD	Units	Method No.
Sample ID	CWPT_CRTD1_08:50	CWPT_CRTD1_10:50	CWPT_CRTD1_12:50	CWPT_CRTD1_14:50	CWPT_CRTD1_16:10	CWPT_CRTD1_DUP	CWPT_CRTD2_13:20						
Depth													
COC No / misc													
Containers	H HN P	H HN P	H HN P	H HN P	H HN P	H HN P	H HN P						
Sample Date	05/02/2014	05/02/2014	05/02/2014	05/02/2014	05/02/2014	05/02/2014	06/02/2014						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	07/02/2014	07/02/2014	07/02/2014	07/02/2014	07/02/2014	07/02/2014	07/02/2014						
Dissolved Calcium #	137.4	132.1	134.2	134.6	135.8	132.8	133.0				<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	<20	<20	<20	<20	<20	<20	<20				<20	ug/l	TM30/PM14
Dissolved Magnesium #	17.0	16.7	16.8	16.8	17.0	16.9	17.0				<0.1	mg/l	TM30/PM14
Dissolved Manganese #	56	95	108	124	128	123	158				<2	ug/l	TM30/PM14
Dissolved Potassium #	8.7	8.6	8.6	8.5	8.8	8.9	8.9				<0.1	mg/l	TM30/PM14
Dissolved Sodium #	87.0	89.7	90.5	88.7	90.6	92.3	91.2				<0.1	mg/l	TM30/PM14
Total Iron	42	<20	<20	<20	<20	<20	22				<20	ug/l	TM30/PM14
Total Manganese	62	96	114	124	132	128	162				<2	ug/l	TM30/PM14
Fluoride	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3				<0.3	mg/l	TM27/PM0
Sulphate #	129.68	127.42	129.74	130.28	129.22	129.38	129.81				<0.05	mg/l	TM38/PM0
Chloride #	97.7	96.9	96.0	97.0	97.1	97.7	99.1				<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	17.8	24.7	35.9	14.7	34.8	35.2	20.9				<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02				<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4	0.03	0.06	0.03	0.03	0.05	0.07	0.04				<0.03	mg/l	TM38/PM0
Ammoniacal Nitrogen as N #	0.06	0.11	0.12	0.13	0.12	0.13	0.15				<0.03	mg/l	TM38/PM0
Carbonate Alkalinity as CaCO3	<1	<1	<1	<1	<1	<1	<1				<1	mg/l	TM75/PM0
Bicarbonate Alkalinity as CaCO3	334	309	358	359	330	334	332				<1	mg/l	TM75/PM0
Enterococci*	<1	9	4	2	2	<1	<1				<1	MPN/100ml	Subcontracted
Escherichia Coli*	<1	31	8	9	8	11	12				<1	MPN/100ml	Subcontracted
Turbidity	0.7	0.4	0.6	1.0	0.6	1.5	0.3				<0.1	NTU	TM34/PM0

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/2629

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

NOTE

Data is only accredited when all the requirements of our Quality System have been met. In certain circumstances where the requirements have not been met, the laboratory may issue the data in an interim report but will remove the accreditation, in this instance results should be considered indicative only. Where possible samples will be re-extracted and a final report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance.
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
OC	Outside Calibration Range
NFD	No Fibres Detected

JE Job No: 14/2629

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM27	In-House method based on USEPA 9056. Analysis of samples using a Dionex Ion-Chromatograph instrument.	PM0	No preparation is required.				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM75	Alkalinity by Metrohm	PM0	No preparation is required.				
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
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URS
410/411 Q House
76 Furze Road
Sandyford
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Attention :	Sinead Fitzpatrick
Date :	24th February, 2014
Your reference :	47092660
Our reference :	Test Report 14/2791 Batch 1 Schedule B
Location :	SJG
Date samples received :	12th February, 2014
Status :	Final report
Issue :	1

Three samples were received for analysis on 12th February, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Kim Mills
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Jones Environmental Laboratory

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick
JE Job No.: 14/2791

Report : **Liquid**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

		LOD	Units	Method No.
J E Sample No.	7-9			
Sample ID	CWPT_CRT_QAQC			
Depth				
COC No / misc				
Containers	H HN P			
Sample Date	10/02/2014			
Sample Type	Ground Water			
Batch Number	1			
Date of Receipt	12/02/2014			
Dissolved Calcium #	124.1	<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	<20	<20	ug/l	TM30/PM14
Dissolved Magnesium #	16.8	<0.1	mg/l	TM30/PM14
Dissolved Manganese #	238	<2	ug/l	TM30/PM14
Dissolved Potassium #	8.0	<0.1	mg/l	TM30/PM14
Dissolved Sodium #	89.5	<0.1	mg/l	TM30/PM14
Total Iron	<20	<20	ug/l	TM30/PM14
Total Manganese	253	<2	ug/l	TM30/PM14
Fluoride	<0.3	<0.3	mg/l	TM27/PM0
Sulphate #	116.28	<0.05	mg/l	TM38/PM0
Chloride #	94.5	<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	26.1	<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4	0.04	<0.03	mg/l	TM38/PM0
Ammoniacal Nitrogen as N #	0.19	<0.03	mg/l	TM38/PM0
Carbonate Alkalinity as CaCO3	<1	<1	mg/l	TM75/PM0
Bicarbonate Alkalinity as CaCO3	307	<1	mg/l	TM75/PM0
Enterococci*	<0.1	<0.1	CFU/100ml	Subcontracted
Escherichia Coli*	<0.1	<0.1	CFU/100ml	Subcontracted
Turbidity	0.8	<0.1	NTU	TM34/PM0

Client Name: URS **Matrix : Liquid**
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

JE Job No.: 14/2791

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

NOTE

Data is only accredited when all the requirements of our Quality System have been met. In certain circumstances where the requirements have not been met, the laboratory may issue the data in an interim report but will remove the accreditation, in this instance results should be considered indicative only. Where possible samples will be re-extracted and a final report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance.
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
OC	Outside Calibration Range
NFD	No Fibres Detected

JE Job No: 14/2791

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM27	In-House method based on USEPA 9056. Analysis of samples using a Dionex Ion-Chromatograph instrument.	PM0	No preparation is required.				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM75	Alkalinity by Metrohm	PM0	No preparation is required.				
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

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Zone 3
Deeside Industrial Park
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URS
410/411 Q House
76 Furze Road
Sandyford
Dublin 18
Ireland

Attention :	Sinead Fitzpatrick
Date :	24th February, 2014
Your reference :	47092660
Our reference :	Test Report 14/2996 Batch 1
Location :	SJG
Date samples received :	18th February, 2014
Status :	Final report
Issue :	1

Three samples were received for analysis on 18th February, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Kim Mills
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Jones Environmental Laboratory

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick
JE Job No.: 14/2996

Report : **Liquid**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HNO_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-3	4-6	7-9			
Sample ID	CWPT_CRTD8_16:40	CWPT_CRTD10_10:30	CWPT_CRTD13_12:20			
Depth						
COC No / misc						
Containers	H HN P	H HN P	H HN P			
Sample Date	12/02/2014	12/02/2014	12/02/2014			
Sample Type	Ground Water	Ground Water	Ground Water			
Batch Number	1	1	1			
Date of Receipt	18/02/2014	18/02/2014	18/02/2014	LOD	Units	Method No.
Dissolved Calcium #	123.3	120.6	116.9	<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	<20	<20	<20	<20	ug/l	TM30/PM14
Dissolved Magnesium #	17.0	16.8	17.3	<0.1	mg/l	TM30/PM14
Dissolved Manganese #	295	301	309	<2	ug/l	TM30/PM14
Dissolved Potassium #	8.2	7.9	7.9	<0.1	mg/l	TM30/PM14
Dissolved Sodium #	91.1	96.0	96.2	<0.1	mg/l	TM30/PM14
Total Iron	<20	<20	<20	<20	ug/l	TM30/PM14
Total Manganese	297	307	316	<2	ug/l	TM30/PM14
Fluoride	<0.3	<0.3	<0.3	<0.3	mg/l	TM27/PM0
Sulphate #	112.31	109.40	106.12	<0.05	mg/l	TM38/PM0
Chloride #	93.9	93.5	93.9	<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	25.4	24.6	23.6	<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	<0.02	<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4	<0.03	<0.03	<0.03	<0.03	mg/l	TM38/PM0
Ammoniacal Nitrogen as N #	0.20	0.22	0.24	<0.03	mg/l	TM38/PM0
Carbonate Alkalinity as CaCO3	<1	<1	<1	<1	mg/l	TM75/PM0
Bicarbonate Alkalinity as CaCO3	306	300	309	<1	mg/l	TM75/PM0
Enterococci*	<0.1	<0.1	<0.1	<0.1	CFU/100ml	Subcontracted
Escherichia Coli*	<0.1	<0.1	<0.1	<0.1	CFU/100ml	Subcontracted
Turbidity	0.7	0.9	0.9	<0.1	NTU	TM34/PM0

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Notification of Deviating Samples

Client Name: URS

Reference: 47092660

Location: SJG

Contact: Sinead Fitzpatrick

Matrix : Liquid

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.

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NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/2996

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As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

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NOTE

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ABBREVIATIONS and ACRONYMS USED

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DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance.
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
OC	Outside Calibration Range
NFD	No Fibres Detected

JE Job No: 14/2996

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM27	In-House method based on USEPA 9056. Analysis of samples using a Dionex Ion-Chromatograph instrument.	PM0	No preparation is required.				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM75	Alkalinity by Metrohm	PM0	No preparation is required.				
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						

Jones Environmental Laboratory

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URS
410/411 Q House
76 Furze Road
Sandyford
Dublin 18
Ireland

Attention :	Sinead Fitzpatrick
Date :	5th March, 2014
Your reference :	47092660
Our reference :	Test Report 14/3063 Batch 1
Location :	SJG
Date samples received :	20th February, 2014
Status :	Final report
Issue :	1

Two samples were received for analysis on 20th February, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Kim Mills
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick
JE Job No.: 14/3063

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-9			
Sample ID	CWPT-CRT-FS-A			
Depth				
COC No / misc				
Containers	V H HN N P G			
Sample Date	18/02/2014			
Sample Type	Ground Water			
Batch Number	1			
Date of Receipt	20/02/2014	LOD	Units	Method No.
Dissolved Aluminium #	<20	<20	ug/l	TM30/PM14
Dissolved Antimony #	<2	<2	ug/l	TM30/PM14
Dissolved Arsenic #	<0.9	<0.9	ug/l	TM30/PM14
Dissolved Boron	80	<12	ug/l	TM30/PM14
Dissolved Cadmium #	<0.5	<0.5	ug/l	TM30/PM14
Dissolved Calcium #	108.9	<0.2	mg/l	TM30/PM14
Total Dissolved Chromium #	<1.5	<1.5	ug/l	TM30/PM14
Dissolved Copper #	<7	<7	ug/l	TM30/PM14
Total Dissolved Iron #	<20	<20	ug/l	TM30/PM14
Dissolved Lead #	<5	<5	ug/l	TM30/PM14
Dissolved Magnesium #	17.0	<0.1	mg/l	TM30/PM14
Dissolved Manganese #	297	<2	ug/l	TM30/PM14
Dissolved Mercury #	<1	<1	ug/l	TM30/PM14
Dissolved Nickel #	19	<2	ug/l	TM30/PM14
Dissolved Potassium #	8.0	<0.1	mg/l	TM30/PM14
Dissolved Selenium #	<3	<3	ug/l	TM30/PM14
Dissolved Sodium #	96.4	<0.1	mg/l	TM30/PM14
Dissolved Zinc #	7	<3	ug/l	TM30/PM14
Total Hardness Dissolved (as CaCO3)	344	<1	mg/l	TM30/PM14
PAH MS				
Naphthalene	0.04	<0.01	ug/l	TM4/PM30
Acenaphthylene	<0.01	<0.01	ug/l	TM4/PM30
Acenaphthene	<0.01	<0.01	ug/l	TM4/PM30
Fluorene	<0.01	<0.01	ug/l	TM4/PM30
Phenanthrene	<0.01	<0.01	ug/l	TM4/PM30
Anthracene	0.02	<0.01	ug/l	TM4/PM30
Fluoranthene	<0.01	<0.01	ug/l	TM4/PM30
Pyrene	<0.01	<0.01	ug/l	TM4/PM30
Benzo(a)anthracene	<0.01	<0.01	ug/l	TM4/PM30
Chrysene	<0.01	<0.01	ug/l	TM4/PM30
Benzo(bk)fluoranthene	<0.01	<0.01	ug/l	TM4/PM30
Benzo(a)pyrene	<0.01	<0.01	ug/l	TM4/PM30
Indeno(123cd)pyrene	<0.01	<0.01	ug/l	TM4/PM30
Dibenzo(ah)anthracene	<0.01	<0.01	ug/l	TM4/PM30
Benzo(ghi)perylene	<0.01	<0.01	ug/l	TM4/PM30
PAH 16 Total	<0.1	<0.1	ug/l	TM4/PM30
Benzo(b)fluoranthene	<0.01	<0.01	ug/l	TM4/PM30
Benzo(k)fluoranthene	<0.01	<0.01	ug/l	TM4/PM30
PAH Surrogate % Recovery	94	<0	%	TM4/PM30
Epichlorohydrin	ND	<0.1	ug/l	
VOC TICs	ND		None	TM15/PM10
Methyl Tertiary Butyl Ether #	<0.1	<0.1	ug/l	TM15/PM10
Benzene #	<0.5	<0.5	ug/l	TM15/PM10

Jones Environmental Laboratory

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick
JE Job No.: 14/3063

Report : **Liquid**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=HNO_3

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-9												
Sample ID	CWPT-CRT-FS-A												
Depth													
COC No / misc													
Containers	V H HN N P G												
Sample Date	18/02/2014												
Sample Type	Ground Water												
Batch Number	1												
Date of Receipt	20/02/2014										LOD	Units	Method No.
Toluene #	<0.5										<0.5	ug/l	TM15/PM10
Ethylbenzene #	<0.5										<0.5	ug/l	TM15/PM10
p/m-Xylene #	<1										<1	ug/l	TM15/PM10
o-Xylene #	<0.5										<0.5	ug/l	TM15/PM10
Surrogate Recovery Toluene D8	86										<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	98										<0	%	TM15/PM10
Pesticides MS													
Organochlorine Pesticides													
Aldrin	<0.01										<0.01	ug/l	TM42/PM30
Alpha-BHC	<0.01										<0.01	ug/l	TM42/PM30
Beta-BHC	<0.01										<0.01	ug/l	TM42/PM30
Dieldrin	<0.01										<0.01	ug/l	TM42/PM30
Endosulphan I	<0.01										<0.01	ug/l	TM42/PM30
Endosulphan II	<0.01										<0.01	ug/l	TM42/PM30
Endosulphan sulphate	<0.01										<0.01	ug/l	TM42/PM30
Endrin	<0.01										<0.01	ug/l	TM42/PM30
Gamma-BHC	<0.01										<0.01	ug/l	TM42/PM30
Heptachlor	<0.01										<0.01	ug/l	TM42/PM30
Heptachlor Epoxide	<0.01										<0.01	ug/l	TM42/PM30
p,p'-DDE	<0.01										<0.01	ug/l	TM42/PM30
p,p'-DDT	<0.01										<0.01	ug/l	TM42/PM30
p,p'-TDE	<0.01										<0.01	ug/l	TM42/PM30
Total Methoxychlor	<0.01										<0.01	ug/l	TM42/PM30
Organophosphorus Pesticides													
Azinphos methyl	<0.01										<0.01	ug/l	TM42/PM30
Diazinon	<0.01										<0.01	ug/l	TM42/PM30
Dichlorvos	<0.01										<0.01	ug/l	TM42/PM30
Disulfoton	<0.01										<0.01	ug/l	TM42/PM30
Ethion	<0.01										<0.01	ug/l	TM42/PM30
Ethyl Parathion (Parathion)	<0.01										<0.01	ug/l	TM42/PM30
Fenitrothion	<0.01										<0.01	ug/l	TM42/PM30
Malathion	<0.01										<0.01	ug/l	TM42/PM30
Methyl Parathion	<0.01										<0.01	ug/l	TM42/PM30
Mevinphos	<0.01										<0.01	ug/l	TM42/PM30
Fluoride	<0.3										<0.3	mg/l	TM27/PM0
Bromide	0.55										<0.05	mg/l	TM27/PM0
Sulphate #	100.57										<0.05	mg/l	TM38/PM0
Chloride #	96.8										<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	24.2										<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02										<0.02	mg/l	TM38/PM0

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick
JE Job No.: 14/3063

Report : **Liquid**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-9												
Sample ID	CWPT-CRT-FS-A												
Depth													
COC No / misc													
Containers	V H HN N P G												
Sample Date	18/02/2014												
Sample Type	Ground Water												
Batch Number	1										LOD	Units	Method No.
Date of Receipt	20/02/2014												
Total Cyanide #	<0.01										<0.01	mg/l	TM89/PM0
Total Ammonia as NH4 #	0.31										<0.03	mg/l	TM38/PM0
Acrylamide	<50										<50	ug/l	TM103/PM59
Laurylamine	<50										<50	ug/l	TM103/PM59
Hydroxyethyl ethylene diamine	<50										<50	ug/l	TM103/PM59
Myristyl dimethlyamine	<50										<50	ug/l	TM103/PM59
Octyldimethylamine	<50										<50	ug/l	TM103/PM59
para phenylene diamine	<50										<50	ug/l	TM103/PM59
Tetra ethylene pentamine	<200										<200	ug/l	TM103/PM59
Clostridium perfringens*	<1										<1	CFU/100ml	Subcontracted
Electrical Conductivity @25C #	1161										<2	uS/cm	TM76/PM0
Escherichia Coli*	<1										<1	MPN/100ml	Subcontracted
pH #	7.43										<0.01	pH units	TM73/PM0
Total Organic Carbon #	<2										<2	mg/l	TM60/PM0
Total Coliforms*	<1										<1	MPN/100ml	Subcontracted
Total Enterococci*	<1										<1	MPN/100ml	Subcontracted
True Colour	22										<15	PCU	TM35/PM0
Turbidity	0.4										<0.1	NTU	TM34/PM0
TVC @22°C 3 day*	14											CFU/ml	Subcontracted

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick
JE Job No.: 14/3063

VOC Report : **Liquid**

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-9												
Sample ID	CWPT-CRT-FS-A												
Depth													
COC No / misc													
Containers	V H HN N P G												
Sample Date	18/02/2014												
Sample Type	Ground Water												
Batch Number	1										LOD	Units	Method No.
Date of Receipt	20/02/2014												
VOC MS													
Dichlorodifluoromethane	<2										<2	ug/l	TM15/PM10
Methyl Tertiary Butyl Ether #	<0.1										<0.1	ug/l	TM15/PM10
Chloromethane #	<3										<3	ug/l	TM15/PM10
Vinyl Chloride	<0.1										<0.1	ug/l	TM15/PM10
Bromomethane	<1										<1	ug/l	TM15/PM10
Chloroethane #	<3										<3	ug/l	TM15/PM10
Trichlorofluoromethane #	<3										<3	ug/l	TM15/PM10
1,1-Dichloroethene (1,1 DCE) #	<3										<3	ug/l	TM15/PM10
Dichloromethane (DCM) #	<3										<3	ug/l	TM15/PM10
trans-1-2-Dichloroethene #	<3										<3	ug/l	TM15/PM10
1,1-Dichloroethane #	<3										<3	ug/l	TM15/PM10
cis-1-2-Dichloroethene #	<3										<3	ug/l	TM15/PM10
2,2-Dichloropropane	<1										<1	ug/l	TM15/PM10
Bromochloromethane #	<2										<2	ug/l	TM15/PM10
Chloroform #	<2										<2	ug/l	TM15/PM10
1,1,1-Trichloroethane #	<2										<2	ug/l	TM15/PM10
1,1-Dichloropropene #	<3										<3	ug/l	TM15/PM10
Carbon tetrachloride #	<2										<2	ug/l	TM15/PM10
1,2-Dichloroethane #	<2										<2	ug/l	TM15/PM10
Benzene #	<0.5										<0.5	ug/l	TM15/PM10
Trichloroethene (TCE) #	<3										<3	ug/l	TM15/PM10
1,2-Dichloropropane #	<2										<2	ug/l	TM15/PM10
Dibromomethane #	<3										<3	ug/l	TM15/PM10
Bromodichloromethane #	<2										<2	ug/l	TM15/PM10
cis-1-3-Dichloropropene	<2										<2	ug/l	TM15/PM10
Toluene #	<0.5										<0.5	ug/l	TM15/PM10
trans-1-3-Dichloropropene	<2										<2	ug/l	TM15/PM10
1,1,2-Trichloroethane #	<2										<2	ug/l	TM15/PM10
Tetrachloroethene (PCE) #	<3										<3	ug/l	TM15/PM10
1,3-Dichloropropane #	<2										<2	ug/l	TM15/PM10
Dibromochloromethane #	<2										<2	ug/l	TM15/PM10
1,2-Dibromoethane #	<2										<2	ug/l	TM15/PM10
Chlorobenzene #	<2										<2	ug/l	TM15/PM10
1,1,1,2-Tetrachloroethane #	<2										<2	ug/l	TM15/PM10
Ethylbenzene #	<0.5										<0.5	ug/l	TM15/PM10
p/m-Xylene #	<1										<1	ug/l	TM15/PM10
o-Xylene #	<0.5										<0.5	ug/l	TM15/PM10
Styrene	<2										<2	ug/l	TM15/PM10
Bromoform #	<2										<2	ug/l	TM15/PM10
Isopropylbenzene #	<3										<3	ug/l	TM15/PM10
1,1,2,2-Tetrachloroethane	<4										<4	ug/l	TM15/PM10
Bromobenzene #	<2										<2	ug/l	TM15/PM10
1,2,3-Trichloropropane #	<3										<3	ug/l	TM15/PM10
Propylbenzene #	<3										<3	ug/l	TM15/PM10
2-Chlorotoluene #	<3										<3	ug/l	TM15/PM10
1,3,5-Trimethylbenzene #	<3										<3	ug/l	TM15/PM10
4-Chlorotoluene #	<3										<3	ug/l	TM15/PM10
tert-Butylbenzene #	<3										<3	ug/l	TM15/PM10
1,2,4-Trimethylbenzene #	<3										<3	ug/l	TM15/PM10
sec-Butylbenzene #	<3										<3	ug/l	TM15/PM10
4-Isopropyltoluene #	<3										<3	ug/l	TM15/PM10
1,3-Dichlorobenzene #	<3										<3	ug/l	TM15/PM10
1,4-Dichlorobenzene #	<3										<3	ug/l	TM15/PM10
n-Butylbenzene #	<3										<3	ug/l	TM15/PM10
1,2-Dichlorobenzene #	<3										<3	ug/l	TM15/PM10
1,2-Dibromo-3-chloropropane	<2										<2	ug/l	TM15/PM10
1,2,4-Trichlorobenzene	<3										<3	ug/l	TM15/PM10
Hexachlorobutadiene	<3										<3	ug/l	TM15/PM10
Naphthalene	<2										<2	ug/l	TM15/PM10
1,2,3-Trichlorobenzene	<3										<3	ug/l	TM15/PM10
Surrogate Recovery Toluene D8	86										<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	98										<0	%	TM15/PM10

Client Name: URS
Reference: 47092660
Location: SJG
Contact: Sinead Fitzpatrick

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
No deviating sample report results for job 14/3063						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/3063

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

NOTE

Data is only accredited when all the requirements of our Quality System have been met. In certain circumstances where the requirements have not been met, the laboratory may issue the data in an interim report but will remove the accreditation, in this instance results should be considered indicative only. Where possible samples will be re-extracted and a final report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance.
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
OC	Outside Calibration Range
NFD	No Fibres Detected

JE Job No: 14/3063

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM4	16 PAH by GC-MS, modified USEPA 8270	PM30	In-house method based on USEPA 3510. Liquid samples are mixed with solvent and agitated with an automatic magnetic stirrer with a stir bar for 15 minutes to extract organic molecules. ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM15	In-House method based on USEPA 8260. Determination of Volatile Organic compounds (VOCs) by Headspace GC-MS. Accredited to ISO 17025 for soils and waters and MCERTS for Soils. All accreditation is matrix specific. Quantification by Internal Standard method.	PM10	In-house method based on USEPA 5021. Preparation of solid and liquid samples for headspace analysis. Samples are spiked with surrogates to facilitate quantification. ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM15	In-House method based on USEPA 8260. Determination of Volatile Organic compounds (VOCs) by Headspace GC-MS. Accredited to ISO 17025 for soils and waters and MCERTS for Soils. All accreditation is matrix specific. Quantification by Internal Standard method.	PM10	In-house method based on USEPA 5021. Preparation of solid and liquid samples for headspace analysis. Samples are spiked with surrogates to facilitate quantification. ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM27	In-House method based on USEPA 9056. Analysis of samples using a Dionex Ion-Chromatograph instrument.	PM0	No preparation is required.				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM35	Colour by Spectrophotometer	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM42	In-House method based on USEPA 8270. Determination of Semi-Volatile Organic compounds (SVOCs) including Organochlorine Pesticides and Organophosphorus Pesticides by GC-MS.	PM30	In-house method based on USEPA 3510. Liquid samples are mixed with solvent and agitated with an automatic magnetic stirrer with a stir bar for 15 minutes to extract organic molecules. ISO 17025 accredited extraction method. All accreditation is matrix specific				

JE Job No: 14/3063

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM60	TOC/DOC by NDIR	PM0	No preparation is required.	Yes			
TM73	pH in by Metrohm	PM0	No preparation is required.	Yes			
TM76	Electrical Conductivity by Metrohm	PM0	No preparation is required.	Yes			
TM89	In-house method based on USEPA method OIA-1667. Determination of cyanide by Flow Injection Analyser. ISO17025 accredited method for soils and waters and MCERTS on soils. Accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM103	Amines by LC-MS	PM59	Preparation of sample for Amines by LC-MS				
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						