

**P-06-229**

**Supplement 1**

June 2007

## **Oskarshamn site investigation**

### **Difference flow logging of boreholes KLX09G, KLX10B and KLX10C**

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# Description

In the present supplement all groundwater head calculations have been redone on revised borehole elevation data (Z-coordinates).

The borehole coordinates that formed the basis for this revision of groundwater head data were retrieved from SKB Sicada 2007-03-07 EG154 (provided by SKB in file Krökdata\_korrigerade\_070307\_KLX03-KLX29 utom KLX15, HLX13,15,26-28,32,36-38,43.xls) /Stenberg and Håkansson 2007/.

Some mistakes in the fracture frequency graphs have also been fixed.

Specifically the following appendices are revised and included in this supplement;

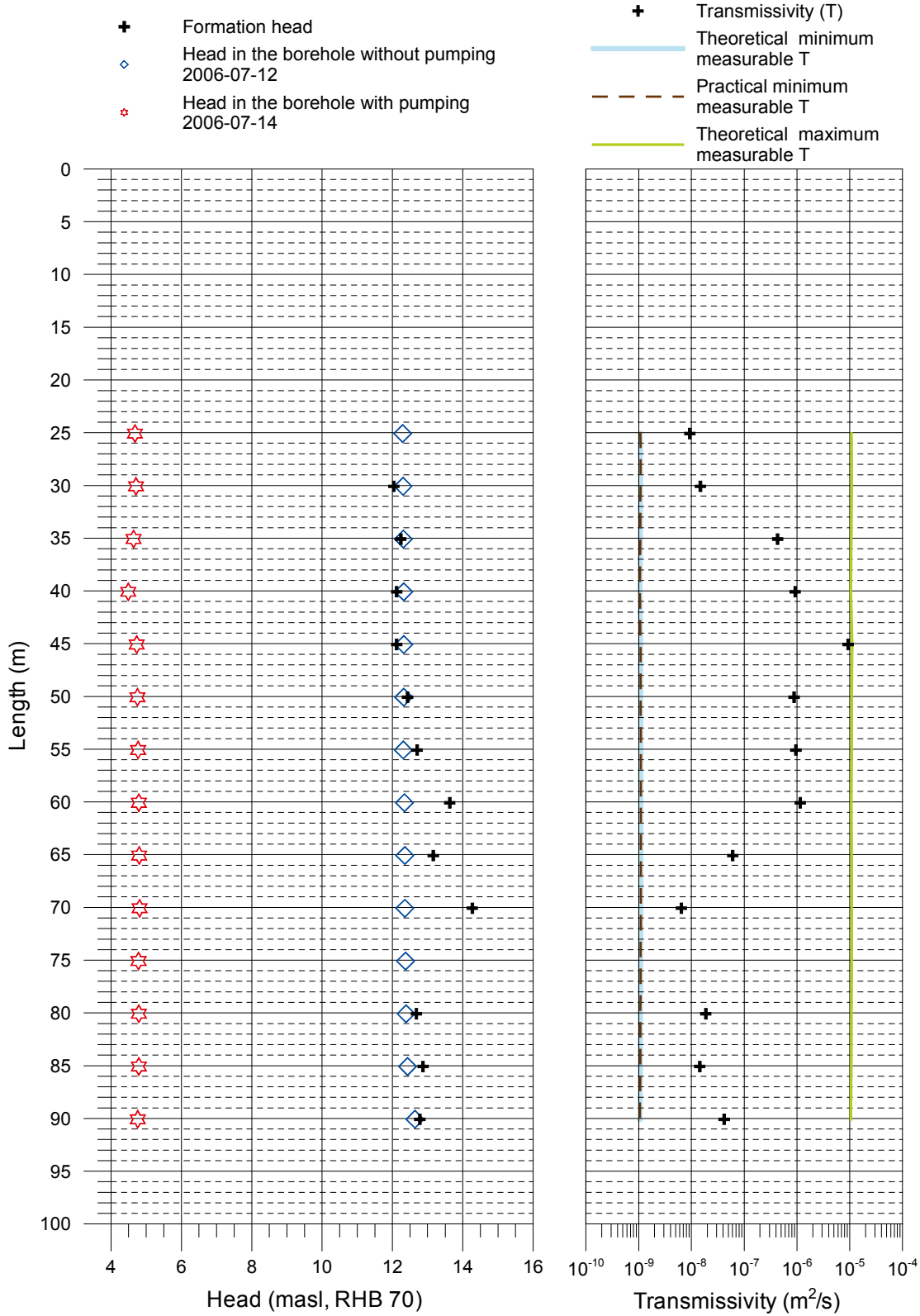
<b>Revised appendices</b>	<b>Appendix number</b>
<b>Borehole KLX09G</b>	
Transmissivity and head of 5 m sections	Appendix 9G.4.2
Transmissivity and head of detected fractures	Appendix 9G.5
Sequential flow logging	Appendix 9G.7
Inferred flow anomalies from overlapping flow logging	Appendix 9G.8.1
Plotted conductive fracture frequency	Appendix 9G.11
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<b>Borehole KLX10C</b>	
Transmissivity and head of 5 m sections	Appendix 10C.4.2
Transmissivity and head of detected fractures	Appendix 10C.5
Sequential flow logging	Appendix 10C.7
Inferred flow anomalies from overlapping flow logging	Appendix 10C.8
Plotted conductive fracture frequency	Appendix 10C.11
Comparison between section transmissivity and fracture transmissivity	Appendix 10C.12
Head in the borehole during flowlogging	Appendix 10C.13.1
Air pressure, water level in borehole and pumping rate during flow logging	Appendix 10C.13.2
Groundwater recovery after pumping	Appendix 10C.13.3
Water level and air pressure measured by SKB	Appendix SKB.1

## Reference

**Stenberg L, Håkansson N, 2007.** Revision of borehole deviation measurements in Oskarshamn, Svensk Kärnbränslehantering AB (in preparation).

## Appendix 9G.4.2

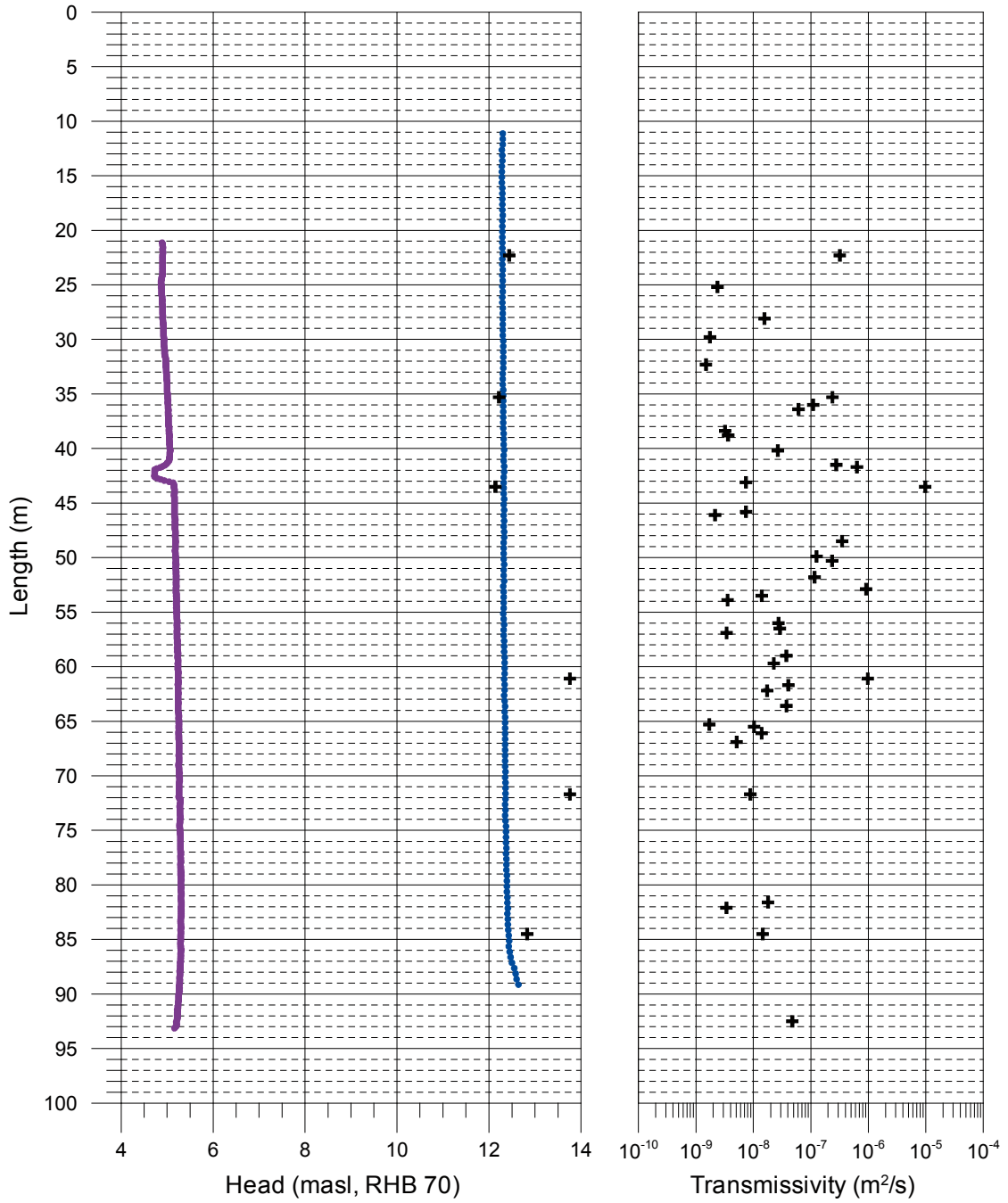
### Laxemar, borehole KLX09G Transmissivity and head of 5 m sections



# Appendix 9G.5

## Laxemar, borehole KLX09G Transmissivity and head of detected fractures

- + Fracture head
- Head in the borehole without pumping (L=5 m, dL=0.5 m) 2006-07-12
- Head in the borehole with pumping (L=1 m, dL=0.1 m) 2006-07-14 - 2006-07-15
- + Transmissivity of fracture



## Appendix 9G.7

### Difference flow logging – Sequential flow logging

Borehole ID	Secup L (m)	Seclow L (m)	L <sub>w</sub> (m)	Q <sub>0</sub> (m <sup>3</sup> /s)	h <sub>0FW</sub> (m.a.s.l.)	Q <sub>1</sub> (m <sup>3</sup> /s)	h <sub>1FW</sub> (m.a.s.l.)	T <sub>D</sub> (m <sup>2</sup> /s)	h <sub>i</sub> (m.a.s.l.)	Q-lower limit P (mL/h)	TD-meas <sub>LT</sub> (m <sup>2</sup> /s)	TD-meas <sub>LP</sub> (m <sup>2</sup> /s)	TD-meas <sub>U</sub> (m <sup>2</sup> /s)	Comments
KLX09G	22.58	27.58	5	–	12.29	7.17E–08	4.68	9.3E–09	–	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	27.58	32.58	5	–3.89E–09	12.30	1.09E–07	4.71	1.5E–08	12.0	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	32.58	37.58	5	–2.92E–08	12.31	3.31E–06	4.64	4.3E–07	12.2	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	37.58	42.58	5	–1.87E–07	12.32	7.11E–06	4.49	9.2E–07	12.1	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	42.58	47.58	5	–1.86E–06	12.32	6.97E–05	4.73	9.3E–06	12.1	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	47.58	52.58	5	9.56E–08	12.32	6.86E–06	4.75	8.8E–07	12.4	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	52.58	57.58	5	3.81E–07	12.31	7.67E–06	4.77	9.6E–07	12.7	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	57.58	62.58	5	1.51E–06	12.34	1.03E–05	4.79	1.2E–06	13.6	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	62.58	67.58	5	4.94E–08	12.35	5.11E–07	4.80	6.0E–08	13.2	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	67.58	72.58	5	1.25E–08	12.35	6.17E–08	4.81	6.5E–09	14.3	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	72.58	77.58	5	–	12.37	–	4.78	–	–	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	77.58	82.58	5	5.56E–09	12.39	1.49E–07	4.79	1.9E–08	12.7	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	82.58	87.58	5	6.39E–09	12.43	1.17E–07	4.79	1.4E–08	12.9	30	1.1E–09	1.1E–09	1.1E–05	
KLX09G	87.58	92.58	5	6.11E–09	12.64	3.39E–07	4.76	4.2E–08	12.8	30	1.0E–09	1.0E–09	1.0E–05	

## Appendix 9G.8.1

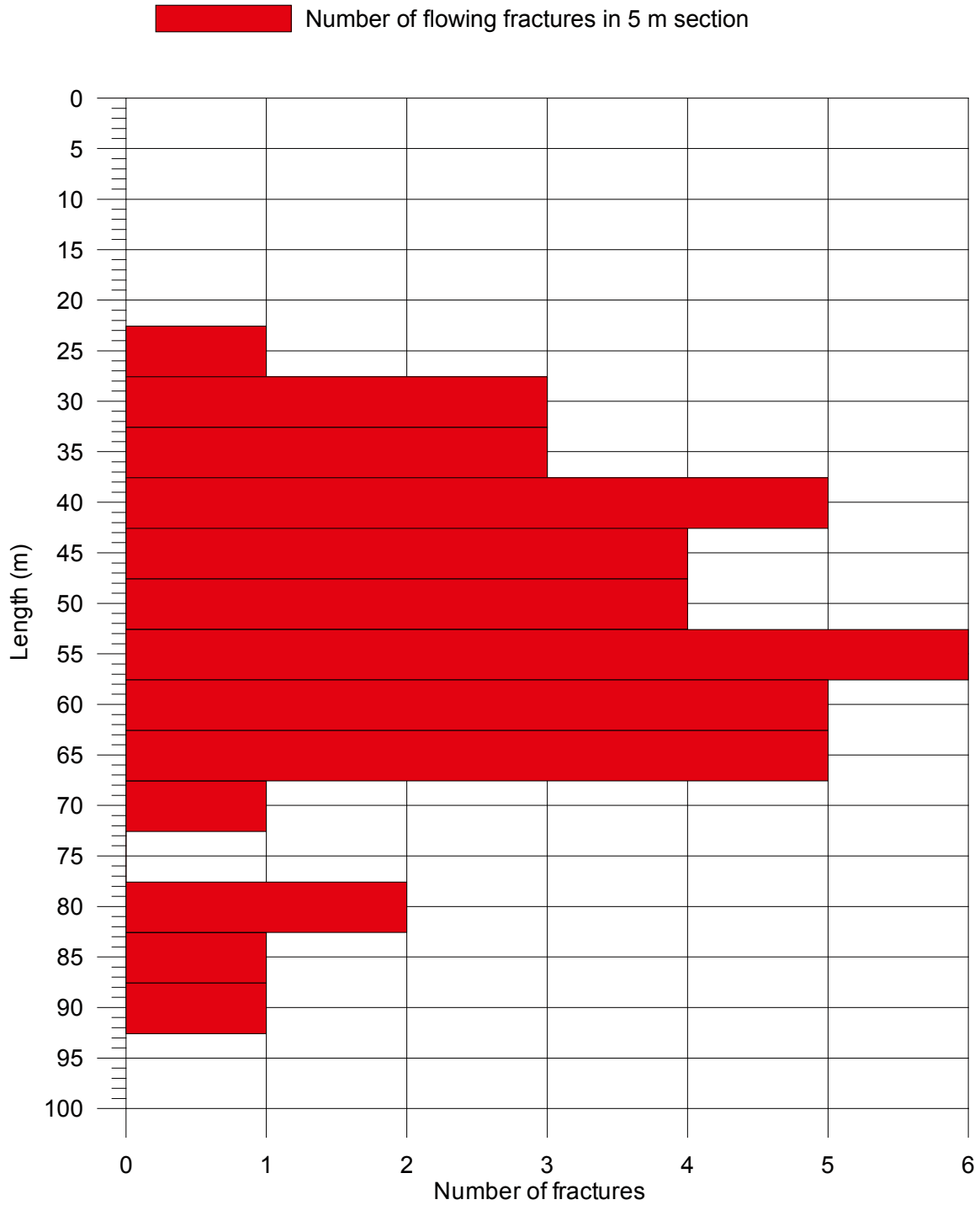
### PFL – Difference flow logging – Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	L <sub>w</sub> (m)	dL (m)	Q <sub>0</sub> (m <sup>3</sup> /s)	h <sub>0FW</sub> (m.a.s.l.)	Q <sub>1</sub> (m <sup>3</sup> /s)	h <sub>1FW</sub> (m.a.s.l.)	T <sub>D</sub> (m <sup>2</sup> /s)	h <sub>i</sub> (m.a.s.l.)	Comments
KLX09G	22.3	1	0.1	4.47E-08	12.30	2.44E-06	4.90	3.2E-07	12.4	
KLX09G	25.2	1	0.1	–	12.29	1.78E-08	4.87	2.4E-09	–	*
KLX09G	28.1	1	0.1	–	12.30	1.17E-07	4.90	1.6E-08	–	
KLX09G	29.8	1	0.1	–	12.30	1.31E-08	4.93	1.8E-09	–	*
KLX09G	32.3	1	0.1	–	12.31	1.11E-08	4.98	1.5E-09	–	*
KLX09G	35.3	1	0.1	-2.28E-08	12.31	1.73E-06	5.01	2.4E-07	12.2	
KLX09G	36.0	1	0.1	–	12.31	8.11E-07	5.02	1.1E-07	–	
KLX09G	36.4	1	0.1	–	12.31	4.50E-07	5.03	6.1E-08	–	
KLX09G	38.4	1	0.1	–	12.32	2.36E-08	5.04	3.2E-09	–	*
KLX09G	38.8	1	0.1	–	12.32	2.67E-08	5.06	3.6E-09	–	*
KLX09G	40.2	1	0.1	–	12.33	1.95E-07	5.07	2.7E-08	–	
KLX09G	41.5	1	0.1	–	12.33	2.06E-06	4.96	2.8E-07	–	
KLX09G	41.7	1	0.1	–	12.33	4.78E-06	4.87	6.3E-07	–	
KLX09G	43.1	1	0.1	–	12.32	5.44E-08	5.09	7.5E-09	–	*
KLX09G	43.5	1	0.1	-1.79E-06	12.32	6.92E-05	5.15	9.8E-06	12.1	
KLX09G	45.8	1	0.1	–	12.33	5.42E-08	5.16	7.5E-09	–	
KLX09G	46.1	1	0.1	–	12.32	1.56E-08	5.16	2.2E-09	–	*
KLX09G	48.5	1	0.1	–	12.32	2.52E-06	5.19	3.5E-07	–	
KLX09G	49.9	1	0.1	–	12.32	9.11E-07	5.19	1.3E-07	–	*
KLX09G	50.3	1	0.1	–	12.32	1.68E-06	5.19	2.3E-07	–	
KLX09G	51.8	1	0.1	–	12.32	8.36E-07	5.19	1.2E-07	–	*
KLX09G	52.9	1	0.1	–	12.32	6.61E-06	5.19	9.2E-07	–	
KLX09G	53.5	1	0.1	–	12.32	1.01E-07	5.20	1.4E-08	–	
KLX09G	53.9	1	0.1	–	12.32	2.56E-08	5.21	3.6E-09	–	
KLX09G	56.0	1	0.1	–	12.33	1.97E-07	5.21	2.7E-08	–	
KLX09G	56.5	1	0.1	–	12.32	2.08E-07	5.22	2.9E-08	–	
KLX09G	56.9	1	0.1	–	12.32	2.44E-08	5.22	3.4E-09	–	*
KLX09G	59.0	1	0.1	–	12.34	2.69E-07	5.23	3.8E-08	–	
KLX09G	59.7	1	0.1	–	12.34	1.63E-07	5.23	2.3E-08	–	*
KLX09G	61.1	1	0.1	1.41E-06	12.33	8.42E-06	5.24	9.8E-07	13.8	
KLX09G	61.7	1	0.1	–	12.34	2.92E-07	5.24	4.1E-08	–	
KLX09G	62.2	1	0.1	–	12.34	1.25E-07	5.24	1.7E-08	–	*
KLX09G	63.6	1	0.1	–	12.35	2.71E-07	5.24	3.8E-08	–	
KLX09G	65.3	1	0.1	–	12.35	1.22E-08	5.26	1.7E-09	–	*
KLX09G	65.5	1	0.1	–	12.35	7.39E-08	5.26	1.0E-08	–	
KLX09G	66.1	1	0.1	–	12.35	9.97E-08	5.25	1.4E-08	–	*
KLX09G	66.9	1	0.1	–	12.35	3.67E-08	5.26	5.1E-09	–	
KLX09G	71.7	1	0.1	1.25E-08	12.36	7.61E-08	5.26	8.9E-09	13.8	
KLX09G	81.6	1	0.1	–	12.40	1.29E-07	5.31	1.8E-08	–	
KLX09G	82.1	1	0.1	–	12.41	2.44E-08	5.30	3.4E-09	–	
KLX09G	84.5	1	0.1	5.83E-09	12.43	1.10E-07	5.30	1.5E-08	12.8	
KLX09G	92.5	1	0.1	–	12.43	3.47E-07	5.20	4.8E-08	–	

\* Uncertain = The flow rate is less than 30 mL/h or the flow anomalies are overlapping or they are unclear because of noise.

## Appendix 9G.11

Laxemar, borehole KLX09G  
Calculation of conductive fracture frequency



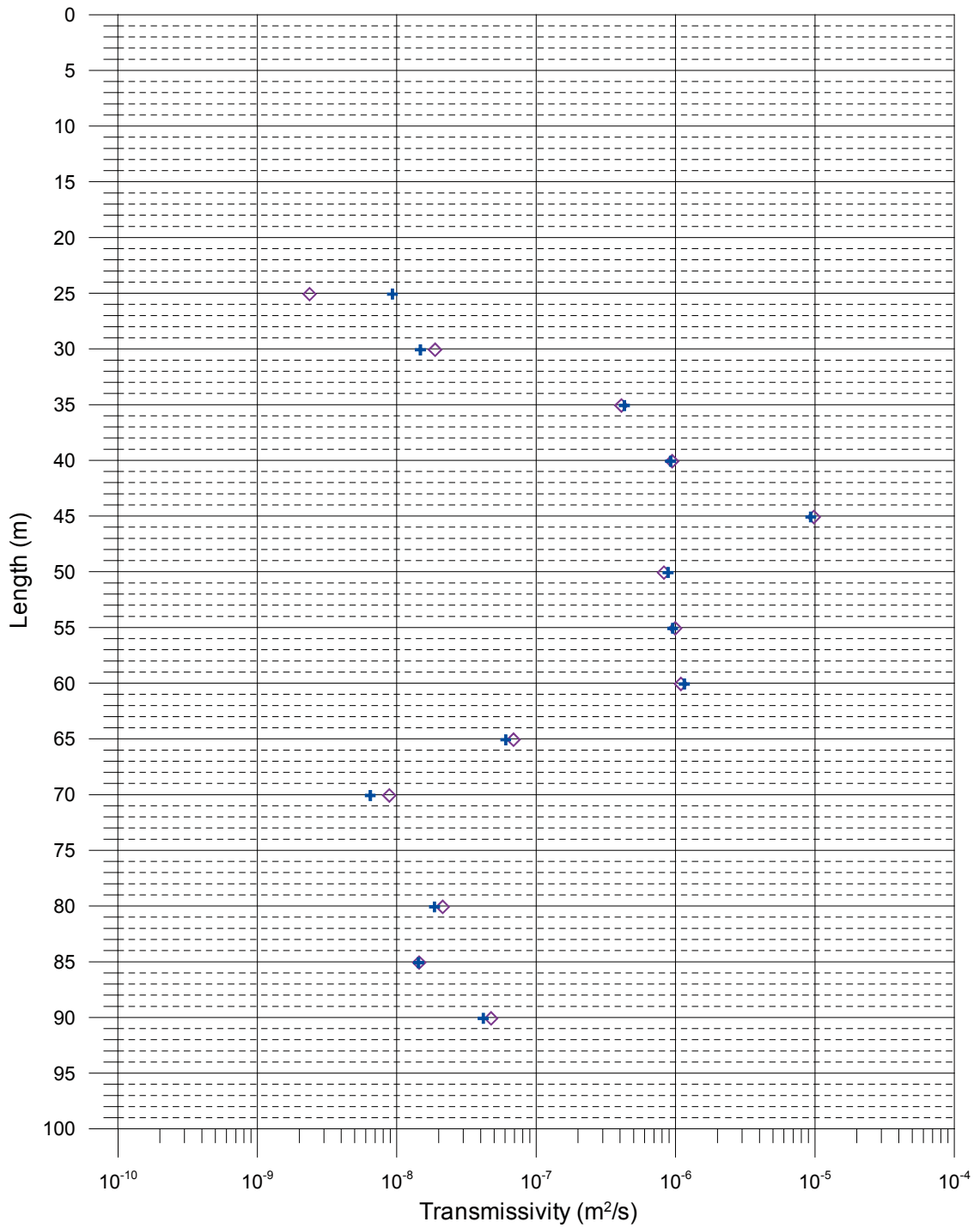


# Appendix 9G.12

Laxemar, borehole KLX09G

Comparison between section transmissivity and fracture transmissivity

- ◇ Transmissivity (sum of fracture specific results  $T_f$ )
- + Transmissivity (results of 5m measurements  $T_s$ )

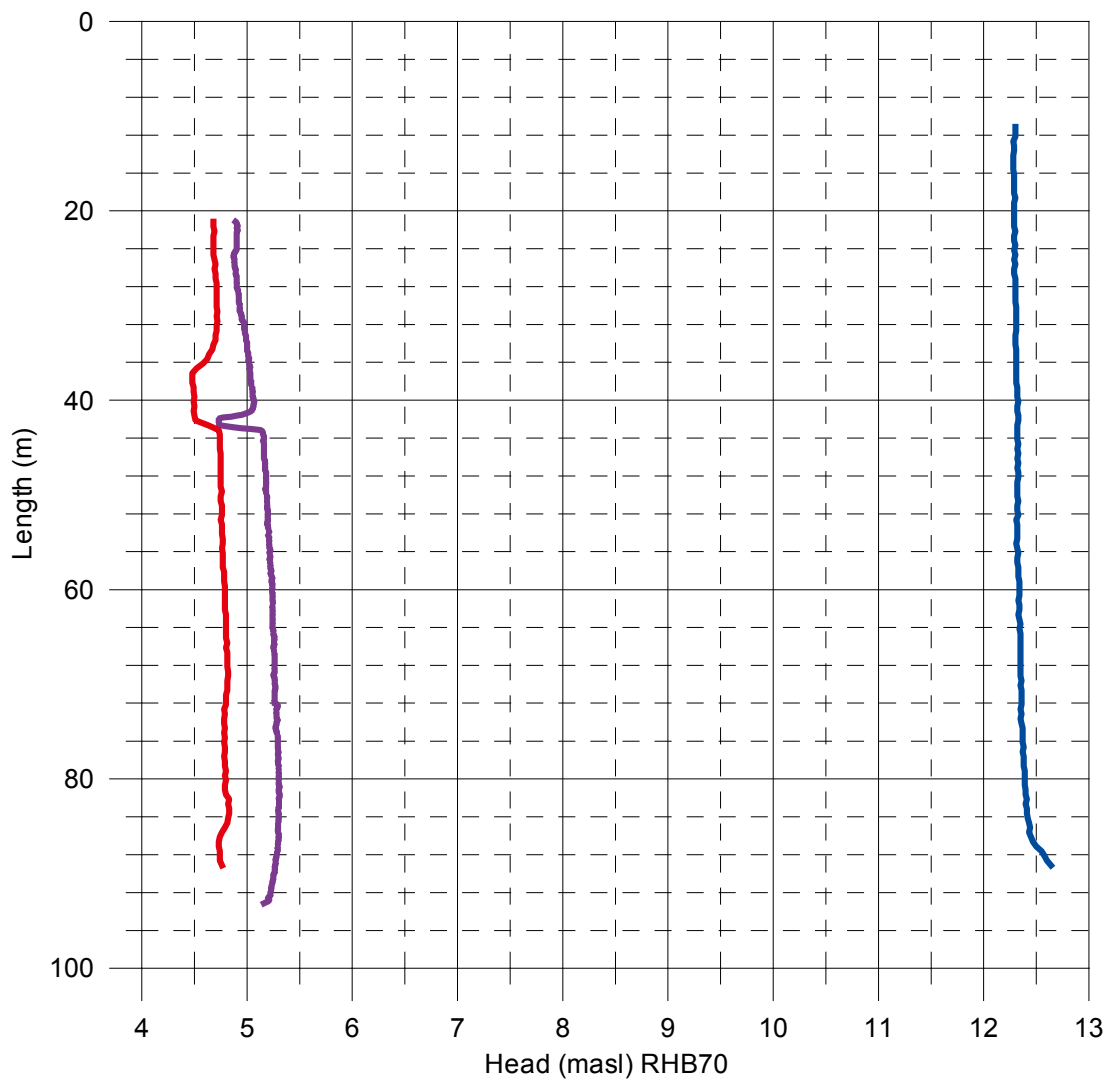


## Appendix 9G.13.1

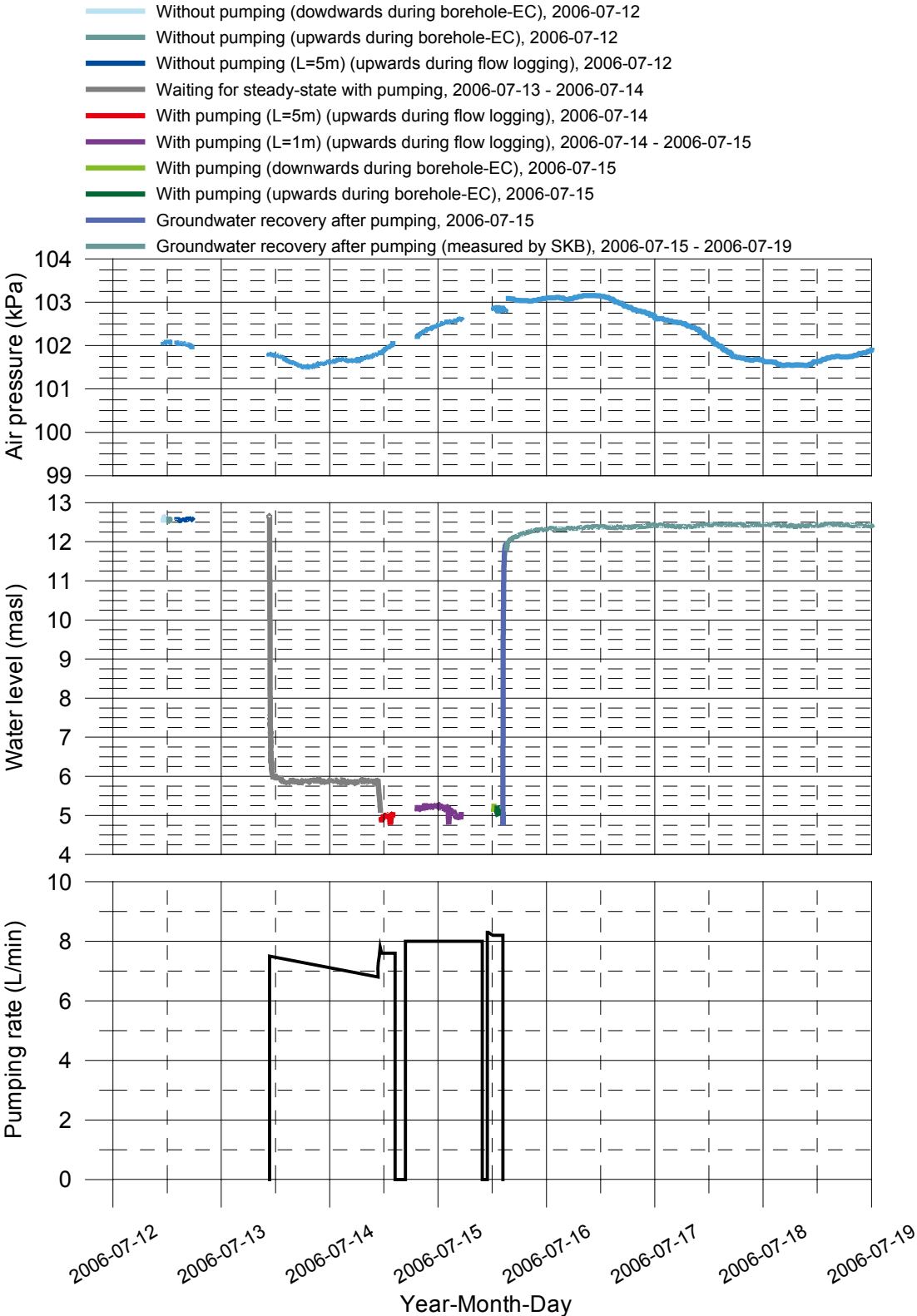
### Laxemar, borehole KLX09G Head in the borehole during flow logging

Head(masl)= (Absolute pressure (Pa) - Airpressure (Pa) + Offset) / (1000 kg/m<sup>3</sup> \* 9.80665 m/s<sup>2</sup>) + Elevation (m)  
Offset = 2300 Pa (Correction for absolut pressure sensor)

- Without pumping (upwards during flow logging, L=5 m, dL=0.5 m), 2006-07-12 - 2006-07-12
- With pumping (upwards during flow logging, Drawdown 7.87 m, L=5 m, dL=0.5 m), 2006-07-14 - 2006-07-14
- With pumping (upwards during flow logging Drawdown 7.87 m, L=1 m, dL=0.1 m), 2006-07-14 - 2006-07-15



Laxemar, borehole KLX09G  
 Air pressure, water level in the borehole and pumping rate during flow logging

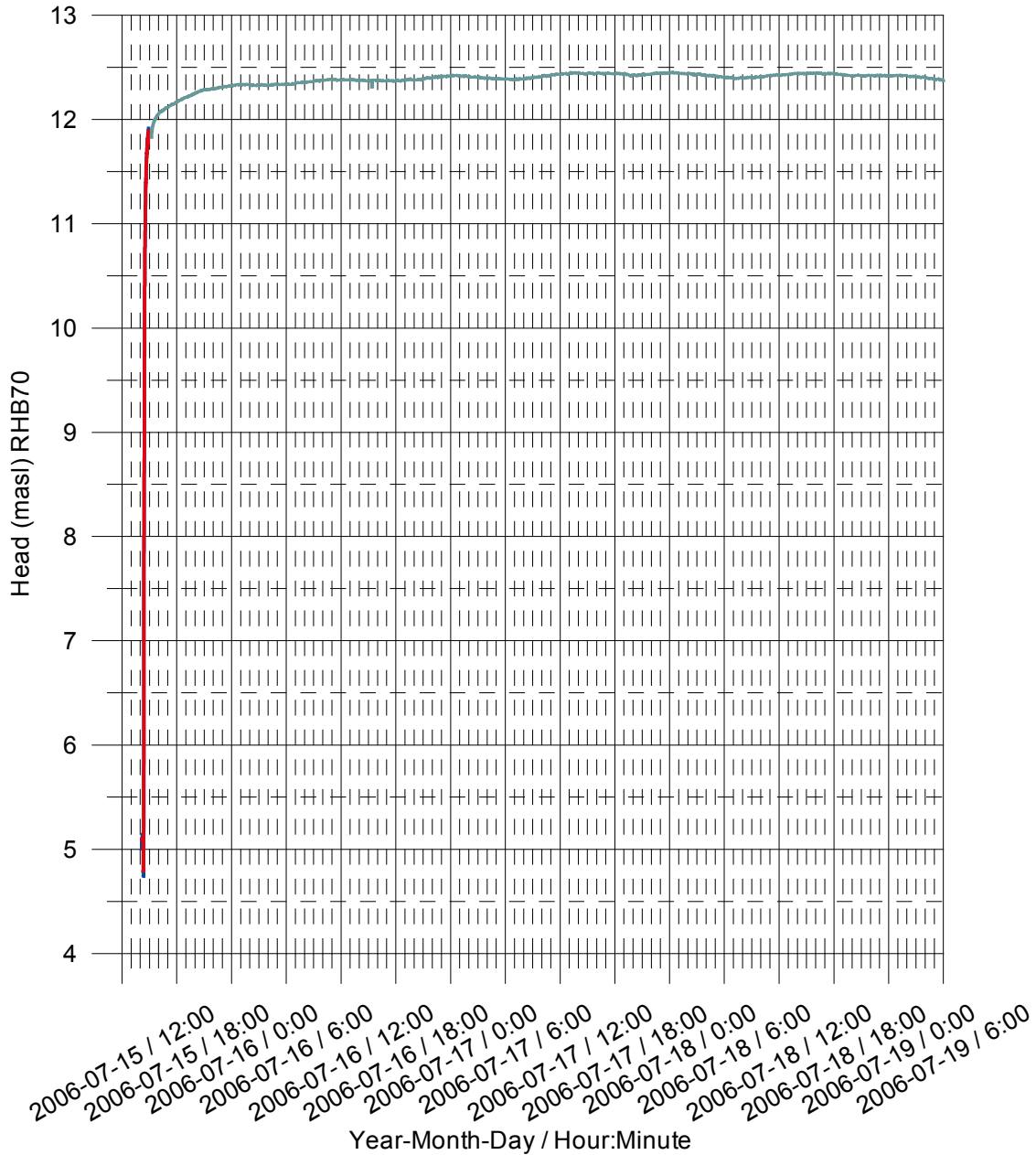


## Appendix 9G.13.3

### Laxemar, borehole KLX09G Groundwater recovery after pumping

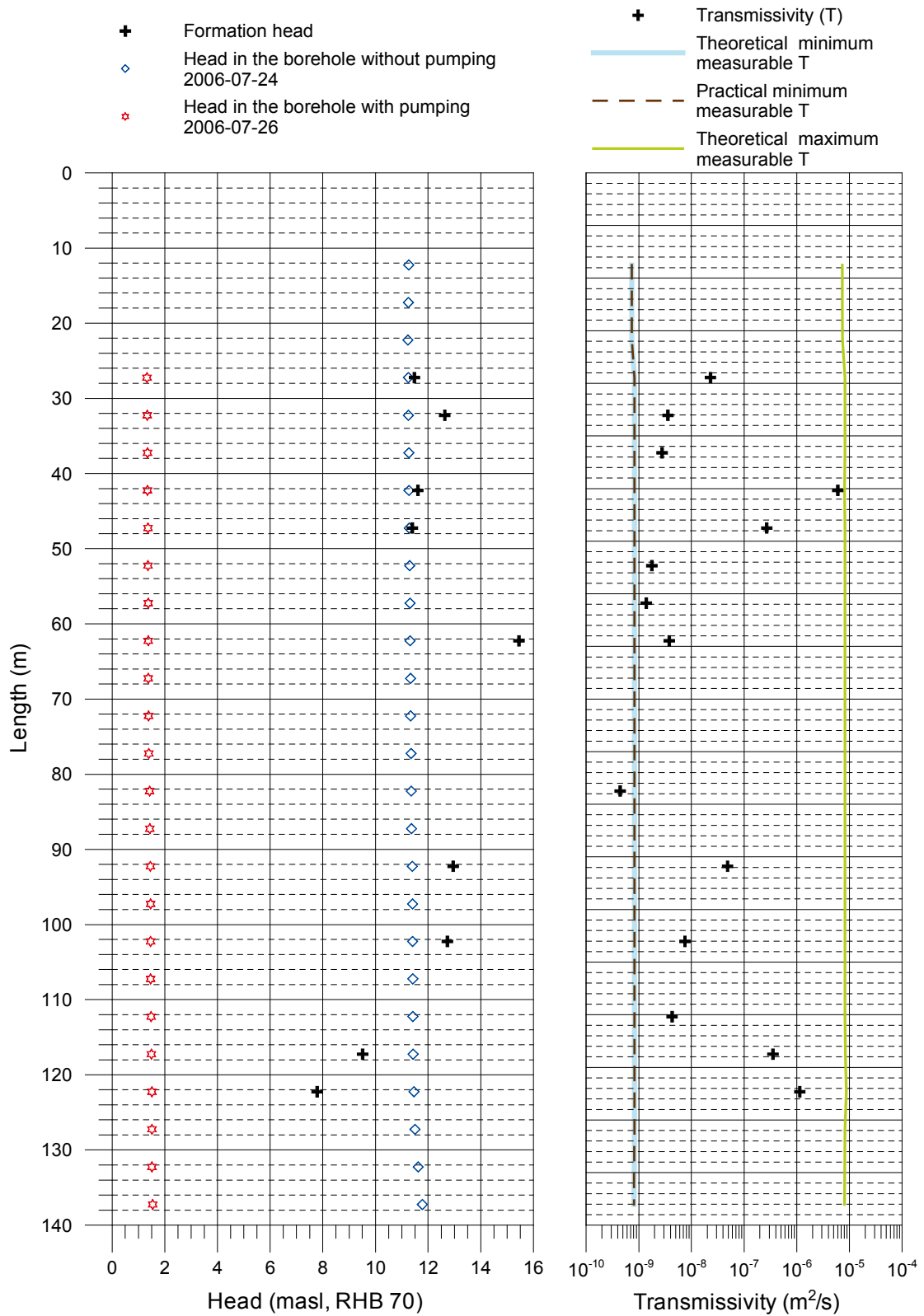
Head(masl) = (Absolute pressure (Pa) - Airpressure (Pa) + Offset) / (1000 kg/m<sup>3</sup> \* 9.80665 m/s<sup>2</sup>) + Elevation (m)  
Offset = 2300 Pa (Correction for absolut pressure sensor)

- Measured at the length of 18.06 m using water level pressure sensor
- Corrected pressure measured at the length of 22.14 m using absolute pressure sensor
- Measured by SKB using water level pressure sensor



## Appendix 10C.4.2

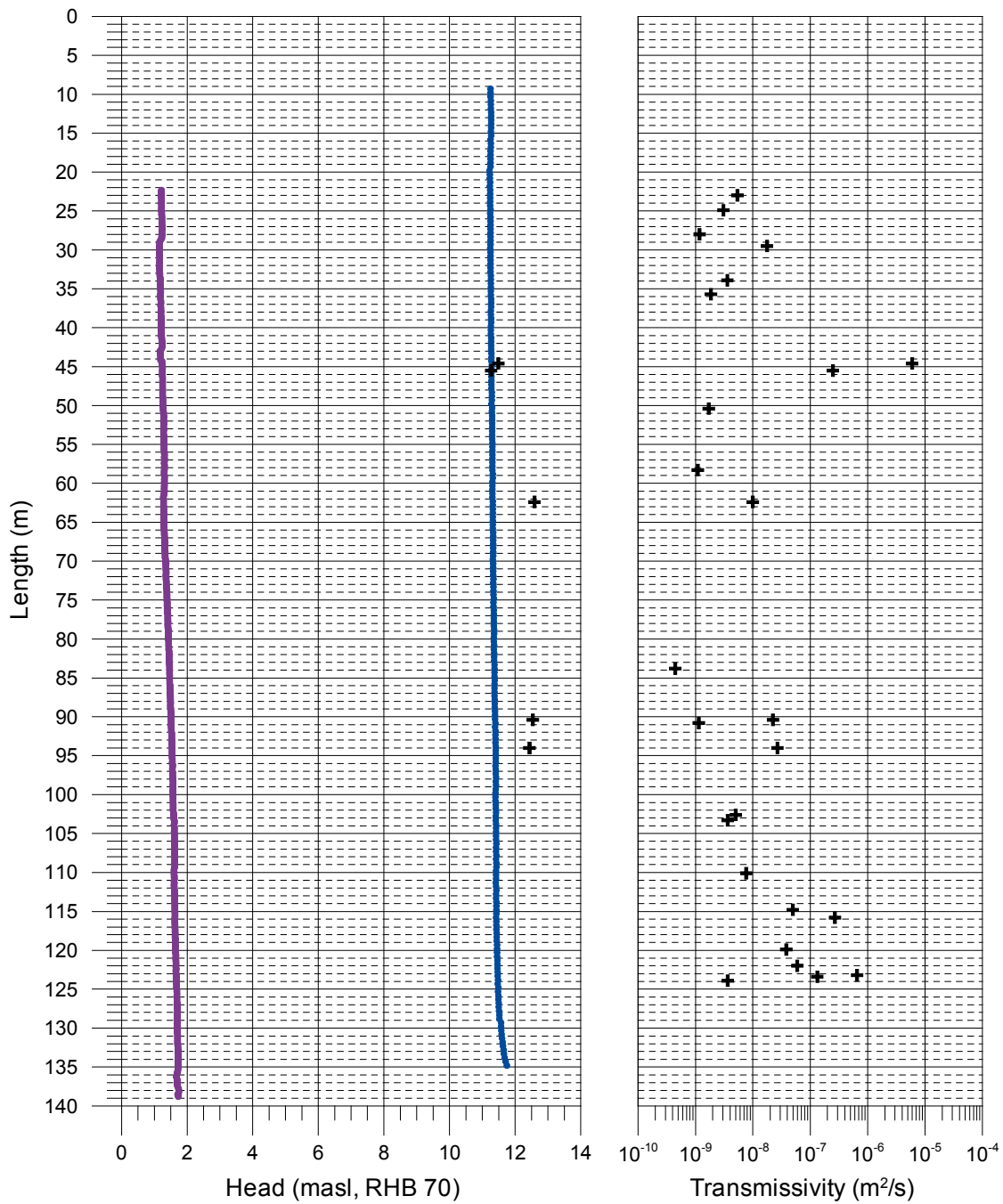
### Laxemar, borehole KLX10C Transmissivity and head of 5 m sections



## Appendix 10C.5

### Laxemar, borehole KLX10C Transmissivity and head of detected fractures

- + Fracture head
- Head in the borehole without pumping (L=5 m, dL=0.5 m)  
2006-07-24
- Head in the borehole with pumping (L=1 m, dL=0.1 m)  
2006-07-26 - 2006-07-27
- + Transmissivity of fracture



## Appendix 10C.7

### Difference flow logging – Sequential flow logging

Borehole ID	Secup L (m)	Seclow L (m)	L <sub>w</sub> (m)	Q <sub>0</sub> (m <sup>3</sup> /s)	h <sub>0FW</sub> (m.a.s.l.)	Q <sub>1</sub> (m <sup>3</sup> /s)	h <sub>1FW</sub> (m.a.s.l.)	T <sub>D</sub> (m <sup>2</sup> /s)	h <sub>i</sub> (m.a.s.l.)	Q-lower limit P (mL/h)	TD-meas <sub>LT</sub> (m <sup>2</sup> /s)	TD-meas <sub>LP</sub> (m <sup>2</sup> /s)	TD-meas <sub>U</sub> (m <sup>2</sup> /s)	Comments
KLX10C	9.75	14.75	5	–	11.26	–	–	–	–	30	7.3E–10	7.3E–10	7.3E–06	
KLX10C	14.75	19.75	5	–	11.25	–	–	–	–	30	7.3E–10	7.3E–10	7.3E–06	
KLX10C	19.75	24.75	5	–	11.23	–	–	–	–	30	7.3E–10	7.3E–10	7.3E–06	
KLX10C	24.75	29.75	5	5.28E–09	11.25	2.36E–07	1.32	2.3E–08	11.5	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	29.75	34.75	5	5.00E–09	11.25	4.08E–08	1.33	3.6E–09	12.6	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	34.75	39.75	5	–	11.27	2.78E–08	1.34	2.8E–09	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	39.75	44.75	5	2.03E–06	11.27	6.22E–05	1.34	6.0E–06	11.6	30	8.3E–10	8.3E–10	8.1E–06	
KLX10C	44.75	49.75	5	3.19E–08	11.28	2.73E–06	1.36	2.7E–07	11.4	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	49.75	54.75	5	–	11.30	1.78E–08	1.36	1.8E–09	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	54.75	59.75	5	–	11.31	1.39E–08	1.37	1.4E–09	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	59.75	64.75	5	1.58E–08	11.31	5.39E–08	1.37	3.8E–09	15.5	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	64.75	69.75	5	–	11.33	–	1.37	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	69.75	74.75	5	–	11.33	–	1.38	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	74.75	79.75	5	–	11.35	–	1.39	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	79.75	84.75	5	–	11.36	4.44E–09	1.42	4.4E–10	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	84.76	89.76	5	–	11.37	–	1.43	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	89.76	94.76	5	7.61E–08	11.40	5.64E–07	1.45	4.8E–08	13.0	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	94.76	99.76	5	–	11.41	–	1.46	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	99.75	104.75	5	1.00E–08	11.41	8.56E–08	1.46	7.5E–09	12.7	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	104.74	109.74	5	–	11.42	–	1.46	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	109.75	114.75	5	–	11.42	4.31E–08	1.48	4.3E–09	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	114.75	119.75	5	–6.86E–07	11.43	2.86E–06	1.49	3.5E–07	9.5	30	8.3E–10	8.3E–10	8.4E–06	
KLX10C	119.76	124.76	5	–4.25E–06	11.46	7.25E–06	1.51	1.1E–06	7.8	30	8.3E–10	8.3E–10	8.7E–06	
KLX10C	124.75	129.75	5	–	11.50	–	1.51	–	–	30	8.3E–10	8.3E–10	8.3E–06	
KLX10C	129.75	134.75	5	–	11.62	–	1.51	–	–	30	8.2E–10	8.2E–10	8.2E–06	
KLX10C	134.75	139.75	5	–	11.78	–	1.54	–	–	30	8.0E–10	8.0E–10	8.1E–06	

## Appendix 10C.8

### PFL – Difference flow logging – Inferred flow anomalies from overlapping flow logging

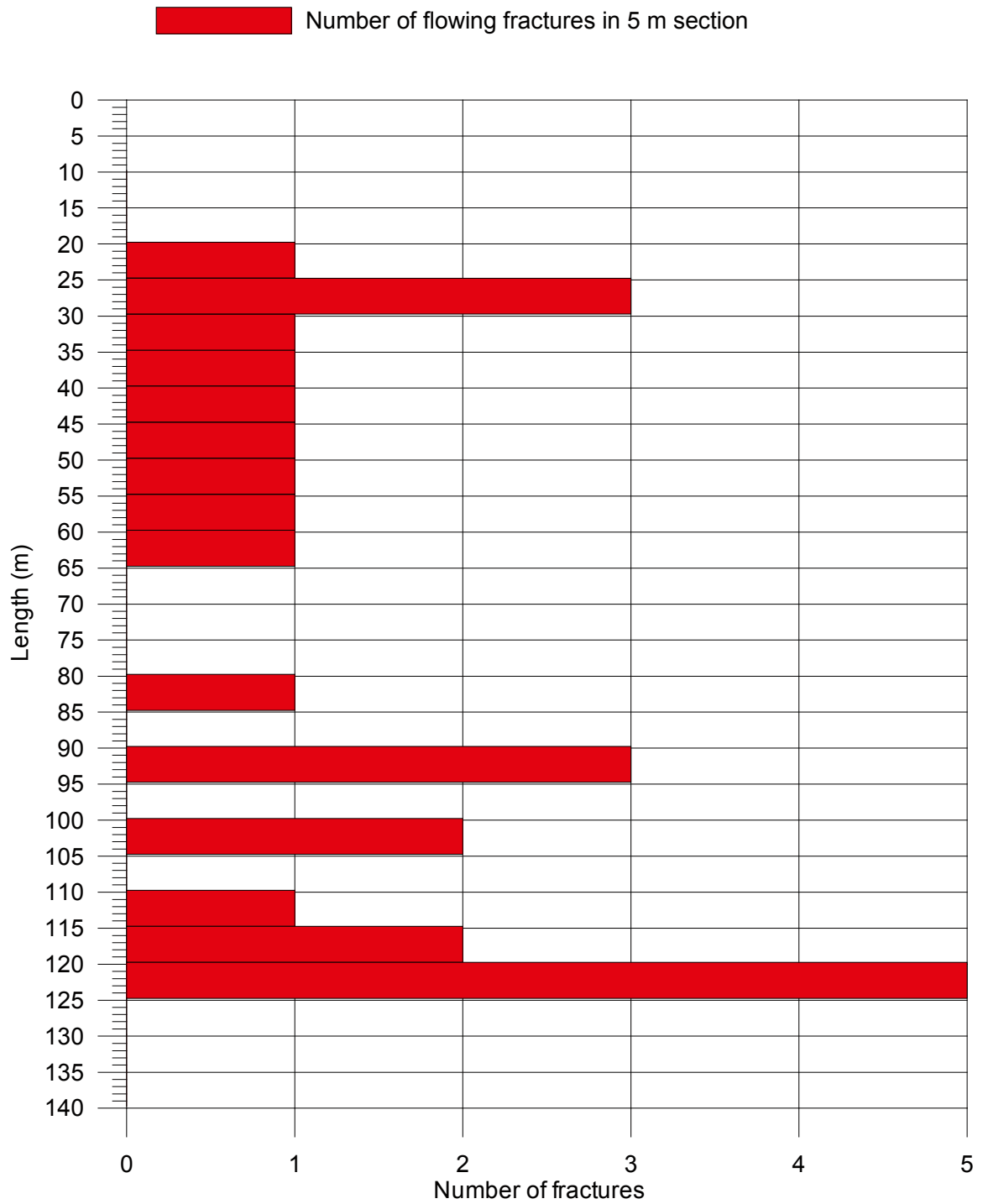
Borehole ID	Length to flow anom. L (m)	$L_w$ (m)	dL (m)	$Q_0$ (m <sup>3</sup> /s)	$h_{0FW}$ (m.a.s.l.)	$Q_1$ (m <sup>3</sup> /s)	$h_{1FW}$ (m.a.s.l.)	$T_D$ (m <sup>2</sup> /s)	$h_i$ (m.a.s.l.)	Comments
KLX10C	23.0	1	0.1	–	11.24	5.44E-08	1.21	5.4E-09	–	*
KLX10C	24.9	1	0.1	–	11.25	3.11E-08	1.21	3.1E-09	–	
KLX10C	28.0	1	0.1	–	11.25	1.19E-08	1.24	1.2E-09	–	
KLX10C	29.5	1	0.1	–	11.25	1.81E-07	1.15	1.8E-08	–	
KLX10C	33.9	1	0.1	–	11.26	3.67E-08	1.18	3.6E-09	–	
KLX10C	35.7	1	0.1	–	11.26	1.89E-08	1.19	1.9E-09	–	
KLX10C	44.6	1	0.1	2.08E-06	11.29	6.25E-05	1.23	5.9E-06	11.6	
KLX10C	45.5	1	0.1	3.28E-08	11.28	2.54E-06	1.24	2.5E-07	11.4	
KLX10C	50.4	1	0.1	–	11.30	1.72E-08	1.27	1.7E-09	–	
KLX10C	58.3	1	0.1	–	11.31	1.11E-08	1.31	1.1E-09	–	
KLX10C	62.4	1	0.1	1.56E-08	11.32	1.17E-07	1.28	1.0E-08	12.9	
KLX10C	83.8	1	0.1	–	11.37	4.44E-09	1.47	4.4E-10	–	*
KLX10C	90.4	1	0.1	3.89E-08	11.39	2.62E-07	1.51	2.2E-08	13.1	
KLX10C	90.8	1	0.1	–	11.40	1.14E-08	1.51	1.1E-09	–	*
KLX10C	94.0	1	0.1	4.44E-08	11.41	3.11E-07	1.54	2.7E-08	13.1	
KLX10C	102.6	1	0.1	–	11.41	5.00E-08	1.59	5.0E-09	–	
KLX10C	103.3	1	0.1	–	11.41	3.61E-08	1.61	3.7E-09	–	
KLX10C	110.1	1	0.1	–	11.42	7.61E-08	1.60	7.7E-09	–	
KLX10C	114.8	1	0.1	–	11.43	4.92E-07	1.62	5.0E-08	–	
KLX10C	115.8	1	0.1	–	11.42	2.67E-06	1.62	2.7E-07	–	
KLX10C	119.9	1	0.1	–	11.45	3.78E-07	1.64	3.8E-08	–	
KLX10C	122.0	1	0.1	–	11.46	5.89E-07	1.66	5.9E-08	–	
KLX10C	123.2	1	0.1	–	11.47	6.50E-06	1.67	6.6E-07	–	
KLX10C	123.4	1	0.1	–	11.47	1.32E-06	1.67	1.3E-07	–	*
KLX10C	123.9	1	0.1	–	11.48	3.61E-08	1.67	3.6E-09	–	*

\* Uncertain = The flow rate is less than 30 mL/h or the flow anomalies are overlapping or they are unclear because of noise.



## Appendix 10C.11

Laxemar, borehole KLX10C  
Calculation of conductive fracture frequency

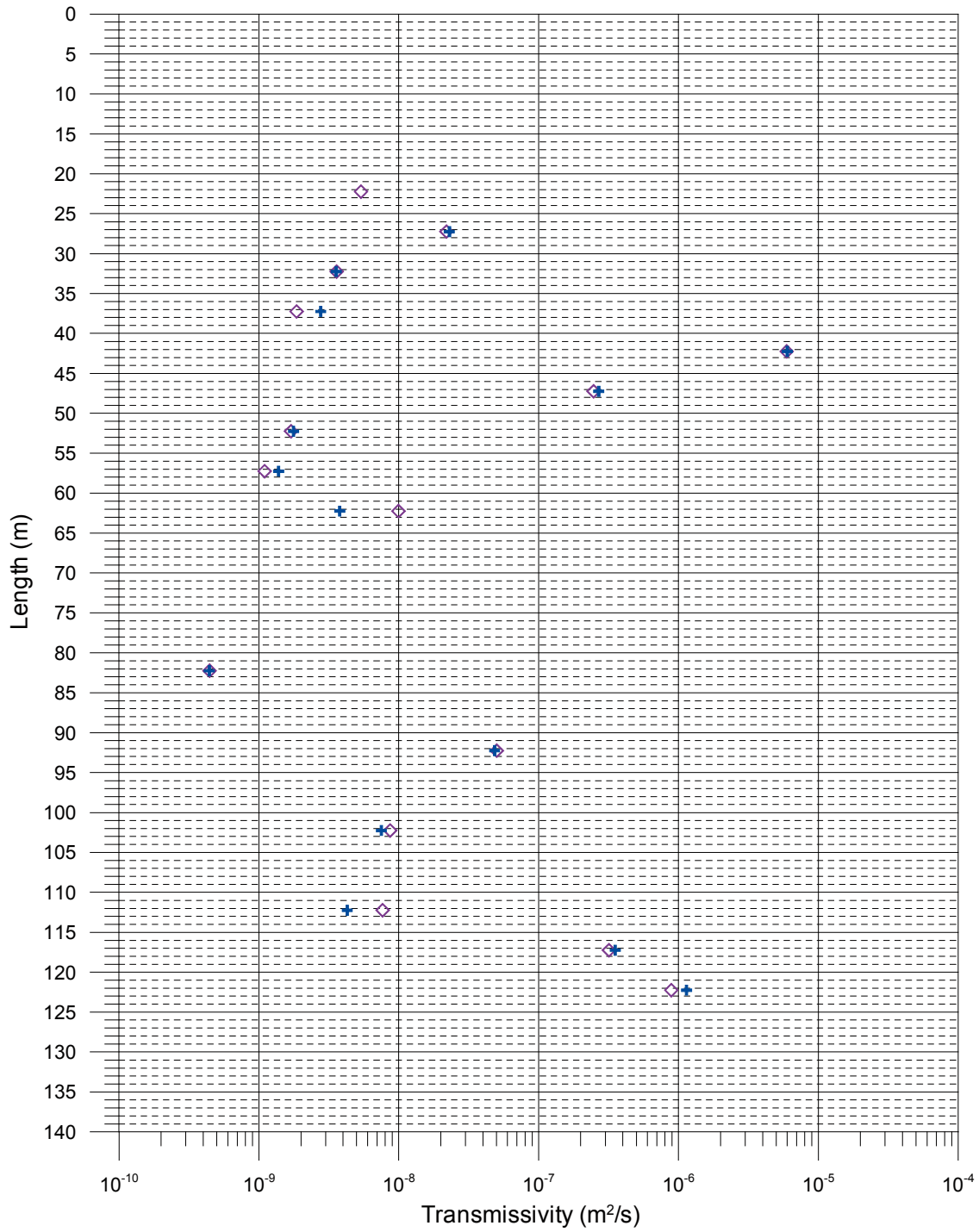


# Appendix 10C.12

Laxemar, borehole KLX10C

Comparison between section transmissivity and fracture transmissivity

- ◇ Transmissivity (sum of fracture specific results  $T_f$ )
- + Transmissivity (results of 5m measurements  $T_s$ )

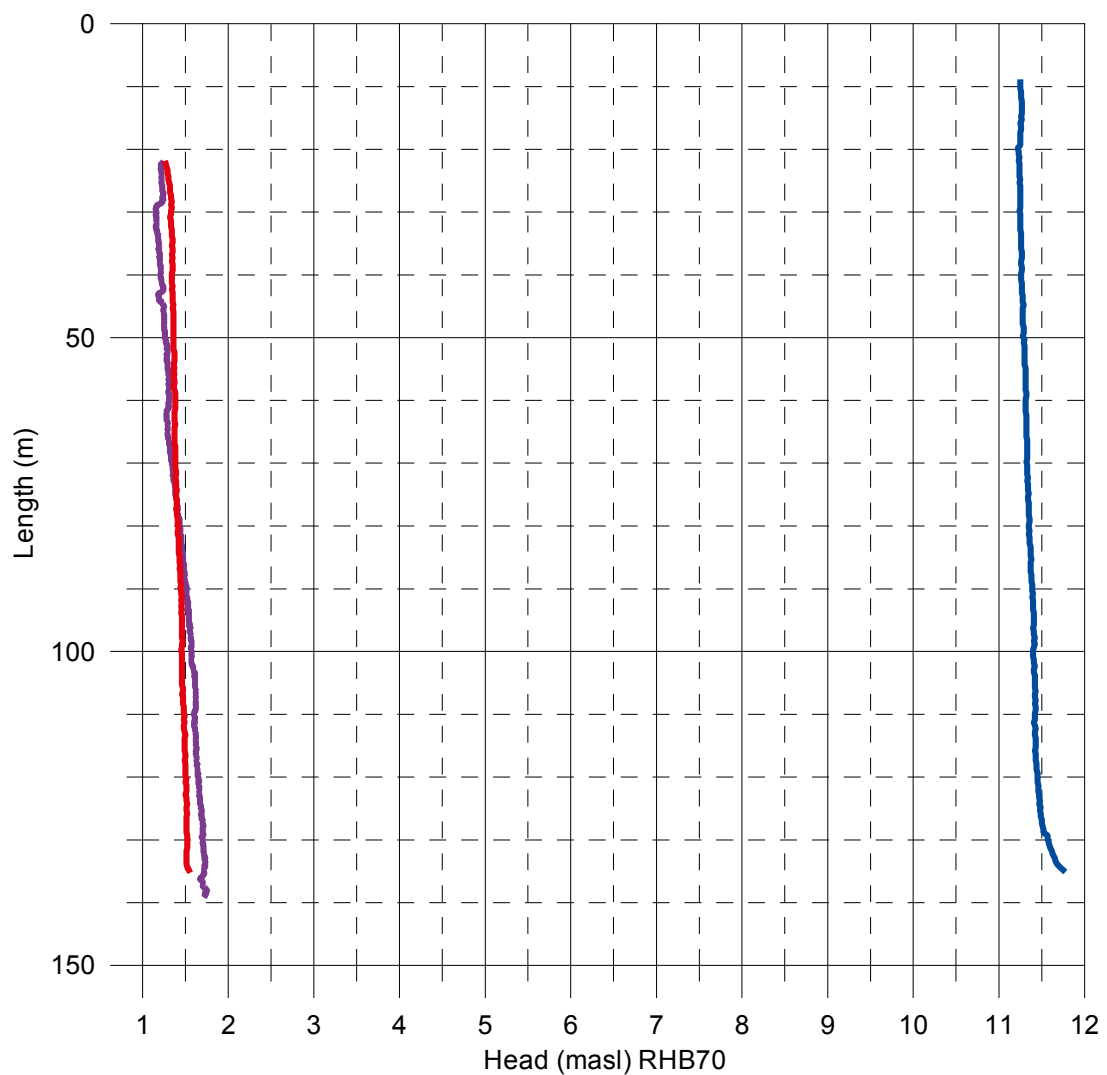


## Appendix 10C.13.1

### Laxemar, borehole KLX10C Head in the borehole during flow logging

Head(masl) = (Absolute pressure (Pa) - Airpressure (Pa) + Offset) / (1000 kg/m<sup>3</sup> \* 9.80665 m/s<sup>2</sup>) + Elevation (m)  
Offset = 2300 Pa (Correction for absolute pressure sensor)

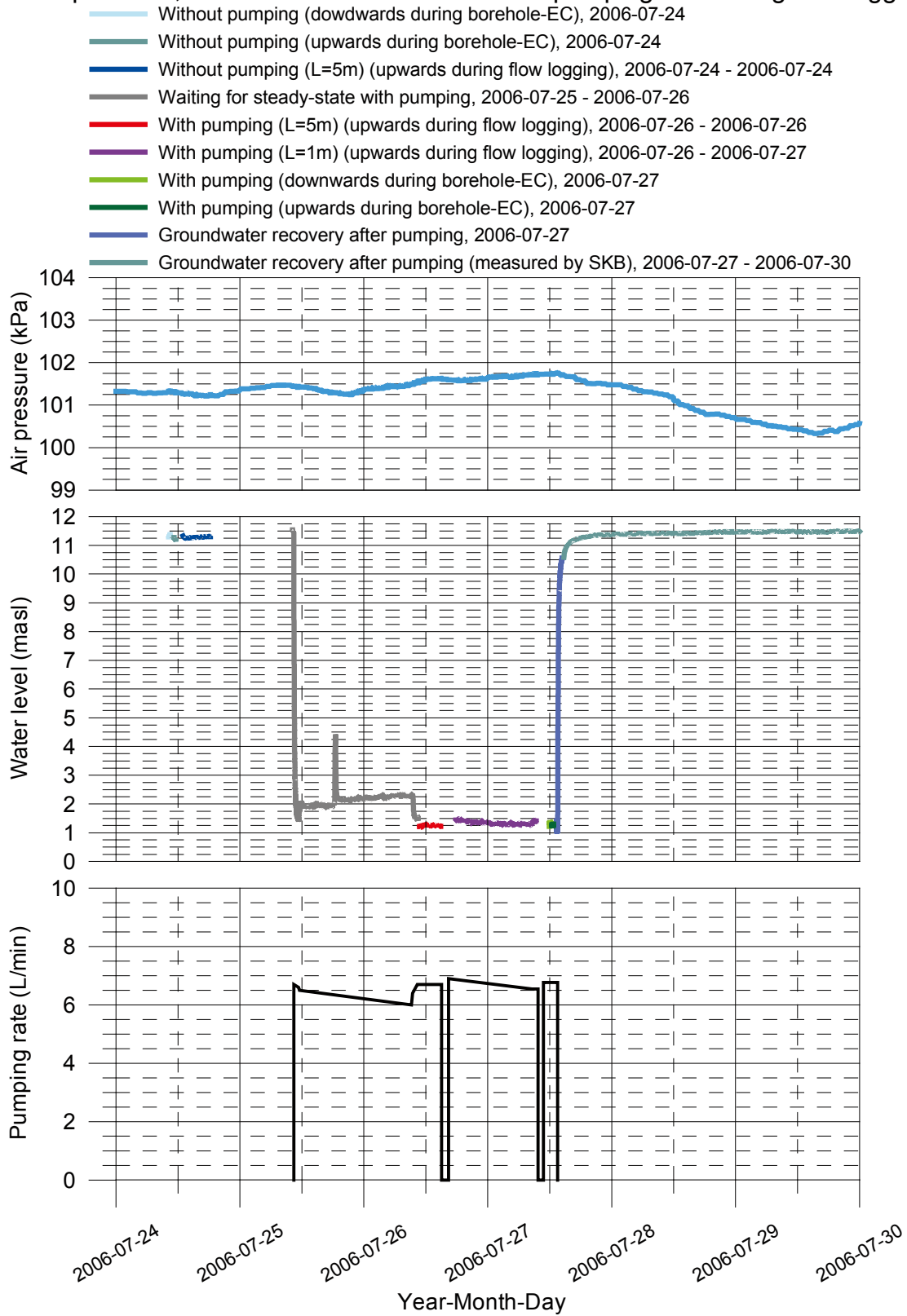
- Without pumping (upwards during flow logging, L=5 m, dL=0.5 m), 2006-07-24
- With pumping (upwards during flow logging, Drawdown 10.00 m, L=5 m, dL=0.5 m), 2006-07-26
- With pumping (upwards during flow logging Drawdown 10.00 m, L=1 m, dL=0.1 m), 2006-07-26 - 2006-07-27



## Appendix 10C.13.2

### Laxemar, borehole KLX10C

#### Air pressure, water level in the borehole and pumping rate during flow logging

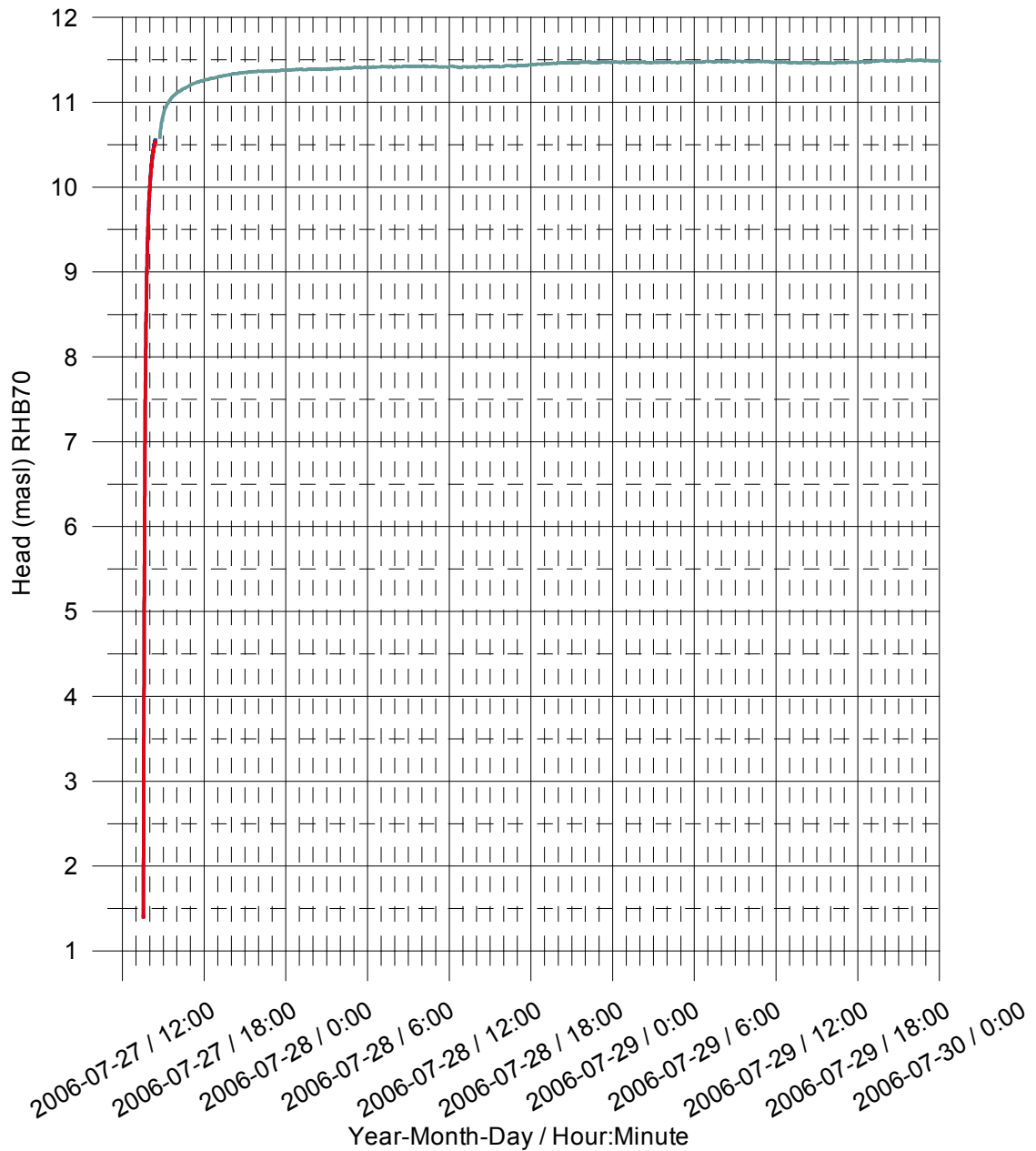


## Appendix 10C.13.3

### Laxemar, borehole KLX10C Groundwater recovery after pumping

Head(masl)= (Absolute pressure (Pa) - Airpressure (Pa) + Offset) / (1000 kg/m<sup>3</sup> \* 9.80665 m/s<sup>2</sup>) + Elevation (m)  
Offset = 2300 Pa (Correction for absolut pressure sensor)

- Measured at the length of 20.02 m using water level pressure sensor
- Corrected pressure measured at the length of 29.31 m using absolute pressure sensor
- LMeasured by SKB using water level pressure sensor



Laxemar, borehole KLX10B-C  
 Water level and air pressure measured by SKB

