P-06-147

Oskarshamn site investigation

Flow logging in boreholes HLX21, HLX35 and HLX38

Subarea Laxemar

Stephan Rohs, Golder Associates GmbH

September 2006

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-06-147

Oskarshamn site investigation

Flow logging in boreholes HLX21, HLX35 and HLX38

Subarea Laxemar

Stephan Rohs, Golder Associates GmbH

September 2006

Keywords: Laxemar, Flow logging, Water sampling, Pump tests, Hydraulic parameters, Transmissivity, Hydrogeology, Hydraulic tests.

Abstract

Flow logging was performed in the percussion boreholes HLX21, HLX35 and HLX38 at the Laxemar area, Oskarshamn. In addition water samples were taken in HLX21 and HLX38 and a pump test was performed in HLX38. The tests are part of the general program for site investigations and specifically for the Laxemar subarea. The aim of the flow logging was to identify the positions and size of flow anomalies. The purposes of the additional tasks (pump test and water samples) were to characterise the rock with respect to its hydraulic properties and the water quality. Data are subsequently delivered for the site descriptive model.

This report describes the results and primary data evaluation of the performed flow logging and pump test. The field work was carried out between the 16th and 23rd of May 2006.

The pump phase conducted during the flow logging was recorded and used for a transient analysis to achieve a borehole transmissivity. The derived borehole transmissivities ranges between $1.2 \cdot 10^{-4}$ m²/s and $4.8 \cdot 10^{-4}$ m²/s.

The results of the flow logging show that the main water inflow (approx. 71%) in borehole HLX21 is located between 85 and 86 m below ToC.

Two major inflow zones are identified in borehole HLX35. One inflow is located between 134 m and 132 m below ToC (approx. 55%) and the other one between 124 m and 123.5 m below ToC (approx. 35%).

Borehole HLX38 shows two major inflow zones as well. They are situated from 65.5 m to 64 m below ToC (approx. 44%) and 30.5 m to 29.5 m below ToC (approx. 49%).

Sammanfattning

Flödesloggning har utförts i hammaborrhål HLX21, HLX35 och HLX38 i Laxemar området, Oskarshamn. Vattenprover togs i hammaborrhål HLX21 och HLX38. I hammarborrhål HLX38 utfördes även ett pumptest. Syftet med flödesloggningen var att identifiera lägen och storlek på flödesanomalier längs borrhålet. Syftet med pumptestet och vattenprovtagningen var att karakterisera berget med avseende på dess hydrauliska egenskaper samt vattenkvaliteten i berget. Data överförs från testerna till den platsspecifika modellen.

Föreliggande rapport redovisar resultaten och primärdata från utvärderingen av flödesloggningen och pumptestet. Fältundersökningen utfördes mellan den 16:e och 23:e maj, 2006.

Pumpfasen under flödesloggningen har med transient analys använts för att erhålla transmissiviteten.

Resultaten från flödesloggningen visar att det största flödet (ca 71 % av det totala inflödet) i borrhål HLX21 är lokaliserad mellan 85–86 m under r.ö.k. (foderrrörets övre kant).

Två större inflöden identifierades i borrhål HLX35. Ett inflöde är lokaliserat mellan 132–134 m under r.ö.k (ca 55 % av det totala inflödet) och det andra inflödet är lokaliserat mellan 123,5–124 m under r.ö.k. (ca 35 % av det totala inflödet).

I borrhål HLX38 identifierades två större inflöden lokaliserade mellan 64–65,5 m under r.ö.k. (ca 44 % av det totala inflödet) och det andra inflödet är lokaliserat mellan 29,5–30,5 m under r.ö.k. (ca 49 % av det totala inflödet).

Contents

1 Introduction

SKB conducts site investigations for a future deep repository for spent nuclear fuel in Oskarshamn. A general program for site investigations presenting survey methods has been prepared /SKB 2001/ as well as a site-specific program for the investigations in the Oskarshamn area /SKB 2005/. The flow logging form part of the site characterisation program under item 1.1.5.5 in the work breakdown structure of the execution programme.

Measurements were carried out in percussion boreholes HLX21, HLX35 and HLX38 during 16th of May and 23rd of May 2006 following the methodology described in SKB MD 322.009 (flow logging), SKB MD 321.003 (pump test) and according to the activity plan AP PS 400-06-014 (SKB controlling documents). Data and results were delivered to the SKB site characterisation database SICADA and are traceable by the activity plan number.

Flow logging was the main task of the measurements in the boreholes HLX21, HLX35 and HLX38. The pump phase conducted during the flow logging was recorded and analysed to derive a borehole transmissivity. After flow logging in HLX38 the pump phase was extended and after shutdown of the pump the recovery phase was also recorded to receive additional information about the hydraulic properties of the rock (pump test). In addition water samples were taken in borehole HLX21 and HLX38. The commission was conducted by Golder Associates AB and Golder Associates GmbH.

The work was carried out in accordance with activity plan AP PS 400-06-14. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents. Measurements were conducted utilising SKB's custom made flow logging and pumping equipment HTHB 2.

The investigated percussion boreholes are located in the Laxemar area west of the nuclear power plant of Simpevarp, Figure 1-1. The boreholes are drilled between summer 2004 and spring 2006. The depth of the boreholes ranges from approximately 150 m to 200 m with an inner diameter of mainly 140 mm. The upper part (between 6.10 m and 15.10 m) of the boreholes is cased with large diameter telescopic casing ranging from diameter 140 mm to 167 mm.The boreholes are inclined with –57.0° to –59.9°.

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	**Number**	**Version**
Flödesloggning I HLX21, HLX35 och HLX38	AP PS 400-06-014	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för flödesloggning	SKB MD 322.009	1.0
Mätsystembeskrivning (MSB) för HTHB – Allmän del	SKB MD 326.001	1.0
Hydraulisk Enhålspumptester	SKB MD 321.003	1.0
Analysis of injection and single-hole pumping tests	SKB MD 320.004e	1.0
Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning	SKB MD 600.004	1.0
Allmäna ordning-,skydds- och miljöregler för platsundersökningar Oskarshamn	SKB MD SDPO-003	1.0
Miljökontrollprogram Platsundersökningar	SKB SDP-301	1.0
Hantering av primärdata vid platsundersökningar	SKB SDP-508	1.0

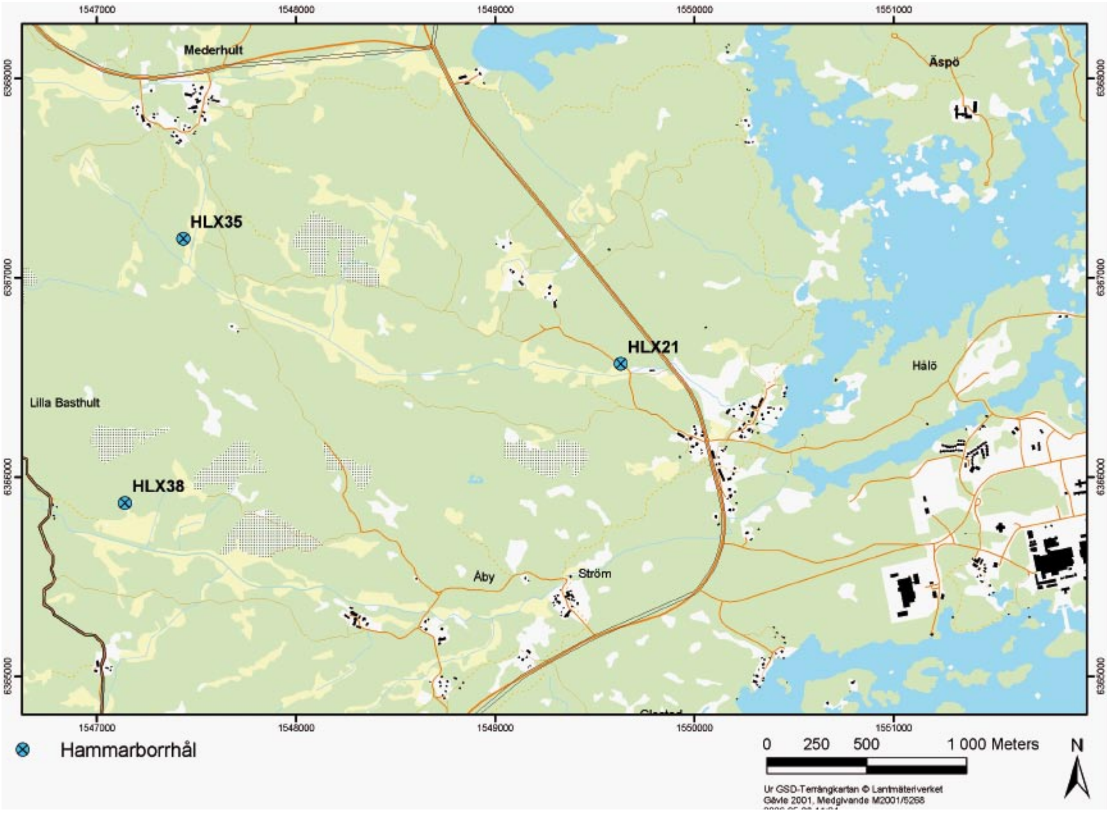


Figure 1-1. *Investigation area Laxemar, Oskarshamn with location of boreholes.*

2 Objective and scope

2.1 Objective

The objective of the flow logging in the percussion boreholes HLX21, HLX35 and HLX38 was to identify the positions and size of flow anomalies. Based on the borehole transmissivities derived from a transient analysis and the measured inflow a cumulative transmissivity profile of each borehole was calculated.

The objective of the pump test in HLX38 was to describe the rock around the borehole with respect to hydraulic parameters, mainly transmissivity (T) and hydraulic conductivity (K). Transient evaluation during the pump and recovery period provides additional information such as flow regimes and hydraulic boundaries

The objective of the water sample in HLX21 and HLX38 was to investigate the water quality of the boreholes.

2.2 Scope

The scope of of work consisted of preparations of the HTHB 2 tool, which include cleaning of the down-hole equipment, synchronisation of the data logger clock, functional checks and checks of the calibration constants. Furthermore the scope of work consists of flow logging, water sampling and pump test (see Table 2-1 for details).

Preparation for testing was done according to the activity plan (AP PS 400-06-014) and relevant SKB method descriptions for flow logging (SKB MD 322.009) and pump tests (SKB MD 321.003). This step mainly consists of function checks of the equipment to be used, the HTHB 2 tool. Function checks were documented in the daily log and/or relevant documents.

The following test programme was performed:

Table 2-1. Performed test programme.

Borehole ID	Date	Activity
HLX21	2006-05-18	Flow logging, water sampling
HLX35	2006-05-20	Flow logging
HLX38	2006-05-22	Flow logging, pump test, water sampling

2.2.1 Boreholes

Technical data of the tested boreholes are shown in Tables 2-2 to 2-4. The reference point in the boreholes is the centre of top of casing (ToC), given as elevation in the tables below. The swedish national coordinate system (RT90) is used in the x-y direction and RHB70 in the z-direction. Northing and easting refer to the top of the boreholes at the ground surface. The borehole diameters in the tables refer to the final diameter of the drill bit after drilling to full depth.

Table 2-2. Information about HLX21 (from SICADA 2006-05-02).

Title	Value				
Borehole length (m):	150.300				
Reference level:	TOC				
Drilling Period(s):	**From Date**	**To Date**	**Secup (m)**	**Seclow (m)**	**Drilling Type**
	2004-08-30	2004-09-02	0.000	150.300	Percussion drilling
Starting point coordinate:	**Length (m)**	**Northing (m)**	**Easting (m)**	**Elevation**	**Coord System**
(centerpoint of ToC)	0.000	6366568.750	1549632.363	10.312	RT90-RHB70
Angles:	**Length (m)**	**Bearing**	**Inclination (– = down)**	**Coord system**	
	0.000	185.541	–56.991	RT90-RHB70	
Borehole diameter:	**Secup (m)**	**Seclow (m)**	**Hole Diam (m)**		
	0.000	9.100	0.190		
	9.100	150.300	0.138		
Casing diameter:	**Secup (m)**	**Seclow (m)**	**Case In (m)**	**Case Out (m)**	
	0.000	8.940	0.160	0.168	
	8.940	9.030	0.147	0.168	

Table 2-3. Information about HLX35 (from SICADA 2006-01-17).

Title	Value				
Borehole length (m):	151.800				
Reference level:	TOC				
Drilling Period(s):	**From Date**	**To Date**	**Secup (m)**	**Seclow (m)**	**Drilling Type**
	2005-05-28	2005-06-02	0.000	151.800	Percussion drilling
Starting point coordinate:	**Length (m)**	**Northing (m)**	**Easting (m)**	**Elevation**	**Coord System**
(centerpoint of ToC)	0.000	6367194.788	1547437.792	14.444	RT90-RHB70
Angles:	**Length (m)**	**Bearing**	**Inclination (– = down)**	**Coord System**	
	0.000	102.216	–59.877	RT90-RHB70	
Borehole diameter:	**Secup (m)**	**Seclow (m)**	**Hole Diam (m)**		
	0.000	6.100	0.190		
	6.100	151.800	0.140		
Casing diameter:	**Secup (m)**	**Seclow (m)**	**Case In (m)**	**Case Out (m)**	
	0.000	5.940	0.160	0.168	
	5.940	6.030	0.147	0.168	

Table 2-4. Information about HLX38 (from SICADA 2006-05-23).

Title	Value				
Borehole length (m):	199.500				
Reference level:	TOC				
Drilling Period(s):	**From Date**	**To Date**	**Secup (m)**	**Seclow (m)**	**Drilling Type**
	2006-04-10	2006-04-10	0.000	199.500	Percussion drilling
Starting point coordinate:	**Length (m)**	**Northing (m)**	**Easting (m)**	**Elevation**	**Coord System**
(centerpoint of ToC)	0.000	6365868.861	1547146.084	11.530	RT90-RHB70
Angles:	**Length (m)**	**Bearing**	**Inclination (– = down)**	**Coord System**	
	0.000	110.043	–59.389	RT90-RHB70	
Borehole diameter:	**Secup (m)**	**Seclow (m)**	**Hole Diam (m)**		
	0.000	15.100	0.190		
	15.100	103.200	0.140		
	103.200	199.500	0.139		
Casing diameter:	**Secup (m)**	**Seclow (m)**	**Case In (m)**	**Case Out (m)**	
	0.000	14.930	0.160	0.168	
	14.930	15.020	0.140	0.168	

2.2.2 Tests

The hydraulic measurements performed in the boreholes were conducted according to the Activity Plan AP PS 400-06-14 (SKB internal document) and according to the instructions of the Activity leader (see Table 2-5 for details). Flow logging tests and the pump test were carried out with SKB's custom made equipment called HTHB (Hydro Testutrustning i Hammar-Borrhål). The different test types were conducted and evaluated according to the corresponding methodology descriptions for impeller flow logging (SKB MD 322.009) and for pump tests (SKB MD 321.003 and SKB 320.004e). In conjunction with the flow logging an electric conductivity and temperature logging of the borehole was performed.

Table 2-5. Tests performed.

Borehole ID	Test section (m)	Test type[1]	Test no	Test start Date, time (yyyy-mm-dd hh:mm:ss)	Test stop Date, time (yyyy-mm-dd hh:mm:ss)
HLX21	19.50–148.00	6,L-EC, L-Te	1	2006-05-18 14:39:09	2006-05-18 21:19:51
HLX35	14.00–148.00	6,L-EC, L-Te	1	2006-05-20 11:55:49	2006-05-20 18:18:36
HLX38	29.00–190.00	6,L-EC, L-Te	1	2006-05-22 14:47:13	2006-05-22 18:21:11
HLX38	15.10–199.50	1B	1	2006-05-22 12:31:00	2006-05-23 09:30:21

[1] 1B: Pump test submersible pump, 6: flow logging-impeller, L-EC: electric conductivity logging, L-Te: temperature logging.

During the pump phases at borehole HLX21 and HLX38 water samples were taken and submitted to the Äspö Laboratory for analysis.

Manual groundwater level measurements were performed in the investigated boreholes and documented in the relevant protocol (Groundwater level for hydraulic tests). In addition the electric conductivity of the discharged water at borehole HLX38 was measured because of the unknown salt content and to avoid an enviromental impact in case of a higher salinity.

2.2.3 Control of equipment

Control of equipment was mainly performed according to the HTHB 2 tool description (Mätssystembeskrivning (MSB) för HTHB), SKB MD 326.001–015, which is composed of a general part and technical documents of the HTHB 2 tool components.

After the establishment of the equipment the calibration constants were entered into the data logger and/or checked against the calibration protocols. The following function checks were performed before and during the tests. Among these pressure sensors were checked at air pressure and in the hole calculated to the static head. Temperature and electric conductivity was checked at ground level and while running in. The impeller used in the flow logging tool was checked by the rotation of the impeller during the lowering into the borehole. The measuring wheel (used to indicate the position of the flow logging tool in the borehole) was checked with one turn and for comparison of the measured values with given standard.

3 Equipment

3.1 Description of equipment

The equipment called HTHB (Swedish abbreviation for Hydraulic Test System for Percussion Boreholes) is a modular tool for testing boreholes up to approx. 200 m depth. It is designed to perform pump tests and injection tests. It is possible to combine a pump test in an open borehole with a flow logging survey along the borehole (see conceptual drawing in Figure 3-1). Hydraulic tests can also be performed in discrete borehole sections sealed by expandable packers (not conducted during this test campaign).

The system components are stored inside a container suitable for transport to remote test sites and use at any weather. Briefly, the components consist of a submersible borehole pump with housing, expandable packers, pressure transducers, a pipe string and hoses. During flow logging, sensors for measuring electric conductivity and temperature as well as an impeller for measuring the downhole flow rate are used. On the surface, the total pump rate (or injection rate) is adjusted manually by a control valve and monitored by an electromagnetic flow meter. Data are sampled by a logger with automatically sequenced intervals or at intervals set by the test operator. An external power supply of 230V is necessary to run the HTHB system.

The HTHB 2 equipment is documented in photographs 1–4.

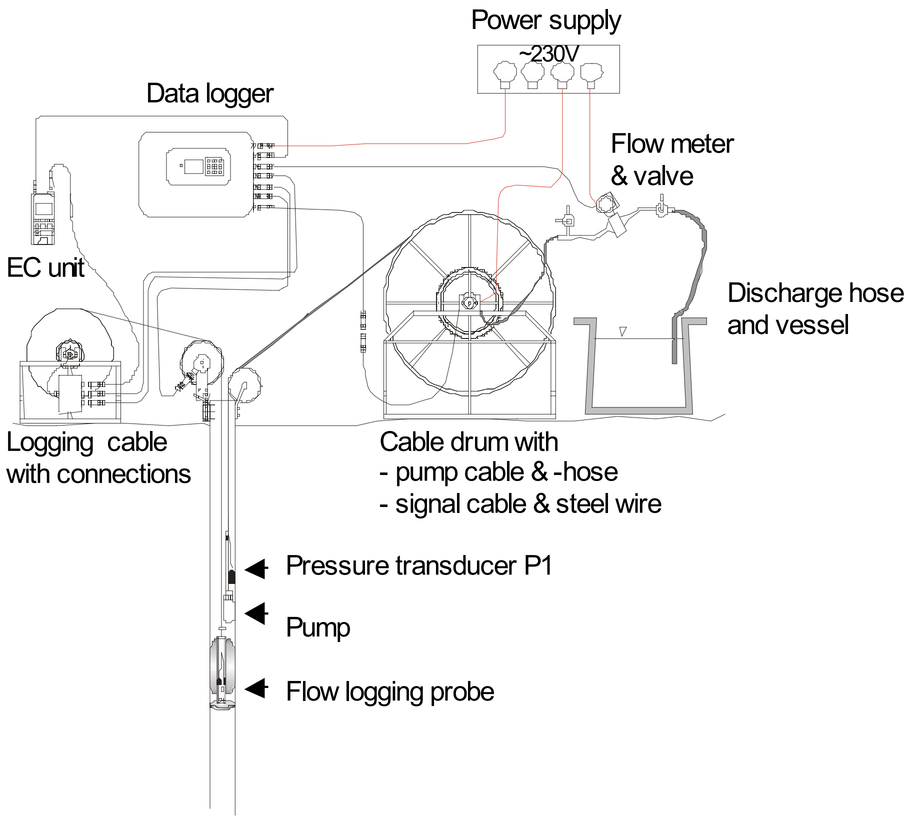


Figure 3-1. *A view of the layout and equipment of HTHB for a pump test and flow logging in an open borehole.*

Photo 1*. Container with spool for hose.*

Photo 2. *Equipment installed in a borehole with guiding spools on TOC.*

Photo 3. *Surface flow meter for measuring total flow rate.*

Photo 4. *Depth measuring wheel on TOC.*

3.2 Sensors

Technical specifications of the sensors used together with estimated data specifications of the HTHB 2 test equipment for pump tests and flow logging are listed in Table 3-1.

Errors in reported borehole data (e.g. borehole diameter) may significantly increase the error in measured and calculated data. Especially the flow logging impeller is very sensitive to variations in the borehole diameter. A rough borehole wall or variations in borehole diameter may lead to a bypassing water flow, indicating a too low water flow at the flow logging.

In general, the flow logging impeller is calibrated for different borehole diameters. The nominal borehole diameter for all tested boreholes is 140 mm, however, the information provided from the SICADA database indicating borehole diameters ranging from 138 mm to 140 mm. After positioning of the flow logger to a measurement depth, sufficient stabilisation time should be provided. The stabilisation time may be up to 30 s at flow rates close to the lower measurement limit whereas at high flow rates this stabilisation time is almost of no importance.

Table 3-1. Technical specifications of sensors.

Parameter	Sensor	Unit	Sensor range	HTHB range	Comments
Pressure	Output signal	mA	4–20		
	Meas. range	kPa	0–1,500	0–1,500	
	Resolution	kPa	0.05		
	Accuracy	kPa	±1.5 *	±10	Depending on uncertainties of sensor position
Temperature	Output signal	mA	4–20		
	Meas. range	°C	0–50	0–50	
	Resolution	°C	0.1		
	Accuracy	°C	±0.6	±0.6	
Electric Conductivity	Output signal	V	0–2		
	Meas. range	mS/m	0–50,000	0–50,000	With conductivity meter
	Resolution	% o.r. **		1	
	Accuracy	% o.r. **		±10	
Flow (Spinner)	Output signal	Pulses/s	c 0.1–c 15		
	Meas. range	L/min		2–100	115 mm borehole diameter
				3–100	140 mm borehole diameter
				4–100	165 mm borehole diameter
	Resolution ***	L/min		0.2	140 mm borehole diameter
	Accuracy ***	% o.r. **		±20	and 100 s sampling time
Flow (surface)	Output signal	mA	4–20		Passive
	Meas. range	L/min	1–150	5–c 80	Pumping tests
	Resolution	L/min	0.1	****	
	Accuracy	% o.r. **	±0.5	0.1	
				±0.5	

* Includes hysteresis, linearity and repeatability.

** Maximum error in % of actual reading (% o.r.).

*** Applicable to boreholes with a borehole diameter of 140 mm and 100s sampling time.

**** For injection tests the minimal flow rate is 1l/min.

Table 3-2 shows the position of sensors for each test. Positions for the following equipments are given: Pump (bottom), pressure (P1) and flow logging equipment. The flow logging impeller and the sensors for temperature and electric conductivity are placed in the flow logging unit and therefore of variable depth during a test. Positions are given in meter from the reference point (TOC). Equipment affecting the wellbore storage coefficient (WBS) is given with diameter of the submerged tool. All pump tests were performed in open boreholes, therefore, all positions are "in section". The volume of the submerged pump (ca 4 dm^3) is of minor importance.

Table 3-2. Sensor positions and wellbore storage (WBS) controlling factors.

Borehole information			Sensors		Equipment affecting WBS coefficient		
ID	Test section (m)	Test no	Type	Position (m fr ToC)	Position	Function	Outer diameter (mm)
HLX21	9.10–150.30	1	Pump (bottom)	15.00	in section	Pump string	37
			P1	13.50		(hose)	8
			Flow logging	variable		signal cable	13.5
			Equipment	(19.0–148.0)		signal cable	
HLX35	6.10–151.80	1	Pump (bottom)	10.00	in section	Pump string	37
			P1	8.50		(hose)	8
			Flow logging	variable		signal cable	13.5
			Equipment	(14.0–148.0)		signal cable	
HLX38	15.10–199.50	1	Pump (bottom)	25.00	in section	Pump string	37
			P1	23.50		(hose)	8
			Flow logging	variable		signal cable	13.5
			Equipment	(29.0–190.0)		signal cable	

3.3 Data acquisition system

The data acquisition system in the HTHB 2 unit contains a data logger (Campbell CR 5000) which transforms the raw data automatically to engineering units and a laptop with the software PC 9000 to download the data for further processing. A second laptop is connected to the HTHB laptop containing evaluation software.

The data acquisition system can be set to sequenced logging intervals or can be manually set to fix logging intervals depending on the change of pressure versus time. According to the Activity plan the logging interval was set to 10 seconds during the flow logging survey. The pump phases were started and stopped by switching the pump on or off manually.

4 Execution

4.1 General

After establishment and function checks of the equipment and running in with the dummy into the borehole the flow logging tool was assembled and lowered to the bottom of the borehole. The next step is to run in with the pump. The depth of the pump depends on the desired drawdown. For the measurements of this campaign the pump was lowered approx. 10 m below the water level. After approx. two hours from the pump start the flow logger is lifted in steps of two meters from the bottom to the top of the borehole. In case of a detected flow anomaly the measurement steps were refined to a length of 0.5 m. The execution of the work was done according to the relevant method descriptions (SKB MD 322.009 "Metodbeskrivning för flödesloggning", SKB MD 326.001, "Mätsystembeskrivning (MSB) för HTHB – Allmän del" and SKB MD 321.003 "Hydraulisk Enhålspumptester") and to the activity plan PS 400-06-014 (SKB internal documents).

The raw data and evaluated data were handed over to SKB. The evaluation was done according to the internal documents SKB MD 322.009 (Metodbeskrivning för flödesloggning) and SKB MD 320.004e (Analysis of injection and single-hole pumping tests).

The preparation and execution of work is explained in detail in the following chapters.

4.2 Preparations

All sensors of the HTHB system are calibrated at GEOSIGMAs engineering workshop in Librobäck, Uppsala and maintenance of the equipment was done by GEOSIGMA before starting this test campaign. Protocols of the performed calibration were submitted with the HTHB system description, a calibration protocol form including the actual calibration constants was submitted with the delivery of raw data after finishing the test campaign.

The following preparation work and functional checks were conducted prior to starting test activities:

- Placing the container beside the borehole.
- Cleaning of all in-hole equipment with alcohol.
- Synchronize clocks on all computers and on the data logger.
- Run in the borehole with a dummy to check if the hole is free.
- Lowering the flow logger to the bottom of the borehole respectively the lower logging depth.
- Check pressure gauges against atmospheric pressure and then on test depth against column of water.
- Check functionality of sensors for temperature and electric conductivity.
- Check functionality of measuring wheel against measured cable length.
- Measure and assemble test tool.
- Lower the pump according to the previous measured groundwater level considering the expected drawdown.

4.3 Execution of field work

Flow logging

As preparation for flow logging, the flow log impeller was lowered to the bottom of the holes respectively to the lowest flow log depth according to the observations during the borehole check with the dummy.

The flow logging was performed during the pump phase and started approximately 2 hours after start of pumping. Starting from the bottom, the flow logger was lifted in steps of 2 m and kept for measurements with a time period of 100 s. When a flow anomaly was detected, the flow logger was then lowered in 0.5 m steps until the previous flow rate was retrieved for a more detailed depth identification of the anomaly. The flow logging then continued in further 2 m intervals along the hole.

The uppermost flow logging was made with a minimum distance of 4 m to the bottom of the pump to avoid errors caused by turbulences from the pump. The duration of the flow logging was between 4 and 7 hours depending on the character of the borehole.

Pump tests

In the boreholes HLX21 and HLX35 the pump was started to get a water flow in the boreholes for the survey of the flow logging. It was not the aim to conduct a complete pump test including a recovery phase in these boreholes, whereas a complete test was carried out in borehole HLX38. The different test procedures are described below.

Boreholes HLX21 and HLX35

A short (approx. 20 min) flow capacity test was carried out prior to each pump test to choose an appropriate flow rate for the test. The extracted water was discharged in the field.

After the choose of an appropriate flow rate the pump was started for the duration of the flow logging which started two hours after pump start (see above). The sampling rate was set to 1 s at the beginning of the pump phase and after a slight stabilization of the pressure curve to 10 s. After stop of the pump no recovery phase was measured. The conducted pump phase was analysed to derive a borehole transmissivity.

Borehole HLX38

The conducted capacity test was continued after 20 min because the adjusted flow rate was appropriate for the following pump phase and flow logging, respectively. After two hours pumping the flow logging survey started (see above).

The extracted water was discharged in the field. The electric conductivity of the discharged water was measured to avoid an environmental impact in case of a high salinity. In the event of an electric conductivity higher than 300 mS/m (limit set by SKB) water tanks would be provided by SKB. After approx. 30 min. pumping the measured electric conductivity ranges from 239 mS/m to 263 mS/m.

The duration of the pump phase was 10 hours and of the following recovery phase 11 hours. The sampling rate was set to 1 s at the beginning of the pump and recovery phase and after a slight stabilization of the pressure curve to 10 s. Both phases were analysed.

Water sampling

Two water samples were taken during this field work and submitted to the SKB Äspö laboratory. One was taken at borehole HLX21 after the water volume in the borehole was changed approx. three times and the other one at borehole HLX38 at the end of the pump phase. The samples are listed in Table 4-1.

Table 4-1. Data of water samples taken during pumping.

Borehole ID	Date	Time	Section (m)	Pumped volume (m³)
HLX21	2006-05-18	14:30	9.10–150.30	7.9
HLX38	2006-05-22	22:15	15.10–199.50	39.2

4.4 Data handling/post processing

The data handling followed several stages and depends on the type of test (flow logging of pump test). The data acquisition software included in the logger (Campbell CR 5000) transformed the data already to engineering units. The download of the measured data was done with a software called PC9000. These files are comma-separated (*.dat files) and contain the time, pressure flow rate, temperature and electric conductivity.

The *.dat files of the flow logging were synthesized with a macro written by GEOSIGMA AB and designed for Microsoft Excel. This macro allows the evaluation and the graphical presentation.

The *.dat files of the pump test were synthesized in Microsoft Excel for plotting purposes of the Cartesian plot. The generated file was also used for the subsequent test analysis with Golder's analysis program FlowDim.

The raw data files and the processed Excel files were handed over to SKB at the end of the field work.

4.5 Analyses and interpretations

4.5.1 Flow logging

The parameters derived from flow logging (flow rate, temperature and electric conductivity of the borehole fluid) are plotted versus borehole length. Flow anomalies were identified along the borehole. The range of the inflow at a flow anomaly is determined by the relevant change in flow rate at the anomaly interval. In most cases, flow anomalies are accompanied by corresponding changes in temperature and/or electric conductivity.

Flow logging was performed in the borehole interval from approx. 2 m to 10 m above the bottom of the borehole to 4 m below the submersible pump. The upper part of the borehole (from 4 m below the submersible pump to the groundwater level) could not be flow-logged, although high inflow zones may be observed. Such superficial inflows were identified by comparing the cumulative flow at the top of the flow-logged interval (ΣQi) with the discharged flow rate (Qp) from the hole according to the surface flow meter. One or more inflow zones are most likely to exist above the flow-logged interval if the latter flow rate is significantly higher than the cumulative flow rate.

The transmissivity (T) of the entire borehole is calculated from the analysis of the pump test during flow logging. The cumulative transmissivity at the top of the flow-logged interval (ΣTi) is then calculated according to the SKB document "Methodology for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning) with the assumption of a zero natural flow in the borehole.

$$\Sigma Ti = T \cdot \Sigma Qi / Qp \qquad (4\text{-}1)$$

Flow anomalies above the flow-logged interval will lead to ΣQi < Qp. In this case, the order of magnitude of the sum of these anomalies is estimated from equation (4-1).

The transmissivity of an individual flow anomaly in the flow logged interval (Ti) is calculated from the measured inflow rate (Qi) of the anomaly and the calculated transmissivity of the entire borehole (T) according to the SKB document "Methodology for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning):

$$Ti = T \cdot Qi / Qp \quad (4\text{-}2)$$

The lower limit of transmissivity (Tl-measl) in the flow logging interval is estimated similar to equation (4-1):

$$TFmeasl\text{-}L = T \cdot QFmeasl\text{-}L / Qp \quad (4\text{-}3)$$

In a borehole with a diameter of 140mm, the lower measuring limit for the flow rate is: QFmeasl-L = 3 l/min (see Table 3.1) whereas Qp is the actual flow rate during flow logging measured with the surface flow meter.

The flow logging analysis diagrams and test data are summarized in Appendix 4 and 5.

4.5.2 Pump tests

Analysis software

The pump tests were analysed using a type curve matching method. The analysis was performed using Golder's test analysis program FlowDim. FlowDim is an interactive analysis environment allowing the user to interpret constant pressure, constant rate and slug/pulse tests in source as well as observation boreholes. The program allows the calculation of type-curves for homogeneous, dual porosity and composite flow models in variable flow geometries from linear to spherical.

Analysis approach

Constant rate and pressure recovery tests are analysed using the method described by /Gringarten 1986/ and /Bourdet et al. 1989/ by using type curve derivatives calculated for different flow models.

Analysis methodology

Each of the relevant test phases is subsequently analyzed using the following steps:

- Identification of the flow model by evaluation of the derivative on the log-log diagnostic plot. Initial estimates of the model parameters are obtained by conventional straight-line analysis.
- Superposition type curve matching in log-log coordinates. A non-linear regression algorithm is used to provide optimized model parameters in the latter stages.
- Non-linear regression in semi-log coordinates (superposition Horner plot; /Horner 1951/). In this stage of the analysis, the static formation pressure is selected for regression.

The test analysis methodology is best explained in /Horne 1990/.

Steady state analysis

In addition to the type curve analysis, an interpretation based on the assumption of stationary conditions was performed as described by /Moye 1967/.

Flow models used for analysis

The flow models used in analysis were derived from the shape of the pressure derivative calculated with respect to log time and plotted in log-log coordinates.

In several cases the pressure derivative suggests a change of transmissivity with the distance from the borehole. In such cases a composite flow model was used in the analysis.

If there were different flow models matching the data in a comparable quality the most simple model was preferred.

The flow dimension displayed by the test can be diagnosed from the slope of the pressure derivative. A slope of 0.5 indicates linear flow, a slope of 0 (horizontal derivative) indicates radial flow and a slope of –0.5 indicates spherical flow. The flow dimension diagnosis was commented for each of the tests. However, in all cases it was possible to achieve to acceptable analysis results (good match quality) by using radial flow geometry (flow dimension of 2).

Calculation of the static formation pressure and equivalent freshwater head

The static formation pressure (p*) measured at transducer depth, was derived from the pressure recovery (CRwr) following the constant pressure injection phase by using:

(1) straight line extrapolation in cases infinite acting radial flow (IARF) occurred,

(2) type curve extrapolation in cases infinite acting radial flow (IARF) is unclear or was not reached.

The equivalent freshwater head (expressed in meters above sea level) was calculated from the extrapolated static formation pressure (p*), corrected for athmospheric pressure measured by the surface gauge and corrected for the vertical depth considering the inclination of the borehole, by assuming a water density of 1,000 kg/m^3 (freshwater). The equivalent freshwater head is the static water level an individual test interval would show if isolated and connected to the surface by tubing full of freshwater. Figure 4-1 shows the methodology schematically.

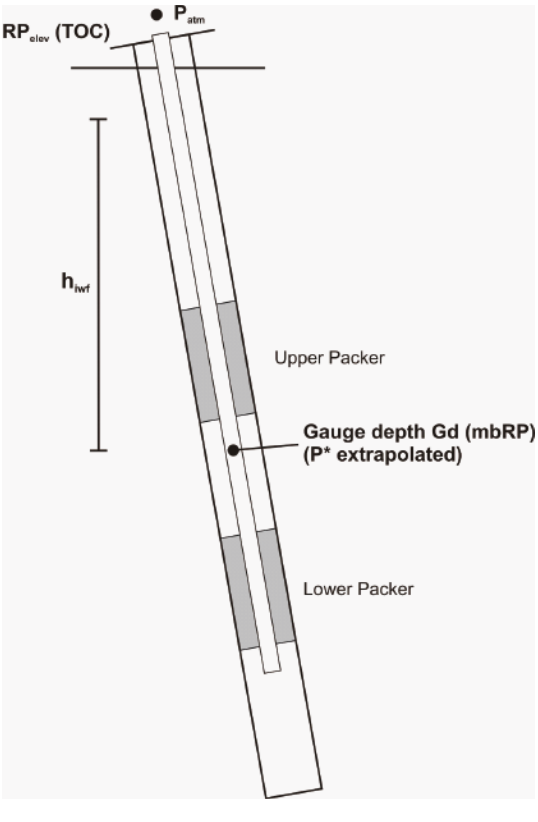


Figure 4-1. *Schematic methodologies for calculation of the freshwater head.*

The freshwater head in meters above sea level is calculated as following:

$$head = \frac{(p^* - p_{atm})}{\rho \cdot g}$$

which is the p* value expressed in a water column of freshwater.

With consideration of the elevation of the reference point (RP) and the gauge depth (Gd), the freshwater head hiwf is:

$$h_{iwf} = RP_{elev} - Gd + \frac{(p^* - p_{atm})}{\rho \cdot g}$$

Derivation of the recommended transmissivity and the confidence range

The pump phases (CRw) in all three boreholes were analysed and also the recovery phase (CRwr) in HLX38. The parameter sets (i.e. transmissivities) derived from the analyses of a specific test usually differ (inner and outer zone transmissivity, differences in CRw and CRwr phases). In the case when the differences are small the recommended transmissivity value is chosen from the test phase that shows the best data and derivative quality. In cases when a composite flow model was deemed to be most representative for the hydraulic behaviour of the specific test section, than the inner zone transmissivity was selected as recommended value.

The confidence range of the transmissivity was derived using expert judgement. Factors considered were the range of transmissivities derived from the individual analyses of the test as well as additional sources of uncertainty such as noise in the flow rate measurement, numeric effects in the calculation of the derivative or possible errors in the measurement of the wellbore storage coefficient. No statistical calculations were performed to derive the confidence range of transmissivity.

4.6 Nonconformities

No nonconformities have been observed or reported.

5 Results

In the following the results of all tests are presented and analysed. Chapter 5.2 presents the pump tests and chapter 5.3 the flow logging survey. The results are stored in the primary data base (SICADA). The SICADA data base contains data that will be used for further interpretation (modelling). The data are traceable in SICADA by the Activity plan number (AP PS 400-06-014; SKB controlling documents).

5.1 Nomenclature and symbols

The nomenclature and symbols used during evaluation and for presentation of the results of the pump tests and flow logging are according to the SKB documents "Instruction for analysis of single-hole injection and pump tests" (SKB MD 320.004e) and "Metodbeskrivning för flödesloggning" (SKB MD 322.009), respectively. If additional symbols are used, they are explained in the report text.

5.2 Pump tests

In the following the results of the single borehole pump tests are represented. Note that the pump tests in borehole HLX21 and HLX35 consists of a pump phase, only. The goal of the analysis of the pump phase (CRw) is to derive a borehole transmissivity for the evaluation of the flow logging measurements. In borehole HLX38 a complete pump test (CRw and CRwr) was conducted and both phases were analysed. The recommended transmissivity is also used as borehole transmissivity for the evaluation of the flow logger.

The results of the pump tests are given as general comments to test performance, the identified flow regimes and calculated parameters and finally the parameters wich are considered as most representative are chosen and justification is given. The results are summarized in Tables 6-1 and 6-2 of the synthesis chapter and in the test summary sheets (Appendix 3).

5.2.1 Borehole HLX21 (section 9.10–150.30 m)

Comments to test

The test was composed of a constant rate pump phase (CRw) with a mean flow rate of 65.3 l/min and a duration of 8.9 hours. The flow rate control during the CRw phase was good. The pumped flow rate decreased from 65.8 l/min at the start of the CRw phase to 64.8 l/min at the end with a maximum drawdown of 30 kPa. No recovery phase (CRwr) was conducted. The CRw phase shows no problems and is adequate for quantitative analysis.

Flow regimes and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test, the derivative of the CRw phase shows a flat derivative at early times followed by an upward trend at middle times which is typical for a decrease of transmissivity in some distance from the borehole. The late time data shows a slight horizontal stabilisation indicating radial flow. For the analysis of the CRw phase a two shell composite flow model with wellbore storage and skin was used. The analysis is presented in Appendix 2-1.

Selected representative parameters

The inner zone transmissivity of $4.32 \cdot 10^{-4}$ m^2/s is deemed to be the recommended transmissivity. The confidence range for the transmissivity is estimated to be $2.0 \cdot 10^{-4}$ to $6.0 \cdot 10^{-4}$ m^2/s. The flow dimension displayed during the test is 2.

The recommended transmissivity is used as borehole transmissivity for the evaluation of the flow logging survey.

5.2.2 Borehole HLX35 (section 6.10–151.80 m)

Comments to test

The test was composed of a constant rate pump phase (CRw) with a mean flow rate of 60.0 l/min and a duration of 8.3 hours. Due to a power short circuit and the following stop of the pump, only the first part of the CRw phase was analysed. However, the flow rate control during the first part of the CRw phase was good. The pumped flow rate decreased from 60.7 l/min at the start of the CRw phase to 59.8 l/min at the end with a maximum drawdown of 36 kPa. No recovery phase (CRwr) was conducted. The CRw phase shows no problems and is adequate for quantitative analysis.

Flow regimes and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test, the CRw phase shows a relatively flat derivative at middle times followed by an upward trend at late times which is indicative for a decrease of transmissivity or a change in flow dimension. A two shell composite flow model was chosen for the analysis. The analysis is presented in Appendix 2-2.

Selected representative parameters

The inner zone transmissivity of $4.82 \cdot 10^{-4}$ m^2/s is deemed to be the recommended transmissivity. The confidence range for the transmissivity is estimated to be $2.0 \cdot 10^{-4}$ to $7.0 \cdot 10^{-4}$ m^2/s. The flow dimension displayed during the test is 2.

The recommended transmissivity is used as borehole transmissivity for the evaluation of the flow logging survey.

5.2.3 Borehole HLX38 (section 15.10–199.50 m)

Comments to test

The test was composed of a constant rate pump phase (CRw) with a mean flow rate of 66.5 l/min and a duration of 9.7 hours followed by a pressure recovery phase (CRwr) with a duration of 11.0 hours. The flow rate control of the CRw phase was good. The pumped flow rate decreased from 67.2 l/min at the start of the CRw phase to 66.1 l/min at the end with a maximum drawdown of 73 kPa. During the CRw phase a power short circuit occured and the pump stops for approx 5 min. The CRwr phase shows no problems. Both phases are adequate for quantitative analysis.

Flow regimes and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw phase shows a flat derivative at middle and late times indicating a flow dimension of two (radial flow) The CRw phase was matched using a radial homogeneous flow model. The CRwr phase shows a horizontal stabilisation at middle times followed by an upward trend at late times. This behaviour indicates whether a transition to a zone of lower transmissivity or a change of flow dimension. A two shell composite flow model was chosen for the analysis of the CRwr phase. The analysis is presented in Appendix 2-2.

Selected representive parameters

The recommended transmissivity of $1.16 \cdot 10^{-4}$ m²/s was derived from the analysis of the CRw phase, which shows the better data and derivative quality. The confidence range for the transmissivity is estimated to be $9.0 \cdot 10^{-5}$ to $3.0 \cdot 10^{-4}$ m²/s. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRwr phase using straight line extrapolation in the Horner plot to a value of 254.5 kPa.

The analyses of the CRw and CRwr phases show some inconsistency regarding the chosen flow models. However, regarding the derived transmissivities both transmissivities show very good consistency. No further analysis is recommended.

The recommended transmissivity is used as borehole transmissivity for the evaluation of the flow logging survey.

5.3 Flow logging

The nomenclature used for the flow logging test evaluation is according to the SKB document "Method description for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning). The measured inflow (Q_i) at the detected flow anomalies together with the percentages of the total flow rate at the surface are presented in subsequent tables at logging results. The cumulative transmissivity (ΣT_i) at the top of the flow-logged borehole section was calculated according to equation (4-1) and the individual transmissivity of single flow anomalies (T_i) according to equation (4-2). This method is described in detail in chapter 4.5.1.The specific flow (Q_i/s_{FL}) of single anomalies was also used for an interpretation of the transmissivity of these anomalies. The above mentioned parameters are summarized in Table 6-3 of the synthesis chapter.

Flow logging diagrams including the measured flow rates along the borehole during flow logging in combination with the electric conductivity (EC) and the temperature (Te) of the borehole fluid is shown in Chapter 6 and in Appendix 4. All flow logging was performed during the pump tests in the open boreholes.

5.3.1 Borehole HLX21

Comments to test

The flow logging in HLX21 was performed between 148.0 m and 19.5 m below ToC. There was no flow logging from 148.0 m to the bottom of the hole at 150.3 m to avoid lowering the flow logger in drill mud at the bottom of the hole. Below the first anomaly detected between 134.0 m and 133.5 m the inflow was below measurement limit (3 l/min).

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump phase during flow logging to $T = 4.32 \cdot 10^{-4}$ m²/s.

The total flow of the logged interval ($\sum Q_i$) is slightly above the measured flow rate of the total flow at the surface (Q_p). The difference between the flow rates is 0.75 l/min. This indicates that there is probably no additional inflow to the borehole above the top of the logged section. The main inflow to the borehole was detected between 86.0 m and 85.5 m below ToC. This inflow covers about 70.5% of the total flow and is related to decrease in electric conductivity and temperature. Five minor inflows are detected as well, they are covering all together about 31%.

In the upper part of the borehole a decrease of the flow was measured. This could indicate weather out flow zones or a cavernous borehole that can causes turbulences or a flow bypassing the flow logging tool.

Table 5-1. Analyses results; flow logging HLX21.

HLX35 Q_p = 1.00·10⁻³ m²/s		T = 4.82·10⁻⁴ m²/s		$T_{Fmeasl-L}$ = 2.41·10-5 m²/s	s_{FL} = 3.67 m	
Anomaly depth (m from TOC)	**Anomaly length (m)**	**Q_i (m³/s)**	**Q_i/Q_p (%)**	**Ti (m²/s)**	**Q_i/s_{FL} (m²/s)**	**Remarks**
134.0–133.5	0.5	$7.50·10^{-5}$	6.9	$2.98·10^{-5}$	$2.51·10^{-5}$	
121.0–120.5	0.5	$6.33·10^{-5}$	5.8	$2.52·10^{-5}$	$2.12·10^{-5}$	
87.0–86.5	0.5	$6.17·10^{-5}$	5.7	$2.45·10^{-5}$	$2.06·10^{-5}$	
86.0–85.0	1.0	$7.67·10^{-4}$	70.5	$3.05·10^{-4}$	$2.57·10^{-4}$	main inflow
66.0–64.0	2	$1.33·10^{-4}$	12.3	$5.30·10^{-5}$	$4.46·10^{-5}$	
Total (cumulative)		**$1.10·10^{-3}$**	**101.1**	**$4.37·10^{-4}$**	**$3.68·10^{-4}$**	
Difference		Q_p-ΣQ_i = $-1.25·10^{-5}$	1.1	T– ΣT_i = $-4.97·10^{-6}$		Inconsistency in flow rates Q_p and ΣQ_i

Q_i = measured inflow rate of a single anomaly, ΣQ_i = cumulative flow at the top of the logged section.

Q_p = pumped flow rate at surface flow meter.

T = Transmissivity of the entire borehole, T_i = Transmissivity of a single anomaly.

ΣT_i = cumulative transmissivity at the top of the logged section.

s_{FL} = drawdown during pump test.

The diagrams of the flow logging measurements in HLX21 are presented in Figure 6-1 and Appendix 4-1.

5.3.2 Borehole HLX35

Comments to test

The flow logging in HLX35 was performed between 148.0 m and 14.0 m below ToC. There was no flow logging from 148.0 m to the bottom of the hole at 151.8 m to avoid lowering the flow logger in drill mud at the bottom of the hole. Below the first anomaly detected between 134.0 m and 132.0 m the inflow was below measurement limit (3 l/min).

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump phase during flow logging to T = $4.82·10^{-4}$ m²/s.

The total flow of the logged interval ($\sum Q_i$) is above the measured flow rate of the total flow at the surface (Q_p). The difference between the flow rates is 1.2 l/min. This indicates that there is probably no additional inflow to the borehole above the top of the logged section. Two major inflow zones are detected. The first between 134.0 and 132.0 m below ToC and the second between 124.0 m and 123.5 m below ToC. They are covering 54.8% and 34.7%, respectively, of the total flow. A smaller anomaly is detected between 124.5 m and 124.0 m below ToC covering 12.5% of the total flow. All inflows are related to a decrease of electric conductivity.

The diagrams of the flow logging measurements in HLX35 are presented in Figure 6-2 and Appendix 4-2.

5.3.3 Borehole HLX38

Comments to test

The flow logging in HLX35 was performed between 190.0 m and 29.0 m below ToC. There was no flow logging from 190.0 m to the bottom of the hole at 199.5 m because of problems during the passage of the dummy at this depth. Below the first anomaly detected between 94.5 m and 94.0 m the inflow was below measurement limit (3 l/min).

Table 5-2. Analyses results; flow logging HLX35.

HLX35 $Q_p = 1.00 \cdot 10^{-3}$ m²/s		T = $4.82 \cdot 10^{-4}$ m²/s		$T_{Fmeasl-L}$ = 2.41·10-5 m²/s	s_{FL} = 3.67 m	
Anomaly depth (m from TOC)	**Anomaly length (m)**	**Q_i (m³/s)**	**Q_i/Q_p (%)**	**T_i (m²/s)**	**Q_i/s_{FL} (m²/s)**	**Remarks**
134.0-132.0	2.0	$5.48 \cdot 10^{-4}$	54.8	$2.64 \cdot ^{10-4}$	$1.49 \cdot 10^{-4}$	
124.5-124.0	0.5	$1.25 \cdot 10^{-4}$	12.5	$6.03 \cdot ^{10-5}$	$3.41 \cdot 10^{-5}$	
124.0-123.5	0.5	$3.47 \cdot 10^{-4}$	34.7	$1.67 \cdot ^{10-4}$	$9.45 \cdot 10^{-5}$	
Total (cumulative)		**$1.02 \cdot 10^{-3}$**	**102.0**	**$4.92 \cdot 10^{-4}$**	**$2.78 \cdot 10^{-4}$**	
Difference		Qp-ΣQ_i = $-2.00 \cdot 10^{-5}$	2.0	T- ΣT_i = $-9.64 \cdot 10^{-6}$		Inconsistency in flow rates Q_p and ΣQ_i

Q_i = measured inflow rate of a single anomaly, ΣQ_i = cumulative flow at the top of the logged section.

Q_p = pumped flow rate at surface flow meter.

T = Transmissivity of the entire borehole, T_i = Transmissivity of a single anomaly.

ΣT_i = cumulative transmissivity at the top of the logged section.

s_{FL} = drawdown during pump test.

Table 5-3. Analyses results; flow logging HLX35.

HLX35 $Q_p = 1.00 \cdot 10^{-3}$ m²/s		T = $4.82 \cdot 10^{-4}$ m²/s		$T_{Fmeasl-L}$ = $2.41 \cdot 10^{-5}$ m²/s	s_{FL} = 3.67 m	
Anomaly depth (m from TOC)	**Anomaly length (m)**	**Q_i (m³/s)**	**Q_i/Q_p (%)**	**T_i (m²/s)**	**Q_i/sFL (m²/s)**	**Remarks**
94.5–94.0	0.5	$5.60 \cdot 10^{-5}$	5.1	$5.86 \cdot 10^{-6}$	$7.77 \cdot 10^{-6}$	
92.5–92.0	0.5	$5.28 \cdot 10^{-5}$	4.8	$5.53 \cdot 10^{-6}$	$7.33 \cdot 10^{-6}$	
65.5–64.0	1.5	$4.91 \cdot 10^{-4}$	44.3	$5.14 \cdot 10^{-5}$	$6.82 \cdot 10^{-5}$	
30.5–29.5	1.0	$5.38 \cdot 10^{-4}$	48.6	$5.63 \cdot 10^{-5}$	$7.47 \cdot 10^{-5}$	
Total (cumulative)		**$1.14 \cdot 10^{-3}$**	**102.7**	**$1.19 \cdot 10^{-4}$**	**$1.58 \cdot 10^{-4}$**	
Difference		$Q_p - \Sigma Q_i$ = $-3.00 \cdot 10^{-5}$	2.7	T– ΣT_i = $-3.14 \cdot 10^{-6}$		Inconsistency in flow rates Q_p and ΣQ_i

Q_i = measured inflow rate of a single anomaly, ΣQi = cumulative flow at the top of the logged section.

Q_p = pumped flow rate at surface flow meter.

T = Transmissivity of the entire borehole, Ti = Transmissivity of a single anomaly.

ΣT_i = cumulative transmissivity at the top of the logged section.

s_{FL} = drawdown during pump test.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump phase during flow logging to T = $1.16 \cdot 10^{-4}$ m²/s.

The total flow of the logged interval ($\sum Q_i$)is above the measured flow rate of the total flow at the surface (Q_p). The difference between the flows is 1.8 l/min. This indicates that there is probably no additional inflow to the borehole above the top of the logged section. Two major inflow zones are detected. The first between 66.5 and 64.0 m below ToC and the second between 30.5 m and 29.5 m below ToC. They are covering 44.3% and 48.6%, respectively, of the total flow. Additionally, two smaller inflows are identified in the middle of the borehole (94.5 m–94.0 m below ToC and 92.5 m – 92.0 m below ToC). Both inflows covering 9.9% of the total flow. The inflows are related to a decrease of electric conductivity.

The diagrams of the flow logging measurements in HLX38 are presented in Figure 6-3 and Appendix 4-3.

6 Summary of results

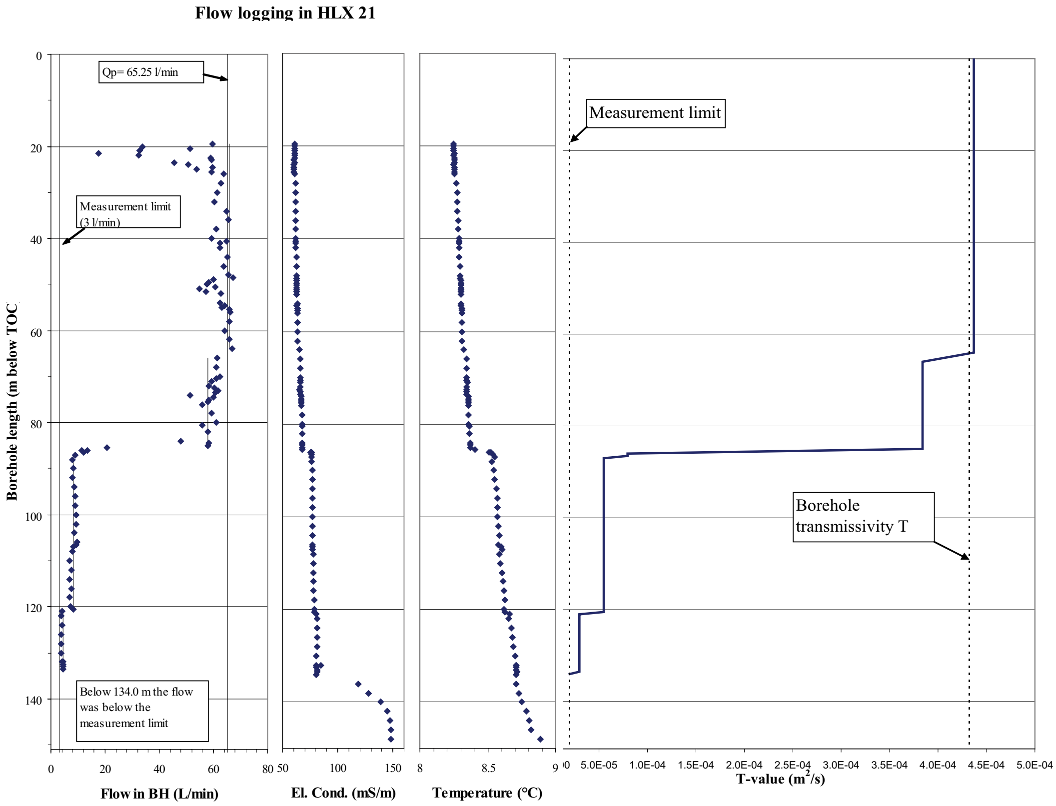


Figure 6-1. Results of the flow logging survey in borehole HLX21.

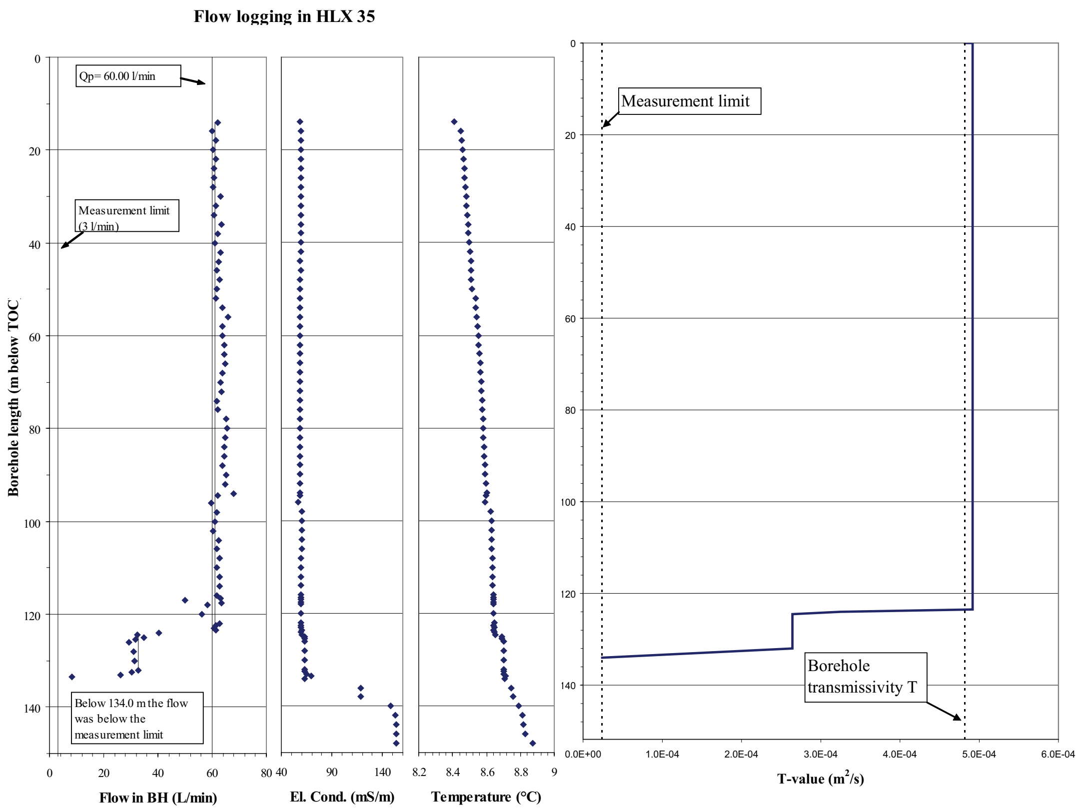


Figure 6-2. Results of the flow logging survey in borehole HLX35.

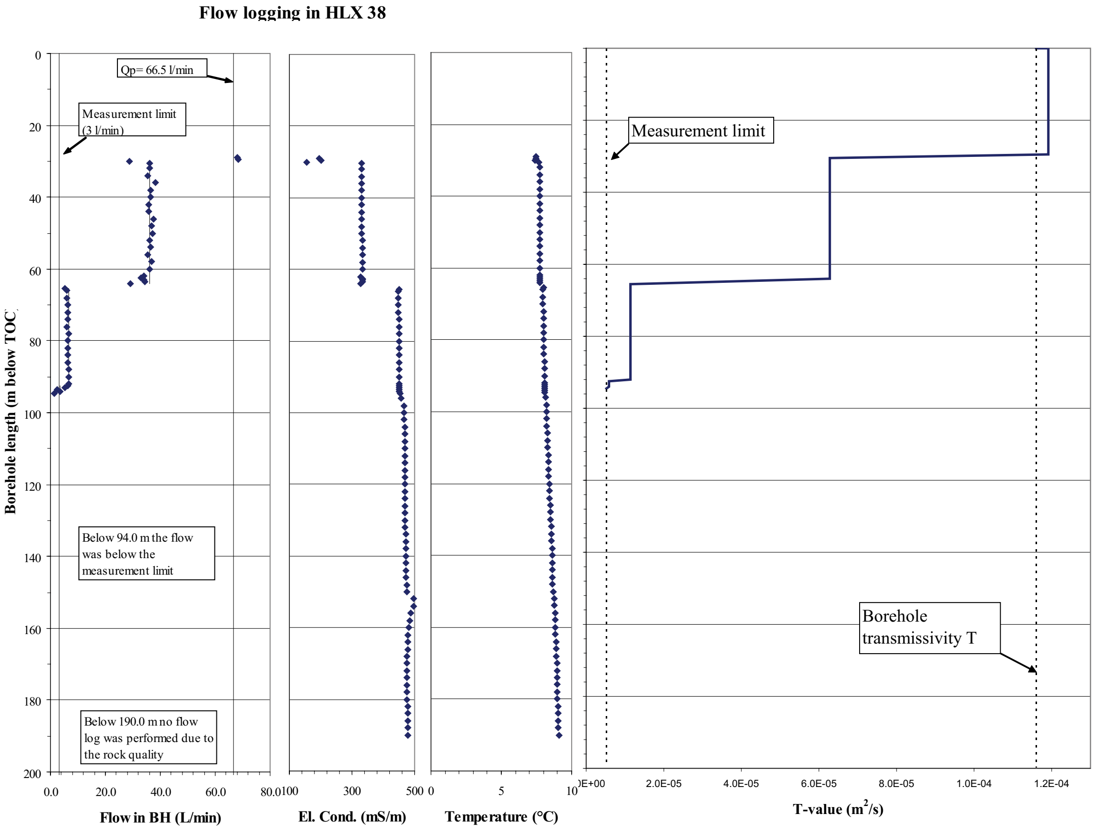


Figure 6-3. *Results of the flow logging survey in borehole HLX38.*

Table 6-1. General test data from constant rate pump tests.

Borehole ID	Borehole secup (m)	Borehole seclow (m)	Date and time for test start YYYYMMDD hh:mm	Date and time for test stop YYYYMMDD hh:mm	Q_p (m^3/s)	Q_m (m^3/s)	tp (s)	t_F (s)	p_0 (kPa)	p_i (kPa)	p_p (kPa)	p_F (kPa)	Te_w (°C)	EC_w (mS/m)	Test phases measured Analysed test phases marked bold
HLX21	9.10	150.30	20060518 10:16	20060518 21:29	1.07E–3	1.09E–3	32,086	–	–	188	158	–	8.7	64.1	**CRw**
HLX35	6.10	151.80	20060520 09:15	20060520 18:21	9.97E–4	1.00E–3	30,047	–	–	166	132	–	8.7	118.0	**CRw**
HLX38	15.10	199.50	20060522 12:31	20060523 09:30	1.10E–3	1.11E–3	35,059	39.597	–	252	179	248	8.1	306.7	**CRw** **CRwr**

#NV not analysed.

CRw: constant rate pump (withdrawal) phase.

CRr: recovery phase following the constant rate pump phase.

Table 6-2. Results from analysis of constant rate pump tests.

Borehole ID	Borehole secup (m)	Borehole seclow (m)	Stationary flow parameters Q/s (m^2/s)	T_M (m^2/s)	Transient analysis Flow regime Perturb. Phase	Recovery Phase	Formation parameters T_{f1} (m^2/s)	T_{f2} (m^2/s)	T_{s1} (m^2/s)	T_{s2} (m^2/s)	T_T (m^2/s)	T_{TMIN} (m^2/s)	T_{TMAX} (m^2/s)	C (m^3/Pa)	ξ –	dt_1 min	dt_2 min	Static conditions p* kPa	h_{wif} masl
HLX21	9.10	150.30	3.5E–4	4.7E–4	WBS22	–	4.3E–4	2.1E–4	–	–	4.3E–4	2.0E–4	6.0E–4	3.0E–6	–2.78	0.6	3.0	–	–
HLX35	6.10	151.80	2.7E–4	3.7E–4	WBS22	–	4.8E–4	1.4E–4	–	–	4.8E–4	2.0E–4	7.0E–4	2.6E–6	0.10	5.2	16.3		
HLX38	15.10	199.50	1.5E–4	2.1E–4	WBS2	WBS22	1.2E–4	–	1.6E–4	1.1E–4	1.2E–4	9.0E–05	3.0E–4	2.6E–6	–2.43	19.2	531.6	254.5	4.88

T1 and T2 refer to the transmissivity(s) derived from the analysis while using the recommended flow model. In case a homogeneous flow model was recommended only one T value is reported, in case a two zones composite model was recommended both T1 and T2 are given recommended only one T value is reported, in case a two zones composite model was recommended both T1 and T2 are given. The recommended transmissivity TT typically refers to the T1 value (inner zone transmissivity).

The parameter p* denoted the static formation pressure (measured at transducer depth) and was derived from the HORNER plot of the CRr phase using straight line or type-curve extrapolation.

The flow regime description refers to the recommended model used in the transient analysis. WBS denotes wellbore storage and skin and is followed by a set of numbers describing the flow dimension used in the analysis (1 = linear flow, 2 = radial flow, 3 = spherical flow). If only one number is used (e.g. WBS2 or 2) a homogeneous flow model (1 composite zone) was used in the analysis, if two numbers are given (WBS22 or 22) a 2 zones composite model was used.

#NV not analysed.

Table 6-3. General results from flow logging survey.

Borehole ID	Test section secup (m)	seclow (m)	Date and time for test start YYYYMMDD hh:mm	Date and time for test sop YYYYMMDD hh:mm	Q_p (m^3/s)	$\sum Q_i$ (m^3/s)	s_{FL} (m)	Q_p-$\sum Q_i$ (m^3/s)	T (m^2/s)	$\sum T_i$ (m^2/s)	$T_{Fmeasl-L}$ (m^2/s)	$\sum Q_i/s_{FL}$ (m^2/s)	T-$\sum T_i$ (kPa)
HLX21	19.5	148.0	20060518 14:39	20060518 21:19	1.09E–3	1.10E–3	2.99	–1.25E–5	4.32E–4	4.37E–4	1.99E–5	3.68E–4	–4.97E–6
HLX35	14.0	148.0	20060520 11:55	20060520 18:18	1.00E–3	1.02E–3	3.67	–2.00E–5	4.82E–4	4.92E–4	2.41E–5	2.78E–4	–9.64E–6
HLX38	29.0	190.0	20060520 14:47	20060520 18:21	1.11E–3	1.14E–3	7.21	-3.00E–5	1.16E–4	1.19E–4	5.23E–6	1.58E–4	–3.12E–6

References

Bourdet D, Ayoub J A, Pirard Y M, 1989. Use of pressure derivative in well-test interpretation. – Coc. Of Petroleum Engineers, SPE Formation Evaluation, pp. 293–302.

Gringarten A C, 1986. Computer-aided well-test analysis. – SPE Paper 14099.

Horne, R N, 1990. Modern well test analysis. – Petroway, Inc., Palo Alto, Calif.

Horner D R, 1951. Pressure build-up in wells. – Third World Pet. Congress, E.J. Brill, Leiden II, pp. 503–521.

Moye D G, 1967. Diamond drilling for foundation exploration Civil Eng. Trans., Inst. Eng. Australia, Apr. 1967, pp 95–100.

SKB, 2001. Platsundersökningar. Undersökningar och generellt genomförandeprogram. SKB TR-01-29, Svensk Kärnbränslehantering AB.

SKB, 2005. Program för fortsatta undersökningar av bergrund, mark, vatten och miljö inom delområde Laxemar. Platsundersökning Oskarshamn. SKB R-06-29, Svensk Kärnbränslehantering AB.

APPENDIX 1

File Description Table

Borehole: HLX 21, HLX 35
HLX 38

HYDROTESTING WITH HTHB					**DRILLHOLE IDENTIFICATION NO.: HLX 21, HLX 35, HLX 38**		
TEST- AND FILEPROTOCOL					**Testorder dated: 2006-05-16**		
Teststart		Test Section					
Date	Time	Upper	Lower	Borehole	Data file	Testtype*	Comments
2006-05-18	14:39	19.50	148.00	HLX 21	Spinne_HLX21_060518.dat	6, L-EC, L-Te	
2006-05-18	10:16	9.10	150.30	HLX 21	FlowLo_HLX21_060518.dat	1B	No recovery phase conducted
2006-05-20	11:55	14.00	148.00	HLX 35	Spinne_HLX35_060520.dat	6, L-EC, L-Te	
2006-05-20	09:16	6.10	151.80	HLX 35	FlowLo_HLX21_060520.dat	1B	No recovery phase conducted
2006-05-22	14:47	29.00	190.00	HLX 38	Spinne_HLX38_060522.dat	6, L-EC, L-Te	
2006-05-22	12:31	15.10	199.50	HLX 38	FlowLo_HLX38_060522.dat	1B	

* 1B: Pump test submersible pump, 6: flow logging-impeller, L-EC: electric conductivity logging,
L-Te: temperature logging

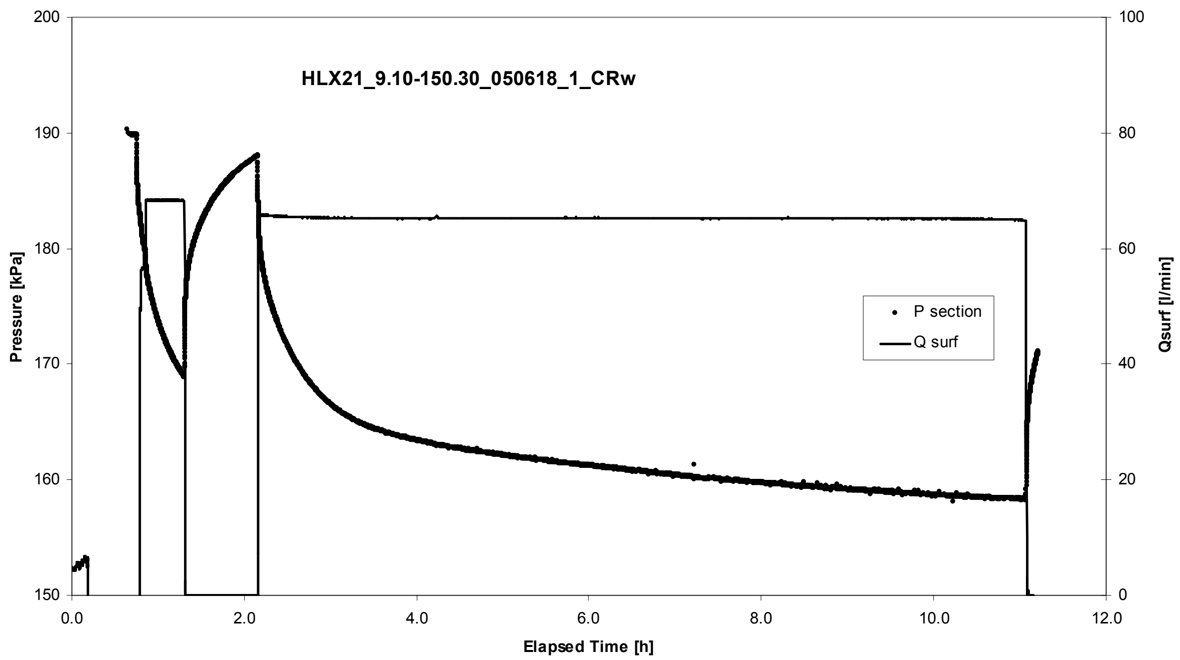
APPENDIX 2

Pump Test Analysis diagrams

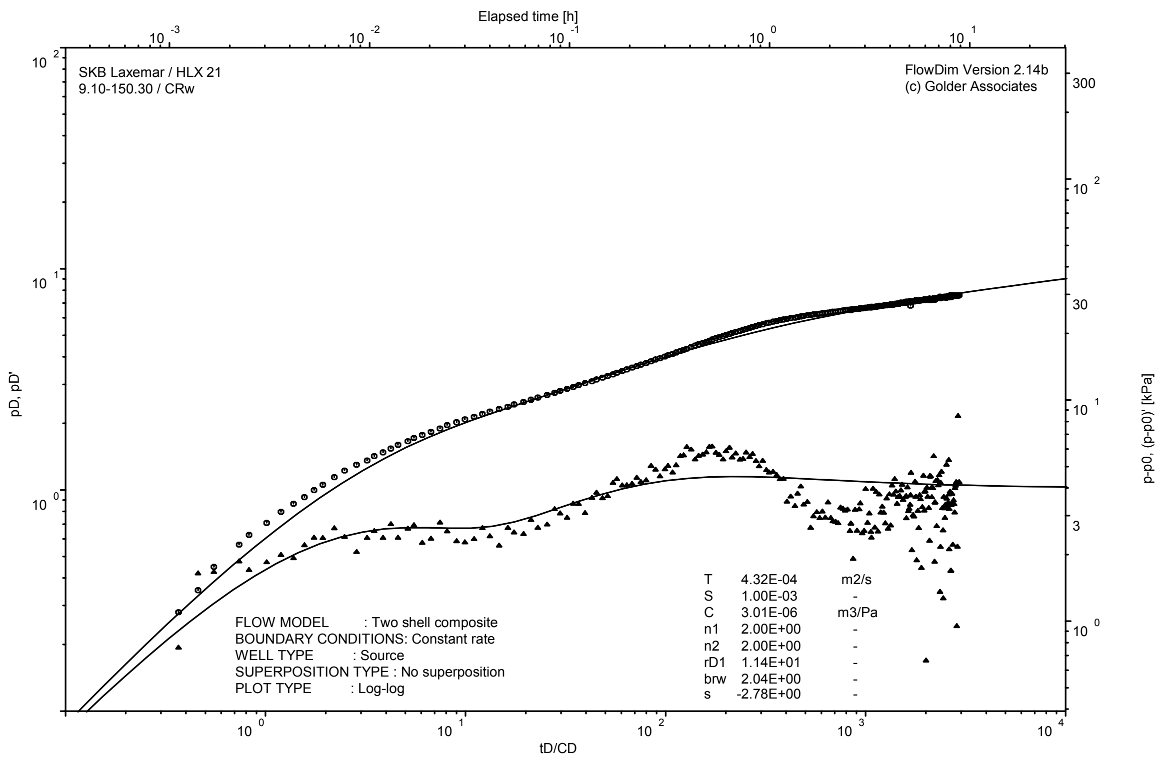
APPENDIX 2-1

HLX 21

Pump Test Analysis diagrams



Pressure and flow rate vs. time; cartesian plot

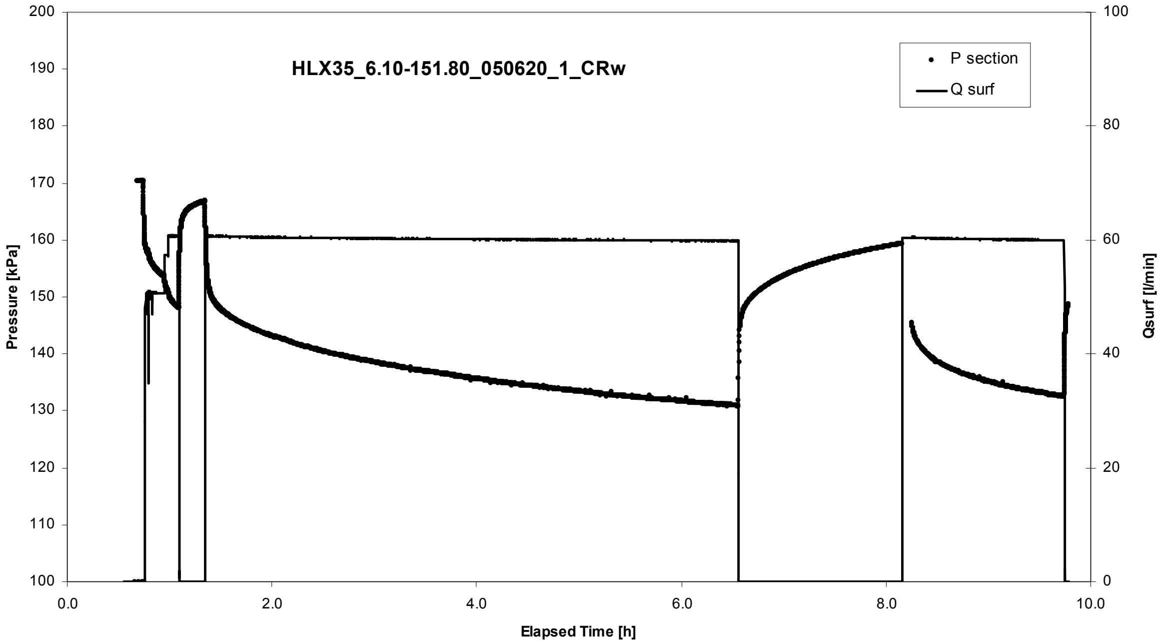


CRw phase; log-log match

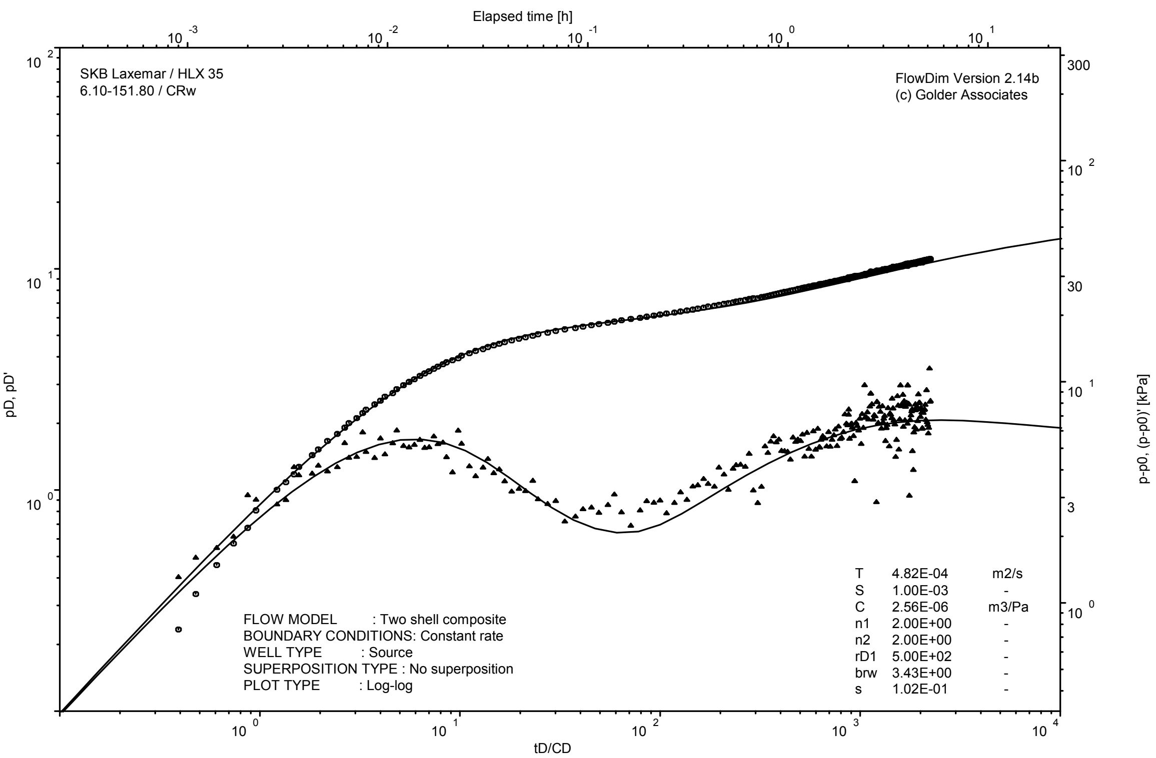
APPENDIX 2-2

HLX 35

Pump Test Analysis diagrams



Pressure and flow rate vs. time; cartesian plot

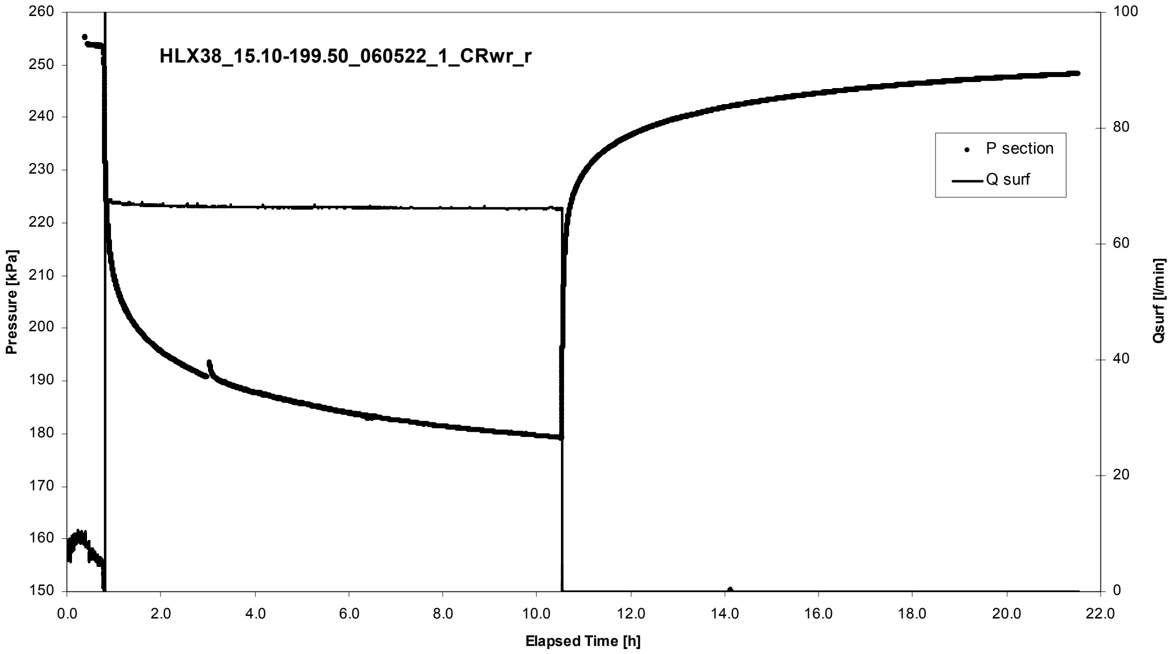


CRw phase; log-log match

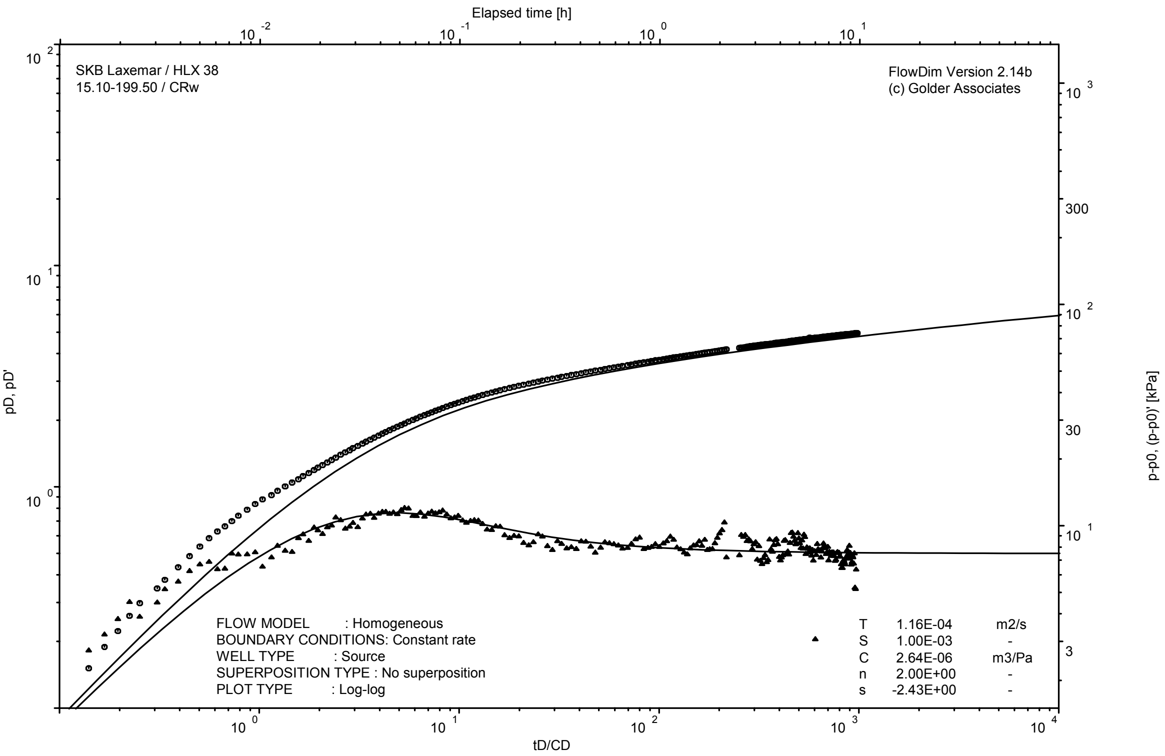
APPENDIX 2-3

HLX 38

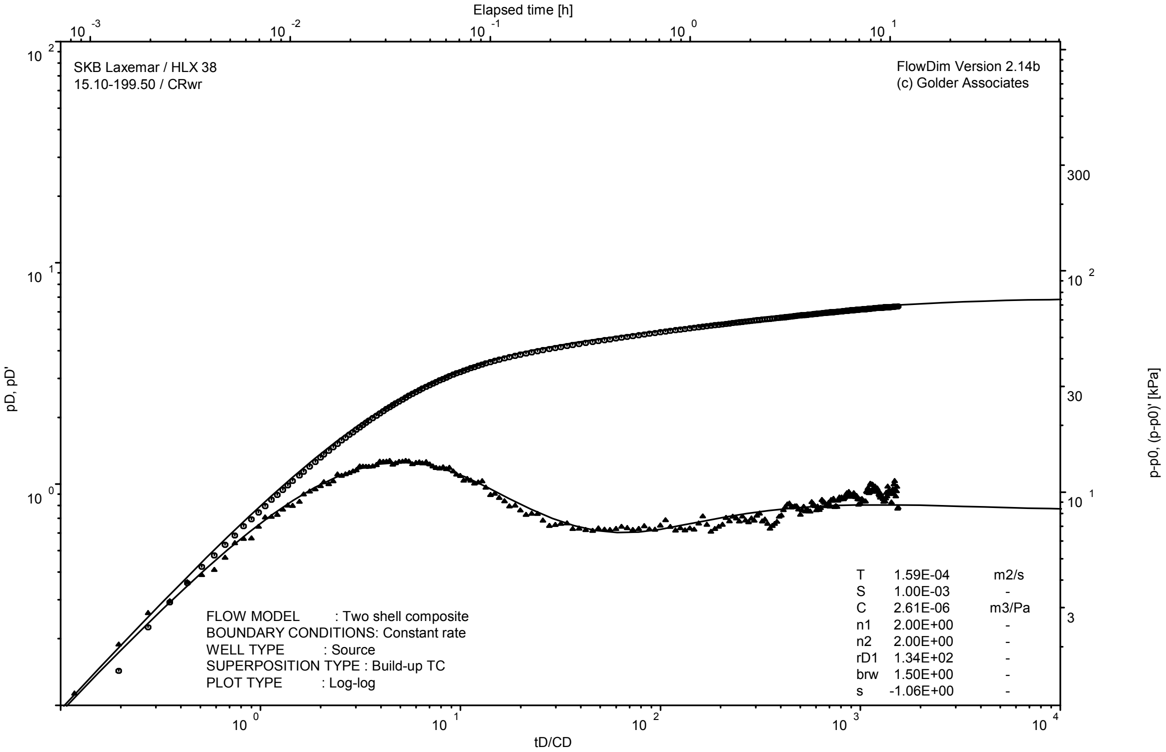
Pump Test Analysis diagrams



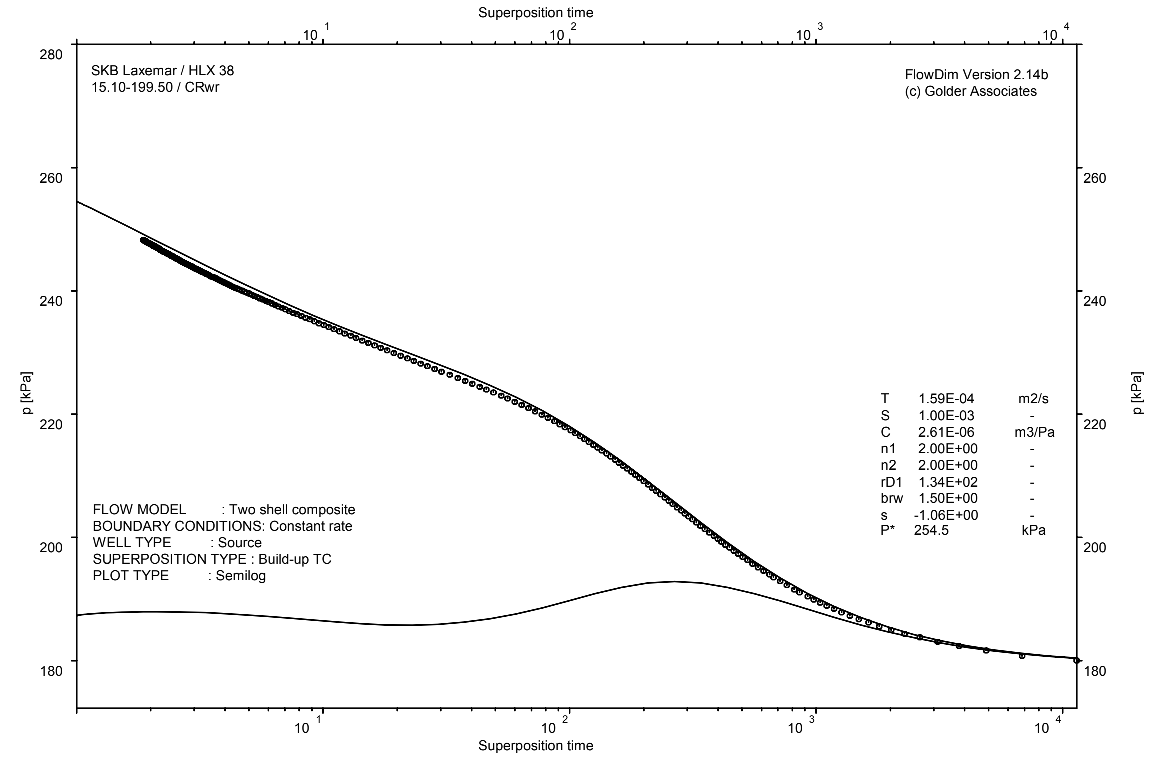
Pressure and flow rate vs. time; cartesian plot



CRw phase; log-log match



CRwr phase; log-log match



CRwr phase; HORNER match

APPENDIX 3

Pump Test Summary Sheets

APPENDIX 3-1

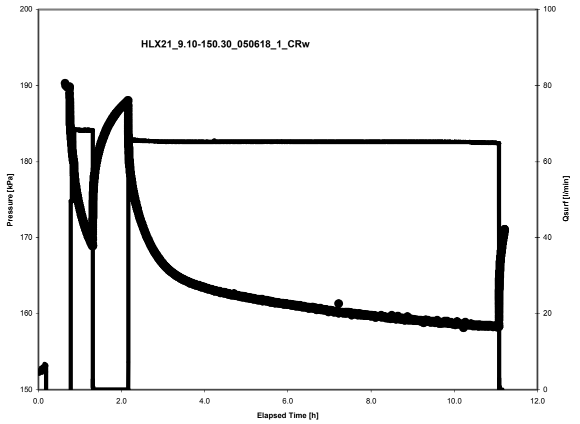
HLX 21

Pump Test Summary Sheets

Test Summary Sheet

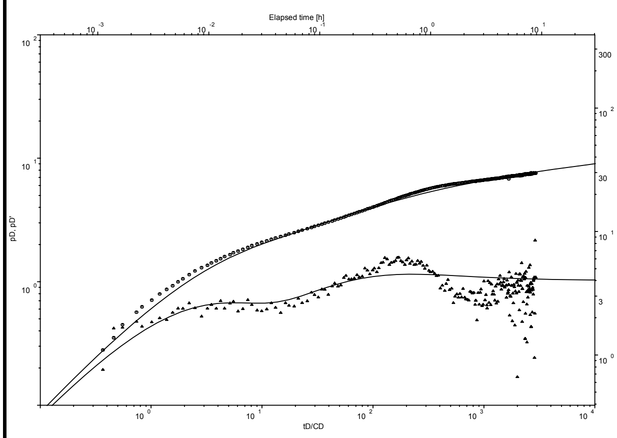
Project:	Oskarshamn site investigation	Test type:[1]	CRw
Area:	Laxemar	Test no:	1
Borehole ID:	HLX21	Test start:	060518 10:16
Test section from - to (m):	9.10-150.30	Responsible for test execution:	Stephan Rohs
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for test evaluation:	Cristian Enachescu

Linear plot Q and p



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa) =	-		
p_i (kPa) =	188		
p_p(kPa) =	158	p_F (kPa) =	-
Q_p (m^3/s)=	1.07E-03		
tp (s) =	32086	t_F (s) =	-
S el S^* (-)=	1.00E-03	S el S^* (-)=	-
EC_w (mS/m)=	64.1		
$Temp_w$(gr C)=	8.7		
Derivative fact.=	0	Derivative fact.=	-
Results		**Results**	
Q/s (m^2/s)=	3.5E-04		
T_M (m^2/s)=	4.7E-04		
Flow regime:	IARF	Flow regime:	-
dt_1 (min) =	0.63	dt_1 (min) =	-
dt_2 (min) =	2.95	dt_2 (min) =	-
T (m^2/s) =	4.3E-04	T (m^2/s) =	
S (-) =	1.0E-03	S (-) =	-
K_s (m/s) =	3.1E-06	K_s (m/s) =	-
S_s (1/m) =	7.1E-06	S_s (1/m) =	-
C (m^3/Pa) =	3.0E-06	C (m^3/Pa) =	
C_D (-) =	9.8E-02	C_D (-) =	-
ξ (-) =	-2.78	ξ (-) =	
T_{GRF}(m^2/s) =		T_{GRF}(m^2/s) =	
S_{GRF}(-) =		S_{GRF}(-) =	
D_{GRF} (-) =		D_{GRF} (-) =	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period

not conducted

Selected representative parameters.

dt_1 (min) =	0.63	C (m^3/Pa) =	3.0E-06
dt_2 (min) =	2.95	C_D (-) =	9.8E-02
T_T (m^2/s) =	4.3E-04	ξ (-) =	-2.78
S (-) =	1.0E-03		
K_s (m/s) =	3.1E-06		
S_s (1/m) =	7.1E-06		

Comments:

The inner zone transmissivity of 4.3•10-4 m2/s is deemed to be the recommended transmissivity. The confidence range for the transmissivity is estimated to be 2.0•10-4 to 6.0•10-4 m2/s. The flow dimension displayed during the test is 2.
The recommended transmissivity is used as borehole transmissivity for the evaluation of the flow logging survey.

APPENDIX 3-2

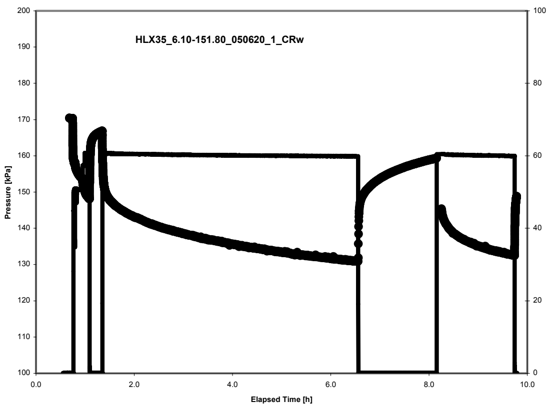
HLX 35

Pump Test Summary Sheets

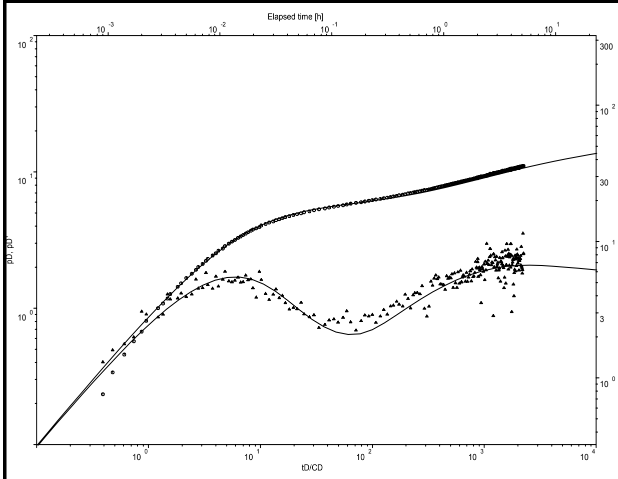
Test Summary Sheet

Project:	Oskarshamn site investigation	Test type:[1]	CRw
Area:	Laxemar	Test no:	1
Borehole ID:	HLX35	Test start:	060520 09:15
Test section from - to (m):	6.10-151.80	Responsible for test execution:	Stephan Rohs
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for test evaluation:	Cristian Enachescu

Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period

not conducted

Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa) =	-		
p_i (kPa) =	166		
p_p(kPa) =	132	p_F (kPa) =	-
Q_p (m^3/s)=	9.97E-04		
tp (s) =	30047	t_F (s) =	-
S el S^* (-)=	1.00E-03	S el S^* (-)=	-
EC_w (mS/m)=	118.0		
$Temp_w$(gr C)=	8.7		
Derivative fact.=	0	Derivative fact.=	-
Results		**Results**	
Q/s (m^2/s)=	2.7E-04		
T_M (m^2/s)=	3.7E-04		
Flow regime:	IARF	Flow regime:	-
dt_1 (min) =	5.20	dt_1 (min) =	-
dt_2 (min) =	16.26	dt_2 (min) =	-
T (m^2/s) =	4.8E-04	T (m^2/s) =	
S (-) =	1.0E-03	S (-) =	-
K_s (m/s) =	3.3E-06	K_s (m/s) =	-
S_s (1/m) =	6.9E-06	S_s (1/m) =	-
C (m^3/Pa) =	2.6E-06	C (m^3/Pa) =	
C_D (-) =	8.3E-02	C_D (-) =	-
ξ (-) =	0.10	ξ (-) =	
T_{GRF}(m^2/s) =		T_{GRF}(m^2/s) =	
S_{GRF}(-) =		S_{GRF}(-) =	
D_{GRF} (-) =		D_{GRF} (-) =	

Selected representative parameters.

dt_1 (min) =	5.20	C (m^3/Pa) =	2.6E-06
dt_2 (min) =	16.26	C_D (-) =	8.3E-02
T_T (m^2/s) =	4.8E-04	ξ (-) =	0.10
S (-) =	1.0E-03		
K_s (m/s) =	3.3E-06		
S_s (1/m) =	5.0E-05		

Comments:

The inner zone transmissivity of 4.8•10-4 m2/s is deemed to be the recommended transmissivity. The confidence range for the transmissivity is estimated to be 2.0•10-4 to 7.0•10-4 m2/s. The flow dimension displayed during the test is 2.
The recommended transmissivity is used as borehole transmissivity for the evaluation of the flow logging survey.

APPENDIX 3-3

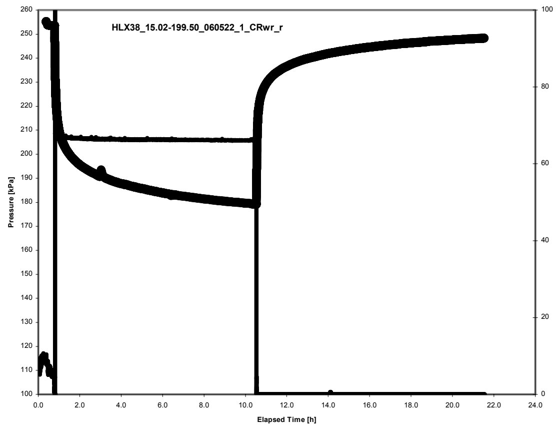
HLX 38

Pump Test Summary Sheets

Test Summary Sheet

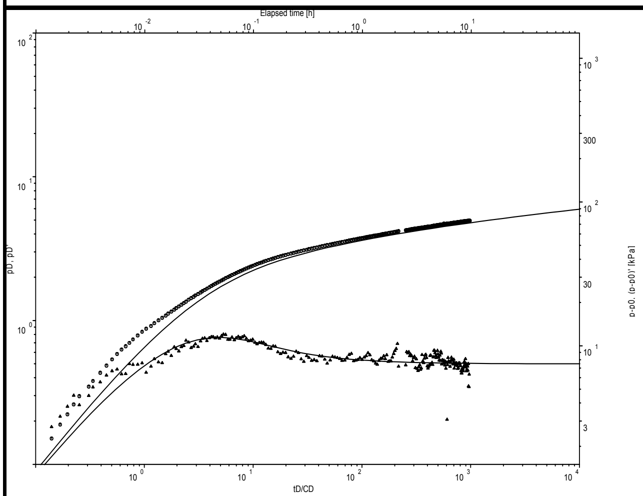
Project:	Oskarshamn site investigation	Test type:[1]	CRwr
Area:	Laxemar	Test no:	1
Borehole ID:	HLX38	Test start:	060522 12:21
Test section from - to (m):	15.10-199.50	Responsible for test execution:	Stephan Rohs
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for test evaluation:	Cristian Enachescu

Linear plot Q and p

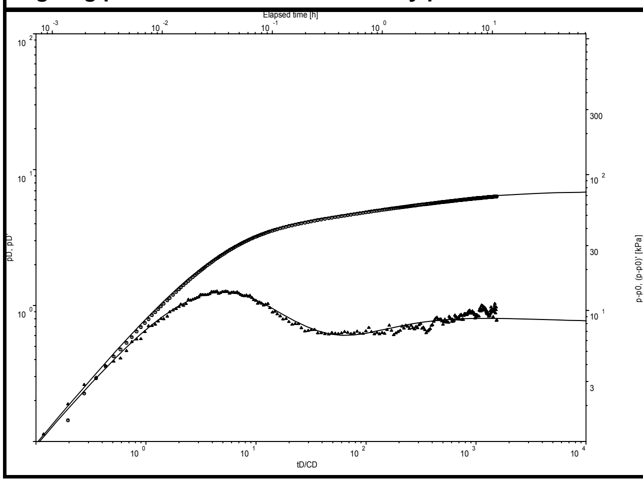


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa) =	-		
p_i (kPa) =	252		
p_p(kPa) =	179	p_F (kPa) =	248
Q_p (m^3/s)=	1.10E-03		
tp (s) =	35059	t_F (s) =	39597
S el S^* (-)=	1.00E-03	S el S^* (-)=	1.00E-06
EC_w (mS/m)=	306.7		
$Temp_w$(gr C)=	8.1		
Derivative fact.=	0	Derivative fact.=	0
Results		**Results**	
Q/s (m^2/s)=	1.5E-04		
T_M (m^2/s)=	2.1E-04		
Flow regime:	IARF	Flow regime:	IARF
dt_1 (min) =	19.20	dt_1 (min) =	19.50
dt_2 (min) =	531.60	dt_2 (min) =	425.40
T (m^2/s) =	1.2E-04	T (m^2/s) =	1.6E-04
S (-) =	1.0E-03	S (-) =	1.0E-03
K_s (m/s) =	6.3E-07	K_s (m/s) =	8.6E-07
S_s (1/m) =	5.4E-06	S_s (1/m) =	5.4E-06
C (m^3/Pa) =	2.6E-06	C (m^3/Pa) =	2.6E-06
C_D (-) =	8.6E-02	C_D (-) =	8.5E-02
ξ (-) =	-2.43	ξ (-) =	-1.06
T_{GRF}(m^2/s) =		T_{GRF}(m^2/s) =	
S_{GRF}(-) =		S_{GRF}(-) =	
D_{GRF} (-) =		D_{GRF} (-) =	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min) =	19.20	C (m^3/Pa) =	2.6E-06
dt_2 (min) =	531.60	C_D (-) =	8.6E-02
T_T (m^2/s) =	1.2E-04	ξ (-) =	-2.43
S (-) =	1.0E-03		
K_s (m/s) =	6.3E-07		
S_s (1/m) =	5.4E-06		

Comments:

The recommended transmissivity of 1.2•10-4 m2/s was derived from the analysis of the CRw phase, which shows the better data and derivative quality. The confidence range for the transmissivity is estimated to be 9.0•10-5 to 3.0•10-4 m2/s. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRwr phase using straight line extrapolation in the Horner plot to a value of 254.5 kPa.

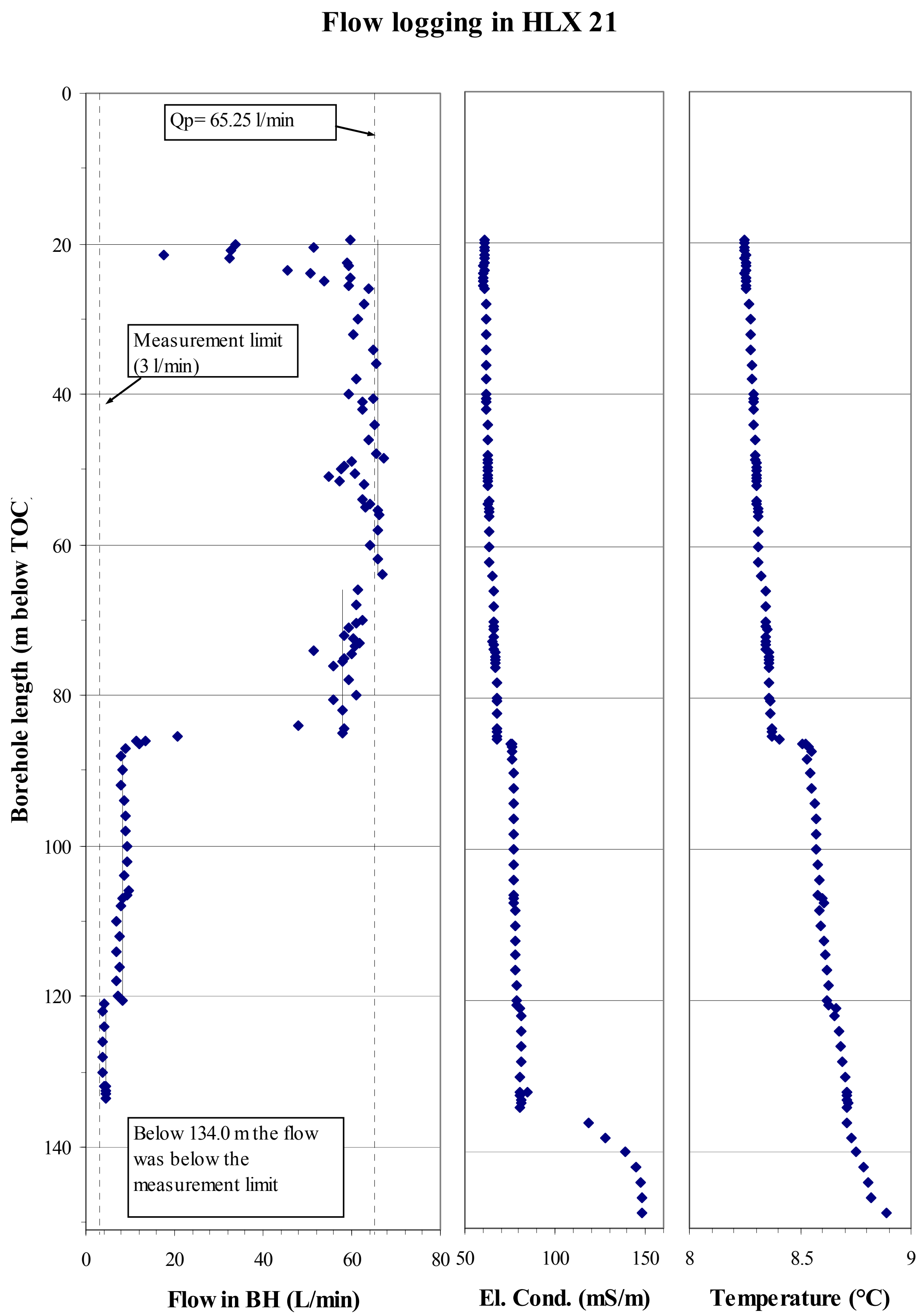
APPENDIX 4

Flow Logging Analysis Duagramms

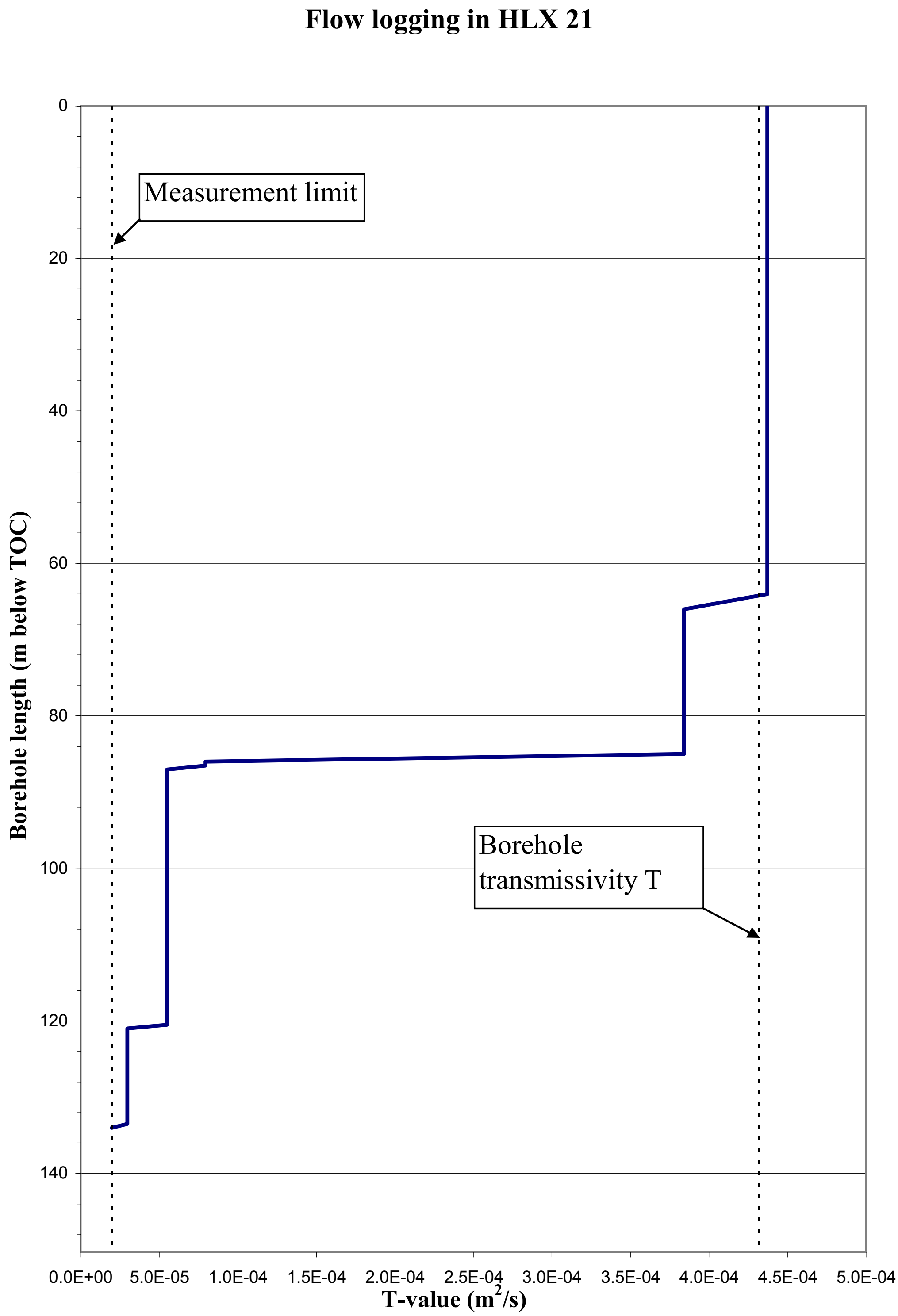
APPENDIX 4-1

HLX 21

Flow Logging Results diagrams



HLX 21: Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole

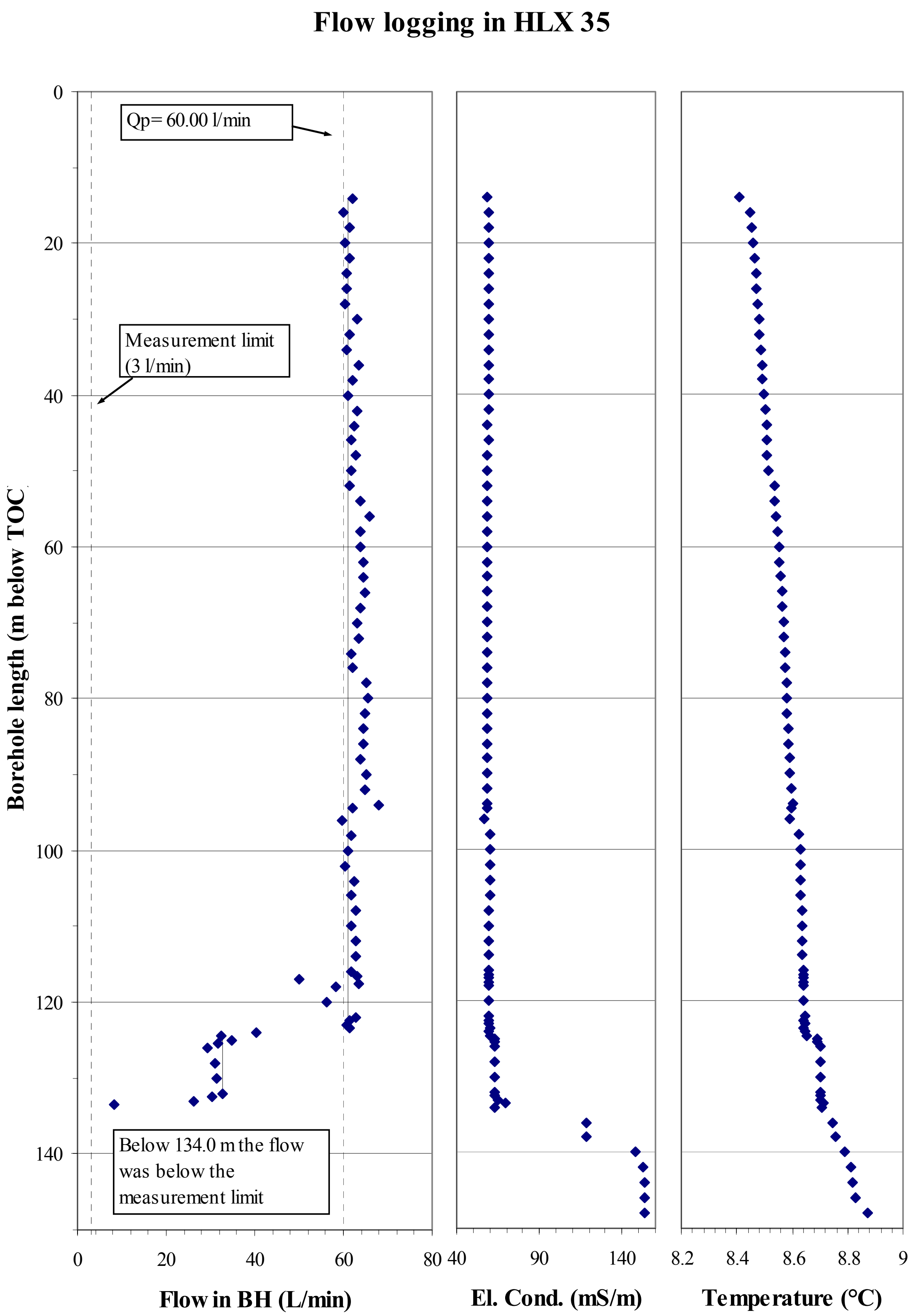


HLX 21: Calculated cumulative transmissivity (T_i) along the borehole

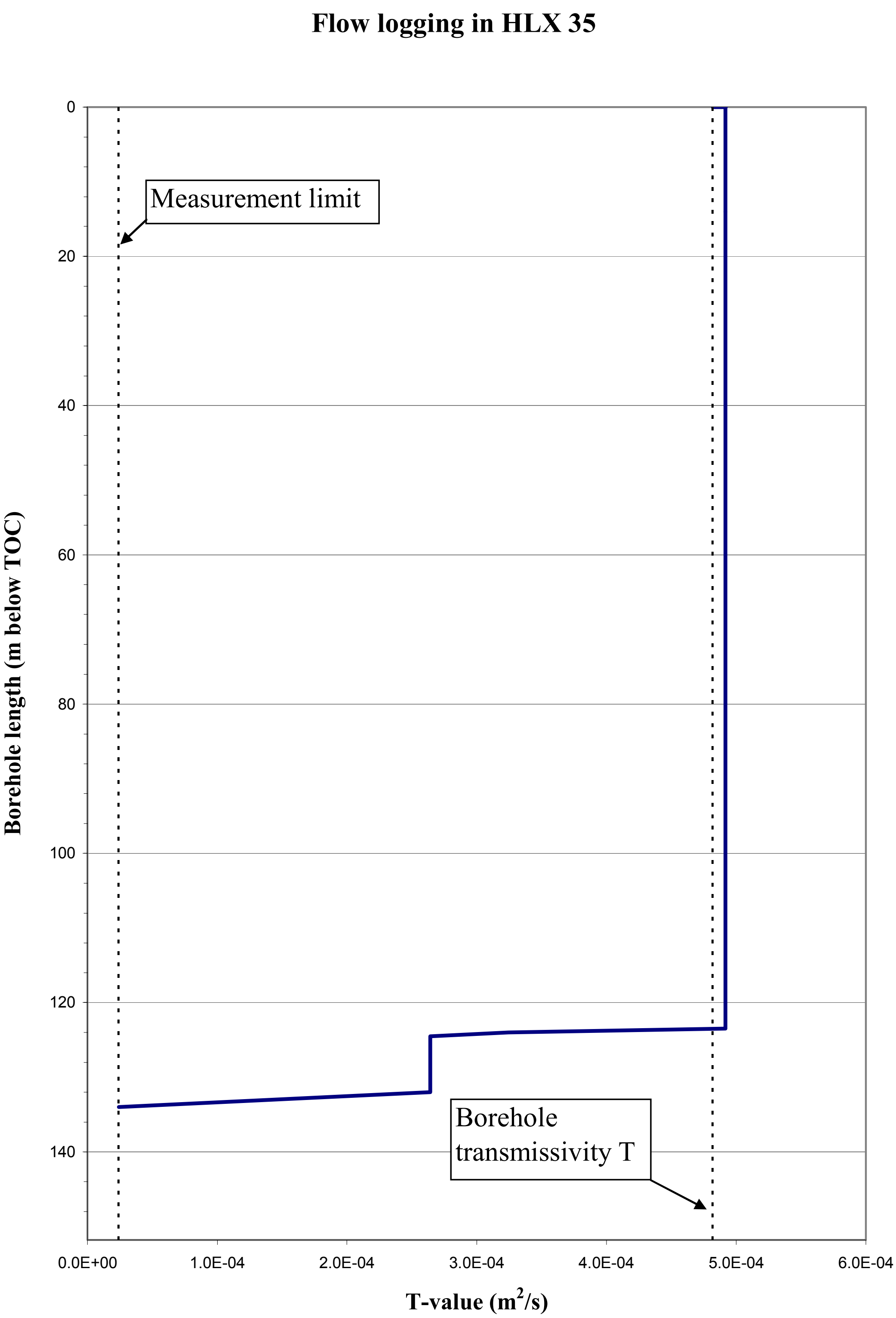
APPENDIX 4-2

HLX 35

Flow Logging Results diagrams



HLX 35: Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole

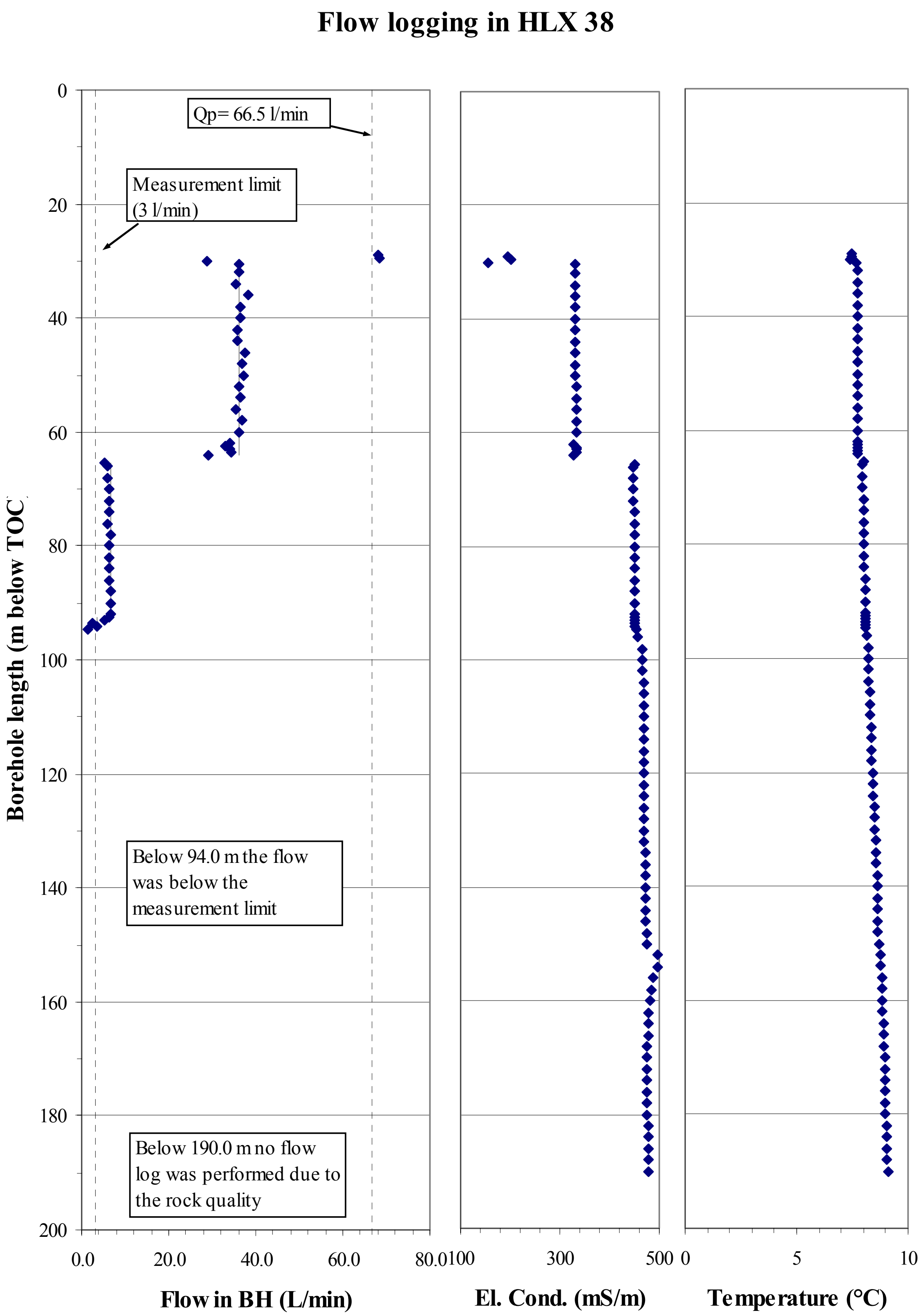


HLX 35: Calculated cumulative transmissivity (T_i) along the borehole

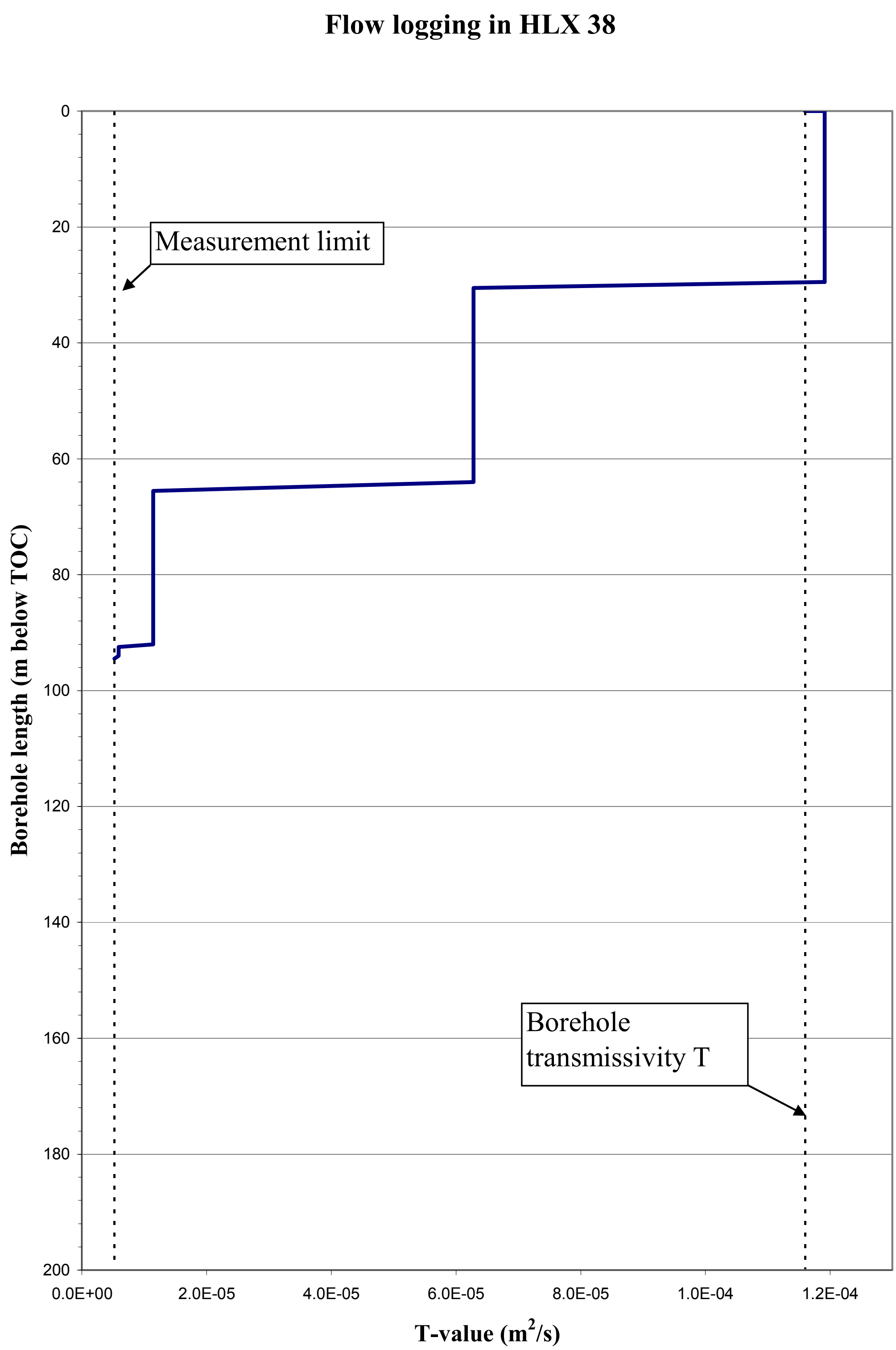
APPENDIX 4-3

HLX 38

Flow Logging Results diagrams



HLX 38: Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole



HLX 38: Calculated cumulative transmissivity (T_i) along the borehole

APPENDIX 5

Nomenclature

Character	SICADA designation	Explanation	Dimension	Unit
Variables, constants				
A_w		Horizontal area of water surface in open borehole, not including area of signal cables, etc.	$[L^2]$	m^2
b		Aquifer thickness (Thickness of 2D formation)	[L]	m
B		Width of channel	[L]	m
L		Corrected borehole length	[L]	m
L_0		Uncorrected borehole length	[L]	m
L_p		Point of application for a measuring section based on its centre point or centre of gravity for distribution of transmissivity in the measuring section.	[L]	m
L_w		Test section length.	[L]	m
dL		Step length, Positive Flow Log - overlapping flow logging. (step length, PFL)	[L]	m
r		Radius	[L]	m
r_w		Borehole, well or soil pipe radius in test section.	[L]	m
r_{we}		Effective borehole, well or soil pipe radius in test section. (Consideration taken to skin factor)	[L]	m
r_s		Distance from test section to observation section, the shortest distance.	[L]	m
r_t		Distance from test section to observation section, the **interpreted** shortest distance via conductive structures.	[L]	m
r_D		Dimensionless radius, $r_D=r/r_w$	-	-
z		Level above reference point	[L]	m
z_r		Level for reference point on borehole	[L]	m
z_{wu}		Level for test section (section that is being flowed), upper limitation	[L]	m
z_{wl}		Level for test section (section that is being flowed), lower limitation	[L]	m
z_{ws}		Level for sensor that measures response in test section (section that is flowed)	[L]	m
z_{ou}		Level for observation section, upper limitation	[L]	m
z_{ol}		Level for observation section, lower limitation	[L]	m
z_{os}		Level for sensor that measures response in observation section	[L]	m
E		Evaporation: hydrological budget:	$[L^3/(T\ L^2)]$ $[L^3/T]$	mm/y, mm/d, m^3/s
ET		Evapotranspiration hydrological budget:	$[L^3/(T\ L^2)]$ $[L^3/T]$	mm/y, mm/d, m^3/s
P		Precipitation hydrological budget:	$[L^3/(T\ L^2)]$ $[L^3/T]$	mm/y, mm/d, m^3/s
R		Groundwater recharge hydrological budget:	$[L^3/(T\ L^2)]$ $[L^3/T]$	mm/y, mm/d, m^3/s
D		Groundwater discharge hydrological budget:	$[L^3/(T\ L^2)]$ $[L^3/T]$	mm/y, mm/d, m^3/s
Q_R		Run-off rate	$[L^3/T]$	m^3/s
Q_p		Pumping rate	$[L^3/T]$	m^3/s
Q_I		Infiltration rate	$[L^3/T]$	m^3/s
Q		Volumetric flow. Corrected flow in flow logging ($Q_1 - Q_0$) (Flow rate)	$[L^3/T]$	m^3/s
Q_0		Flow in test section during undisturbed conditions (flow logging).	$[L^3/T]$	m^3/s
Q_p		Flow in test section immediately before stop of flow. Stabilised pump flow in flow logging.	$[L^3/T]$	m^3/s

Character	SICADA designation	Explanation	Dimension	Unit
Q_m		Arithmetical mean flow during perturbation phase.	[L^3/T]	m^3/s
Q_1		Flow in test section during pumping with pump flow Q_{p1}, (flow logging).	[L^3/T]	m^3/s
Q_2		Flow in test section during pumping with pump flow Q_{p1}, (flow logging).	[L^3/T]	m^3/s
ΣQ	SumQ	Cumulative volumetric flow along borehole	[L^3/T]	m^3/s
ΣQ_0	SumQ0	Cumulative volumetric flow along borehole, undisturbed conditions (ie, not pumped)	[L^3/T]	m^3/s
ΣQ_1	SumQ1	Cumulative volumetric flow along borehole, with pump flow Q_{p1}	[L^3/T]	m^3/s
ΣQ_2	SumQ2	Cumulative volumetric flow along borehole, with pump flow Q_{p2}	[L^3/T]	m^3/s
ΣQ_{C1}	SumQC1	Corrected cumulative volumetric flow along borehole, ΣQ_1-ΣQ_0	[L^3/T]	m^3/s
ΣQ_{C2}	SumQC2	Corrected cumulative volumetric flow along borehole, ΣQ_2-ΣQ_0	[L^3/T]	m^3/s
q		Volumetric flow per flow passage area (Specific discharge (Darcy velocity, Darcy flux, Filtration velocity)).	([L^3/T*L^2]	m/s
V		Volume	[L^3]	m^3
V_w		Water volume in test section.	[L^3]	m^3
V_p		Total water volume injected/pumped during perturbation phase.	[L^3]	m^3
v		Velocity	([L^3/T*L^2]	m/s
v_a		Mean transport velocity (Average linear velocity (Average linear groundwater velocity, Mean microscopic velocity));. $v_a=q/n_e$	([L^3/T*L^2]	m/s
t		Time	[T]	hour,min,s
t_0		Duration of rest phase before perturbation phase.	[T]	s
t_p		Duration of perturbation phase. (from flow start as far as p_p).	[T]	s
t_F		Duration of recovery phase (from p_p to p_F).	[T]	s
t_1, t_2 etc		Times for various phases during a hydro test.	[T]	hour,min,s
dt		Running time from start of flow phase and recovery phase respectively.	[T]	s
dt_e		dt_e = (dt · tp) / (dt + tp) Agarwal equivalent time with dt as running time for recovery phase.	[T]	s
t_D		$t_D = T\cdot t / (S\cdot r_w^2)$. Dimensionless time	-	-
p		Static pressure; including non-dynamic pressure which depends on water velocity. Dynamic pressure is normally ignored in estimating the potential in groundwater flow relations.	[M/$(LT)^2$]	kPa
p_a		Atmospheric pressure	[M/$(LT)^2$]	kPa
p_t		Absolute pressure; $p_t=p_a+p_g$	[M/$(LT)^2$]	kPa
p_g		Gauge pressure; Difference between absolute pressure and atmospheric pressure.	[M/$(LT)^2$]	kPa
p_0		Initial pressure before test begins, prior to packer expansion.	[M/$(LT)^2$]	kPa
p_i		Pressure in measuring section before start of flow.	[M/$(LT)^2$]	kPa
p_f		Pressure during perturbation phase.	[M/$(LT)^2$]	kPa
p_s		Pressure during recovery.	[M/$(LT)^2$]	kPa
p_p		Pressure in measuring section before flow stop.	[M/$(LT)^2$]	kPa
p_F		Pressure in measuring section at end of recovery.	[M/$(LT)^2$]	kPa
p_D		$p_D=2\pi\cdot T\cdot p/(Q\cdot\rho_w g)$, Dimensionless pressure	-	-
dp		Pressure difference, drawdown of pressure surface between two points of time.	[M/$(LT)^2$]	kPa

Character	SICADA designation	Explanation	Dimension	Unit
dp_f		$dp_f = p_i - p_f$ or $= p_f – p_i$, drawdown/pressure increase of pressure surface between two points of time during perturbation phase. dp_f usually expressed positive.	$[M/(LT)^2]$	kPa
dp_s		$dp_s = p_s – p_p$ or $= p_p – p_s$, pressure increase/drawdown of pressure surface between two points of time during recovery phase. dp_s usually expressed positive.	$[M/(LT)^2]$	kPa
dp_p		$dp_p = p_i – p_p$ or $= p_p – p_i$, **maximal** pressure increase/drawdown of pressure surface between two points of time during perturbation phase. dp_p expressed positive.	$[M/(LT)^2]$	kPa
dp_F		$dp_F = p_p – p_F$ or $= p_F – p_p$, **maximal** pressure increase/drawdown of pressure surface between two points of time during recovery phase. dp_F expressed positive.	$[M/(LT)^2]$	kPa
H		Total head; (potential relative a reference level) (indication of h for phase as for p). $H=h_e+h_p+h_v$	[L]	m
h		Groundwater pressure level (hydraulic head (piezometric head; possible to use for level observations in boreholes, static head)); (indication of h for phase as for p). $h=h_e+h_p$	[L]	m
h_e		Height of measuring point (Elevation head); Level above reference level for measuring point.	[L]	m
h_p		Pressure head; Level above reference level for height of measuring point of stationary column of water giving corresponding static pressure at measuring point	[L]	m
h_v		Velocity head; height corresponding to the lifting for which the kinetic energy is capable (usually neglected in hydrogeology)	[L]	m
s		Drawdown; Drawdown from undisturbed level (same as dh_p, positive)	[L]	m
s_p		Drawdown in measuring section before flow stop.	[L]	m
			[L]	
h_0		Initial above reference level before test begins, prior to packer expansion.	[L]	m
h_i		Level above reference level in measuring section before start of flow.	[L]	m
h_f		Level above reference level during perturbation phase.	[L]	m
h_s		Level above reference level during recovery phase.	[L]	m
h_p		Level above reference level in measuring section before flow stop.	[L]	m
h_F		Level above reference level in measuring section at end of recovery.	[L]	m
dh		Level difference, drawdown of water level between two points of time.	[L]	m
dh_f		$dh_f = h_i - h_f$ or $= h_f – h_i$, drawdown/pressure increase of pressure surface between two points of time during perturbation phase. dh_f usually expressed positive.	[L]	m
dh_s		$dh_s = h_s – h_p$ or $= h_p – h_s$, pressure increase/drawdown of pressure surface between two points of time during recovery phase. dh_s usually expressed positive.	[L]	m
dh_p		$dh_p = h_i – h_p$ or $= h_p –h_i$, maximal pressure increase/drawdown of pressure surface between two points of time during perturbation phase. dh_p expressed positive.	[L]	m
dh_F		$dh_F = h_p – h_F$ or $= h_F – h_p$, maximal pressure increase/drawdown of pressure surface between two points of time during perturbation phase. dh_F expressed positive.	[L]	m
Te_w		Temperature in the test section (taken from temperature logging). Temperature		^oC
Te_{w0}		Temperature in the test section during undisturbed conditions (taken from temperature logging).		^oC

Character	SICADA designation	Explanation	Dimension	Unit
Te_o		Temperature in the observation section (taken from temperature logging). Temperature		°C
EC_w		Electrical conductivity of water in test section.		mS/m
EC_{w0}		Electrical conductivity of water in test section during undisturbed conditions.		mS/m
EC_o		Electrical conductivity of water in observation section		mS/m
TDS_w		Total salinity of water in the test section.	$[M/L^3]$	mg/L
TDS_{w0}		Total salinity of water in the test section during undisturbed conditions.	$[M/L^3]$	mg/L
TDS_o		Total salinity of water in the observation section.	$[M/L^3]$	mg/L
g		Constant of gravitation (9.81 $m{*}s^{-2}$) (Acceleration due to gravity)	$[L/T^2]$	m/s^2
π	pi	Constant (approx 3.1416).	[-]	
r		Residual. r= p_c-p_m , r= h_c-h_m, etc. Difference between measured data (p_m, h_m, etc) and estimated data (p_c, h_c, etc)		
ME		Mean error in residuals. $ME = \frac{1}{n}\sum_{i=1}^{n} r_i$		
NME		Normalized ME. NME=ME/(x_{MAX}-x_{MIN}), x: measured variable considered.		
MAE		Mean absolute error. $MAE = \frac{1}{n}\sum_{i=1}^{n} \lvert r_i \rvert$		
NMAE		Normalized MAE. NMAE=MAE/(x_{MAX}-x_{MIN}), x: measured variable considered.		
RMS		Root mean squared error. $RMS = \left(\frac{1}{n}\sum_{i=1}^{n} r_i^2\right)^{0.5}$		
NRMS		Normalized RMR. NRMR=RMR/(x_{MAX}-x_{MIN}), x: measured variable considered.		
SDR		Standard deviation of residual. $SDR = \left(\frac{1}{n-1}\sum_{i=1}^{n} (r_i - ME)^2\right)^{0.5}$		
SEMR		Standard error of mean residual. $SEMR = \left(\frac{1}{n(n-1)}\sum_{i=1}^{n} (r_i - ME)^2\right)^{0.5}$		
Parameters				
Q/s		Specific capacity s=dp_p or s=s_p=h_0-h_p (open borehole)	$[L^2/T]$	m^2/s
D		Interpreted flow dimension according to Barker, 1988.	[-]	-
dt_1		Time of starting for semi-log or log-log evaluated characteristic counted from start of flow phase and recovery phase respectively.	[T]	s
dt_2		End of time for semi-log or log-log evaluated characteristic counted from start of flow phase and recovery phase respectively.	[T]	s
dt_L		Response time to obtain 0.1 m (or 1 kPa) drawdown in observation section counted from start of recovery phase.	[T]	s
TB		Flow capacity in a one-dimensional structure of width B and transmissivity T. Transient evaluation of one-dimensional structure	$[L^3/T]$	m^3/s
T		Transmissivity	$[L^2/T]$	m^2/s
T_M		Transmissivity according to Moye (1967)	$[L^2/T]$	m^2/s
T_Q		Evaluation based on Q/s and regression curve between Q/s and T, as example see Rhén et al (1997) p. 190.	$[L^2/T]$	m^2/s
T_S		Transmissivity evaluated from slug test	$[L^2/T]$	m^2/s

Character	SICADA designation	Explanation	Dimension	Unit
T_D		Transmissivity evaluated from PFL-Difference Flow Meter	$[L^2/T]$	m^2/s
T_I		Transmissivity evaluated from Impeller flow log	$[L^2/T]$	m^2/s
T_{Sf}, T_{Lf}		Transient evaluation based on semi-log or log-log diagram for perturbation phase in injection or pumping.	$[L^2/T]$	m^2/s
T_{Ss}, T_{Ls}		Transient evaluation based on semi-log or log-log diagram for recovery phase in injection or pumping.	$[L^2/T]$	m^2/s
T_T		Transient evaluation (log-log or lin-log). Judged best evaluation of T_{Sf}, T_{Lf}, T_{Ss}, T_{Ls}	$[L^2/T]$	m^2/s
T_{NLR}		Evaluation based on non-linear regression.	$[L^2/T]$	m^2/s
T_{Tot}		Judged most representative transmissivity for particular test section and (in certain cases) evaluation time with respect to available data (made by SKB at a later stage).	$[L^2/T]$	m^2/s
K		Hydraulic conductivity	[L/T]	m/s
K_s		Hydraulic conductivity based on spherical flow model	[L/T]	m/s
K_m		Hydraulic conductivity matrix, intact rock	[L/T]	m/s
k		Intrinsic permeability	$[L^2]$	m^2
kb		Permeability-thickness product: kb=k·b	$[L^3]$	m^3
SB		Storage capacity in a one-dimensional structure of width B and storage coefficient S. Transient evaluation of one-dimensional structure	[L]	m
SB*		Assumed storage capacity in a one-dimensional structure of width B and storage coefficient S. Transient evaluation of one-dimensional structure	[L]	m
S		Storage coefficient, (Storativity)	[-]	-
S*		Assumed storage coefficient	[-]	-
S_y		Theoretical specific yield of water (Specific yield; unconfined storage. Defined as total porosity (n) minus retention capacity (S_r)	[-]	-
S_{ya}		Specific yield of water (Apparent specific yield); unconfined storage, field measuring. Corresponds to volume of water achieved on draining saturated soil or rock in free draining of a volumetric unit. $S_{ya}= S_y$ (often called S_y in literature)	[-]	-
S_r		Specific retention capacity, (specific retention of water, field capacity) (Specific retention); unconfined storage. Corresponds to water volume that the soil or rock has left after free draining of saturated soil or rock.	[-]	-
S_f		Fracture storage coefficient	[-]	-
S_m		Matrix storage coefficient	[-]	-
S_{NLR}		Storage coefficient, evaluation based on non-linear regression	[-]	-
S_{Tot}		Judged most representative storage coefficient for particular test section and (in certain cases) evaluation time with respect to available data (made by SKB at a later stage).	[-]	-
S_s		Specific storage coefficient; confined storage.	[1/L]	1/m
S_s*		Assumed specific storage coefficient; confined storage.	[1/L]	1/m
c_f		Hydraulic resistance: The hydraulic resistance is an aquitard with a flow vertical to a two-dimensional formation. The inverse of c is also called Leakage coefficient. c_f=b´/K´ where b´ is thickness of the aquitard and K´ its hydraulic conductivity across the aquitard.	[T]	s
L_f		Leakage factor: $L_f =(K\cdot b\cdot c_f)^{0.5}$ where K represents characteristics of the aquifer.	[L]	m
ξ	Skin	Skin factor	[-]	-

Character	SICADA designation	Explanation	Dimension	Unit
ξ^*	Skin	Assumed skin factor	[-]	-
C		Wellbore storage coefficient	$[(LT^2)\cdot M^2]$	m^3/Pa
C_D		$C_D = C\cdot\rho_w g /(2\pi\cdot S\cdot r_w^2)$, Dimensionless wellbore storage coefficient	[-]	-
ω	Stor-ratio	$\omega= S_f /(S_f + S_m)$, storage ratio (Storativity ratio); the ratio of storage coefficient between that of the fracture and total storage.	[-]	-
λ	Interflow-coeff	$\lambda= \alpha\cdot (K_m / K_f) \cdot r_w^2$ interporosity flow coefficient.	[-]	-
T_{GRF}		Transmissivity interpreted using the GRF method	$[L^2/T]$	m^2/s
S_{GRF}		Storage coefficient interpreted using the GRF method	[1/L]	1/m
D_{GRF}		Flow dimension interpreted using the GRF method	[-]	-
c_w		Water compressibility; corresponding to β in hydrogeological literature.	$[(LT^2)/M]$	1/Pa
c_r		Pore-volume compressibility, (rock compressibility); Corresponding to α/n in hydrogeological literature.	$[(LT^2)/M]$	1/Pa
c_t		$c_t = c_r + c_w$, total compressibility; compressibility per volumetric unit of rock obtained through multiplying by the total porosity, n. (Presence of gas or other fluids can be included in c_t if the degree of saturation (volume of respective fluid divided by n) of the pore system of respective fluid is also included)	$[(LT^2)/M]$	1/Pa
nc_t		Porosity-compressibility factor: $nc_t= n\cdot c_t$	$[(LT^2)/M]$	1/Pa
nc_tb		Porosity-compressibility-thickness product: $nc_tb= n\cdot c_t\cdot b$	$[(L^2T^2)/M]$	m/Pa
n		Total porosity	-	-
n_e		Kinematic porosity, (Effective porosity)	-	-
e		Transport aperture. $e = n_e\cdot b$	[L]	m
ρ	Density	Density	$[M/L^3]$	$kg/(m^3)$
ρ_w	Density-w	Fluid density in measurement section during pumping/injection	$[M/L^3]$	$kg/(m^3)$
ρ_o	Density-o	Fluid density in observation section	$[M/L^3]$	$kg/(m^3)$
ρ_{sp}	Density-sp	Fluid density in standpipes from measurement section	$[M/L^3]$	$kg/(m^3)$
μ	my	Dynamic viscosity	[M/LT]	Pa s
μ_w	my	Dynamic viscosity (Fluid density in measurement section during pumping/injection)	[M/LT]	Pa s
FC_T		Fluid coefficient for intrinsic permeability, transference of k to K; $K=FC_T\cdot k$; $FC_T=\rho_w \cdot g/ \mu_w$	[1/LT]	1/(ms)
FC_S		Fluid coefficient for porosity-compressibility, transference of c_t to S_s ; $S_s=FC_S\cdot n\cdot c_t$; $FC_S=\rho_w \cdot g$	$[M/T^2L^2]$	Pa/m
Index on K, T and S				
S		S: semi-log		
L		L: log-log		
f		Pump phase or injection phase, designation following S or L (withdrawal)		
s		Recovery phase, designation following S or L (recovery)		
NLR		NLR: Non-linear regression. Performed on the entire test sequence, perturbation and recovery		
M		Moye		
GRF		Generalised Radial Flow according to Barker (1988)		
m		Matrix		
f		Fracture		
T		Judged best evaluation based on transient evaluation.		

Character	SICADA designation	Explanation	Dimension	Unit
Tot		Judged most representative parameter for particular test section and (in certain cases) evaluation time with respect to available data (made by SKB at a later stage).		
b		Bloch property in a numerical groundwater flow model		
e		Effective property (constant) within a domain in a numerical groundwater flow model.		
Index on p and Q				
0		Initial condition, undisturbed condition in open holes		
i		Natural, "undisturbed" condition of formation parameter		
f		Pump phase or injection phase (withdrawal, flowing phase)		
s		Recovery, shut-in phase		
p		Pressure or flow in measuring section at end of perturbation period		
F		Pressure in measuring section at end of recovery period.		
m		Arithmetical mean value		
c		Estimated value. The index is placed last if index for “where” and “what” are used. Simulated value		
m		Measured value. The index is placed last if index for “where” and “what” are used. Measured value		
Some miscellaneous indexes on p and h				
w		Test section (final difference pressure during flow phase in test section can be expressed dp_{wp}; First index shows “where” and second index shows “what”)		
o		Observation section (final difference pressure during flow phase in observation section can be expressed dp_{op}; First index shows “where” and second index shows “what”)		
f		Fresh-water head. Water is normally pumped up from section to measuring hoses where pressure and level are observed. Density of the water is therefore approximately the same as that of the measuring section. Measured groundwater level is therefore normally represented by what is defined as point-water head. If pressure at the measuring level is recalculated to a level for a column of water with density of fresh water above the measuring point it is referred to as fresh-water head and h is indicated last by an f. Observation section (final level during flow phase in observation section can be expressed h_{opf}; the first index shows “where” and the second index shows “what” and the last one “recalculation”)		

APPENDIX 6

SICADA Data Tables

APPENDIX 6-1

SICADA Data Tables

Flow Logging

(Simplified version v1.7)

SICADA/Data Import Template

File Identity	2480
Created By	Stephan Rohs
Created	2006.05.23 16:13

File Time Zone

Compiled By	
Quality Check For Delivery	
Delivery Approval	

Activity Type	HY690 HY690 - PLU Flow logging-Impeller

Project	AP PS 400-06-14

Activity Information						**Additional Activity Data**						
						C10	I250	P20	P200	P220	R240	R25
Idcode	**Start Date**	**Stop Date**	**Secup (m)**	**Seclow (m)**	**Section No**	**Company**	**Test equipment**	**Field crew manager**	**Field crew**	**evaluating data**	**calibration type**	**Report**
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		Golder Associates	HTHB2	Stephan Rohs	Stephan Rohs, Philipp Wolf	Stephan Rohs		Stephan Rohs
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		Golder Associates	HTHB2	Stephan Rohs	Stephan Rohs, Philipp Wolf	Stephan Rohs		Stephan Rohs
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		Golder Associates	HTHB2	Stephan Rohs	Stephan Rohs, Philipp Wolf	Stephan Rohs		Stephan Rohs

Table	plu_impell_main_res		
	Flowlogging with impeller, evaluated data of the entire hole		

Column	Datatype	Unit	Column Description
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
start_date	DATE		Date (yymmdd hh:mm:ss)
stop_date	DATE		Date (yymmdd hh:mm:ss)
project	CHAR		project code
idcode	CHAR		Object or borehole identification code
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
section_no	INTEGER	number	Section number
l	FLOAT	m	Corrected borehole length
cum_flow_q0	FLOAT	m**3/s	Undisturbed cumulative flow rate, see table description
cum_flow_q1	FLOAT	m**3/s	Cumulative flow rate at pumping flow Q1/head h1,see descr.
cum_flow_q2	FLOAT	m**3/s	Cumulative flow rate at pumping flow Q2/head h2, see descr.
cum_flow_q1t	FLOAT	m**3/s	Cumulative flow at the top of measured interval,pump flow Q1
cum_flow_q2t	FLOAT	m**3/s	Cumulative flow at the top of measured interval,pump flow Q2
corr_cum_flow_q1c	FLOAT	m**3/s	Corrected cumulative flow q1 at pump flow Q1,see tabledescr.
corr_cum_flow_q2c	FLOAT	m**3/s	Corrected cumulative flow q2 at pump flow Q2,see tabledescr.
corr_cum_flow_q1tc	FLOAT	m**3/s	Corrected cumulative flow q1T at pump flow Q1,see...
corr_cum_flow_q2tc	FLOAT	m**3/s	Corrected cumulative flow q2T at pump flow Q2,see...
corr_com_flow_q1tcr	FLOAT	m**3/s	Corrected q1Tc for estimated borehole radius (rwa)
corr_com_flow_q2tcr	FLOAT	m**3/s	Corrected q2Tc for estimated borehole radius (rwa)
transmissitivy_hole_t	FLOAT	m**2/s	T: Transmissivity of the entire hole, see table description
value_type_t	CHAR		0:true value,-1:T<lower meas.limit,1:T>upper meas.limit
bc_t	CHAR		Best choice code: 1 means T is best transm. choice, else 0
cum_transmissivity_t	FLOAT	m**2	T_F: Cumulative transmissivity, see table description
value_type_tf	CHAR		0:true value,-1:TF<lower meas.limit,1:TF>upper meas.limit
bc_tf	CHAR		Best choice code: 1 means TF is best transm. choice, else 0
l_measl_tf	FLOAT	m**2/s	Lower measurement limit of T_F,see table description
cum_transmissivity_t	FLOAT	m**2	T_FT: Cumulative transmissivity, see table description
value_type_tft	CHAR		0:true value,-1:TFT<lower meas.limit,1:TFT>upper meas.limit
bc_tft	CHAR		Best choice code: 1 means TFT is best transm. choice,else 0
u_measl_tf	FLOAT	m**2/s	Upper measurement limit of T_F, see table description
reference	CHAR		SKB number for reports describing data and results
comments	CHAR		Short comment to evaluated data (optional)
error_flag	CHAR		If error_flag = "*" then an error occured and an error
in_use	CHAR		If in_use = "*" then the activity has been selected as
sign	CHAR		Activity QA signature

idcode	start_date	stop_date	secup (m)	seclow (m)	section_no	l (m)	cum_flow_q0 (m**3/s)	cum_flow_q1 (m**3/s)	cum_flow_q2 (m**3/s)	cum_flow_q1t (m**3/s)	cum_flow_q2t (m**3/s)	corr_cum_flow_q1c (m**3/s)	corr_cum_flow_q2c (m**3/s)	corr_cum_flow_q1tc (m**3/s)
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00			1.1000E-03	1.0900E-03						
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00			1.0200E-03	1.0000E-03						
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00			1.1400E-03	1.1100E-03						

idcode	corr_cum_flow_q2tc (m**3/s)	corr_com_flow_q1tcr (m**3/s)	corr_com_flow_q2tcr (m**3/s)	transmissivy_hole_t (m**2/s)	value_type_t	bc_t	cum_transmissivity_tf (m**2)	value_type_tf	bc_tf	l_measl_tf (m**2/s)	cum_transmissivity_tft (m**2)	value_type_tft	bc_tft	u_measl_tf (m**2/s)	reference	comments
HLX 21				4.32E-04	0	1	4.37000E-04	0	0	1.99E-05						
HLX 35				4.82E-04	0	1	4.92000E-04	0	0	2.41E-05						
HLX 38				1.16E-04	0	1	1.19000E-04	0	0	5.23E-06						

Table	plu_impeller_anomaly Evaluated data of interpreted anomalies		
Column	**Datatype**	**Unit**	**Column Description**
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
start_date	DATE		Date (yymmdd hh:mm:ss)
stop_date	DATE		Date (yymmdd hh:mm:ss)
project	CHAR		project code
idcode	CHAR		Object or borehole identification code
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
section_no	INTEGER	number	Section number
l_a_upper	FLOAT	m	Borehole length to upper limit of inferred flow anomaly
l_a_lower	FLOAT	m	Borehole length to lower limit of inferred flow anomaly
fluid_temp_tea	FLOAT	oC	Measured borehole fluid temperature at inferred anomaly.
fluid_elcond_eca	FLOAT	mS/m	Measured fluid el conductivity of borehole fluid at anomaly
fluid_salinity_tdsa	FLOAT	mg/l	Calculated total dissolved solids of fluid at anomaly, see.
dq1	FLOAT	m**3/s	Flow rate of inferred flow anomaly at pump flow Q1or head h1
dq2	FLOAT	m**3/s	Flow rate of inferred flow anomaly at pump flowQ2 or head h2
r_wa	FLOAT	m	Estimated borehole radius
dq1_corrected	FLOAT	m**3/s	Corrected flow rate of anomaly at pump flow Q1 or see descr.
dq2_corrected	FLOAT	m**3/s	Corrected flow rate of anomaly at pump flow Q2, or see descr
spec_cap_dq1c_s1	FLOAT	m**2/s	dq1/s1.Spec. capacity of anomaly at pump flow Q1 or ..,see
spec_cap_dq2c_s2	FLOAT	m**2/s	dq2/s2.Spec. capacity of anomaly at pump flow Q2 or.,see des
value_type_dq1_s1	CHAR		0:true value,-1:<lower meas.limit,1:>upper meas.limit.
value_type_dq2_s2	CHAR		0:true value,-1:<lower meas.limit,1:>upper meas.limit.
ba	FLOAT	m	Representative thickness of anomaly for TFa,see description
transmissivity_tfa	FLOAT	m**2/s	Transmissivity of inferred flow anomaly.
value_type_tfa	CHAR		0:true value,-1:TFa<lower meas.limit,1:TFa>upper meas.limit.
bc_tfa	CHAR		Best choice code.1 means TFa is best choice of T, else 0
l_measl_tfa	FLOAT	m**2/s	Lower measurement limit of TFa, see table description
u_measl_tfa	FLOAT	m**2/s	Upper measurement limit of TFa, see table description
comments	CHAR		Short comment on evaluated parameters
error_flag	CHAR		If error_flag = "*" then an error occured and an error
in_use	CHAR		If in_use = "*" then the activity has been selected as
sign	CHAR		Activity QA signature

idcode	start_date	stop_date	secup (m)	seclow (m)	section_no	l_a_upper (m)	l_a_lower (m)	fluid_temp_tea (oC)	fluid_elcond_eca (mS/m)	fluid_salinity_tdsa (mg/l)	dq1 (m**3/s)
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		133.50	134.00	8.70	80.8		7.5000E-05
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		120.50	121.00	8.60	80.4		6.3300E-05
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		86.50	87.00	8.60	76.2		6.1700E-05
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		85.00	86.00	8.40	68.2		7.6700E-04
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		64.00	66.00	8.30	65.7		1.3300E-04
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		132.00	134.00	8.70	63.4		5.4800E-04
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		124.00	124.50	8.60	60.2		1.2500E-04
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		123.50	124.00	8.60	60.0		3.4700E-04
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		94.00	94.50	8.10	450.5		5.6000E-05
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		92.00	92.50	8.10	450.5		5.2800E-05
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		64.00	65.50	7.70	329.1		4.9100E-04
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		29.50	30.50	7.50	201.6		5.3800E-04

idcode	dq2 (m**3/s)	r_wa (m)	dq1_corrected (m**3/s)	dq2_corrected (m**3/s)	spec_cap_dq1c_s1 (m**2/s)	spec_cap_dq2c_s2 (m**2/s)	value_type_dq1_s1	value_type_dq2_s2	ba (m)	transmissivity_tfa (m**2/s)	value_type_tfa	bc_tfa	l_measl_tfa (m**2/s)	u_measl_tfa (m**2/s)	comments
HLX 21		0.07			2.51E-05		0		0.50	2.98E-05	0	1	1.99E-05		
HLX 21		0.07			2.12E-05		0		0.50	2.52E-05	0	1	1.99E-05		
HLX 21		0.07			2.06E-05		0		0.50	2.45E-05	0	1	1.99E-05		
HLX 21		0.07			2.57E-04		0		1.00	3.05E-04	0	1	1.99E-05		
HLX 21		0.07			4.46E-05		0		2.00	5.30E-05	0	1	1.99E-05		
HLX 35		0.07			1.49E-04		0		2.00	2.64E-04	0	1	2.41E-05		
HLX 35		0.07			3.41E-05		0		0.50	6.03E-05	0	1	2.41E-05		
HLX 35		0.07			9.45E-05		0		0.50	1.67E-04	0	1	2.41E-05		
HLX 38		0.07			7.77E-06		0		0.50	5.86E-06	0	1	5.23E-06		
HLX 38		0.07			7.33E-06		0		0.50	5.53E-06	0	1	5.23E-06		
HLX 38		0.07			6.82E-05		0		1.00	5.14E-05	0	1	5.23E-06		
HLX 38		0.07			7.47E-05		0		1.00	5.63E-05	0	1	5.23E-06		

Table	plu_impeller_basic_d Flow logging using impeller, basic data		
Column	**Datatype**	**Unit**	**Column Description**
site	CHAR		Investigation site name
start_date	DATE		Date (yymmdd hh:mm:ss)
stop_date	DATE		Date (yymmdd hh:mm:ss)
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
sign	CHAR		Activity QA signature
start_flowlogging	DATE	yyyymmdd	Date and time of flowlogging start (YYYY-MM-DD hh:mm:ss)
stop_flowlogging	DATE	yyyymmdd	Date and time of flowlogging stop (YYYY-MM-DD hh:mm:ss)
l	FLOAT	m	Corrected borehole length during logging, see table descr.
test_type	CHAR		Type of test,(1- 7); see table description
formation_type	CHAR		1: Rock, 2: Soil (supeficial deposits)
q_measl_l	FLOAT	m**3/s	Estimated lower measurement limit of borehole flow,see des.
q_measl_u	FLOAT	m**3/s	Estimated upper measurement limit of borehole flow,see desc.
pump_flow_q1	FLOAT	m**3/s	Flow rate at surface during flow logging period 1
pump_flow_q2	FLOAT	m**3/s	Flow rate at surface during flow logging period 2
dur_flow_phase_tp1	FLOAT	s	Duration of flow period 1
dur_flow_phase_tp2	FLOAT	s	Duration of flow period 2
dur_flowlog_tfl_1	FLOAT	s	Duration of the flowlogging survey 1
dur_flowlog_tfl_2	FLOAT	s	Duration of the flowlogging survey 2
drawdown_s1	FLOAT	m	Representative drawdown in borehole during flowlog period 1
drawdown_s2	FLOAT	m	Representative drawdown in borehole during flowlog period 2
initial_head_ho	FLOAT	m.a.s.l.	Initial hydraulic head (open borehole),see table description
hydraulic_head_h1	FLOAT	m.a.s.l.	Represen. hydr.head during flow period 1,see table descr.
hydraulic_head_h2	FLOAT	m.a.s.l.	Represen. hydr.head during flow period 2,see table descr.
reference	CHAR		SKB report number for reports describing data & evaluation
comments	VARCHAR		Short comment to the evaluated parameters (optional))

idcode	start_date	stop_date	(m) secup	(m) seclow	section_no	(yyyymmdd) start_flowlogging	(yyyymmdd) stop_flowlogging	(m) l	test_type	formation_type	(m**3/s) q_measl_l	(m**3/s) q_measl_u
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		20060518	20060518		6	1	5.0000E-05	1.6667E-03
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		20060520	20060520		6	1	5.0000E-05	1.6667E-03
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		20060522	20060522		6	1	5.0000E-05	1.6667E-03

idcode	(m**3/s) pump_flow_q1	(m**3/s) pump_flow_q2	(s) dur_flow_phase_tp1	(s) dur_flow_phase_tp2	(s) dur_flowlog_tfl_1	(s) dur_flowlog_tfl_2	(m) drawdown_s1	(m) drawdown_s2	(m.a.s.l.) initial_head_ho	(m.a.s.l.) hydraulic_head_h1	(m.a.s.l.) hydraulic_head_h2	reference	comments
HLX 21	1.0900E-03		32086.00		24000.00		2.99		188.00	158.00			
HLX 35	1.0000E-03		30047.00		22980.00		3.67		166.00	132.00			
HLX 38	1.1100E-03		35059.00		12840.00		7.21		252.00	179.00			

Table	plu_impeller_ec_temp Measurements of EC and Temp during Impeller Flow logging		
Column	**Datatype**	**Unit**	**Column Description**
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
idcode	CHAR		Object or borehole identification code
sign	CHAR		Activity QA signature
test_type	CHAR		Test type 1-7; see table description
date	DATE	yyyymmdd	Date and time of measurement(YYYY_MM_DD hh:mm:ss)
bhlen	FLOAT	m	Borehole lenght to point of measuring
temperature	FLOAT	degrees	Fluid temperature iat measured depth
elcond	FLOAT	mS/m	Electric conductivity of borehole fluid at measured depth.
reference	CHAR		SKB report No for reports describing data and evaluation
comments	CHAR		Short comment to the measurements

idcode	start_date	stop_date	secup (m)	seclow (m)	section_no	test_type	date (yyyymmdd)	bhlen (m)	temperature (degrees)	elcond (mS/m)	reference	comments
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:39	148	8.88863	148.534		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:42	146	8.81952	147.989		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:45	144	8.80364	146.992		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:48	142	8.78521	144.937		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:50	140	8.75489	138.497		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:52	138	8.73123	127.856		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:53	136	8.71173	118.449		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:55	134	8.7123	80.7809		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 14:58	132	8.70915	84.4775		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:05	133.5	8.71385	81.1873		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:09	133	8.71361	81.0011		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:12	132.5	8.71151	80.7741		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:16	132	8.71043	80.7723		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:21	130	8.70382	80.8788		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:24	128	8.69181	81.156		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:31	126	8.68215	81.0003		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:36	124	8.67443	81.0008		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:39	122	8.65659	81.2932		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:43	120	8.61909	78.6545		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:49	120.5	8.62854	78.8635		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:53	121	8.66373	80.4089		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 15:57	118	8.62552	78.5602		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:03	116	8.62216	78.2691		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:07	114	8.61431	78.1472		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:11	112	8.60911	78.1537		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:15	110	8.59585	78.1451		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:22	108	8.58634	77.6872		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:28	106	8.58116	77.4809		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:32	106.5	8.60139	77.3516		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:37	107	8.60376	77.377		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:41	104	8.58361	77.1086		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:46	102	8.57709	77.134		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:52	100	8.5749	77.129		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 16:58	98.01	8.57336	77.0593		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:03	96	8.57071	77.0536		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:07	94.01	8.56431	76.9431		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:11	92	8.55329	76.8221		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:15	90.01	8.54601	76.7637		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:19	88.06	8.53429	76.5342		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:22	86	8.50748	75.9117		

idcode	start_date	stop_date	secup (m)	seclow (m)	section_no	test_type	date (yyyymmdd)	bhlen (m)	temperature (degrees)	elcond (mS/m)	reference	comments
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:26	86.5	8.53818	76.1583		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:29	87	8.55247	76.1521		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:33	84.01	8.37114	67.8602		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:36	84.51	8.37154	68.0622		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:40	85	8.3747	68.0536		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:43	85.53	8.40976	68.1657		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:48	86.02	8.52308	75.7992		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:52	82.01	8.36623	67.872		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 17:57	80	8.36116	67.568		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:01	80.5	8.3627	67.4462		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:05	78.01	8.361	67.4596		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:10	76.01	8.36111	67.3168		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:16	74.01	8.35986	67.2737		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:23	74.5	8.35982	67.2821		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:27	75.01	8.3609	67.2646		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:31	75.5	8.36083	67.1521		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:34	72.01	8.34739	65.7365		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:37	72.5	8.34604	65.5612		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:41	73.01	8.3465	65.6738		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:44	73.5	8.34724	65.9792		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:49	70	8.34697	65.7541		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:52	70.5	8.3466	65.8484		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:55	71	8.34842	65.7474		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 18:58	68	8.34567	65.738		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:01	66	8.34352	65.7354		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:04	64	8.32345	64.8504		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:12	62	8.31298	63.6491		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:15	60	8.31294	63.4164		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:18	58.01	8.31257	63.4242		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:23	56	8.30939	63.363		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:26	54.01	8.30618	63.1368		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:29	54.51	8.30592	62.9538		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:32	55.01	8.30838	63.1223		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:35	55.5	8.30963	63.1301		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:38	52.01	8.30415	63.0671		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:41	50.01	8.30289	62.9377		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:45	50.51	8.30186	62.8346		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:49	51.01	8.30118	62.7164		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:51	51.5	8.3031	62.7055		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:55	48	8.2974	62.6477		

idcode	start_date	stop_date	secup (m)	seclow (m)	section_no	test_type	date (yyyymmdd)	bhlen (m)	temperature (degrees)	elcond (mS/m)	reference	comments
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 19:58	48.51	8.298	62.7014		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:00	49.01	8.30033	62.7165		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:03	49.51	8.30156	62.7039		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:06	46.01	8.2962	62.5326		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:09	44.01	8.29233	62.3703		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:12	42.01	8.2895	62.2229		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:15	40.01	8.28639	62.0578		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:18	40.5	8.28847	62.1141		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:20	41.01	8.28899	62.0931		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:23	38	8.28498	62.053		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:26	36.01	8.28064	61.8046		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:29	34	8.2786	61.7924		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:32	32	8.27545	61.7476		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:35	30.01	8.27313	61.6277		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:38	28	8.27059	61.6324		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:40	26	8.25398	60.6075		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:43	24	8.25139	60.2045		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:46	24.5	8.25296	60.5073		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:49	25	8.2541	60.4948		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:52	25.51	8.25633	60.5014		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 20:55	22	8.25167	60.628		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:00	22.51	8.25255	60.6286		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:03	23.01	8.25318	60.491		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:06	23.52	8.25403	61.045		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:09	21.5	8.25328	60.7427		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:11	21	8.2506	60.8028		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:14	20.51	8.24887	60.8029		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:17	20	8.24876	60.7919		
HLX 21	2006.05.18 14:39	2006.05.18 21:19	19.50	148.00		6	2006.05.18 21:19	19.51	8.24785	60.8069		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 11:55	148	8.87112	153.66		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 11:57	146	8.82796	153.357		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 11:59	144	8.81931	153.229		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:00	142	8.8113	152.736		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:01	140	8.79158	148.144		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:03	138	8.75957	118.634		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:04	136	8.74707	118.457		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:05	134	8.71002	62.9563		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:11	132	8.70183	63.3758		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:14	132.5	8.70194	63.0751		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:17	133	8.7048	64.9633		

			(m)	(m)			(yyyymmdd)	(m)	(degrees)	(mS/m)		
idcode	start_date	stop_date	secup	seclow	section_no	test_type	date	bhlen	temperature	elcond	reference	comments
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:20	133.5	8.71045	69.0774		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:24	130	8.70132	63.2646		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:27	128	8.7001	63.3543		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:31	126	8.6996	63.3583		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:34	124	8.64631	59.7348		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:36	124.5	8.65052	60.2128		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:39	125	8.69334	63.4062		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:42	125.5	8.69343	63.4183		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:46	122	8.64435	59.735		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:49	122.5	8.64396	59.7345		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:52	123	8.64547	59.7814		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:54	123.5	8.64361	60.0171		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 12:58	120	8.64362	59.8277		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:01	118	8.63966	59.6234		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:04	116	8.63949	59.4984		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:07	116.5	8.63864	59.4917		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:09	117	8.63944	59.736		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:13	117.5	8.6395	59.7138		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:16	114	8.63723	59.7414		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:19	112	8.63615	59.79		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:22	110	8.636	59.8003		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:25	108	8.6341	59.7914		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:28	106	8.63302	59.9045		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:32	104	8.63146	59.9959		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:35	102	8.6313	60.0321		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:38	100	8.62916	60.0336		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:41	98	8.62668	60.0844		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:44	96	8.59039	56.8396		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:47	94	8.60092	58.2165		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:50	94.5	8.59938	58.4392		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:53	92	8.59551	58.2093		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 13:56	90	8.59253	58.1421		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:00	88	8.5894	58.1673		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:03	86.01	8.58779	58.1645		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:06	84.01	8.5847	58.155		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:09	82	8.58293	58.2098		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:12	80	8.58031	58.2171		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:15	78.01	8.5784	58.2204		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:18	76	8.57527	58.2065		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:21	74	8.57387	58.3292		

idcode	start_date	stop_date	secup (m)	seclow (m)	section_no	test_type	date (yyyymmdd)	bhlen (m)	temperature (degrees)	elcond (mS/m)	reference	comments
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:24	72.01	8.57107	58.3303		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:27	70	8.56901	58.3357		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:31	68.01	8.56583	58.3168		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:34	66	8.56226	58.4419		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:37	64	8.5597	58.4575		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:40	62.01	8.55533	58.4346		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:43	60.01	8.55222	58.4436		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:46	58	8.54768	58.4509		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:49	56	8.54401	58.506		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:52	54.01	8.53924	58.5093		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 14:55	52	8.53622	58.5041		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:26	50.01	8.51369	58.8153		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:29	48.01	8.51044	58.9006		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:32	46.01	8.50874	58.928		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:35	44.01	8.50655	58.9036		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:37	42	8.5024	58.9284		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:40	40	8.49952	58.9278		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:43	38	8.49445	59.0364		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:46	36	8.49123	59.031		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:49	34.01	8.48717	59.0434		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:52	32	8.48373	59.0422		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:55	30	8.47997	59.1657		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 17:57	28.01	8.47518	59.1562		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:00	26.01	8.47129	59.1533		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:03	24	8.46786	59.1436		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:06	22	8.46261	59.1498		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:09	20.01	8.45806	59.1942		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:12	18.01	8.45342	59.2193		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:15	16	8.44902	59.2122		
HLX 35	2006.05.20 11:55	2006.05.20 18:18	14.00	148.00		6	2006.05.20 18:18	14.01	8.41217	58.9202		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:47	190	9.09801	66.4173		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:48	188	9.03999	66.4334		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:50	186	9.04036	66.4676		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:51	184	9.04183	66.4868		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:52	182	9.02768	66.4142		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:53	180	9.0062	66.5415		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 14:55	178	8.99096	66.4207		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:04	176	9.00219	66.4207		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:05	174	8.96326	66.4276		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:06	172	8.94827	66.4656		

			(m)	(m)			(yyyymmdd)	(m)	(degrees)	(mS/m)		
idcode	**start_date**	**stop_date**	**secup**	**seclow**	**section_no**	**test_type**	**date**	**bhlen**	**temperature**	**elcond**	**reference**	**comment s**
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:07	170	8.9448	66.3869		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:09	168	8.92402	66.4234		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:10	166	8.90444	66.3936		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:11	164	8.88279	66.4373		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:12	162	8.85991	66.4365		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:13	160	8.84388	66.3879		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:15	158	8.82715	66.4233		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:16	156	8.80534	66.4364		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:17	154	8.79222	66.4534		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:19	152	8.76907	66.4228		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:20	150	8.68997	66.3838		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:21	148	8.65847	66.4353		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:23	146	8.64544	66.3881		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:24	144	8.63939	66.3732		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:26	142	8.63463	66.3513		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:29	140	8.63645	66.4221		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:30	138	8.59789	66.402		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:31	136	8.56861	66.4669		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:33	134	8.54984	66.4771		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:34	132	8.52915	66.3758		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:36	130	8.50795	66.4041		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:37	128	8.48068	66.3454		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:38	126	8.46129	66.3678		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:40	124	8.44562	66.3538		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:41	122	8.41254	66.3142		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:42	120	8.3991	66.3798		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:44	118	8.36966	66.4512		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:45	116	8.36044	66.3303		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:47	114	8.33713	66.3968		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:49	112	8.32391	66.3411		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:50	110	8.30604	66.3998		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:51	108	8.2846	66.3889		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:52	106	8.27666	66.3497		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:53	104	8.23253	66.411		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:54	102	8.20692	66.3545		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:56	100	8.19488	66.3994		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:57	98.01	8.18633	66.3243		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 15:59	96.01	8.1198	66.3203		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:03	94	8.1028	450.507		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:07	94.5	8.10756	454.028		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:10	92.01	8.07408	451.047		

			(m)	(m)			(yyyymmdd)	(m)	(degrees)	(mS/m)		
idcode	**start_date**	**stop_date**	**secup**	**seclow**	**section_no**	**test_type**	**date**	**bhlen**	**temperature**	**elcond**	**reference**	**comments**
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:13	92.51	8.07338	450.534		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:16	93.01	8.07263	451.243		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:19	93.51	8.07294	451.502		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:22	90	8.07139	450.647		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:25	88.01	8.06433	450.992		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:28	86	8.05591	450.649		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:31	84	8.04761	450.587		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:34	82	8.03752	450.784		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:37	80.01	8.02765	449.456		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:40	78	8.01802	449.287		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:43	76.01	8.00847	449.314		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:46	74	7.99731	449.593		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:49	72.01	7.98891	448.224		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:52	70	7.9765	448.164		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:55	68.01	7.96731	448.358		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 16:58	66.01	7.95707	448.169		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:02	64.01	7.72077	329.08		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:10	65.5	8.02492	451.079		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:14	62.01	7.73378	327.757		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:17	62.5	7.75018	333.105		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:19	63.01	7.74949	335.21		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:23	63.5	7.74893	335.04		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:26	60.01	7.7481	333.391		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:29	58.01	7.74591	333.929		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:32	56.01	7.74301	332.989		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:35	54	7.74259	333.053		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:40	52.01	7.73834	333.315		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:43	50.01	7.73653	331.858		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:46	48.01	7.73384	332.01		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:48	46.01	7.73039	332.054		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:52	44	7.72917	331.089		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:55	42.01	7.72619	330.898		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 17:57	40.01	7.72419	330.555		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:00	38.01	7.71962	330.042		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:03	36.01	7.71539	330.26		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:06	34.01	7.71324	330.132		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:08	32.01	7.70896	330.156		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:11	30	7.37619	154.069		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:14	30.5	7.69441	330.288		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:17	29	7.4629	195.813		
HLX 38	2006.05.22 14:47	2006.05.22 18:21	29.00	190.00		6	2006.05.22 18:21	29.51	7.46248	201.587		

APPENDIX 6-2

SICADA Data Tables

Pump Tests

(Simplified version v1.4)

SICADA/Data Import Template

File Identity	
Created By	Stephan Rohs
Created	2006-06-15

Compiled By	
Quality Check For Delivery	
Delivery Approval	

Activity Type	HY 690 Pump tests

Project	AP PS 400-06-014

Activity Information						**Additional Activity Data**				
						C10	P20	P200	P220	R25
Idcode	**Start Date**	**Stop Date**	**Secup (m)**	**Seclow (m)**	**Section No**	**Company**	**Field crew manager**	**Field crew**	**evaluating data**	**Report**
HLX 21	2006.05.18 10:16	2006.05.18 21:29	9.10	150.30		Golder Associates	Stephan Rohs	Stephan Rohs, Philipp Wolf	Stephan Rohs	Stephan Rohs
HLX 35	2006.05.20 09:15	2006.05.20 18:21	6.10	151.80		Golder Associates	Stephan Rohs	Stephan Rohs, Philipp Wolf	Stephan Rohs	Stephan Rohs
HLX 38	2006.05.22 12:31	2006.05.23 09:30	15.10	199.50		Golder Associates	Stephan Rohs	Stephan Rohs, Philipp Wolf	Stephan Rohs	Stephan Rohs

Table	plu_s_hole_test_d PLU Injection and pumping, General information

Column	Datatype	Unit	Column Description
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
start_date	DATE		Date (yymmdd hh:mm:ss)
stop_date	DATE		Date (yymmdd hh:mm:ss)
project	CHAR		project code
idcode	CHAR		Object or borehole identification code
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
section_no	INTEGER	number	Section number
test_type	CHAR		Test type code (1-7), see table description
formation_type	CHAR		1: Rock, 2: Soil (superficial deposits)
start_flow_period	DATE	yyyymmdd	Date & time of pumping/injection start (YYYY-MM-DD hh:mm:ss)
stop_flow_period	DATE	yyyymmdd	Date & time of pumping/injection stop (YYYY-MM-DD hh:mm:ss)
flow_rate_end_qp	FLOAT	m**3/s	Flow rate at the end of the flowing period
value_type_qp	CHAR		0:true value,-1<lower meas.limit1:>upper meas.limit
mean_flow_rate_qm	FLOAT	m**3/s	Arithmetic mean flow rate during flow period
q_measl__l	FLOAT	m**3/s	Estimated lower measurement limit of flow rate
q_measl__u	FLOAT	m**3/s	Estimated upper measurement limit of flow rate
tot_volume_vp	FLOAT	m**3	Total volume of pumped or injected water
dur_flow_phase_tp	FLOAT	s	Duration of the flowing period of the test
dur_rec_phase_tf	FLOAT	s	Duration of the recovery period of the test
initial_head_hi	FLOAT	m	Hydraulic head in test section at start of the flow period
head_at_flow_end_h	FLOAT	m	Hydraulic head in test section at stop of the flow period.
final_head_hf	FLOAT	m	Hydraulic head in test section at stop of recovery period.
initial_press_pi	FLOAT	kPa	Groundwater pressure in test section at start of flow period
press_at_flow_end_	FLOAT	kPa	Groundwater pressure in test section at stop of flow period.
final_press_pf	FLOAT	kPa	Ground water pressure at the end of the recovery period.
fluid_temp_tew	FLOAT	oC	Measured section fluid temperature, see table description
fluid_elcond_ecw	FLOAT	mS/m	Measured section fluid el. conductivity,see table descr.
fluid_salinity_tdsw	FLOAT	mg/l	Total salinity of section fluid based on EC,see table descr.
fluid_salinity_tdswm	FLOAT	mg/l	Tot. section fluid salinity based on water sampling,see...
reference	CHAR		SKB report No for reports describing data and evaluation
comments	VARCHAR		Short comment to data
error_flag	CHAR		If error_flag = "*" then an error occured and an error
in_use	CHAR		If in_use = "*" then the activity has been selected as
sign	CHAR		Signature for QA data accknowledge (QA - OK)
lp	FLOAT	m	Hydraulic point of application

idcode	start_date	stop_date	secup	seclow	section_ no	test_type	formation_ type	start_flow_period	stop_flow_period	flow_rate_end_ qp	value_type_ qp	mean_flow_ rate_qm	q_measl__l	q_measl__u
HLX 21	060518 10:16:00	060518 21:29:00	9.10	150.30		1B	1	2006-05-18 12:26:33	2006-05-18 21:21:33	1.07E-03	0	1.09E-03	1.67E-05	2.50E-03
HLX 35	060520 09:15:00	060520 18:21:00	6.10	151.80		1B	1	2006-05-20 09:55:46	2006-05-20 09:55:46	9.97E-04	0	1.00E-03	1.67E-05	2.50E-03
HLX 38	060522 12:31:00	060523 09:30:21	15.10	199.50		1B	1	2006-05-22 12:46:30	2006-05-22 22:30:30	1.10E-03	0	1.11E-03	1.67E-05	2.50E-03

idcode	tot_volume_vp	dur_flow_ phase_tp	dur_rec_ phase_tf	initial_head_ hi	head_at_flow_ end_hp	final_head_ hf	initial_press_ pi	press_at_flow _end_pp	final_press_ pf	fluid_temp_ tew	fluid_elcond_ ecw	fluid_salinity _tdsw	fluid_salinity _tdswm	reference	comments	lp
HLX 21	3.50E+01	32086	#NF			#NF	188	158	#NF	8.7						
HLX 35	3.00E+01	30047	#NF			#NF	166	132	#NF	8.7						
HLX 38	3.89E+01	35059	39597			4.88	252	179	248	8.1						

Table	plu_s_hole_test_ed1		
	PLU Single hole tests, pumping/injection. Basic evaluation		
Column	**Datatype**	**Unit**	**Column Description**
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
start_date	DATE		Date (yymmdd hh:mm:ss)
stop_date	DATE		Date (yymmdd hh:mm:ss)
project	CHAR		project code
idcode	CHAR		Object or borehole identification code
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
section_no	INTEGER	number	Section number
test_type	CHAR		Test type code (1-7), see table description!
formation_type	CHAR		Formation type code. 1: Rock, 2: Soil (superficial deposits)
lp	FLOAT	m	Hydraulic point of application for test section, see descr.
seclen_class	FLOAT	m	Planned ordinary test interval during test campaign.
spec_capacity_q_s	FLOAT	m**2/s	Specific capacity (Q/s) of test section, see table descript.
value_type_q_s	CHAR		0:true value,-1:Q/s<lower meas.limit,1:Q/s>upper meas.limit
transmissivity_tq	FLOAT	m**2/s	Tranmissivity based on Q/s, see table description
value_type_tq	CHAR		0:true value,-1:TQ<lower meas.limit,1:TQ>upper meas.limit.
bc_tq	CHAR		Best choice code. 1 means TQ is best choice of T, else 0
transmissivity_moye	FLOAT	m**2/s	Transmissivity,TM, based on Moye (1967)
bc_tm	CHAR		Best choice code. 1 means Tmoye is best choice of T, else 0
value_type_tm	CHAR		0:true value,-1:TM<lower meas.limit,1:TM>upper meas.limit.
hydr_cond_moye	FLOAT	m/s	K_M: Hydraulic conductivity based on Moye (1967)
formation_width_b	FLOAT	m	b:Aquifer thickness repr. for T(generally b=Lw) ,see descr.
width_of_channel_b	FLOAT	m	B:Inferred width of formation for evaluated TB
tb	FLOAT	m**3/s	TB:Flow capacity in 1D formation of T & width B, see descr.
l_measl_tb	FLOAT	m**3/s	Estimated lower meas. limit for evaluated TB,see description
u_measl_tb	FLOAT	m**3/s	Estimated upper meas. limit of evaluated TB,see description
sb	FLOAT	m	SB:S=storativity,B=width of formation,1D model,see descript.
assumed_sb	FLOAT	m	SB* : Assumed SB,S=storativity,B=width of formation,see...
leakage_factor_lf	FLOAT	m	Lf:1D model for evaluation of Leakage factor
transmissivity_tt	FLOAT	m**2/s	TT:Transmissivity of formation, 2D radial flow model,see...
value_type_tt	CHAR		0:true value,-1:TT<lower meas.limit,1:TT>upper meas.limit,
bc_tt	CHAR		Best choice code. 1 means TT is best choice of T, else 0
l_measl_q_s	FLOAT	m**2/s	Estimated lower meas. limit for evaluated TT,see table descr
u_measl_q_s	FLOAT	m**2/s	Estimated upper meas. limit for evaluated TT,see description
storativity_s	FLOAT		S:Storativity of formation based on 2D rad flow,see descr.
assumed_s	FLOAT		Assumed Storativity,2D model evaluation,see table descr.
bc_s	FLOAT		Best choice of S (Storativity) ,see descr.
ri	FLOAT	m	Radius of influence
ri_index	CHAR		ri index=index of radius of influence :-1,0 or 1, see descr.
leakage_coeff	FLOAT	1/s	K'/b':2D rad flow model evaluation of leakage coeff,see desc
hydr_cond_ksf	FLOAT	m/s	Ksf:3D model evaluation of hydraulic conductivity,see desc.
value_type_ksf	CHAR		0:true value,-1:Ksf<lower meas.limit,1:Ksf>upper meas.limit,
l_measl_ksf	FLOAT	m/s	Estimated lower meas.limit for evaluated Ksf,see table desc.
u_measl_ksf	FLOAT	m/s	Estimated upper meas.limit for evaluated Ksf,see table descr
spec_storage_ssf	FLOAT	1/m	Ssf:Specific storage,3D model evaluation,see table descr.
assumed_ssf	FLOAT	1/m	Ssf*:Assumed Spec.storage,3D model evaluation,see table des.
c	FLOAT	m**3/pa	C: Wellbore storage coefficient; flow or recovery period
cd	FLOAT		CD: Dimensionless wellbore storage coefficient
skin	FLOAT		Skin factor;best estimate of flow/recovery period,see descr.
dt1	FLOAT	s	Estimated start time of evaluation, see table description
dt2	FLOAT	s	Estimated stop time of evaluation. see table description
t1	FLOAT	s	Start time for evaluated parameter from start flow period
t2	FLOAT	s	Stop time for evaluated parameter from start of flow period
dte1	FLOAT	s	Start time for evaluated parameter from start of recovery
dte2	FLOAT	s	Stop time for evaluated parameter from start of recovery
p_horner	FLOAT	kPa	p*:Horner extrapolated pressure, see table description
transmissivity_t_nlr	FLOAT	m**2/s	T_NLR Transmissivity based on None Linear Regression...
storativity_s_nlr	FLOAT		S_NLR=storativity based on None Linear Regression,see..
value_type_t_nlr	CHAR		0:true value,-1:T_NLR<lower meas.limit,1:>upper meas.limit
bc_t_nlr	CHAR		Best choice code. 1 means T_NLR is best choice of T, else 0
c_nlr	FLOAT	m**3/pa	Wellbore storage coefficient, based on NLR, see descr.
cd_nlr	FLOAT		Dimensionless wellbore storage constant, see table descrip.
skin_nlr	FLOAT		Skin factor based on Non Linear Regression,see desc.
transmissivity_t_grf	FLOAT	m**2/s	T_GRF:Transmissivity based on Genelized Radial Flow,see...
value_type_t_grf	CHAR		0:true value,-1:T_GRF<lower meas.limit,1:>upper meas.limit
bc_t_grf	CHAR		Best choice code. 1 means T_GRF is best choice of T, else 0
storativity_s_grf	FLOAT		S_GRF:Storativity based on Generalized Radial Flow, see des.
flow_dim_grf	FLOAT		Inferred flow dimesion based on Generalized Rad. Flow model
comment	VARCHAR	no_unit	Short comment to the evaluated parameters
error_flag	CHAR		If error_flag = "*" then an error occured and an error
in_use	CHAR		If in_use = "*" then the activity has been selected as
sign	CHAR		Signature for QA data accknowledge (QA - OK)

idcode	start_date	stop_date	secup	seclow	section_no	test_type	formation_type	lp	seclen_class	spec_capacity_q_s	value_type_q_s	transmissivity_tq	value_type_tq	bc_tq	transmissivity_moye	bc_tm	value_type_tm	hydr_cond_moye	formation_width_b
HLX 21	060518 10:16:00	060518 21:29:00	9.10	150.30		1B	1		141	3.50E-04	0				4.75E-04	0	0	3.36E-06	
HLX 35	060520 09:15:00	060520 18:21:00	6.10	151.80		1B	1		146	2.72E-04	0				3.70E-04	0	0	2.54E-06	
HLX 38	060522 12:31:00	060523 09:30:21	15.10	199.50		1B	1		184	1.48E-04	0				2.07E-04	0	0	1.12E-06	

idcode	width_of_channel_b	tb	l_measl_tb	u_measl_tb	sb	assumed_sb	leakage_factor_lf	transmissivity_tt	value_type_tt	bc_tt	l_measl_q_s	u_measl_q_s	storativity_s	assumed_s	bc_s	ri	ri_index	leakage_coeff	hydr_cond_ksf	value_type_ksf	l_measl_ksf	u_measl_ksf
HLX 21								4.32E-04	0	1	2.00E-04	6.00E-04	1.00E-03	1.00E-03		137.02	-1					
HLX 35								4.82E-04	0	1	2.00E-04	7.00E-04	1.00E-03	1.00E-03		330.61	-1					
HLX 38								1.16E-04	0	1	9.00E-05	3.00E-04	1.00E-03	1.00E-03		1388.12	0					

idcode	spec_storage_ssf	assumed_ssf	c	cd	skin	dt1	dt2	t1	t2	dte1	dte2	p_horner	transmissivity_t_nlr	storativity_s_nlr	value_type_t_nlr	bc_t_nlr	c_nlr	cd_nlr	skin_nlr	transmissivity_t_grf	value_type_t_grf	bc_t_grf	storativity_s_grf	flow_dim_grf	comment
HLX 21			3.01E-06	9.78E-02	-2.78	535	#NF					#NF													
HLX 35			2.56E-06	8.32E-02	0.10	501	#NF					#NF													
HLX 38			2.64E-06	8.57E-02	-2.43	584	660					254.5													