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Forsmark site investigation

Difference flow logging in borehole KFM02A

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August 2004

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This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

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Abstract

Difference flow logging is a swift method for determination of the transmissivity and the hydraulic head in borehole sections and fractures/fracture zones in core drilled boreholes. This report presents the main principles of the method as well as results of measurements carried out in the borehole KFM02A at Forsmark, Sweden, in April and May 2003, using the Posiva Flow Log. The primary aim of the measurements was to determine the position and flow rate of flow yielding fractures in borehole KFM02A prior to groundwater sampling.

The flow rate into or out of a 5 m long test section was measured between 100–1,000 m borehole length during natural (un-pumped) as well as pumped conditions. The flow measurements were repeated at the location of the detected flow anomalies using a 1 m long test section, successively transferred with an overlapping of 0.1 m.

Length calibration was made based on length marks milled into the borehole wall at accurately determined positions along the borehole. The length marks were detected by caliper measurements and by single point resistance measurements using sensors connected to the flow logging tool.

A high-resolution absolute pressure sensor was used to measure the absolute total pressure along the borehole. These measurements were carried out together with the flow measurements.

Electric conductivity (EC) and temperature of borehole water was also measured. The EC-measurements were used to study the occurrence of saline water in the borehole during natural as well as pumped conditions. Finally EC of fracture-specific water was measured for a selection of fractures.

Sammanfattning

Differensflödesloggning är en snabb metod för bestämning av transmissivitet och hydraulisk tryckhöjd i borrhålssektioner och sprickor/sprickzoner i kärnborrhål. Denna rapport presenterar huvudprinciperna för metoden och resultat av mätningar utförda i borrhål KFM02A i Forsmark, Sverige, i april och maj 2003 med Posiva flödesloggningsmetod. Det primära syftet med mätningarna var att bestämma läget av och flödet i vattenförande sprickor i borrhål KFM02A före grundvattenprovtagning.

Flödet till eller från en 5 m lång testsektion mättes mellan 100–1 000 m borrhålslängd under såväl naturliga (icke-pumpade) som pumpade förhållanden. Flödesmätningarna upprepades vid lägena för de detekterade flödesanomalierna med en 1 m lång test-sektion som förflyttades successivt med 0.1 m.

Längdkalibrering gjordes baserad på längdmärkena som frästs in i borrhålsväggen vid noggrant bestämda positioner längs borrhålet. Längdmärkena detekterades med caliper- och punktresistansmätningar med hjälp av sensorer anslutna på flödesloggningssonden.

En högupplösande absoluttryckgivare användes för att mäta det absoluta totala trycket längs borrhålet. Dessa mätningar utfördes tillsammans med flödesmätningarna.

Elektrisk konduktivitet och temperatur på borrhålsvattnet mättes också. EC-mätningarna användes för att studera förekomsten av saltvatten i borrhålet under såväl naturliga som pumpade förhållanden. Slutligen mättes EC på vattnet i ett antal utvalda sprickor.

Contents

1 Introduction

The difference flow logging of the core drilled borehole KFM02A at Forsmark was conducted between April 23 and May 13, 2003. KFM02A is the second core drilled borehole in the Forsmark candidate area. The borehole is inclined c 85° from the horizontal. The c 1,000 m deep borehole is performed with telescopic drilling technique, where the interval 0–c 100 m is percussion drilled with the diameter c 250 mm and the remaining interval, c 100–1,000 m, is core drilled with the diameter 77.3 mm. The interval 0–c 100 m is cased with the inner diameter 200 mm. The location of borehole KFM02A at drilling site DS2 within the Forsmark area is shown in Figure 1-1.

The field work and the subsequent interpretation were conducted by PRG-Tec Oy. The Posiva flow log/difference flow method has previously been employed in Posiva's site characterisation programme in Finland as well as at the Äspö Hard Rock Laboratory at Simpevarp, Sweden. The commissions at the latter site included measurements in the 1,700 m long cored borehole KLX02 at Laxemar together with a methodology study /Ludvigson et al, 2002/.

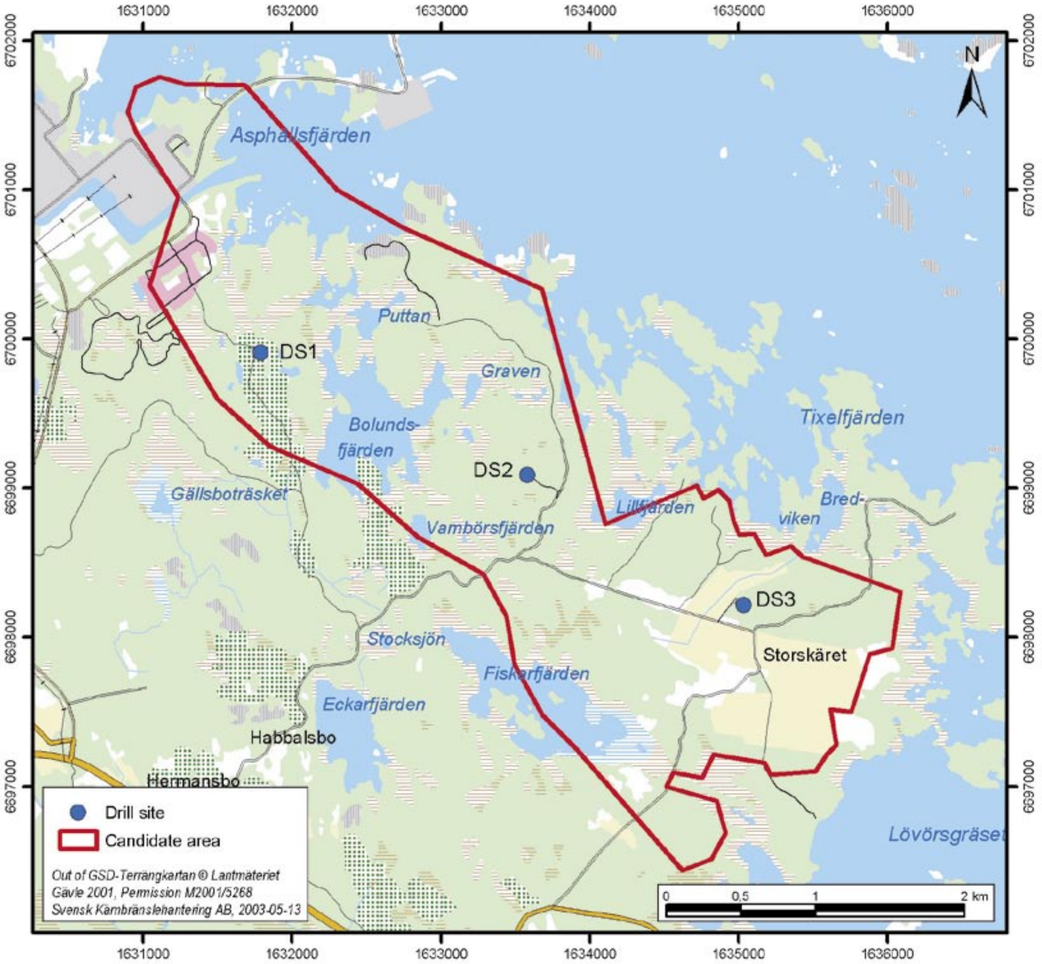

Figure 1-1. *Map of the Forsmark area including the candidate area (red line) selected for more detailed investigations. The drilling sites of the first three deep core drilled boreholes are marked with blue dots. Borehole KFM02A is situated at drilling site DS2.*

This document reports the results gained by the Difference flow logging in borehole KFM02A. The activity is performed within the Forsmak site investigation. The work was carried out in accordance to SKB internal controlling document AP PF 400-03-21. Data and results were delivered to the SKB site characterization database SICADA with Field note no Forsmark 124.

2 Objective and scope

The main objective of the difference flow logging in KFM02A was to identify water-conductive sections/fractures suitable for subsequent hydro-geochemical characterisation. Secondly, the measurements aimed at a hydrogeological characterisation, including the prevailing water flow balance in the borehole and the hydraulic properties (transmissivity and undisturbed hydraulic head) of the tested sections. Based on the results of these investigations, a more detailed characterisation of flow anomalies along the hole, e.g. an estimate of the conductive fracture frequency (CFF), may be obtained.

Besides the difference flow logging, the programme also included supporting measurements, performed for a better understanding of the overall hydrogeochemical conditions. These measurements included electric conductivity and temperature of the borehole fluid as well as single-point resistance of the borehole wall. The electric conductivity was also measured for a number of selected high-transmissive fractures in the borehole. Furthermore, the recovery of the groundwater level after pumping was registered and interpreted hydraulically.

A high-resolution pressure sensor was used to measure the absolute total pressure along the borehole. These measurements were carried out together with the flow measurements. The results are used for calculation of hydraulic head along the borehole.

Single point resistance measurements were also combined with caliper (borehole diameter) measurements for detection of depth marks milled into the borehole wall at accurately determined positions along the borehole. This procedure was applied for length calibration of all measurements.

3 Principles of measurement and interpretation

3.1 Measurements

Unlike traditional types of borehole flowmeters, the Difference flowmeter method measures the flow rate into or out of limited sections of the borehole instead of measuring the total cumulative flow rate along the borehole. The advantage of measuring the flow rate in isolated sections is a better detection of the incremental changes of flow along the borehole, which are generally very small and can easily be missed using traditional types of flowmeters.

Rubber disks at both ends of the downhole tool are used to isolate the flow in the test section from that in the rest of the borehole, see Figure 3-1. The flow along the borehole outside the isolated test section passes through the test section by means of a bypass pipe and is discharged at the upper end of the downhole tool.

The Difference flowmeter can be used in two modes, a sequential mode and an overlapping mode. In the sequential mode, the measurement increment is as long as the section length. It is used for determining the transmissivity and the hydraulic head /Öhberg and Rouhiainen, 2000/. In the overlapping mode, the measurement increment is shorter than the section length. It is mostly used to determine the location of hydraulically conductive fractures and to classify them with regard to their flow rates.

The Difference flowmeter measures the flow rate into or out of the test section by means of thermistors, which track both the dilution (cooling) of a thermal pulse and transfer of thermal pulse with moving water. In the sequential mode, both methods are used, whereas in the overlapping mode, only the thermal dilution method is used because it is faster than the thermal pulse method.

Besides incremental changes of flow, the downhole tool of the Difference flowmeter can be used to measure:

- The electric conductivity (EC) of the borehole water and fracture-specific water. The electrode for the EC measurements is placed on the top of the flow sensor, Figure 3-1.
- The single point resistance (SPR) of the borehole wall (grounding resistance), The electrode of the Single point resistance tool is located in between the uppermost rubber disks, see Figure 3-1. This method is used for high resolution depth/length determination of fractures and geological structures.
- The diameter of the borehole (caliper). The caliper tool, combined with SPR, is used for detection of the depth/length marks milled into the borehole wall, see Chapter 2. This enables an accurate depth/length calibration of the flow measurements.
- The prevailing water pressure profile in the borehole. The pressure sensor is located inside the electronics tube and connected via another tube to the borehole water, Figure 3-2.
- Temperature of the borehole water. The temperature sensor is placed in the flow sensor, Figure 3-1.

All of the above measurements were performed in KFM02A.

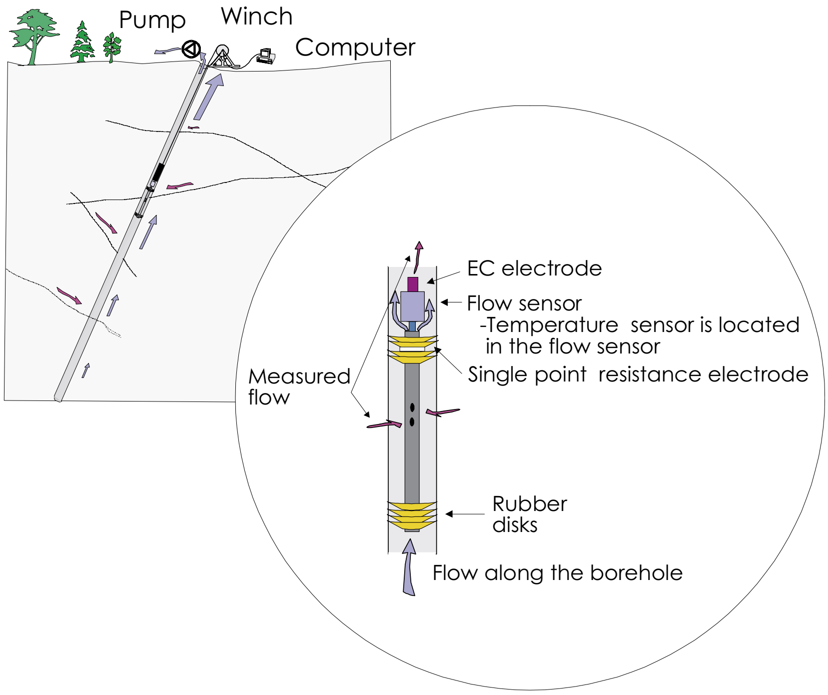

Figure 3-1. *Schematic of the downhole equipment used in the Difference flowmeter.*

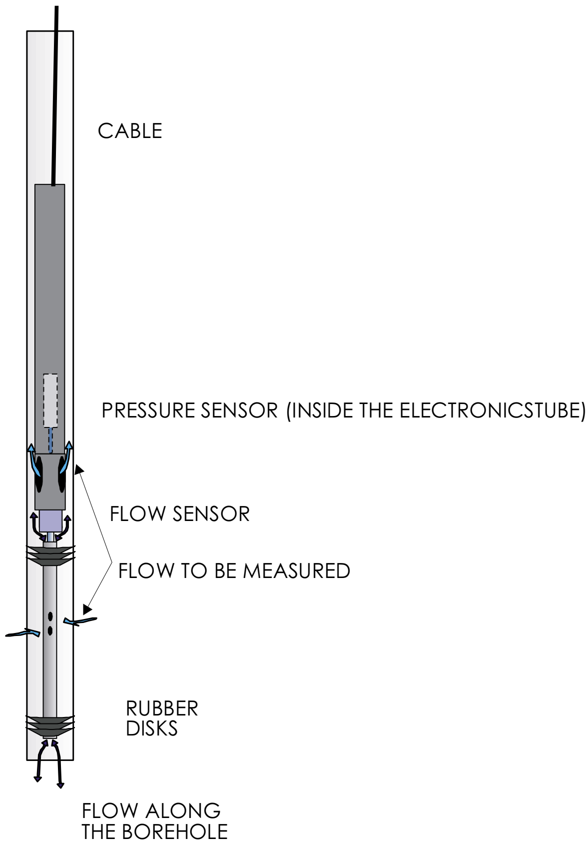

Figure 3-2. *The absolute pressure sensor is located inside the electronics tube and connected via another tube to the borehole water.*

The principles of difference flow measurements are described in Figures 3-3 and 3-4. The flow sensor consists of three thermistors, see Figure 3-3a. The central thermistor, A, is used both as a heating element for the thermal pulse method and for registration of temperature changes in the thermal dilution method, Figures 3-3b and c. The side thermistors, B1 and B2, serve to detect the moving thermal pulse, Figure 3-3d, caused by the constant power heating in A, Figure 3-3b.

Flow rate is measured during the constant power heating (Figure 3-3b). If the flow rate exceeds 600 mL/h, the constant power heating is increased, Figure 3-4a, and the thermal dilution method is applied.

If the flow rate during the constant power heating (Figure 3-3b) falls below 600 mL/h, the measurement continues with monitoring of transient thermal dilution and thermal pulse response (Figure 3-3d). When applying the thermal pulse method, also thermal dilution is always measured. The same heat pulse is used for both methods.

Flow is measured when the tool is at rest. After transfer to a new position, there is a waiting time (the duration can be adjusted according to the prevailing circumstances) before the heat pulse (Figure 3-3b) is launched. The waiting time after the constant power thermal pulse can also be adjusted, but is normally 10 s long for thermal dilution and 300 s long for thermal pulse. The measuring range of each method is given in Table 3-1.

The lower end limits of the thermal dilution and the thermal pulse methods in Table 3-1 correspond to the theoretical lowest measurable values. Depending on the borehole conditions, these limits may not always prevail. Examples of disturbing conditions are floating drilling debris in the borehole water, gas bubbles in the water and high flow rates (above about 30 L/min) along the borehole. If disturbing conditions are significant, a practical measurement limit is calculated for each set of data.

Table 3-1. Ranges of flow measurements.

Method	Range of measurement (mL/h)
Thermal dilution P1	30–6 000
Thermal dilution P2	600–300 000
Thermal pulse	6–600

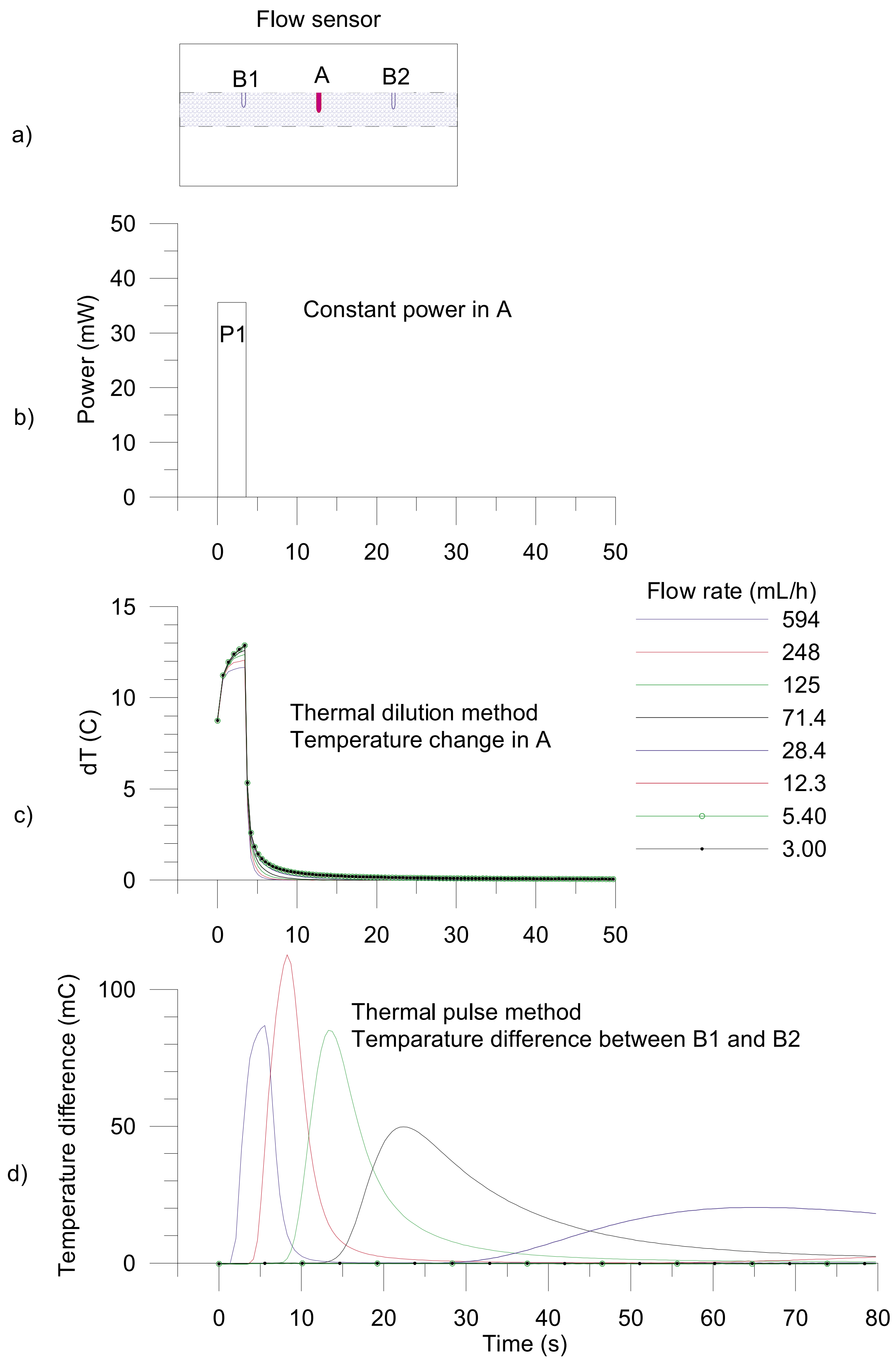

Figure 3-3. *Flow measurement, flow rate <600 mL/h.*

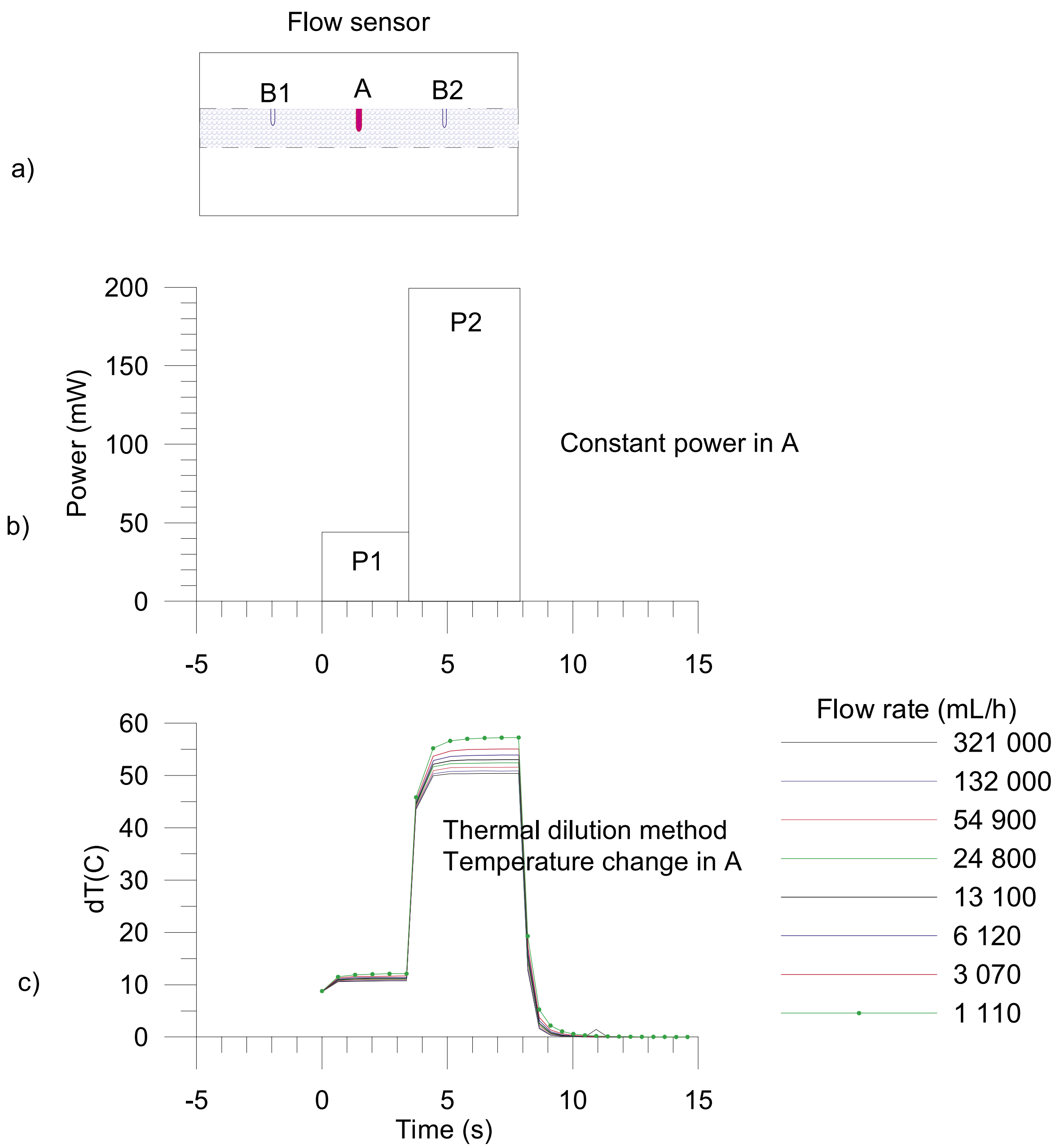

Figure 3-4. *Flow measurement, flow rate > 600 mL/h.*

3.2 Interpretation

The interpretation is based on Thiems or Dupuits formula that describes a steady state and two dimensional radial flow into the borehole /Marsily, 1986/:

$$h_s - h = Q/(T \cdot a) \qquad 3\text{-}1$$

where

h is hydraulic head in the vicinity of the borehole and $h = h_s$ at the radius of influence (R),

Q is the flow rate into the borehole,

T is the transmissivity of the test section,

a is a constant depending on the assumed flow geometry. For cylindrical flow, the constant a is:

$$a = 2 \cdot \pi / \ln(R/r_0) \qquad 3\text{-}2$$

where

r_0 is the radius of the well and

R is the radius of influence, i.e. the zone inside which the effect of the pumping is felt.

If flow rate measurements are carried out using two levels of hydraulic heads in the borehole, i.e. natural or pump-induced hydraulic heads, then the undisturbed (natural) hydraulic head and transmissivity of the tested borehole sections can be calculated. Two equations can be written directly from equation 3-1:

$$Q_{s1} = T_s \cdot a \cdot (h_s - h_1) \qquad 3\text{-}3$$

$$Q_{s2} = T_s \cdot a \cdot (h_s - h_2) \qquad 3\text{-}4$$

where

h_1 and h_2 are the hydraulic heads in the borehole at the test level,

Q_{s1} and Q_{s2} are the measured flow rates in the test section,

T_s is the transmissivity of the test section and

h_s is the undisturbed hydraulic head of the tested zone far from the borehole.

Since, in general, very little is known of the flow geometry, cylindrical flow without skin zones is assumed. Cylindrical flow geometry is also justified because the borehole is at a constant head and there are no strong pressure gradients along the borehole, except at its ends.

The radial distance R to the undisturbed hydraulic head h_s is not known and must be assumed. Here a value of 500 is selected for the quotient R/r_0.

The hydraulic head and the test section transmissivity can be deduced from the two measurements:

$$h_s = (h_1 - b \cdot h_2)/(1 - b) \qquad 3\text{-}5$$

$$T_s = (1/a)\,(Q_{s1} - Q_{s2})/(h_2 - h_1) \qquad 3\text{-}6$$

where

$b = Q_{s1}/Q_{s2}$

Transmissivity (T_f) and hydraulic head (h_f) of individual fractures can be calculated provided that the flow rates of individual fractures are known. Similar assumptions as above have to be used (a steady state cylindrical flow regime without skin zones).

$h_f = (h_1 – b\ h_2)/(1–b)$ 3-7

$T_f = (1/a)\ (Q_{f1}–Q_{f2})/(h_2–h_1)$ 3-8

where

Q_{f1} and Q_{f2} are the flow rates at a fracture and

h_f and T_f are the hydraulic head (far away from borehole) and the transmissivity of a fracture, respectively.

Since the actual flow geometry and the skin effects are unknown, transmissivity values should be taken as indicating orders of magnitude. As the calculated hydraulic heads do not depend on geometrical properties but only on the ratio of the flows measured at different heads in the borehole, they should be less sensitive to unknown fracture geometry. A discussion of potential uncertainties in the calculation of transmissivity and hydraulic head is provided in /Ludvigson et al, 2002/.

4 Equipment specifications

The Posiva Flow Log/Difference flowmeter monitors the flow of groundwater into or out from a borehole by means of a flow guide (rubber discs). The flow guide thereby defines the test section to be measured without altering the hydraulic head. Groundwater flowing into or out from the test section is guided to the flow sensor. Flow is measured using the thermal pulse and/or thermal dilution methods. Measured values are transferred in digital form to the PC computer.

Type of instrument:	Posiva Flow Log/Difference Flowmeter
Borehole diameters:	56 mm, 66 mm and 76–77 mm
Length of test section:	A variable length flow guide is used
Method of flow measurement:	Thermal pulse and/or thermal dilution
Range and accuracy of measurement:	Table 4-1
Additional measurements:	Temperature, Single point resistance, Electric conductivity of water, Caliper, Water pressure
Winch:	Mount Sopris Wna 10, 0.55 kW, 220V/50Hz. Steel wire cable 1,500 m, four conductors, Gerhard-Owen cable head
Length determination	Based on the marked cable and on the digital length counter
Logging computer:	PC, Windows 2000
Software	Based on MS Visual Basic
Total power consumption:	1.5–2.5 kW depending on the pumps
Calibrated	April 2004
Calibration of cable length	Using length marks in the borehole

Range and accuracy of sensors is presented in Table 4-1.

Table 4-1. Range and accuracy of sensors.

Sensor	Range	Accuracy
Flow	6–300 000 mL/h	+/– 10% curr.value
Temperature (middle thermistor)	0–50 °C	0.1 °C
Temperature difference (between outer thermistors)	–2 – + 2 °C	0.0001 °C
Electric conductivity of water (EC)	0.02–11 S/m	+/– 5% curr.value
Single point resistance	5–500 000 Ω	+/– 10% curr.value
Groundwater level sensor	0–0.1 Mpa	+/– 1 % fullscale
Absolute pressure sensor	0–20 MPa	+/– 0.01 % fullscale

5 Performance

The Commission was performed according to Activity Plan AP PF 400-03-21 following the SKB Method Description 322.010, Version 1.0 (Method description for difference flow logging). The Activity Plan and the Method Description are both SKB internal controlling document. Prior to the measurements, the downhole tools and the measurement cable were disinfected. Time was synchronized with local Swedish time. The activity schedule of the borehole measurements is presented in Table 5-1. The items and activities in Table 5-1 are the same as in the Activity Plan.

Logging cables, wires, and pipe strings are exposed to stretching when lowered into a vertical or sub-vertical borehole. This will introduce a certain error in defining the position of a test tool connected to the end of e.g. a logging cable. Immediately after completion of the drilling operations in borehole KFM02A, length marks were milled into the borehole wall at certain intervals to be used for length calibration of various logging tools. By using the known positions of the length marks, logging cables etc can be calibrated in order to obtain an accurate length correction of the testing tool.

Each length mark includes two 20 mm wide tracks in the borehole wall. The distance between the marks is 100 mm. The upper track represents the reference level. An inevitable condition for a successful length calibration is that all length marks, or at least the major part of them, are detectable. The Difference flow meter system uses caliper measurements in combination with single point resistance measurements (SPR) for this purpose, and these measurements were the first to be performed in borehole KFM02A (Item 7 in Table 5-1). These methods also reveal parts of the borehole widened for other reason (fracture zones, breakouts etc).

Table 5-1. Flow logging and testing in KFM02A. Activity schedule.

Item	Activity	Explanation	Date
7	Length calibration of the downhole tool	Dummy logging (SKB Caliper and SPR). Logging without the lower rubber discs, no pumping	2003-04-23 2003-04-25
8	EC- and temp-logging of the borehole fluid	Logging without the lower rubber discs, no pumping	2003-04-24 2003-04-25
9	Combined sequential and overlapping flow logging	Section length Lw=5 m, Step length dL=0.5 m. Pulse measurement every 10th point, no pumping	2003-04-26 2003-04-28
10	Combined sequential and overlapping flow logging	Section length Lw=5 m. Step length dL=0.5 m. Pulse measurement every 10th point, at pumping (includes 1 day waiting after beginning of pumping)	2003-05-06 2003-05-08
11	Overlapping flow logging	Section length Lw=1 m. Step length dL=0.1 m, at pumping (only in conductive borehole intervals). Measurement of fracture-specific EC	2003-05-08 2003-05-11
12	EC- and temp-logging of the borehole fluid	Logging without the lower rubber discs, at pumping	2003-05-11
13	Recovery transient	Measurement of water level in the borehole after completed pumping	2003-05-11 2003-05-12
11 extra	Overlapping flow logging with smaller pumping	Section length Lw=1 m, Step length dL=0.1 m, at pumping (only borehole interval 107.5 m–122.5 m)	2003-05-12
13 extra	Recovery transient	Measurement of water level in the borehole after completed pumping	2003-05-12 2003-05-13

The caliper- and SPR-measurements were preceded by measurements of electric conductivity (EC) of the borehole water (Item 8) during natural (un-pumped) conditions.

The combined sequential/overlapping flow logging (Item 9) was carried out in the borehole interval 100–1,000 m. The section length was 5 m, and the length increment (step length) 5 m for the thermal pulse method, respectively 0.5 m for thermal dilution method. The measurements were performed during natural (un-pumped) conditions.

Pumping was started on May 5. After 24 hours waiting time, the combined sequential/overlapping flow logging (Item 10) was measured in the same interval, 100–1,000 m using the same section and step lengths as before.

The overlapping flow logging was then continued in the way that previously measured flow anomalies were re-measured with 1 m section length and 0.1 m step length (Item 11). During the flow measurements, the tool was stopped on selected fractures for measurements of EC of fracture-specific water. The measurement and results are presented in Section 6.2.2.

Still during pumped conditions, the EC of the borehole water (Item 12) was measured. After this the pump was stopped and the recovery of the groundwater level was monitored (Item 13).

The length interval 107.5–122.5 m was re-measured using a smaller drawdown, since the flow rate was above the measurement limit in several fractures in this interval. A section length of 1 m and a step length of 0.1 m were used here, (Item 11 extra). After this, the pump was stopped again and the groundwater recovery was monitored (Item 13 extra).

6 Results

6.1 Length calibration

6.1.1 Caliper and SPR measurements

An accurate length scale of measurements is difficult to achieve in long boreholes. The main cause of inaccuracy is stretching of the logging cable. The stretching depends on the tension of the cable, the magnitude of wich in turn depends, among other things, on the inclination of the borehole and the friction of the borehole wall. The cable tension is larger when the borehole is measured upward. The cables, especially new cables, may also stretch out permanently. In KFM02A the measurements were performed from the top of the borehole in the downward direction.

Length marks on the borehole wall can be used to minimise the length errors. Such marks are milled into the borehole wall every 50 m in KFM02A (with few exeptions). The length marks are detected with the SKB caliper tool. The length scale is firstly corrected according to the length marks. Single point resistance is recorded simultaneously with the caliper logging. All flow measurement sequences can then be length corrected by synchronizing the SPR results (SPR is recorded during all measurements) with the original caliper/SPR measurements.

The procedure of length correction was the following:

- Caliper+SPR measurements (Item 7) were initially length corrected against to the known length marks, Appendix 1.37, black curve. Corrections between the length marks were obtained by linear interpolation.
- The SPR curve of Item 7 was then compared with the SPR curves of Items 9, 10 and 11 to obtain relative length errors of these measurement sequences.
- All SPR curves could then be synchronized, as can be seen in Appendices 1.2–1.36.

The results of the caliper and single point resistance measurements from all measurements in the entire borehole are presented in Appendix 1.1. Four SPR-curves are plotted together with caliper-data. These measurements correspond to Items 7, 9, 10 and 11 in Table 5-1.

Zoomed results of caliper and SPR are presented in Appendices 1.2–1.36. The length marks were detected at 110 m, 150 m, 200 m, 250 m, 304.5 m, 350 m, 400 m, 450 m, 506 m, 550 m, 600 m, 650 m, 700 m, 750 m, 800 m, 850 m, 900 m and at 950 m. In other words, every mark was detected. They can also be seen in SPR results. However, the anomaly is complicated due to the four rubber disks used at the upper end of the section, two at each side of the resistance electrode. A selection of length intervals where clear SPR-anomalies were found, are plotted as well.

The aim of the plots in Appendices 1.2–1.36 is to verify the accuracy of the length correction. The curves in these plots represent length corrected results. The same length corrections were applied to the flow- and EC measurements.

The magnitude of length correction along the borehole is presented in Appendix 1.37. The error is negative, due to fact that the stretching extends the logging cable (i.e. the cable is longer than the nominal length marked on the cable).

6.1.2 Estimated error in location of detected fractures

In spite of the length correction described above, there are still length errors due to the following reasons:

1. Point interval in flow measurements is 0.1 m in overlapping mode. This could cause an error of +/– 0.05 m.
2. The length of the test section is not exact. The specified section length denotes the distance between the nearest upper and lower rubber disks. Effectively, the section length can be larger. At the upper end of the test section there are four rubber disks. The distance between these is 5 cm. This will cause rounded flow anomalies. Flow may be detected already when a fracture is situated between the upper rubber disks. These phenomena, wich can only be seen with a short step length (0.1 m), could cause an error of +/– 0.05 m.
3. Corrections between the length marks can be other than linear. This could cause an error of +/– 0.1 m in the caliper/SPR measurement (Item 7).
4. SPR curves may be imperfectly synchronized. This could cause an error of +/– 0.1 m.

In the worst case, the errors of points 1, 2, 3 and 4 are summed up. Then the total estimated error between the length marks would be +/– 0.3 m.

Near the length marks the situation is slightly better. In the worst case, the errors of points 1, 2 and 4 are summed up. Then the total estimated error near the length marks would be +/– 0.2 m.

Accurate location is important when different measurements are compared, for instance if the flow logging and borehole TV are compared. In that case the situation may not be as severe as the worst case above, since part of the length errors are systematic and the length error is nearly constant in fractures near each other. However, the error of point 1 is of random type.

Fractures nearly parallel with the borehole may also be problematic. Fracture location may be difficult to accurately define in such cases.

6.2 Electric conductivity and temperature

6.2.1 Electric conductivity and temperature of borehole water

The electric conductivity of the borehole water (EC) was initially measured when the borehole was at rest, i.e. at natural, un-pumped conditions. The measurements were performed in both directions, downwards and upwards, see Appendix 2.1.

The EC measurements were repeated during pumping (after a pumping period of about six days), see Appendix 2.1, red curves. The results show clear inflow of saline water at the depth of about 125 m. Very clear inflow of saline water was detected also at the depth of 895 m. At this depth there was a high calculated hydraulic head, see Appendices 6.2 and 7.6.

Temperature of borehole water was measured simultaneously with the EC-measurements. The EC-values are temperature corrected to 25 °C to make them more comparable with other EC measurements /Heikkonen et al, 2002/. The temperature results in Appendix 2.2 correspond to the EC results in Appendix 2.1. Pumping changed temperature profiles above the length of 515 m; high pumping flow rate is an apparent reason to this.

6.2.2 EC of fracture-specific water

The flow direction is always from the fractures into the borehole if the borehole is pumped with a sufficiently large drawdown. This enables the determination of electric conductivity from fracture-specific water. Both electric conductivity and temperature of flowing water from the fractures were measured.

The flow measurement makes it possible to find the fractures for the EC measurement. The tool is moved so that the fracture to be tested will be located within the test section (L = 1 m). The EC measurements begin if the flow rate is larger than a predetermined limit. The tool is kept on the selected fracture. The measurement is continued at the given length allowing the fracture-specific water to enter the section. The waiting time for the EC measurement can be automatically calculated from the measured flow rate. The aim is to flush the water volume within the test section well enough. The measuring computer is programmed to change the water volume within the test section about three times. The water volume in a one metre long test section was 3.6 L.

Electric conductivity of fracture-specific water is presented on a time scale, see Appendices 8.1–8.3. The blue symbol represents the value when the tool was moved (one metre point interval) and the red symbol illustrates that the tool was stopped on a fracture for a fracture specific EC measurement.

Borehole lengths at the upper and lower ends of the section, fracture locations as well as the final EC values are listed in Table 6-1.

Table 6-1. Fracture-specific EC.

Upper end of section (m)	Lower end of section (m)	Fractures measured (m)	EC (S/m) at 25 °C
110.3	111.3	110.7	0.22
111.1	112.1	111.1	0.22
112.6	113.6	112.9	0.16
113.8	114.8	114.2	0.18
116.2	117.2	116.6	0.14
117.0	118.0	117.5	0.15
117.8	118.8	118.3	0.12
118.6	119.6	118.9, 119.1	0.12
120.1	121.1	120.9	0.35
120.9	121.9	120.9, 121.2	0.41
162.21	163.21	162.5, 163.0	1.3
171.21	173.21	171.5, 171.9	1.2
426.58	427.58	426.8	1.6
513.28	514.28	513.6	1.6

6.3 Pressure measurements

The absolute pressure was registered together with the other measurements in Items 8–13 in Table 5-1. The absolute pressure sensor measures the sum of hydrostatic pressure in the borehole and the air pressure. Air pressure was registered by SKB in a near-sited environmental monitoring station, Appendix 10.1. Hydraulic head along the borehole at natural and pumped conditions respectively is determined in the following way. Firstly, the monitored air pressure at the site is subtracted from the measured absolute pressure by the pressure sensor. The hydraulic head (h) at a certain elevation z is calculated according to the following expression /Nordqvist, 2001/:

$$h = (p_{abs} - p_b)/\rho_{fw}\, g + z \qquad (6\text{-}1)$$

where

h is the hydraulic head (masl) according to the RHB 70 reference system,

p_{abs} is the absolute pressure (Pa),

p_b is the barometric (air) pressure (Pa),

ρ_{fw} is the unit density 1,000 kg/m^3,

g is the standard gravity 9.80065 m/s^2 and

z is the elevation of measurement (masl) according to the RHB 70 reference system.

An offset of 13.5 kPa is subtracted from all absolute pressure results.

The calculated head results are presented in Appendix 4. Exact z-coordinates are important in head calculation. 10 cm error in z-coordinate means 10 cm error in head.

The length calibration of the borehole EC measurements is not as accurate as of the other measurements because SPR is not registered during the borehole EC measurements. Instead the length correction of Caliper measurement was applied to the borehole EC measurements, black curve in Appendix 1.37.

In general, pressure measurements were carried out downwards. However, during the borehole EC logging, measurements were performed also upwards. In these cases measured pressures are a little higher, Appendix 4. The probable reason is the exteursion of the cable when the tool was lifted up. It was driven fast up during this measurement and the sensor was probably deeper than it was assumed in the length correction.

6.4 Flow logging

6.4.1 General comments on results

The measuring program contains several flow logging sequences. They were join on the same diagram as the single point resistance (right hand side) and caliper plots (in the middle), see Appendices 3.1–3.45. Single point resistance usually shows a low resistance value on a fracture where flow is detected. There are also many other resistance anomalies from other fractures and geological features. The electrode of the Single point resistance tool is located within the section with the upper rubber disks. Thus, the locations of the resistance anomalies of the leaky fractures fit with the lower end of the flow anomalies.

The caliper tool shows low voltages when the borehole diametre is below 77 mm and high voltages when the borehole diametre exceeds 77 mm.

The flow logging was firstly performed with a 5 m section length and with 0.5 m length increments, see Appendices 3.1–3.45 (red curve with pumping, dark blue curve without pumping). The method (overlapping flow logging) gives the length and the thickness of conductive zones with a length resolution of 0.5 m. To obtain quick results, only the thermal dilution method is firstly used for flow determination.

Under natural conditions every tenth flow measurement was carried out using the thermal pulse method (sequential flow logging). This method is slower but has the advantage of rendering measurements of very small flow rates possible, as well as of their flow directions (into the borehole or out of it). The pulse method was used only without pumping.

The test section length determines the width of a flow anomaly of a single fracture in the plots. If the distance between flow yielding fractures is less than the section length, the anomalies will be overlapped, resulting in a stepwise flow anomaly. The overlapping flow logging was therefore repeated in the vicinity of identified flow anomalies using a 1 m long test section and 0.1 m length increments. The upper part of the borehole (108–123 m) was re-measured using a smaller drawdown. The flow rate exceeded the measurement limit in this interval. The first pumping rate was about 75 L/min and during the repeated measurements it was only about 5 L/min.

Detected fractures are shown on the caliper scale with their positions (borehole length). They are interpreted on the basis of the flow curves and therefore represent flowing fractures. A long line represents the location of a leaky fracture; short line denotes that the existence of a leaky fracture is uncertain. A short line is used if the flow rate is less than 30 mL/h or if the flow anomalies are overlapping.

6.4.2 Transmissivity and hydraulic head of borehole sections

The entire borehole between 100 m and 1,000 m was flow logged with a 5 m section length and with 0.5 m length increments. The major part of the flow logging results presented in this report is derived from measurements with the thermal dilution method. However, every tenth flow measurement without pumping was carried out using the thermal pulse method (sequential flow logging without pumping), which enables measurements of smaller flow rates, less than 600 mL/h, above which limit thermal pulse results were used only for detection of flow direction.

The results of the sequential measurements with a 5 m section length are presented in tables, see Appendices 5.1–6.2. Only the results with a 5 m length increments are used, all borehole sections are shown in Appendices 3.1–3.45. Secup1 and Secup2 presented in Appendices 5.1–5.7 are calculated as the distance along the borehole from the reference level (top of the casing tube) to the upper end of the test section. Secup1 refers to the measurements at natural, i.e. un-pumped conditions, and Secup2 to measurements during pumping. They are not identical, due to a minor difference of the cable stretching between the two sequences.

Pressure was measured and calculated as described in Chapter 6.3. Borehole Head1 and Borehole Head2 in Appendices 5.1–5.7 represent heads determined without respectively with pumping. Head in the borehole and calculated heads of borehole sections are given in RHB 70 scale.

The flow results presented in Appendices 5.1–5.7 (Flow1 and Flow2), representing flow rates derived from measurements during un-pumped respectively pumped conditions, are presented side by side to make comparison easier. Flow rates are positive if the flow direction is from the bedrock into the borehole and vice versa. With the borehole at rest, 30 sections were detected as flow yielding, of which 6 had a flow direction from the borehole into the bedrock (negative flow). During pumping, all 45 detected flows were directed towards the borehole.

The measurable flow ranges were exceeded at lengths of 106.00 m, 111.00 m and 116.00 m (Secup) when the borehole was pumped. Flow rates for transmissivity calculations and corresponding borehole heads at these locations (lengths) were taken from the re-measurements with a smaller drawdown (with a section length of 1 m).

The flow data are presented as a plot, see Appendix 6.1. The left hand side of each diagram represents flow from the borehole into the bedrock for the respective test sections, whereas the right hand side represents the opposite. If the measured flow was zero (below the measurement limit), it is not visible in the logarithmic scale of the appendices.

In the plots (Appendix 6.1) and in the tables (Appendix 5), also the lower and upper measurement limits of flow are presented. There are theoretical and practical lower limits of flow, see Chapter 6.4.4.

Hydraulic head and transmissivity (T_S) of borehole sections can be calculated from flow data using the method described in Chapter 3. Hydraulic head of sections is presented in the plots if none of the two flow values at the same length is equal to zero. Transmissivity is presented if none or just one of the flows is equal to zero, see Appendix 6.2. The measurement limit of transmissivity are also shown in Appendix 6.2 and in Appendix 5. All the measurement limits values of transmissivity are based on the actual pressure difference in the borehole (Borehole Head1 and Borehole Head 2 in Appendix 5).

The sum of detected flows without pumping (Flow1) was –216 mL/h. This sum should normally be zero if all the flows in the borehole are correctly measured, the borehole is not pumped, the water level is constant, the salinity distribution in the borehole is stabilized and the fractures are at steady state pressure. In this case the sum is close to zero.

6.4.3 Transmissivity and hydraulic head of fractures

An attempt was made to evaluate the magnitude of fracture-specific flow rates. The results for a 1 m section length and for 0.1 m length increments were used for this purpose. The first step in this procedure is to identify the locations of individual flowing fractures and then to evaluate their flow rates.

In cases where the fracture distance is less than one metre, it may be difficult to evaluate the flow rate. There are such cases for instance in Appendices 3.1 and 3.2. Increase or decrease of a flow anomaly at the fracture location (marked with the lines in Appendix 3) is used for determination of flow rate.

Since sections with 1 m length were not used at un-pumped conditions, the results for a 5 m section length were used instead. The fracture locations are important when evaluating flow rate at un-pumped conditions. The fracture locations are known on the basis of the measurements for a 1 m section length. Increase or decrease of the flow anomaly at the fracture location determines the flow rate. The measurement for a 5 m section length at un-pumped conditions are used for the corresponding fracture flow rates. The flow direction is evaluated as well. The results of evaluation are plotted in Appendix 3, blue filled triangle.

Total amount of detected flowing fractures is 106, but only 16 are seen without pumping. These 16 fractures could be used for head estimations and all 106 were used for transmissivity estimations. Transmissivity and hydraulic head of fractures are presented in Appendices 7.1–7.3.

A speciality in this borehole was the interval with round flow anomalies. Such anomalies can be seen between 273 m and 291 m. Clear flow rates were measured but they were not interpreted as fractures. This interval is also exclude the 106 fractures mentioned above. However, the flow rates for each one metre interval is presented in Appendix 7. The interval is assumed to consist of porous rock.

Some fracture-specific results were rated to be "uncertain", see Appendix 7. The criterion of "uncertain" was in most cases a minor flow rate (< 30 mL/h). In some cases fracture anomalies were unclear, since the distance between them was less than one metre.

Fracture-specific transmissivities were compared with transmissivities of borehole sections in Appendix 9. All fracture-specific transmisivities within each 5 m interval were first summed up to make them comparable with measurements with a 5 m section length. The results are, in most cases, consistent between the two types of measurements.

6.4.4 Theoretical and practical measurement limits of flow and transmissivity

The theoretical minimum of measurable flow rate in the overlapping results (thermal dilution method only) is about 30 mL/h. The thermal pulse method was also used when the borehole was not pumped. Its theoretical lower limit is about 6 mL/h. The upper limit of flow measurement is 300 000 mL/h. These limits are determined on the basis of flow calibration. It is assumed that flow can be reliably detected between the upper and lower theoretical limits for favourable borehole conditions.

The minimum measurable flow rate may, however, be much higher in practice, because the borehole conditions may have an influense on the base level of flow (noise level). The noise level, wich may vary along the borehole can be evaluated for such intervals of the borehole where there are no flowing fractures or other structures.

There are several known reasons for increased noise in flow:

1) Rough borehole wall.

2) Solid particles in water such as clay or drilling debris.

3) Gas bubbles in water.

4) High flow rate along the borehole.

Rough borehole walls always cause a high noise not only in flow but also in single point resistance results. The flow curve and SPR curves are typically spiky when the borehole wall is rough.

Drilling debris usually increases the noise level. Typically this kind of noise is seen both without pumping and with pumping.

Pumping causes a pressure drop in the borehole water and in fractur water near the borehole. This may lead to release of gas from dissolved form to gas bubbles. Some fractures may produce more gas than others. Sometimes increased noise level is obtained just above certain fractures (when the borehole is measured upwards). The reason is assumed to be gas bubbles. Bubbles may cause decrease of average density of water and therefore also decrease of measured head in the borehole.

The effect of a high flow rate along the borehole can often be seen above high flowing fractures. Any minor leak at the lower rubber disks is directly measured as increased noise in flow.

A high noise level in flow masks a "real" flow that is smaller than the noise. Real flows are totally invisible if they are about ten times smaller than the noise. Real flows are registered correctly if they are about ten times larger than the noise. By experience, real flows between 1/10 times the noise and 10 times the noise are summed up with the noise. Therefore the noise level could be subtracted from the measured flow to get the real flow. This correction has not been done so far, because it is not clear whether it is applicable in each case.

The noise level was not a serious problem in borehole KFM02A, except in the uppermost part of the borehole. The practical minimum level of flow rate is evaluated and presented in Appendices 3.1–3.45 using a grey dashed line (Lower limit of flow rate). Below this line there may be fractures or structures that remain undetected.

The noise level in KFM02A was between 10–500 mL/h. Mostly it even fell below 30 mL/h, i.e. below the theoretical limit of the thermal dilution method. However, the noise line (grey dashed line) was never drawn below 30 mL/h. In many cases there are flow anomalies smaller than 30 mL/h. These fractures are marked with a short line indicating "uncertain".

In some boreholes the upper limit of flow measurement (300 000 mL/h) may be exceeded. Such fractures or structures hardly remain undetected (as the fractures below the lower limit). High flow fractures can be measured separately at a smaller drawdown.

The practical minimum of measurable flow rate is also presented in Appendix 5 (Q-lower limit Practical). It is taken from the plotted curve in Appendix 3 (Lower limit of flow rate). The practical minimum of measurable transmissivity can be evaluated using Q-lower limit and the actual head difference at each measurement, see Appendix 5. The theoretical minimum measurable transmissivity can also be evaluated using a Q value of 6 mL/h (minimum theoretical flow rate with thermal pulse method) instead of Q-lower limit Practical.

The upper measurement limit of transmissivity can be evaluated using the maximum flow rate (300 000 mL/h) at the actual head difference as above, see Appendix 5 (T_s-Upper Limit).

All three flow limits are also plotted with measured flow rates, see Appendix 6.1. Theoretical minimum and maximum values are 6 mL/h and 300 000 mL/h, respectively.

The three transmissivity limits are also presented graphically, see Appendix 6.2. The upper measurement limit T is not even but shows steps upwards. At these locations a smaller pumping rate (smaller head difference) was used, because there are highly flowing fractures at these locations.

Similar flow and transmissivity limits are not given for the fracture-specific results, Appendices 7.1–7.3. Approximately the same limits would be valid also for these results. The limits for fracture-specific results are more difficult to define. For instance, it may be difficult to see a small flow rate near (< 1 m) a high flowing fracture. The situation is similar for the upper flow limit. If there are several high flowing fractures nearer each other than one metre, the upper flow limit depends on the sum of flows which must be below 300,000 mL/h.

6.5 Groundwater level and pumping rate

The level of the groundwater table in the borehole during the measurement sequences is presented in Appendix 10.2. The borehole was pumped between May 5 and 11 with a drawdown of about 5.8 metres. The borehole was pumped on May 12 a short time with a very small drawdown.

The groundwater recovery was measured after the first pumping period, May 11–12, Appendix 10.3. The recovery was measured with two sensors, using the water level sensor (pressure sensor for monitoring water level) and the absolute pressure sensor. There is a small difference between the results, about 10 cm. The accuracy of the absolute pressure sensor is +/– 20 cm.

Pumping rate was measured during the flow loggings, see Appendix 10.4. It showed a decreasing trend from the beginning of the pumping period, changing from 80 L/min to 75 L/min. This can not be compared with the summed up flow result from of flow measurements from the entire borehole, because the measured flow rates at the depths of 108.5 m, 113.5 m and 118.5 m exceeded the limit of the measurable range. The sum (including the mentioned too small results) is only about 35 L/min.

Data from the recovery period of the pumping period was utilized to calculate the total borehole transmissivity, see Appendix 11.

7 Summary

In this study, the Posiva Flow Log/Difference Flow method has been used to determine the location and flow rate of flowing fractures or structures in borehole KFM02A at Forsmark. Measurements were carried out both when the borehole was at rest and during pumping. A 5 m section length with 0.5 m length increments was used firstly. The measurements were repeated using 1 m section length with 0.1 m length increments over the flow anomalies.

Length calibration was made using the length marks on the borehole wall. The length marks were detected by caliper and single point resistance logging. The latter method was also performed simultaneously with the flow measurements, and thus all flow results could be length calibrated by synchronising the single point resistance logs.

The distribution of saline water along the borehole was logged by electric conductivity and temperature measurements of the borehole water. In addition, electric conductivity was measured in selected flowing fractures.

The total amount of detected flowing fractures was 106. In addition to this, an interval assumed to be porous rock was detected between 273 m and 291 m Transmissivity and hydraulic head were calculated for borehole sections and fractures. The highest transmissivity ($4.2 \cdot 10^{-5}$ m^2/s) was detected in a fracture at the borehole length of 110.7 m. High-transmissive fractures were also found at 114.2 m, 118.3 m and 120.9 m. Below 514 m no flowing fractures were identified, except small flow indications at 556 m and 895 m.

The field work went smoothly, at least from the contactors point of view. An important reason to this fact is that the site was well organized. The measurements could be carried out in relatively short time although there was a break between April 28 and May 8. The measurements were going on during nearly all days and nights.

The result tables of the difference flow logging in borehole KFM02A stored in the Sicada database are presented in Appendix 12.

8 References

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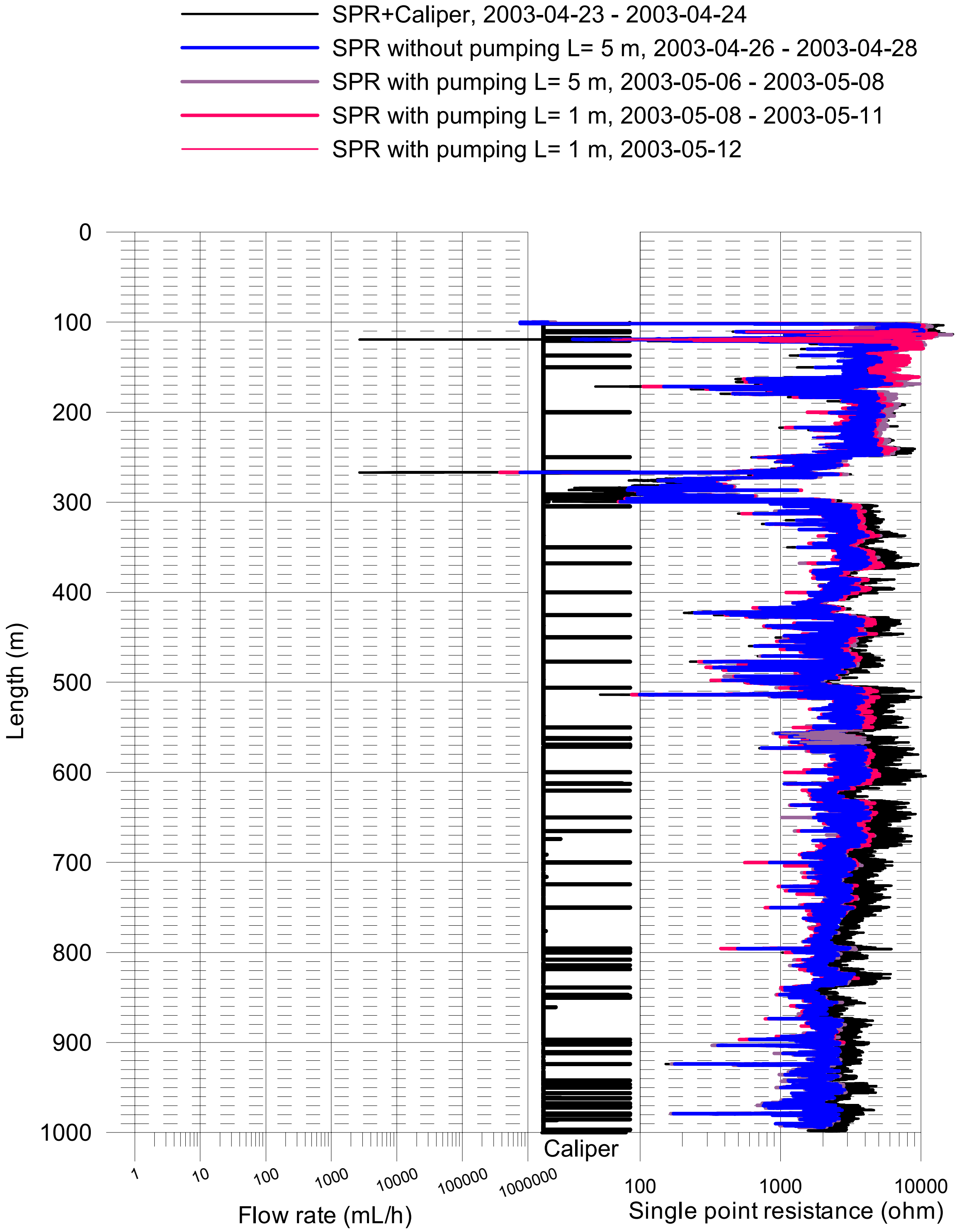
Öhberg A, Rouhiainen P, 2000. Posiva groundwater flow measuring techniques. Helsinki, Posiva Oy. Report POSIVA 2000-12.

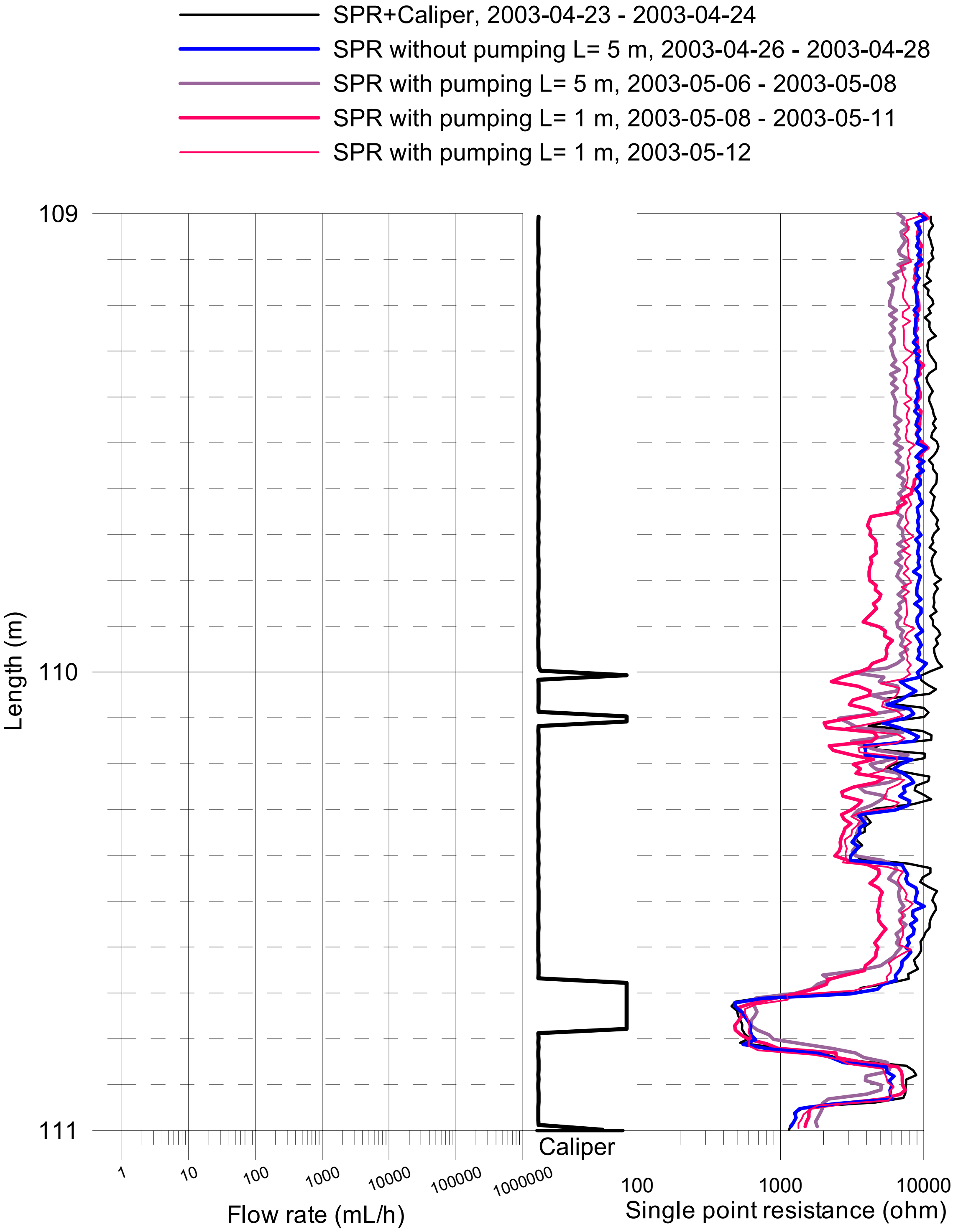
Appendices

Appendix 1.1

Forsmark, KFM02A
SPR and Caliper results after length correction

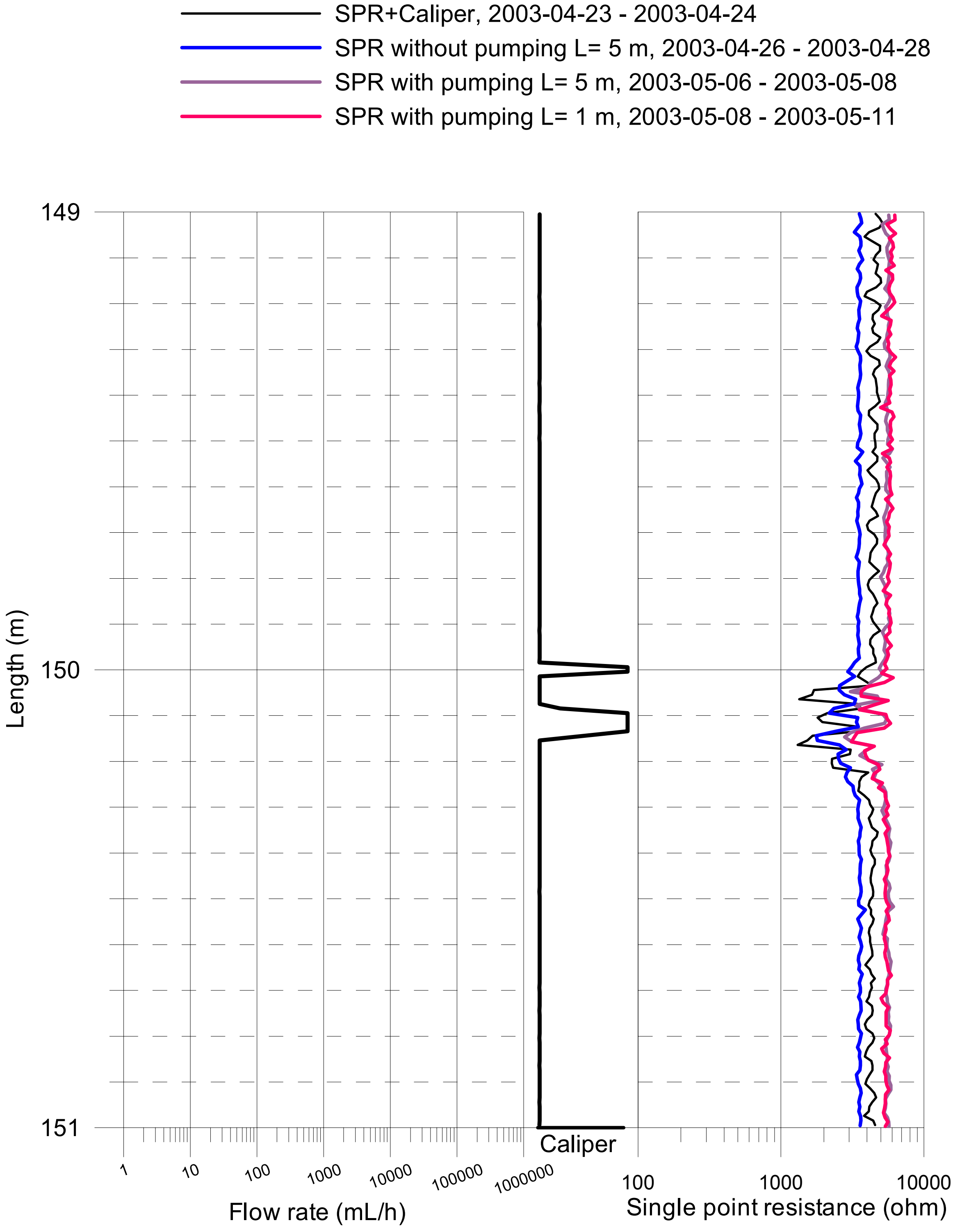


Forsmark, KFM02A
SPR and Caliper results after length correction



Appendix 1.3

Forsmark, KFM02A
SPR and Caliper results after length correction



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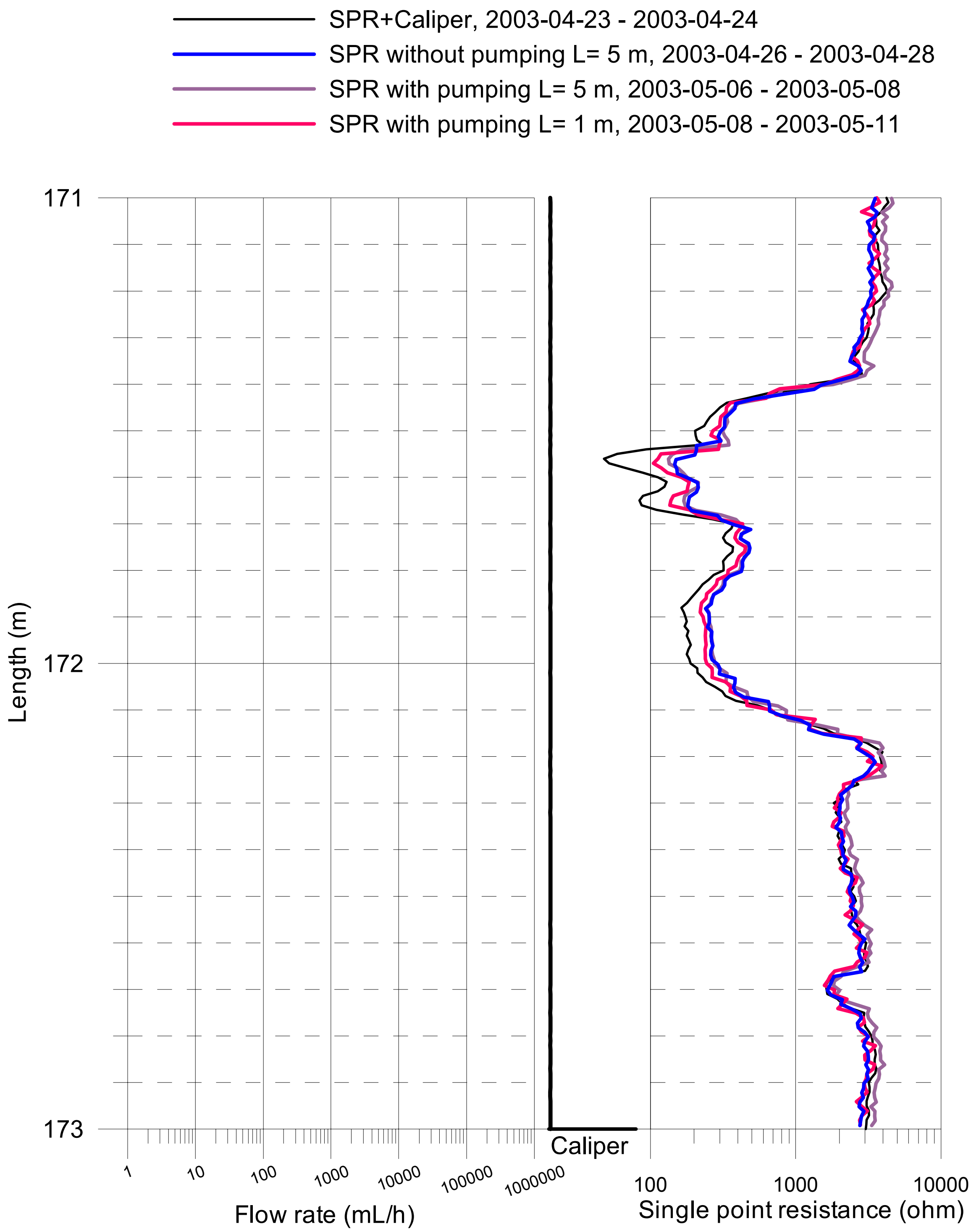
SPR and Caliper results after length correction



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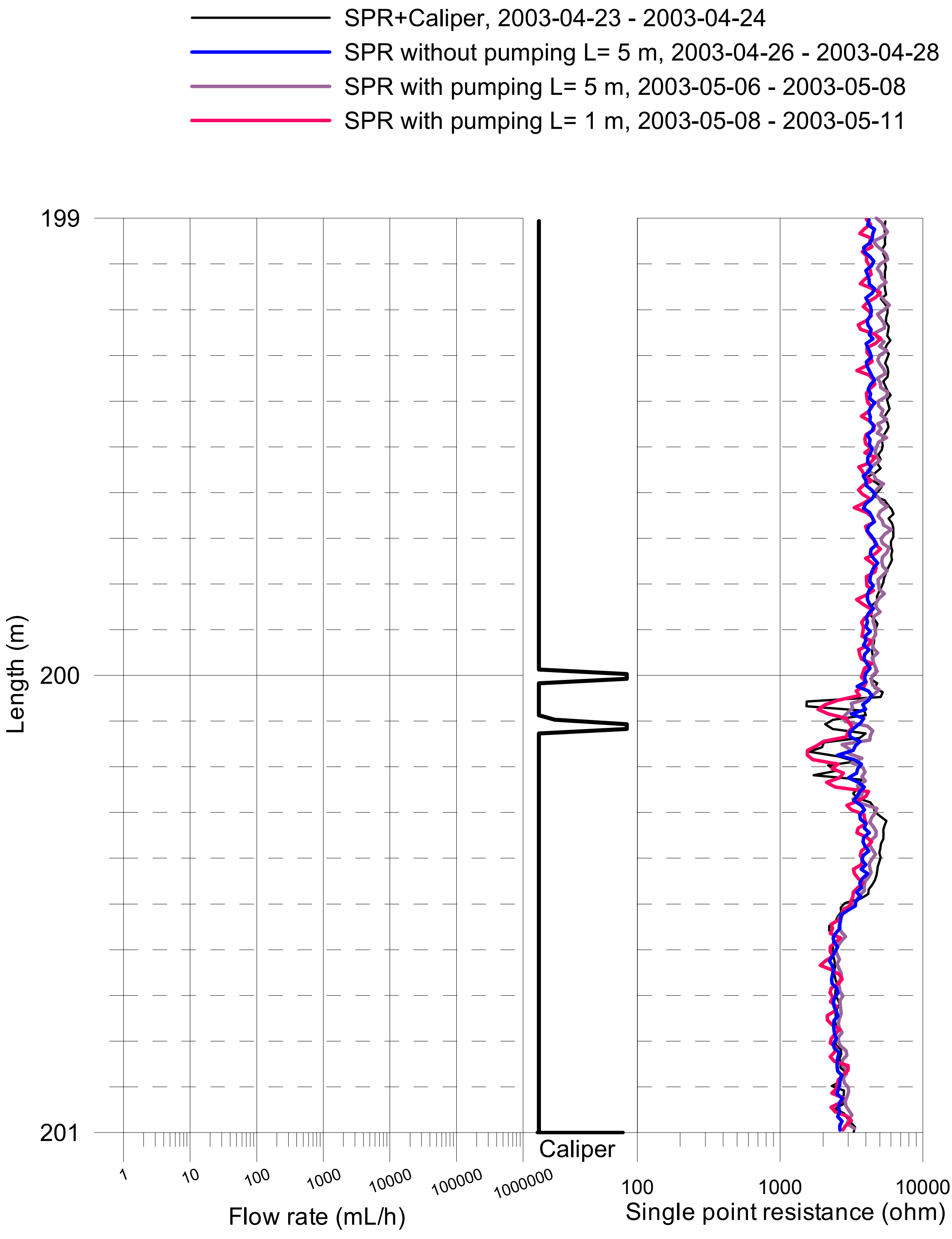
SPR and Caliper results after length correction



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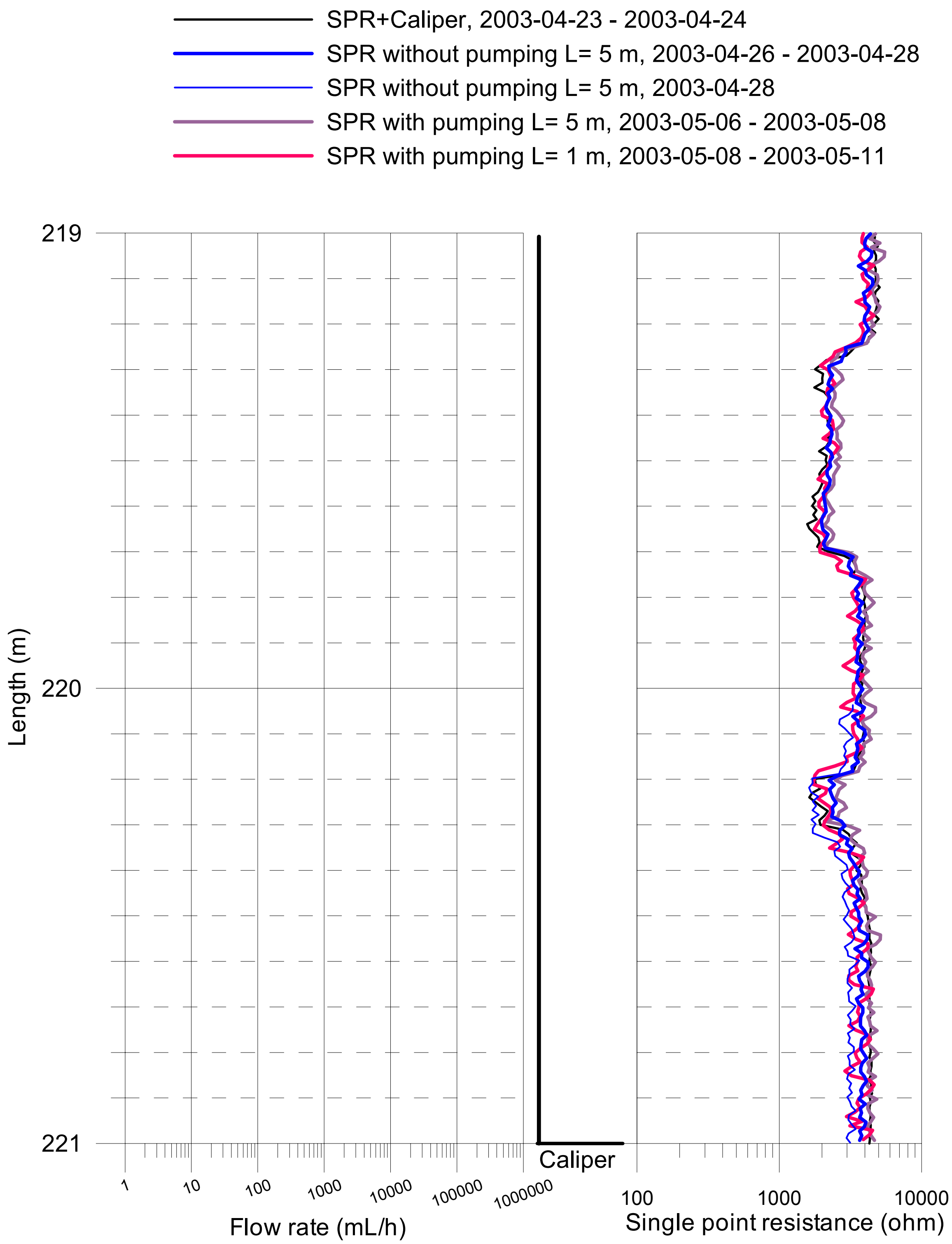

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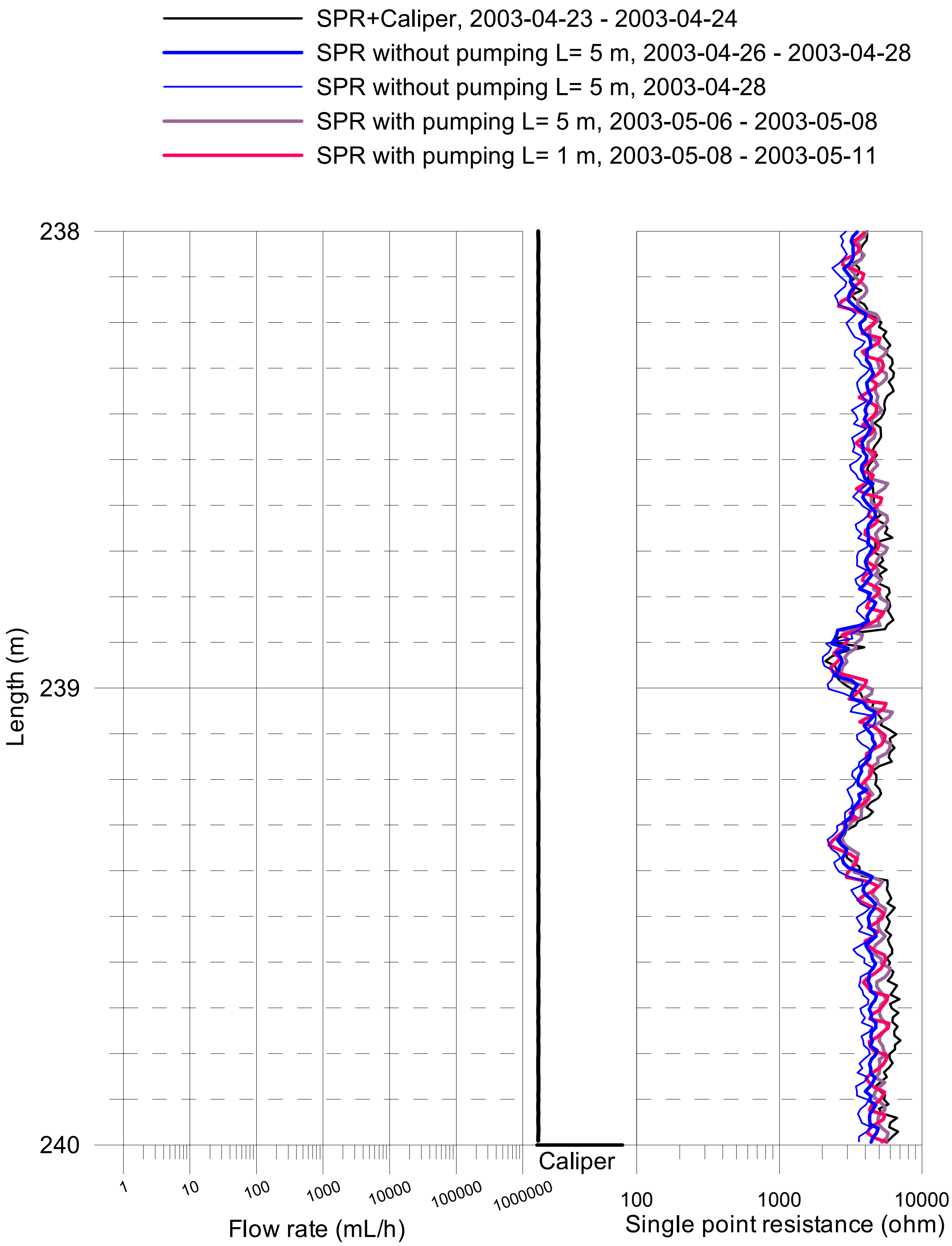
SPR and Caliper results after length correction



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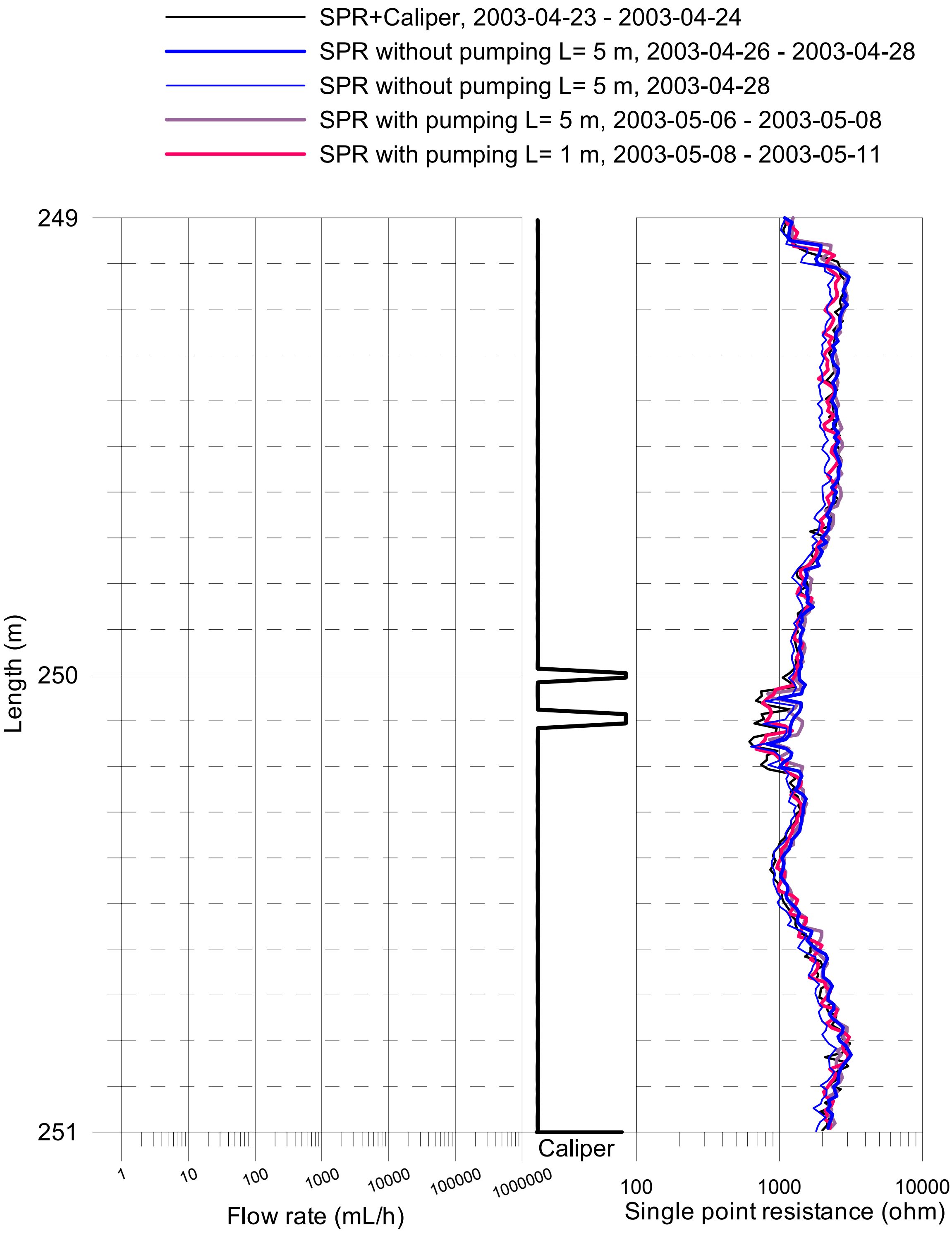
SPR and Caliper results after length correction



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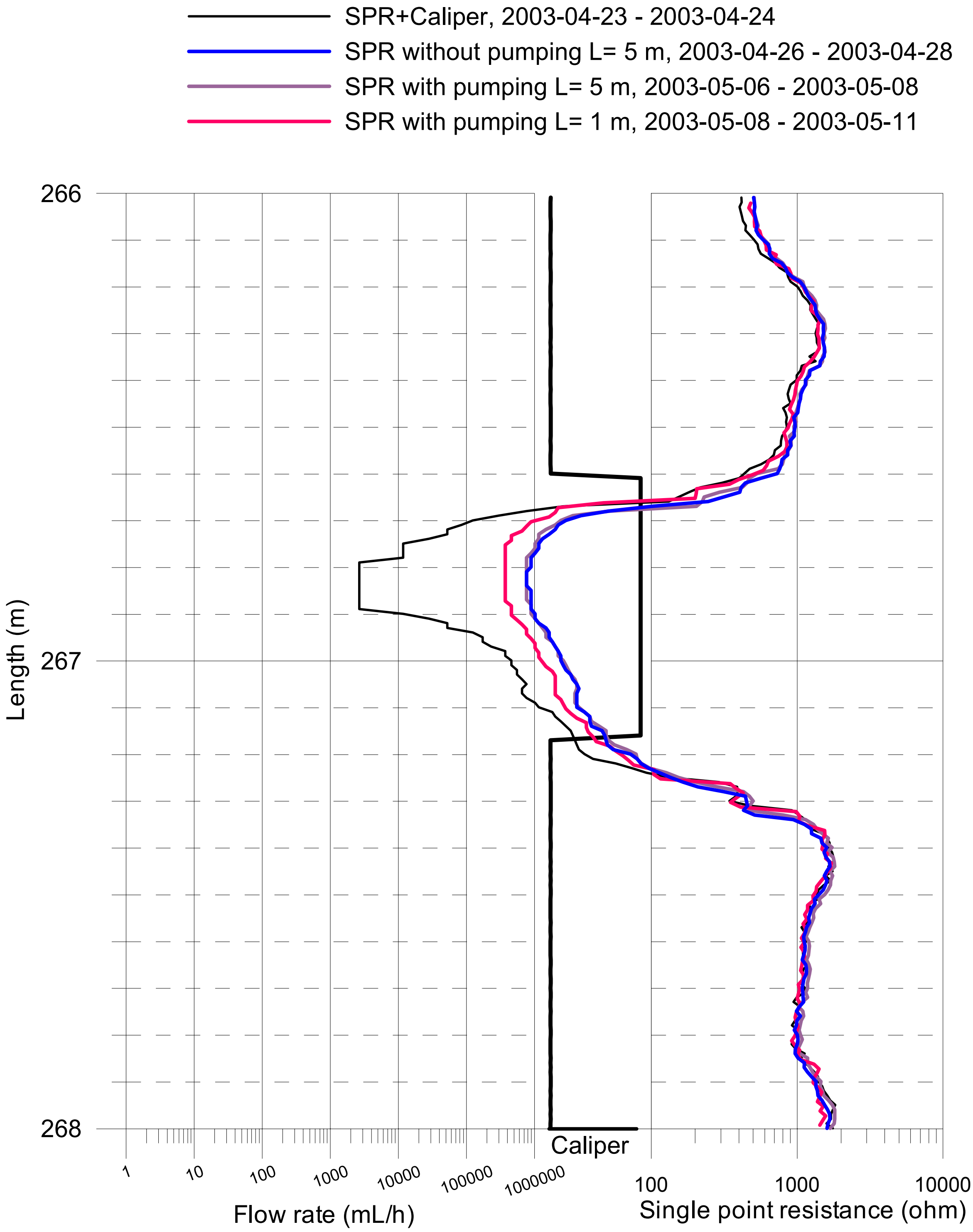
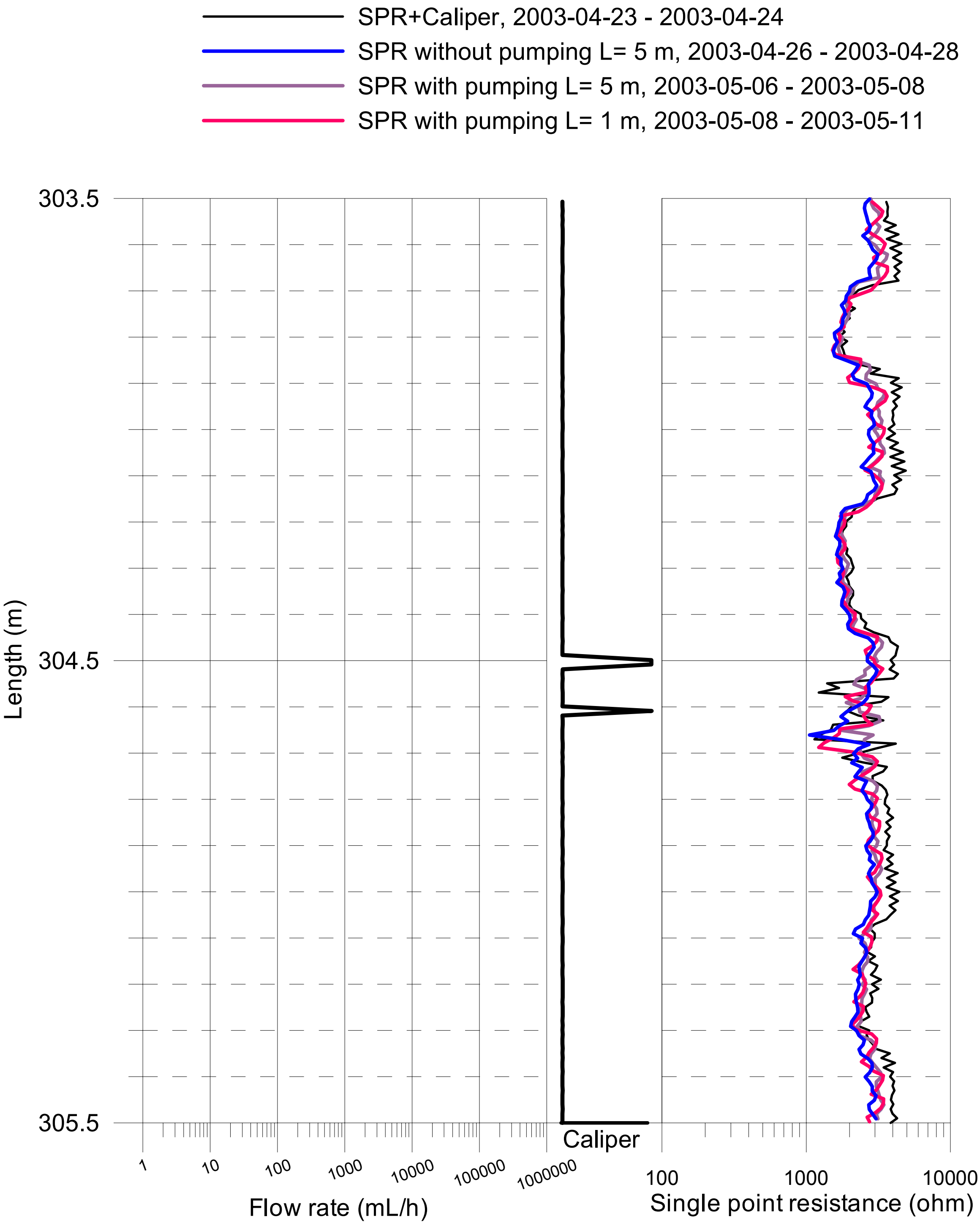
SPR and Caliper results after length correction



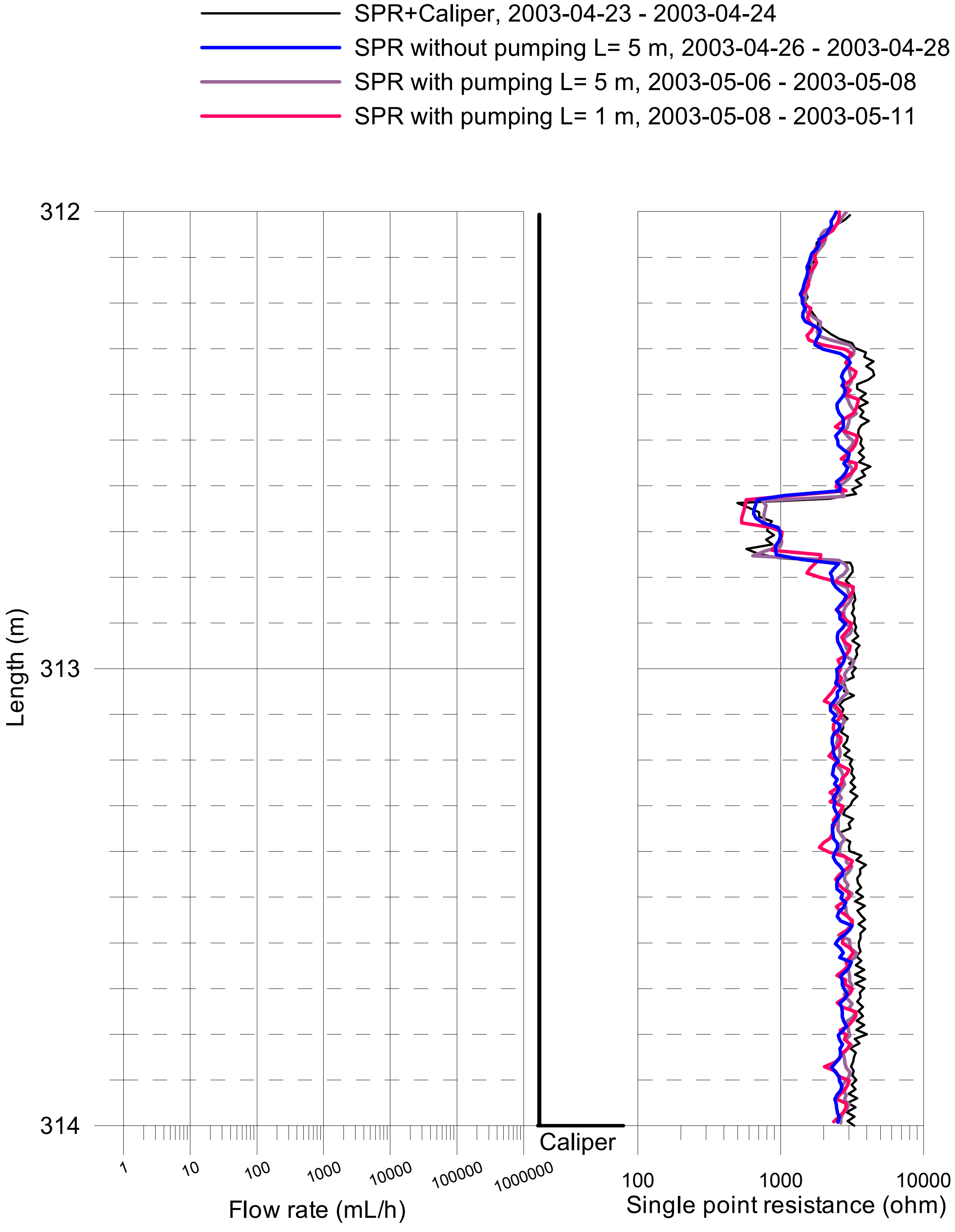
Appendix 1.10

Forsmark, KFM02A
SPR and Caliper results after length correction



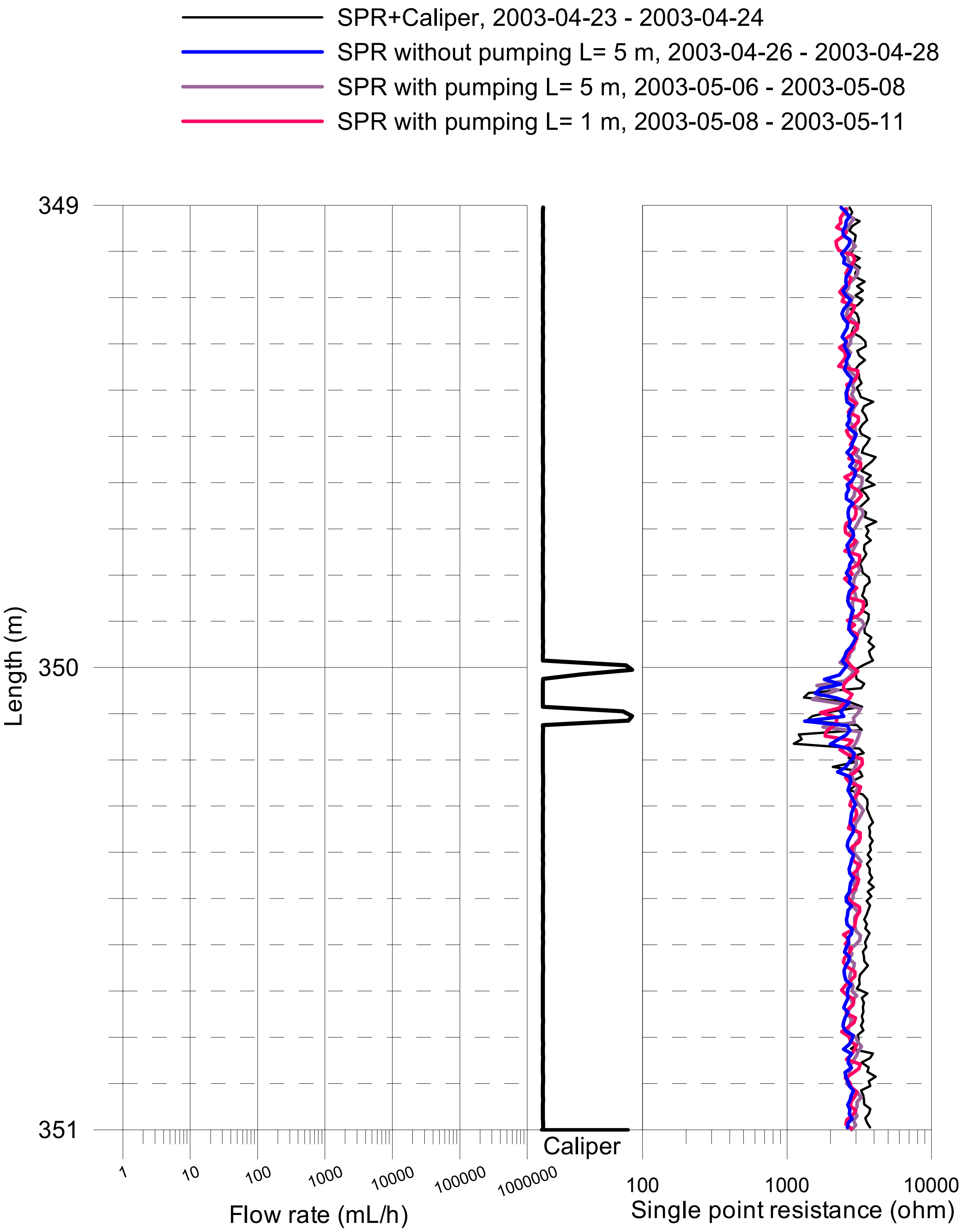
Appendix 1.11

Forsmark, KFM02A
SPR and Caliper results after length correction

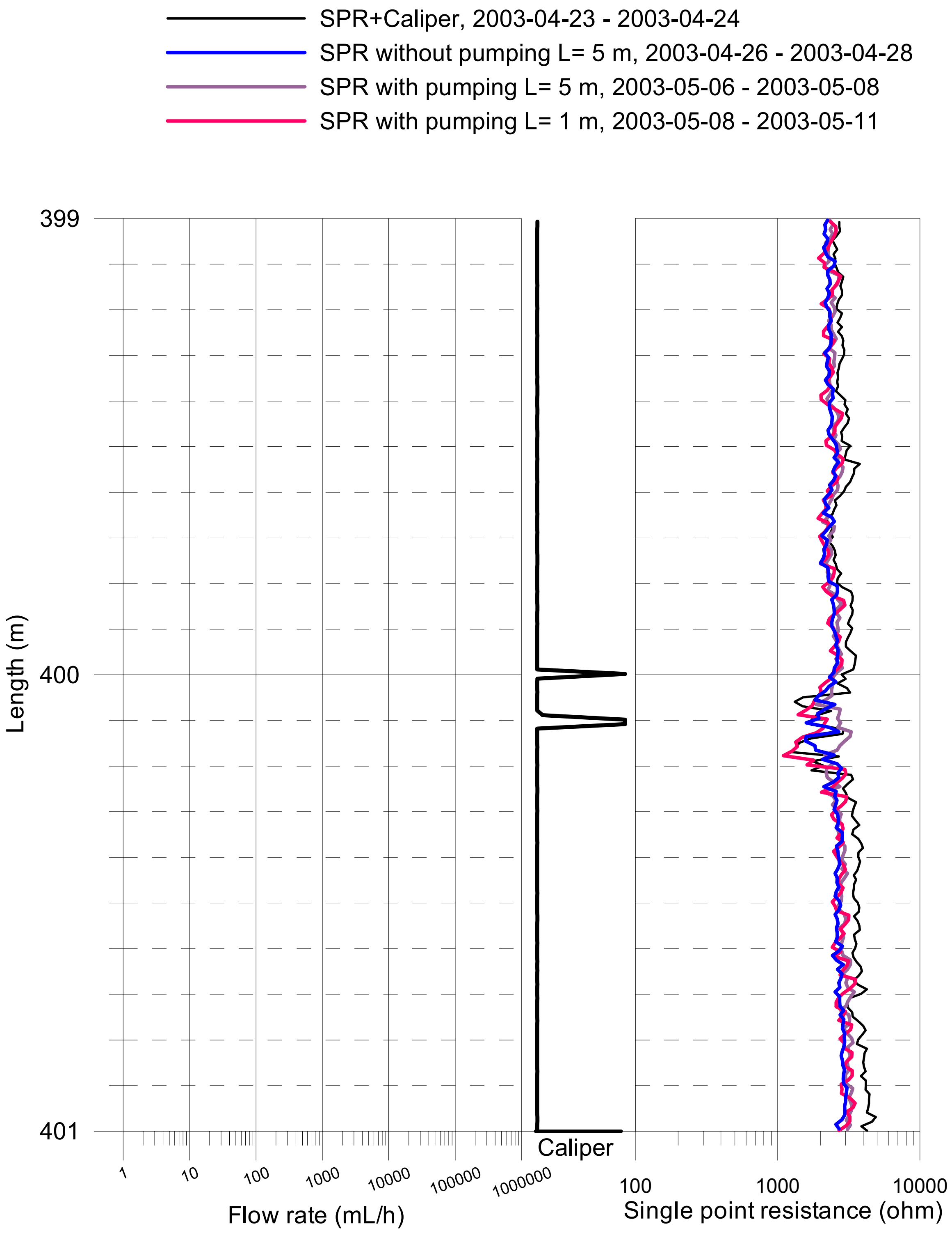


Appendix 1.12

Forsmark, KFM02A
SPR and Caliper results after length correction



Forsmark, KFM02A
SPR and Caliper results after length correction



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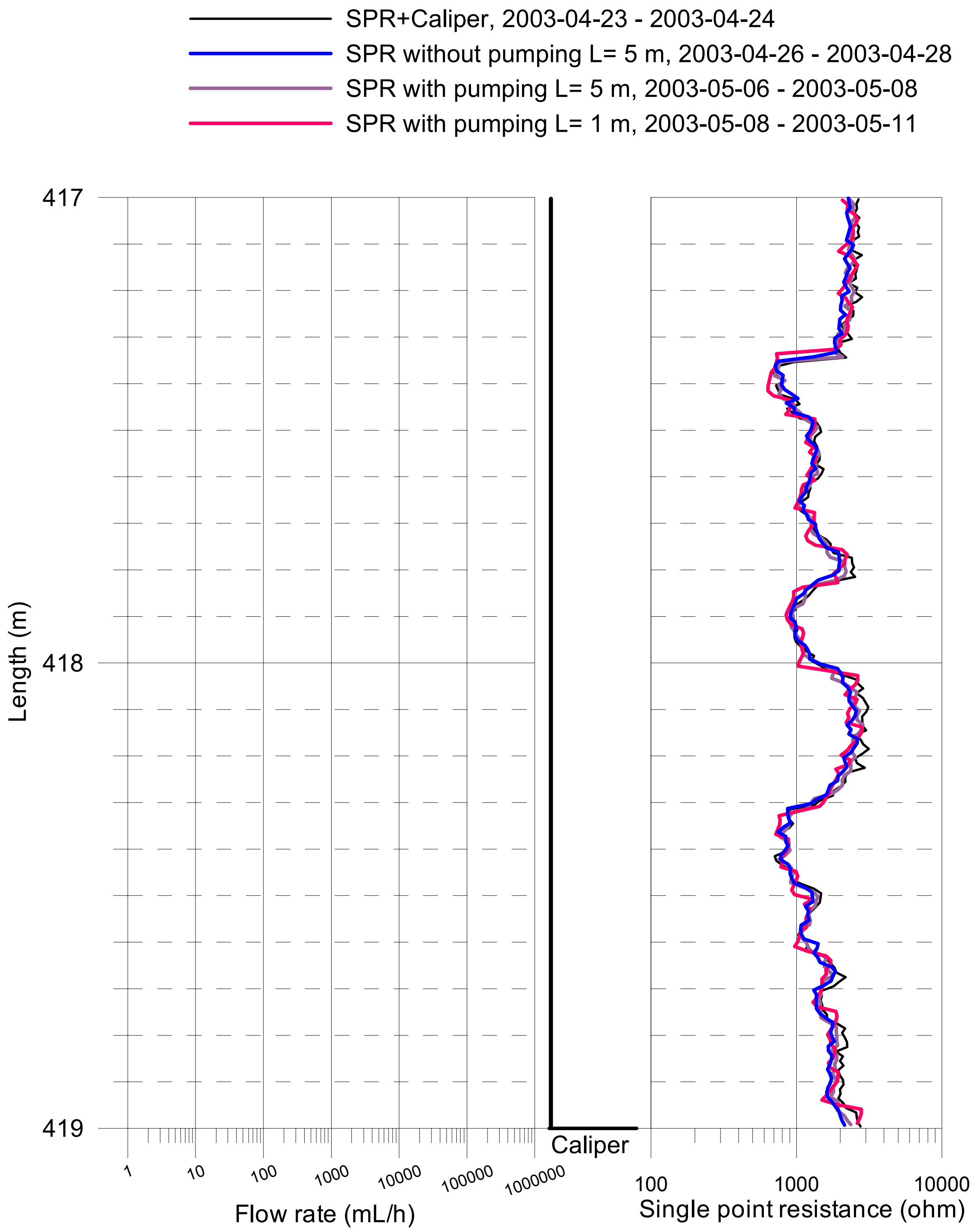
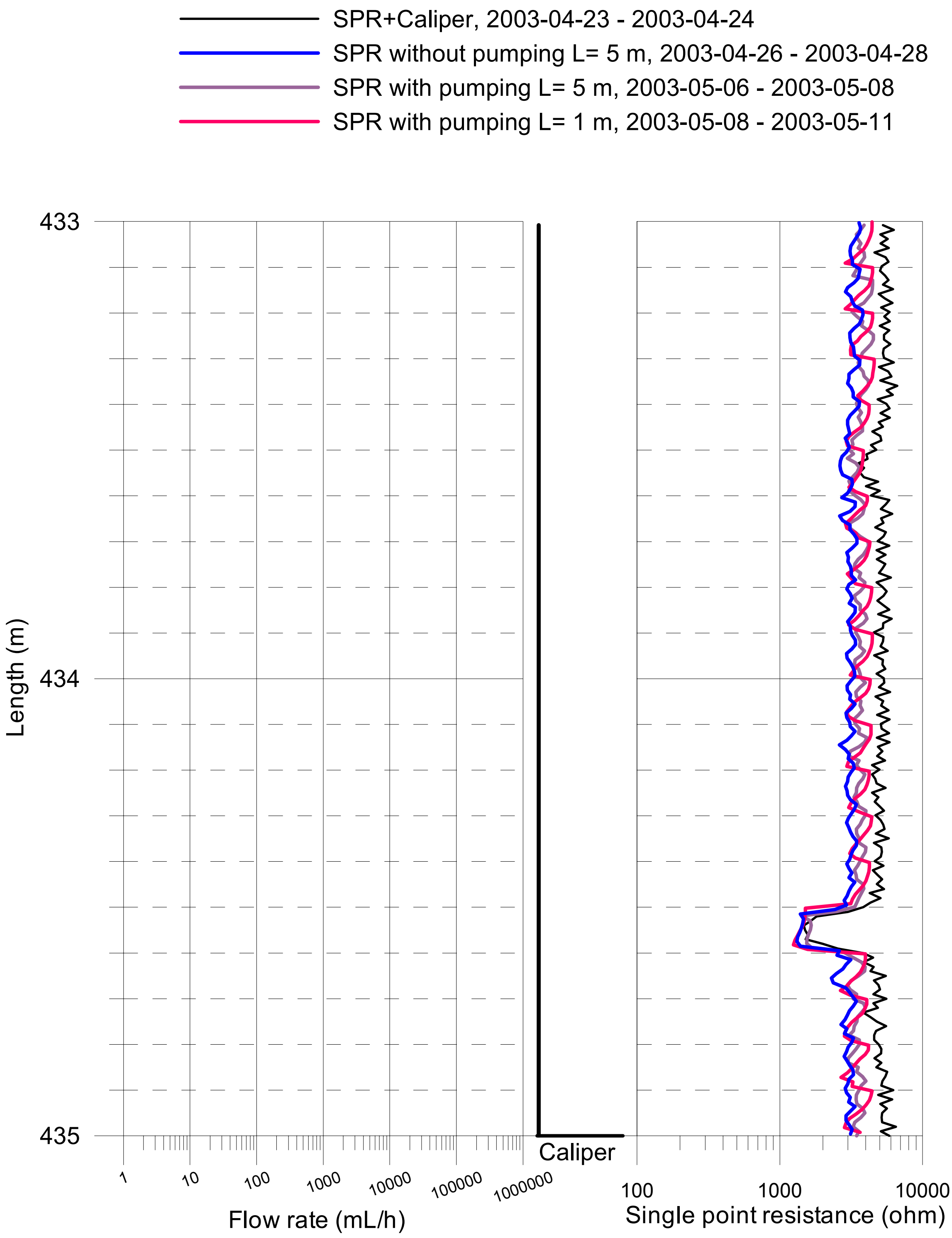
SPR and Caliper results after length correction

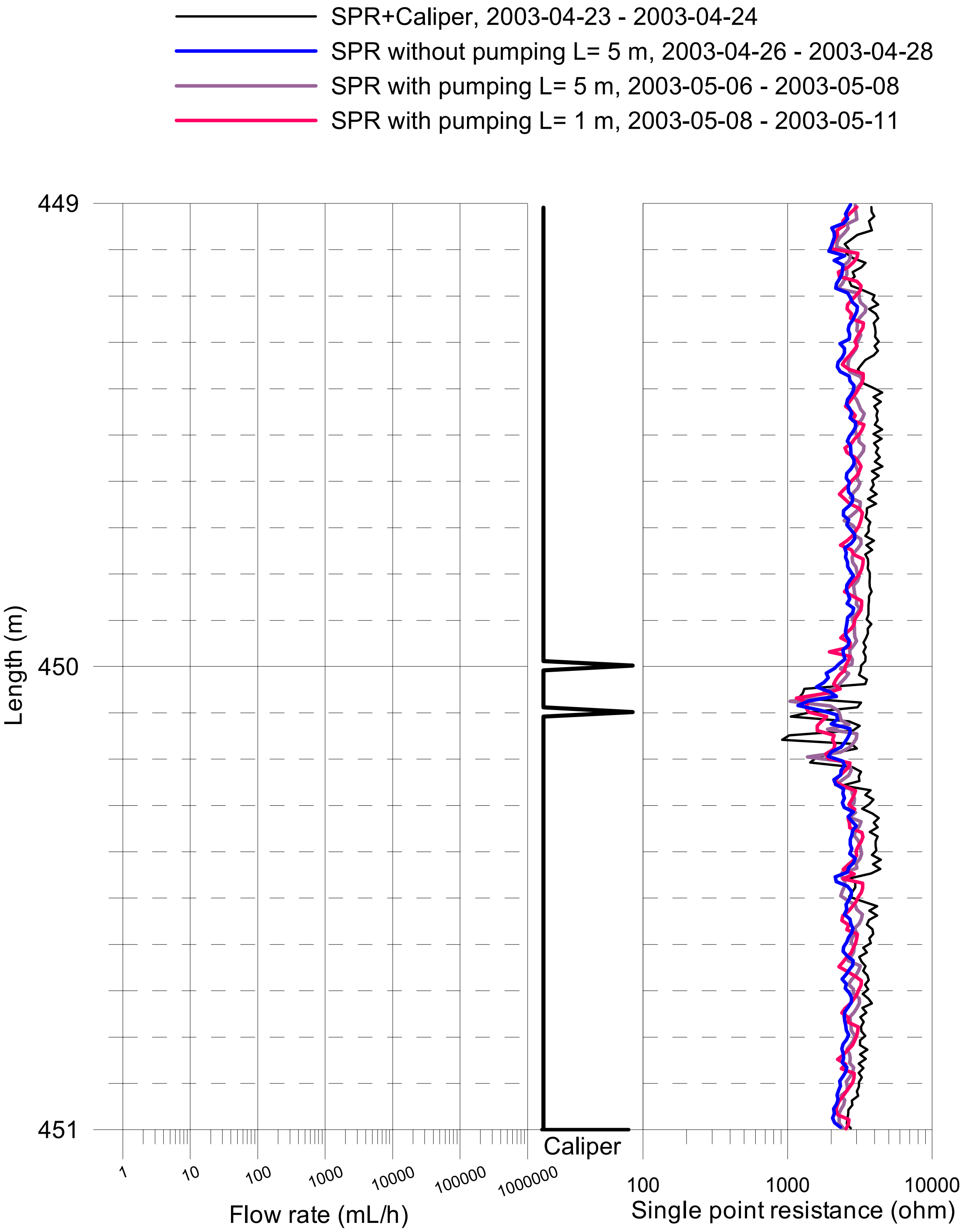


Forsmark, KFM02A
SPR and Caliper results after length correction



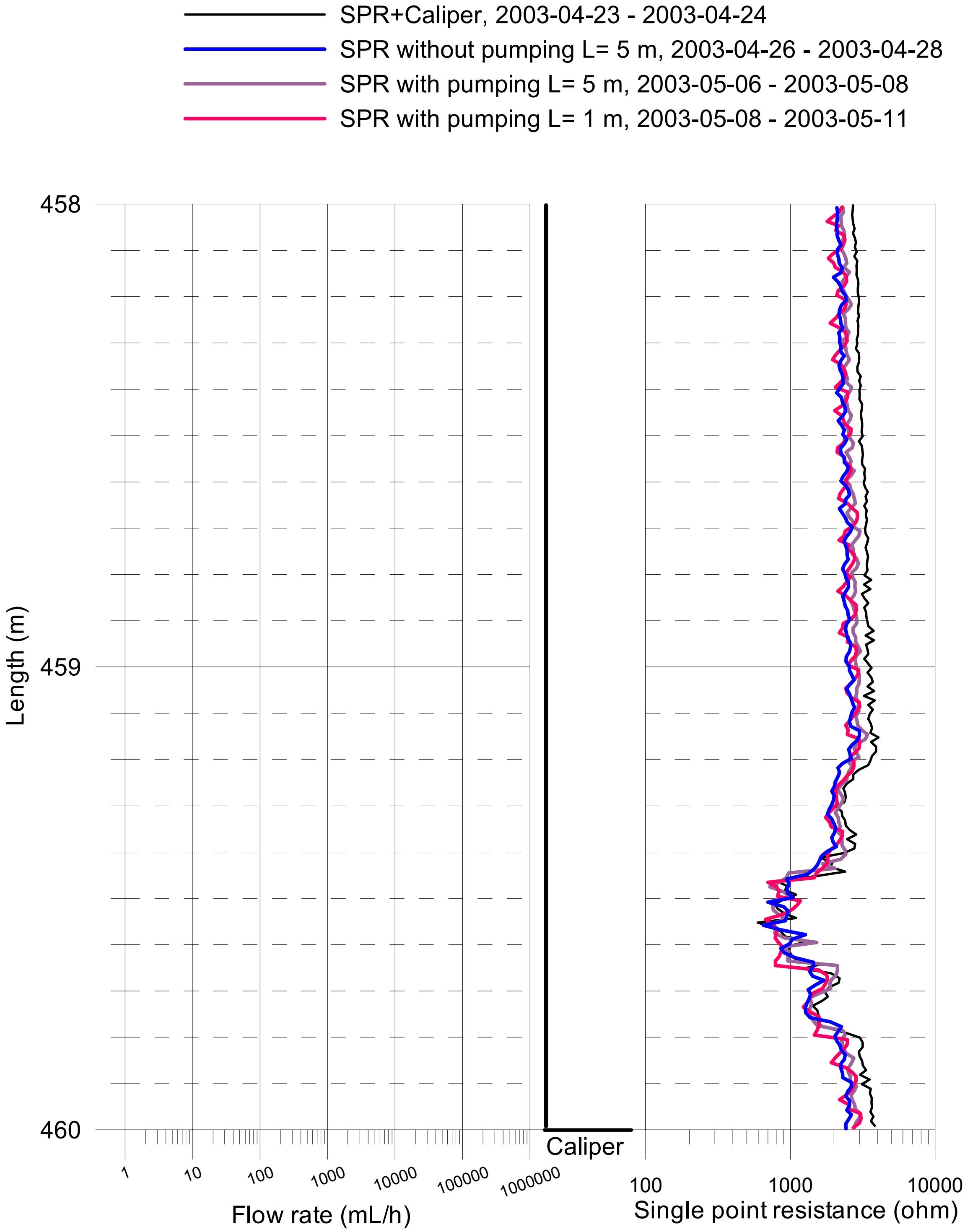
Appendix 1.16

Forsmark, KFM02A
SPR and Caliper results after length correction

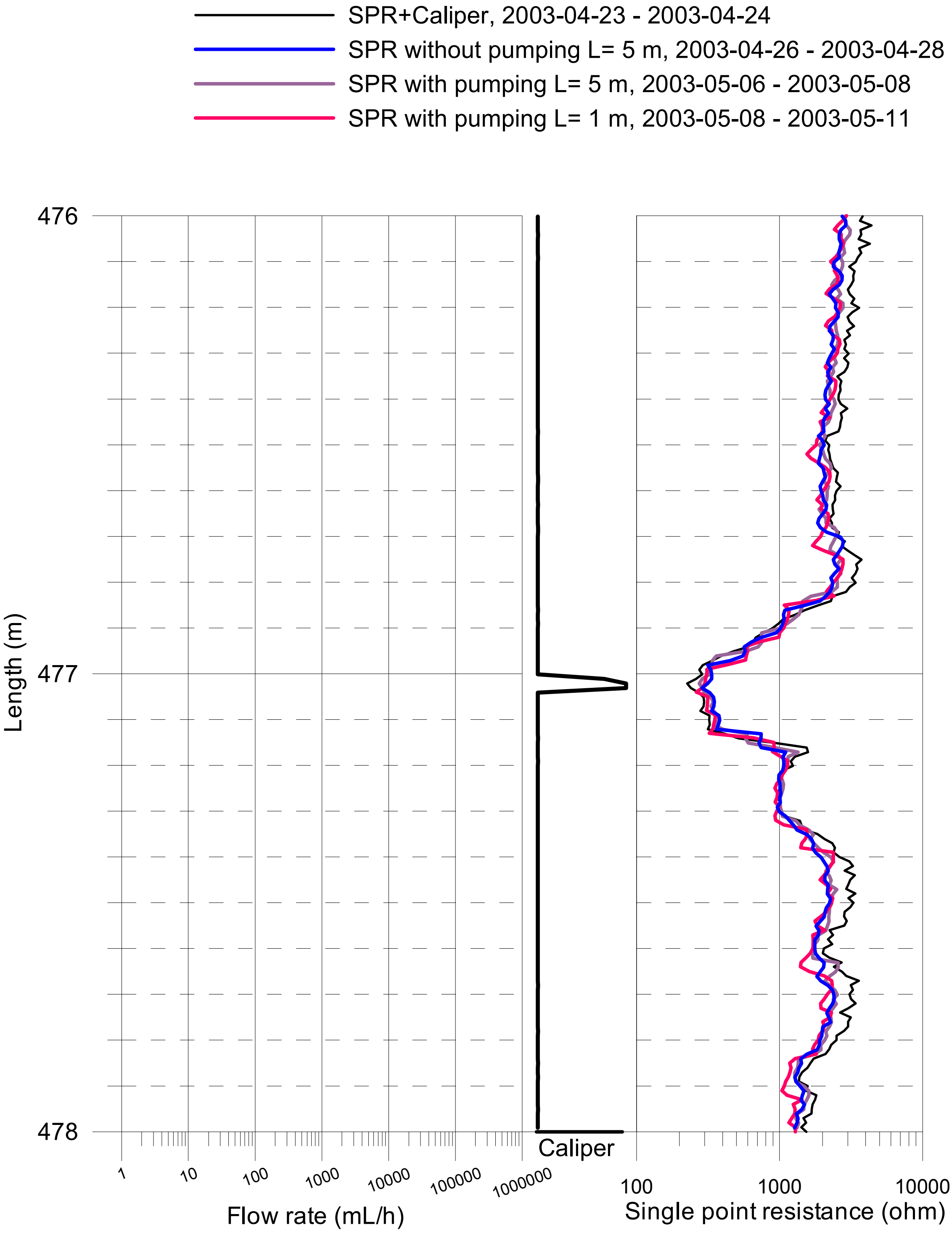


Appendix 1.17

Forsmark, KFM02A
SPR and Caliper results after length correction

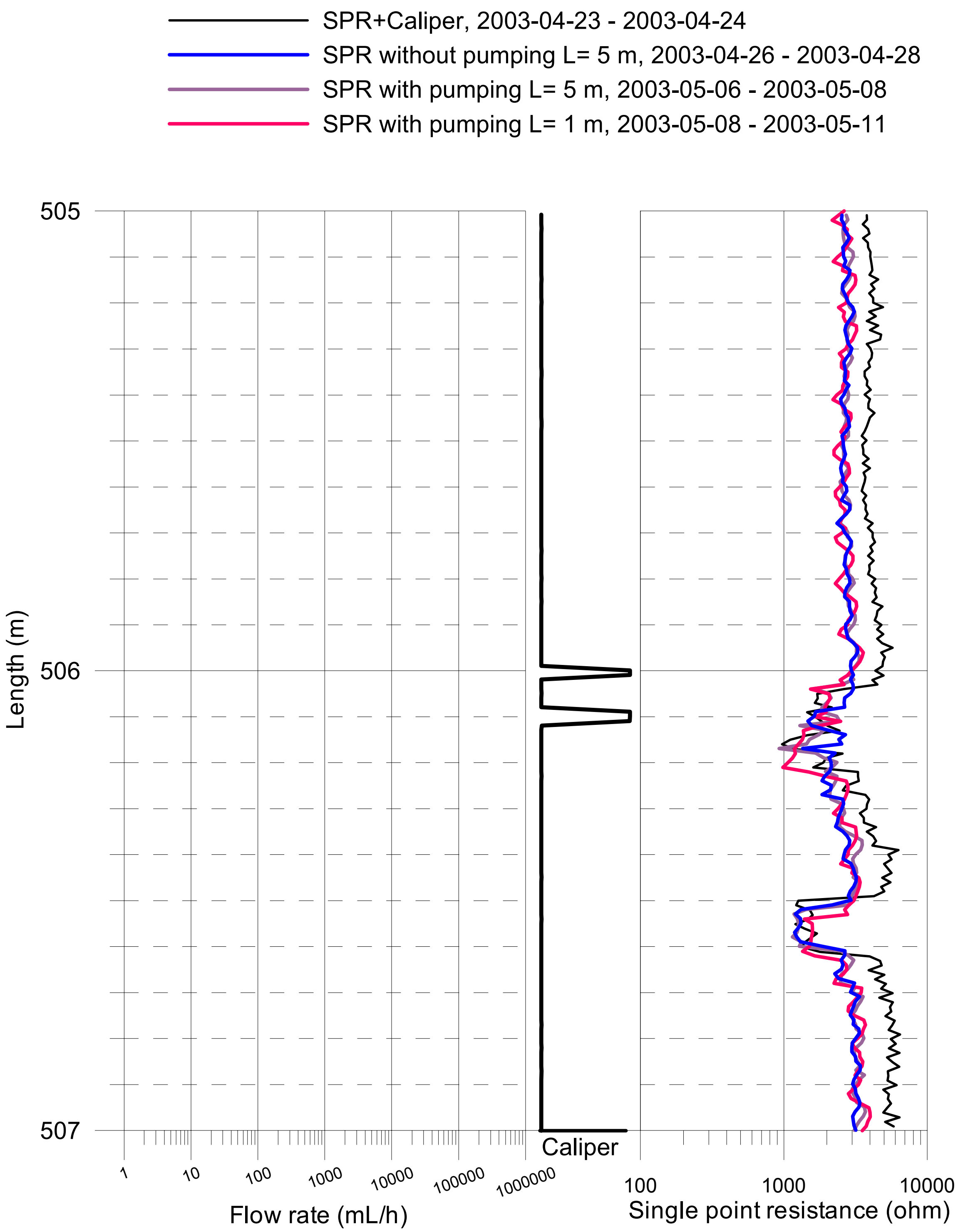


Forsmark, KFM02A
SPR and Caliper results after length correction



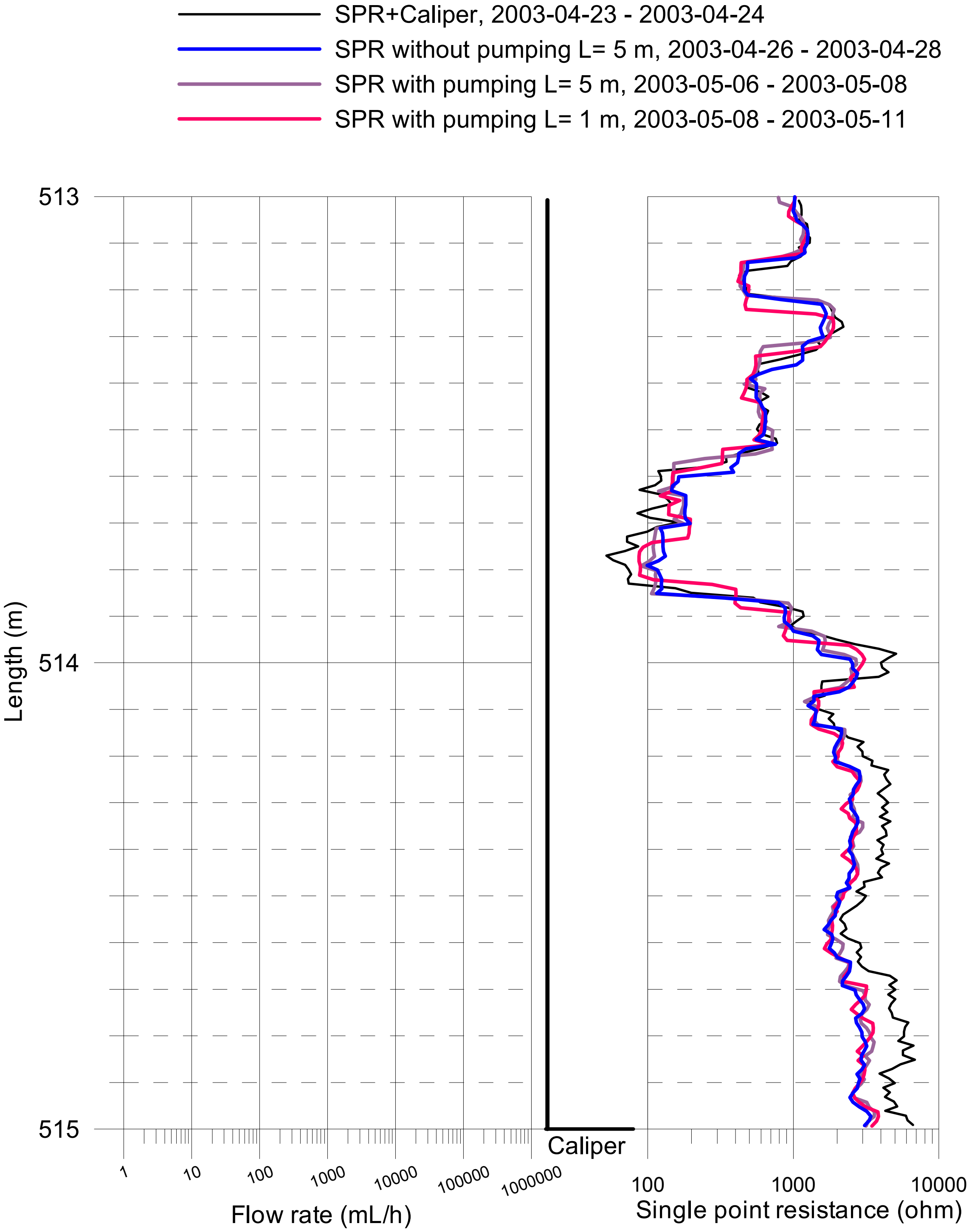
Appendix 1.19

Forsmark, KFM02A
SPR and Caliper results after length correction



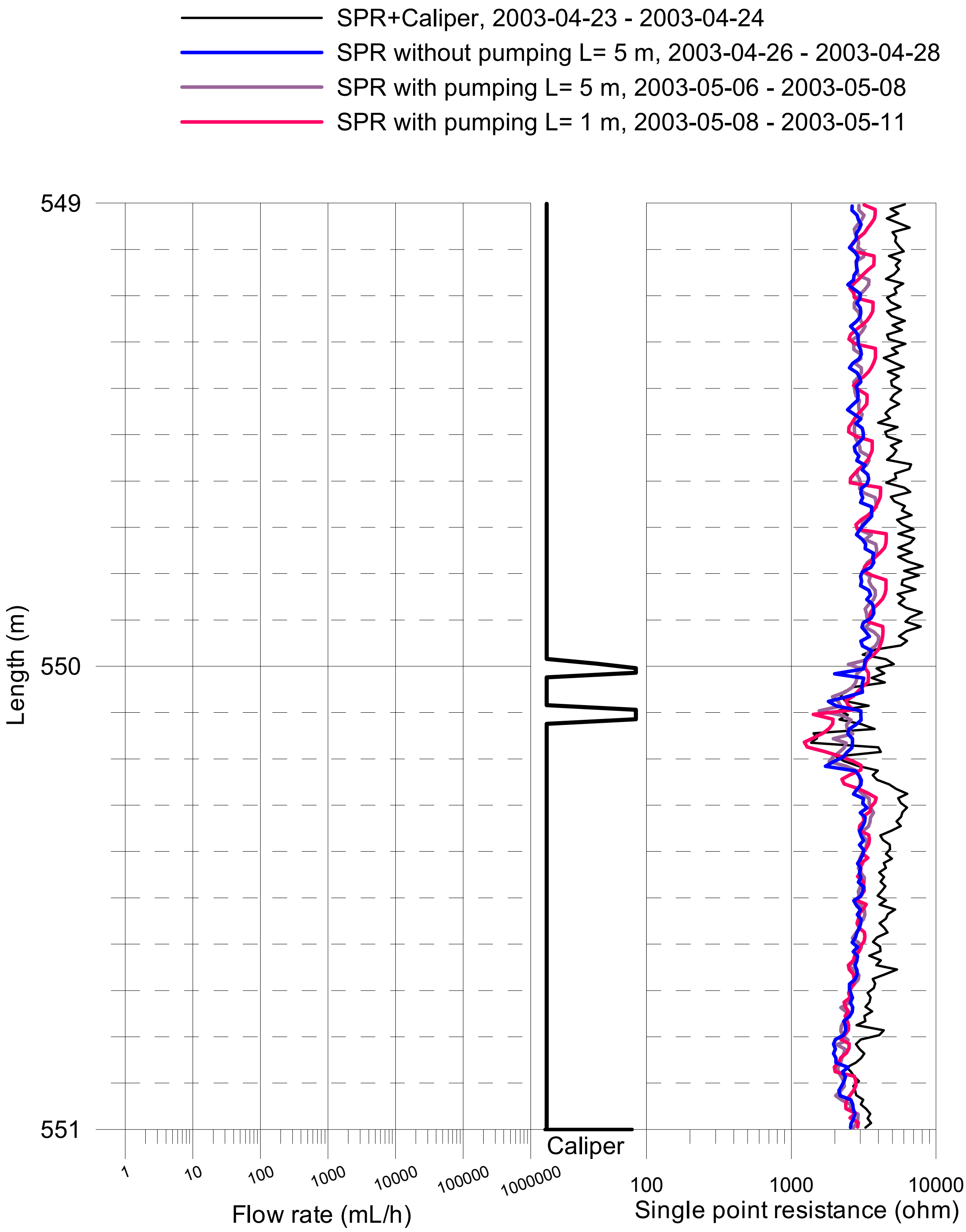
Appendix 1.20

Forsmark, KFM02A
SPR and Caliper results after length correction



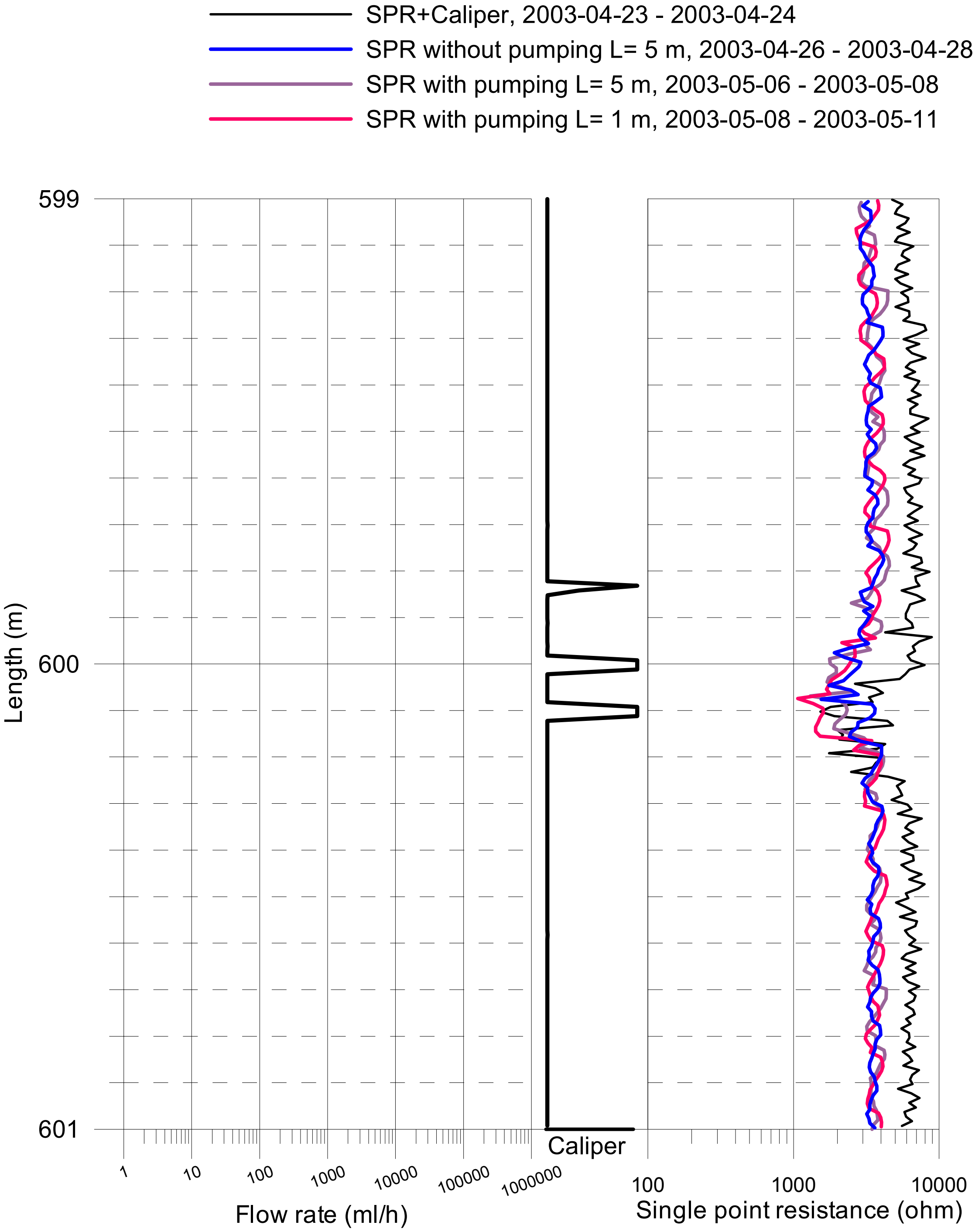
Appendix 1.21

Forsmark, KFM02A
SPR and Caliper results after length correction



Appendix 1.22

Forsmark, KFM02A
SPR and Caliper results after length correction



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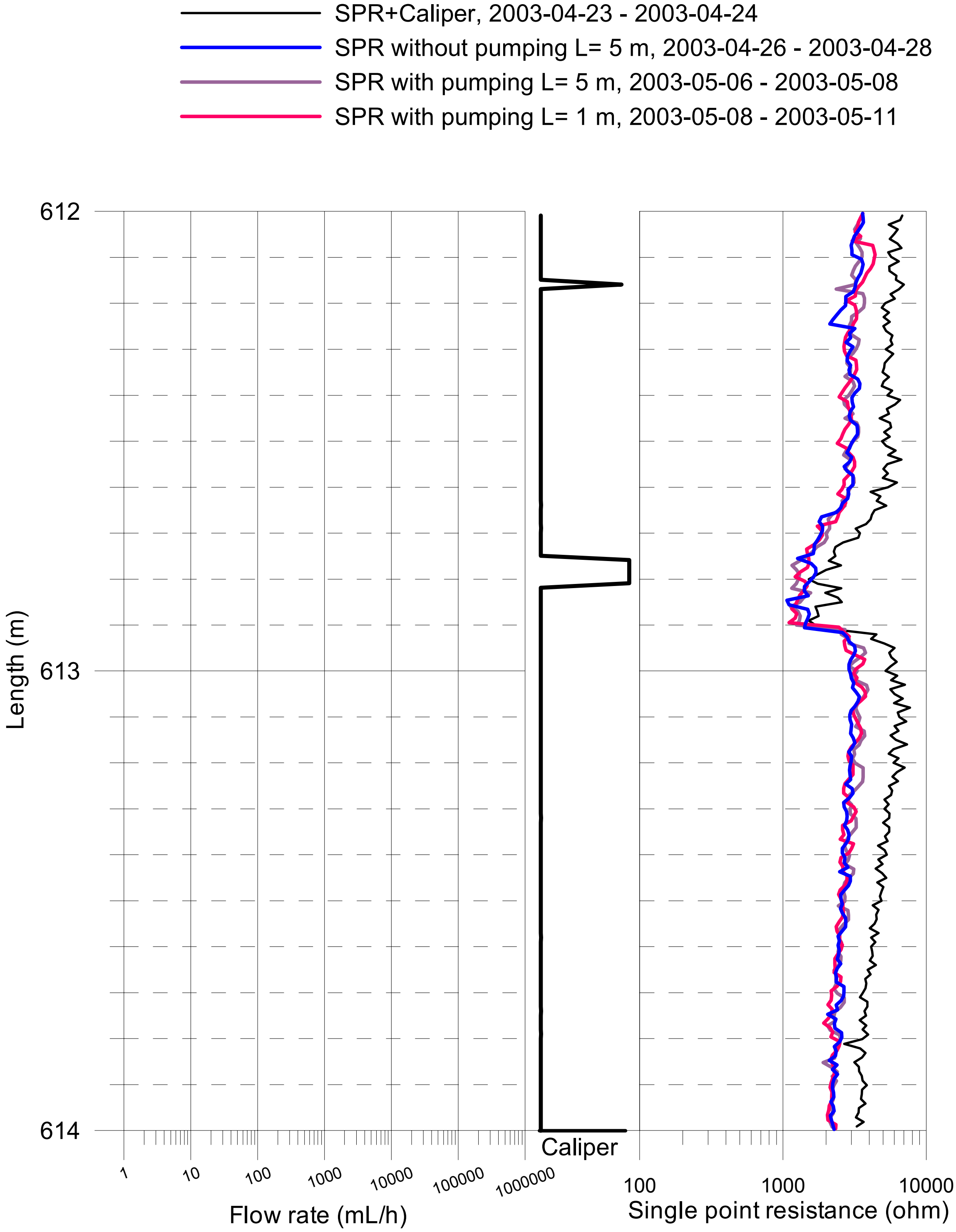
SPR and Caliper results after length correction



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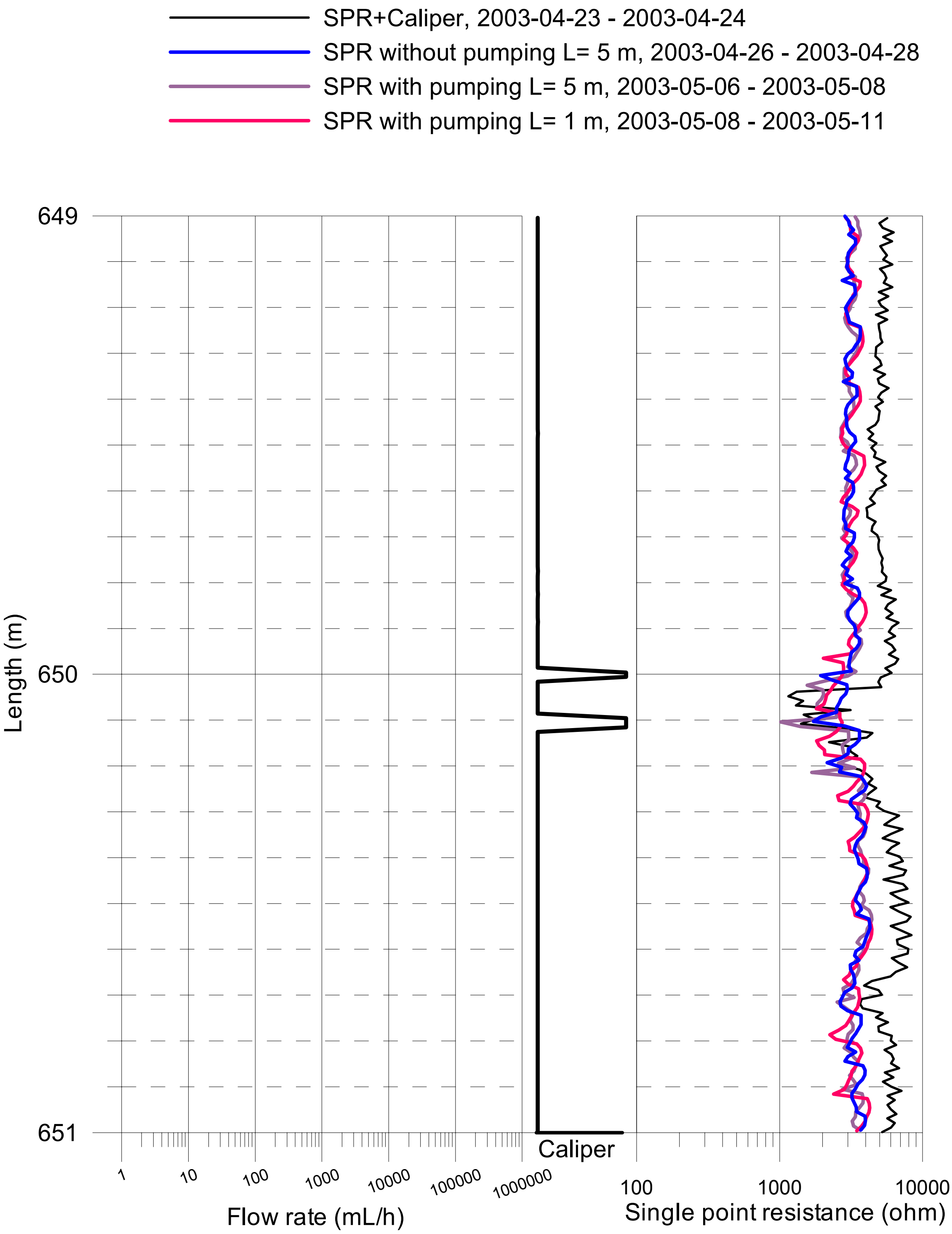
SPR and Caliper results after length correction



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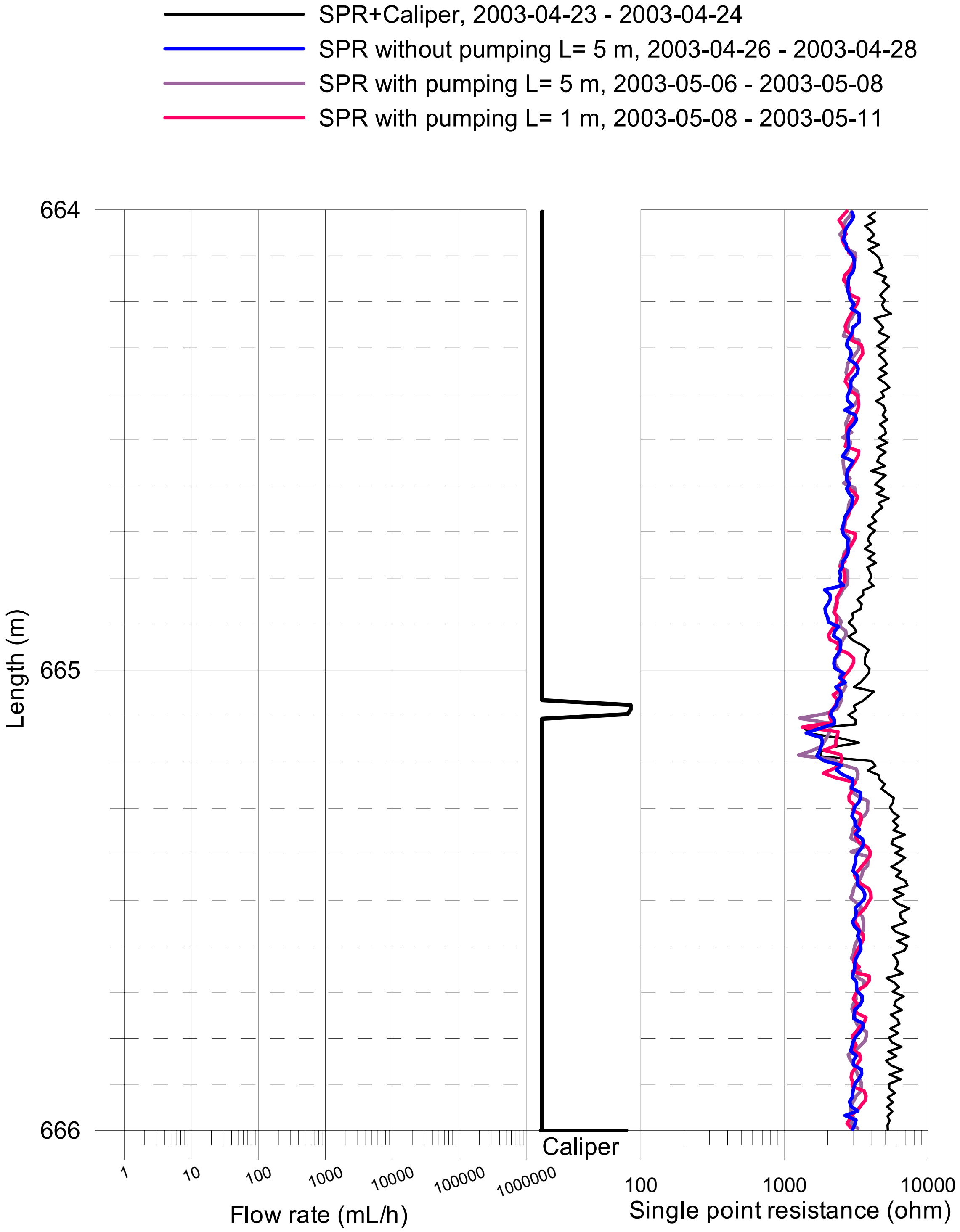
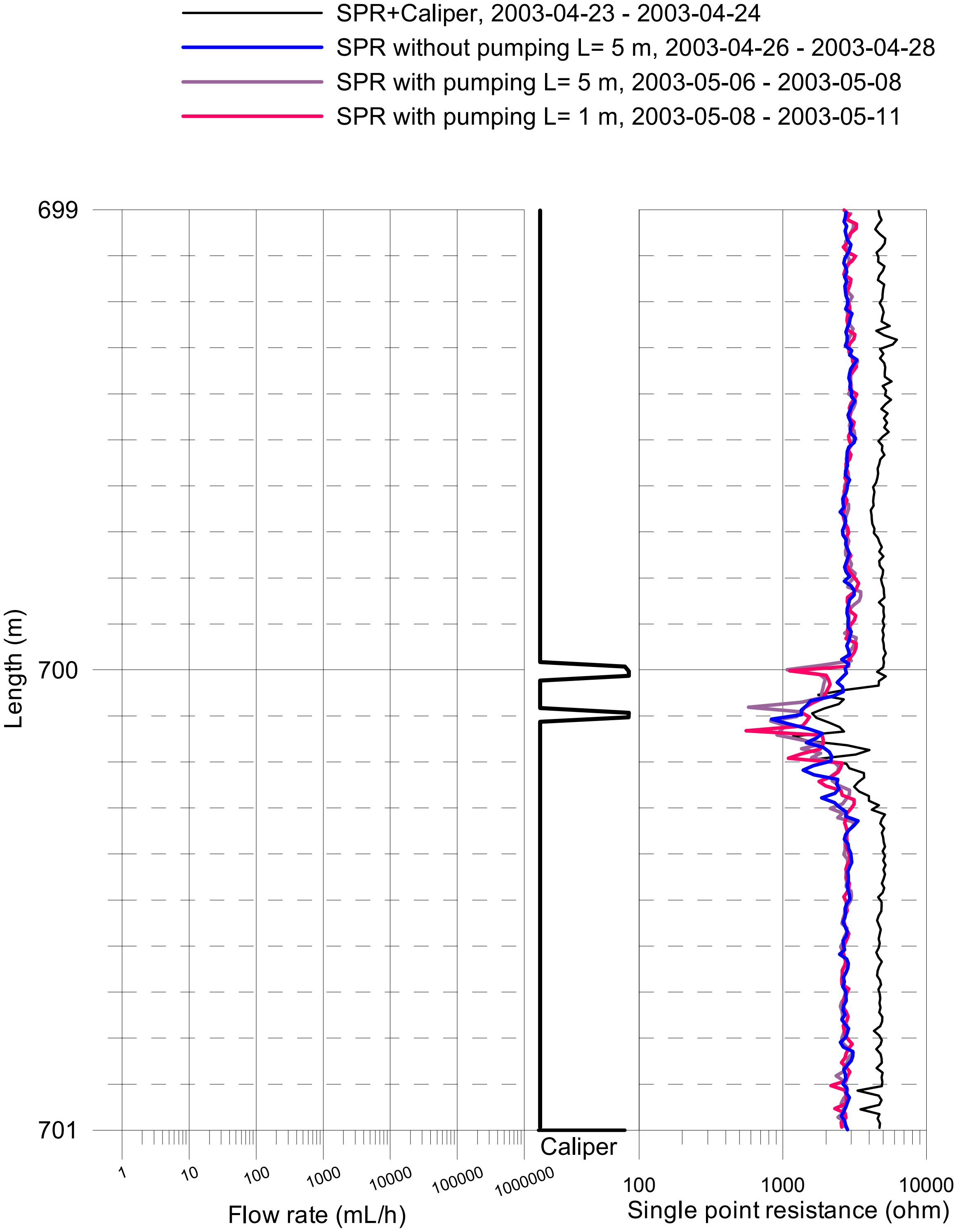
SPR and Caliper results after length correction



Appendix 1.26

Forsmark, KFM02A
SPR and Caliper results after length correction



Appendix 1.27

Forsmark, KFM02A
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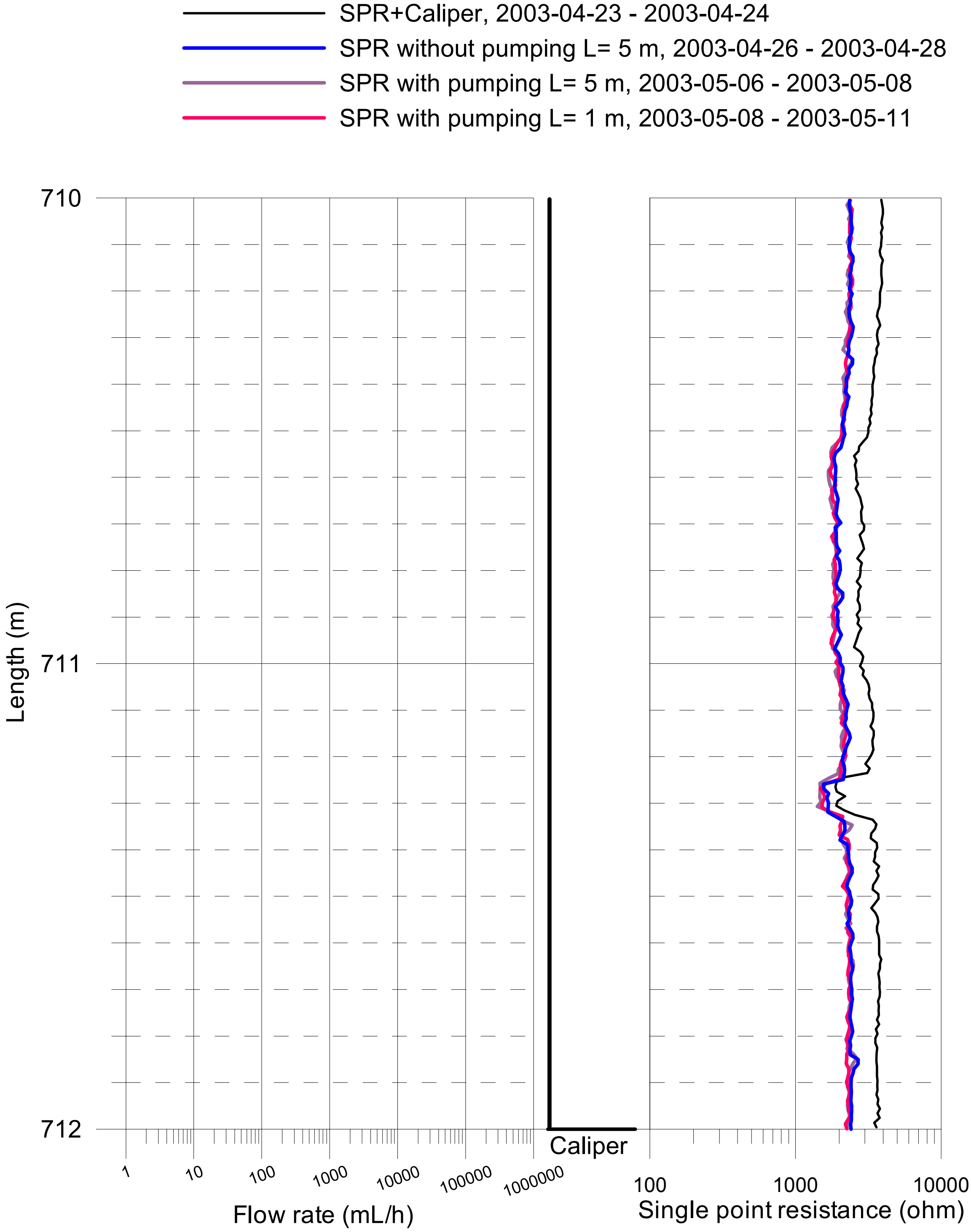
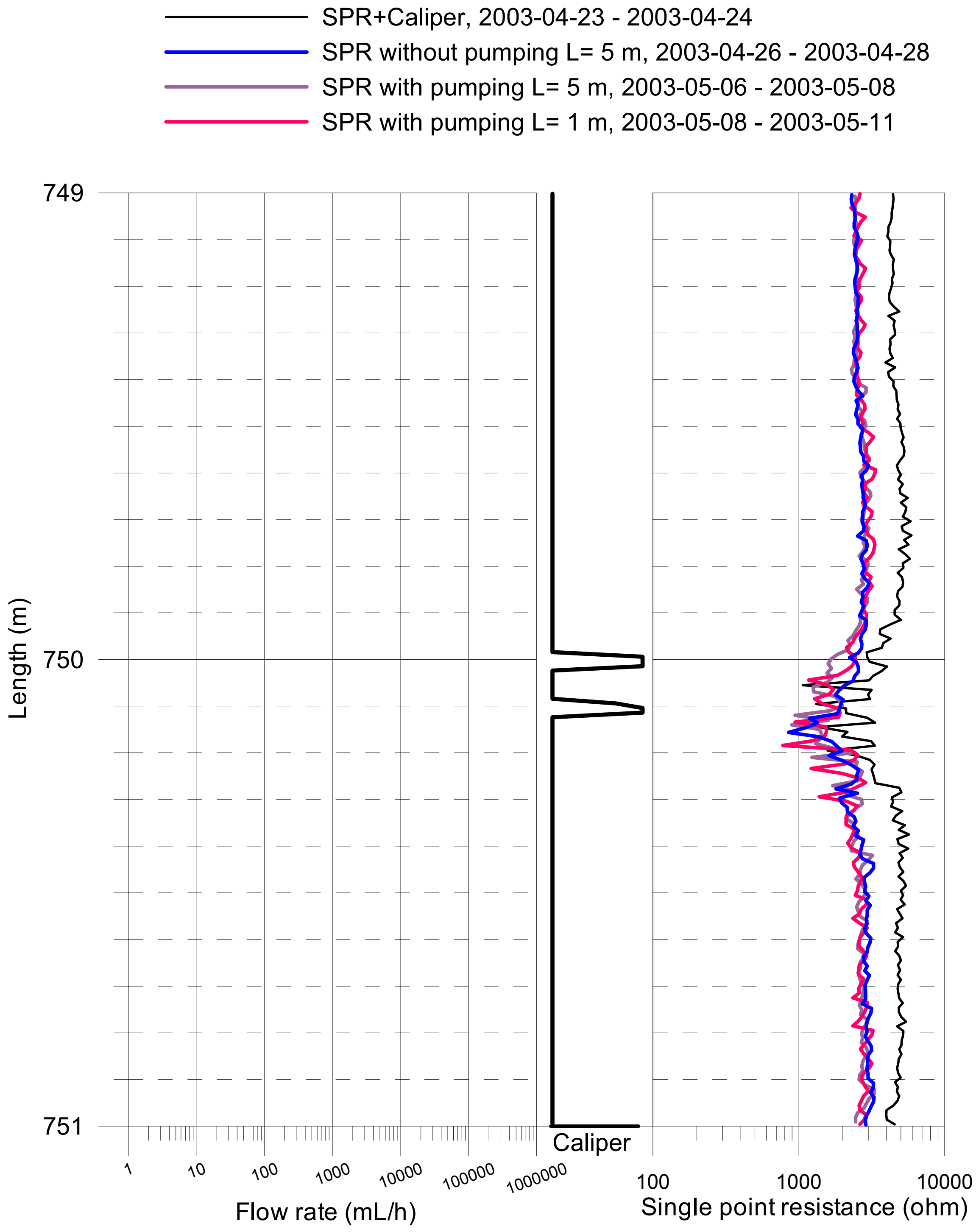


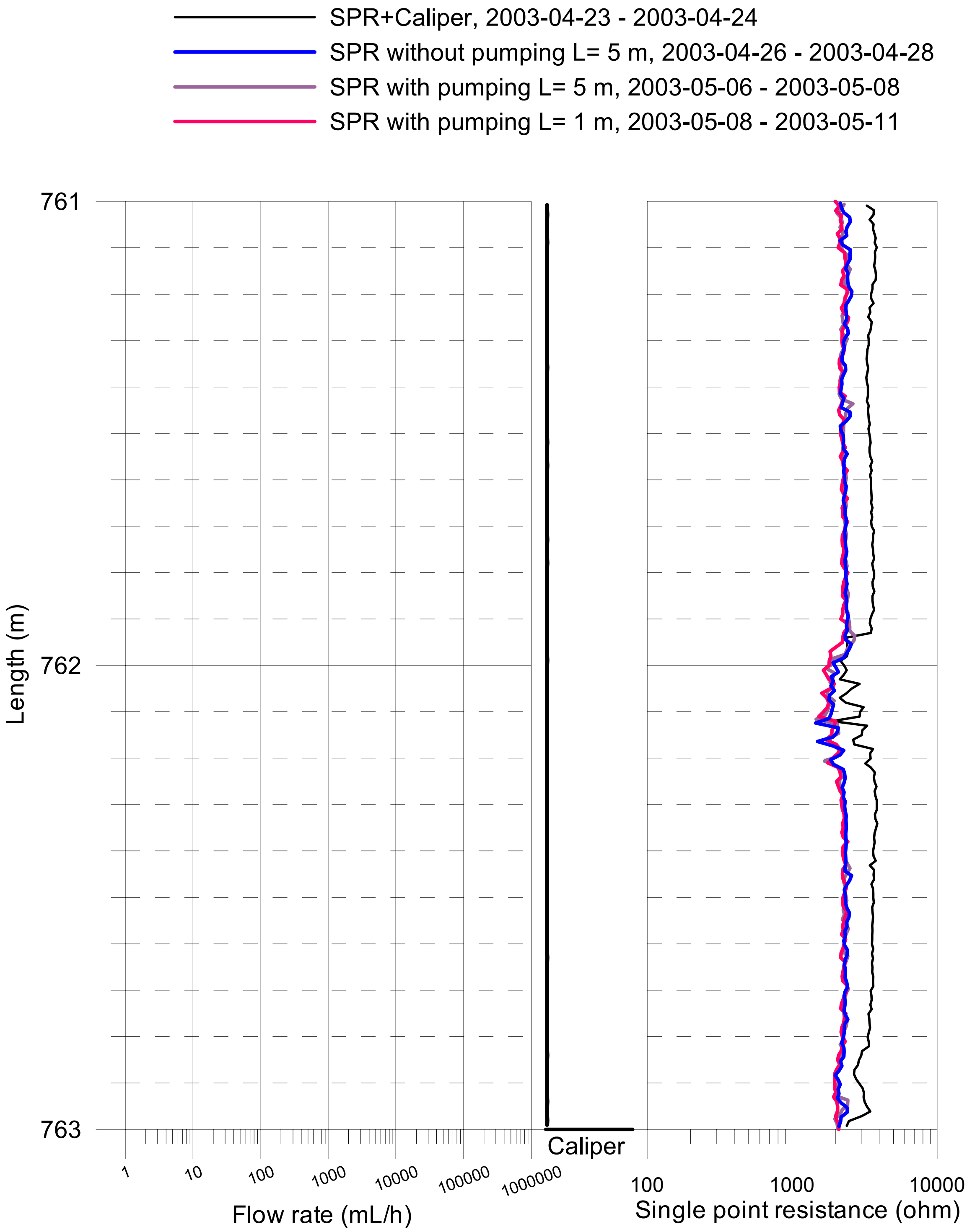
Appendix 1.28

Forsmark, KFM02A
SPR and Caliper results after length correction

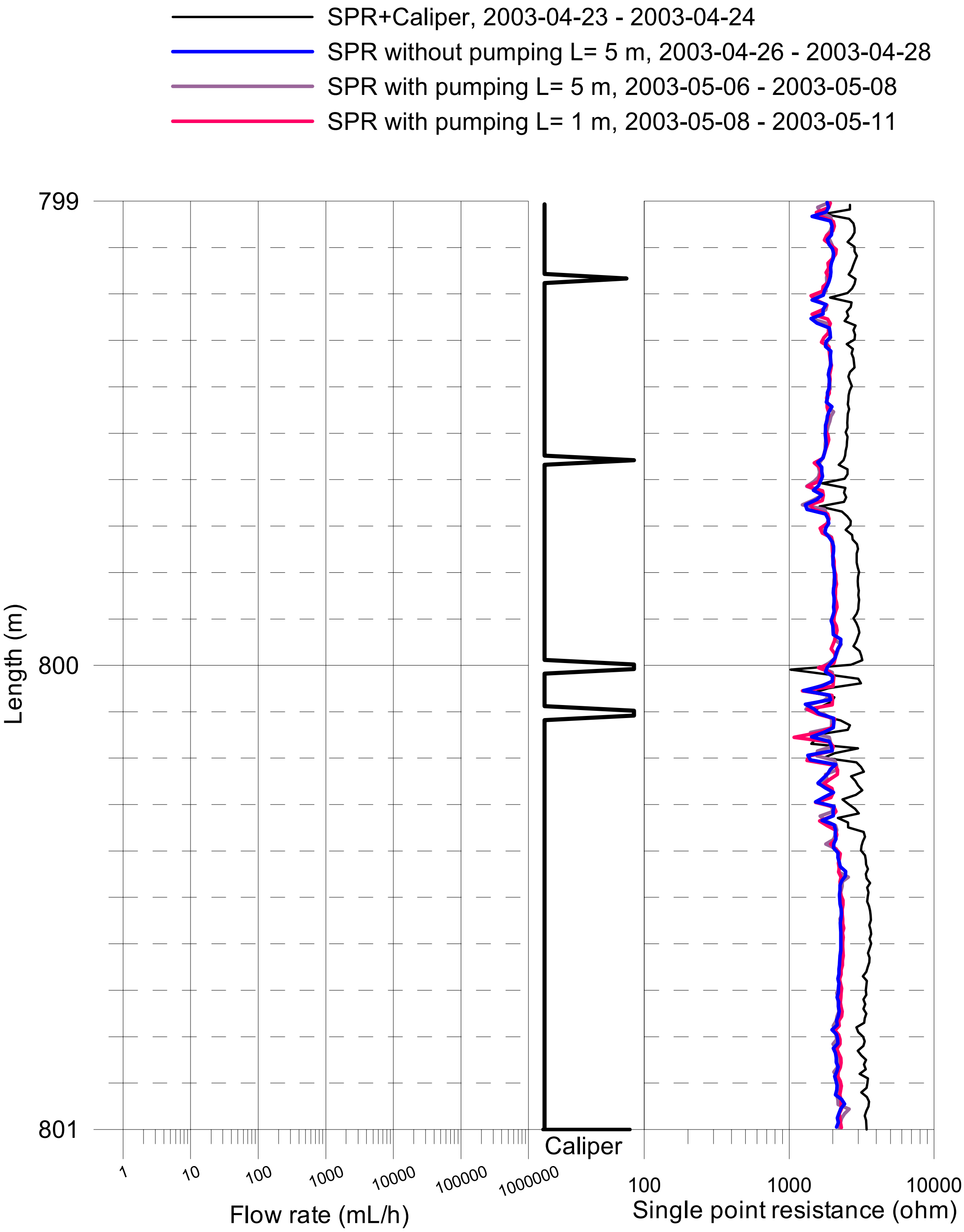


Appendix 1.29

Forsmark, KFM02A
SPR and Caliper results after length correction

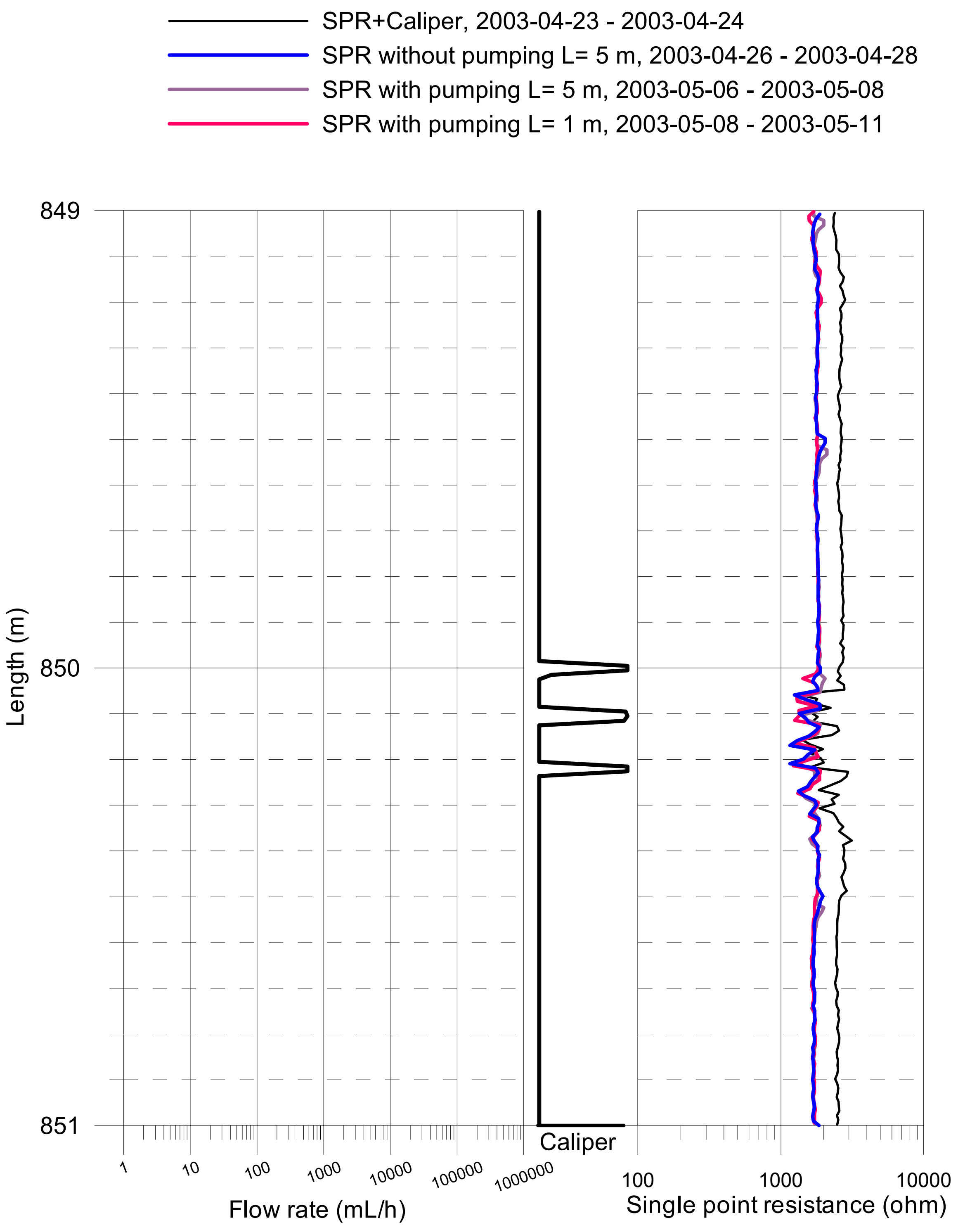


Forsmark, KFM02A
SPR and Caliper results after length correction

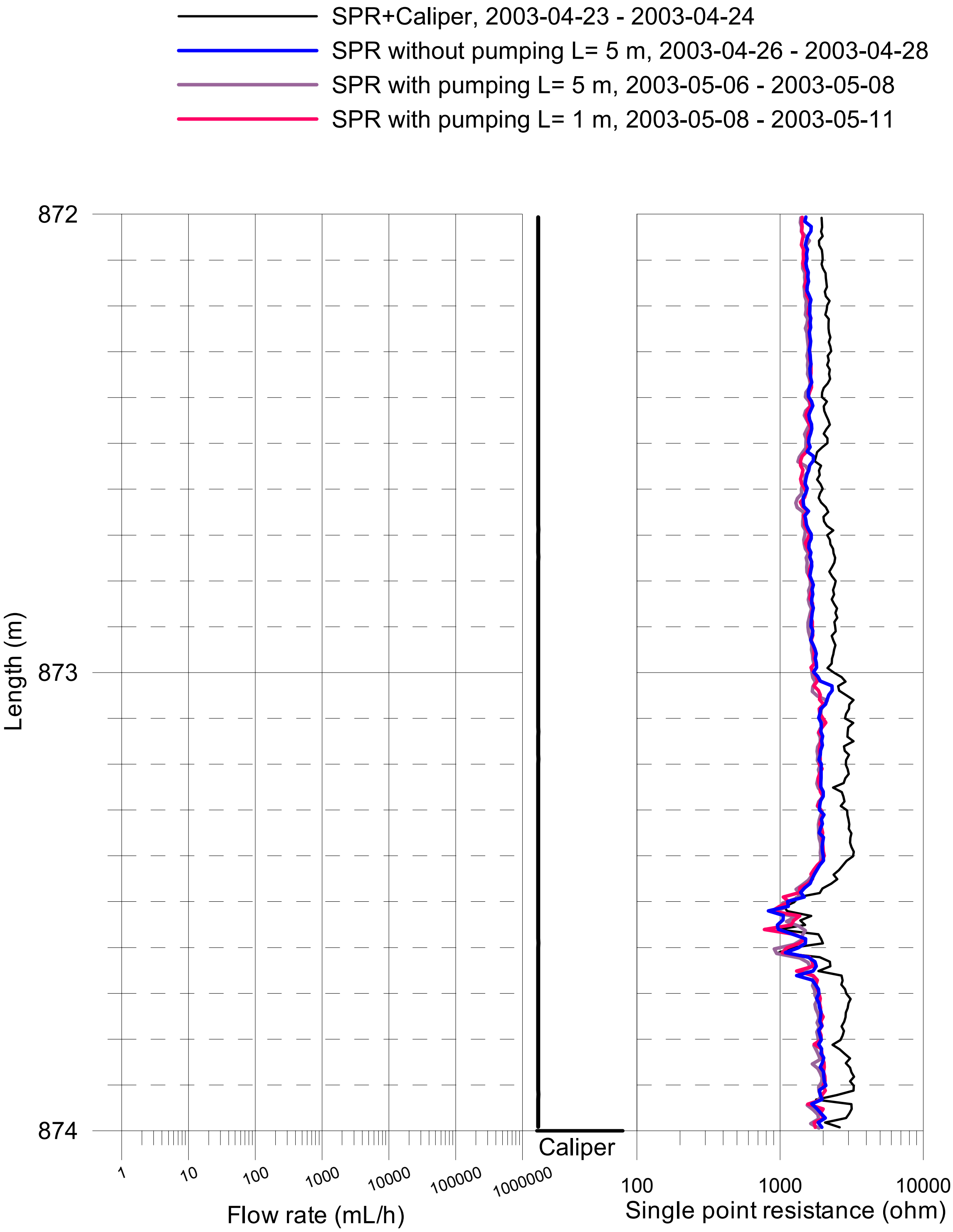


Appendix 1.31

Forsmark, KFM02A
SPR and Caliper results after length correction

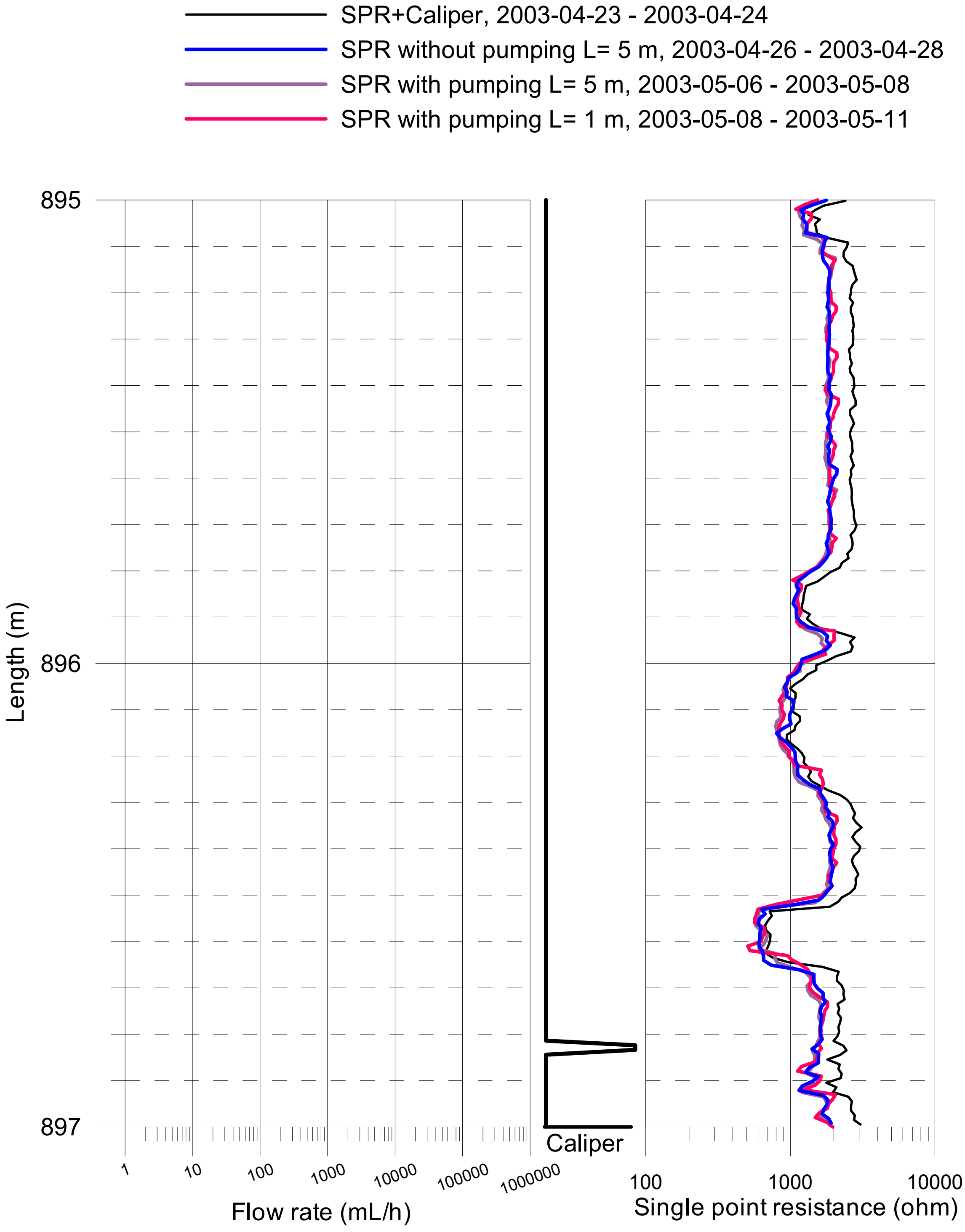


Forsmark, KFM02A
SPR and Caliper results after length correction



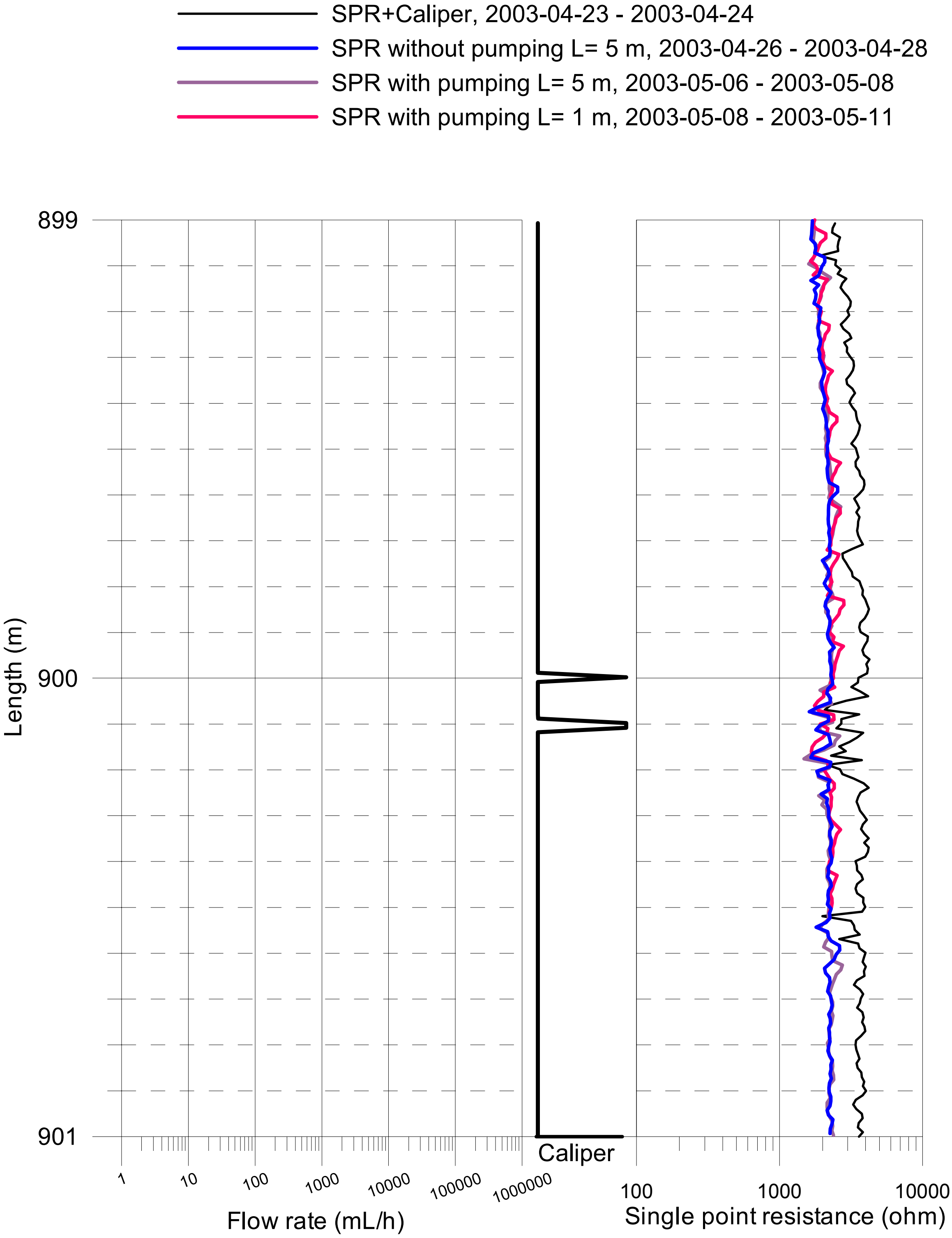
Appendix 1.33

Forsmark, KFM02A
SPR and Caliper results after length correction



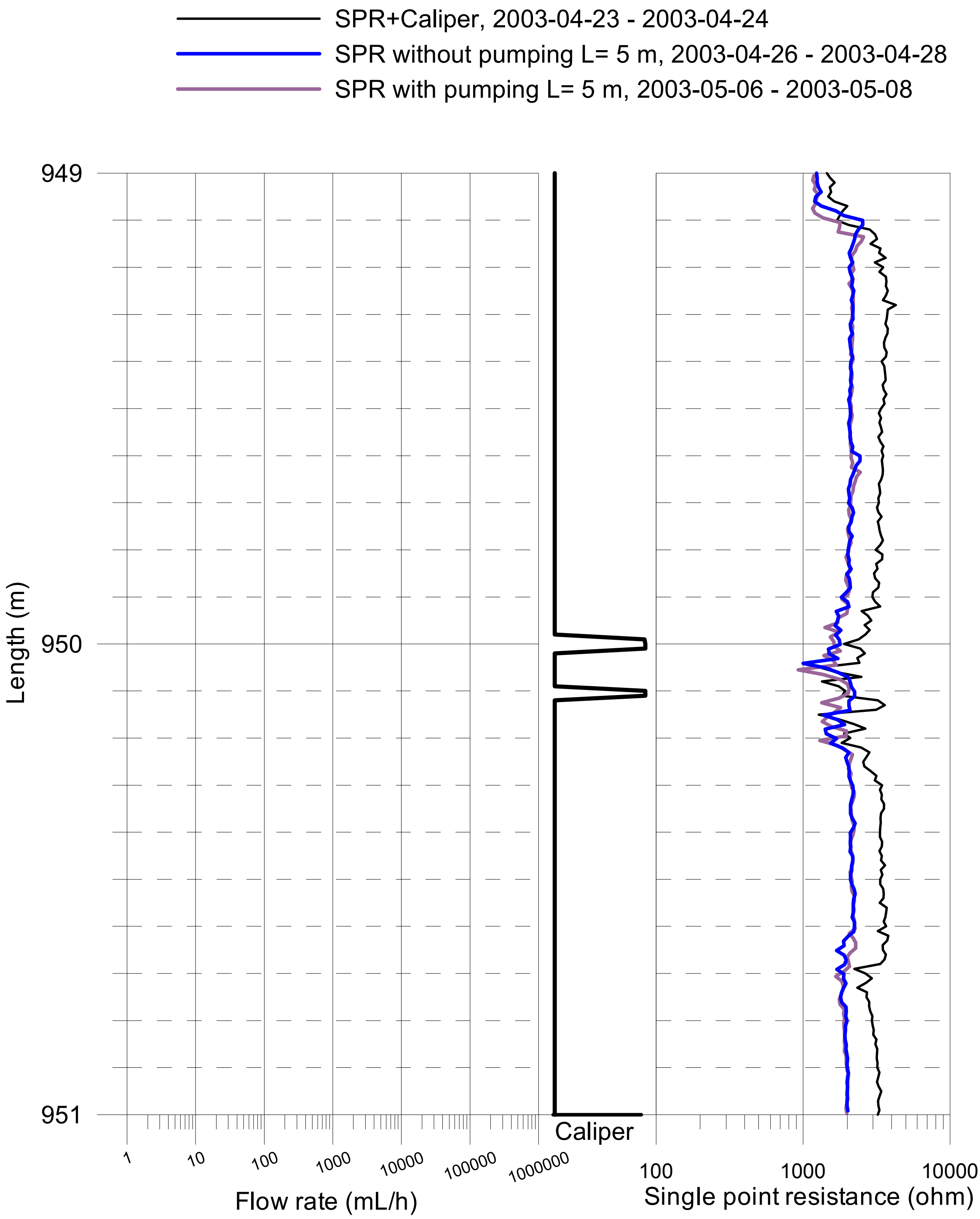
Appendix 1.34

Forsmark, KFM02A
SPR and Caliper results after length correction



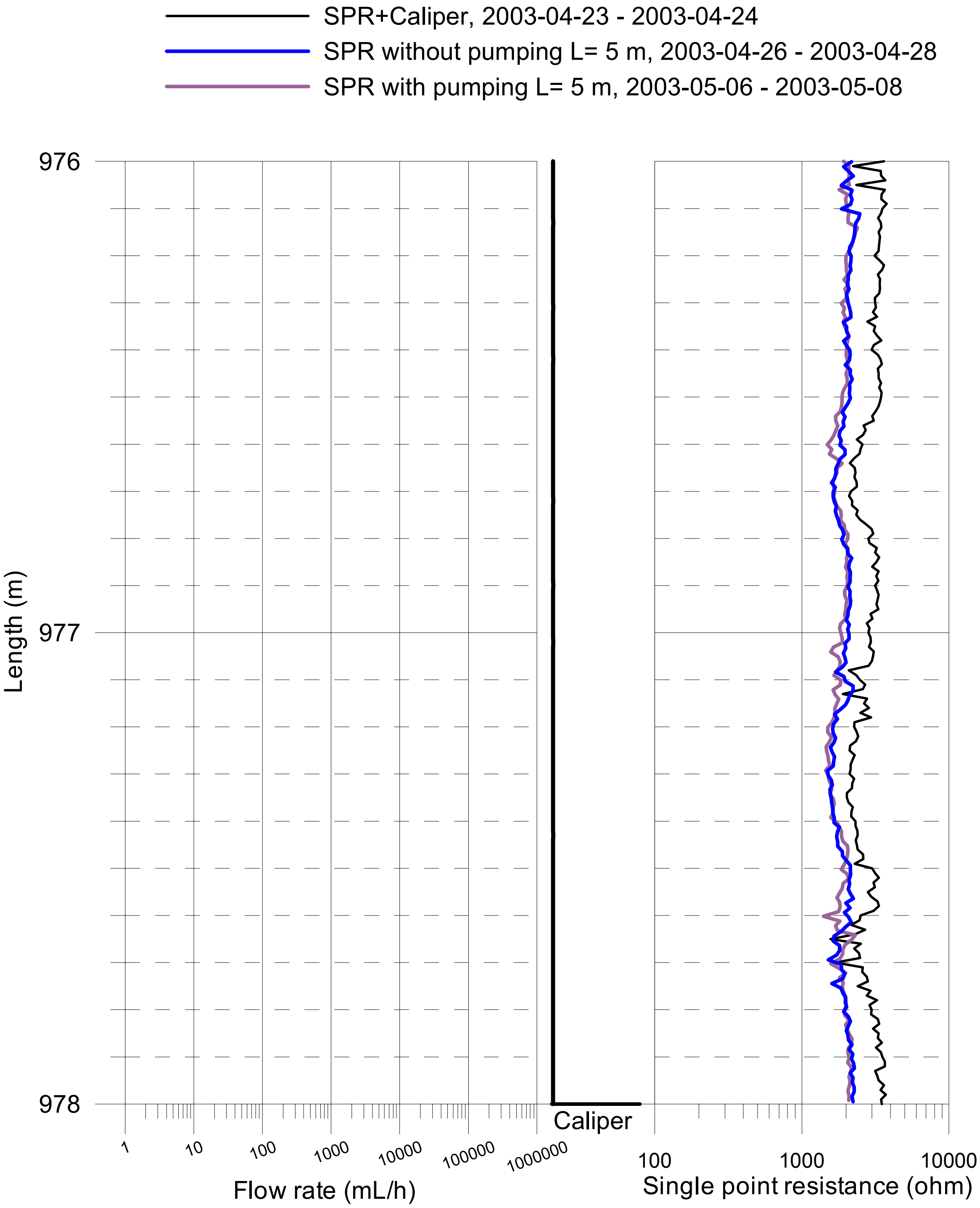
Appendix 1.35

Forsmark, KFM02A
SPR and Caliper results after length correction

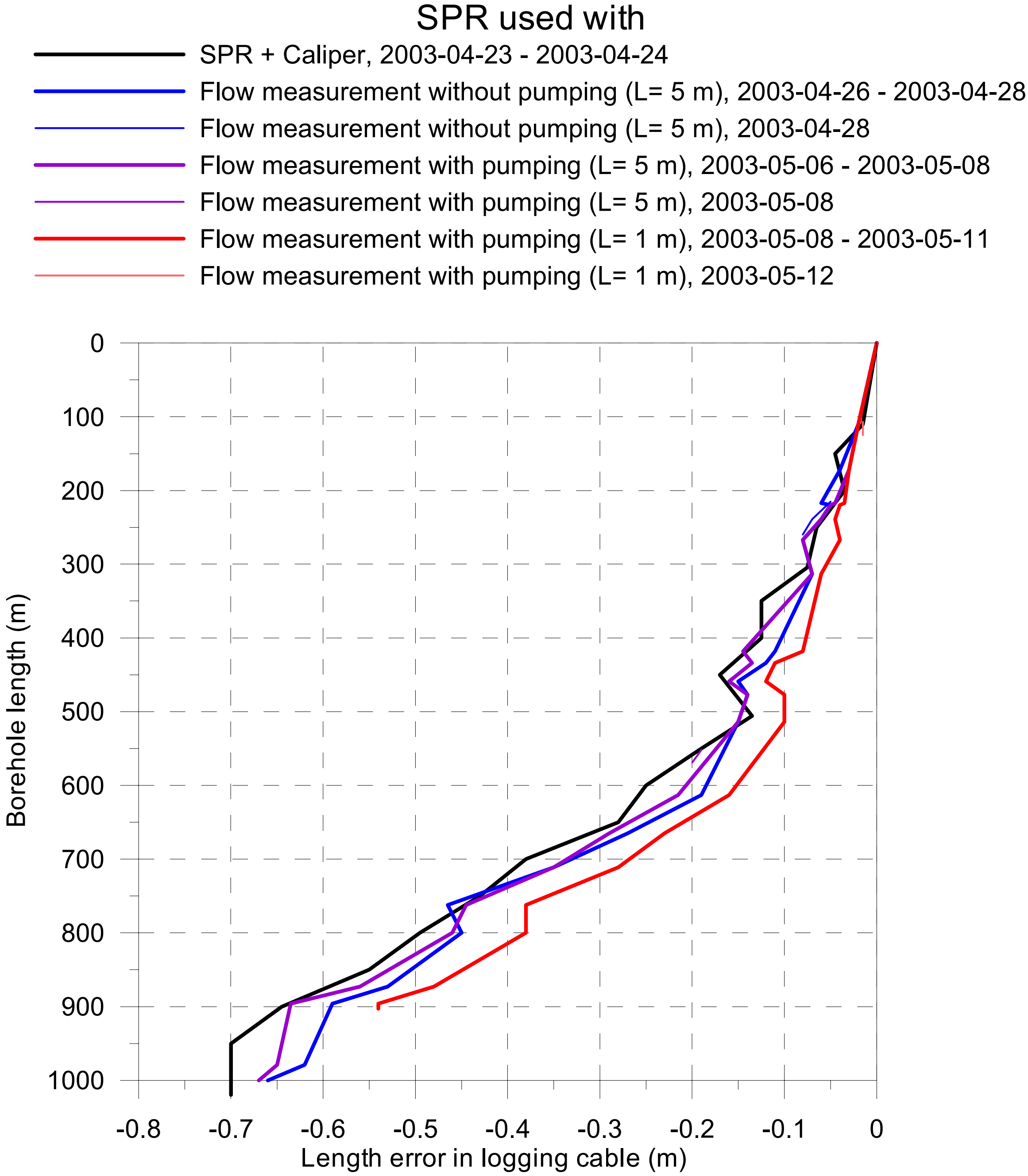


Appendix 1.36

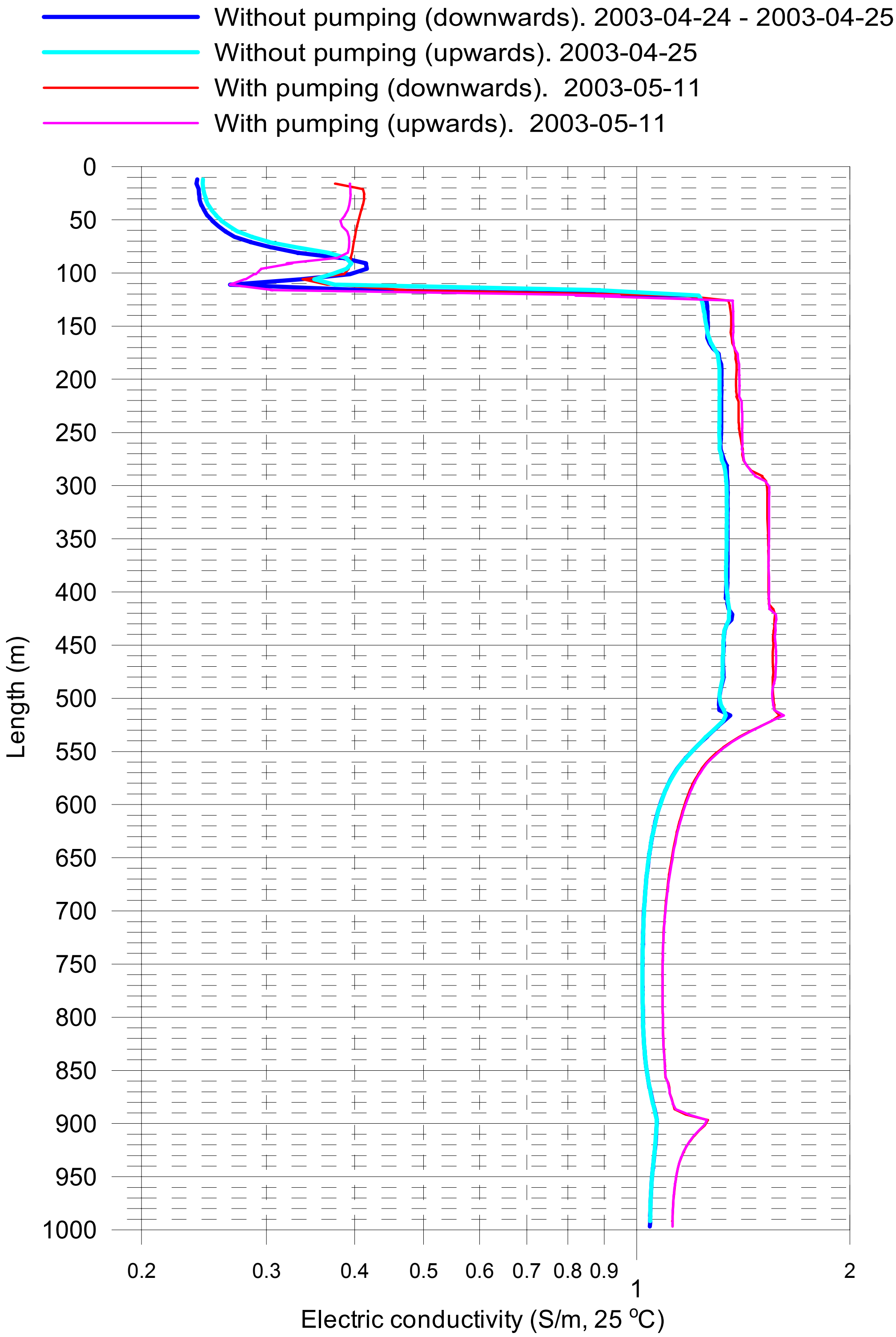
Forsmark, KFM02A
SPR and Caliper results after length correction



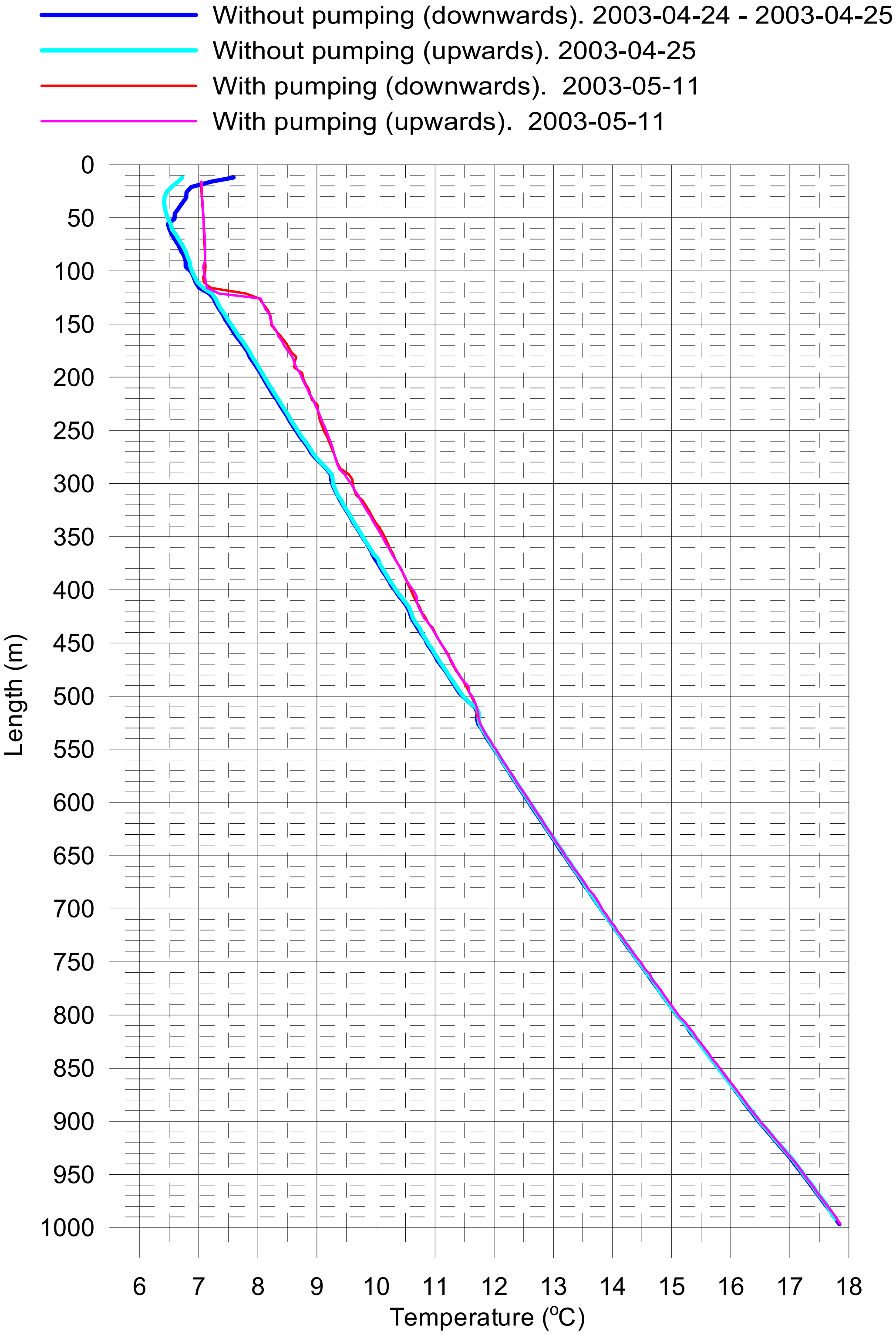
Appendix 1.37

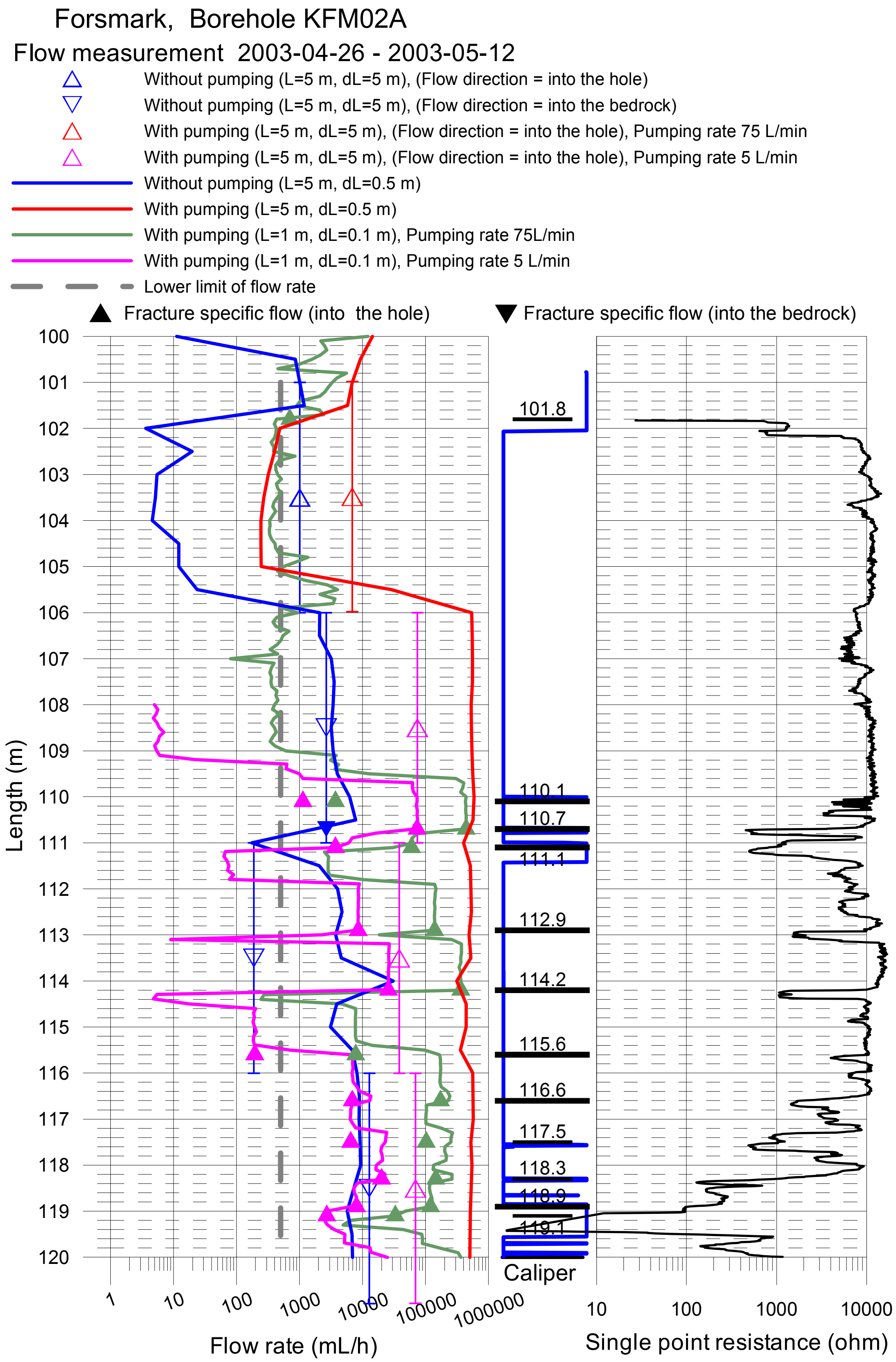


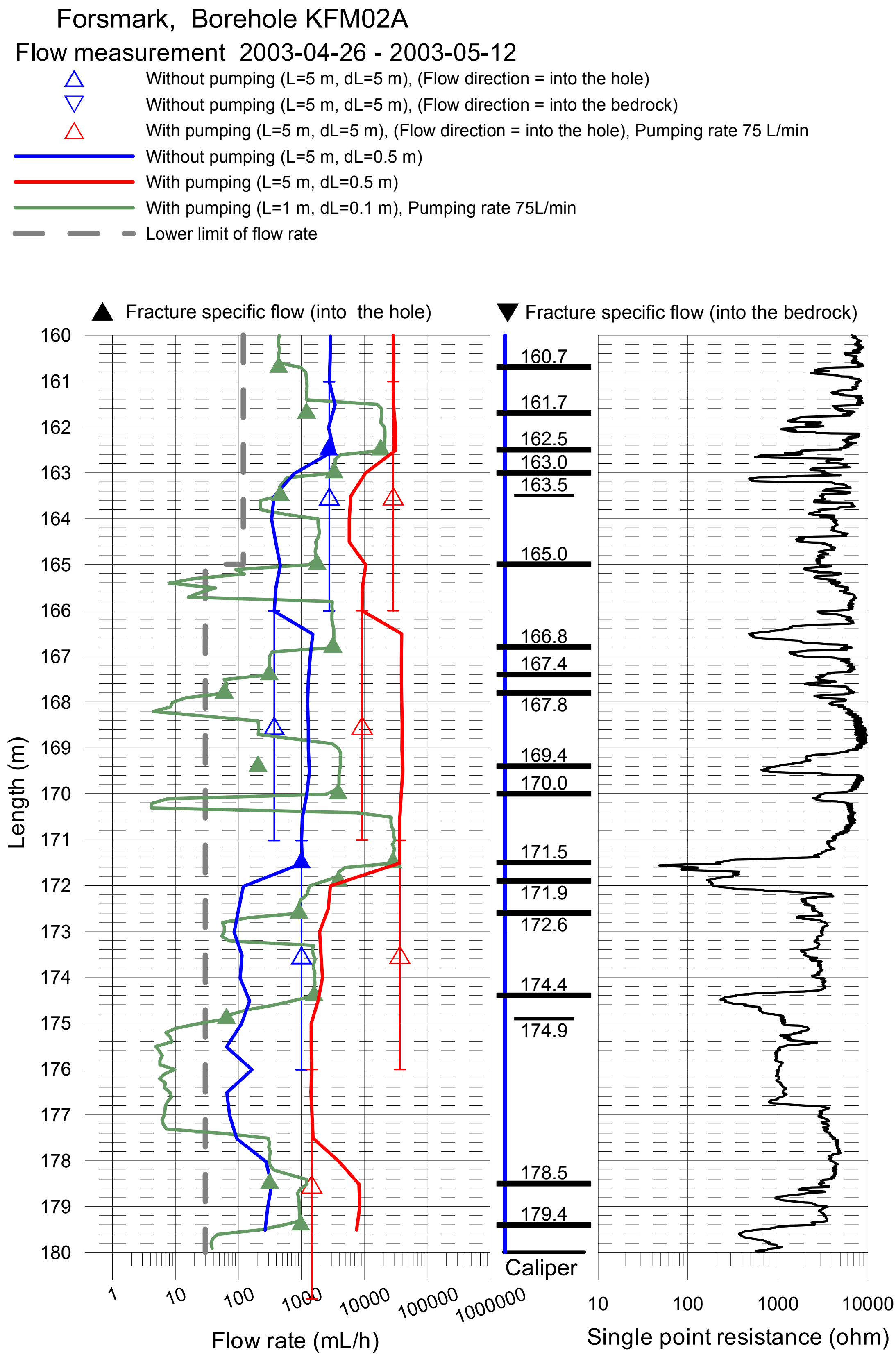
Forsmark, Borehole KFM02A
Electric conductivity of borehole water
Measured without lower rubber disks

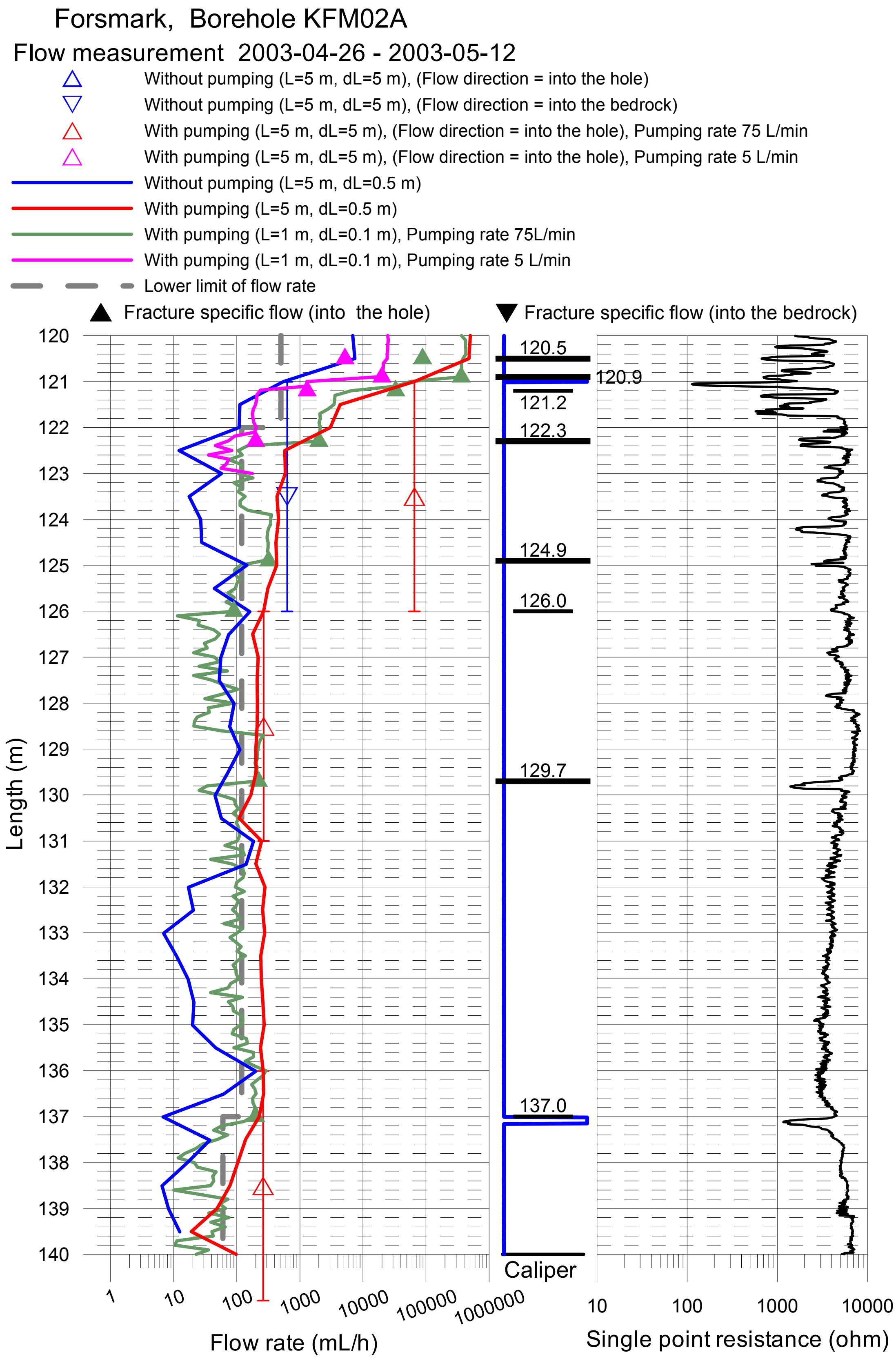


Forsmark, Borehole KFM02A
Temperature of borehole water
Measured without lower rubber disks

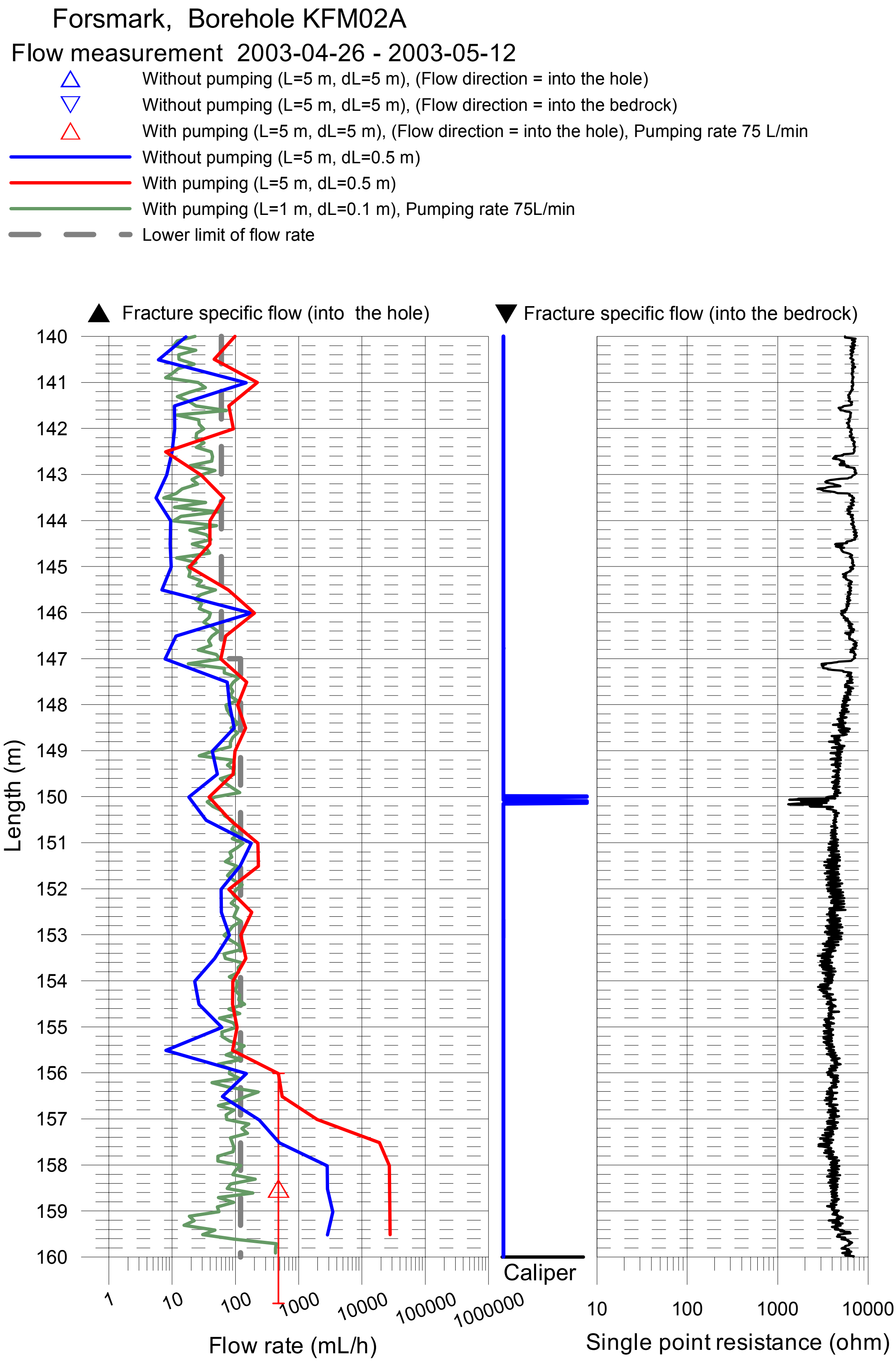



Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 5 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
With pumping (L=1 m, dL=0.1 m), Pumping rate 5 L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
Flow rate (mL/h)
Caliper
Single point resistance (ohm)
101.8
110.1
110.7
111.1
112.9
114.2
115.6
116.6
117.5
118.3
118.9
119.1

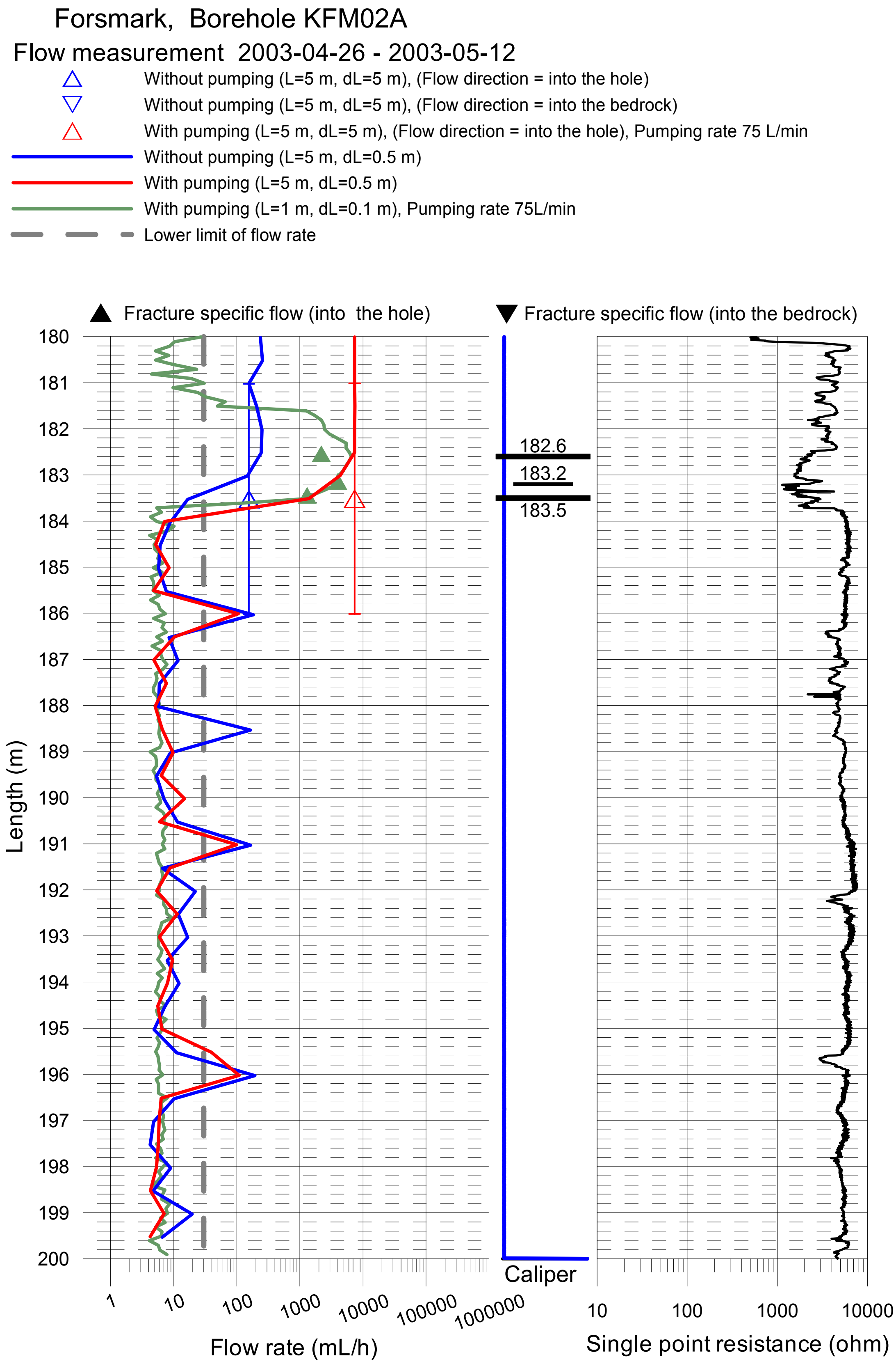

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
160.7
161.7
162.5
163.0
163.5
165.0
166.8
167.4
167.8
169.4
170.0
171.5
171.9
172.6
174.4
174.9
178.5
179.4
Caliper
Flow rate (mL/h)
Single point resistance (ohm)



Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 5 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
With pumping (L=1 m, dL=0.1 m), Pumping rate 5 L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
120.5
120.9
121.2
122.3
124.9
126.0
129.7
137.0
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)



Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

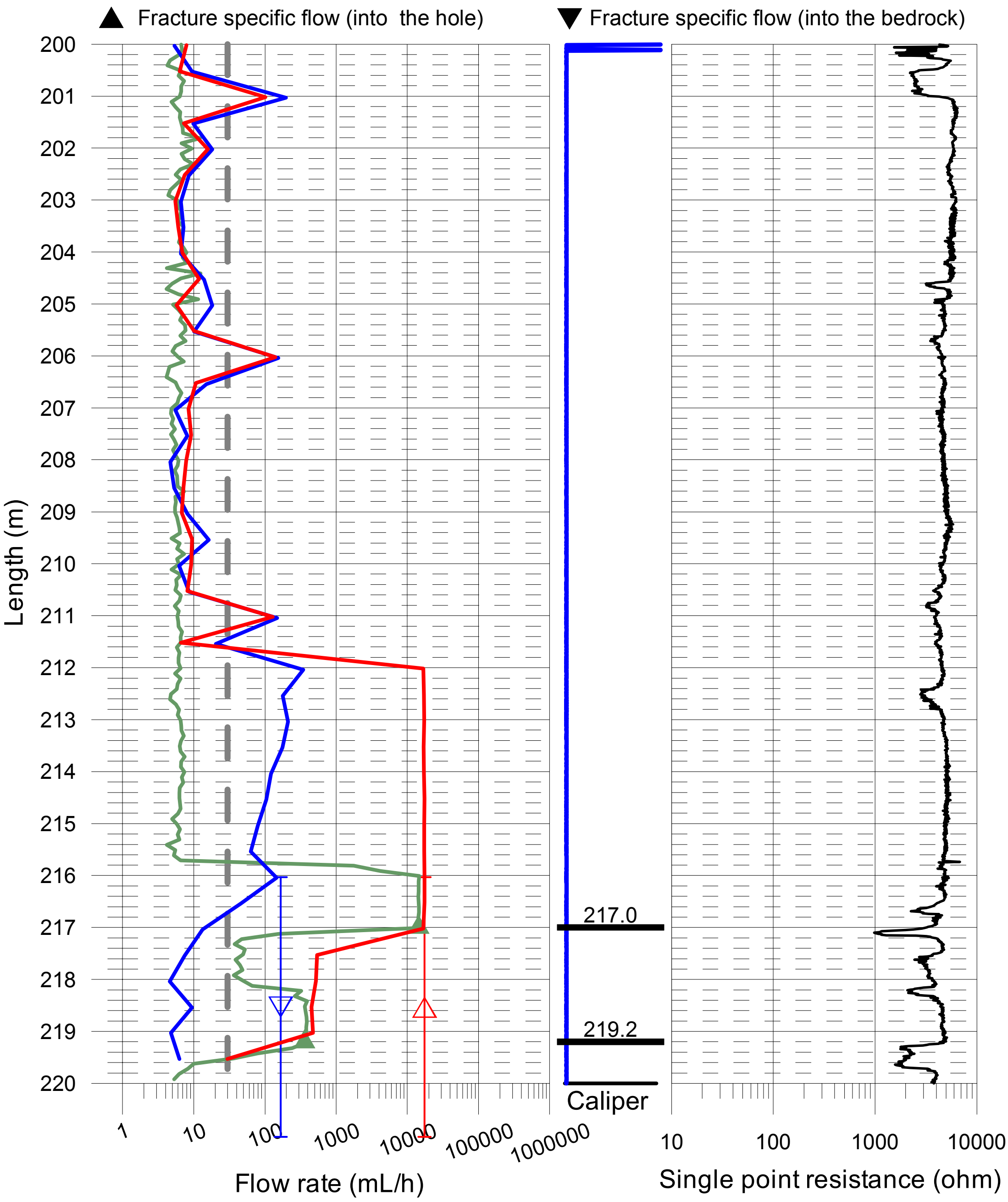


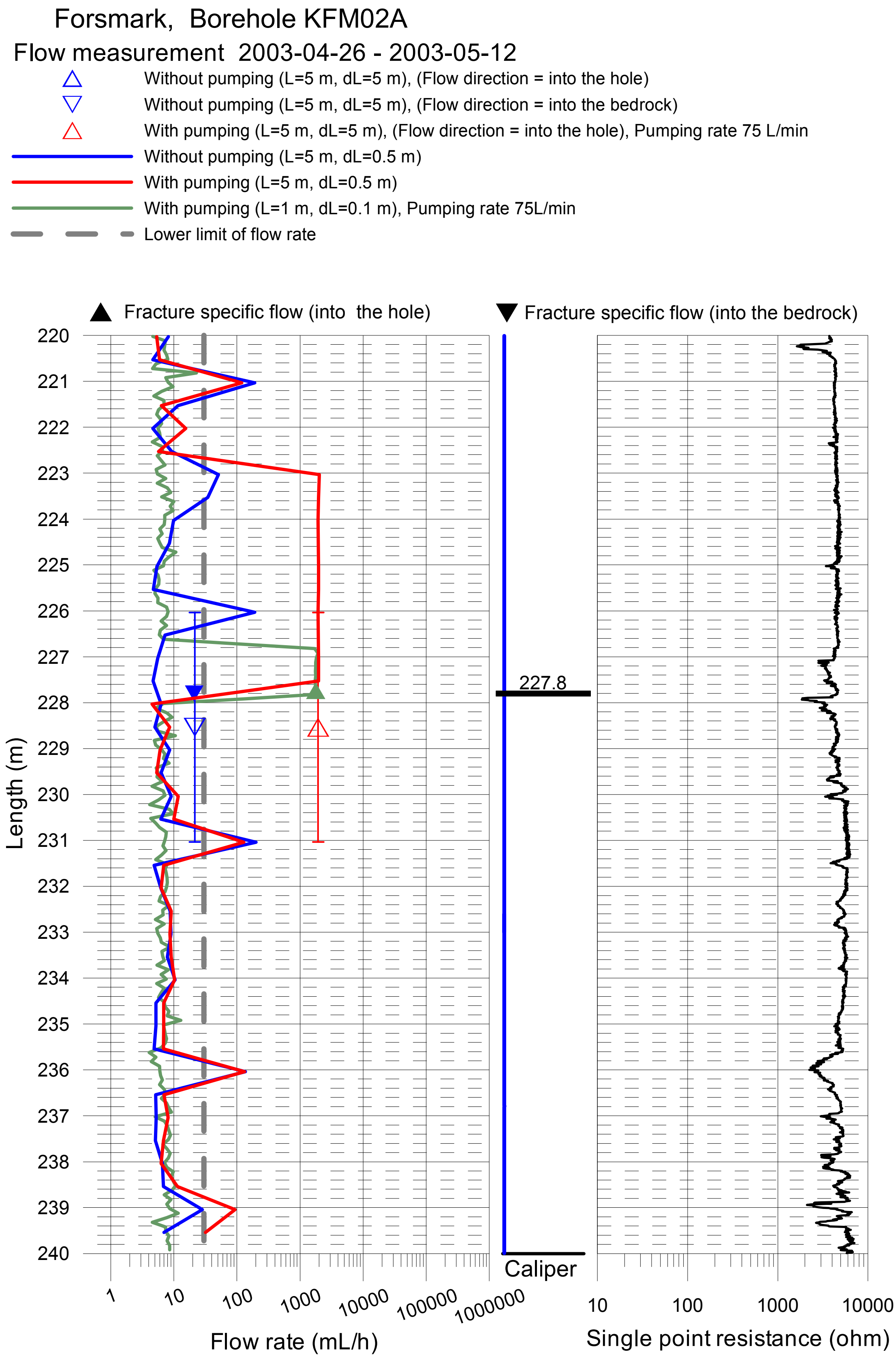
Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
182.6
183.2
183.5
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

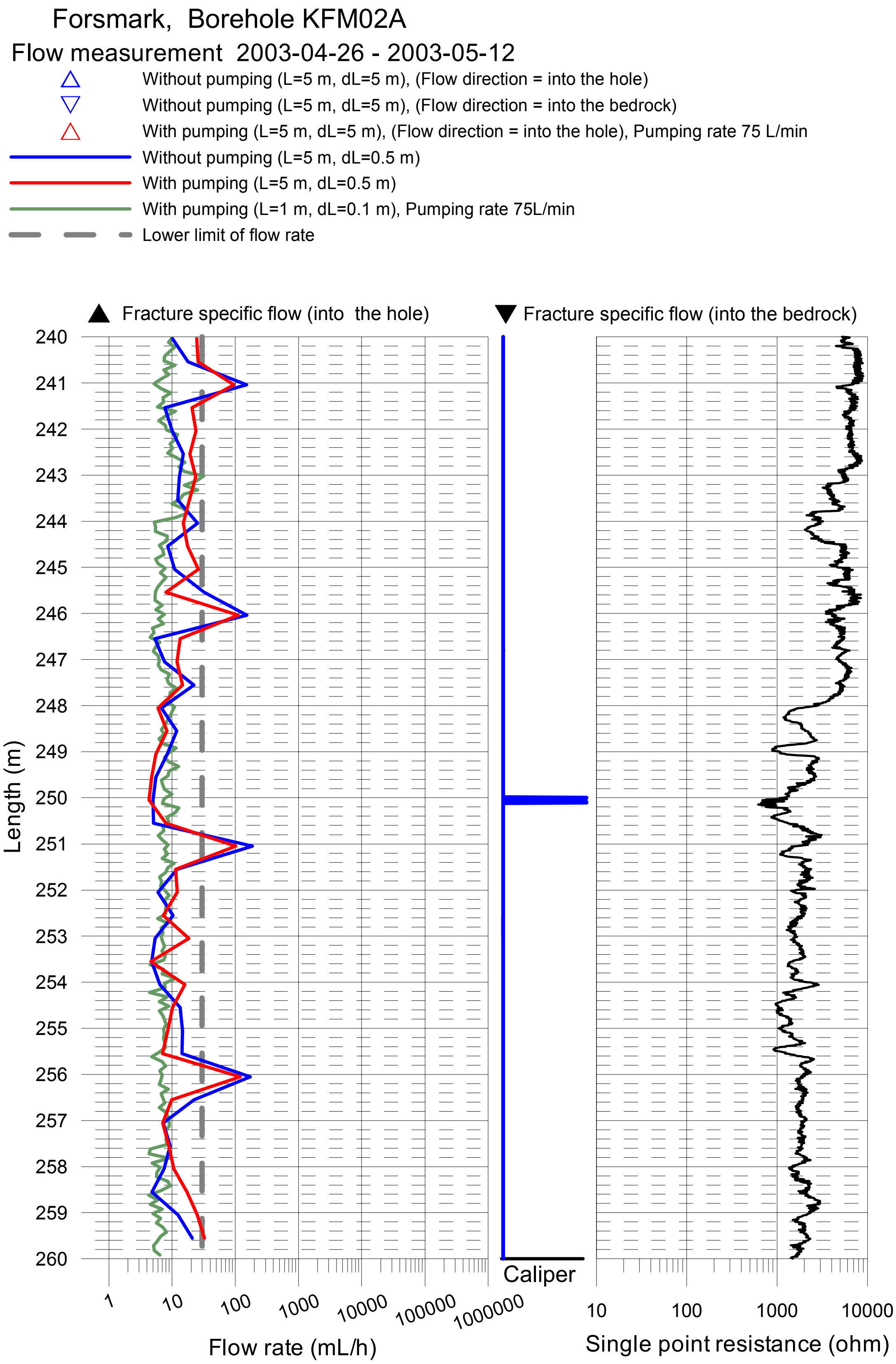
Forsmark, Borehole KFM02A

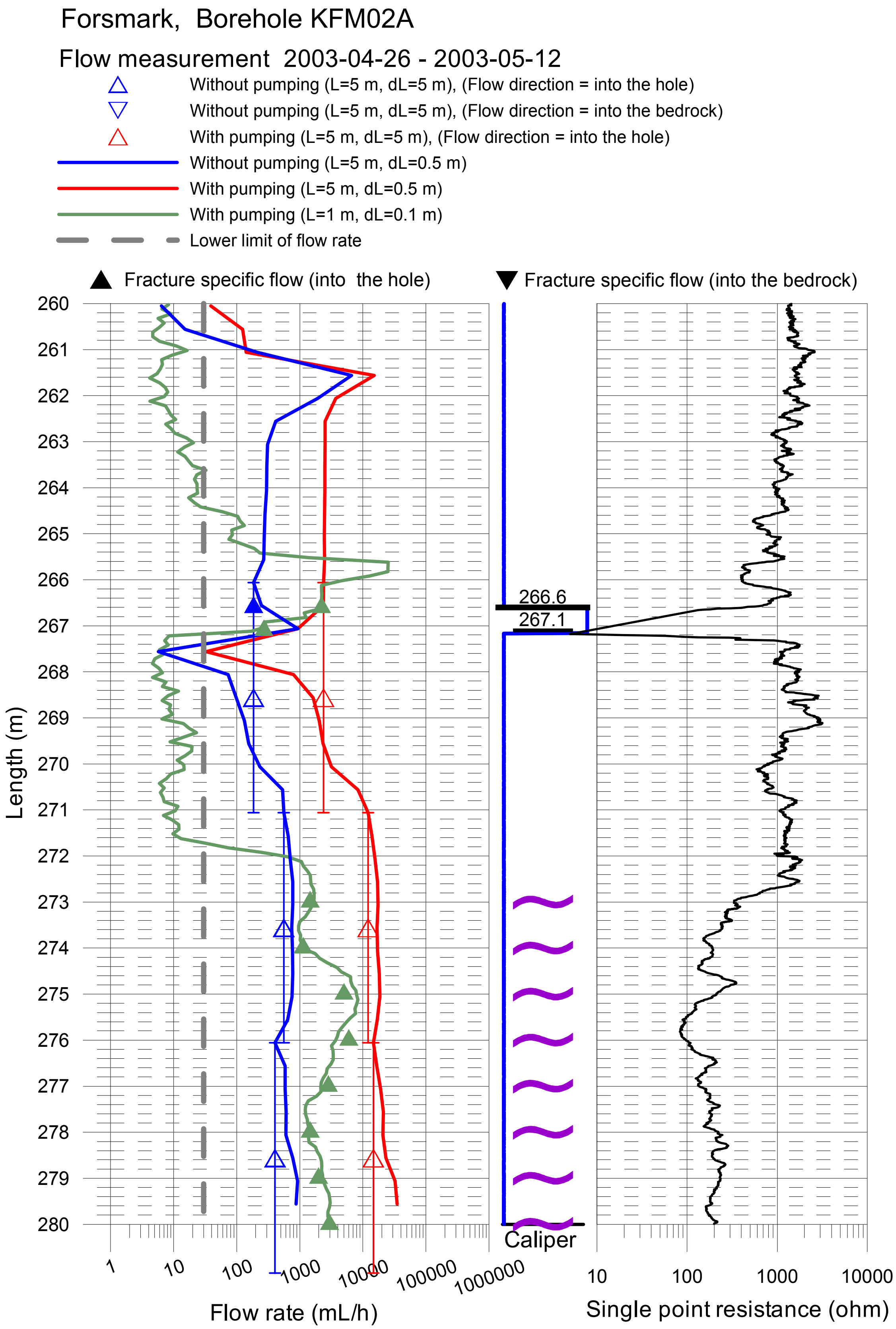
Flow measurement 2003-04-26 - 2003-05-12

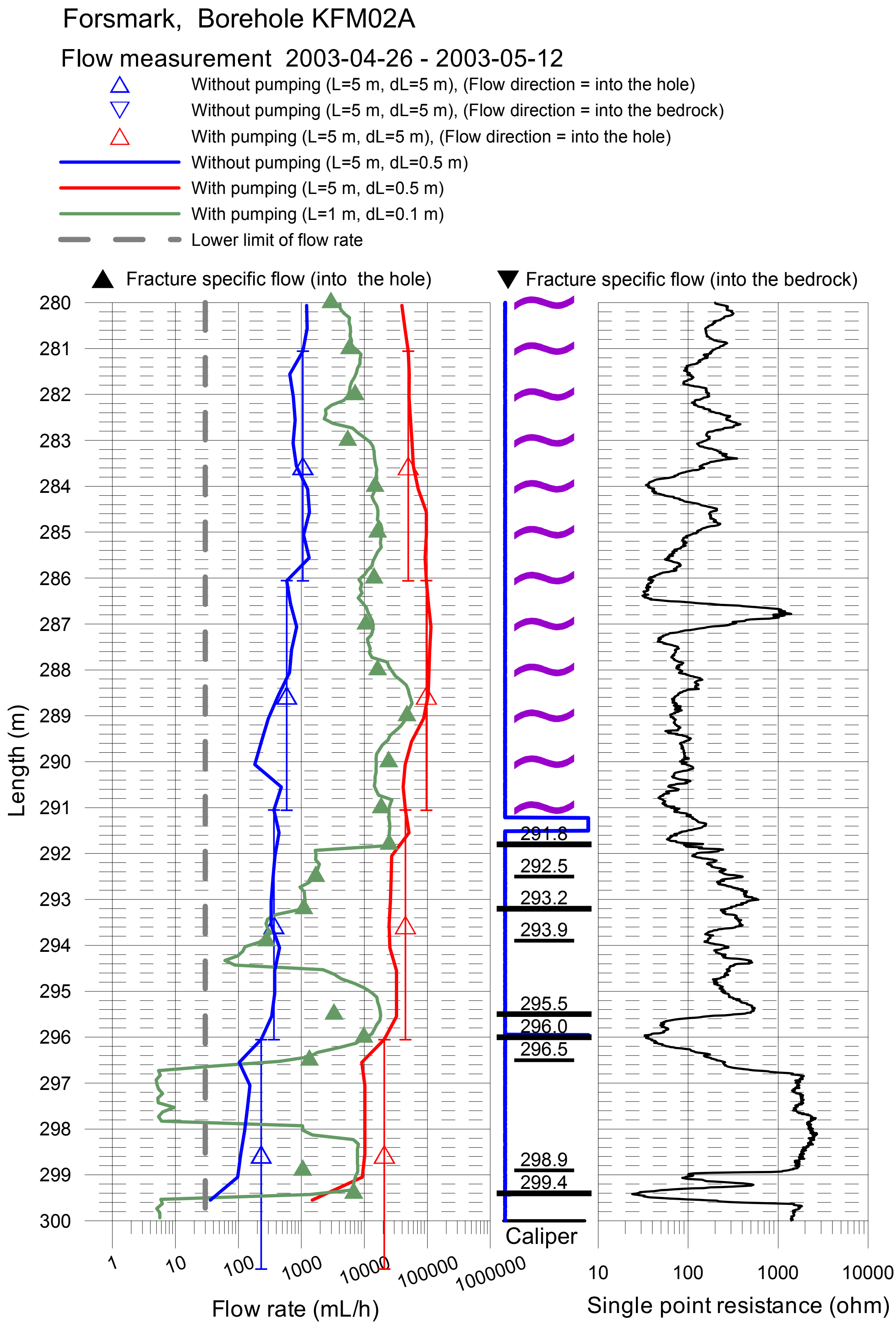
△ Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
▽ Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
△ With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate

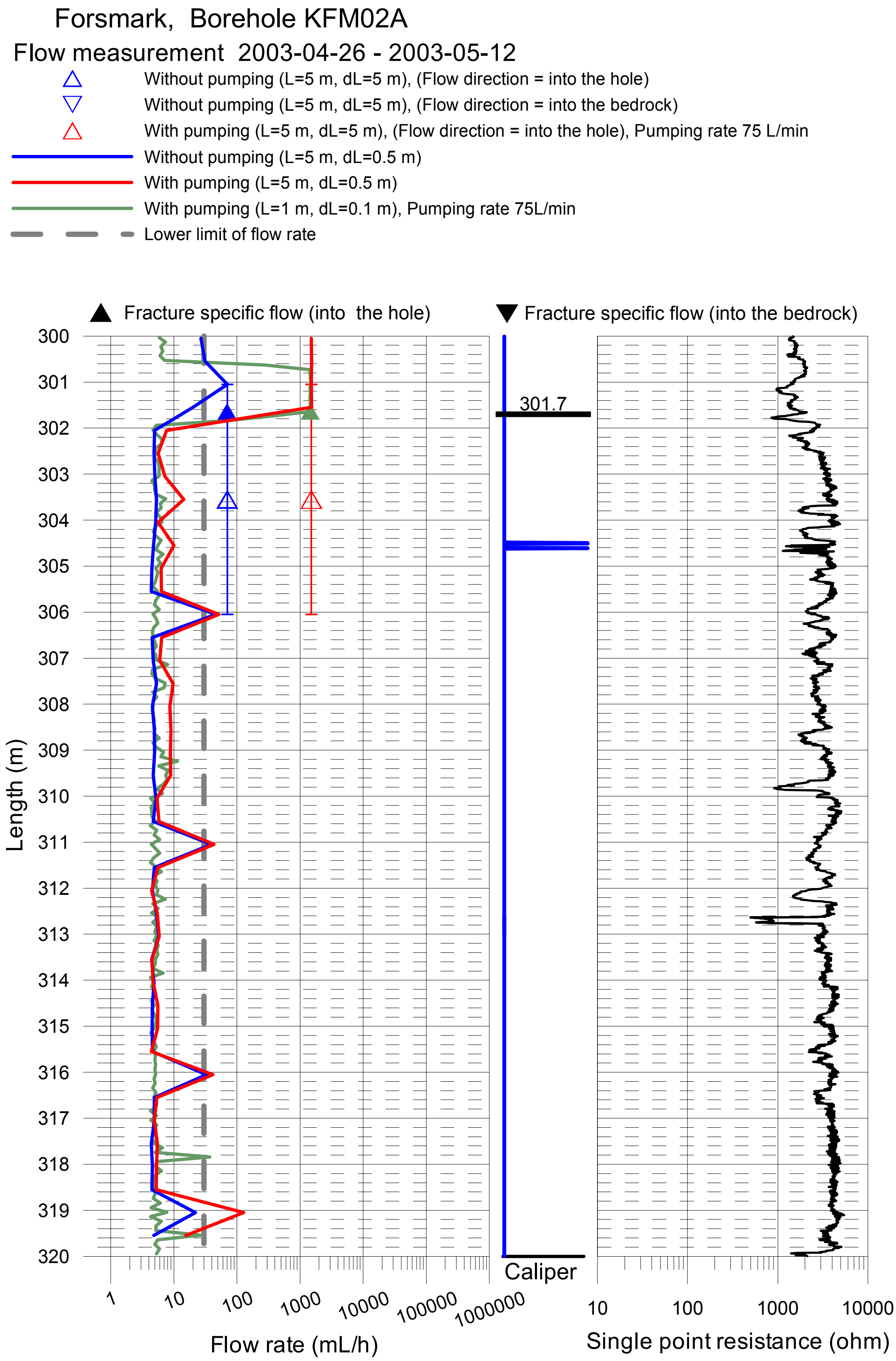



Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
227.8
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

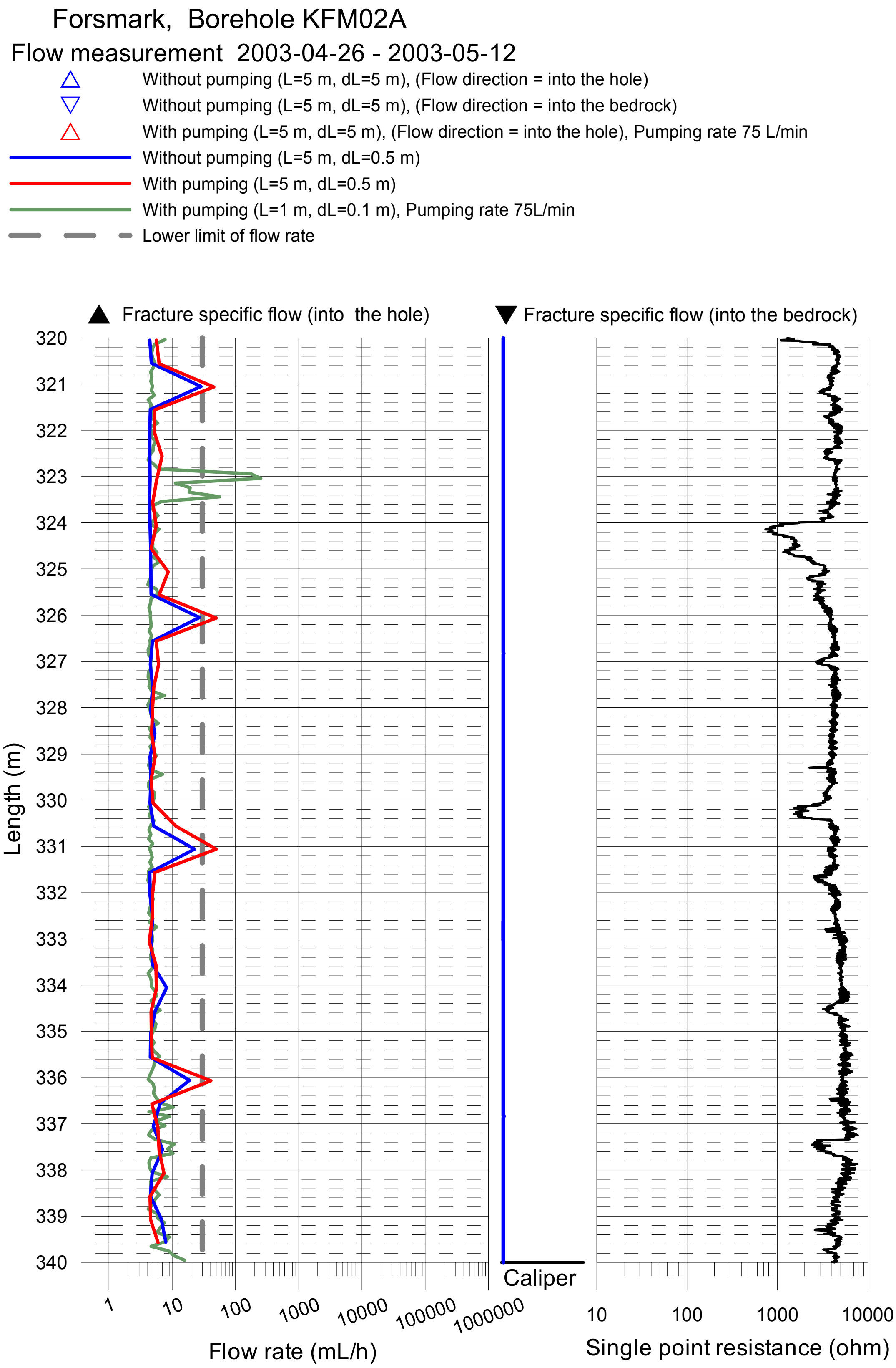

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

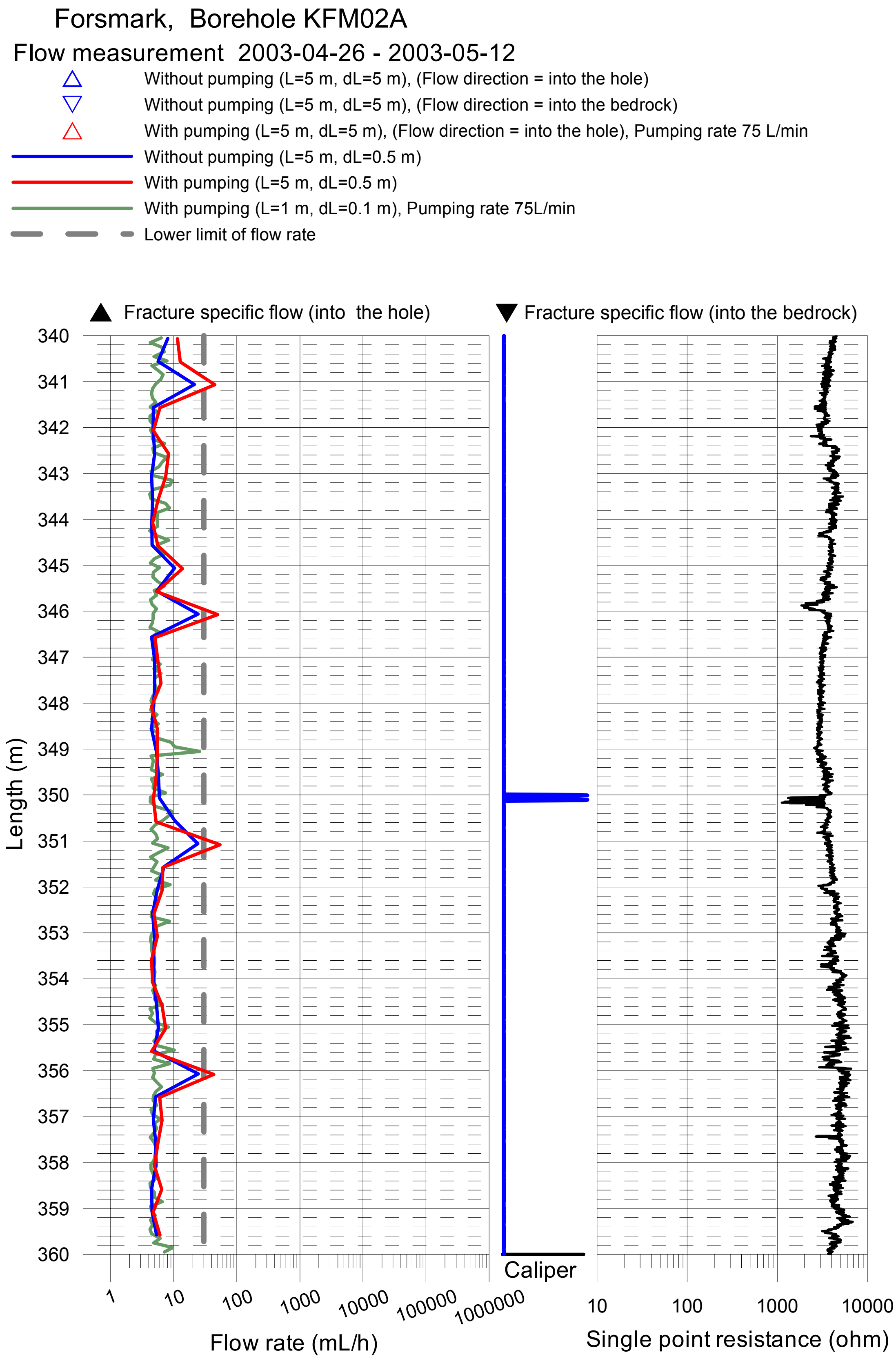

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
266.6
267.1
Caliper
Flow rate (mL/h)
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
291.8
292.5
293.2
293.9
295.5
296.0
296.5
298.9
299.4
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

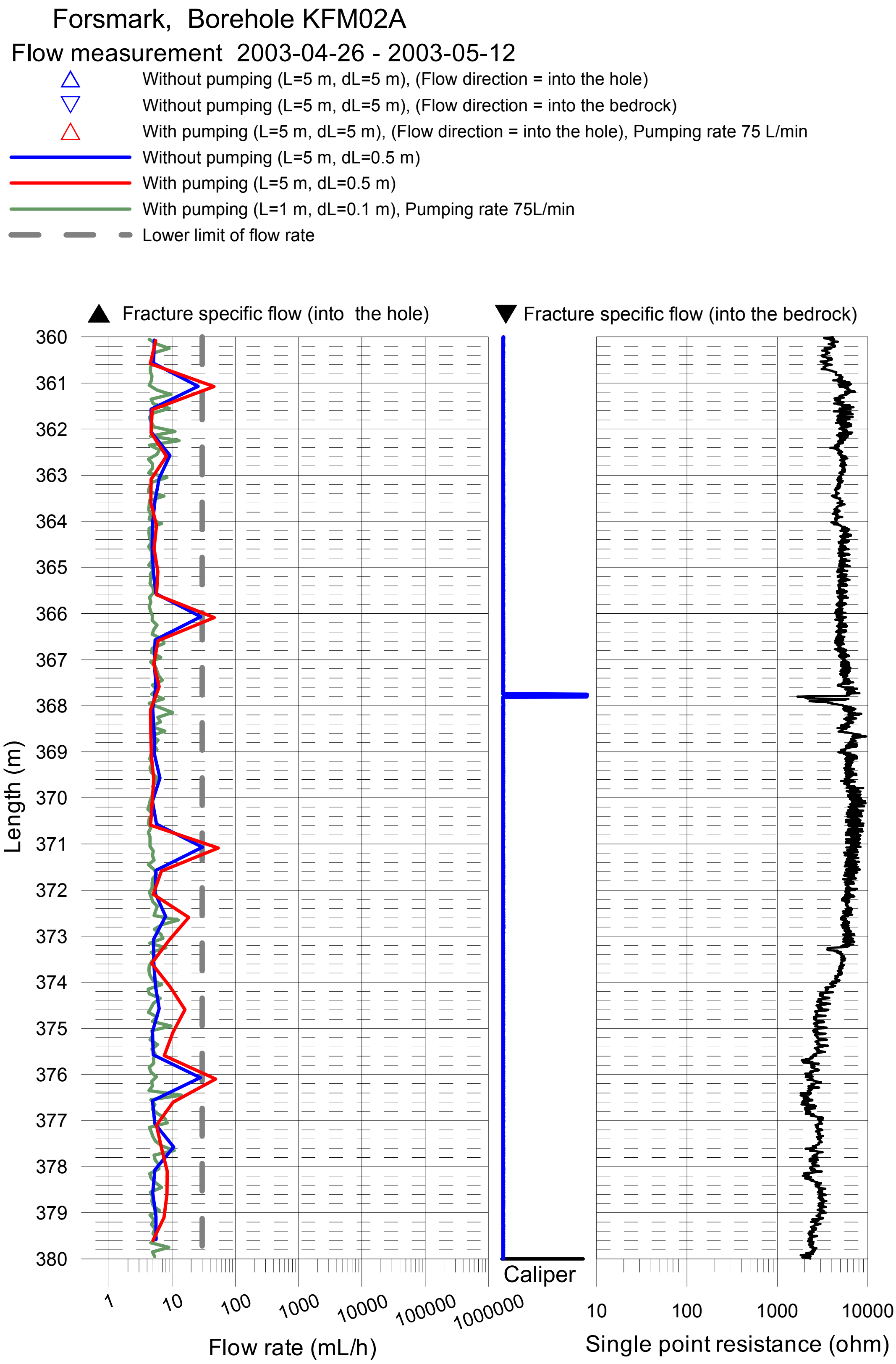


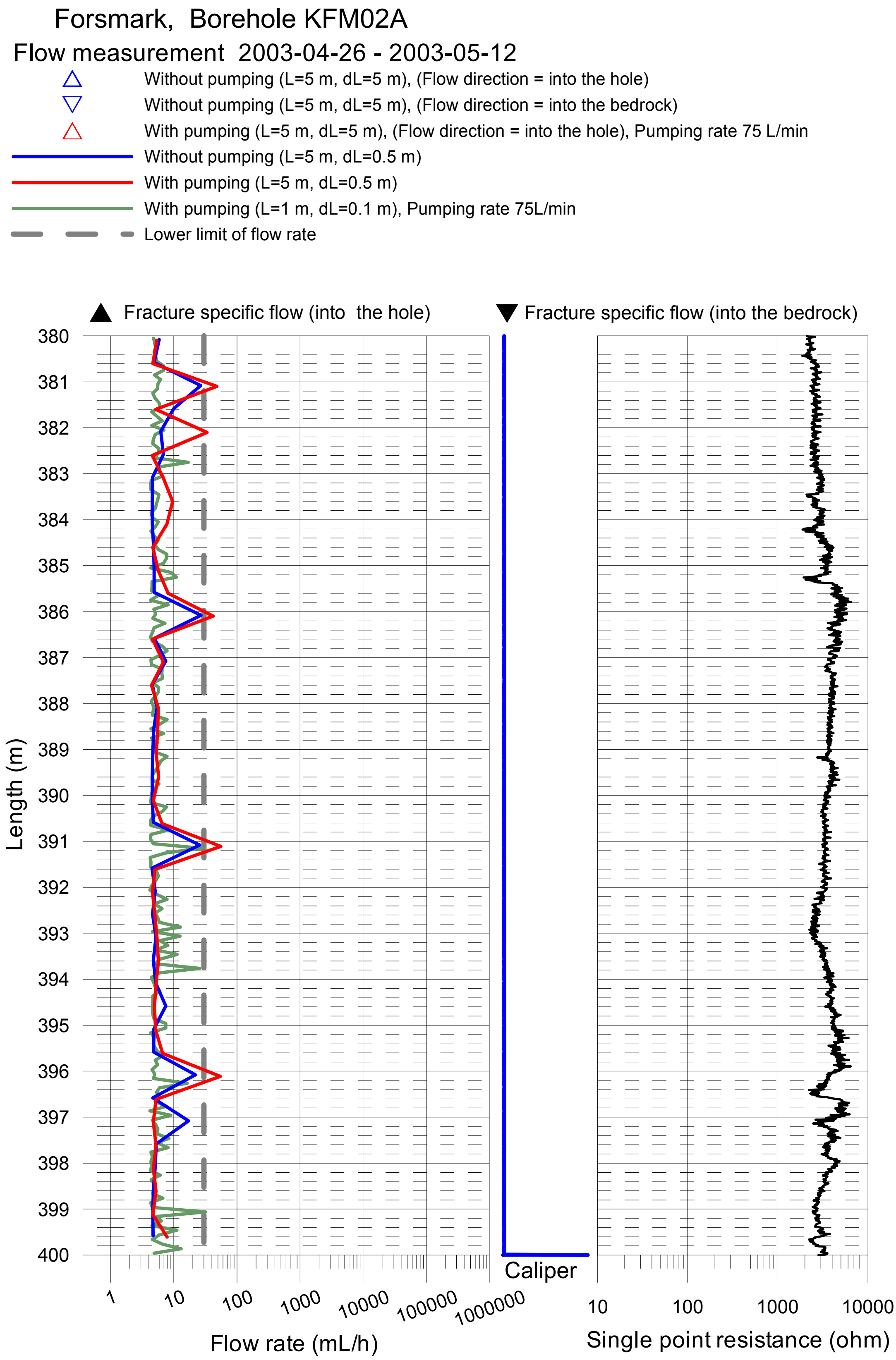
Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
301.7
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

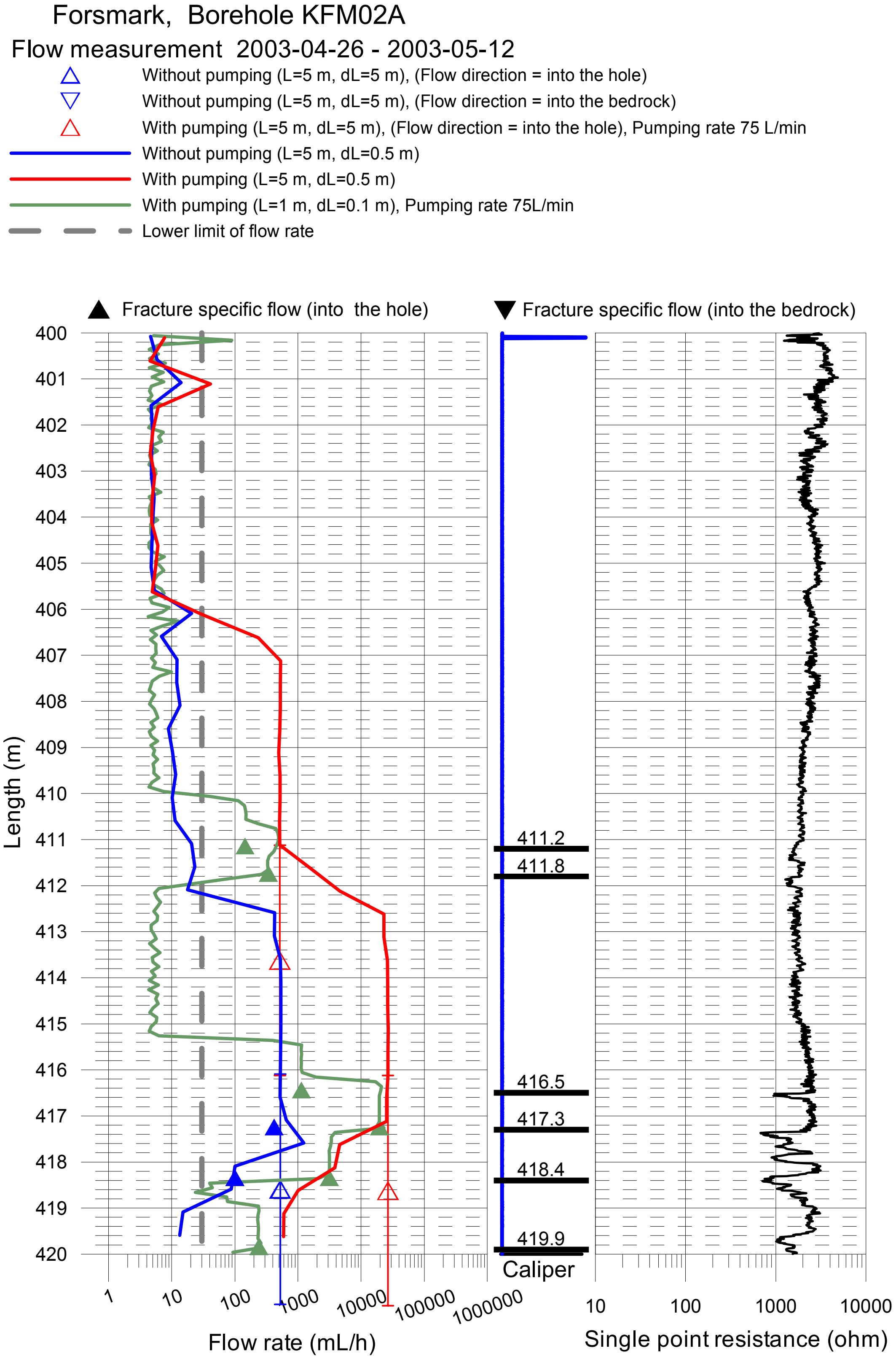


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

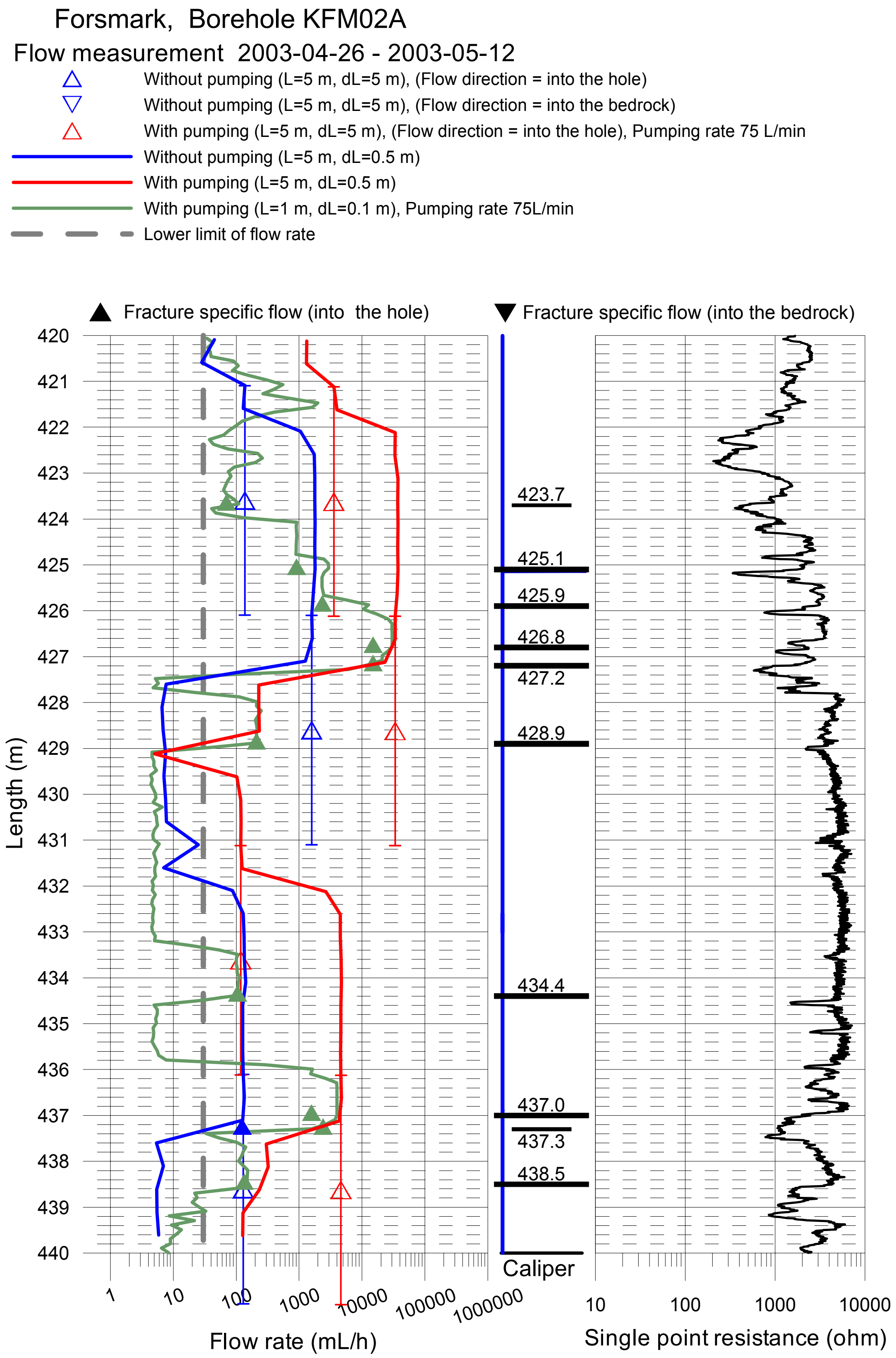

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

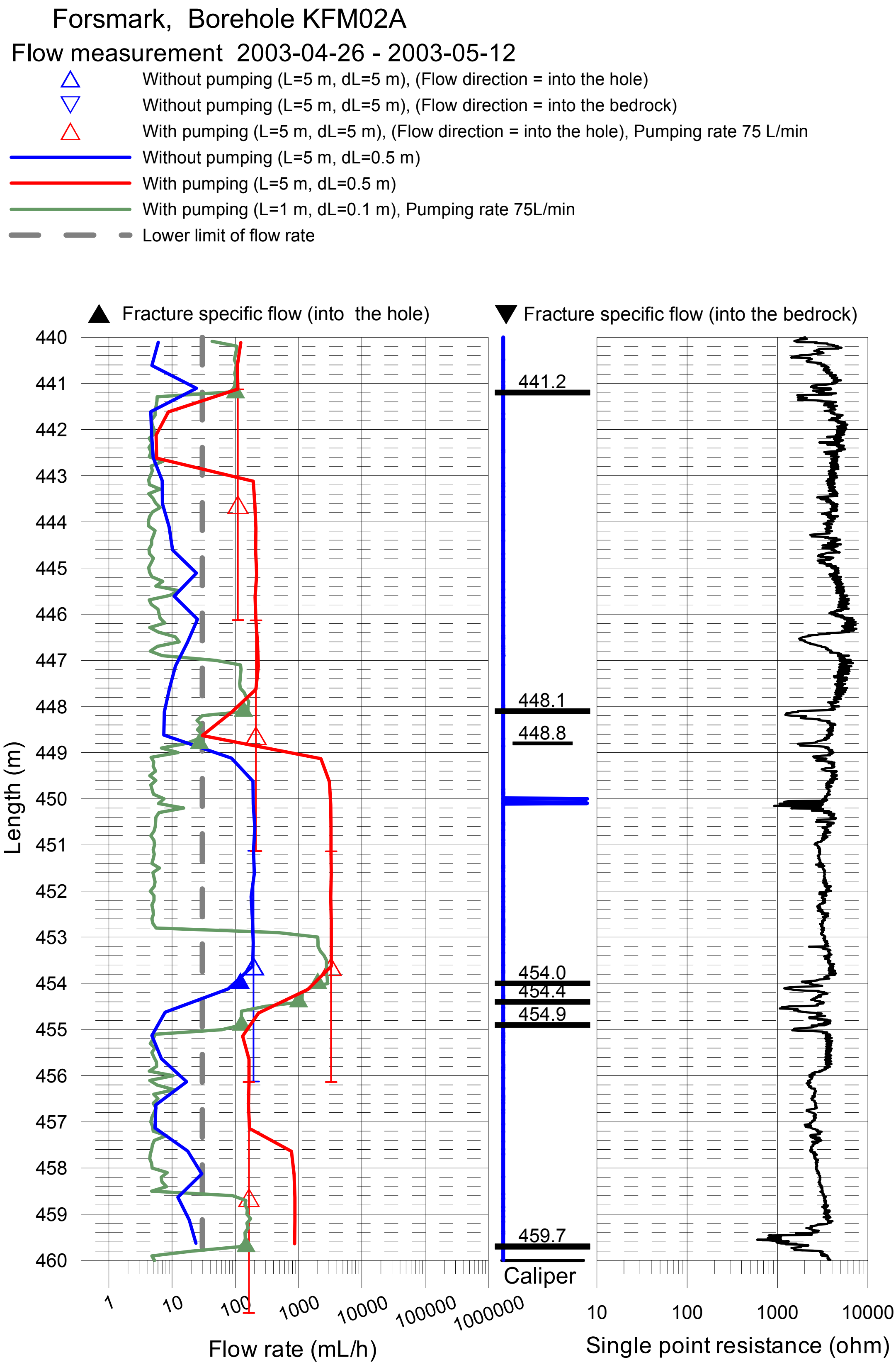

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

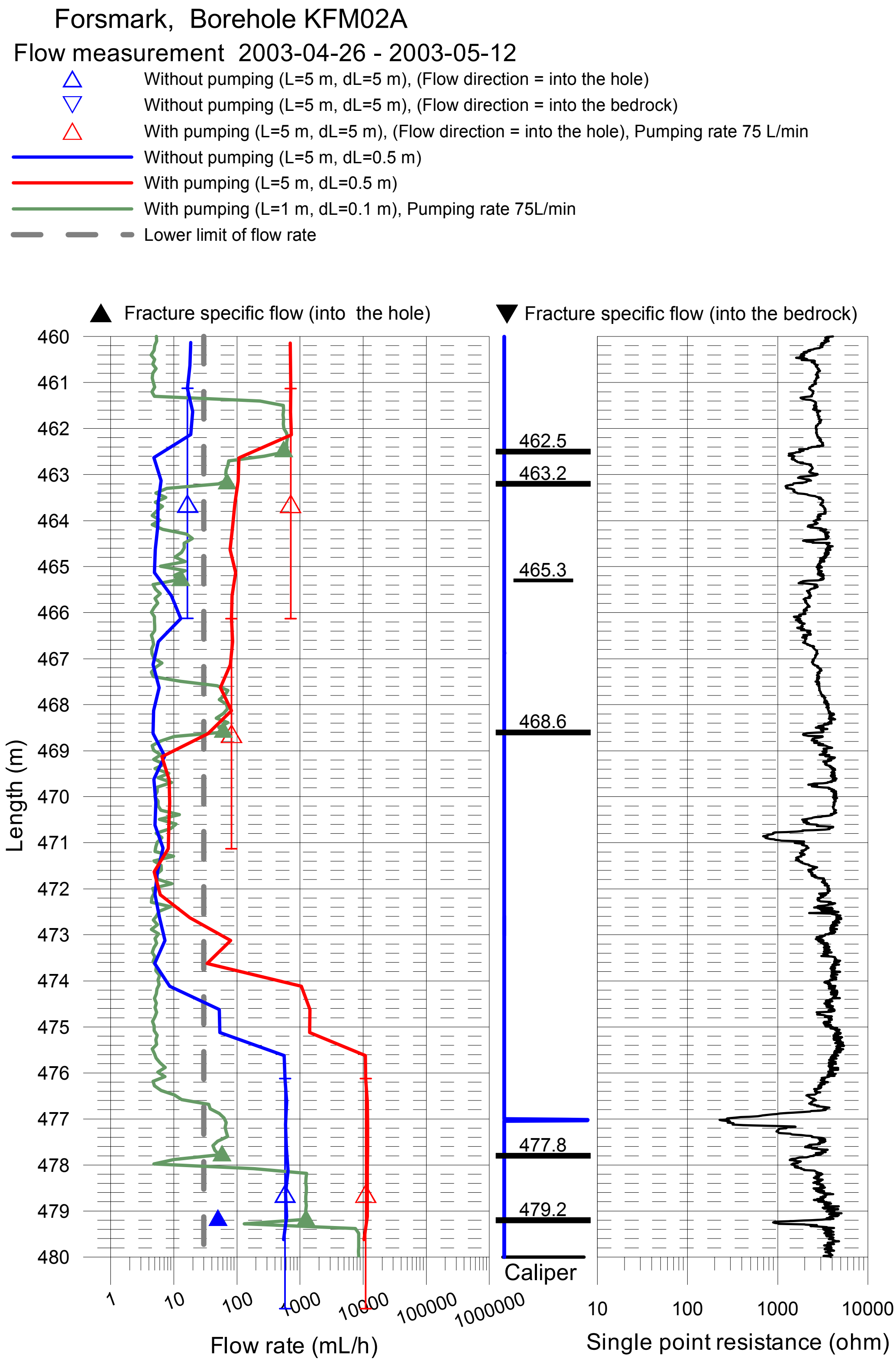
Appendix 3.16



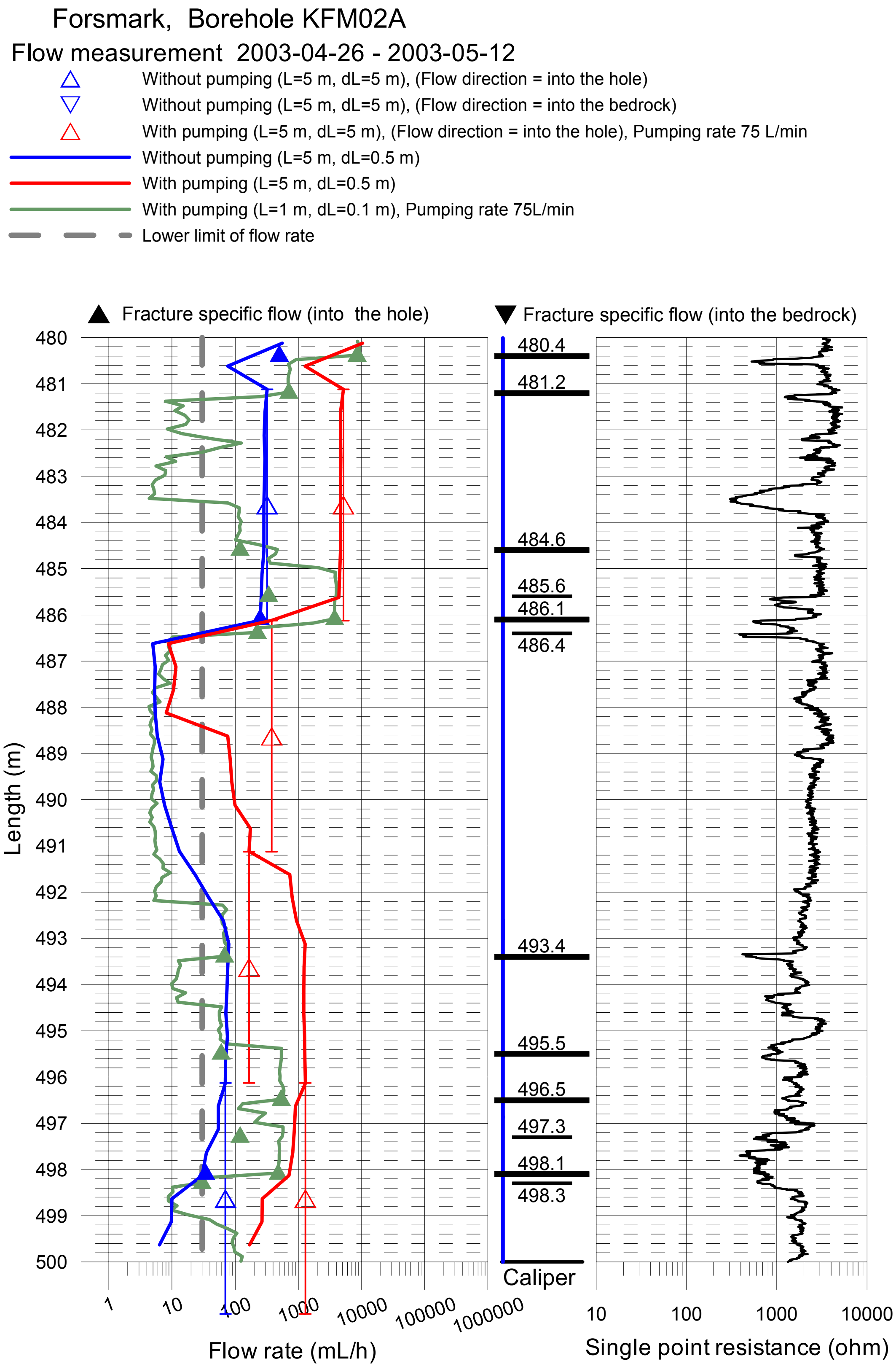
Appendix 3.17

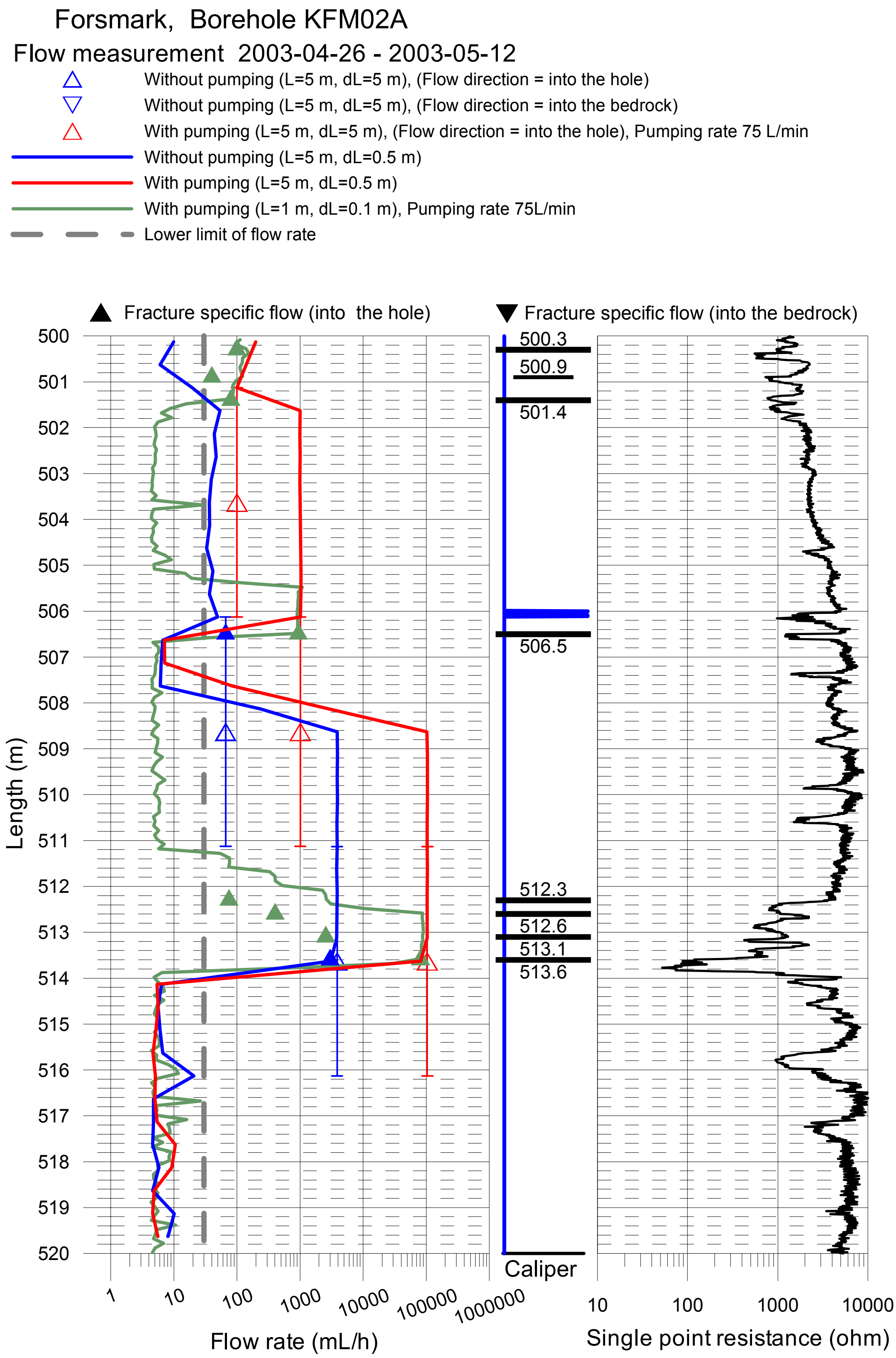



Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
441.2
448.1
448.8
454.0
454.4
454.9
459.7
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

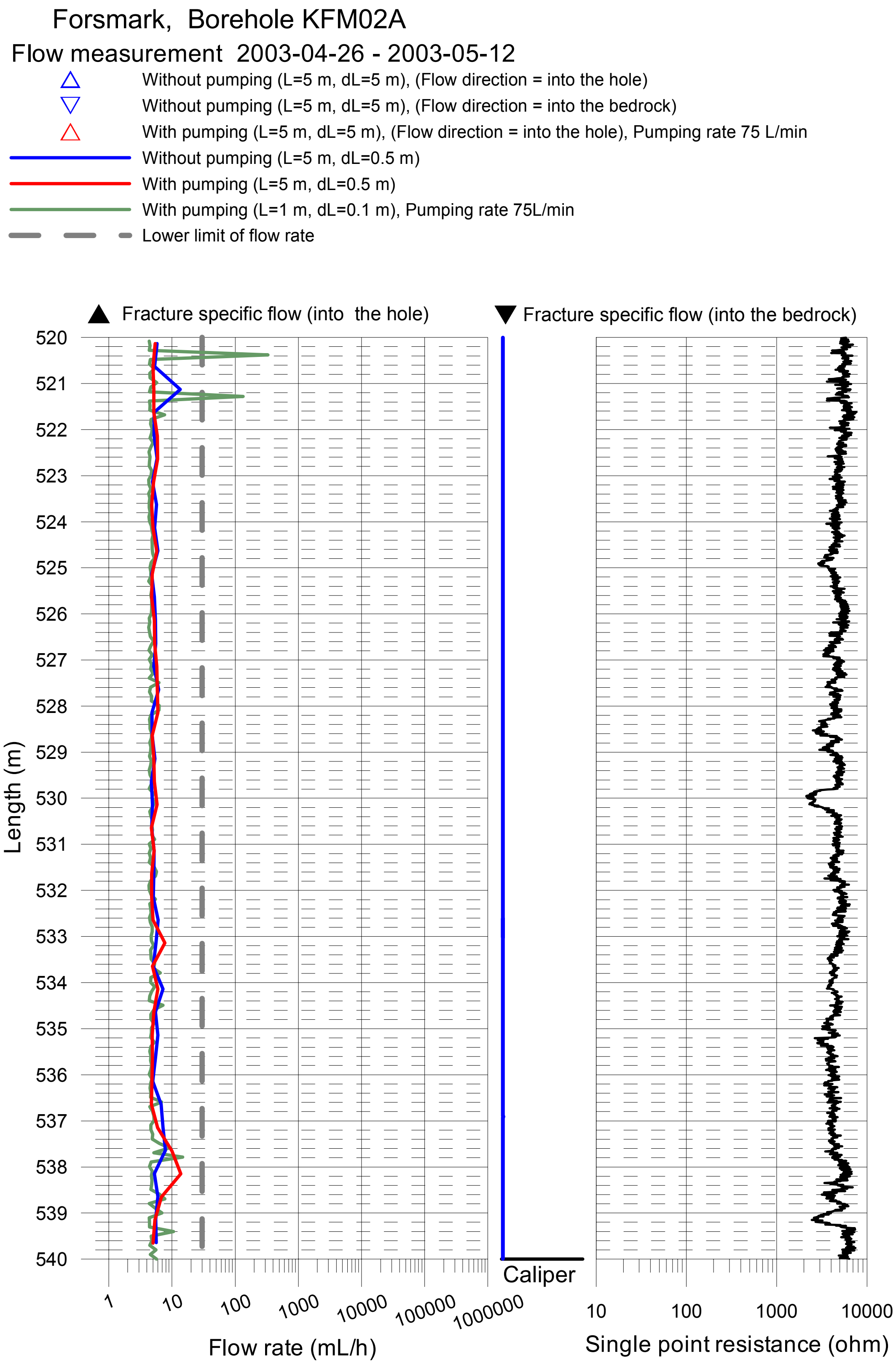


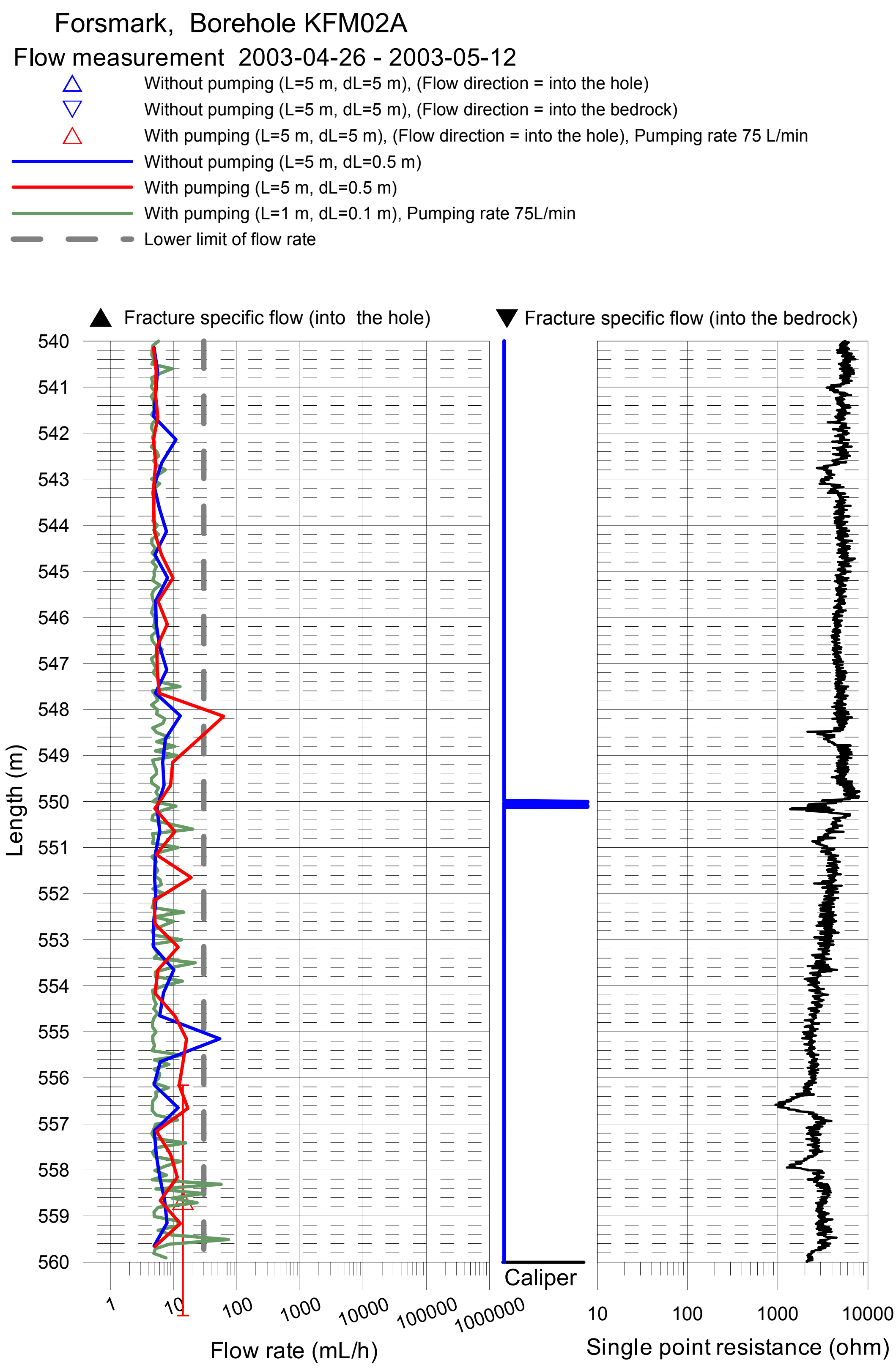
Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
462.5
463.2
465.3
468.6
477.8
479.2
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
480.4
481.2
484.6
485.6
486.1
486.4
493.4
495.5
496.5
497.3
498.1
498.3
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

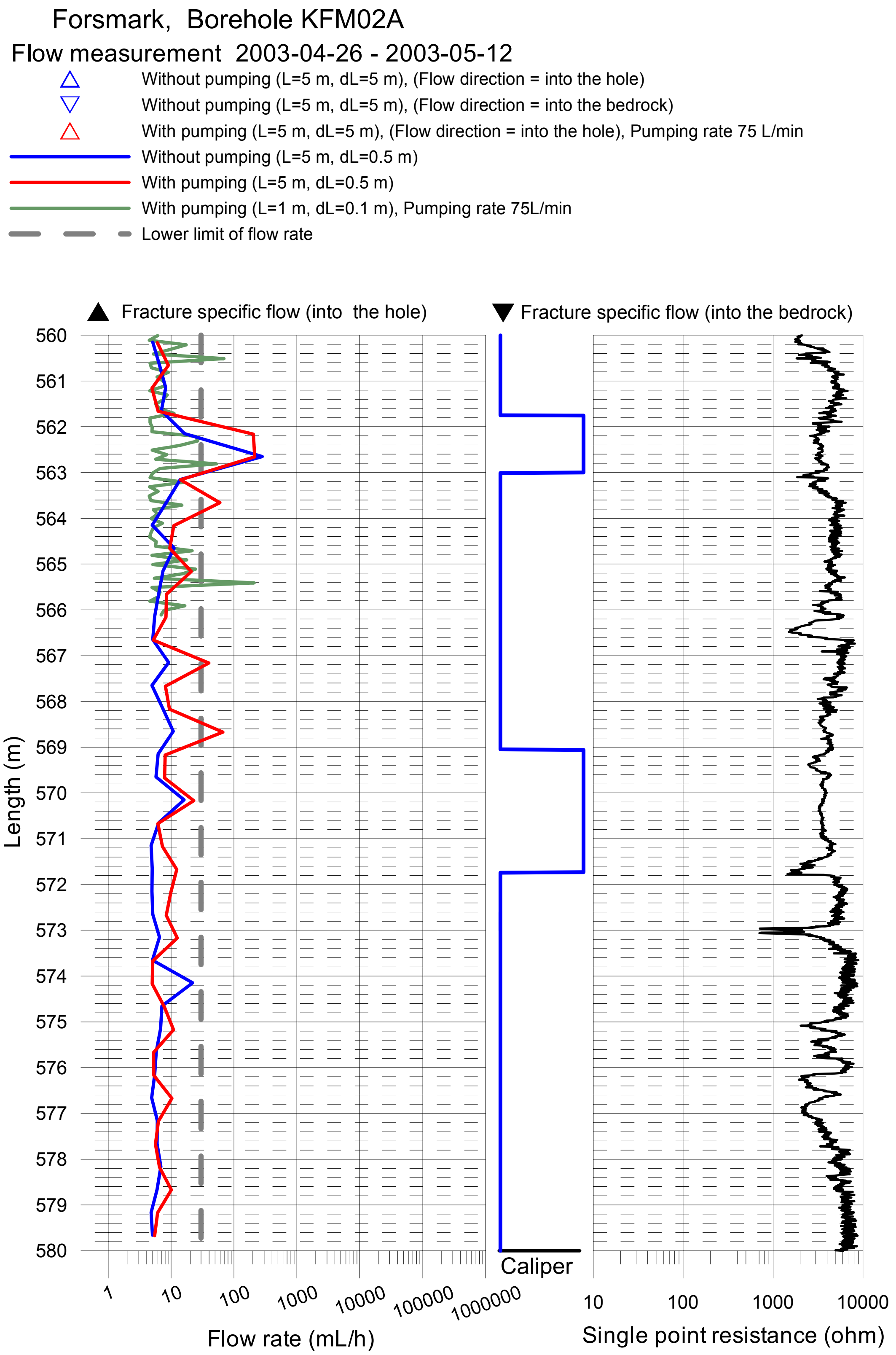

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
500.3
500.9
501.4
506.5
512.3
512.6
513.1
513.6
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

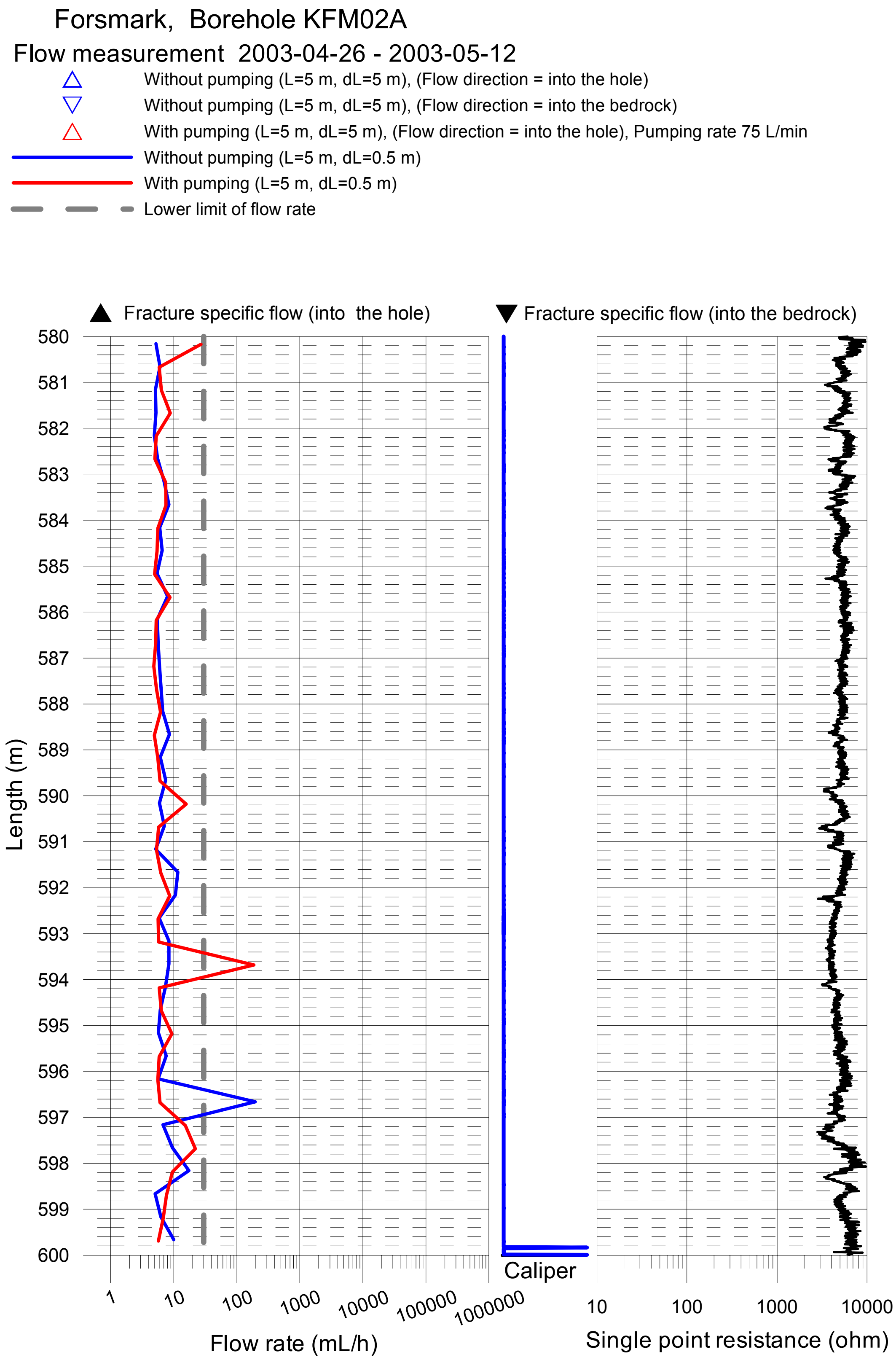
Appendix 3.22

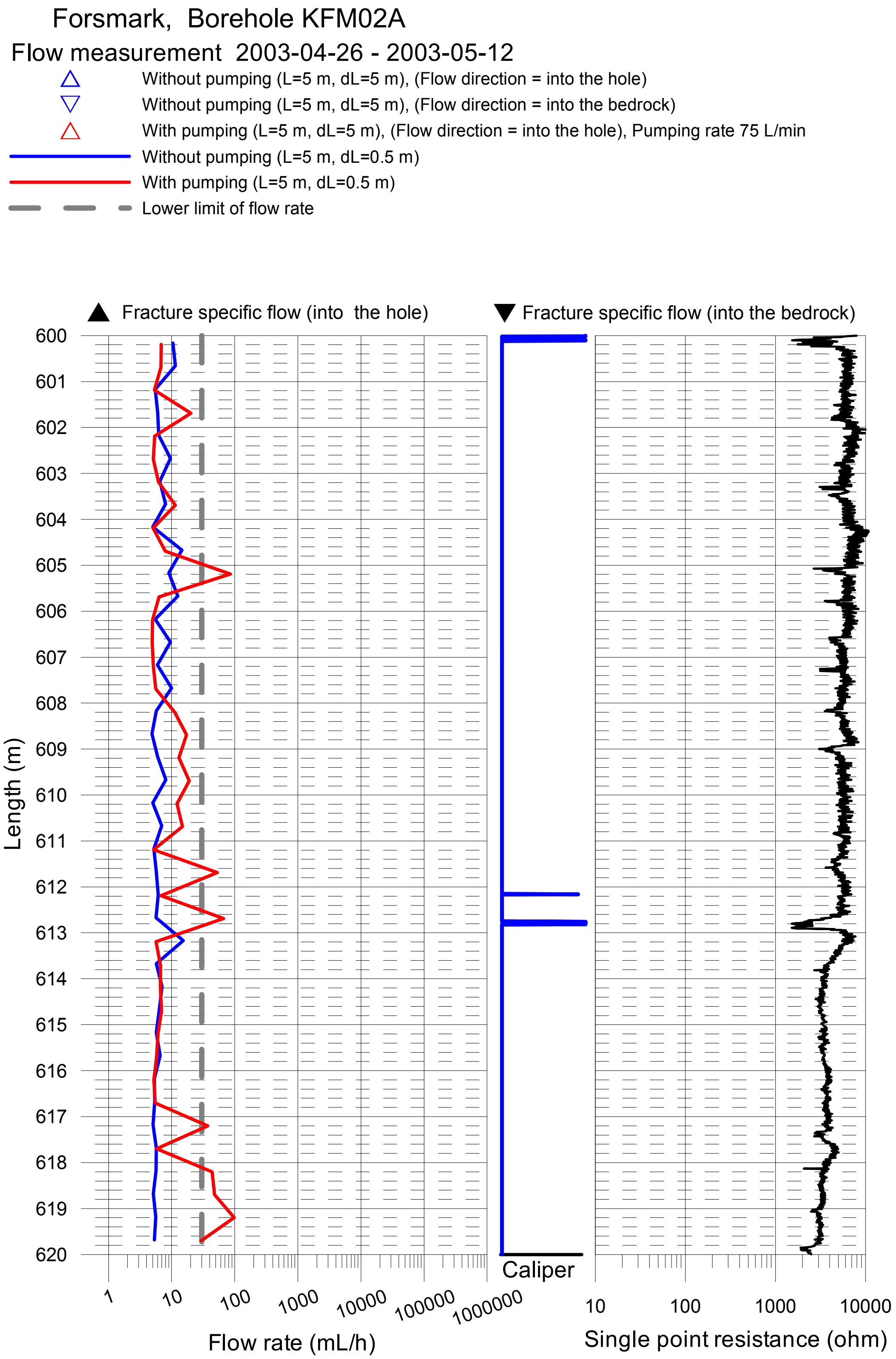


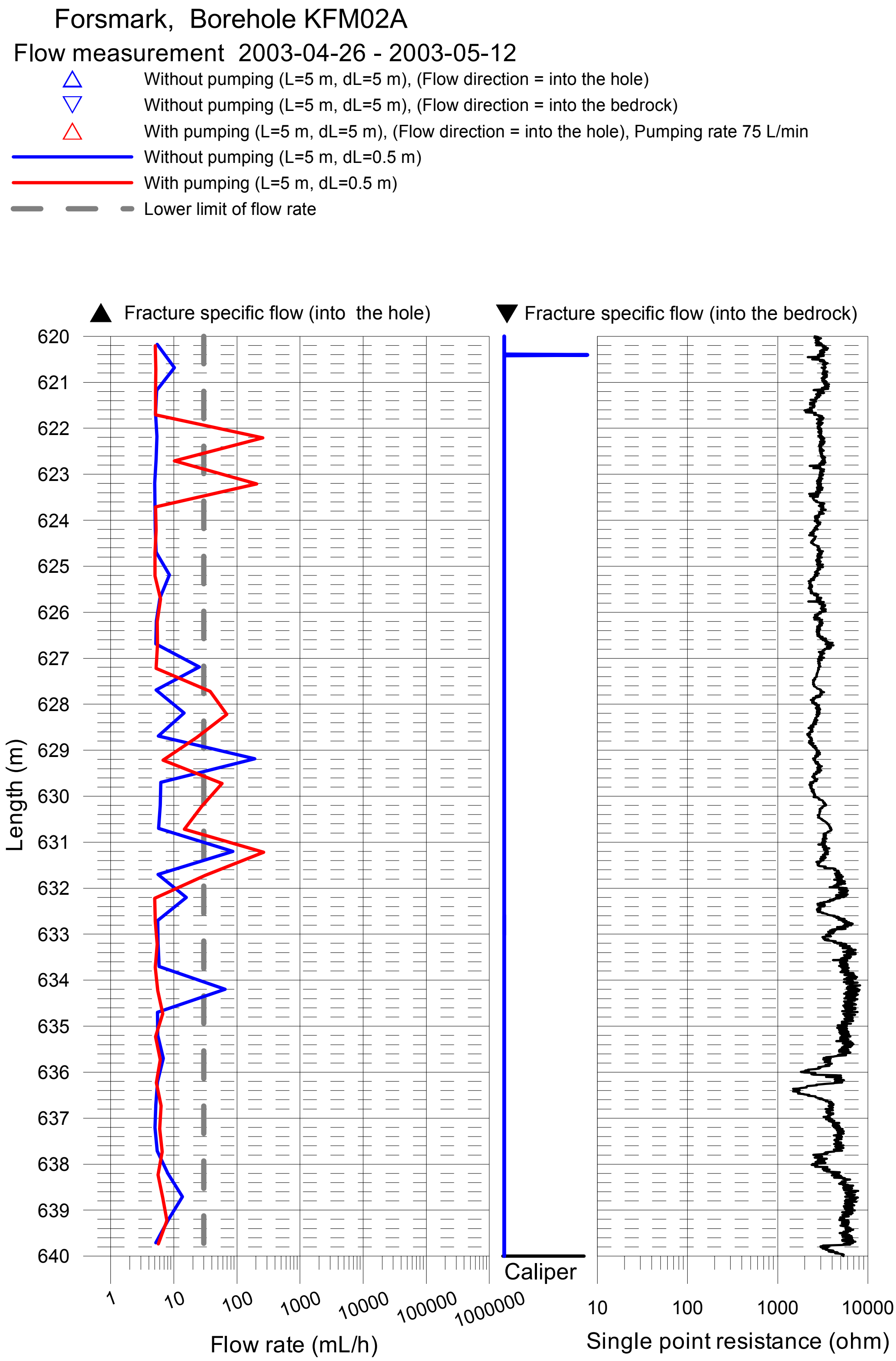


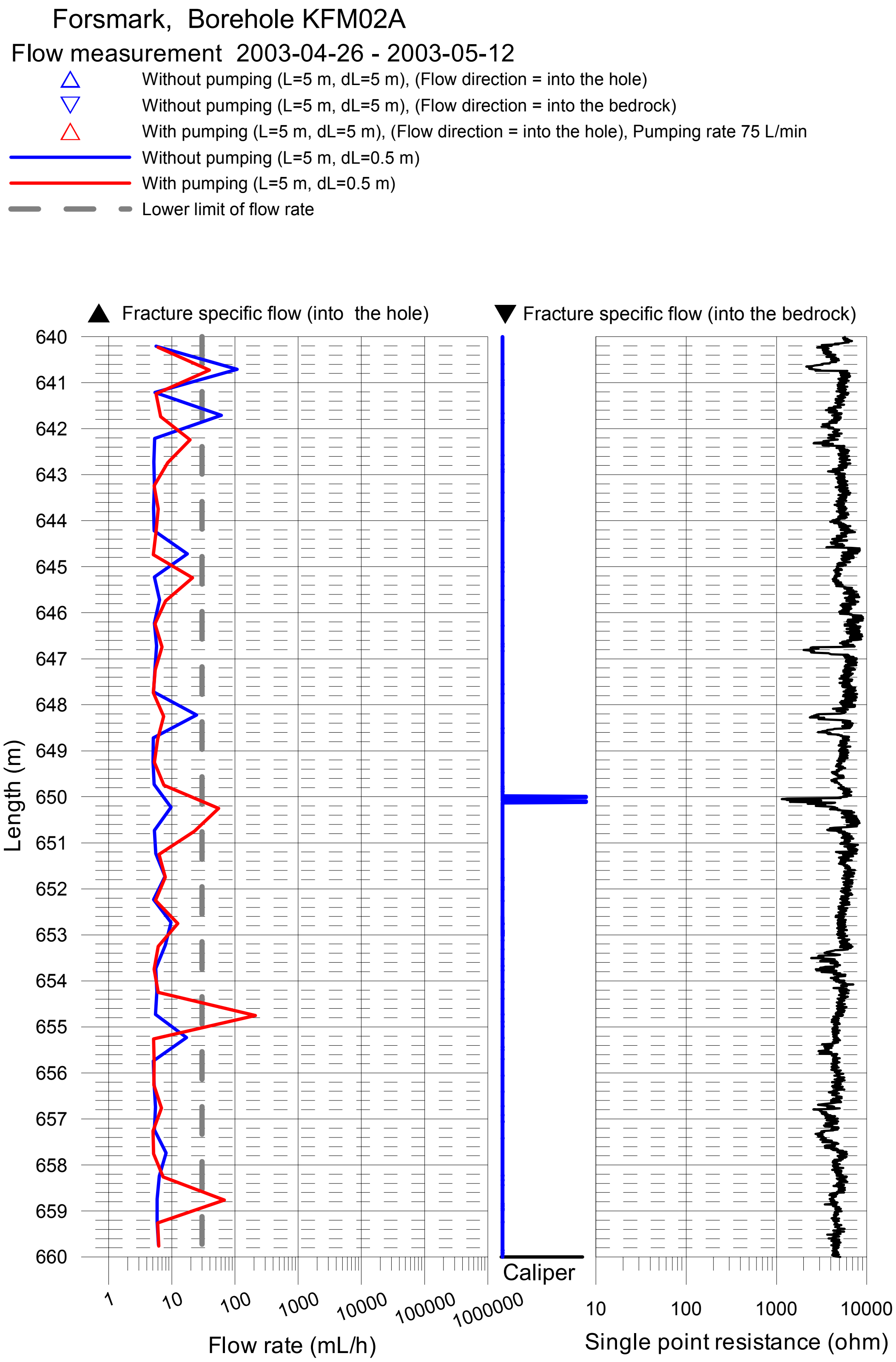
Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), Pumping rate 75L/min
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
Length (m)
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

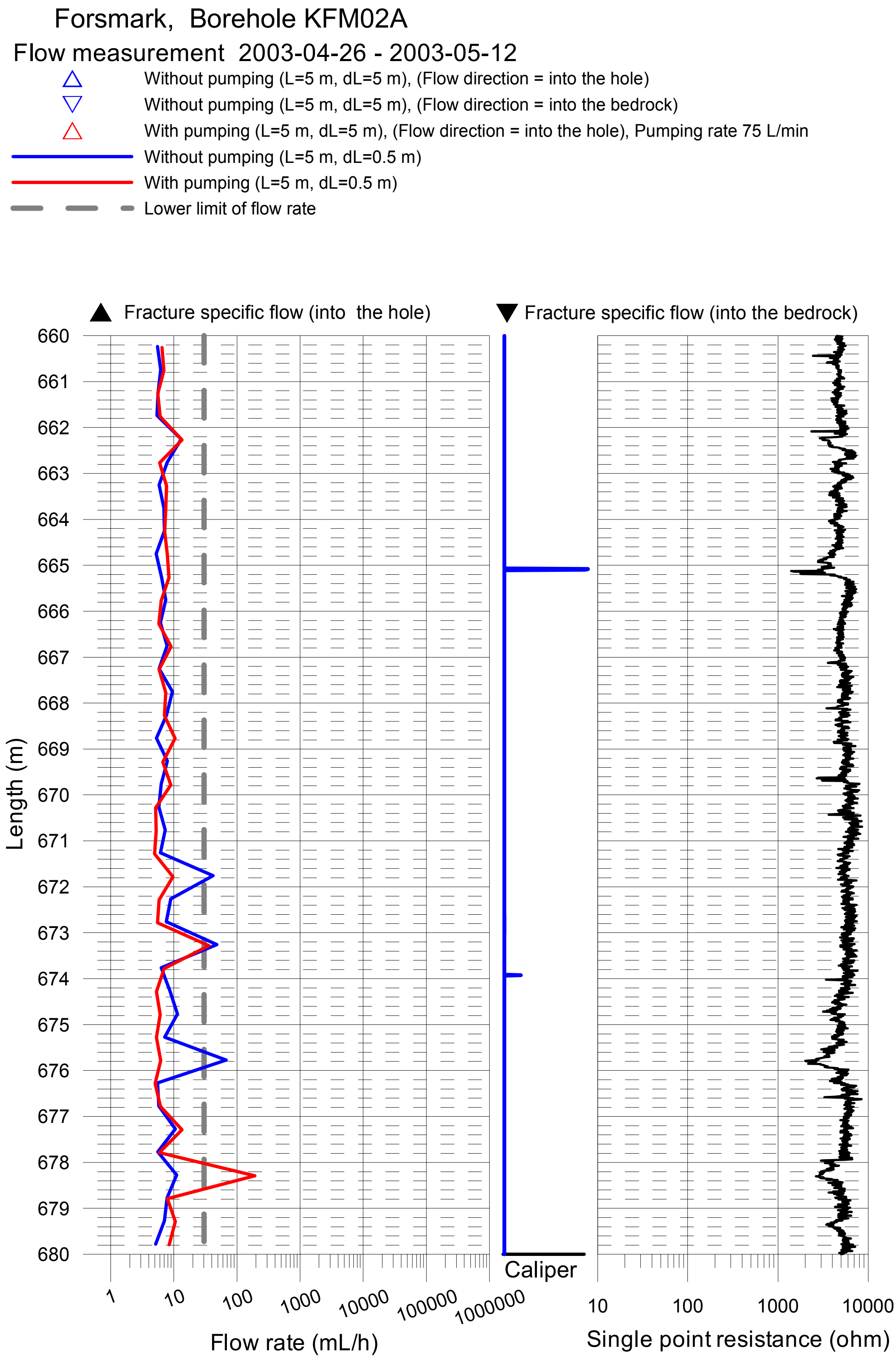

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

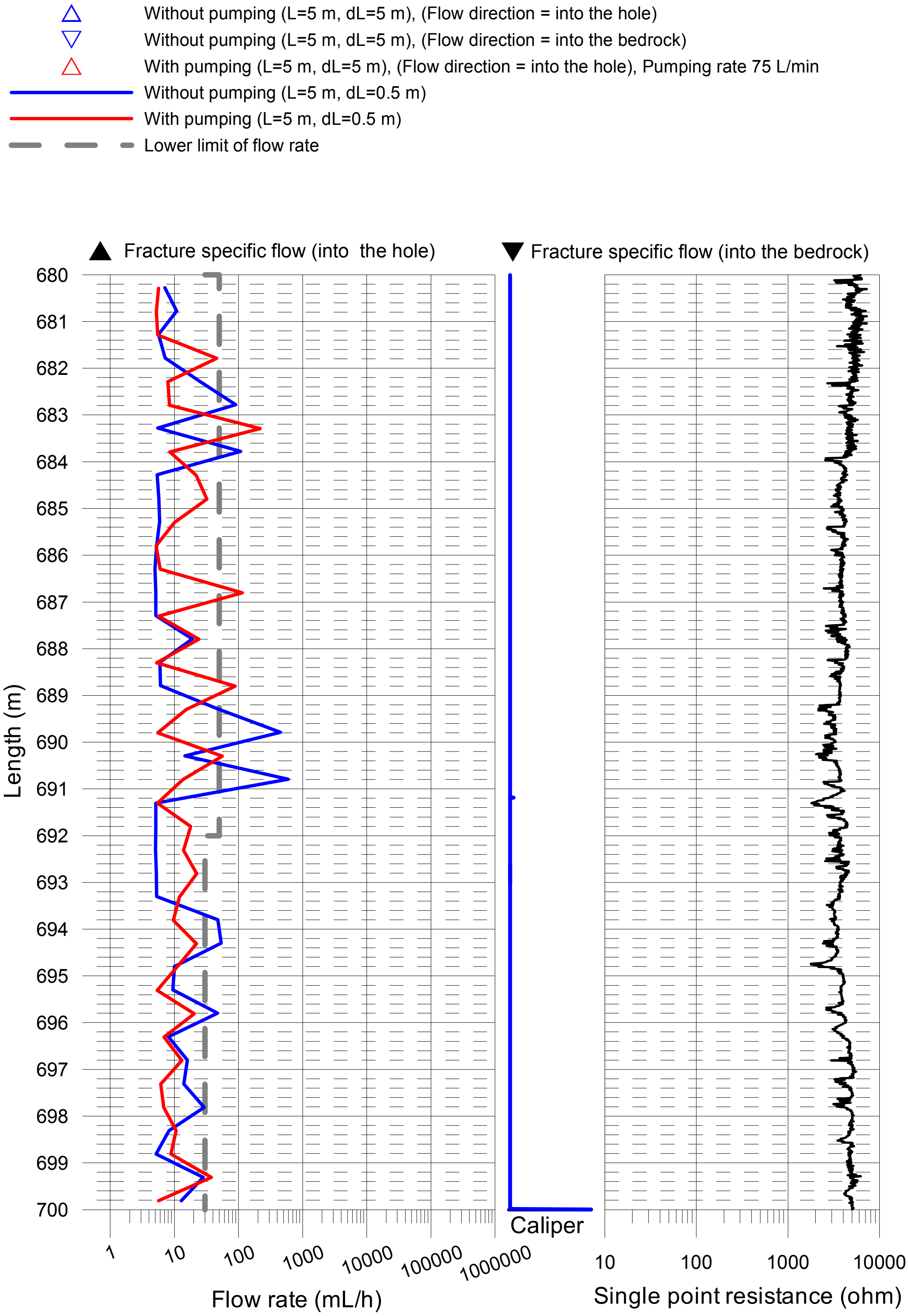
Appendix 3.29



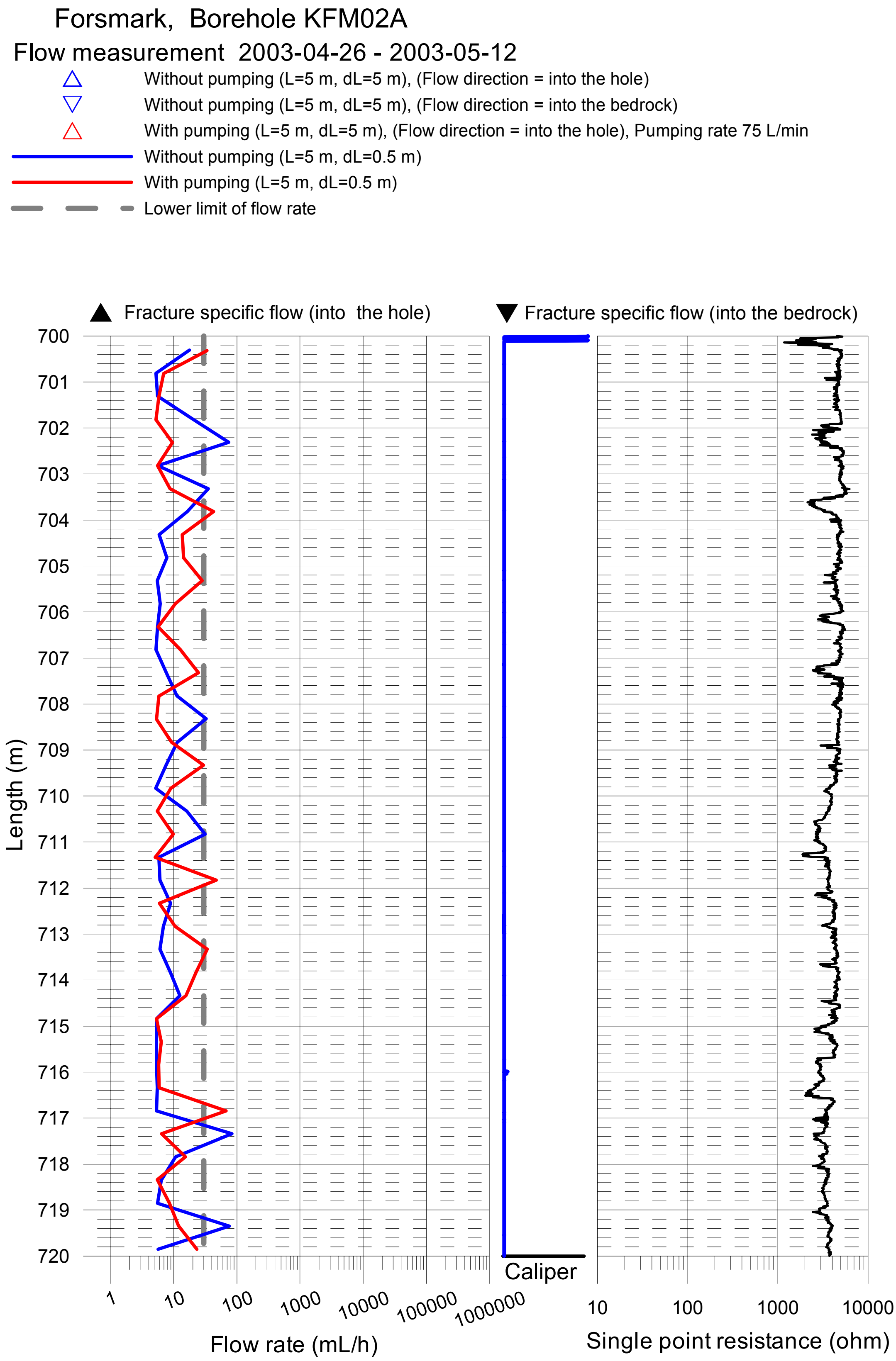
Appendix 3.30

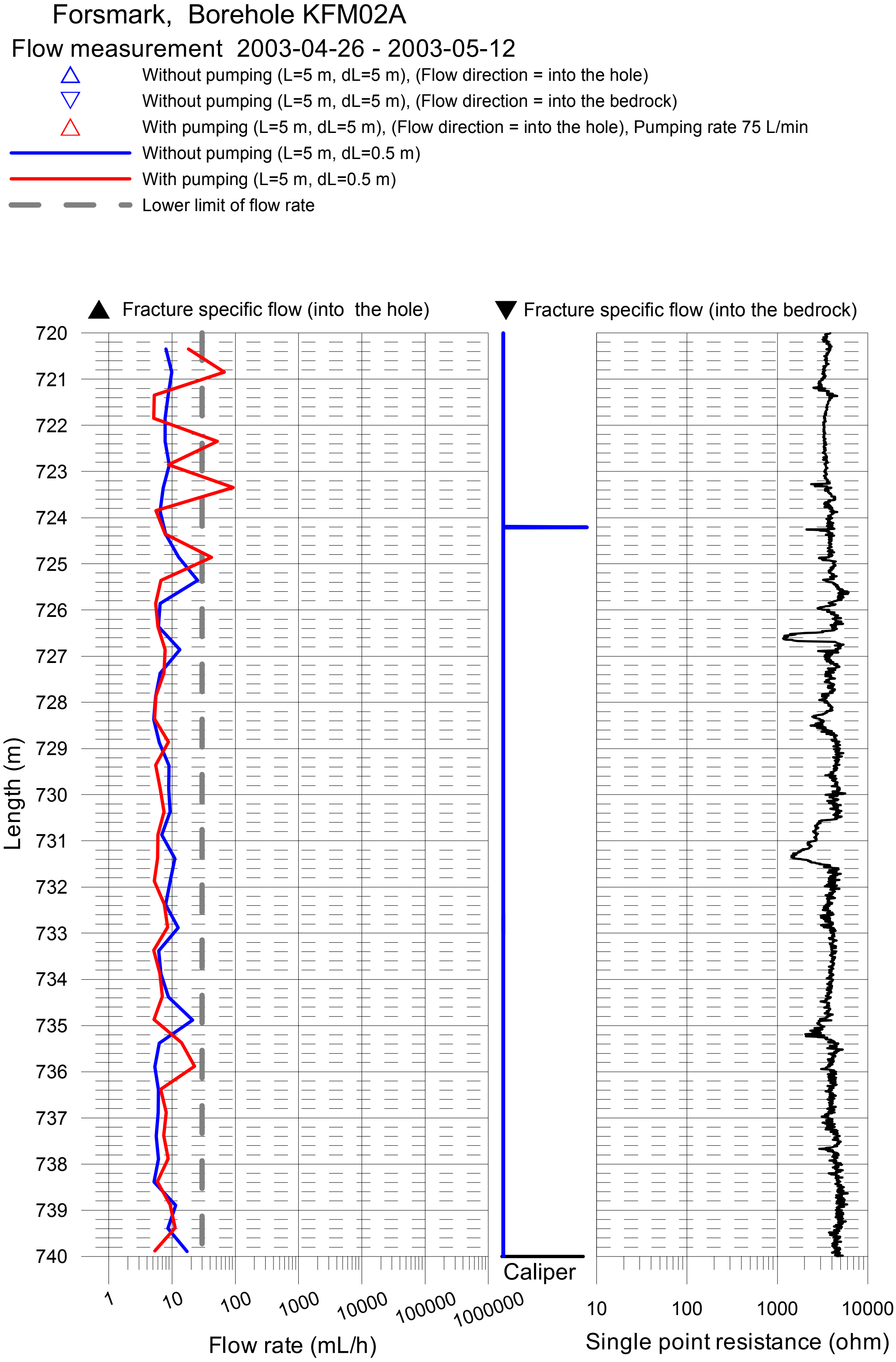
Forsmark, Borehole KFM02A

Flow measurement 2003-04-26 - 2003-05-12



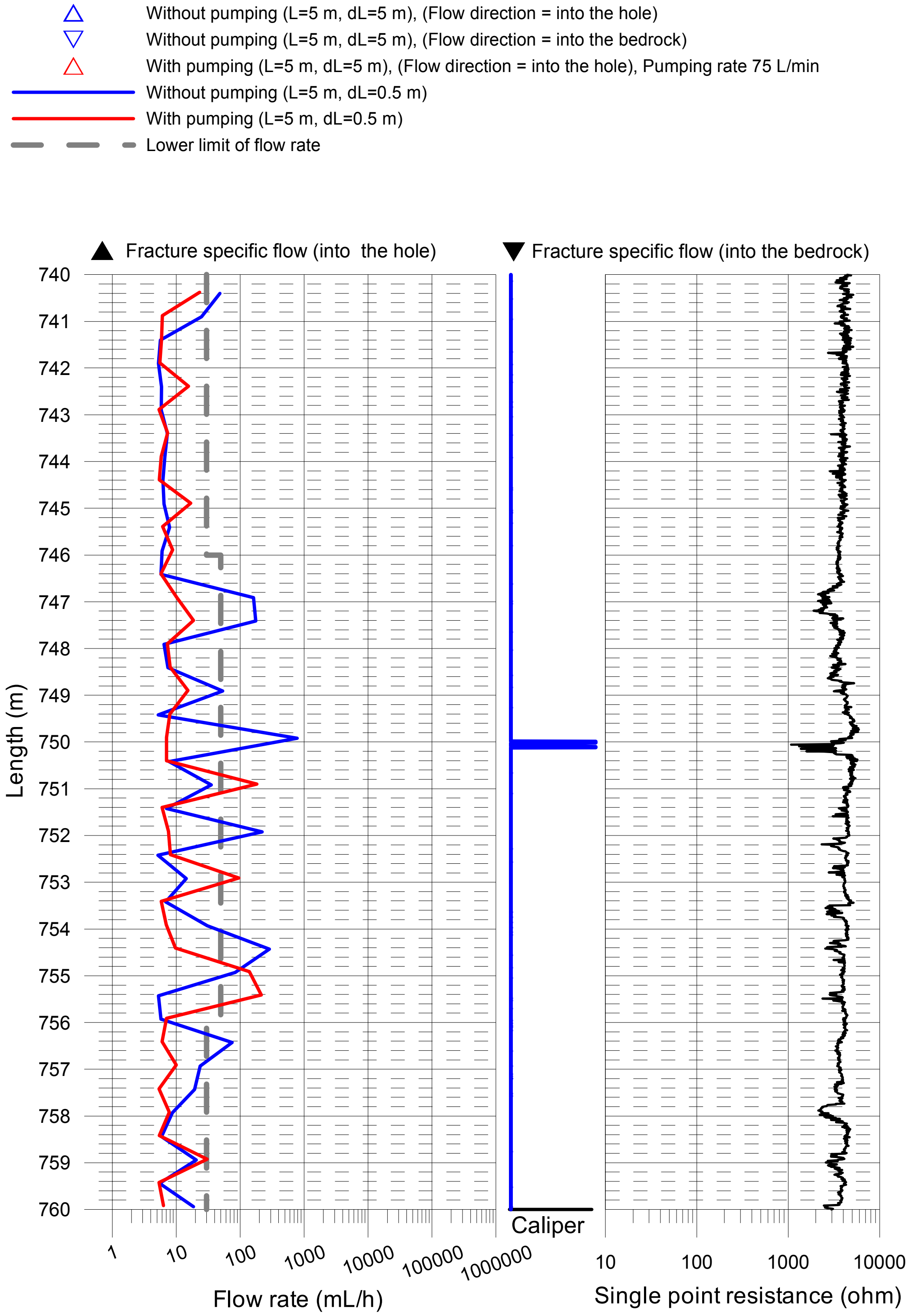
Appendix 3.31

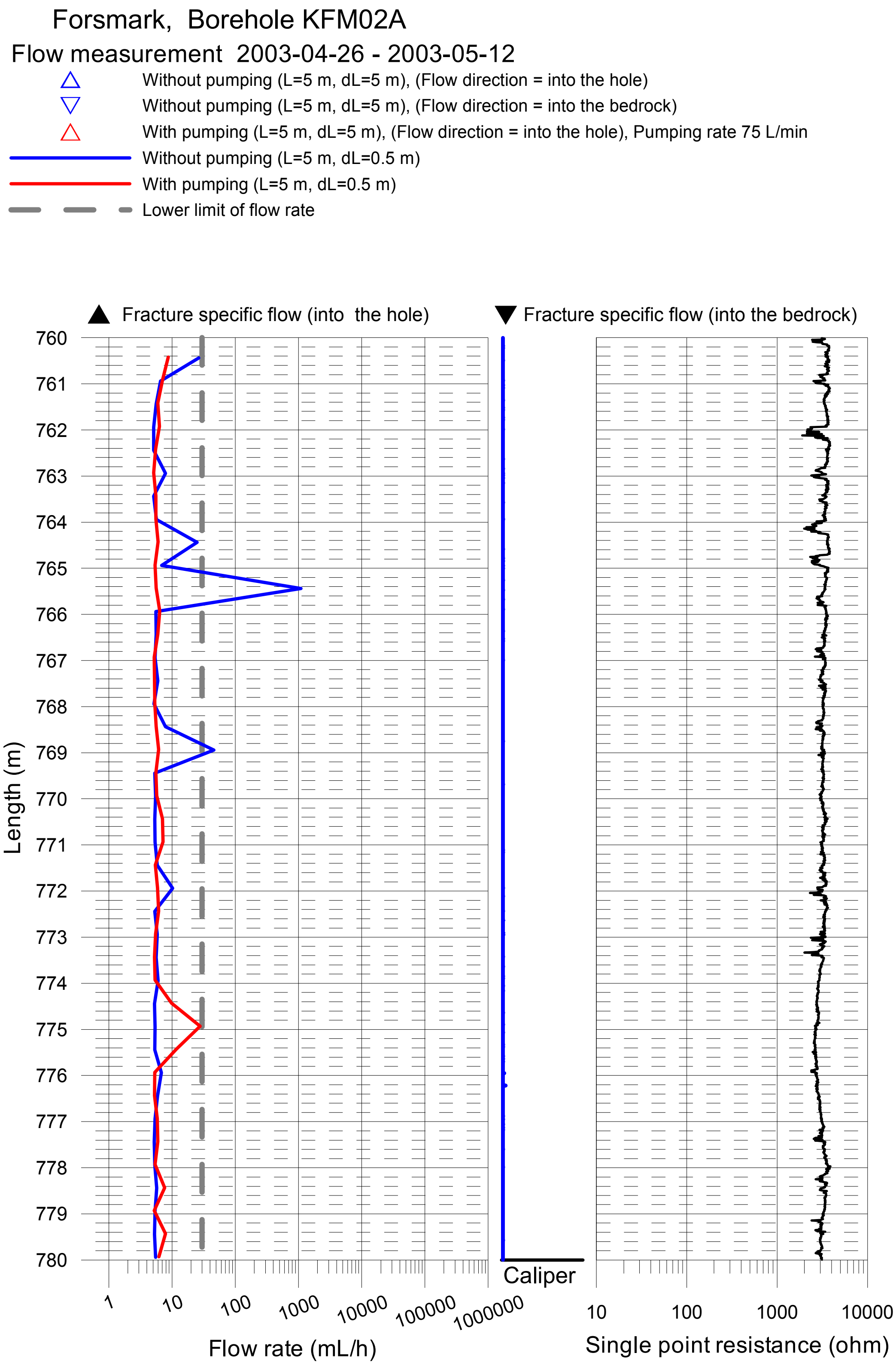


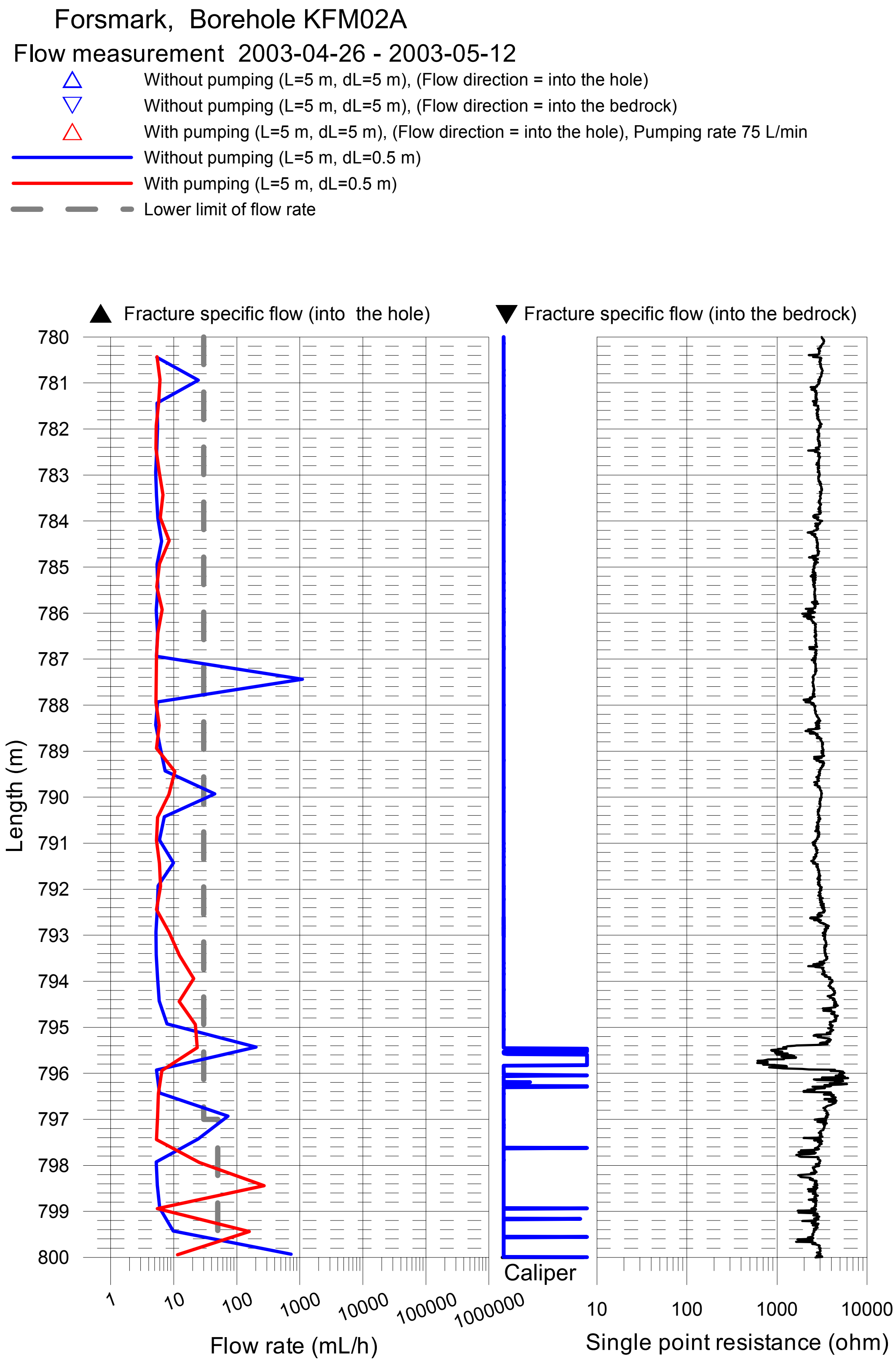

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
Length (m)
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

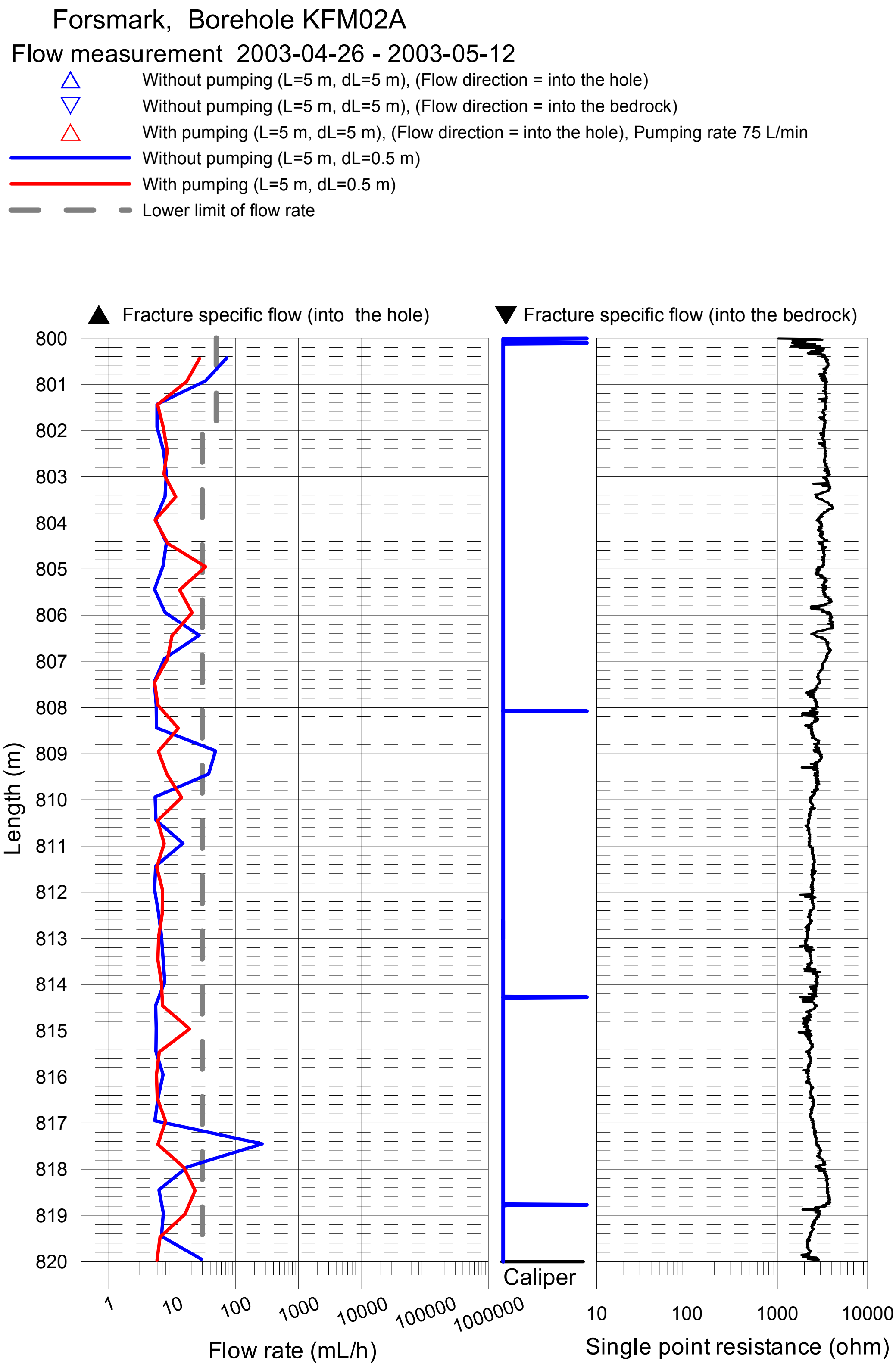
Forsmark, Borehole KFM02A

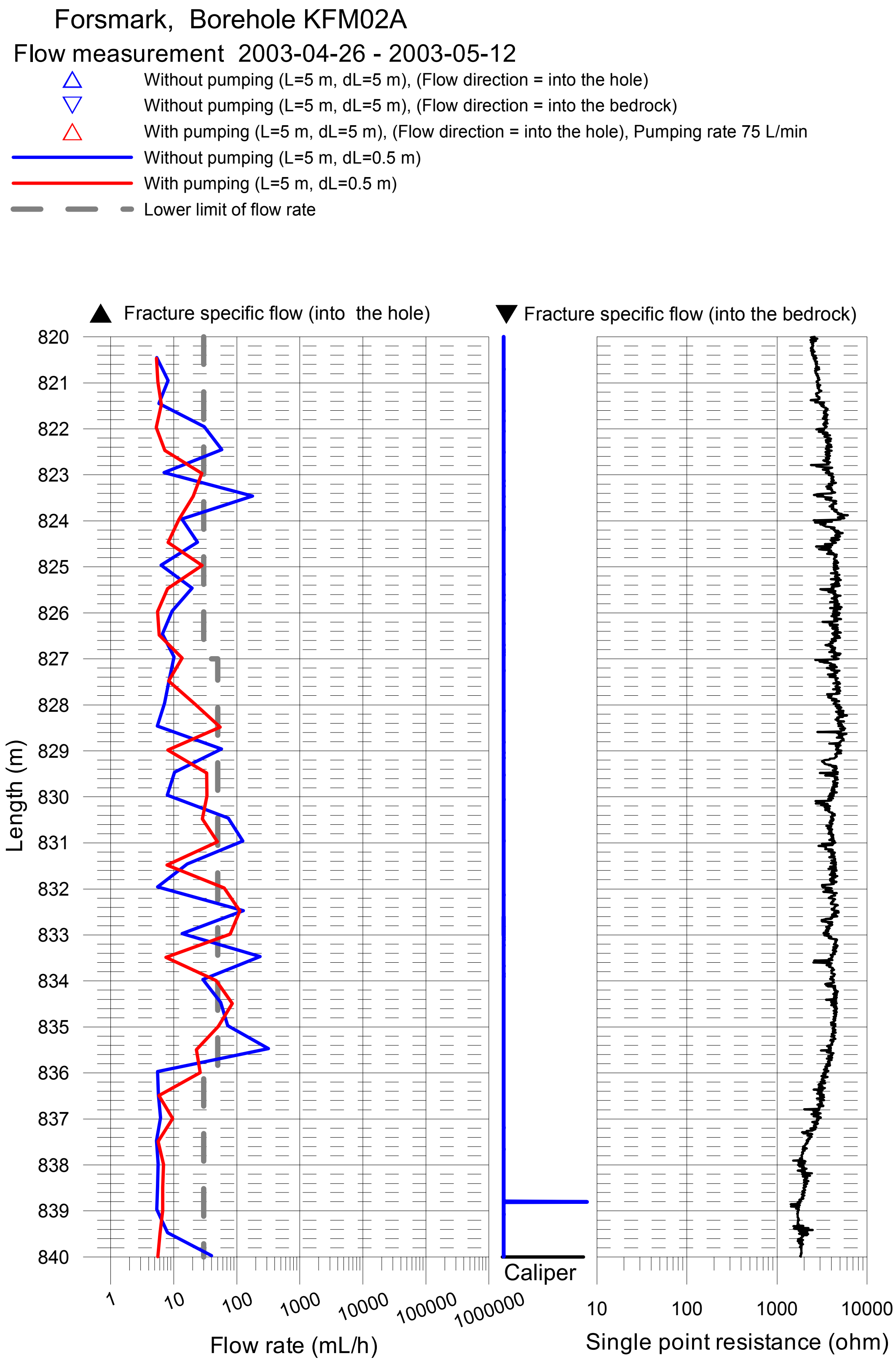
Flow measurement 2003-04-26 - 2003-05-12

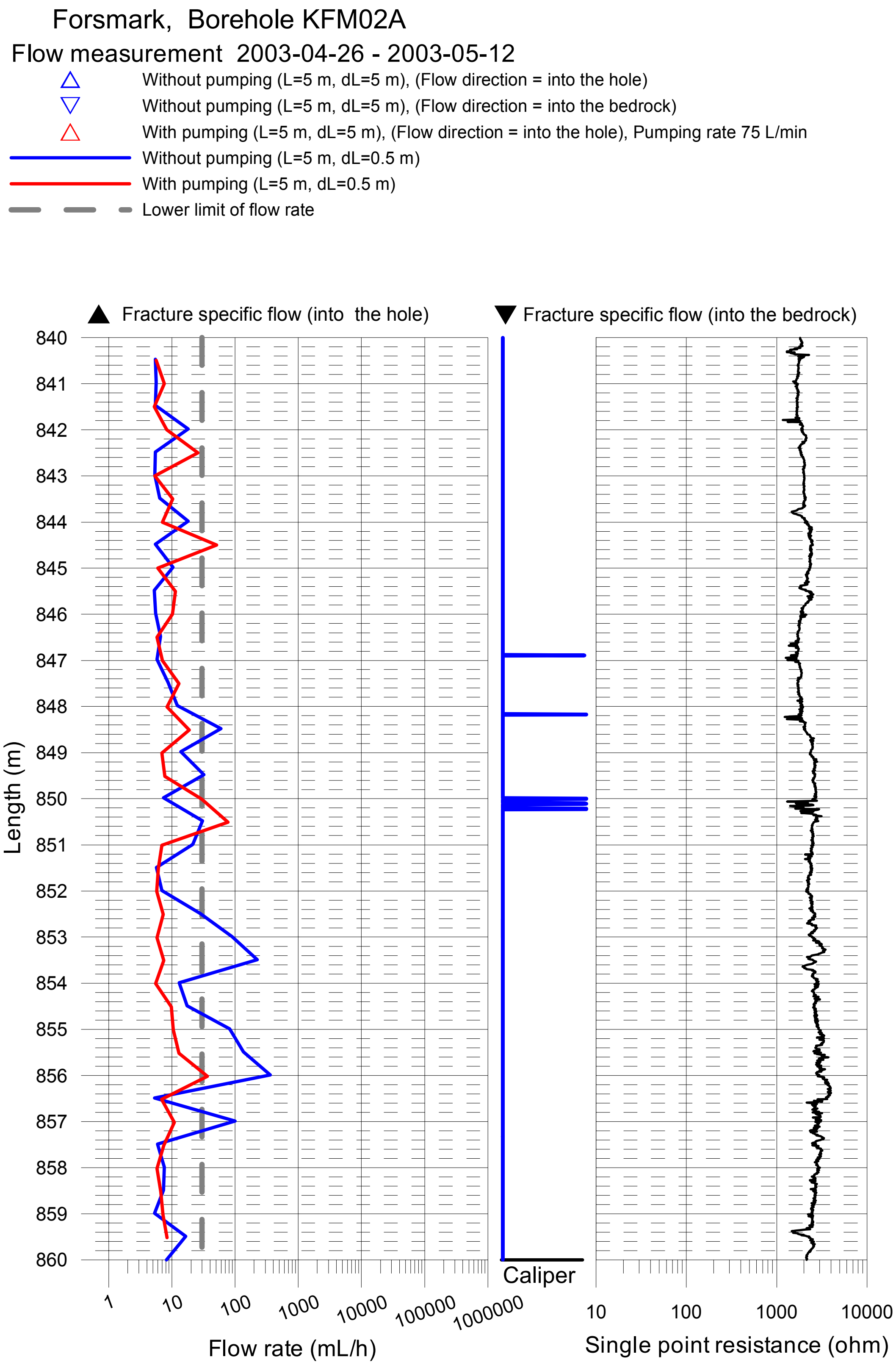



Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

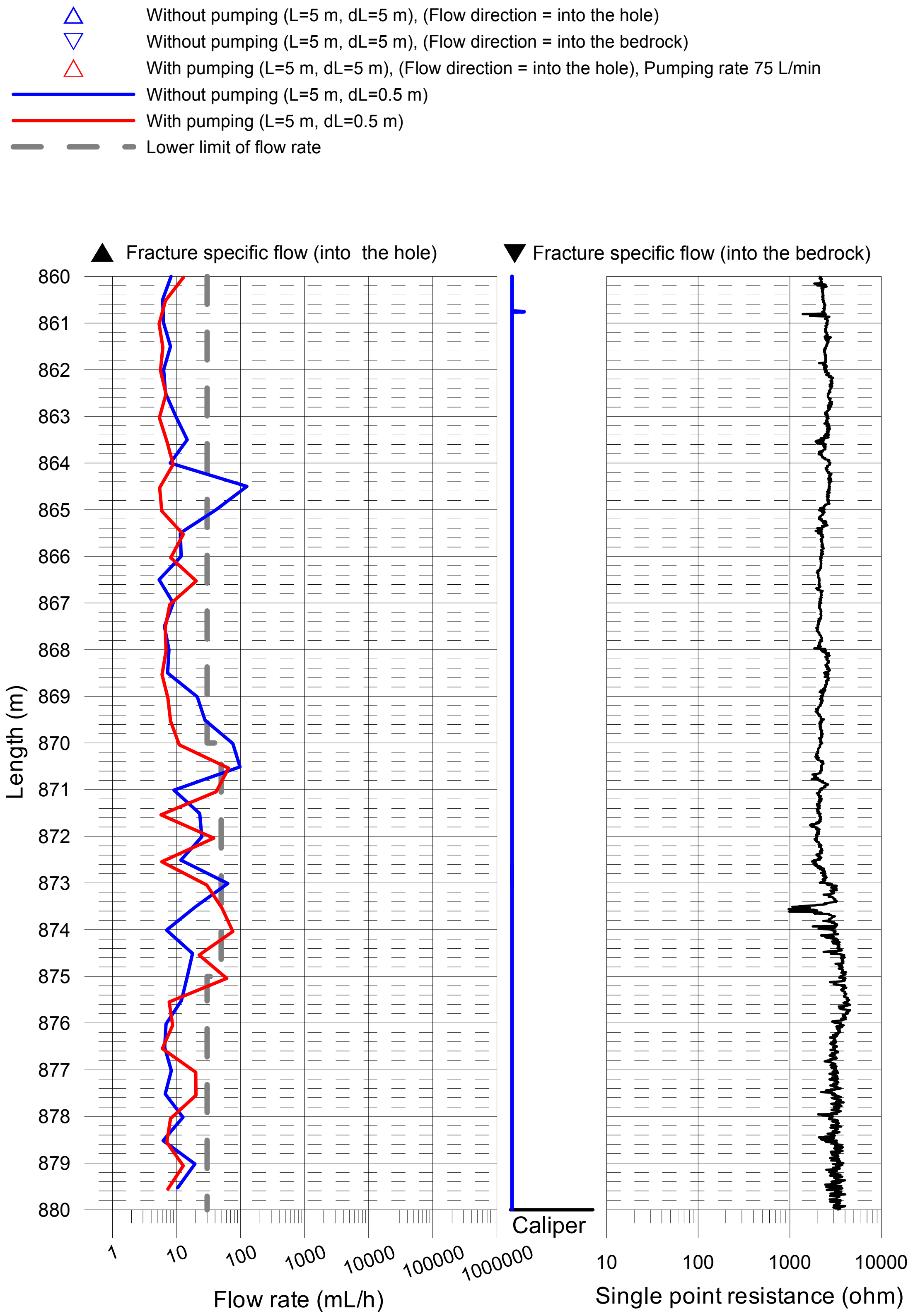

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

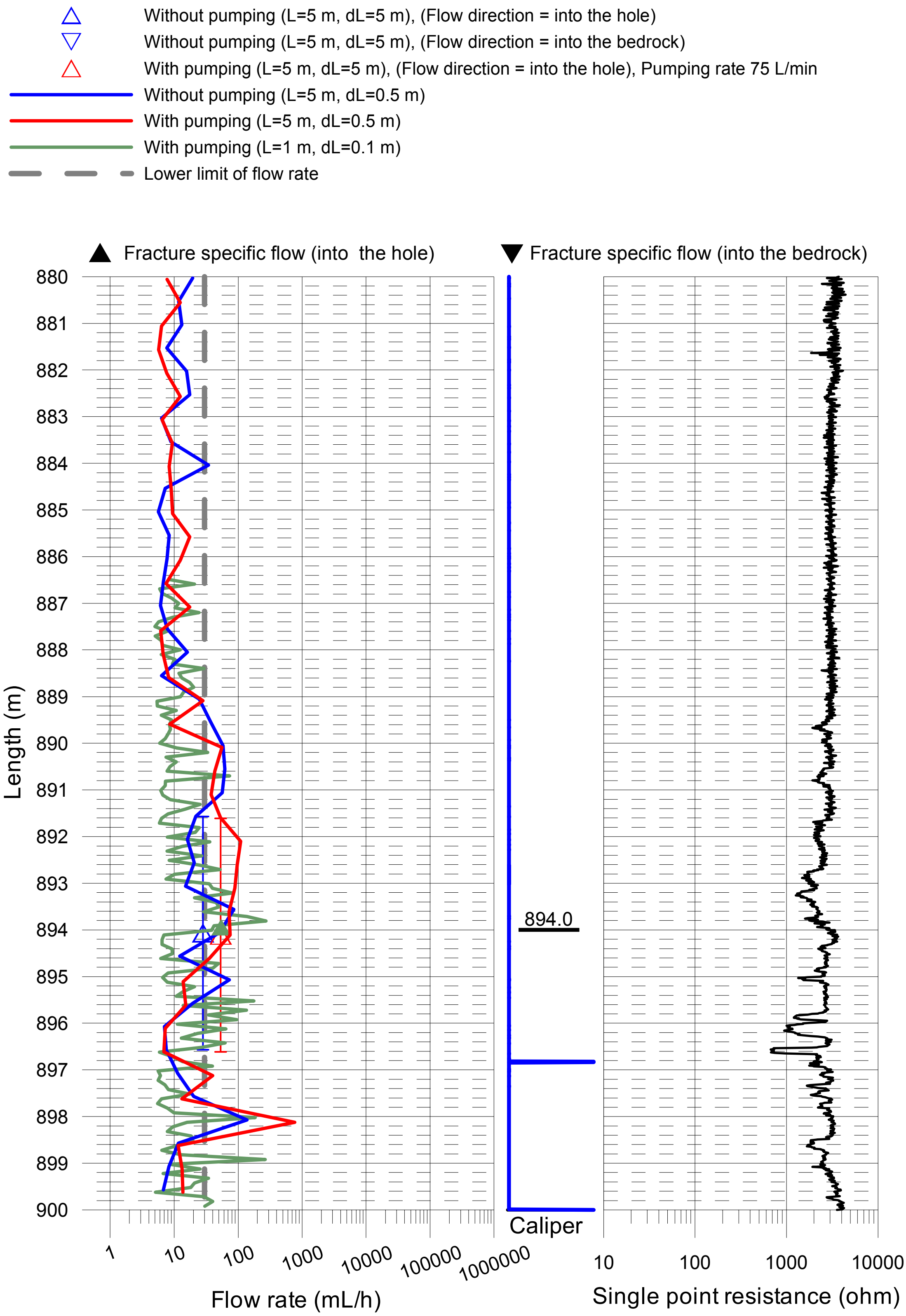
Forsmark, Borehole KFM02A

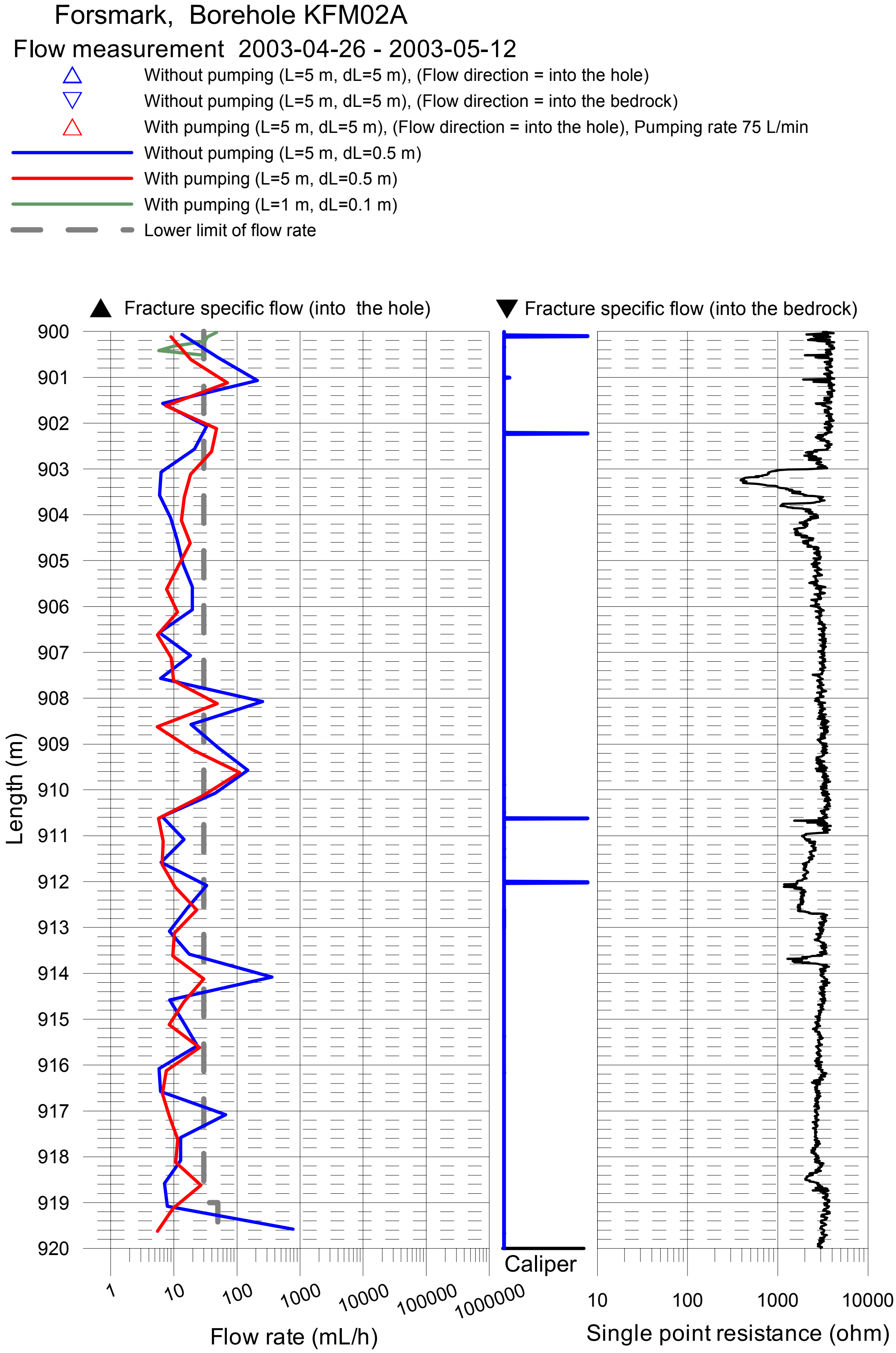
Flow measurement 2003-04-26 - 2003-05-12

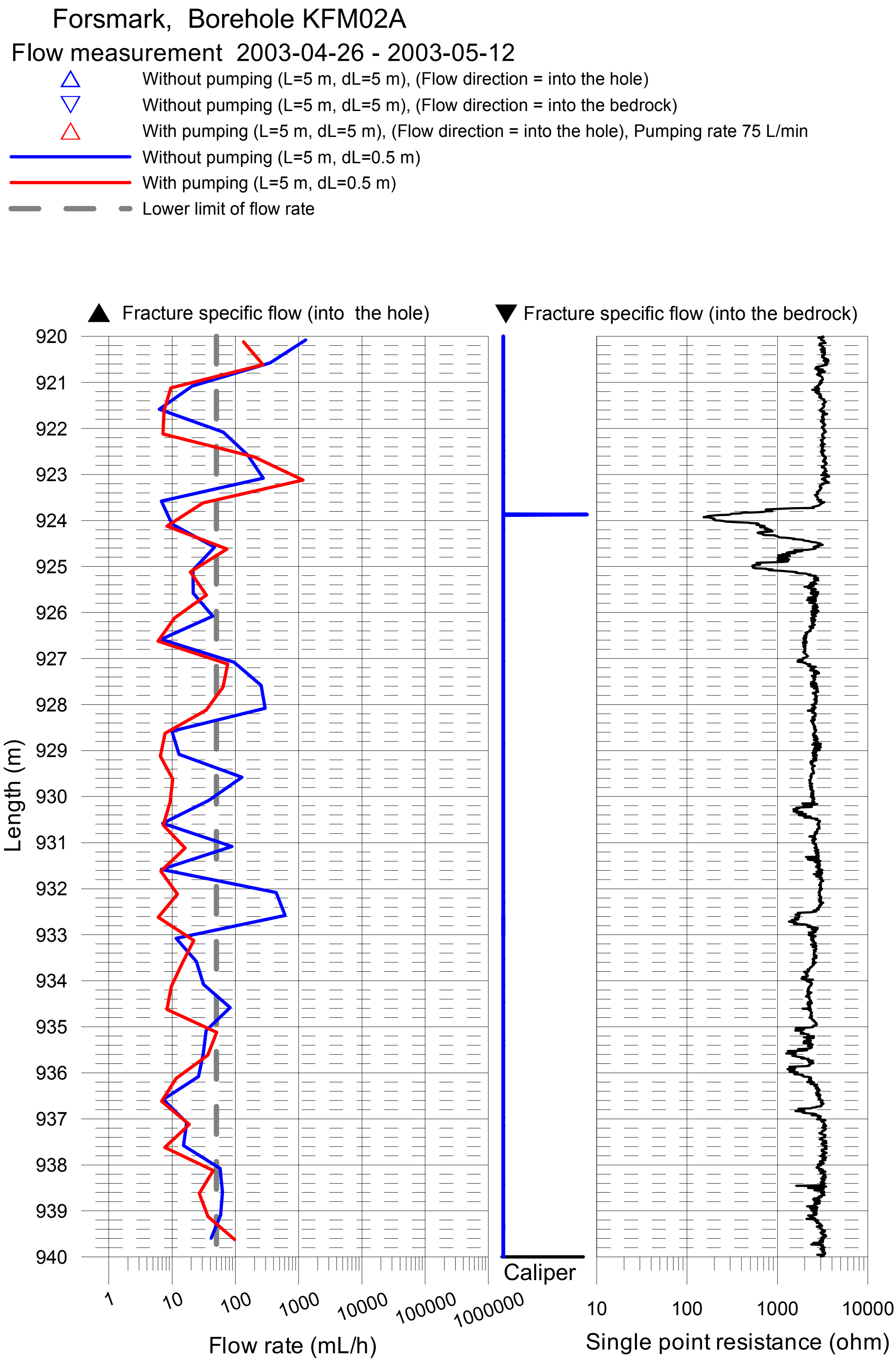


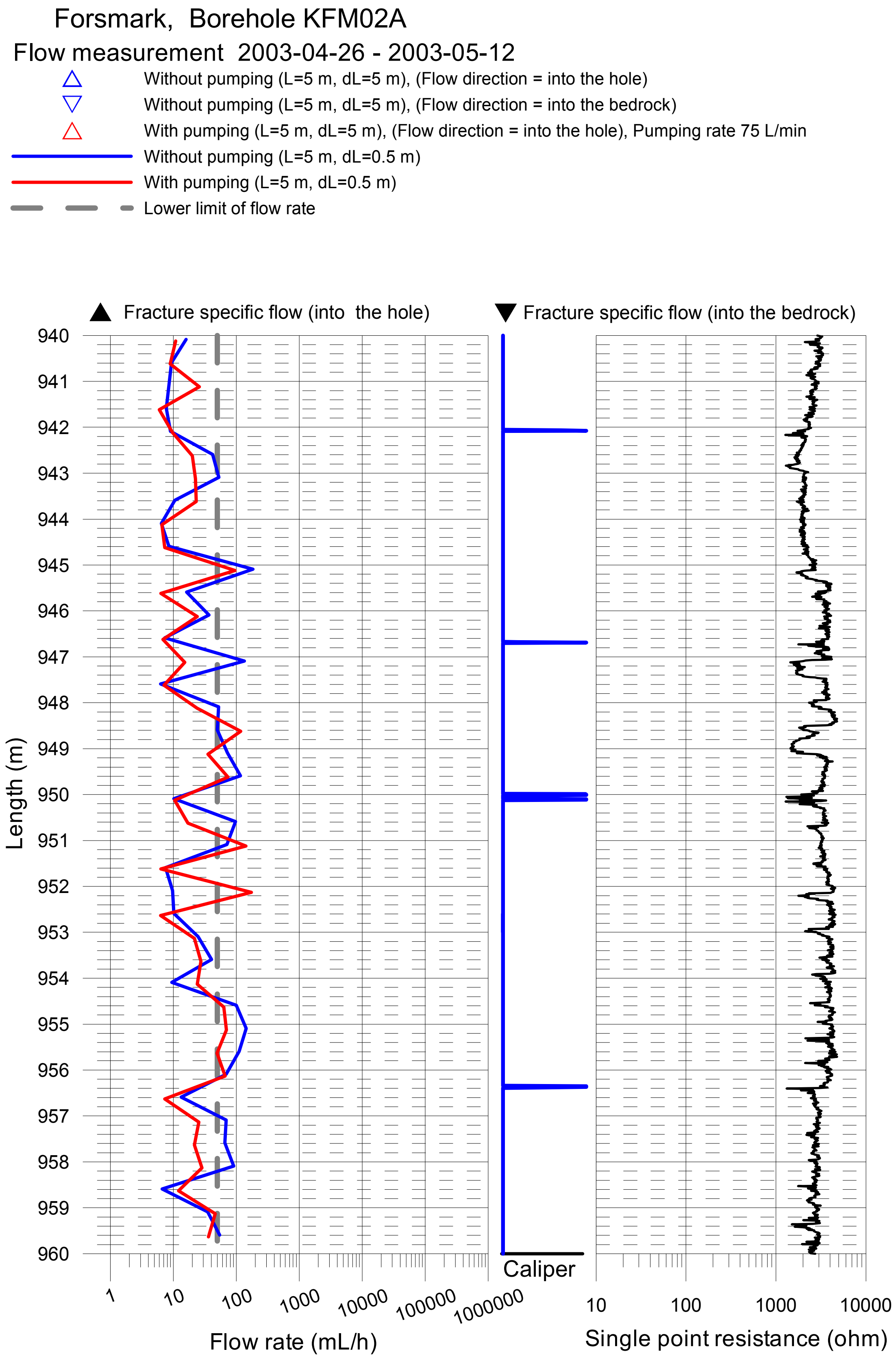
Forsmark, Borehole KFM02A

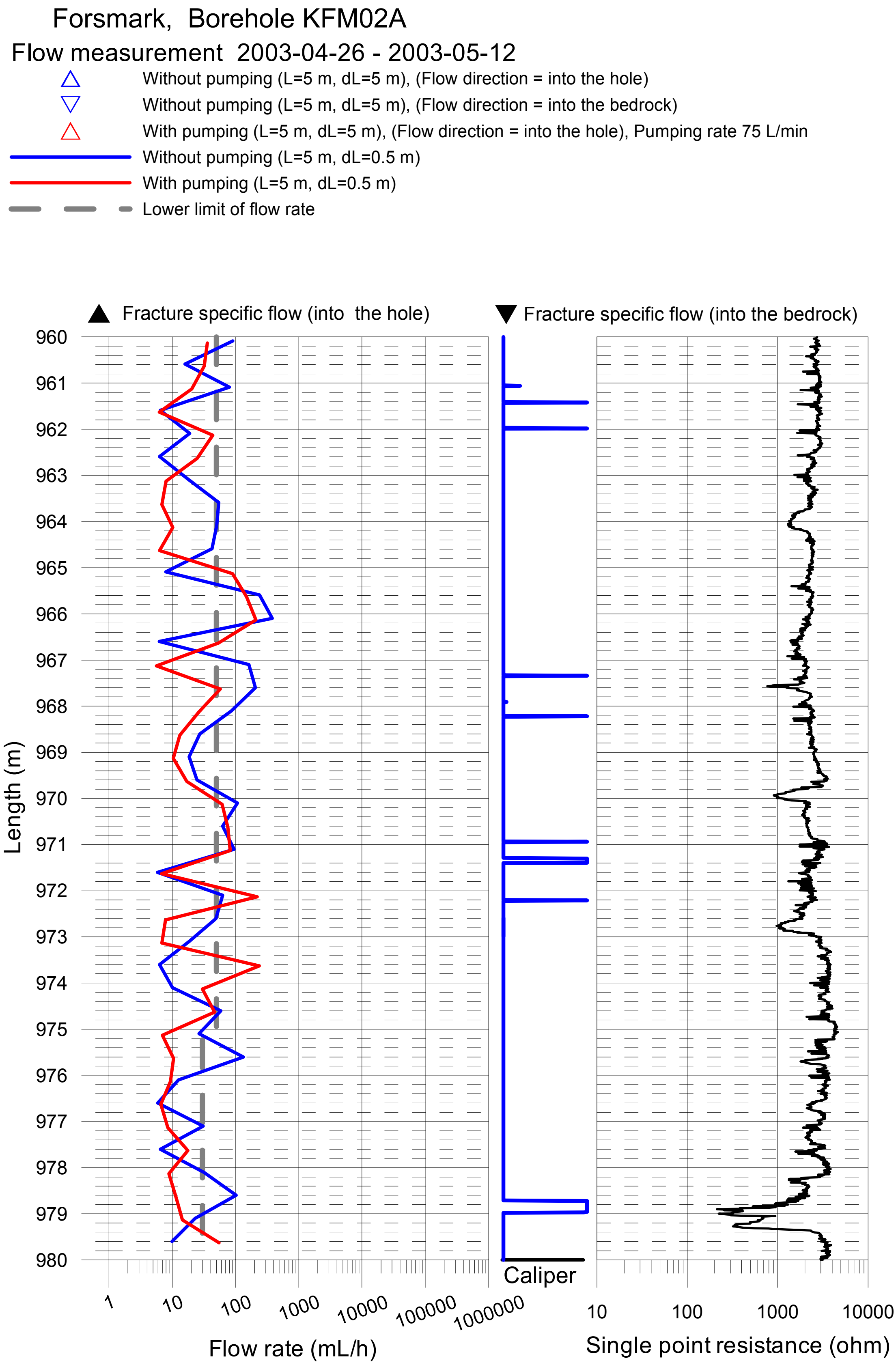
Flow measurement 2003-04-26 - 2003-05-12




Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

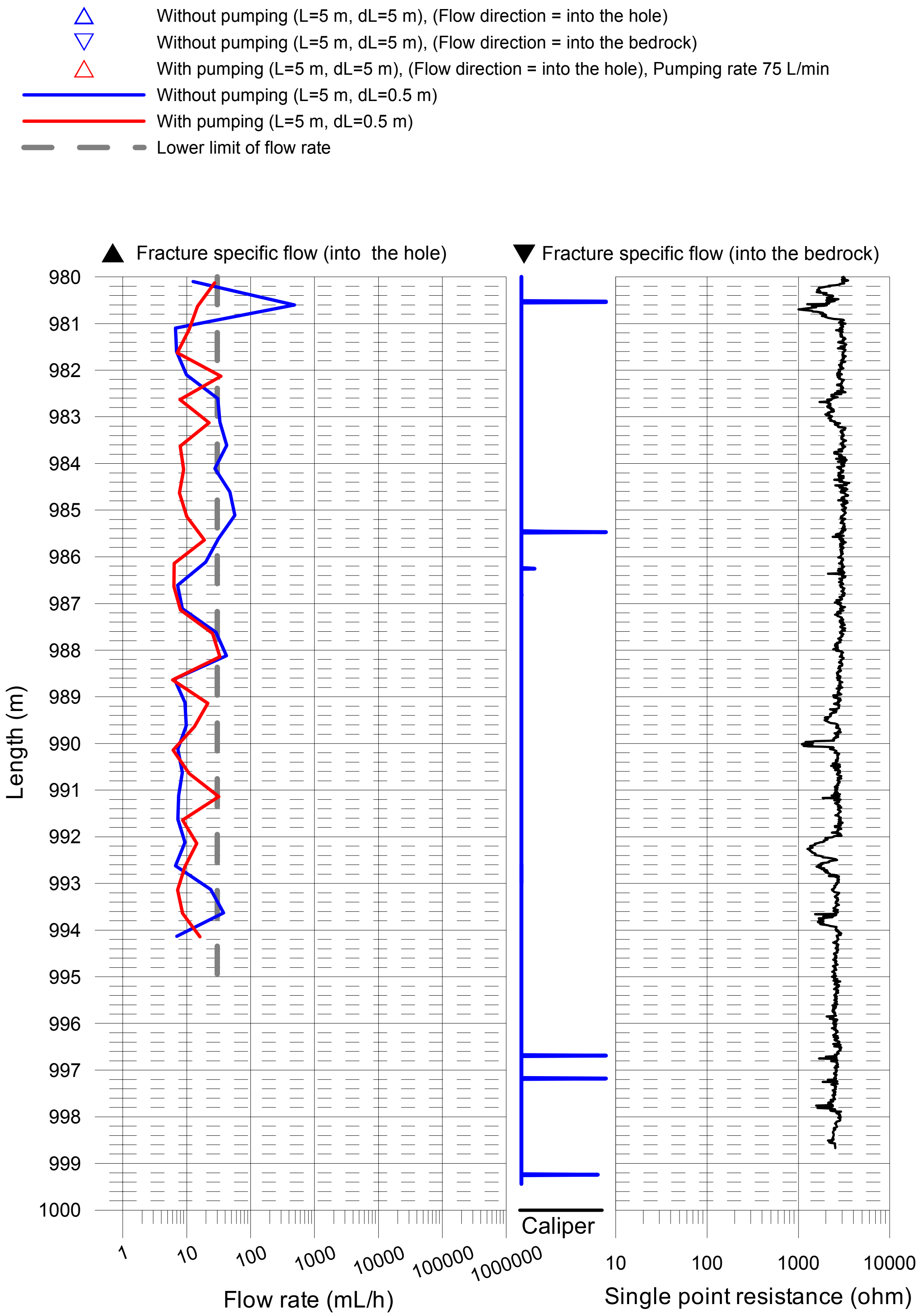

Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)


Forsmark, Borehole KFM02A
Flow measurement 2003-04-26 - 2003-05-12
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole), Pumping rate 75 L/min
Without pumping (L=5 m, dL=0.5 m)
With pumping (L=5 m, dL=0.5 m)
Lower limit of flow rate
Fracture specific flow (into the hole)
Fracture specific flow (into the bedrock)
Length (m)
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

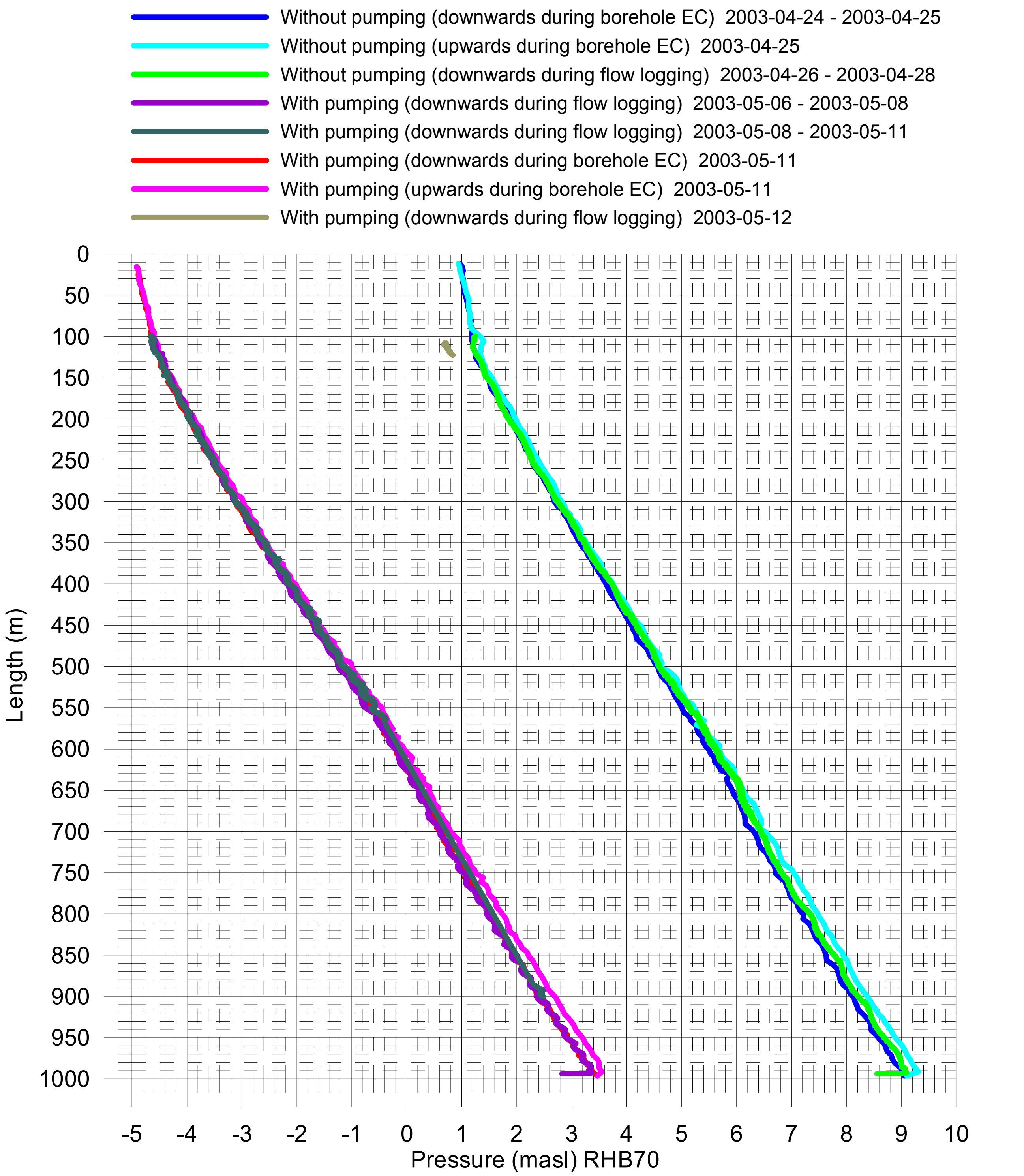
Forsmark, Borehole KFM02A

Flow measurement 2003-04-26 - 2003-05-12



Head during flow logging in borehole KFM02A

Head(masl)= (Absolute pressure (Pa) - Airpressure (Pa) + Offset) /(1000 kg/m^3 * 9.80065 m/s^2) + Elevation (m)
Offset = 13500 Pa (Correction for absolut pressure sensor)



Appendix 5.1

Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
101.00	1.21	1008	101.00	-4.62	6850	2.22	2.75E-07	500	2.83E-10	2.36E-08	1.41E-05
106.00	1.21	-2655	106.00	0.71	74250	1.19	4.27E-05 *	500	3.33E-09	2.36E-08	1.67E-04
111.00	1.21	-188	111.00	0.73	38295	1.21	2.20E-05 *	500	3.42E-09	2.36E-08	1.71E-04
116.00	1.24	-12855	116.00	0.78	69220	1.17	4.94E-05 *	500	3.61E-09	2.36E-08	1.80E-04
121.01	1.28	-626	121.00	-4.47	65546	1.23	3.16E-06	120	2.86E-10	5.73E-09	1.43E-05
126.01	1.33	0	126.00	-4.42	267	-	1.28E-08	120	2.87E-10	5.73E-09	1.43E-05
131.01	1.36	0	131.00	-4.42	0	-	-	120	2.85E-10	5.71E-09	1.43E-05
136.01	1.39	0	136.01	-4.40	262	-	1.25E-08	60	2.85E-10	2.85E-09	1.42E-05
141.01	1.40	0	141.01	-4.36	0	-	-	60	2.86E-10	2.86E-09	1.43E-05
146.01	1.45	0	146.01	-4.31	0	-	-	120	2.87E-10	5.73E-09	1.43E-05
151.02	1.51	0	151.01	-4.27	0	-	-	120	2.85E-10	5.71E-09	1.43E-05
156.02	1.56	0	156.01	-4.25	480	-	2.27E-08	120	2.84E-10	5.68E-09	1.42E-05
161.02	1.60	2780	161.01	-4.22	28872	2.22	1.23E-06	120	2.83E-10	5.66E-09	1.42E-05
166.02	1.63	370	166.01	-4.18	9248	1.87	4.20E-07	30	2.84E-10	1.42E-09	1.42E-05
171.02	1.65	1007	171.01	-4.12	36897	1.82	1.71E-06	30	2.86E-10	1.43E-09	1.43E-05
176.02	1.68	0	176.01	-4.06	1468	-	7.00E-08	30	2.87E-10	1.44E-09	1.44E-05
181.03	1.72	156	181.01	-4.04	7355	1.84	3.44E-07	30	2.86E-10	1.43E-09	1.43E-05
186.03	1.77	0	186.02	-4.00	0	-	-	30	2.86E-10	1.43E-09	1.43E-05
191.03	1.80	0	191.02	-3.96	0	-	-	30	2.86E-10	1.43E-09	1.43E-05
196.03	1.84	0	196.02	-3.92	0	-	-	30	2.86E-10	1.43E-09	1.43E-05
201.04	1.88	0	201.02	-3.90	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
206.04	1.93	0	206.02	-3.86	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
211.04	2.00	0	211.02	-3.82	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
216.03	2.06	-166	216.03	-3.77	17401	2.00	8.30E-07	30	2.83E-10	1.42E-09	1.42E-05
221.03	2.09	0	221.03	-3.73	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
226.04	2.13	-22	226.04	-3.71	1941	2.07	9.25E-08	30	2.82E-10	1.41E-09	1.41E-05
231.04	2.17	0	231.04	-3.67	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
236.04	2.20	0	236.04	-3.61	0	-	-	30	2.84E-10	1.42E-09	1.42E-05

Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
241.04	2.23	0	241.04	-3.56	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
246.05	2.27	0	246.05	-3.54	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
251.05	2.30	0	251.05	-3.52	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
256.06	2.35	0	256.06	-3.48	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
261.06	2.41	0	261.06	-3.42	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
266.06	2.47	185	266.06	-3.37	2374	2.96	1.03E-07	30	2.82E-10	1.41E-09	1.41E-05
271.06	2.52	559	271.06	-3.36	12107	2.80	5.40E-07	30	2.81E-10	1.40E-09	1.40E-05
276.06	2.57	404	276.06	-3.33	14640	2.74	6.65E-07	30	2.80E-10	1.40E-09	1.40E-05
281.06	2.61	1056	281.06	-3.27	49928	2.73	2.29E-06	30	2.81E-10	1.40E-09	1.40E-05
286.06	2.64	586	286.06	-3.20	96951	2.68	4.54E-06	30	2.82E-10	1.41E-09	1.41E-05
291.05	2.68	367	291.05	-3.17	45088	2.72	2.10E-06	30	2.82E-10	1.41E-09	1.41E-05
296.05	2.73	231	296.05	-3.14	20784	2.79	9.65E-07	30	2.81E-10	1.41E-09	1.41E-05
301.05	2.78	71	301.05	-3.08	1511	3.07	6.75E-08	30	2.81E-10	1.41E-09	1.41E-05
306.05	2.83	0	306.05	-3.01	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
311.05	2.88	0	311.05	-2.96	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
316.05	2.94	0	316.06	-2.92	0	-	-	30	2.81E-10	1.41E-09	1.41E-05
321.06	3.01	0	321.06	-2.90	0	-	-	30	2.79E-10	1.40E-09	1.40E-05
326.06	3.04	0	326.06	-2.85	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
331.06	3.09	0	331.07	-2.78	0	-	-	30	2.81E-10	1.41E-09	1.41E-05
336.06	3.12	0	336.07	-2.74	0	-	-	30	2.81E-10	1.41E-09	1.41E-05
341.06	3.15	0	341.07	-2.71	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
346.06	3.22	0	346.08	-2.66	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
351.07	3.27	0	351.08	-2.59	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
356.07	3.29	0	356.08	-2.53	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
361.07	3.33	0	361.09	-2.51	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
366.07	3.39	0	366.09	-2.50	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
371.07	3.44	0	371.09	-2.44	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
376.08	3.48	0	376.10	-2.37	0	-	-	30	2.82E-10	1.41E-09	1.41E-05

Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
381.08	3.55	0	381.10	-2.33	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
386.08	3.61	0	386.11	-2.31	0	-	-	30	2.78E-10	1.39E-09	1.39E-05
391.08	3.66	0	391.11	-2.27	0	-	-	30	2.78E-10	1.39E-09	1.39E-05
396.08	3.71	0	396.11	-2.20	0	-	-	30	2.79E-10	1.39E-09	1.39E-05
401.09	3.76	0	401.12	-2.14	0	-	-	30	2.79E-10	1.40E-09	1.40E-05
406.09	3.80	0	406.12	-2.11	0	-	-	30	2.79E-10	1.39E-09	1.39E-05
411.09	3.84	0	411.12	-2.08	516	-	2.40E-08	30	2.79E-10	1.39E-09	1.39E-05
416.09	3.87	524	416.12	-2.02	26518	3.98	1.22E-06	30	2.80E-10	1.40E-09	1.40E-05
421.09	3.91	137	421.12	-1.95	3565	4.14	1.61E-07	30	2.82E-10	1.41E-09	1.41E-05
426.10	3.96	1584	426.12	-1.90	33756	4.25	1.51E-06	30	2.81E-10	1.41E-09	1.41E-05
431.10	3.99	0	431.12	-1.87	118	-	5.55E-09	30	2.81E-10	1.41E-09	1.41E-05
436.11	4.06	130	436.12	-1.80	4645	4.23	2.12E-07	30	2.82E-10	1.41E-09	1.41E-05
441.11	4.13	0	441.13	-1.73	110	-	5.15E-09	30	2.81E-10	1.41E-09	1.41E-05
446.12	4.16	0	446.13	-1.69	211	-	9.90E-09	30	2.82E-10	1.41E-09	1.41E-05
451.13	4.19	194	451.14	-1.67	3248	4.56	1.44E-07	30	2.82E-10	1.41E-09	1.41E-05
456.13	4.24	0	456.14	-1.64	164	-	7.65E-09	30	2.80E-10	1.40E-09	1.40E-05
461.13	4.29	16	461.13	-1.58	709	4.43	3.24E-08	30	2.81E-10	1.40E-09	1.40E-05
466.12	4.35	0	466.13	-1.51	82	-	3.83E-09	30	2.81E-10	1.41E-09	1.41E-05
471.12	4.41	0	471.12	-1.46	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
476.12	4.46	580	476.12	-1.42	10998	4.79	4.87E-07	30	2.80E-10	1.40E-09	1.40E-05
481.12	4.48	320	481.12	-1.37	5174	4.87	2.28E-07	30	2.82E-10	1.41E-09	1.41E-05
486.12	4.50	0	486.12	-1.31	378	-	1.79E-08	30	2.84E-10	1.42E-09	1.42E-05
491.13	4.54	0	491.13	-1.26	165	-	7.85E-09	30	2.84E-10	1.42E-09	1.42E-05
496.13	4.58	70	496.13	-1.23	1291	4.92	5.75E-08	30	2.83E-10	1.42E-09	1.42E-05
501.13	4.62	0	501.13	-1.19	100	-	4.72E-09	30	2.84E-10	1.42E-09	1.42E-05
506.13	4.67	66	506.13	-1.12	1008	5.07	4.47E-08	30	2.85E-10	1.42E-09	1.42E-05
511.13	4.73	3866	511.13	-1.05	103735	4.96	4.75E-06	30	2.85E-10	1.43E-09	1.43E-05
516.13	4.79	0	516.13	-1.00	0	-	-	30	2.85E-10	1.42E-09	1.42E-05

Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
521.13	4.83	0	521.14	-0.98	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
526.14	4.89	0	526.14	-0.93	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
531.14	4.94	0	531.14	-0.87	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
536.14	5.01	0	536.15	-0.82	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
541.14	5.08	0	541.15	-0.79	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
546.15	5.14	0	546.15	-0.74	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
551.15	5.17	0	551.16	-0.66	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
556.15	5.25	0	556.16	-0.59	14	-	6.55E-10	30	2.83E-10	1.41E-09	1.41E-05
561.15	5.31	0	561.16	-0.55	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
566.15	5.35	0	566.17	-0.52	0	-	-	30	2.81E-10	1.41E-09	1.41E-05
571.16	5.37	0	571.17	-0.46	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
576.16	5.40	0	576.17	-0.40	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
581.16	5.46	0	581.18	-0.33	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
586.16	5.50	0	586.18	-0.29	0	-	-	30	2.85E-10	1.43E-09	1.43E-05
591.16	5.53	0	591.18	-0.28	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
596.17	5.59	0	596.19	-0.18	0	-	-	30	2.86E-10	1.43E-09	1.43E-05
601.17	5.66	0	601.19	-0.13	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
606.17	5.69	0	606.19	-0.13	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
611.17	5.72	0	611.20	-0.11	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
616.18	5.79	0	616.21	-0.09	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
621.19	5.84	0	621.21	-0.03	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
626.20	5.89	0	626.22	0.05	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
631.20	5.94	0	631.23	0.06	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
636.21	6.02	0	636.23	0.11	0	-	-	30	2.79E-10	1.40E-09	1.40E-05
641.22	6.05	0	641.24	0.18	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
646.23	6.06	0	646.25	0.22	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
651.24	6.08	0	651.26	0.24	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
656.24	6.10	0	656.26	0.25	0	-	-	30	2.82E-10	1.41E-09	1.41E-05

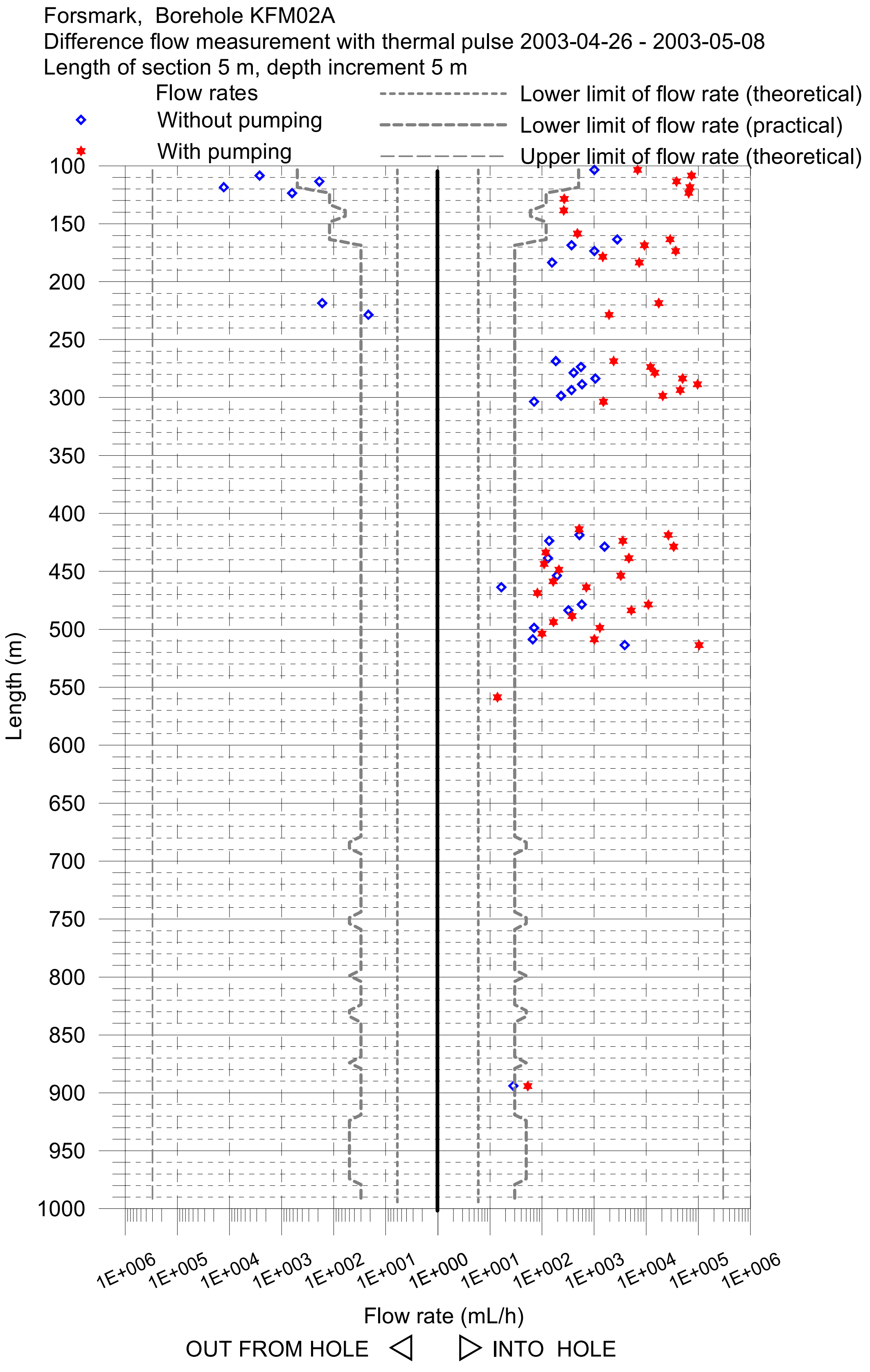
Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
661.25	6.12	0	661.27	0.31	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
666.26	6.17	0	666.28	0.37	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
671.27	6.20	0	671.28	0.40	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
676.28	6.25	0	676.29	0.41	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
681.29	6.31	0	681.30	0.44	0	-	-	50	2.81E-10	2.34E-09	1.40E-05
686.29	6.35	0	686.30	0.50	0	-	-	50	2.82E-10	2.35E-09	1.41E-05
691.30	6.40	0	691.31	0.56	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
696.31	6.44	0	696.32	0.60	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
701.32	6.46	0	701.32	0.63	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
706.33	6.50	0	706.33	0.69	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
711.34	6.55	0	711.34	0.75	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
716.35	6.57	0	716.35	0.76	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
721.36	6.60	0	721.36	0.77	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
726.37	6.64	0	726.37	0.83	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
731.38	6.67	0	731.38	0.89	0	-	-	30	2.85E-10	1.43E-09	1.43E-05
736.40	6.72	0	736.38	0.93	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
741.41	6.76	0	741.39	0.95	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
746.42	6.81	0	746.40	1.02	0	-	-	50	2.84E-10	2.37E-09	1.42E-05
751.43	6.86	0	751.41	1.09	0	-	-	50	2.86E-10	2.38E-09	1.43E-05
756.44	6.92	0	756.42	1.10	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
761.44	6.96	0	761.43	1.11	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
766.44	7.00	0	766.43	1.18	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
771.44	7.03	0	771.43	1.24	0	-	-	30	2.85E-10	1.43E-09	1.43E-05
776.44	7.07	0	776.43	1.28	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
781.44	7.13	0	781.43	1.32	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
786.43	7.19	0	786.44	1.41	0	-	-	30	2.85E-10	1.43E-09	1.43E-05
791.43	7.26	0	791.44	1.47	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
796.43	7.33	0	796.44	1.48	0	-	-	50	2.82E-10	2.35E-09	1.41E-05

Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
801.44	7.39	0	801.45	1.51	0	-	-	30	2.81E-10	1.40E-09	1.40E-05
806.44	7.42	0	806.45	1.59	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
811.45	7.44	0	811.46	1.62	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
816.45	7.46	0	816.47	1.62	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
821.46	7.49	0	821.47	1.70	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
826.46	7.54	0	826.48	1.79	0	-	-	50	2.86E-10	2.39E-09	1.43E-05
831.47	7.60	0	831.49	1.80	0	-	-	50	2.84E-10	2.37E-09	1.42E-05
836.47	7.66	0	836.50	1.83	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
841.48	7.71	0	841.50	1.91	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
846.49	7.78	0	846.51	1.93	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
851.49	7.83	0	851.52	1.94	0	-	-	30	2.80E-10	1.40E-09	1.40E-05
856.50	7.88	0	856.52	2.04	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
861.50	7.92	0	861.53	2.09	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
866.51	7.94	0	866.54	2.10	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
871.52	7.96	0	871.55	2.17	0	-	-	50	2.85E-10	2.37E-09	1.42E-05
876.53	8.00	0	876.56	2.24	0	-	-	30	2.86E-10	1.43E-09	1.43E-05
881.54	8.04	0	881.58	2.24	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
886.55	8.09	0	886.60	2.30	0	-	-	30	2.85E-10	1.42E-09	1.42E-05
891.57	8.14	28	891.61	2.37	53	14.66	1.19E-09	30	2.85E-10	1.43E-09	1.43E-05
896.57	8.21	0	896.62	2.38	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
901.57	8.27	0	901.62	2.43	0	-	-	30	2.82E-10	1.41E-09	1.41E-05
906.58	8.33	0	906.62	2.52	0	-	-	30	2.84E-10	1.42E-09	1.42E-05
911.58	8.39	0	911.62	2.56	0	-	-	30	2.83E-10	1.41E-09	1.41E-05
916.58	8.42	0	916.62	2.60	0	-	-	30	2.83E-10	1.42E-09	1.42E-05
921.58	8.44	0	921.62	2.69	0	-	-	50	2.87E-10	2.39E-09	1.43E-05
926.58	8.48	0	926.62	2.72	0	-	-	50	2.86E-10	2.39E-09	1.43E-05
931.58	8.51	0	931.62	2.76	0	-	-	50	2.87E-10	2.39E-09	1.43E-05
936.59	8.56	0	936.62	2.84	0	-	-	50	2.88E-10	2.40E-09	1.44E-05

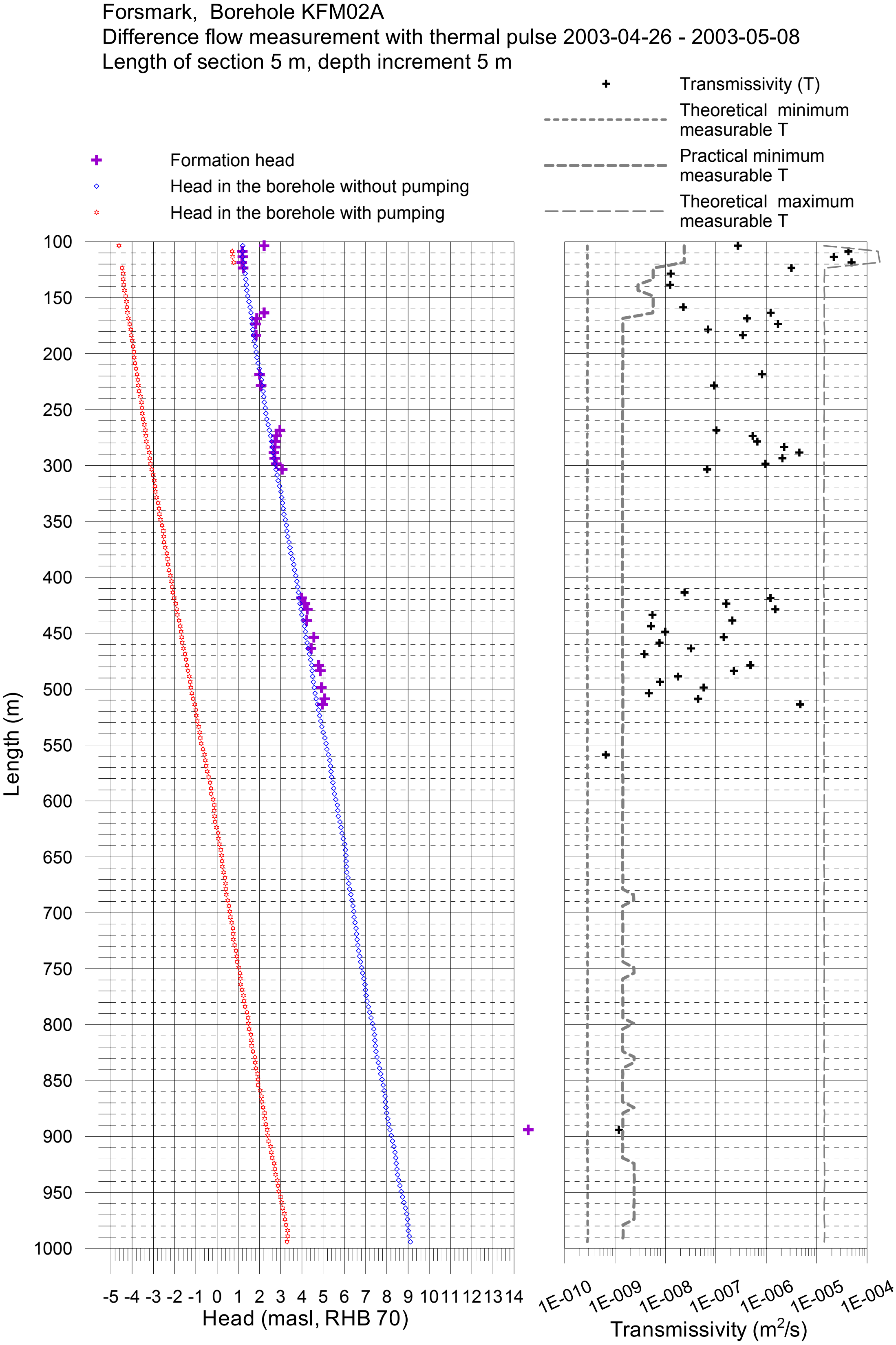
Appendix 5.7

Secup1 (m)	Borehole Head1 (masl)	Flow1 (mL/h)	Secup2 (m)	Borehole Head2 (masl)	Flow2 (mL/h)	Section Head (masl)	T_s (m^2/s)	Q-lower limit Practical (mL/h)	T_s-Lower Limit Theoretical (m^2/s)	T_s-Lower Limit Practical (m^2/s)	T_s-Upper Limit (m^2/s)
941.59	8.62	0	941.62	2.87	0	-	-	50	2.87E-10	2.39E-09	1.43E-05
946.59	8.68	0	946.63	2.90	0	-	-	50	2.85E-10	2.38E-09	1.43E-05
951.59	8.74	0	951.63	2.99	0	-	-	50	2.87E-10	2.39E-09	1.43E-05
956.59	8.81	0	956.63	3.04	0	-	-	50	2.86E-10	2.38E-09	1.43E-05
961.60	8.88	0	961.63	3.08	0	-	-	50	2.85E-10	2.37E-09	1.42E-05
966.60	8.94	0	966.63	3.17	0	-	-	50	2.86E-10	2.38E-09	1.43E-05
971.60	8.97	0	971.63	3.20	0	-	-	50	2.85E-10	2.38E-09	1.43E-05
976.60	8.99	0	976.63	3.25	0	-	-	30	2.87E-10	1.43E-09	1.43E-05
981.61	9.01	0	981.64	3.32	0	-	-	30	2.90E-10	1.45E-09	1.45E-05
986.62	9.06	0	986.64	3.33	0	-	-	30	2.88E-10	1.44E-09	1.44E-05
991.63	9.11	0	991.65	3.30	0	-	-	30	2.84E-10	1.42E-09	1.42E-05

* Drawdown = 0.5 m result was used for calculations


Forsmark, Borehole KFM02A
Difference flow measurement with thermal pulse 2003-04-26 - 2003-05-08
Length of section 5 m, depth increment 5 m
Flow rates
Without pumping
With pumping
Lower limit of flow rate (theoretical)
Lower limit of flow rate (practical)
Upper limit of flow rate (theoretical)
Length (m)
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1E+006
1E+005
1E+004
1E+003
1E+002
1E+001
1E+000
1E+001
1E+002
1E+003
1E+004
1E+005
1E+006
Flow rate (mL/h)
OUT FROM HOLE
INTO HOLE

Appendix 6.2


Forsmark, Borehole KFM02A
Difference flow measurement with thermal pulse 2003-04-26 - 2003-05-08
Length of section 5 m, depth increment 5 m
Formation head
Head in the borehole without pumping
Head in the borehole with pumping
Transmissivity (T)
Theoretical minimum measurable T
Practical minimum measurable T
Theoretical maximum measurable T
Length (m)
Head (masl, RHB 70)
Transmissivity (m²/s)
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
1E-010 1E-009 1E-008 1E-007 1E-006 1E-005 1E-004

Appendix 7.1

Length to fracture (m)	Borehole head1 (masl)	Flow1 (mL/h)	Borehole head2 (masl)	Flow2 (mL/h)	T_f (m^2/s)	Fracture head (masl)
101.8	1.23	0	-4.64	700	3.28E-08 **	
110.1	1.21	0	0.68	1130	5.86E-07 *	
110.7	1.21	-2660	0.71	73120	4.21E-05 *	1.19
111.1	1.20	0	0.72	3700	2.10E-06 *	
112.9	1.20	0	0.73	8550	4.99E-06 *	
114.2	1.20	0	0.74	25850	1.53E-05 *	
115.6	1.21	0	0.75	195	1.15E-07 *	
116.6	1.22	0	0.76	6850	4.08E-06 *	
117.5	1.23	0	0.76	6500	3.82E-06 */**	
118.3	1.24	0	0.77	20000	1.17E-05 */**	
118.9	1.25	0	0.79	8000	4.84E-06 *	
119.1	1.24	0	0.78	2700	1.60E-06 */**	
120.5	1.26	0	0.81	5200	3.15E-06 *	
120.9	1.26	0	0.81	20000	1.22E-05 *	
121.2	1.26	0	0.82	1300	8.04E-07 */**	
122.3	1.27	0	0.84	200	1.27E-07 *	
124.9	1.30	0	-4.49	320	1.52E-08	
126.0	1.31	0	-4.49	90	4.26E-09 **	
129.7	1.35	0	-4.47	220	1.04E-08	
137.0	1.38	0	-4.45	200	9.42E-09 **	
160.7	1.58	0	-4.26	440	2.07E-08	
161.7	1.60	0	-4.24	1210	5.69E-08	
162.5	1.60	2700	-4.24	18200	7.30E-07	2.61
163.0	1.59	0	-4.22	3300	1.56E-07	
163.5	1.59	0	-4.21	460	2.18E-08 **	
165.0	1.62	0	-4.20	1790	8.46E-08	
166.8	1.64	0	-4.19	3180	1.50E-07	
167.4	1.64	0	-4.17	310	1.47E-08	
167.8	1.63	0	-4.17	60	2.84E-09	
169.4	1.63	0	-4.17	205	9.71E-09	
170.0	1.63	0	-4.15	3860	1.83E-07	
171.5	1.66	1000	-4.15	28700	1.31E-06	1.87
171.9	1.66	0	-4.14	3900	1.85E-07	
172.6	1.66	0	-4.15	920	4.36E-08	
174.4	1.66	0	-4.14	1600	7.58E-08	
174.9	1.67	0	-4.15	65	3.07E-09 **	
178.5	1.68	0	-4.12	315	1.49E-08	
179.4	1.68	0	-4.12	980	4.64E-08	
182.6	1.70	0	-4.08	2180	1.04E-07	
183.2	1.71	0	-4.07	4000	1.90E-07 **	
183.5	1.71	0	-4.06	1300	6.19E-08	
217.0	2.05	0	-3.81	14450	6.77E-07	
219.2	2.06	0	-3.82	360	1.68E-08	
227.8	2.14	-21	-3.71	1780	8.46E-08	2.07
266.6	2.47	185	-3.37	2210	9.53E-08	3.00

Appendix 7.2

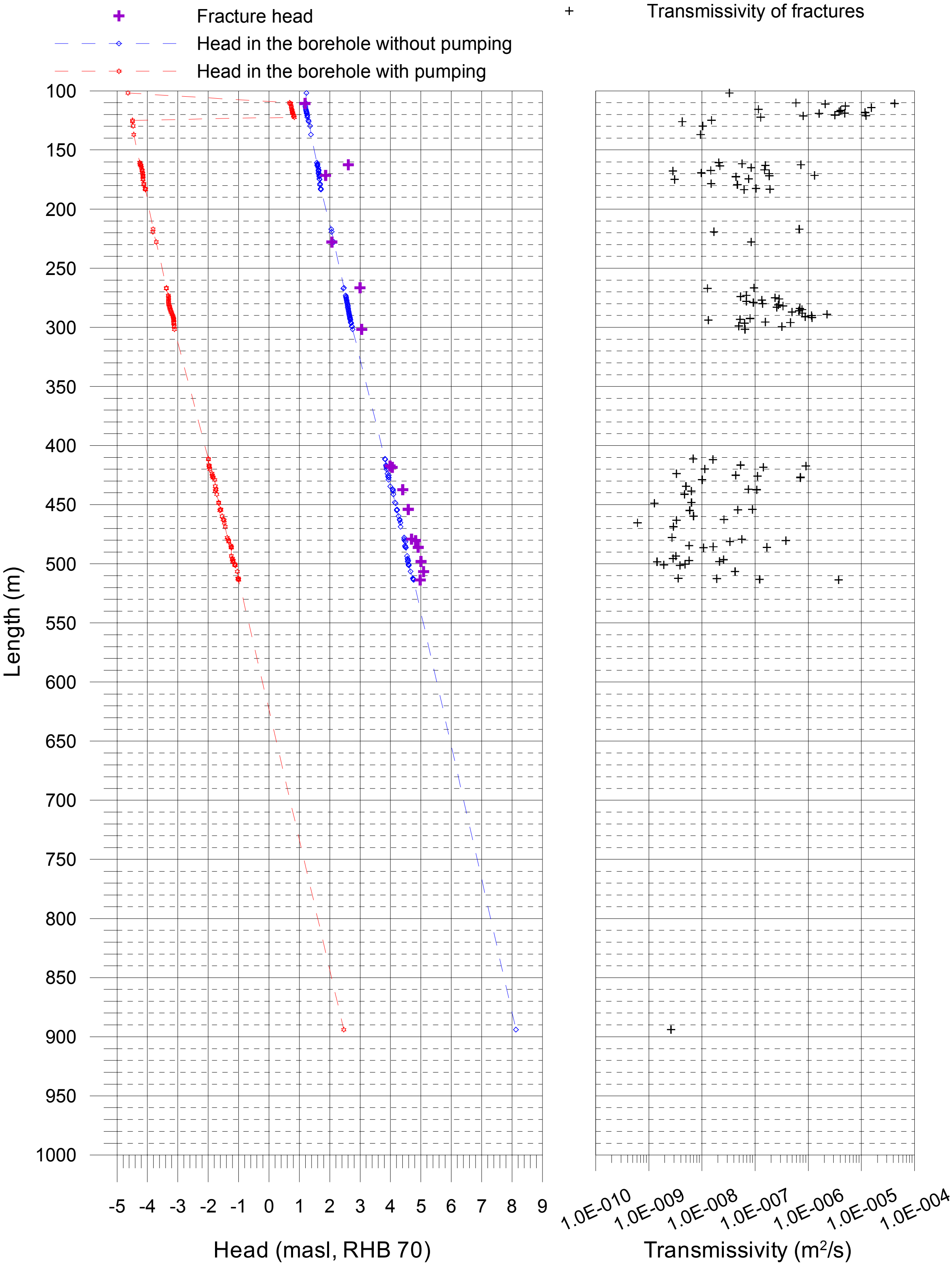
Length to fracture (m)	Borehole head1 (masl)	Flow1 (mL/h)	Borehole head2 (masl)	Flow2 (mL/h)	T_f (m^2/s)	Fracture head (masl)
267.1	2.45	0	-3.38	270	1.27E-08 **	
273.0	2.52	0	-3.31	1460	6.87E-08 ***	
274.0	2.53	0	-3.31	1130	5.32E-08 ***	
275.0	2.54	0	-3.30	5030	2.37E-07 ***	
276.0	2.54	0	-3.31	6000	2.82E-07 ***	
277.0	2.56	0	-3.31	2850	1.34E-07 ***	
278.0	2.56	0	-3.31	1460	6.83E-08 ***	
279.0	2.57	0	-3.31	1980	9.26E-08 ***	
280.0	2.58	0	-3.30	2960	1.38E-07 ***	
281.0	2.59	0	-3.30	5850	2.73E-07 ***	
282.0	2.60	0	-3.28	7160	3.35E-07 ***	
283.0	2.60	0	-3.27	5460	2.56E-07 ***	
284.0	2.61	0	-3.26	14800	6.93E-07 ***	
285.0	2.61	0	-3.24	16260	7.64E-07 ***	
286.0	2.62	0	-3.24	14260	6.69E-07 ***	
287.0	2.63	0	-3.22	10560	4.96E-07 ***	
288.0	2.63	0	-3.20	16280	7.67E-07 ***	
289.0	2.64	0	-3.19	47620	2.25E-06 ***	
290.0	2.65	0	-3.17	24390	1.15E-06 ***	
291.0	2.66	0	-3.16	18490	8.74E-07 ***	
291.8	2.67	0	-3.15	24800	1.17E-06	
292.5	2.67	0	-3.14	1700	8.04E-08 **	
293.2	2.67	0	-3.14	1100	5.20E-08	
293.9	2.68	0	-3.14	280	1.32E-08 **	
295.5	2.69	0	-3.13	3300	1.56E-07	
296.0	2.70	0	-3.13	9800	4.62E-07	
296.5	2.71	0	-3.14	1350	6.34E-08 **	
298.9	2.72	0	-3.12	1050	4.94E-08 **	
299.4	2.74	0	-3.12	6800	3.19E-07	
301.7	2.75	70	-3.11	1450	6.46E-08	3.05
411.2	3.82	0	-2.00	145	6.85E-09	
411.8	3.83	0	-1.99	340	1.61E-08	
416.5	3.85	0	-1.98	1130	5.32E-08	
417.3	3.86	420	-1.96	19500	9.01E-07	3.99
418.4	3.87	100	-1.97	3140	1.43E-07	4.06
419.9	3.87	0	-1.95	240	1.13E-08	
423.7	3.90	0	-1.88	70	3.33E-09 **	
425.1	3.94	0	-1.86	910	4.31E-08	
425.9	3.92	0	-1.87	2340	1.11E-07	
426.8	3.93	0	-1.83	15000	7.15E-07	
427.2	3.94	0	-1.84	15000	7.13E-07	
428.9	3.94	0	-1.78	210	1.01E-08	
434.4	3.99	0	-1.77	105	5.01E-09	
437.0	4.07	0	-1.74	1580	7.47E-08	
437.3	4.08	125	-1.75	2400	1.07E-07 **	4.40
438.5	4.09	0	-1.77	135	6.34E-09	
441.2	4.10	0	-1.72	100	4.73E-09	

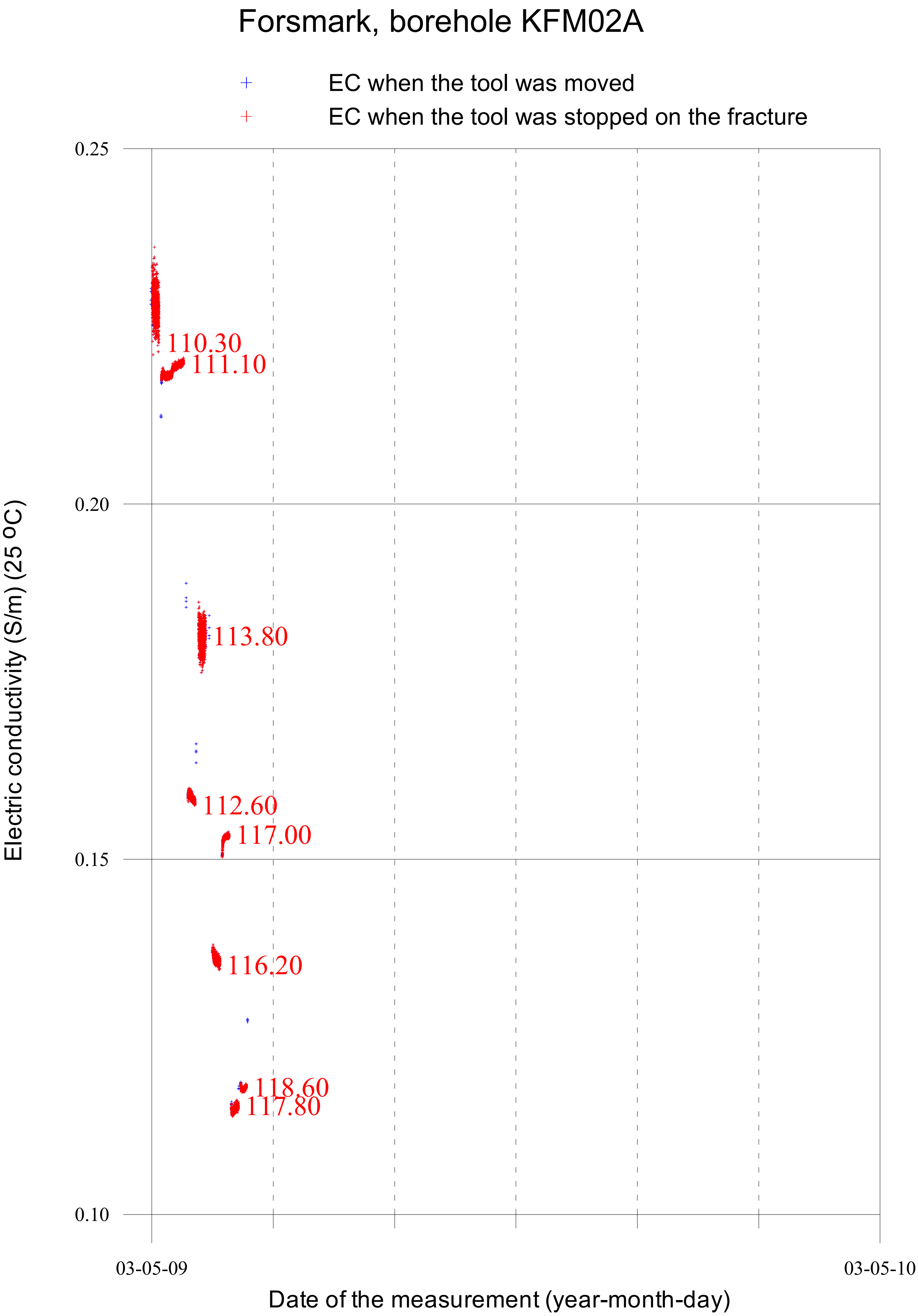
Appendix 7.3

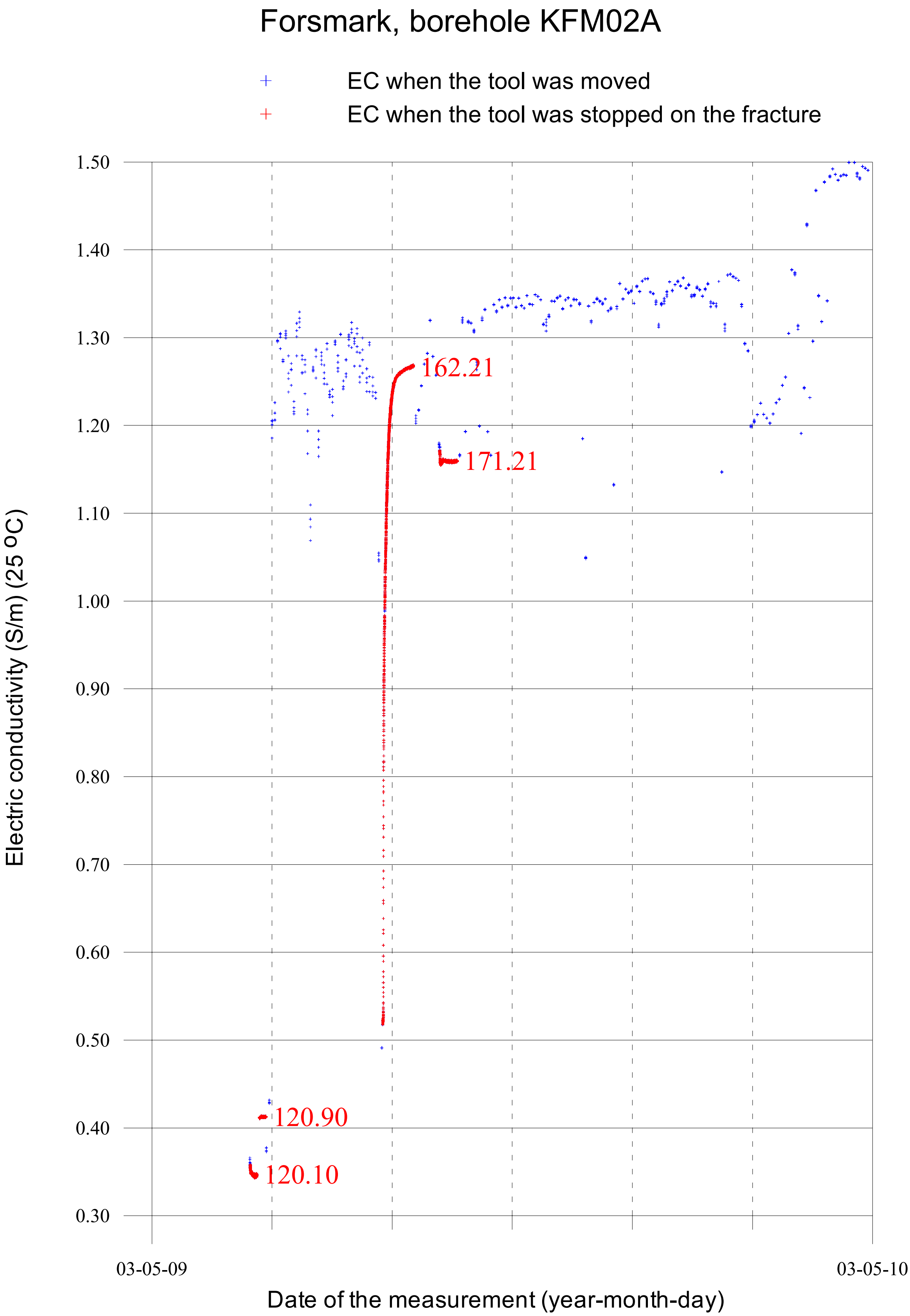
Length to fracture (m)	Borehole head1 (masl)	Flow1 (mL/h)	Borehole head2 (masl)	Flow2 (mL/h)	T_f (m^2/s)	Fracture head (masl)
448.1	4.15	0	-1.66	134	6.35E-09	
448.8	4.17	0	-1.65	27	1.27E-09 **	
454.0	4.21	120	-1.60	2000	8.89E-08	4.58
454.4	4.22	0	-1.58	1000	4.74E-08	
454.9	4.21	0	-1.62	125	5.89E-09	
459.7	4.27	0	-1.54	147	6.95E-09	
462.5	4.30	0	-1.51	550	2.60E-08	
463.2	4.30	0	-1.47	70	3.33E-09	
465.3	4.33	0	-1.47	13	6.16E-10 **	
468.6	4.33	0	-1.44	61	2.90E-09	
477.8	4.45	0	-1.38	58	2.74E-09	
479.2	4.45	50	-1.35	1240	5.64E-08	4.69
480.4	4.46	500	-1.33	8500	3.79E-07	4.83
481.2	4.49	0	-1.32	710	3.35E-08	
484.6	4.48	0	-1.26	120	5.75E-09	
485.6	4.48	0	-1.24	340	1.63E-08 **	
486.1	4.50	250	-1.25	3740	1.67E-07	4.91
486.4	4.51	0	-1.23	225	1.08E-08 **	
493.4	4.55	0	-1.24	68	3.23E-09	
495.5	4.56	0	-1.20	60	2.86E-09	
496.5	4.57	0	-1.21	535	2.55E-08	
497.3	4.59	0	-1.18	120	5.72E-09 **	
498.1	4.57	34	-1.18	480	2.13E-08	5.01
498.3	4.57	0	-1.19	30	1.43E-09 **	
500.3	4.59	0	-1.13	100	4.81E-09	
500.9	4.60	0	-1.13	40	1.92E-09 **	
501.4	4.60	0	-1.10	80	3.85E-09	
506.5	4.66	66	-1.04	940	4.21E-08	5.09
512.3	4.74	0	-1.01	75	3.59E-09	
512.6	4.75	0	-1.03	400	1.90E-08	
513.1	4.75	0	-1.00	2550	1.22E-07	
513.6	4.76	3000	-1.00	81100	3.73E-06	4.98
894.0	8.13	0	2.46	54	2.62E-09 **	

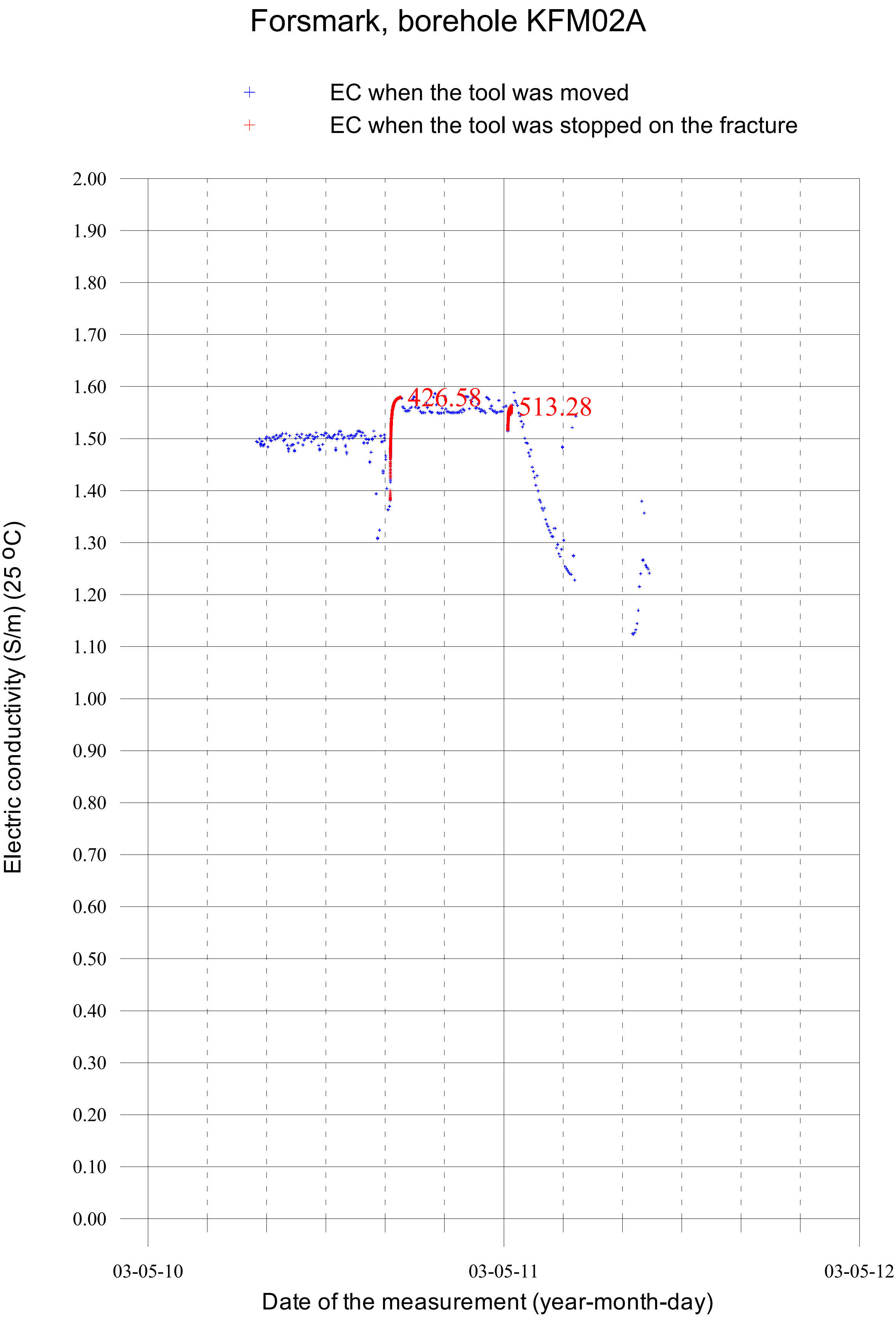
* Drawdown = 0.5 m result was used for calculations
** Uncertain
*** Porous rock

Forsmark, Borehole KFM02A
Difference flow measurement
Fracture specific results

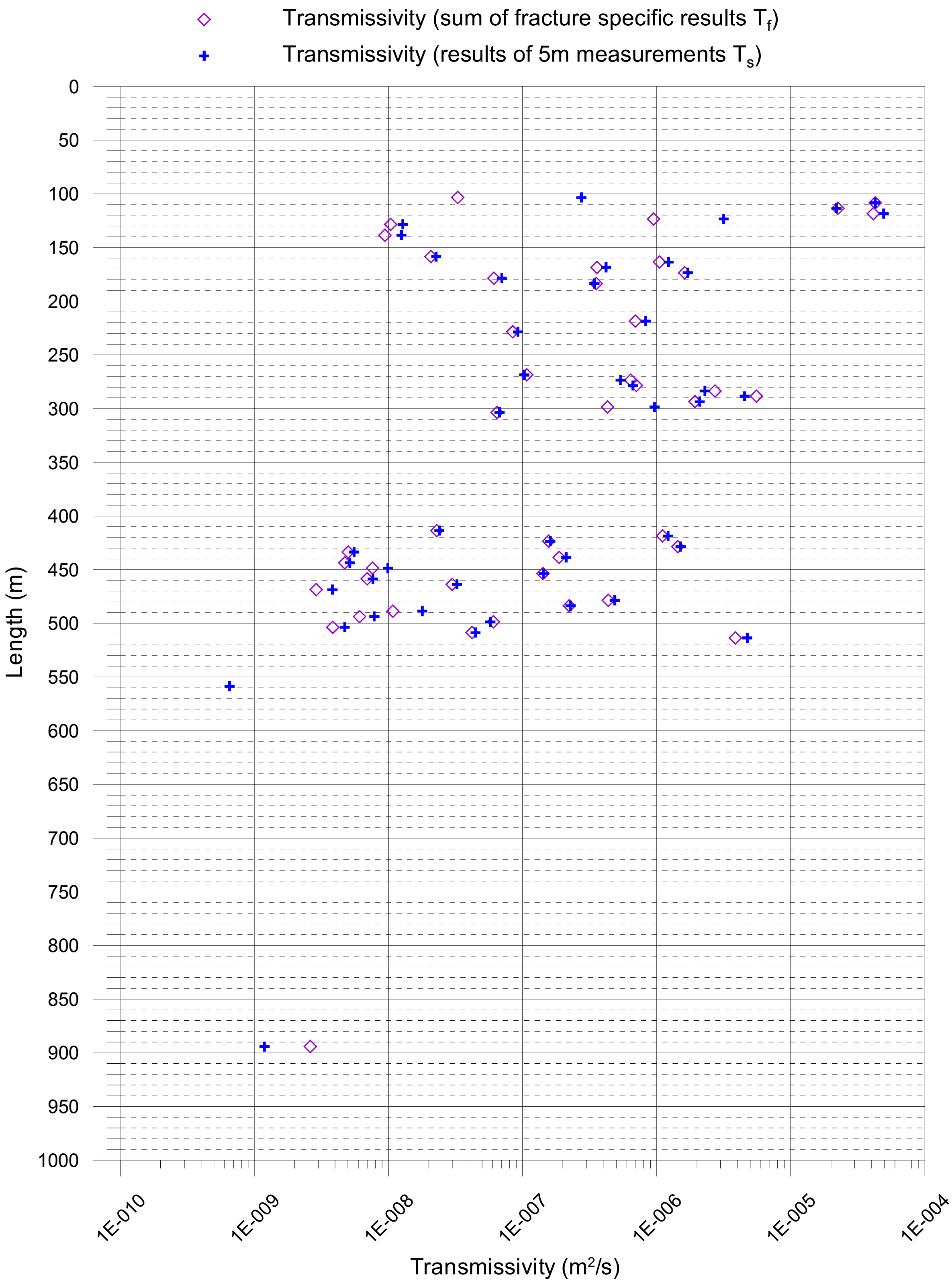


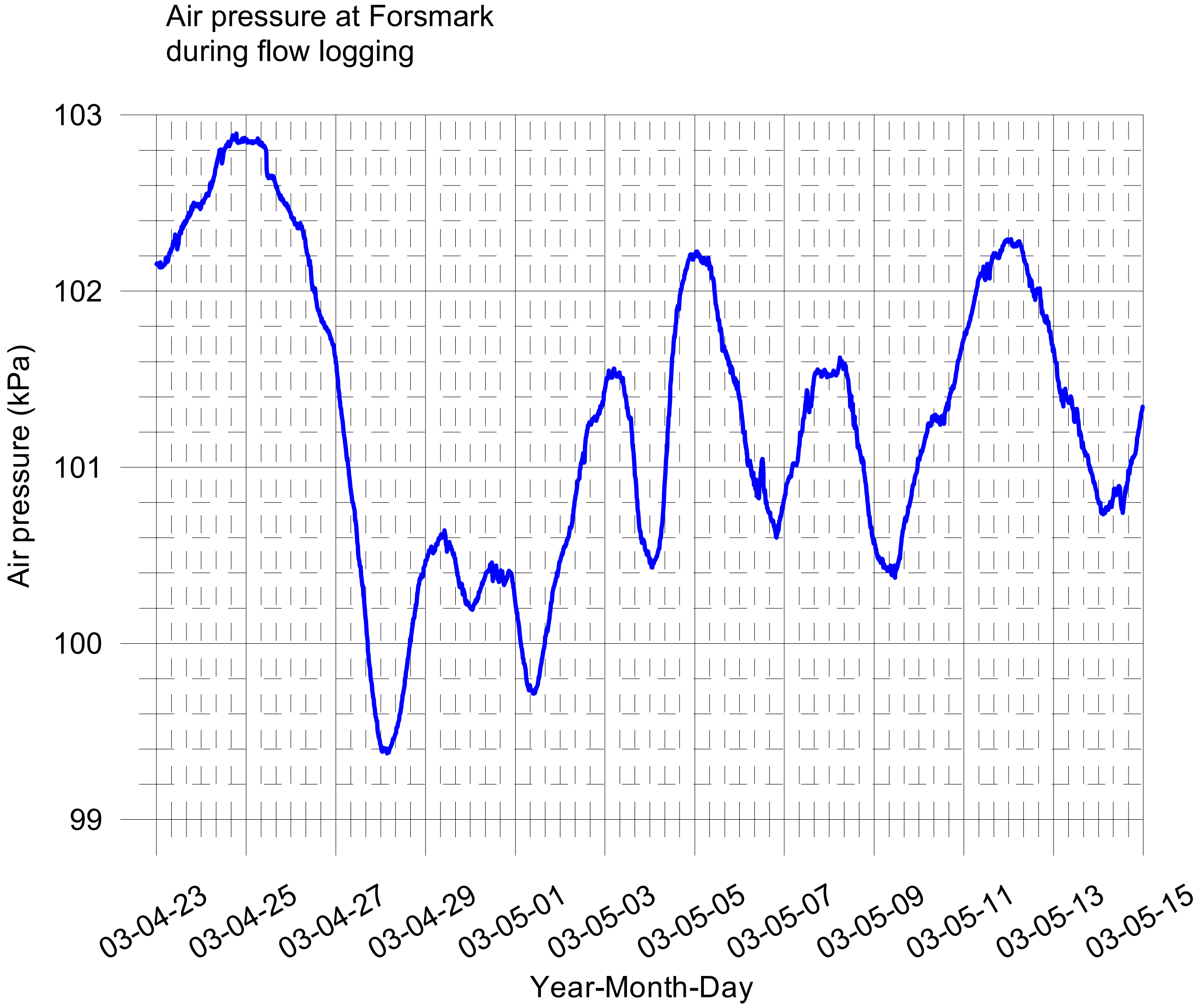

Forsmark, borehole KFM02A
EC when the tool was moved
EC when the tool was stopped on the fracture
0.25
0.20
0.15
0.10
Electric conductivity (S/m) (25 oC)
110.30
111.10
113.80
112.60
117.00
116.20
118.60
117.80
03-05-09
03-05-10
Date of the measurement (year-month-day)


Forsmark, borehole KFM02A
EC when the tool was moved
EC when the tool was stopped on the fracture
Electric conductivity (S/m) (25 oC)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
162.21
171.21
120.90
120.10
03-05-09
03-05-10
Date of the measurement (year-month-day)

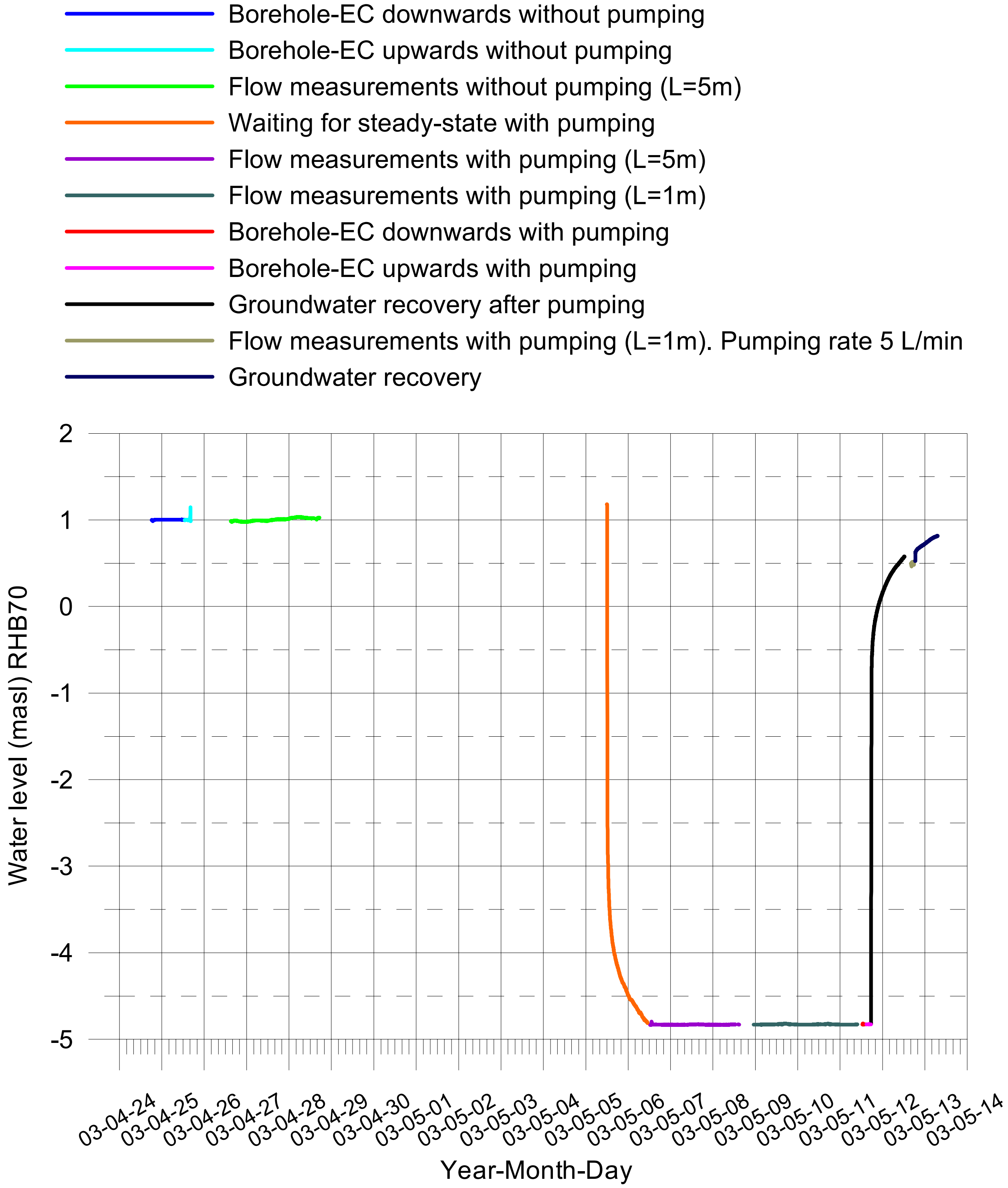

Forsmark, borehole KFM02A
EC when the tool was moved
EC when the tool was stopped on the fracture
426.58
513.28
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Electric conductivity (S/m) (25 °C)
03-05-10
03-05-11
03-05-12
Date of the measurement (year-month-day)

Forsmark, Borehole KFM02A
Comparison of transmissivity of borehole sections (5m) and fracture transmissivities



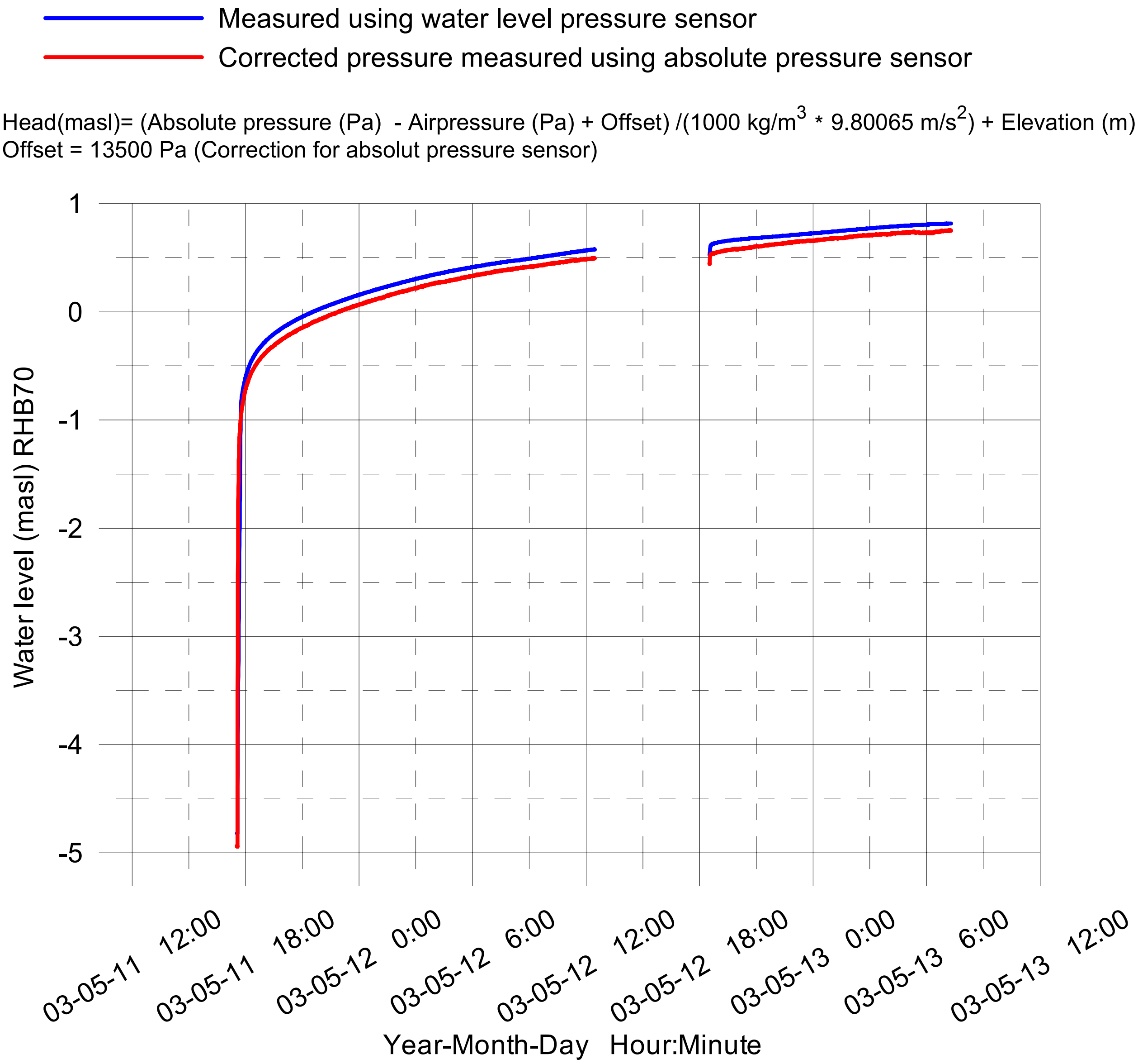

Air pressure at Forsmark
during flow logging
103
102
101
100
99
Air pressure (kPa)
03-04-23
03-04-25
03-04-27
03-04-29
03-05-01
03-05-03
03-05-05
03-05-07
03-05-09
03-05-11
03-05-13
03-05-15
Year-Month-Day

Water level during difference flow measurements
Borehole KFM02A, Forsmark

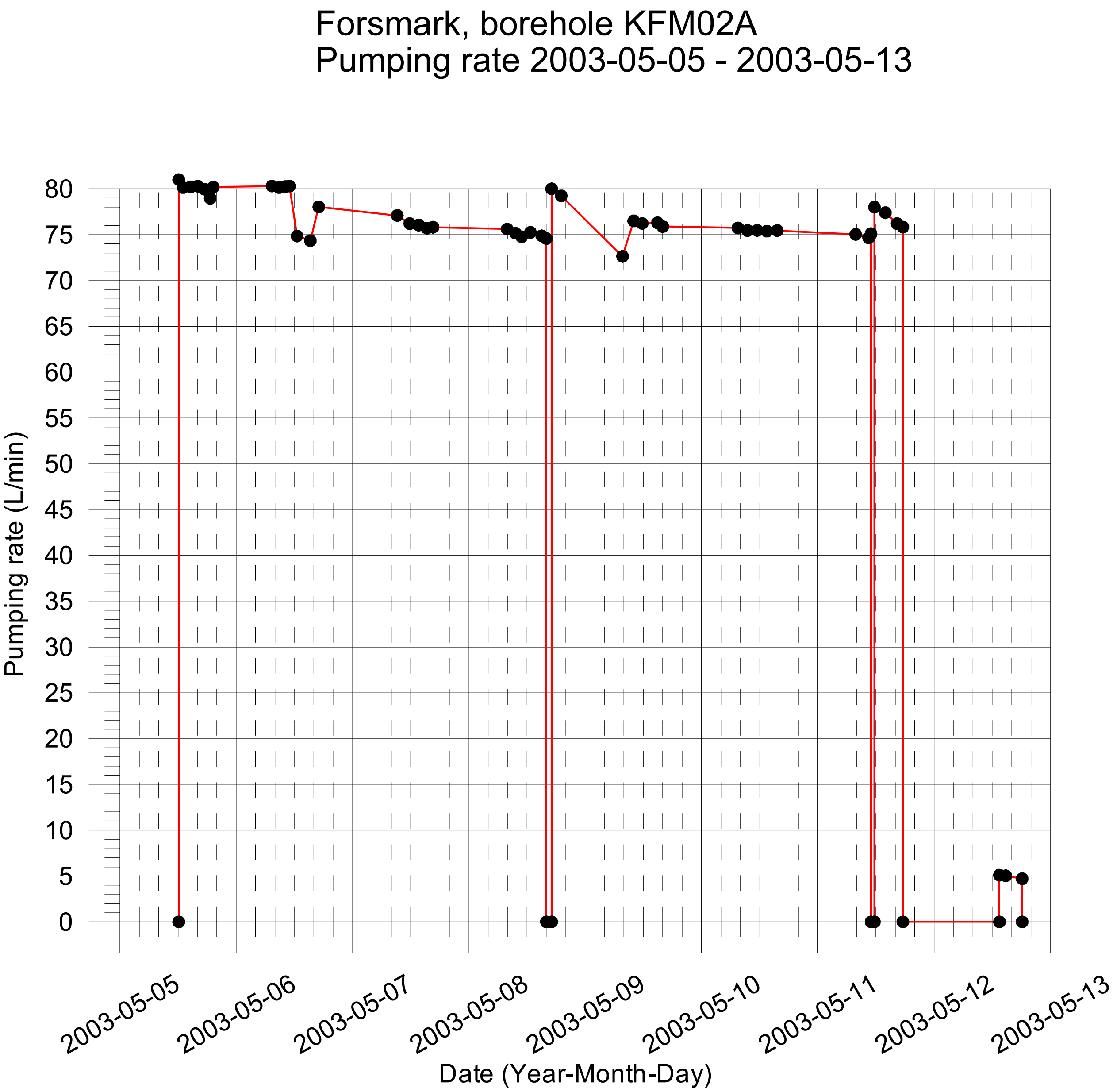


Appendix 10.3

Groundwater recovery after pumping



Appendix 10.4



Appendix 11

Evaluation of pumping test during difference flow logging in borehole KFM02A

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Geosigma AB

June 2004

Keywords: Forsmark, hydrogeology, pumping test, hydraulic parameters, transmissivity, hydraulic conductivity, AP PF 400-02-40

Abstract

The changes of the groundwater level in the borehole during the c. 6 days long open-hole pumping test during the difference flow logging in borehole KFM02A was used to calculate the total transmissivity of the borehole and to study possible effects of outer hydraulic boundaries. The pumping started as a constant flow rate test during c. 1 day but transited then to a constant drawdown test. After stop of pumping, the recovery of the groundwater level in the borehole was recorded during c. 1 day. Both the flow- and the recovery period were evaluated by transient methods.

The water level in the borehole was recorded during both the flow- and recovery period by a superficial pressure sensor. In addition, the recovery of the water level was, in this case, also recorded by an absolute pressure sensor, located at about the same depth in the borehole as the superficial sensor. The data sampling of both sensors was frequent enough to permit transient analysis. During the flow period, the flow rate was measured manually.

The transmissivity of the borehole was calculated both from the pressure drawdown response during the first part of the flow period with nearly constant flow rate and from the recovery period. From the flow period, the total transmissivity of the cored borehole (interval c. 100-1000 m) was calculated to c. $2.3 \cdot 10^{-4}$ m^2/s.

No significant effects of outer hydraulic boundaries, e.g. no-flow boundaries, were observed during the relatively long flow period. This fact may indicate that the assumed fracture zone at c. 110-120 m in KFM02A, identified from the difference flow logging, is extensive in the lateral direction.

During the shorter recovery period, slightly different transmissivities were calculated at intermediate and late times ($T=3.6 \cdot 10^{-4}$ m^2/s and $2.5 \cdot 10^{-4}$ m^2/s, respectively).

The results of the pumping test are consistent with the results of the difference flow logging in borehole KFM02A.

Sammanfattning

Ändringarna av grundvattennivån i borrhålet under den c:a 6 dygn långa pumptesten i öppet hål under differensflödesloggningen i borrhål KFM02A användes för att beräkna borrhålets totala transmissivitet och studera förekomsten av eventuella hydrauliska gränser. Pumpningen startade som en konstant flödestest under c: a 1 dygn men övergick sedan i en konstant avsänkningstest. Efter avslutad pumpning registrerades återhämtningen av grundvattennivån i borrhålet under c:a 1 dygn. Såväl flödes- som återhämtningsperioden utvärderades med transienta metoder.

Vattennivån i borrhålet registrerades under såväl flödes- som återhämtningsperioden med en ytligt belägen tryckgivare. Dessutom registrerades återhämtningen av vattennivån i detta fall med en absoluttryckgivare, belägen på ungefär samma djup i borrhålet som den ytliga tryckgivaren. Mätfrekvensen för båda givarna var tillräckligt hög för att tillåta transient analys. Under flödesperioden mättes flödet manuellt.

Borrhålets transmissivitet beräknades dels från den första delen av avsänkningsförloppet med nästan konstant flöde och dels från återhämtningsperioden. Från flödesperioden beräknades kärnborrhålets (intervallet c:a 100-1000 m) totala transmissivitet till $2.3 \cdot 10^{-4}$ m^2/s.

Inga tydliga effekter av yttre hydrauliska gränser, t ex negativa gränser, observerades under den relativt långa flödesperioden. Detta kan tyda på att den förmodade sprickzonen på c:a 110-120 m i KFM02A, identifierad från differensflödesloggningen, har stor utbredning i lateral riktning.

Under den kortare återhämtningsperioden beräknades något olika transmissiviteter för intermediär och lång tid ($T=3.6 \cdot 10^{-4}$ m^2/s respektive $2.5 \cdot 10^{-4}$ m^2/s).

Resultaten från pumptesten är samstämmiga med resultaten från differensflödes-loggningen i KFM02A.

Contents

1 Introduction

The groundwater level in the open borehole was registered by a superficial pressure sensor during both the flow- and recovery period of the pumping test in conjunction with difference flow logging in borehole KFM02A. In addition, the water level was registered by a new high-resolution absolute pressure sensor as described in the Activity Plan AP PF 400-02-40 (SKB internal controlling document). In this case, the latter sensor was located at about the same depth as the water level sensor. Manual readings of the flow rate were made during the flow period.

2 Objective

The main purposes of the analysis of the pumping test during difference flow logging in borehole KFM02A were to estimate the total transmissivity of the entire cored borehole (c. 100-1000 m) and to deduce information on possible hydraulic outer hydraulic boundaries during the test. The calculated value on the total borehole transmissivity should be compared with the estimated cumulative transmissivity of the measured sections and flow anomalies in the corresponding borehole interval from the difference flow logging in KFM02A.

3 Scope

3.1 Borehole

The main technical data for borehole KFM02A are shown in Table 3-1. More detailed data are available from SICADA. The reference point in the borehole is top of casing (ToC). The reference coordinate system for the X-Y-coordinates is RT90 and RHB70 for the elevation data. The starting point coordinates (at ToC) of the borehole are:

Northing (m): 6698712.501 RT90 2,5 gon V 0:-15

Easting (m): 1633182.863 RT90 2,5 gon V 0:-15

Table 3-1. Main technical data of cored borehole KFM02A. (From SICADA).

Borehole KFM02A							
ID	**Elevation of top of casing (ToC) (m.a.s.l.)**	**Borehole interval from ToC (m)**	**Casing/ Bh-diam. (m)**	**Inclination- top of bh (from horizontal plane) (°)**	**Dip-direction- top of borehole (from local N) (°)**	**Remarks**	**Drilling finished Date (YYYY-MM-DD)**
KFM02A	7.353	0.0-100.140	0.200	-85.385	275.764	Casing ID	
”		102.000-1002.440	0.077			Open hole	2003-03-12

3.2 Tests performed

The registration of the groundwater level and flow rate during the pumping test in conjunction with the difference flow logging in borehole KFM02A was performed according to the Activity Plan, c.f. above and the Methodology description for difference flow logging (SKB MD 322.010, Version 1.0, SKB internal controlling document). Pertinent data of the pumping test are shown in Table 3-2.

Table 3-2. Pertinent data of the pumping test with constant drawdown during difference flow logging in borehole KFM02A.

Pumping Bh ID	Pumped section (open hole) (m)	Test type[1]	Test no	Test start date and time (YYYY-MM-DD tt:mm:ss)	Test stop date and time (YYYY-MM-DD tt:mm:ss)
KFM02A	102.00-1002.44	1B	1	2003-05-05 12:09:00	2003-05-12 12:27:40

1) 1B: Pumping test with submersible pump with subsequent recovery

3.3 Equipment check

An equipment check was performed at the site as a simple and fast test to establish the operating status of sensors and other equipment. In addition, calibration constants were implemented and checked.

4 Equipment

4.1 Description of equipment

The pumping test was carried out with the standard equipment in the Posiva difference flow logging system including the following parts:

- submersible pump and hose to the ground surface
- winch and steel wire
- flow rate control valve at the surface
- vessel in the borehole to maintain a constant water level
- superficial pressure transducer
- data logger
- logging computer

In addition, for the difference flow logging campaign in borehole KFM02A, a high-resolution pressure sensor was implemented in the logging system, c.f. the Methodology description for difference flow logging described above. For the pumping test in KFM02A, the latter sensor was used to measure the recovery of the groundwater level in the borehole. Finally, a pressure sensor for registration of the barometric pressure was used.

4.2 Sensors

Technical specifications of the sensor for barometric pressure and the superficial-and high resolution pressure transducers (P1 and P_{abs}, respectively) used for registration of the groundwater level in the borehole during the pumping test in conjunction with the difference flow logging are listed in Table 4-1, c.f. Chapter 4 in the main report.

Table 4-1. Technical specification of the pressure sensors used for registration of the barometric pressure and the groundwater level in borehole KFM02A. FS=Full Scale.

Technical specification of pressure sensors*				
Sensor	**Parameter**	**Unit**	**Value/range**	**Comments**
Barometric pressure	Output signal Meas. Range Resolution Accuracy	VDC kPa kPa kPa	0 – 5 80-106 0.01 ±0.03	 at +20 °C
Superficial pressure P1 (groundwater level)	Output signal Meas. Range Resolution Accuracy	mA kPa kPa kPa	4 – 20 0 – 100 0.1 ±1% of FS	
Absolute Pressure P_{abs}	Output signal Meas. Range Resolution Accuracy	digital kPa kPa kPa	 0 – 20000 0.0001 % of FS ±0.01% of FS	

* according to the manufacturers

Table 4-2 illustrates the position of the pressure sensors and other borehole equipment during the pumping test. The position of the pressure sensors (P1 and P_{abs}) together with the (lower) level of the submersible pump (Pump) is shown. Positions are given in borehole length from top of casing (ToC). Equipment affecting wellbore storage is given in terms of diameter of the submerged parts. The volume of the submerged pump (~a few dm^3) is in most cases of minor importance regarding wellbore storage.

Table 4-2. Position along the borehole (from ToC) of sensors and equipment affecting wellbore storage in the pumping borehole during the pumping test in conjunction with difference flow logging in KFM02A.

Borehole information			Sensors		Equipment affecting wellbore storage (WBS)		
ID	**Test section (m)**	**Test no**	**Type**	**Position (m b. ToC)**	**Position***	**Function**	**Outer diameter (mm)**
KFM02A	102.00-1002.44	1	Pump vessel (upper level) P (P1) P_{abs}	 12.64 12.64 15.54	 In open borehole	Pump hose Signal cable Pump cable wire	18 6 11.5 3

1) Position of equipment that can affect wellbore storage.

5 Execution

5.1 Performance of the test

5.1.1 Test principle

The first part (c. 1 day) of the pumping test during difference flow logging in KFM02A was carried out as a single-hole constant flow rate test. The remainder of the flow period was performed at a constant drawdown in the borehole. The flow period was followed by a pressure recovery period.

5.1.2 Test procedure

The maximum flow rate (c. 80 L/min) with the actual pump was maintained rather constant during the first part of the pumping test, see Figure 5-4 in the main report. After c. 1 day, a constant drawdown (c. 6 m) was applied in the borehole during the flow period. The flow rate decreased to c. 75 L/min during the remaining part of the flow period. The pumped flow was discharged at the ground surface sloping downhill from the pumping borehole. The flow rate was measured manually c. 5-6 times/day by a mechanical flow meter.

The duration of the flow period during the difference flow logging campaign was c. 6 days, followed by a recovery period of c. 1 d. The sampling frequency of the water level in the borehole by the superficial pressure sensor varied between c. 30-60 s during the flow period. During the recovery period the sampling frequency was according to Table 5-1, both for the water level- and the absolute pressure sensor.

Table 5-1. Sampling frequency for pressure registration during the recovery period of the pumping test in KFM02A.

Time interval (min) from stop of pumping	Sampling frequency (s)
0.02-36.5	11
37.0-1134	31

5.2 Data handling

A list of the data files of pressure versus time from the recovery phase from the data logger is shown in Appendix 11:1. Files in mio-format, to be further processed by the program PUMPKONV, were created through macro-editing the original logger file in the text editor UltraEdit.

By the calculation of the pressure drawdown and -recovery from the absolute pressure sensor, the barometric pressure was firstly subtracted from the measured pressure data.

However, no such corrections were made on the measured (gauge) pressure data from the superficial transducer.

The *.mio-file of pressure versus time data was converted to a recovery file by the code PUMPKONV and plotted in selected diagrams by the code SKB-plot in accordance with the Method Instruction SKB MD 320.004, Version 1.0, SKB internal controlling document, Instruktion för analys av injektions- och enhålspumptester. In addition, log-log and lin-log diagrams were prepared from the data file of the manually registered flow rate data versus time.

By the calculation of the pressure derivative, different values were applied on the filter coefficient (step length) to study its effect on the derivative. It is desired to achieve maximum smoothing of the derivative without altering the original shape of the data.

5.3 Analyses and interpretation

The main evaluation was made on data from the recovery period of the pumping period during difference flow logging using pressure data from the high-resolution absolute pressure sensor. An approximate evaluation was also made from the first part (c. 1 day) of the flow period before constant head conditions were achieved using data from the superficial sensor.

Firstly, a qualitative evaluation of the actual flow regimes during the recovery period was performed (e.g. wellbore storage, pseudo-radial flow etc.) and possible outer hydraulic boundary conditions. The qualitative analysis was mainly made from the transient recovery response together with the corresponding pressure derivative versus time in the log-log diagram. The pressure recovery was plotted versus real time dt after stop of pumping since both the pressure and flow rate were nearly constant by the end of the flow period (except from small variations).

The quantitative, transient interpretation of hydraulic parameters from the pumping borehole (e.g. transmissivity, skin factor and wellbore storage coefficient) is primarily based on the identified pseudo-radial flow regime, if occurring, in log-log and lin-log test data diagrams according to methods described in /1/ and in the Instruction mentioned above for tests in an equivalent porous medium. For tests indicating a wellbore storage dominated response, relevant type curves are used by the analysis. Estimation of the borehole storage coefficient, in constant flow rate- and recovery tests, is based on the early borehole response with 1:1 slope.

Analysis of the flow period for constant flow rate- and constant drawdown tests was made according to e.g. the methods described in /1/. In addition, a steady-state analysis (Moye's formula) was also made from the flow period.

6 Results

6.1 Nomenclature and symbols

The nomenclature and symbols used for the results of the pumping test are according to SKB MD 320.004. Additional symbols used are explained in the text.

6.2 Single-hole pumping test

General test data from the pumping borehole KFM02A are presented in Table 6-1. The atmospheric pressure during the difference flow logging campaign in KFM02A is shown in Appendix 10.1 in the main report.

Since no data from observation boreholes were available, a value on the storativity must be assumed by the calculation of the skin factor. In this case the value $S^*=5\cdot10^{-5}$, obtained from interference tests between HFM01 and HFM02, /2/, was used. A summary of the results of the single-hole pumping test in KFM02A is presented in Section 6.3. Test diagrams are shown in Appendix 11:2 in this report. The result tables to the Sicada data base are shown in Appendix 12.

Table 6-1. General test data from the pumping borehole KFM02A.

General test data			
Testtype[1]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	J. Pöllänen and P. Heikkinen, PRG Tec-Oy		
Test equipment system	Posiva difference flow logging system		
General comment	Single-hole test		
	Nomen-clature	**Unit**	**Value**
Borehole length	L	m	1002.44
Casing length	L_c	m	100.14 (ID 0.200 m)
Test section- secup	Secup	m	102.00
Test section- seclow	Seclow	m	1002.44
Test section length	L_w	m	900.44
Test section diameter	$2\cdot r_w$	mm	77
Test start (start of pressure registration)		yymmdd hh:mm	20030505 12:09
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20030505 12:09:00
Stop of flow period		yymmdd hh:mm:ss	20030511 17:34:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20030512 12:27:40
Total flow time	t_p	min	8965
Total recovery time	t_F	min	1134

Groundwater level data

Groundwater level data in pumping borehole KFM02A	Nomen-clature	Unit	Value (m.a.s.l)
Level in borehole before start of flow period	h_i	m	1.18
Level in borehole before stop of flow period	h_p	m	-4.83
Level in borehole at stop of recovery period	h_F	m	0.58
Maximum drawdown in borehole during flow period	s_p	m	6.01

Manual water level measurements in pumping borehole KFM02A				
Date YYYY-MM-DD	**Time tt:mm.ss**	**Time (min)**	**GW level (m b. ToC)**	**GW level (m a s l)**
2003-04-23	16:15:00		6.4	0.97

Flow data

Flow data in pumping borehole KFM02A	Nomen-clature	Unit	Value
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$1.25 \cdot 10^{-3}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	
Total volume discharged during flow period	V_p	m^3	

Interpreted flow regimes

Selected test diagrams according to the Instruction for analysis of single-hole injection- and pumping tests are presented in Appendix 11:2. A well-defined period with pseudo-radial flow occurred during the first part (c. 1 day) of the flow period at constant flow rate. During this first period no evidences of outer hydraulic boundaries were seen. Furthermore, the flow rate record during the remaining part of the c. 6 days long flow period at constant drawdown neither indicated any significant effects of outer hydraulic boundaries, e.g. no-flow boundaries.

During the initial phase of the recovery period, wellbore storage effects (WBS) dominated the response in the (open) pumping borehole. After a transition period, a well-defined period with pseudo-radial flow occurred. After a transition period another pseudo-radial flow period appeared by the end of the recovery period. The calculated transmissivity of the latter pseudo-radial flow period was slightly lower. However, this behaviour was not observed during the flow period. Thus, the responses during the flow- and recovery periods were not quite consistent.

Interpreted parameters

The transient analyses of the flow-and recovery periods according to the methods described in Section 5-3, based on certain periods with approximate pseudo-radial flow, are shown in Figures 11:2-5 in Appendix 11:2. The results are presented in Table 6-3.

6.3 Summary of test data

Test data from the single-hole pumping test in conjunction with difference flow logging in borehole KFM02A are summarized in Table 6-2. The calculated hydraulic parameters together with the estimated measurement limits are presented in Table 6-3 and in the Test Summary Sheet below. The transient evaluation from the late phase of the recovery period is considered as the most robust and unambiguous and is thus selected as the representative one. The evaluation of the late phase of the recovery period is very consistent with the one from the flow period.

The parameter files of the results from the pumping test for storage in the SICADA data base are presented in Appendix 11:3 below.

Table 6-2. Summary of test data of the single-hole pumping test during the difference flow logging in the open borehole KFM02A.

Borehole ID	Interval (m)	Test type[1)]	h_i (m a s l)	h_p (m a s l)	h_F (m a s l)	Q_p (m^3/s)
KFM02A	102.00-1002.44	1B	1.18	-4.83	0.58	$1.25 \cdot 10^{-3}$

[1)] 1B: Pumping test-submersible pump followed by a recovery test

Table 6-3. Summary of calculated hydraulic parameters from the pumping test in conjunction with difference flow logging in borehole KFM02A.

Borehole ID	Test period	Time of evaluation	Q/s (m^2/s)	T_M (m^2/s)	T (m^2/s)	S* (-)	ζ (-)
KFM02A	flow	first day	$2.08 \cdot 10^{-4}$	$3.43 \cdot 10^{-4}$	$2.33 \cdot 10^{-4}$	$5 \cdot 10^{-5}$	-2.62
KFM02A	recovery	intermediate			$3.56 \cdot 10^{-4}$	$5 \cdot 10^{-5}$	0.06
KFM02A	recovery	late			$2.50 \cdot 10^{-4}$	$5 \cdot 10^{-5}$	-2.35

Q/s= specific flow
T_M= steady-state transmissivity from Moye´s formula
T = calculated transmissivity from transient evaluation of the test
S^*= assumed value on the storativity
ζ = skin factor

6.4 Conclusions

The total transmissivity of borehole KFM02A was calculated to c. $2 \cdot 10^{-4}$ m^2/s from the pumping test. As identified from the difference flow logging, the dominant inflow in KFM02A occurred at the interval c. 110-120 m. The pumping test showed that no significant effects of outer hydraulic boundaries, e.g. no-flow boundaries, occurred during the rather long (c. 6 days) flow period. This fact indicates that the assumed fracture zone at this interval is extensive in the lateral direction.

The calculated transmissivity from the pumping test is consistent with the results of the difference flow logging. The differences are considered to be within the error bands of the methods. Table 6-4 shows the cumulative transmissivity in 5 m sections ($\sum T_D$) during the sequential flow logging together with the cumulative transmissivity of the flow anomalies identified in this interval ($\sum T_{Df}$) and the borehole transmissivity from the transient evaluation (T_T) of the pumping test.

Table 6-4. Comparison of calculated total transmissivity of the cored borehole KFM02A from the pumping test and cumulative transmissivities from the difference flow logging along the borehole.

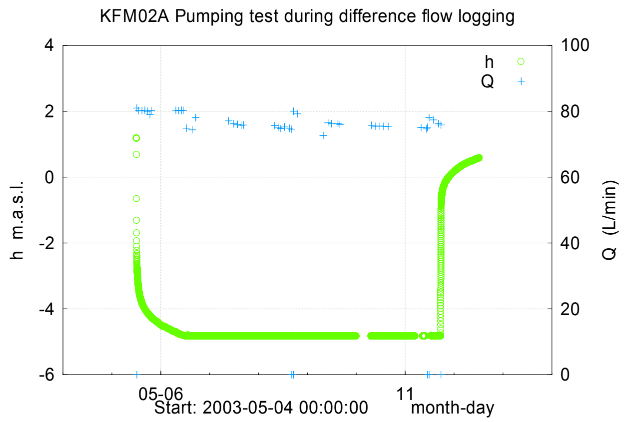
Borehole ID	Test method	Measured interval (m)	T_T (m²/s)	$\sum T_D$ (m²/s)	$\sum T_{Df}$ (m²/s)
KFM02A	Pumping test	102.00-1002.44	$2.50 \cdot 10^{-4}$		
	Difference flow logging	101.00-996.65*		$1.42 \cdot 10^{-4}$	$1.32 \cdot 10^{-4}$

* upper discs in casing

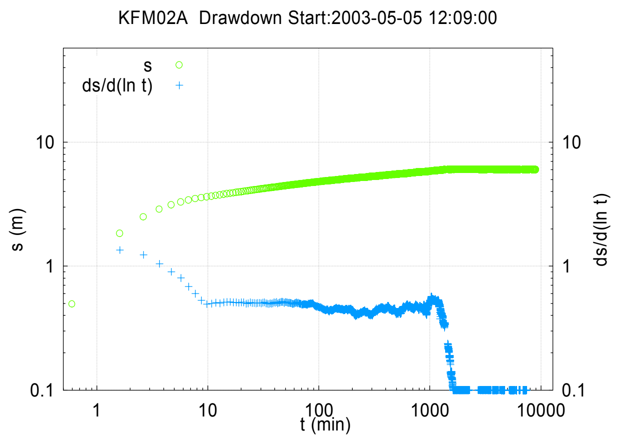
Test Summary Sheet – Pumping borehole KFM02A

Project:	PLU	Test type:	1B
Area:	Forsmark	Test no:	1
Borehole ID:	KFM02A	Test start:	2003-05-05 12:09
Test section (m):	102.00-1002.44	Responsible for test performance:	P. Rouhiainen, PRG-Tec Oy
Section diameter, $2 \cdot r_w$ (m):	0.077	Responsible for test evaluation:	GEOSIGMA AB J-E Ludvigson

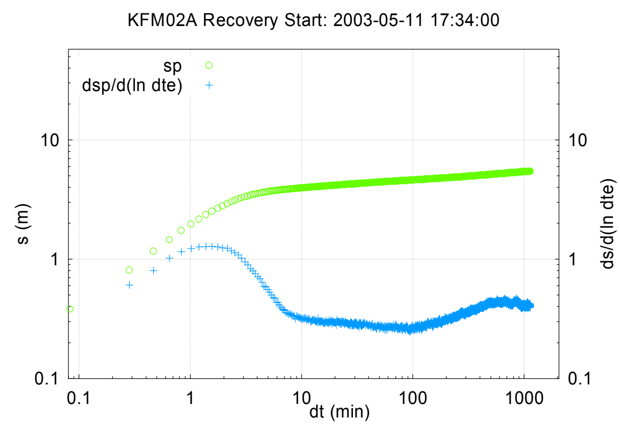
Lin-Lin plot – Entire test period



Log-Log plot incl. derivative- flow period



Log-Log plot incl. derivative- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
h_0 (m a sl)	1.18		
h_i (m a sl)	1.18		
h_p (m a sl)	-4.83	h_F (m a sl)	0.58
Q_p (m^3/s)	$1.25 \cdot 10^{-3}$		
tp (min)	8965	t_F (min)	1134
S^*	$5 \cdot 10^{-5}$	S^*	$5 \cdot 10^{-5}$
EC_w (mS/m)	-		
Te_w(gr C)	-		
Derivative fact.	0.2	Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$2.08 \cdot 10^{-4}$		
T_M (m^2/s)	$3.43 \cdot 10^{-4}$		
Flow regime:	PRF	Flow regime:	PRF
t_1 (min)	70	t_1 (min)	7
t_2 (min)	1400	t_2 (min)	200
T_w (m^2/s)	$2.33 \cdot 10^{-4}$	T_w (m^2/s)	$2.50 \cdot 10^{-4}$
S_w (-)	-	S_w (-)	-
K_{sw} (m/s)	-	K_{sw} (m/s)	-
S_{sw} (1/m)	-	S_{sw} (1/m)	-
C (m^3/Pa)	-	C (m^3/Pa)	-
C_D (-)	-	C_D (-)	-
ξ (-)	-2.62	ξ (-)	-2.35
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Interpreted formation and well parameters.

Flow regime:	PRF	C (m^3/Pa)	-
t_1 (min)	7	C_D (-)	-
t_2 (min)	200	ξ (-)	-2.35
T_T (m^2/s)	$2.50 \cdot 10^{-4}$		
S (-)	-		
K_s (m/s)	-		
S_s (1/m)	-		

Comments: After initial wellbore storage- and skin effects, pseudo-radial flow occurred during the first part of the flow period. During the recovery period pseudo-radial flow occurred both at intermediate and late times.

7 References

1 **Almén K-E, Andersson J-E, Carlsson L, Hansson K, Larsson N-Å, 1986**

Hydraulic testing in crystalline rock. A comparative study of single-hole test methods. Technical Report 86-27, Svensk Kärnbränslehantering AB.

2 **Ludvigson J-E, Jönsson S, 2003**

Forsmark Site Investigation - Hydraulic interference tests. Boreholes HFM01, HFM02 and HFM03. Report P-03-35, Svensk Kärnbränslehantering AB.

8 Appendices

Appendix 11:1: Test data files

Appendix 11:2: Test data diagrams

Appendix 11:3: Parameter file to SICADA

APPENDIX 11:1 – TEST DATA FILES

Bh ID	Test section (m)	Test type[1]	Test start Date, time YYYY-MM-DD tt:mm	Test stop Date, time YYYY-MM-DD tt:mm	Datafile, start Date, time YYYY-MM-DD tt:mm:ss	Datafile, stop Date, time YYYY-MM-DD tt:mm:ss	Data files of raw and primary data	Parameters measured	Comments
KFM02A	102.00-1002.44	1B	2003-05-05 12:09	2003-05-12 13:29	2003-05-11 17:32:13	2003-05-12 12:27:40	FOF02AGL12R050D105.CSV	P1, P_{abs}	Recovery period
KFM02A	102.00-1002.44	1B	2003-05-05 12:09	2003-05-12 13:29	2003-05-05 12:09	2003-05-12 18:10	FOF02APU12E050T105.DAT	Q	Flow period

1: 1B: Pumping test-submersible pump

APPENDIX 11:2 TEST DATA DIAGRAMS

Entire test sequence

Flow period

Recovery period

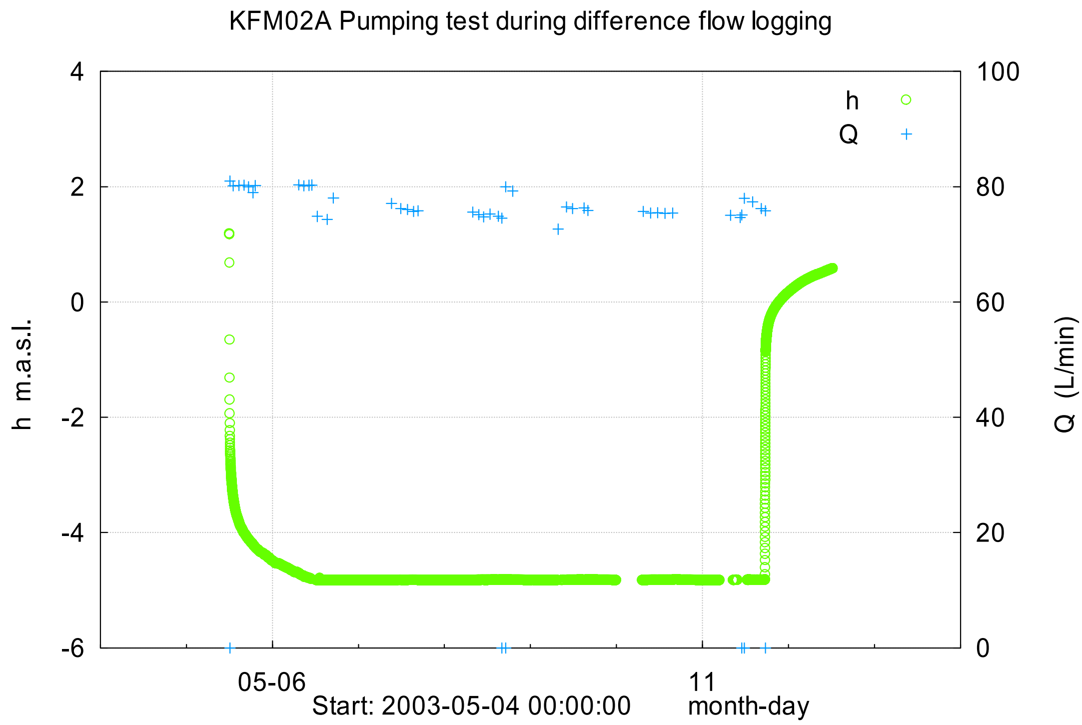


Fig 11:2-1. Linear plot of groundwater level (h) and flow rate (Q) versus time during the pumping test in conjunction with difference flow logging in borehole KFM02A.

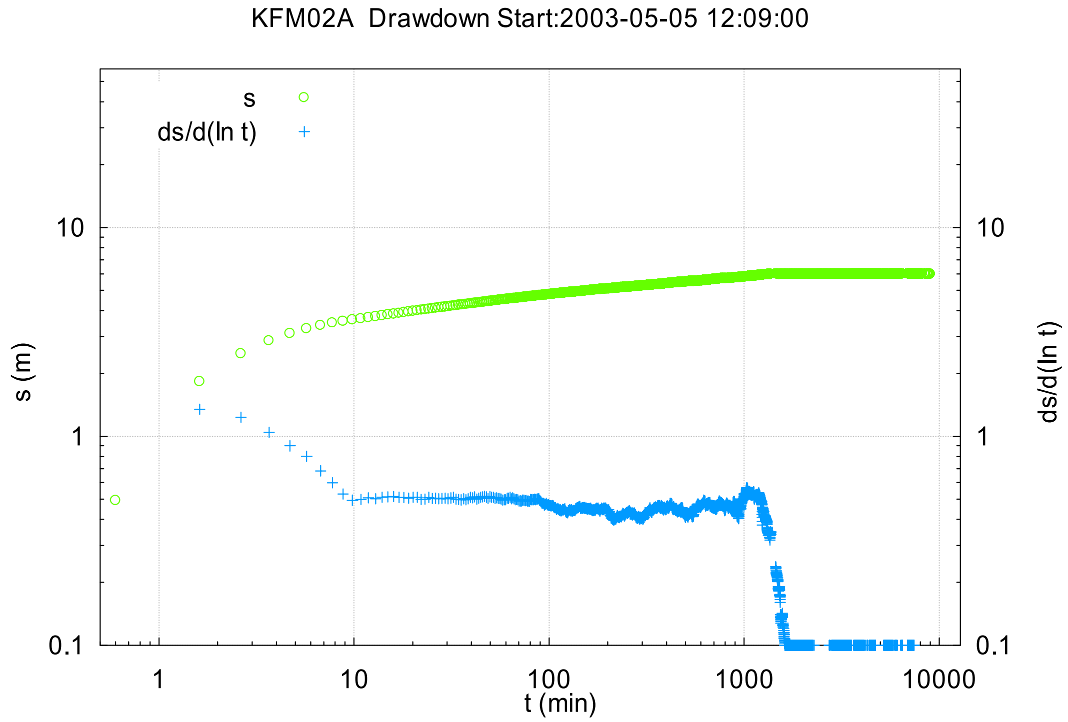


Fig 11:2-2. Log-log plot of drawdown (s) and - derivative, ds/d(ln t) versus time (t) during the pumping test in borehole KFM02A .

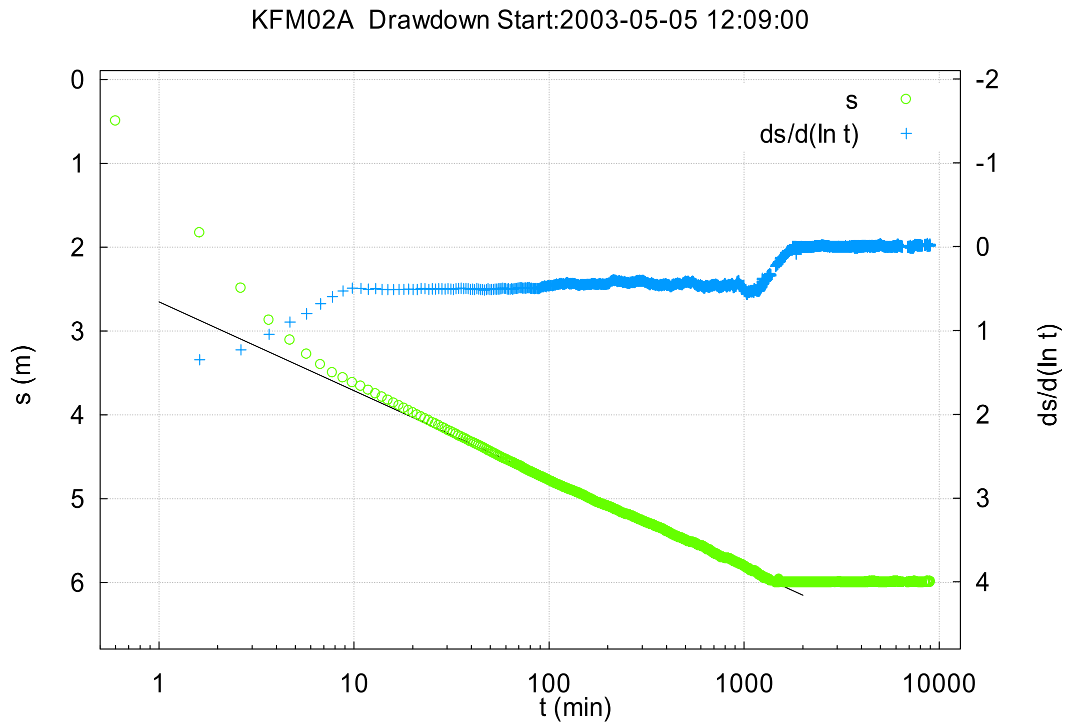


Fig 11:2-3. Lin-log plot of drawdown (s) and - derivative, ds/d(ln t) versus time (t) during the pumping test in borehole KFM02A .

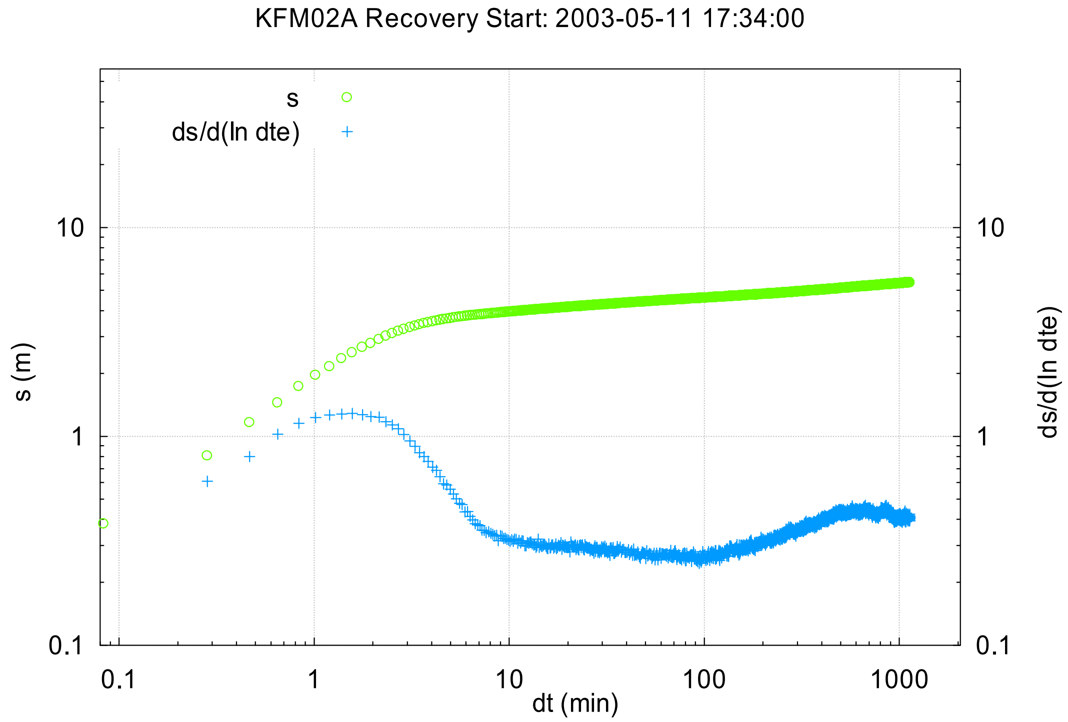


Fig 11:2-4. Log-log plot of pressure recovery (s) and - derivative, ds/d(ln dte) versus time (dt) during the pumping test in borehole KFM02A.

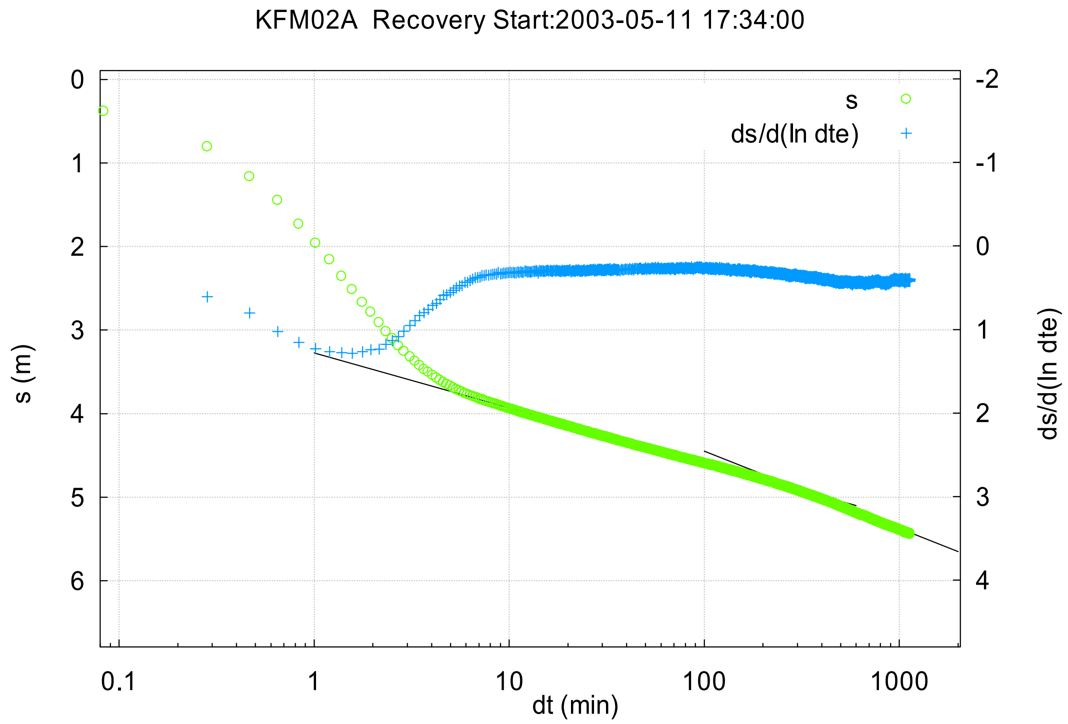


Fig 11:2-5. Lin-log plot of pressure recovery (sp) and - derivative, ds/d(ln dte) versus time (dt) during the pumping test in borehole KFM02A.

APPENDIX 11:3 PARAMETER FILE TO SICADA

Result Tables for Single-hole pumping- and injection tests

Appendix 11

Parameter file of results from single-hole pumping test in borehole KFM02A during difference flow logging.

SINGLEHOLE TESTS, Pumping and injection, s_hole_test_d; General information

Borehole	Borehole secup (m)	Borehole seclow (m)	Test type (1-7)	Formation type (-)	Date and time for test, start YYYYMMDD hh:mm	Date and time for test, stop YYYYMMDD hh:mm	Date and time of flow/ injection, start YYYYMMDD hh:mm:ss	Date and time of flow/ injection, stop YYYYMMDD hh:mm:ss	Q_p (m**3/s)	Value type-Q_p (-1,0,1)	Q-measl-L (m**3)/s	Q-measl-U (m**3)/s
KFM02A	102.00	1002.44	1B	1	2003-05-05 12:09	2003-05-12 12:28	2003-05-05 12:09:00	2003-05-11 17:34:00	1.25E-03	0		

cont.

V_p (m**3)	Q_m (m**3/s)	tp (s)	t_F (s)	h_i (m a sl)	h_p (m a sl)	h_F (m a sl)	p_i (kPa)	p_p (kPa)	p_F (kPa)	Te_w (° C)	EC_w (mS/m)	TDS_w (mg/ L)	TDS_{wm} (mg/ L)	Reference	Comments (-)
		537900	68040	1.18	-4.83	0.58								P-03-xx	

SINGLEHOLE TESTS, Pumping and injection, s_hole_test_ed1; Basic evaluation

Borehole	Borehole secup (m)	Borehole seclow (m)	Date and time for test, start YYYYMMDD hh:mm	Seclen class	Q/s (m^2/ s)	Value type-Q/s (-1, 0, 1)	T_Q (m^2/ s)	T_M (m^2/ s)	b (m)	B (m)	TB (1D) (m^3/ s)	TB-measl-L (1D) (m^3/ s)	TB-measl-U (1D) (m^3/ s)	SB (1D) (m)	SB* (1D) (m)	L_f (1D) (m)	T_T (2D) (m^2/ s)	Value type-T_T (-1, 0, 1)
KFM02A	102.00	1002.44	2003-05-05 12:09		2.08E-04	0		3.43E-04	900.44								2.33E-04	0

cont.

Q/s-measl-L (m^2/ s)	Q/s-measl-U (m^2/ s)	S (2D) (-)	S* (2D) (-)	K´/b´ (2D) (1/s)	K_S (3D) (m/s)	K_S-measl-L (3D) (m/s)	K_S-measl-U (3D) (m/s)	S_S (3D) (1/m)	S_S* (3D) (1/m)	L_p (m)	C (m**3/Pa)	C_D (-)	ξ (2D) (-)	ω (-)	λ (-)	t_1 (s)	t_2 (s)	Comments (-)
2.00E-08	2.00E-03		5.00E-05										-2.62			4200	84000	

Appendix 11

Header	Unit	Explanation
Borehole		ID for borehole
Borehole secup	m	Length coordinate along the borehole for the upper limit of the test section
Borehole seclow	m	Length coordinate along the borehole for the lower limit of the test section
Test type (1- 7)	(-)	1A: Pumping test - wireline eq., 1B:Pumping test-submersible pump, 1C: Pumpingtest-airlift pumping, 2: Interference test, 3: Injection test, 4: Slug test, 5A: Difference flow logging-PFL-DIFF-sequential, 5B: Difference flow logging-PFL-DIFF-overlapping, 6:Flow logging_Impeller,7:Grain size analysis
Date for test start		Date for the start of the pumping or injection test (YYYYMMDD hh:mm)
Start flow / injection		Date and time for the start of the pumping or injection period (YYMMDD hh:mm:ss)
Start flow / injection		Date and time for the end of the pumping or injection period (YYMMDD hh:mm:ss)
Q_m	m^3/s	Arithmetric mean flow rate of the pumping/injection period.
Q_p	m^3/s	Flow rate at the end of the pumping/injection period.
Value type	-	Code for Q_p-value; -1 means Q_p<lower measurement limit, 0 means measured value, 1 means Q_p> upper measurement value of flowrate
Q-measl_L	m^3/s	Estimated lower measurement limit for flow rate
Q-measl_U	m^3/s	Estimated upper measurement limit for flow rate
V_p	m^3	Total volume pumped (positive) or injected (negative) water during the flow period.
t_p	s	Time for the flowing phase of the test
t_F	s	Time for the recovery phase of the test
h_i	m	Initial formation hydraulic head. Measured as water level in open stand pipes from borehole section with reference level in the local coordinates system with z=0 m.
h_p	m	Final hydraulic head at the end of the pumping/injection period. Measured as water level in open stand pipes from borehole section with reference level in the local coordinates system with z=0 m.
h_F	m	Final hydraulic head at the end of the recovery period. Measured as water level in open stand pipes from borehole section with reference level in the local coordinates system with z=0 m.
p_i	kPa	Initial formation pressure.
p_p	kPa	Final pressure at the end of the pumping/injection period.
p_F	kPa	Final pressure at the end of the recovery period.
Te_w	gr C	Fluid temperature in the test section representative for the evaluated parameters
EC_w	mS/m	Electrical conductivity of the fluid in the test section representative for the evaluated parameters
TDS_w	mg/L	Total salinity of the fluid in formation at test section based on EC.
TDS_{wn}	mg/L	Total salinity of the fluid in formation at test section based on water sampling and chemical analysis.
Sec.type,	(-)	Test section (pumping or injection) is labeled 1 and all observation sections are labeled 2
Q/s	m2/s	Specific capacity, based on Qp and s=abs(pi-pp). Only given for test section (label 1) in interference test.
T_Q	m2/s	Transmissivity based on specific capacity and a a function for T=f(Q/s). The fuction used should be refered in "Comments"
T_M	m2/s	Transmissivity based on Moye (1967)
b	m	Interpreted formation thickness representative for evaluated T ot TB.
B	m	Interpreted witdth of a formation with evaluated TB
TB	m3/s	1D model for evaluation of formation properties. T=transmissivity, B=width of formation
TB-measl-L	m2/s	Estimated measurement limit for evaluated TB. If estimated TB equals TB-measlim in the table actual TB is considered to be equal or less than TB-measlim
TB-measl-L	m2/s	Estimated measurement limit for evaluated TB. If estimated TB equals TB-measlim in the table actual TB is considered to be equal or greater than TB-measlim
SB	m	1D model for evaluation of formation properties. S= Storativity, B=width of formation

SB*	m	1D model for evaluation of formation properties. Assumed SB. S= Storativity, B=width of formation
L_f	m	1D model for evaluation of Leakage factor
T_T	m2/s	2D model for evaluation of formation properties. T=transmissivity
T-measl-L	m2/s	Estimated measurement limit for evaluated T (TT, TQ, TM). If estimated T equals T-measlim in the table actual T is considered to be equal or less than T-measlim
T-measl-U	m2/s	Estimated measurement limit for evaluated T (TT, TQ, TM). If estimated T equals T-measlim in the table actual T is considered to be equal or grater than T-measlim
S	(-)	2D model for evaluation of formation properties. S= Storativity
S*	(-)	2D model for evaluation of formation properties. Assumed S. S= Storativity
K´/b´	(1/s)	2D model for evaluation of leakage coefficient. K´= hydraulic conductivity in direction of leaking flow for the aquitard, b´= Saturated thickness of aquitard (leaking formation)
K_S	m/s	3D model for evaluation of formation properties. K=Hydraulic conductivity
K_S-measl-L	m/s	Estimated measurement limit for evaluated KS. If estimated KS equals KS-measlim in the table actual KS is considered to be equal or less than KS-measlim
K_S-measl-U	m/s	Estimated measurement limit for evaluated KS. If estimated KS equals KS-measlim in the table actual KS is considered to be equal or greater than KS-measlim
S_S	1/m	3D model for evaluation of formation properties. Ss=Specific Storage
S_S*	1/m	3D model for evaluation of formation properties. Assumed Ss. Ss=Specific Storage
L_p	m	Hydraulic point of appication, based on hydraulic conductivity distribution (if available) or the midpoint of the borehole test section
C	(m3/Pa)	Wellbore storage coefficient
C_D	(-)	Dimensionless wellbore storage coefficient
ξ	(-)	Skin factor
ω	(-)	Storativity ratio
λ	(-)	Interporosity flow coefficient
dt_1	s	Estimated start time after pump/injection start OR recovery start, for the period used for the evaluated parameter
dt_2	s	Estimated stop time after pump/injection start OR recovery start, for the period used for the evaluated parameter
	m	Length coordinate along the borehole for the upper limit of the observation section
	m	Length coordinate along the borehole for the lower limit of the observation section
p_{ai}	kPa	Initial formation pressure of the observation section, which is located above the test section in the borehole
p_{ap}	kPa	Final pressure at the end of the pumping/injection period in the observation section, which is located above the test section in the borehole
p_{aF}	kPa	Final pressure at the end of the recovery period in the observation section, which is located above the test section in the borehole
p_{bi}	kPa	Initial formation pressure of the observation section, which is located below the test section in the borehole
p_{bp}	kPa	Final pressure at the end of the pumping/injection period in the observation section, which is located below the test section in the borehole
p_{bF}	kPa	Final pressure at the end of the recovery period in the observation section, which is located below the test section in the borehole
References		SKB report No for reports describing data and evaluation
Index w		Active borehole or borehole section

Appendix 12

PFL-Difference flow logging- Basic data

Borehole	Logged interval		Test type	Q-measl-L-theo-retical	Q-measl-L-theoretical	Q-measl-L-practical	Q-measl-U	Q-measl-U	Item in AP	Formation type	Date and time of test, start	Date and time of flowl., start	Date and time of flowl., stop
	from	to											
ID	L (m)	L (m)	(1-6)	(mL/h)	(m3/s)	(mL/h)	(mL/h)	(m3/s)		(-)	YYYYMMDD hh:mm	YYYYMMDD hh:mm	YYYYMMDD hh:mm
KFM02A	101,00	996,63	5A	6	1,6667E-09	30-500	300000	8,33E-05	9	1	2003-04-26 14:59	2003-04-26 14:59	2003-04-28 17:18
KFM02A	101,00	996,63	5B	30	8,3333E-09	30-500	300000	8,33E-05	9	1	2003-04-26 14:59	2003-04-26 14:59	2003-04-28 17:18
KFM02A	101,00	996,65	5A	6	1,6667E-09	30-500	300000	8,33E-05	10	1	2003-05-05 12:09	2003-05-06 12:09	2003-05-08 16:00
KFM02A	101,00	996,65	5B	30	8,3333E-09	30-500	300000	8,33E-05	10	1	2003-05-05 12:09	2003-05-06 12:09	2003-05-08 16:00
KFM02A	100,00	566,21	5B	30	8,3333E-09	30-500	300000	8,33E-05	11	1	2003-05-08 17:05	2003-05-08 23:00	2003-05-11 09:48
KFM02A	886,49	900,62	5B	30	8,3333E-09	30-500	300000	8,33E-05	11	1	2003-05-08 17:05	2003-05-11 07:30	2003-05-11 09:48
KFM02A	108,00	123	5A	6	1,6667E-09	30-500	300000	8,33E-05	11extra	1	2003-05-12 13:29	2003-05-12 16:00	2003-05-12 18:03
KFM02A	108,00	123	5B	30	8,3333E-09	30-500	300000	8,33E-05	11extra	1	2003-05-12 13:29	2003-05-12 16:00	2003-05-12 18:03

Cont.

Lw (m)	dL (m)	Q_{p1} (L/min)	Qp2 (L/min)	tp1 (s)	tp2 (s)	tF1 (s)	tF2 (s)	h0 (m a s l)	h1 (m a s l)	h2 (m)	hF (m a s l)	s1 (m)	s2 (m)	Reference (-)	Comments (-)
5	5							1,18						R-03-	No pumping
5	0,5							1,18						R-03-	No pumping
5	5	75,1		514200					-4,83			6,01		R-03-	High flow rate
5	0,5	75,1		514200					-4,83			6,01		R-03-	High flow rate
1	0,1	75,1		514200		136800			-4,83			6,01		R-03-	High flow rate
1	0,1	75,1		514200		136800			-4,83			6,01		R-03-	High flow rate
5	5		5		18180		46800			0,52	0,82		0,66	R-03-	Low flow rate
1	0,1		5		18180		46800			0,52	0,82		0,66	R-03-	Low flow rate

PFL-Difference flow logging - Sequential flow logging

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m³/s)	Value type-Q1	Q2 (m³/s)	Q-measl-L-practical (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030426	101,00	996,63	101,00	106,00	5	5A	2,80E-7	0				1,39E-7	1,212			2,75E-7	0	2,36E-8	1,41E-5	2,22	0	
KFM02A	20030426	101,00	996,63	106,00	111,00	5	5A	7,38E-7	0				1,39E-7	1,209			4,27E-5	0	2,36E-8	1,67E-4	1,19	0	TD and hi based on Q0 and Q2
KFM02A	20030426	101,00	996,63	111,00	116,00	5	5A	5,22E-8	0				1,39E-7	1,212			2,20E-5	0	2,36E-8	1,71E-4	1,21	0	TD and hi based on Q0 and Q2
KFM02A	20030426	101,00	996,63	116,00	121,00	5	5A	3,57E-6	0				1,39E-7	1,241			4,94E-5	0	2,36E-8	1,80E-4	1,17	0	TD and hi based on Q0 and Q2
KFM02A	20030426	101,00	996,63	121,01	126,01	5	5A	1,74E-7	0				3,33E-8	1,284			3,16E-6	0	5,73E-9	1,43E-5	1,23	0	
KFM02A	20030426	101,00	996,63	126,01	131,01	5	5A		1				3,33E-8	1,327			1,28E-8	0	5,73E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	131,01	136,01	5	5A		1				3,33E-8	1,357				1	5,71E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	136,01	141,01	5	5A		1				1,67E-8	1,385			1,25E-8	0	2,85E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	141,01	146,01	5	5A		1				1,67E-8	1,404				1	2,86E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	146,01	151,01	5	5A		1				3,33E-8	1,445				1	5,73E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	151,02	156,02	5	5A		1				3,33E-8	1,507				1	5,71E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	156,02	161,02	5	5A		1				3,33E-8	1,557			2,27E-8	0	5,68E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	161,02	166,02	5	5A	7,72E-7	0				3,33E-8	1,597			1,23E-6	0	5,66E-9	1,42E-5	2,22	0	
KFM02A	20030426	101,00	996,63	166,02	171,02	5	5A	1,03E-7	0				8,33E-9	1,632			4,20E-7	0	1,42E-9	1,42E-5	1,87	0	
KFM02A	20030426	101,00	996,63	171,02	176,02	5	5A	2,80E-7	0				8,33E-9	1,654			1,71E-6	0	1,43E-9	1,43E-5	1,82	0	
KFM02A	20030426	101,00	996,63	176,02	181,02	5	5A		1				8,33E-9	1,681			7,00E-8	0	1,44E-9	1,44E-5		1	
KFM02A	20030426	101,00	996,63	181,03	186,03	5	5A	4,34E-8	0				8,33E-9	1,719			3,44E-7	0	1,43E-9	1,43E-5	1,84	0	
KFM02A	20030426	101,00	996,63	186,03	191,03	5	5A		1				8,33E-9	1,767				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	191,03	196,03	5	5A		1				8,33E-9	1,798				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	196,03	201,03	5	5A		1				8,33E-9	1,841				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	201,04	206,04	5	5A		1				8,33E-9	1,883				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	206,04	211,04	5	5A		1				8,33E-9	1,933				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	211,04	216,04	5	5A		1				8,33E-9	1,995				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	216,03	221,03	5	5A	4,62E-8	0				8,33E-9	2,055			8,30E-7	0	1,42E-9	1,42E-5	2,00	0	
KFM02A	20030426	101,00	996,63	221,03	226,03	5	5A		1				8,33E-9	2,094				1	1,41E-9	1,41E-5		1	

Appendix 12

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030426	101,00	996,63	226,04	231,04	5	5A	5,99E-9	0				8,33E-9	2,133			9,25E-8	0	1,41E-9	1,41E-5	2,07	0	
KFM02A	20030426	101,00	996,63	231,04	236,04	5	5A		1				8,33E-9	2,167				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	236,04	241,04	5	5A		1				8,33E-9	2,2				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	241,04	246,04	5	5A		1				8,33E-9	2,229				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	246,05	251,05	5	5A		1				8,33E-9	2,269				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	251,05	256,05	5	5A		1				8,33E-9	2,303				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	256,06	261,06	5	5A		1				8,33E-9	2,349				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	261,06	266,06	5	5A		1				8,33E-9	2,406				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	266,06	271,06	5	5A	5,14E-8	0				8,33E-9	2,467			1,03E-7	0	1,41E-9	1,41E-5	2,96	0	
KFM02A	20030426	101,00	996,63	271,06	276,06	5	5A	1,55E-7	0				8,33E-9	2,519			5,40E-7	0	1,40E-9	1,40E-5	2,80	0	
KFM02A	20030426	101,00	996,63	276,06	281,06	5	5A	1,12E-7	0				8,33E-9	2,568			6,65E-7	0	1,40E-9	1,40E-5	2,74	0	
KFM02A	20030426	101,00	996,63	281,06	286,06	5	5A	2,93E-7	0				8,33E-9	2,605			2,29E-6	0	1,40E-9	1,40E-5	2,73	0	
KFM02A	20030426	101,00	996,63	286,06	291,06	5	5A	1,63E-7	0				8,33E-9	2,642			4,54E-6	0	1,41E-9	1,41E-5	2,68	0	
KFM02A	20030426	101,00	996,63	291,05	296,05	5	5A	1,02E-7	0				8,33E-9	2,675			2,10E-6	0	1,41E-9	1,41E-5	2,72	0	
KFM02A	20030426	101,00	996,63	296,05	301,05	5	5A	6,42E-8	0				8,33E-9	2,726			9,65E-7	0	1,41E-9	1,41E-5	2,79	0	
KFM02A	20030426	101,00	996,63	301,05	306,05	5	5A	1,96E-8	0				8,33E-9	2,781			6,75E-8	0	1,41E-9	1,41E-5	3,07	0	
KFM02A	20030426	101,00	996,63	306,05	311,05	5	5A		1				8,33E-9	2,83				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	311,05	316,05	5	5A		1				8,33E-9	2,88				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	316,05	321,05	5	5A		1				8,33E-9	2,944				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	321,06	326,06	5	5A		1				8,33E-9	3,006				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	326,06	331,06	5	5A		1				8,33E-9	3,044				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	331,06	336,06	5	5A		1				8,33E-9	3,085				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	336,06	341,06	5	5A		1				8,33E-9	3,121				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	341,06	346,06	5	5A		1				8,33E-9	3,153				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	346,06	351,06	5	5A		1				8,33E-9	3,217				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	351,07	356,07	5	5A		1				8,33E-9	3,265				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	356,07	361,07	5	5A		1				8,33E-9	3,29				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	361,07	366,07	5	5A		1				8,33E-9	3,33				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	366,07	371,07	5	5A		1				8,33E-9	3,393				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	371,07	376,07	5	5A		1				8,33E-9	3,438				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	376,08	381,08	5	5A		1				8,33E-9	3,478				1	1,41E-9	1,41E-5		1	

Appendix 12

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030426	101,00	996,63	381,08	386,08	5	5A		1				8,33E-9	3,551				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	386,08	391,08	5	5A		1				8,33E-9	3,611				1	1,39E-9	1,39E-5		1	
KFM02A	20030426	101,00	996,63	391,08	396,08	5	5A		1				8,33E-9	3,655				1	1,39E-9	1,39E-5		1	
KFM02A	20030426	101,00	996,63	396,08	401,08	5	5A		1				8,33E-9	3,712				1	1,39E-9	1,39E-5		1	
KFM02A	20030426	101,00	996,63	401,09	406,09	5	5A		1				8,33E-9	3,763				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	406,09	411,09	5	5A		1				8,33E-9	3,802				1	1,39E-9	1,39E-5		1	
KFM02A	20030426	101,00	996,63	411,09	416,09	5	5A		1				8,33E-9	3,835			2,40E-8	0	1,39E-9	1,39E-5		1	
KFM02A	20030426	101,00	996,63	416,09	421,09	5	5A	1,46E-7	0				8,33E-9	3,865			1,22E-6	0	1,40E-9	1,40E-5	3,98	0	
KFM02A	20030426	101,00	996,63	421,09	426,09	5	5A	3,81E-8	0				8,33E-9	3,906			1,61E-7	0	1,41E-9	1,41E-5	4,14	0	
KFM02A	20030426	101,00	996,63	426,10	431,10	5	5A	4,40E-7	0				8,33E-9	3,96			1,51E-6	0	1,41E-9	1,41E-5	4,25	0	
KFM02A	20030426	101,00	996,63	431,10	436,10	5	5A		1				8,33E-9	3,991			5,55E-9	0	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	436,11	441,11	5	5A	3,60E-8	0				8,33E-9	4,06			2,12E-7	0	1,41E-9	1,41E-5	4,23	0	
KFM02A	20030426	101,00	996,63	441,11	446,11	5	5A		1				8,33E-9	4,128			5,15E-9	0	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	446,12	451,12	5	5A		1				8,33E-9	4,163			9,90E-9	0	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	451,13	456,13	5	5A	5,39E-8	0				8,33E-9	4,189			1,44E-7	0	1,41E-9	1,41E-5	4,56	0	
KFM02A	20030426	101,00	996,63	456,13	461,13	5	5A		1				8,33E-9	4,241			7,65E-9	0	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	461,13	466,13	5	5A	4,58E-9	0				8,33E-9	4,293			3,24E-8	0	1,40E-9	1,40E-5	4,43	0	
KFM02A	20030426	101,00	996,63	466,12	471,12	5	5A		1				8,33E-9	4,35			3,83E-9	0	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	471,12	476,12	5	5A		1				8,33E-9	4,41				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	476,12	481,12	5	5A	1,61E-7	0				8,33E-9	4,459			4,87E-7	0	1,40E-9	1,40E-5	4,79	0	
KFM02A	20030426	101,00	996,63	481,12	486,12	5	5A	8,89E-8	0				8,33E-9	4,482			2,28E-7	0	1,41E-9	1,41E-5	4,87	0	
KFM02A	20030426	101,00	996,63	486,12	491,12	5	5A		1				8,33E-9	4,502			1,79E-8	0	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	491,13	496,13	5	5A		1				8,33E-9	4,54			7,85E-9	0	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	496,13	501,13	5	5A	1,95E-8	0				8,33E-9	4,581			5,75E-8	0	1,42E-9	1,42E-5	4,92	0	
KFM02A	20030426	101,00	996,63	501,13	506,13	5	5A		1				8,33E-9	4,62			4,72E-9	0	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	506,13	511,13	5	5A	1,84E-8	0				8,33E-9	4,667			4,47E-8	0	1,42E-9	1,42E-5	5,07	0	
KFM02A	20030426	101,00	996,63	511,13	516,13	5	5A	1,07E-6	0				8,33E-9	4,732			4,75E-6	0	1,43E-9	1,43E-5	4,96	0	
KFM02A	20030426	101,00	996,63	516,13	521,13	5	5A		1				8,33E-9	4,788				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	521,13	526,13	5	5A		1				8,33E-9	4,832				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	526,14	531,14	5	5A		1				8,33E-9	4,887				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	531,14	536,14	5	5A		1				8,33E-9	4,936				1	1,42E-9	1,42E-5		1	

Appendix 12

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m³/s)	Value type-Q1	Q2 (m³/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030426	101,00	996,63	536,14	541,14	5	5A		1				8,33E-9	5,006				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	541,14	546,14	5	5A		1				8,33E-9	5,082				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	546,15	551,15	5	5A		1				8,33E-9	5,14				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	551,15	556,15	5	5A		1				8,33E-9	5,173				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	556,15	561,15	5	5A		1				8,33E-9	5,246			6,55E-10	0	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	561,15	566,15	5	5A		1				8,33E-9	5,314				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	566,15	571,15	5	5A		1				8,33E-9	5,345				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	571,16	576,16	5	5A		1				8,33E-9	5,37				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	576,16	581,16	5	5A		1				8,33E-9	5,404				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	581,16	586,16	5	5A		1				8,33E-9	5,464				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	586,16	591,16	5	5A		1				8,33E-9	5,496				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	591,16	596,16	5	5A		1				8,33E-9	5,533				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	596,17	601,17	5	5A		1				8,33E-9	5,588				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	601,17	606,17	5	5A		1				8,33E-9	5,66				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	606,17	611,17	5	5A		1				8,33E-9	5,687				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	611,17	616,17	5	5A		1				8,33E-9	5,715				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	616,18	621,18	5	5A		1				8,33E-9	5,793				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	621,19	626,19	5	5A		1				8,33E-9	5,843				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	626,20	631,20	5	5A		1				8,33E-9	5,888				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	631,20	636,20	5	5A		1				8,33E-9	5,944				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	636,21	641,21	5	5A		1				8,33E-9	6,021				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	641,22	646,22	5	5A		1				8,33E-9	6,049				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	646,23	651,23	5	5A		1				8,33E-9	6,063				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	651,24	656,24	5	5A		1				8,33E-9	6,08				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	656,24	661,24	5	5A		1				8,33E-9	6,1				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	661,25	666,25	5	5A		1				8,33E-9	6,116				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	666,26	671,26	5	5A		1				8,33E-9	6,171				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	671,27	676,27	5	5A		1				8,33E-9	6,201				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	676,28	681,28	5	5A		1				8,33E-9	6,249				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	681,29	686,29	5	5A		1				1,39E-8	6,308				1	2,34E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	686,29	691,29	5	5A		1				1,39E-8	6,354				1	2,35E-9	1,41E-5		1	

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030426	101,00	996,63	691,30	696,30	5	5A		1				8,33E-9	6,402				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	696,31	701,31	5	5A		1				8,33E-9	6,44				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	701,32	706,32	5	5A		1				8,33E-9	6,46				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	706,33	711,33	5	5A		1				8,33E-9	6,501				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	711,34	716,34	5	5A		1				8,33E-9	6,545				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	716,35	721,35	5	5A		1				8,33E-9	6,574				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	721,36	726,36	5	5A		1				8,33E-9	6,6				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	726,37	731,37	5	5A		1				8,33E-9	6,638				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	731,38	736,38	5	5A		1				8,33E-9	6,672				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	736,40	741,40	5	5A		1				8,33E-9	6,718				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	741,41	746,41	5	5A		1				8,33E-9	6,764				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	746,42	751,42	5	5A		1				1,39E-8	6,814				1	2,37E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	751,43	756,43	5	5A		1				1,39E-8	6,862				1	2,38E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	756,44	761,44	5	5A		1				8,33E-9	6,916				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	761,44	766,44	5	5A		1				8,33E-9	6,962				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	766,44	771,44	5	5A		1				8,33E-9	6,995				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	771,44	776,44	5	5A		1				8,33E-9	7,026				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	776,44	781,44	5	5A		1				8,33E-9	7,071				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	781,44	786,44	5	5A		1				8,33E-9	7,129				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	786,43	791,43	5	5A		1				8,33E-9	7,191				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	791,43	796,43	5	5A		1				8,33E-9	7,256				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	796,43	801,43	5	5A		1				1,39E-8	7,328				1	2,35E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	801,44	806,44	5	5A		1				8,33E-9	7,388				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	806,44	811,44	5	5A		1				8,33E-9	7,42				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	811,45	816,45	5	5A		1				8,33E-9	7,437				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	816,45	821,45	5	5A		1				8,33E-9	7,463				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	821,46	826,46	5	5A		1				8,33E-9	7,487				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	826,46	831,46	5	5A		1				1,39E-8	7,54				1	2,39E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	831,47	836,47	5	5A		1				1,39E-8	7,599				1	2,37E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	836,47	841,47	5	5A		1				8,33E-9	7,655				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	841,48	846,48	5	5A		1				8,33E-9	7,711				1	1,42E-9	1,42E-5		1	

Appendix 12

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m³/s)	Value type-Q1	Q2 (m³/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030426	101,00	996,63	846,49	851,49	5	5A		1				8,33E-9	7,775				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	851,49	856,49	5	5A		1				8,33E-9	7,825				1	1,40E-9	1,40E-5		1	
KFM02A	20030426	101,00	996,63	856,50	861,50	5	5A		1				8,33E-9	7,879				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	861,50	866,50	5	5A		1				8,33E-9	7,919				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	866,51	871,51	5	5A		1				8,33E-9	7,941				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	871,52	876,52	5	5A		1				1,39E-8	7,958				1	2,37E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	876,53	881,53	5	5A		1				8,33E-9	7,998				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	881,54	886,54	5	5A		1				8,33E-9	8,041				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	886,55	891,55	5	5A		1				8,33E-9	8,086				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	891,57	896,57	5	5A	7,85E-9	0				8,33E-9	8,144			1,19E-9	0	1,43E-9	1,43E-5	14,7	0	
KFM02A	20030426	101,00	996,63	896,57	901,57	5	5A		1				8,33E-9	8,208				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	901,57	906,57	5	5A		1				8,33E-9	8,266				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	906,58	911,58	5	5A		1				8,33E-9	8,334				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	911,58	916,58	5	5A		1				8,33E-9	8,387				1	1,41E-9	1,41E-5		1	
KFM02A	20030426	101,00	996,63	916,58	921,58	5	5A		1				8,33E-9	8,418				1	1,42E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	921,58	926,58	5	5A		1				1,39E-8	8,442				1	2,39E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	926,58	931,58	5	5A		1				1,39E-8	8,475				1	2,39E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	931,58	936,58	5	5A		1				1,39E-8	8,51				1	2,39E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	936,59	941,59	5	5A		1				1,39E-8	8,558				1	2,40E-9	1,44E-5		1	
KFM02A	20030426	101,00	996,63	941,59	946,59	5	5A		1				1,39E-8	8,618				1	2,39E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	946,59	951,59	5	5A		1				1,39E-8	8,68				1	2,38E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	951,59	956,59	5	5A		1				1,39E-8	8,74				1	2,39E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	956,59	961,59	5	5A		1				1,39E-8	8,806				1	2,38E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	961,60	966,60	5	5A		1				1,39E-8	8,878				1	2,37E-9	1,42E-5		1	
KFM02A	20030426	101,00	996,63	966,60	971,60	5	5A		1				1,39E-8	8,939				1	2,38E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	971,60	976,60	5	5A		1				1,39E-8	8,974				1	2,38E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	976,60	981,60	5	5A		1				8,33E-9	8,992				1	1,43E-9	1,43E-5		1	
KFM02A	20030426	101,00	996,63	981,61	986,61	5	5A		1				8,33E-9	9,012				1	1,45E-9	1,45E-5		1	
KFM02A	20030426	101,00	996,63	986,62	991,62	5	5A		1				8,33E-9	9,055				1	1,44E-9	1,44E-5		1	
KFM02A	20030426	101,00	996,63	991,63	996,63	5	5A		1				8,33E-9	9,111				1	1,42E-9	1,42E-5		1	
KFM02A	20030505	101,00	996,65	101,00	106,00	5	5A			1,90E-6	0		1,39E-7		4,621								

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030505	101,00	996,65	106,00	111,00	5	5A			1,49E-4	1		1,39E-7										
KFM02A	20030505	101,00	996,65	111,00	116,00	5	5A			1,11E-4	1		1,39E-7										
KFM02A	20030505	101,00	996,65	116,00	121,00	5	5A			1,56E-4	1		1,39E-7										
KFM02A	20030505	101,00	996,65	121,00	126,00	5	5A			1,82E-5	0		3,33E-8		4,473								
KFM02A	20030505	101,00	996,65	126,00	131,00	5	5A			7,42E-8	0		3,33E-8		4,423								
KFM02A	20030505	101,00	996,65	131,00	136,00	5	5A				1		3,33E-8		4,417								
KFM02A	20030505	101,00	996,65	136,01	141,01	5	5A			7,28E-8	0		1,67E-8		4,401								
KFM02A	20030505	101,00	996,65	141,01	146,01	5	5A				1		1,67E-8		4,359								
KFM02A	20030505	101,00	996,65	146,01	151,01	5	5A				1		3,33E-8		4,306								
KFM02A	20030505	101,00	996,65	151,01	156,01	5	5A				1		3,33E-8		4,268								
KFM02A	20030505	101,00	996,65	156,01	161,01	5	5A			1,33E-7	0		3,33E-8		4,248								
KFM02A	20030505	101,00	996,65	161,01	166,01	5	5A			8,02E-6	0		3,33E-8		4,223								
KFM02A	20030505	101,00	996,65	166,01	171,01	5	5A			2,57E-6	0		8,33E-9		4,176								
KFM02A	20030505	101,00	996,65	171,01	176,01	5	5A			1,02E-5	0		8,33E-9		4,115								
KFM02A	20030505	101,00	996,65	176,01	181,01	5	5A			4,08E-7	0		8,33E-9		4,061								
KFM02A	20030505	101,00	996,65	181,01	186,01	5	5A			2,04E-6	0		8,33E-9		4,037								
KFM02A	20030505	101,00	996,65	186,02	191,02	5	5A				1		8,33E-9		3,997								
KFM02A	20030505	101,00	996,65	191,02	196,02	5	5A				1		8,33E-9		3,956								
KFM02A	20030505	101,00	996,65	196,02	201,02	5	5A				1		8,33E-9		3,92								
KFM02A	20030505	101,00	996,65	201,02	206,02	5	5A				1		8,33E-9		3,904								
KFM02A	20030505	101,00	996,65	206,02	211,02	5	5A				1		8,33E-9		3,863								
KFM02A	20030505	101,00	996,65	211,02	216,02	5	5A				1		8,33E-9		3,816								
KFM02A	20030505	101,00	996,65	216,03	221,03	5	5A			4,83E-6	0		8,33E-9		3,766								
KFM02A	20030505	101,00	996,65	221,03	226,03	5	5A				1		8,33E-9		3,734								
KFM02A	20030505	101,00	996,65	226,04	231,04	5	5A			5,39E-7	0		8,33E-9		3,707								
KFM02A	20030505	101,00	996,65	231,04	236,04	5	5A				1		8,33E-9		3,674								
KFM02A	20030505	101,00	996,65	236,04	241,04	5	5A				1		8,33E-9		3,608								
KFM02A	20030505	101,00	996,65	241,04	246,04	5	5A				1		8,33E-9		3,558								
KFM02A	20030505	101,00	996,65	246,05	251,05	5	5A				1		8,33E-9		3,535								
KFM02A	20030505	101,00	996,65	251,05	256,05	5	5A				1		8,33E-9		3,523								
KFM02A	20030505	101,00	996,65	256,06	261,06	5	5A				1		8,33E-9		3,483								

Appendix 12

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030505	101,00	996,65	261,06	266,06	5	5A				1		8,33E-9		3,42								
KFM02A	20030505	101,00	996,65	266,06	271,06	5	5A			6,59E-7	0		8,33E-9		3,374								
KFM02A	20030505	101,00	996,65	271,06	276,06	5	5A			3,36E-6	0		8,33E-9		3,356								
KFM02A	20030505	101,00	996,65	276,06	281,06	5	5A			4,07E-6	0		8,33E-9		3,329								
KFM02A	20030505	101,00	996,65	281,06	286,06	5	5A			1,39E-5	0		8,33E-9		3,266								
KFM02A	20030505	101,00	996,65	286,06	291,06	5	5A			2,69E-5	0		8,33E-9		3,196								
KFM02A	20030505	101,00	996,65	291,05	296,05	5	5A			1,25E-5	0		8,33E-9		3,171								
KFM02A	20030505	101,00	996,65	296,05	301,05	5	5A			5,77E-6	0		8,33E-9		3,137								
KFM02A	20030505	101,00	996,65	301,05	306,05	5	5A			4,20E-7	0		8,33E-9		3,077								
KFM02A	20030505	101,00	996,65	306,05	311,05	5	5A				1		8,33E-9		3,013								
KFM02A	20030505	101,00	996,65	311,05	316,05	5	5A				1		8,33E-9		2,958								
KFM02A	20030505	101,00	996,65	316,06	321,06	5	5A				1		8,33E-9		2,92								
KFM02A	20030505	101,00	996,65	321,06	326,06	5	5A				1		8,33E-9		2,902								
KFM02A	20030505	101,00	996,65	326,06	331,06	5	5A				1		8,33E-9		2,852								
KFM02A	20030505	101,00	996,65	331,07	336,07	5	5A				1		8,33E-9		2,778								
KFM02A	20030505	101,00	996,65	336,07	341,07	5	5A				1		8,33E-9		2,736								
KFM02A	20030505	101,00	996,65	341,07	346,07	5	5A				1		8,33E-9		2,714								
KFM02A	20030505	101,00	996,65	346,08	351,08	5	5A				1		8,33E-9		2,663								
KFM02A	20030505	101,00	996,65	351,08	356,08	5	5A				1		8,33E-9		2,591								
KFM02A	20030505	101,00	996,65	356,08	361,08	5	5A				1		8,33E-9		2,527								
KFM02A	20030505	101,00	996,65	361,09	366,09	5	5A				1		8,33E-9		2,512								
KFM02A	20030505	101,00	996,65	366,09	371,09	5	5A				1		8,33E-9		2,496								
KFM02A	20030505	101,00	996,65	371,09	376,09	5	5A				1		8,33E-9		2,441								
KFM02A	20030505	101,00	996,65	376,10	381,10	5	5A				1		8,33E-9		2,368								
KFM02A	20030505	101,00	996,65	381,10	386,10	5	5A				1		8,33E-9		2,332								
KFM02A	20030505	101,00	996,65	386,11	391,11	5	5A				1		8,33E-9		2,31								
KFM02A	20030505	101,00	996,65	391,11	396,11	5	5A				1		8,33E-9		2,266								
KFM02A	20030505	101,00	996,65	396,11	401,11	5	5A				1		8,33E-9		2,198								
KFM02A	20030505	101,00	996,65	401,12	406,12	5	5A				1		8,33E-9		2,143								
KFM02A	20030505	101,00	996,65	406,12	411,12	5	5A				1		8,33E-9		2,11								
KFM02A	20030505	101,00	996,65	411,12	416,12	5	5A			1,43E-7	0		8,33E-9		2,08								

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m³/s)	Value type-Q1	Q2 (m³/s)	Q-measl-L-practical (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030505	101,00	996,65	416,12	421,12	5	5A			7,37E-6	0		8,33E-9		2,016								
KFM02A	20030505	101,00	996,65	421,12	426,12	5	5A			9,90E-7	0		8,33E-9		1,945								
KFM02A	20030505	101,00	996,65	426,12	431,12	5	5A			9,38E-6	0		8,33E-9		1,901								
KFM02A	20030505	101,00	996,65	431,12	436,12	5	5A			3,28E-8	0		8,33E-9		1,869								
KFM02A	20030505	101,00	996,65	436,12	441,12	5	5A			1,29E-6	0		8,33E-9		1,795								
KFM02A	20030505	101,00	996,65	441,13	446,13	5	5A			3,05E-8	0		8,33E-9		1,733								
KFM02A	20030505	101,00	996,65	446,13	451,13	5	5A			5,86E-8	0		8,33E-9		1,691								
KFM02A	20030505	101,00	996,65	451,14	456,14	5	5A			9,02E-7	0		8,33E-9		1,666								
KFM02A	20030505	101,00	996,65	456,14	461,14	5	5A			4,55E-8	0		8,33E-9		1,641								
KFM02A	20030505	101,00	996,65	461,13	466,13	5	5A			1,97E-7	0		8,33E-9		1,583								
KFM02A	20030505	101,00	996,65	466,13	471,13	5	5A			2,27E-8	0		8,33E-9		1,508								
KFM02A	20030505	101,00	996,65	471,12	476,12	5	5A				0		8,33E-9		1,461								
KFM02A	20030505	101,00	996,65	476,12	481,12	5	5A			3,06E-6	0		8,33E-9		1,42								
KFM02A	20030505	101,00	996,65	481,12	486,12	5	5A			1,44E-6	0		8,33E-9		1,374								
KFM02A	20030505	101,00	996,65	486,12	491,12	5	5A			1,05E-7	0		8,33E-9		1,307								
KFM02A	20030505	101,00	996,65	491,13	496,13	5	5A			4,60E-8	0		8,33E-9		1,264								
KFM02A	20030505	101,00	996,65	496,13	501,13	5	5A			3,59E-7	0		8,33E-9		1,234								
KFM02A	20030505	101,00	996,65	501,13	506,13	5	5A			2,77E-8	0		8,33E-9		1,189								
KFM02A	20030505	101,00	996,65	506,13	511,13	5	5A			2,80E-7	0		8,33E-9		1,122								
KFM02A	20030505	101,00	996,65	511,13	516,13	5	5A			2,88E-5	0		8,33E-9		1,05								
KFM02A	20030505	101,00	996,65	516,13	521,13	5	5A				1		8,33E-9		1,003								
KFM02A	20030505	101,00	996,65	521,14	526,14	5	5A				1		8,33E-9		0,981								
KFM02A	20030505	101,00	996,65	526,14	531,14	5	5A				1		8,33E-9		0,928								
KFM02A	20030505	101,00	996,65	531,14	536,14	5	5A				1		8,33E-9		0,866								
KFM02A	20030505	101,00	996,65	536,15	541,15	5	5A				1		8,33E-9		0,818								
KFM02A	20030505	101,00	996,65	541,15	546,15	5	5A				1		8,33E-9		0,787								
KFM02A	20030505	101,00	996,65	546,15	551,15	5	5A				1		8,33E-9		0,744								
KFM02A	20030505	101,00	996,65	551,16	556,16	5	5A				1		8,33E-9		0,662								
KFM02A	20030505	101,00	996,65	556,16	561,16	5	5A			3,88E-9	0		8,33E-9		0,586								
KFM02A	20030505	101,00	996,65	561,16	566,16	5	5A				1		8,33E-9		0,553								
KFM02A	20030505	101,00	996,65	566,17	571,17	5	5A				1		8,33E-9		0,517								

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030505	101,00	996,65	571,17	576,17	5	5A				1		8,33E-9		0,46								
KFM02A	20030505	101,00	996,65	576,17	581,17	5	5A				1		8,33E-9		0,399								
KFM02A	20030505	101,00	996,65	581,18	586,18	5	5A				1		8,33E-9		0,33								
KFM02A	20030505	101,00	996,65	586,18	591,18	5	5A				1		8,33E-9		0,287								
KFM02A	20030505	101,00	996,65	591,18	596,18	5	5A				1		8,33E-9		0,278								
KFM02A	20030505	101,00	996,65	596,19	601,19	5	5A				1		8,33E-9		0,181								
KFM02A	20030505	101,00	996,65	601,19	606,19	5	5A				1		8,33E-9		0,128								
KFM02A	20030505	101,00	996,65	606,19	611,19	5	5A				1		8,33E-9		0,128								
KFM02A	20030505	101,00	996,65	611,20	616,20	5	5A				1		8,33E-9		0,112								
KFM02A	20030505	101,00	996,65	616,21	621,21	5	5A				1		8,33E-9		0,09								
KFM02A	20030505	101,00	996,65	621,21	626,21	5	5A				1		8,33E-9		0,028								
KFM02A	20030505	101,00	996,65	626,22	631,22	5	5A				1		8,33E-9		0,049								
KFM02A	20030505	101,00	996,65	631,23	636,23	5	5A				1		8,33E-9		0,064								
KFM02A	20030505	101,00	996,65	636,23	641,23	5	5A				1		8,33E-9		0,113								
KFM02A	20030505	101,00	996,65	641,24	646,24	5	5A				1		8,33E-9		0,175								
KFM02A	20030505	101,00	996,65	646,25	651,25	5	5A				1		8,33E-9		0,22								
KFM02A	20030505	101,00	996,65	651,26	656,26	5	5A				1		8,33E-9		0,238								
KFM02A	20030505	101,00	996,65	656,26	661,26	5	5A				1		8,33E-9		0,248								
KFM02A	20030505	101,00	996,65	661,27	666,27	5	5A				1		8,33E-9		0,311								
KFM02A	20030505	101,00	996,65	666,28	671,28	5	5A				1		8,33E-9		0,37								
KFM02A	20030505	101,00	996,65	671,28	676,28	5	5A				1		8,33E-9		0,401								
KFM02A	20030505	101,00	996,65	676,29	681,29	5	5A				1		8,33E-9		0,408								
KFM02A	20030505	101,00	996,65	681,30	686,30	5	5A				1		1,39E-8		0,436								
KFM02A	20030505	101,00	996,65	686,30	691,30	5	5A				1		1,39E-8		0,504								
KFM02A	20030505	101,00	996,65	691,31	696,31	5	5A				1		8,33E-9		0,561								
KFM02A	20030505	101,00	996,65	696,32	701,32	5	5A				1		8,33E-9		0,596								
KFM02A	20030505	101,00	996,65	701,32	706,32	5	5A				1		8,33E-9		0,629								
KFM02A	20030505	101,00	996,65	706,33	711,33	5	5A				1		8,33E-9		0,688								
KFM02A	20030505	101,00	996,65	711,34	716,34	5	5A				1		8,33E-9		0,748								
KFM02A	20030505	101,00	996,65	716,35	721,35	5	5A				1		8,33E-9		0,762								
KFM02A	20030505	101,00	996,65	721,36	726,36	5	5A				1		8,33E-9		0,766								

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m³/s)	Value type-Q1	Q2 (m³/s)	Q-measl-L-practi-cal (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030505	101,00	996,65	726,37	731,37	5	5A				1		8,33E-9		0,827								
KFM02A	20030505	101,00	996,65	731,38	736,38	5	5A				1		8,33E-9		0,894								
KFM02A	20030505	101,00	996,65	736,38	741,38	5	5A				1		8,33E-9		0,93								
KFM02A	20030505	101,00	996,65	741,39	746,39	5	5A				1		8,33E-9		0,951								
KFM02A	20030505	101,00	996,65	746,40	751,40	5	5A				1		1,39E-8		1,018								
KFM02A	20030505	101,00	996,65	751,41	756,41	5	5A				1		1,39E-8		1,089								
KFM02A	20030505	101,00	996,65	756,42	761,42	5	5A				1		8,33E-9		1,103								
KFM02A	20030505	101,00	996,65	761,43	766,43	5	5A				1		8,33E-9		1,109								
KFM02A	20030505	101,00	996,65	766,43	771,43	5	5A				1		8,33E-9		1,178								
KFM02A	20030505	101,00	996,65	771,43	776,43	5	5A				1		8,33E-9		1,244								
KFM02A	20030505	101,00	996,65	776,43	781,43	5	5A				1		8,33E-9		1,276								
KFM02A	20030505	101,00	996,65	781,43	786,43	5	5A				1		8,33E-9		1,321								
KFM02A	20030505	101,00	996,65	786,44	791,44	5	5A				1		8,33E-9		1,41								
KFM02A	20030505	101,00	996,65	791,44	796,44	5	5A				1		8,33E-9		1,471								
KFM02A	20030505	101,00	996,65	796,44	801,44	5	5A				1		1,39E-8		1,477								
KFM02A	20030505	101,00	996,65	801,45	806,45	5	5A				1		8,33E-9		1,513								
KFM02A	20030505	101,00	996,65	806,45	811,45	5	5A				1		8,33E-9		1,591								
KFM02A	20030505	101,00	996,65	811,46	816,46	5	5A				1		8,33E-9		1,62								
KFM02A	20030505	101,00	996,65	816,47	821,47	5	5A				1		8,33E-9		1,624								
KFM02A	20030505	101,00	996,65	821,47	826,47	5	5A				1		8,33E-9		1,695								
KFM02A	20030505	101,00	996,65	826,48	831,48	5	5A				1		1,39E-8		1,786								
KFM02A	20030505	101,00	996,65	831,49	836,49	5	5A				1		1,39E-8		1,796								
KFM02A	20030505	101,00	996,65	836,50	841,50	5	5A				1		8,33E-9		1,83								
KFM02A	20030505	101,00	996,65	841,50	846,50	5	5A				1		8,33E-9		1,911								
KFM02A	20030505	101,00	996,65	846,51	851,51	5	5A				1		8,33E-9		1,929								
KFM02A	20030505	101,00	996,65	851,52	856,52	5	5A				1		8,33E-9		1,939								
KFM02A	20030505	101,00	996,65	856,52	861,52	5	5A				1		8,33E-9		2,039								
KFM02A	20030505	101,00	996,65	861,53	866,53	5	5A				1		8,33E-9		2,094								
KFM02A	20030505	101,00	996,65	866,54	871,54	5	5A				1		8,33E-9		2,102								
KFM02A	20030505	101,00	996,65	871,55	876,55	5	5A				1		1,39E-8		2,172								
KFM02A	20030505	101,00	996,65	876,56	881,56	5	5A				1		8,33E-9		2,239								

Appendix 12

Bore-hole	Date and time of test, start	Logged interval from (m)	Logged interval to (m)	Secup (m)	Seclow (m)	b (m)	Test type	Q0 (m3/s)	Value type-Q0	Q1 (m^3/s)	Value type-Q1	Q2 (m^3/s)	Q-measl-L-practical (m3/s)	h0f (masl)	h1f (masl)	h2f (masl)	TD (m2/s)	Value type-TD	TD-measl-L-practical (m2/s)	TD-measl-U-practical (m2/s)	hi (m)	Value type-hi	Comments
KFM02A	20030505	101,00	996,65	881,58	886,58	5	5A				1		8,33E-9		2,244								
KFM02A	20030505	101,00	996,65	886,60	891,60	5	5A				1		8,33E-9		2,297								
KFM02A	20030505	101,00	996,65	891,61	896,61	5	5A			1,48E-8	0		8,33E-9		2,367								
KFM02A	20030505	101,00	996,65	896,62	901,62	5	5A				1		8,33E-9		2,382								
KFM02A	20030505	101,00	996,65	901,62	906,62	5	5A				1		8,33E-9		2,427								
KFM02A	20030505	101,00	996,65	906,62	911,62	5	5A				1		8,33E-9		2,524								
KFM02A	20030505	101,00	996,65	911,62	916,62	5	5A				1		8,33E-9		2,56								
KFM02A	20030505	101,00	996,65	916,62	921,62	5	5A				1		8,33E-9		2,602								
KFM02A	20030505	101,00	996,65	921,62	926,62	5	5A				1		1,39E-8		2,691								
KFM02A	20030505	101,00	996,65	926,62	931,62	5	5A				1		1,39E-8		2,721								
KFM02A	20030505	101,00	996,65	931,62	936,62	5	5A				1		1,39E-8		2,758								
KFM02A	20030505	101,00	996,65	936,62	941,62	5	5A				1		1,39E-8		2,843								
KFM02A	20030505	101,00	996,65	941,62	946,62	5	5A				1		1,39E-8		2,867								
KFM02A	20030505	101,00	996,65	946,63	951,63	5	5A				1		1,39E-8		2,902								
KFM02A	20030505	101,00	996,65	951,63	956,63	5	5A				1		1,39E-8		2,992								
KFM02A	20030505	101,00	996,65	956,63	961,63	5	5A				1		1,39E-8		3,041								
KFM02A	20030505	101,00	996,65	961,63	966,63	5	5A				1		1,39E-8		3,084								
KFM02A	20030505	101,00	996,65	966,63	971,63	5	5A				1		1,39E-8		3,174								
KFM02A	20030505	101,00	996,65	971,63	976,63	5	5A				1		1,39E-8		3,199								
KFM02A	20030505	101,00	996,65	976,63	981,63	5	5A				1		8,33E-9		3,248								
KFM02A	20030505	101,00	996,65	981,64	986,64	5	5A				1		8,33E-9		3,323								
KFM02A	20030505	101,00	996,65	986,64	991,64	5	5A				1		8,33E-9		3,328								
KFM02A	20030505	101,00	996,65	991,65	996,65	5	5A				1		8,33E-9		3,301								
KFM02A	20030512	108,00	123,00	106,00	111,00	5	5A					2,06E-5	1,39E-7			0,714							Remeasured*
KFM02A	20030512	108,00	123,00	111,00	116,00	5	5A					1,06E-5	1,39E-7			0,73							Remeasured*
KFM02A	20030512	108,00	123,00	116,00	121,00	5	5A					1,92E-5	1,39E-7			0,784							Remeasured*

* Remeasured with lower pumping rate

PFL Difference flow logging - Overlapping logging

Bore-hole ID	Date and time of test, start yyyymmdd hhmm	Logged interval from (m)	Logged interval to (m)	dL (m)	Test type (1-6)	Li (m)	Upper limit L (m)	Lower limit L (m)	Q0 m³/s	Value type-Q0	Q1 m³/s	Q2 m³/s	Q-measl-L-practi-cal m³/s	h0f (masl)	h1f (masl)	h2f (masl)	bi (m)	TD (m²/s)	TD-measl-L-practical (m²/s)	TD-measl-U (m²/s)	hi (m)	Tef °C	ECf (S/m)	tf (s)	Comments
																									(-)
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	101,8	101,75	101,85	8,33E-9	-1	1,94E-7		1,39E-7	1,23	-4,64		0,1	3,28E-8	2,3E-8	1,4E-5		7,1			Uncertain
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	110,1	110,05	110,15	8,33E-9	-1		3,14E-7	1,39E-7	1,21	-4,633	0,68	0,1	5,86E-7	2,4E-8	1,6E-4		7,0			Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	110,7	110,65	110,75	-7,39E-7	0		2,03E-5	1,39E-7	1,21	-4,626	0,71	0,1	4,21E-5	2,4E-8	1,7E-4	1,2	7,0	0,22	800	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	111,1	111,05	111,15	8,33E-9	-1		1,03E-6	1,39E-7	1,20	-4,626	0,72	0,1	2,10E-6	2,4E-8	1,7E-4		7,0	0,22	2594	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	112,9	112,85	112,95	8,33E-9	-1		2,38E-6	1,39E-7	1,20	-4,625	0,73	0,1	4,99E-6	2,4E-8	1,7E-4		7,0	0,16	799	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	114,2	114,15	114,25	8,33E-9	-1		7,18E-6	1,39E-7	1,20	-4,617	0,74	0,1	1,53E-5	2,4E-8	1,8E-4		7,1	0,18	799	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	115,6	115,55	115,65	8,33E-9	-1		5,42E-8	1,39E-7	1,21	-4,599	0,75	0,1	1,15E-7	2,4E-8	1,8E-4		7,1			Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	116,6	116,55	116,65	8,33E-9	-1		1,90E-6	1,39E-7	1,22	-4,611	0,76	0,1	4,08E-6	2,4E-8	1,8E-4		7,1	0,14	799	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	117,5	117,45	117,55	8,33E-9	-1		1,81E-6	1,39E-7	1,23	-4,596	0,76	0,1	3,82E-6	2,4E-8	1,8E-4		7,1	0,15	788	Uncertain. Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	118,3	118,25	118,35	8,33E-9	-1		5,56E-6	1,39E-7	1,24	-4,576	0,77	0,1	1,17E-5	2,4E-8	1,8E-4		7,0	0,12	799	Uncertain. Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	118,9	118,85	118,95	8,33E-9	-1		2,22E-6	1,39E-7	1,25	-4,578	0,79	0,1	4,84E-6	2,4E-8	1,8E-4		7,1	0,12	667	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	119,1	119,05	119,15	8,33E-9	-1		7,50E-7	1,39E-7	1,24	-4,576	0,78	0,1	1,60E-6	2,4E-8	1,8E-4		7,1	0,12	667	Uncertain. Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	120,5	120,45	120,55	8,33E-9	-1		1,44E-6	1,39E-7	1,26	-4,558	0,81	0,1	3,15E-6	2,4E-8	1,8E-4		7,2			Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	120,9	120,85	120,95	8,33E-9	-1		5,56E-6	1,39E-7	1,26	-4,555	0,81	0,1	1,22E-5	2,4E-8	1,8E-4		7,2	0,35	799	Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	121,2	121,15	121,25	8,33E-9	-1		3,61E-7	1,39E-7	1,26	-4,541	0,82	0,1	8,04E-7	2,4E-8	1,9E-4		7,1	0,41	799	Uncertain. Remeasured*
KFM02A	20030512 16:00	108,00	123,00	0,1	5B	122,3	122,25	122,35	8,33E-9	-1		5,56E-8	1,39E-7	1,27	-4,535	0,84	0,1	1,27E-7	2,4E-8	1,9E-4		7,9			Remeasured*
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	124,9	124,85	124,95	8,33E-9	-1	8,89E-8		3,33E-8	1,30	-4,49		0,1	1,52E-8	5,7E-9	1,4E-5		8,1			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	126,0	125,95	126,05	8,33E-9	-1	2,50E-8		3,33E-8	1,31	-4,49		0,1	4,26E-9	5,7E-9	1,4E-5		8,1			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	129,7	129,65	129,75	8,33E-9	-1	6,11E-8		3,33E-8	1,35	-4,47		0,1	1,04E-8	5,7E-9	1,4E-5		8,2			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	137,0	136,95	137,05	8,33E-9	-1	5,56E-8		3,33E-8	1,38	-4,45		0,1	9,42E-9	5,7E-9	1,4E-5		8,2			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	160,7	160,65	160,75	8,33E-9	-1	1,22E-7		3,33E-8	1,58	-4,26		0,1	2,07E-8	5,7E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	161,7	161,65	161,75	8,33E-9	-1	3,36E-7		3,33E-8	1,60	-4,24		0,1	5,69E-8	5,6E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	162,5	162,45	162,55	7,50E-7	0	5,06E-6		3,33E-8	1,60	-4,24		0,1	7,30E-7	5,7E-9	1,4E-5	2,6	8,0	1,27	3683	
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	163,0	162,95	163,05	8,33E-9	-1	9,17E-7		3,33E-8	1,59	-4,22		0,1	1,56E-7	5,7E-9	1,4E-5		8,0	1,27	3683	
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	163,5	163,45	163,55	8,33E-9	-1	1,28E-7		3,33E-8	1,59	-4,21		0,1	2,18E-8	5,7E-9	1,4E-5		8,2			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	165,0	164,95	165,05	8,33E-9	-1	4,97E-7		3,33E-8	1,62	-4,20		0,1	8,46E-8	5,7E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	166,8	166,75	166,85	8,33E-9	-1	8,83E-7		8,33E-9	1,64	-4,19		0,1	1,50E-7	1,4E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	167,4	167,35	167,45	8,33E-9	-1	8,61E-8		8,33E-9	1,64	-4,17		0,1	1,47E-8	1,4E-9	1,4E-5		8,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	167,8	167,75	167,85	8,33E-9	-1	1,67E-8		8,33E-9	1,63	-4,17		0,1	2,84E-9	1,4E-9	1,4E-5		8,5			

Appendix 12

Bore-hole ID	Date and time of test, start yyyymmdd hhmm	Logged interval from (m)	Logged interval to (m)	dL (m)	Test type (1-6)	Li (m)	Upper limit L (m)	Lower limit L (m)	Q0 m³/s	Value type-Q0	Q1 m³/s	Q2 m³/s	Q-measl-L-practi-cal m³/s	h0f (masl)	h1f (masl)	h2f (masl)	bi (m)	TD (m²/s)	TD-measl-L -practical (m²/s)	TD-measl-U (m²/s)	hi (m)	Tef °C	ECf (S/m)	tf (s)	Comments
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	169,4	169,35	169,45	8,33E-9	-1	5,69E-8		8,33E-9	1,63	-4,17		0,1	9,71E-9	1,4E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	170,0	169,95	170,05	8,33E-9	-1	1,07E-6		8,33E-9	1,63	-4,15		0,1	1,83E-7	1,4E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	171,5	171,45	171,55	2,78E-7	0	7,97E-6		8,33E-9	1,66	-4,15		0,1	1,31E-6	1,4E-9	1,4E-5	1,9	8,0	1,16	2104	
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	171,9	171,85	171,95	8,33E-9	-1	1,08E-6		8,33E-9	1,66	-4,14		0,1	1,85E-7	1,4E-9	1,4E-5		8,0	1,16	2104	
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	172,6	172,55	172,65	8,33E-9	-1	2,56E-7		8,33E-9	1,66	-4,15		0,1	4,36E-8	1,4E-9	1,4E-5		8,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	174,4	174,35	174,45	8,33E-9	-1	4,44E-7		8,33E-9	1,66	-4,14		0,1	7,58E-8	1,4E-9	1,4E-5		8,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	174,9	174,85	174,95	8,33E-9	-1	1,81E-8		8,33E-9	1,67	-4,15		0,1	3,07E-9	1,4E-9	1,4E-5		8,6			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	178,5	178,45	178,55	8,33E-9	-1	8,75E-8		8,33E-9	1,68	-4,12		0,1	1,49E-8	1,4E-9	1,4E-5		8,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	179,4	179,35	179,45	8,33E-9	-1	2,72E-7		8,33E-9	1,68	-4,12		0,1	4,64E-8	1,4E-9	1,4E-5		8,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	182,6	182,55	182,65	8,33E-9	-1	6,06E-7		8,33E-9	1,70	-4,08		0,1	1,04E-7	1,4E-9	1,4E-5		8,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	183,2	183,15	183,25	8,33E-9	-1	1,11E-6		8,33E-9	1,71	-4,07		0,1	1,90E-7	1,4E-9	1,4E-5		8,5			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	183,5	183,45	183,55	8,33E-9	-1	3,61E-7		8,33E-9	1,71	-4,06		0,1	6,19E-8	1,4E-9	1,4E-5		8,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	217,0	216,95	217,05	8,33E-9	-1	4,01E-6		8,33E-9	2,05	-3,81		0,1	6,77E-7	1,4E-9	1,4E-5		8,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	219,2	219,15	219,25	8,33E-9	-1	1,00E-7		8,33E-9	2,06	-3,82		0,1	1,68E-8	1,4E-9	1,4E-5		9,0			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	227,8	227,75	227,85	-5,83E-9	0	4,94E-7		8,33E-9	2,14	-3,71		0,1	8,46E-8	1,4E-9	1,4E-5	2,1	9,0			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	266,6	266,55	266,65	5,14E-8	0	6,14E-7		8,33E-9	2,47	-3,37		0,1	9,53E-8	1,4E-9	1,4E-5	3,0	9,2			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	267,1	267,05	267,15	8,33E-9	-1	7,50E-8		8,33E-9	2,45	-3,38		0,1	1,27E-8	1,4E-9	1,4E-5		9,3			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	273,0	272,95	273,05	8,33E-9	-1	4,06E-7		8,33E-9	2,52	-3,31		0,1	6,87E-8	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	274,0	273,95	274,05	8,33E-9	-1	3,14E-7		8,33E-9	2,53	-3,31		0,1	5,32E-8	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	275,0	274,95	275,05	8,33E-9	-1	1,40E-6		8,33E-9	2,54	-3,30		0,1	2,37E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	276,0	275,95	276,05	8,33E-9	-1	1,67E-6		8,33E-9	2,54	-3,31		0,1	2,82E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	277,0	276,95	277,05	8,33E-9	-1	7,92E-7		8,33E-9	2,56	-3,31		0,1	1,34E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	278,0	277,95	278,05	8,33E-9	-1	4,06E-7		8,33E-9	2,56	-3,31		0,1	6,83E-8	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	279,0	278,95	279,05	8,33E-9	-1	5,50E-7		8,33E-9	2,57	-3,31		0,1	9,26E-8	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	280,0	279,95	280,05	8,33E-9	-1	8,22E-7		8,33E-9	2,58	-3,30		0,1	1,38E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	281,0	280,95	281,05	8,33E-9	-1	1,63E-6		8,33E-9	2,59	-3,30		0,1	2,73E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	282,0	281,95	282,05	8,33E-9	-1	1,99E-6		8,33E-9	2,60	-3,28		0,1	3,35E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	283,0	282,95	283,05	8,33E-9	-1	1,52E-6		8,33E-9	2,60	-3,27		0,1	2,56E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	284,0	283,95	284,05	8,33E-9	-1	4,11E-6		8,33E-9	2,61	-3,26		0,1	6,93E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	285,0	284,95	285,05	8,33E-9	-1	4,52E-6		8,33E-9	2,61	-3,24		0,1	7,64E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	286,0	285,95	286,05	8,33E-9	-1	3,96E-6		8,33E-9	2,62	-3,24		0,1	6,69E-7	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	287,0	286,95	287,05	8,33E-9	-1	2,93E-6		8,33E-9	2,63	-3,22		0,1	4,96E-7	1,4E-9	1,4E-5		9,4			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	288,0	287,95	288,05	8,33E-9	-1	4,52E-6		8,33E-9	2,63	-3,20		0,1	7,67E-7	1,4E-9	1,4E-5		9,4			Porous rock

Bore-hole ID	Date and time of test, start yyyymmdd hhmm	Logged interval from (m)	Logged interval to (m)	dL (m)	Test type (1-6)	Li (m)	Upper limit L (m)	Lower limit L (m)	Q0 m^3/s	Value type-Q0	Q1 m^3/s	Q2 m^3/s	Q-measl-L-practi-cal m^3/s	h0f (masl)	h1f (masl)	h2f (masl)	bi (m)	TD (m^2/s)	TD-measl-L -practical (m^2/s)	TD-measl-U (m^2/s)	hi (m)	Tef °C	ECf (S/m)	tf (s)	Comments
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	289,0	288,95	289,05	8,33E-9	-1	1,32E-5		8,33E-9	2,64	-3,19		0,1	2,25E-6	1,4E-9	1,4E-5		9,3			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	290,0	289,95	290,05	8,33E-9	-1	6,78E-6		8,33E-9	2,65	-3,17		0,1	1,15E-6	1,4E-9	1,4E-5		9,4			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	291,0	290,95	291,05	8,33E-9	-1	5,14E-6		8,33E-9	2,66	-3,16		0,1	8,74E-7	1,4E-9	1,4E-5		9,4			Porous rock
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	291,8	291,75	291,85	8,33E-9	-1	6,89E-6		8,33E-9	2,67	-3,15		0,1	1,17E-6	1,4E-9	1,4E-5		9,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	292,5	292,45	292,55	8,33E-9	-1	4,72E-7		8,33E-9	2,67	-3,14		0,1	8,04E-8	1,4E-9	1,4E-5		9,5			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	293,2	293,15	293,25	8,33E-9	-1	3,06E-7		8,33E-9	2,67	-3,14		0,1	5,20E-8	1,4E-9	1,4E-5		9,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	293,9	293,85	293,95	8,33E-9	-1	7,78E-8		8,33E-9	2,68	-3,14		0,1	1,32E-8	1,4E-9	1,4E-5		9,6			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	295,5	295,45	295,55	8,33E-9	-1	9,17E-7		8,33E-9	2,69	-3,13		0,1	1,56E-7	1,4E-9	1,4E-5		9,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	296,0	295,95	296,05	8,33E-9	-1	2,72E-6		8,33E-9	2,70	-3,13		0,1	4,62E-7	1,4E-9	1,4E-5		9,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	296,5	296,45	296,55	8,33E-9	-1	3,75E-7		8,33E-9	2,71	-3,14		0,1	6,34E-8	1,4E-9	1,4E-5		9,5			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	298,9	298,85	298,95	8,33E-9	-1	2,92E-7		8,33E-9	2,72	-3,12		0,1	4,94E-8	1,4E-9	1,4E-5		9,7			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	299,4	299,35	299,45	8,33E-9	-1	1,89E-6		8,33E-9	2,74	-3,12		0,1	3,19E-7	1,4E-9	1,4E-5		9,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	301,7	301,65	301,75	1,94E-8	0	4,03E-7		8,33E-9	2,75	-3,11		0,1	6,46E-8	1,4E-9	1,4E-5	3,1	9,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	411,2	411,15	411,25	8,33E-9	-1	4,03E-8		8,33E-9	3,82	-2,00		0,1	6,85E-9	1,4E-9	1,4E-5		10,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	411,8	411,75	411,85	8,33E-9	-1	9,44E-8		8,33E-9	3,83	-1,99		0,1	1,61E-8	1,4E-9	1,4E-5		10,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	416,5	416,45	416,55	8,33E-9	-1	3,14E-7		8,33E-9	3,85	-1,98		0,1	5,32E-8	1,4E-9	1,4E-5		10,8			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	417,3	417,25	417,35	1,17E-7	0	5,42E-6		8,33E-9	3,86	-1,96		0,1	9,01E-7	1,4E-9	1,4E-5	4,0	10,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	418,4	418,35	418,45	2,78E-8	0	8,72E-7		8,33E-9	3,87	-1,97		0,1	1,43E-7	1,4E-9	1,4E-5	4,1	10,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	419,9	419,85	419,95	8,33E-9	-1	6,67E-8		8,33E-9	3,87	-1,95		0,1	1,13E-8	1,4E-9	1,4E-5		10,8			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	423,7	423,65	423,75	8,33E-9	-1	1,94E-8		8,33E-9	3,90	-1,88		0,1	3,33E-9	1,4E-9	1,4E-5		10,8			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	425,1	425,05	425,15	8,33E-9	-1	2,53E-7		8,33E-9	3,94	-1,86		0,1	4,31E-8	1,4E-9	1,4E-5		10,8			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	425,9	425,85	425,95	8,33E-9	-1	6,50E-7		8,33E-9	3,92	-1,87		0,1	1,11E-7	1,4E-9	1,4E-5		10,8			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	426,8	426,75	426,85	8,33E-9	-1	4,17E-6		8,33E-9	3,93	-1,83		0,1	7,15E-7	1,4E-9	1,4E-5		10,7	1,58	2613	
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	427,2	427,15	427,25	8,33E-9	-1	4,17E-6		8,33E-9	3,94	-1,84		0,1	7,13E-7	1,4E-9	1,4E-5		10,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	428,9	428,85	428,95	8,33E-9	-1	5,83E-8		8,33E-9	3,94	-1,78		0,1	1,01E-8	1,4E-9	1,4E-5		10,9			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	434,4	434,35	434,45	8,33E-9	-1	2,92E-8		8,33E-9	3,99	-1,77		0,1	5,01E-9	1,4E-9	1,4E-5		11,0			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	437,0	436,95	437,05	8,33E-9	-1	4,39E-7		8,33E-9	4,07	-1,74		0,1	7,47E-8	1,4E-9	1,4E-5		11,0			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	437,3	437,25	437,35	3,47E-8	0	6,67E-7		8,33E-9	4,08	-1,75		0,1	1,07E-7	1,4E-9	1,4E-5	4,4	11,0			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	438,5	438,45	438,55	8,33E-9	-1	3,75E-8		8,33E-9	4,09	-1,77		0,1	6,34E-9	1,4E-9	1,4E-5		11,0			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	441,2	441,15	441,25	8,33E-9	-1	2,78E-8		8,33E-9	4,10	-1,72		0,1	4,73E-9	1,4E-9	1,4E-5		11,1			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	448,1	448,05	448,15	8,33E-9	-1	3,72E-8		8,33E-9	4,15	-1,66		0,1	6,35E-9	1,4E-9	1,4E-5		11,1			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	448,8	448,75	448,85	8,33E-9	-1	7,50E-9		8,33E-9	4,17	-1,65		0,1	1,27E-9	1,4E-9	1,4E-5		11,1			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	454,0	453,95	454,05	3,33E-8	0	5,56E-7		8,33E-9	4,21	-1,60		0,1	8,89E-8	1,4E-9	1,4E-5	4,6	11,1			

Appendix 12

Bore-hole ID	Date and time of test, start yyyymmdd hhmm	Logged interval from (m)	Logged interval to (m)	dL (m)	Test type (1-6)	Li (m)	Upper limit L (m)	Lower limit L (m)	Q0 m³/s	Value type-Q0	Q1 m³/s	Q2 m³/s	Q-measl-L-practi-cal m³/s	h0f (masl)	h1f (masl)	h2f (masl)	bi (m)	TD (m²/s)	TD-measl-L -practical (m²/s)	TD-measl-U (m²/s)	hi (m)	Tef °C	ECf (S/m)	tf (s)	Comments
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	454,4	454,35	454,45	8,33E-9	-1	2,78E-7		8,33E-9	4,22	-1,58		0,1	4,74E-8	1,4E-9	1,4E-5		11,1			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	454,9	454,85	454,95	8,33E-9	-1	3,47E-8		8,33E-9	4,21	-1,62		0,1	5,89E-9	1,4E-9	1,4E-5		11,1			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	459,7	459,65	459,75	8,33E-9	-1	4,08E-8		8,33E-9	4,27	-1,54		0,1	6,95E-9	1,4E-9	1,4E-5		11,2			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	462,5	462,45	462,55	8,33E-9	-1	1,53E-7		8,33E-9	4,30	-1,51		0,1	2,60E-8	1,4E-9	1,4E-5		11,3			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	463,2	463,15	463,25	8,33E-9	-1	1,94E-8		8,33E-9	4,30	-1,47		0,1	3,33E-9	1,4E-9	1,4E-5		11,3			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	465,3	465,25	465,35	8,33E-9	-1	3,61E-9		8,33E-9	4,33	-1,47		0,1	6,16E-10	1,4E-9	1,4E-5		11,3			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	468,6	468,55	468,65	8,33E-9	-1	1,69E-8		8,33E-9	4,33	-1,44		0,1	2,90E-9	1,4E-9	1,4E-5		11,3			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	477,8	477,75	477,85	8,33E-9	-1	1,61E-8		8,33E-9	4,45	-1,38		0,1	2,74E-9	1,4E-9	1,4E-5		11,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	479,2	479,15	479,25	1,39E-8	0	3,44E-7		8,33E-9	4,45	-1,35		0,1	5,64E-8	1,4E-9	1,4E-5	4,7	11,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	480,4	480,35	480,45	1,39E-7	0	2,36E-6		8,33E-9	4,46	-1,33		0,1	3,79E-7	1,4E-9	1,4E-5	4,8	11,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	481,2	481,15	481,25	8,33E-9	-1	1,97E-7		8,33E-9	4,49	-1,32		0,1	3,35E-8	1,4E-9	1,4E-5		11,4			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	484,6	484,55	484,65	8,33E-9	-1	3,33E-8		8,33E-9	4,48	-1,26		0,1	5,75E-9	1,4E-9	1,4E-5		11,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	485,6	485,55	485,65	8,33E-9	-1	9,44E-8		8,33E-9	4,48	-1,24		0,1	1,63E-8	1,4E-9	1,4E-5		11,5			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	486,1	486,05	486,15	6,94E-8	0	1,04E-6		8,33E-9	4,50	-1,25		0,1	1,67E-7	1,4E-9	1,4E-5	4,9	11,5			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	486,4	486,35	486,45	8,33E-9	-1	6,25E-8		8,33E-9	4,51	-1,23		0,1	1,08E-8	1,4E-9	1,4E-5		11,5			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	493,4	493,35	493,45	8,33E-9	-1	1,89E-8		8,33E-9	4,55	-1,24		0,1	3,23E-9	1,4E-9	1,4E-5		11,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	495,5	495,45	495,55	8,33E-9	-1	1,67E-8		8,33E-9	4,56	-1,20		0,1	2,86E-9	1,4E-9	1,4E-5		11,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	496,5	496,45	496,55	8,33E-9	-1	1,49E-7		8,33E-9	4,57	-1,21		0,1	2,55E-8	1,4E-9	1,4E-5		11,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	497,3	497,25	497,35	8,33E-9	-1	3,33E-8		8,33E-9	4,59	-1,18		0,1	5,72E-9	1,4E-9	1,4E-5		11,6			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	498,1	498,05	498,15	9,44E-9	0	1,33E-7		8,33E-9	4,57	-1,18		0,1	2,13E-8	1,4E-9	1,4E-5	5,0	11,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	498,3	498,25	498,35	8,33E-9	-1	8,33E-9		8,33E-9	4,57	-1,19		0,1	1,43E-9	1,4E-9	1,4E-5		11,6			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	500,3	500,25	500,35	8,33E-9	-1	2,78E-8		8,33E-9	4,59	-1,13		0,1	4,81E-9	1,4E-9	1,4E-5		11,6			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	500,9	500,85	500,95	8,33E-9	-1	1,11E-8		8,33E-9	4,60	-1,13		0,1	1,92E-9	1,4E-9	1,4E-5		11,6			Uncertain
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	501,4	501,35	501,45	8,33E-9	-1	2,22E-8		8,33E-9	4,60	-1,10		0,1	3,85E-9	1,4E-9	1,4E-5		11,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	506,5	506,45	506,55	1,83E-8	0	2,61E-7		8,33E-9	4,66	-1,04		0,1	4,21E-8	1,4E-9	1,4E-5	5,1	11,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	512,3	512,25	512,35	8,33E-9	-1	2,08E-8		8,33E-9	4,74	-1,01		0,1	3,59E-9	1,4E-9	1,4E-5		11,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	512,6	512,55	512,65	8,33E-9	-1	1,11E-7		8,33E-9	4,75	-1,03		0,1	1,90E-8	1,4E-9	1,4E-5		11,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	513,1	513,05	513,15	8,33E-9	-1	7,08E-7		8,33E-9	4,75	-1,00		0,1	1,22E-7	1,4E-9	1,4E-5		11,7			
KFM02A	20030508 17:05	100,00	566,21	0,1	5B	513,6	513,55	513,65	8,33E-7	0	2,25E-5		8,33E-9	4,76	-1,00		0,1	3,73E-6	1,4E-9	1,4E-5	5,0	11,7	1,56	939	
KFM02A	20030508 17:05	886,49	900,62	0,1	5B	894,0	893,95	894,05	8,33E-9	0	2,50E-8		8,33E-9	8,13	2,46		0,1	2,62E-9	1,5E-9	1,5E-5		16,4			Uncertain

* Remeasured with lower pumping rate

Appendix 12

SICADA - description PLU PFL-Difference Flowlogging

Header	Unit	Description
Borehole		borehole identification code
Secup	m	Length coordinate along the borehole for the upper limit of the logged section (Based on corrected length L)
Seclow	m	Length coordinate along the borehole for the lower limit of the logged section. (Based on corrected length L)
Test type		1A: Pumping test - wireline eq., 1B:Pumping test-submersible pump, 1C: Pumpingtest-airlift pumping, 2: Interference test, 3: Injection test, 4: Slug test, 5A: Difference flow logging-PFL-DIFF-Sequential, 5B: Difference flow logging-PFL-DIFF-Overlapping, 6: Flow logging-Impeller
Formation type		1: Rock, 2: Soil (superficial deposits)
Date and time of test, start		Date for the start of the test (YYYY-MM-DD hh:mm)
Date and time of test, stop		Date for the stop of the test (YYYY-MM-DD hh:mm)
Date and time of flow logging, start		Date and time of flow logging start (YYYY-MM-DD hh:mm:ss)
Date and time of flow logging, stop		Date and time of flow logging stop (YYYY-MM-DD hh:mm:ss)
Lw	m	Section length used in the difference flow logging
dL	m	Step length (increment) used in the difference flow logging
Q-measl-L-theoretical	mL/h	Theoretical lower measurement limit for borehole flow rate in flow logging probe
Q-measl-L-practical	mL/h	Estimated practical lower measurement limit for borehole flow rate in flow logging probe
Q-measl-U	mL/h	Upper measurement limit for borehole flow rate in flowlogging probe
Qp1	m3/s	Flow rate at surface by the end of the first pumping period of the flow logging
Qp2	m3/s	Flow rate at surface by the end of the second pumping period of the flow logging
tp1	s	Duration of the first pumping period
tp2	s	Duration of the second pumping period
tF1	s	Duration of the first recovery period
tF2	s	Duration of the second recovery period
h0	m.a.s.l.	Initial hydraulic head. Measured as water level in open borehole with reference level in the local coordinates system with z=0 m.
h1	m.a.s.l.	Stabilized hydraulic head during first pumping period. Measured as water level in open borehole with reference level in the local coordinates system with z=0 m.
h2	m.a.s.l.	Stabilized hydraulic head during second pumping period.Measured as water level in open borehole with reference level in the local coordinates system with z=0 m.
hF	m.a.s.l.	Stabilized hydraulic head at the end of the recovery period.Measured as water level in open borehole with reference level in the local coordinates system with z=0 m.
s1	m	Drawdown of the water level in the borehole during first pumping period. Difference between the actual hydraulic head and the initial head (s1= h1-h0)
s2	m	Drawdown of the water level in the borehole during second pumping period. Difference between the actual hydraulic head and the initial head (s2=h2-h0)
Upper limit	m	Length along the borehole of the upper limit of the test section or flow anomaly (based on corrected length L)
Lower limit	m	Length along the borehole of the lower limit of the test section or flow anomaly (based on corrected length L)
b	m	Represenative thickness estimated as section length Lw used in the difference flow logging.

Appendix 12

Header	Unit	Description
Q0	mL/h	Measured flow rate through the test section or flow anomaly under natural conditions (no pumping) with h=h0 in the open borehole
Value type-Q0		Code for Q0-value; -1 means Q0< lower measurement limit, 0 means measured value within the meausurement limits, 1 means Q0>upper measurement limit.
Q1	mL/h	Measured flow rate through the test section or flow anomaly during the first pumping period
Value type-Q1		Code for Q1-value; -1 means Q1< lower measurement limit, 0 means measured value within the meausurement limits, 1 means Q1 Q1>upper measurement limit.
Q2	m**3/s	Measured flow rate through the test section or flow anomaly during the second pumping period
Value type-Q2		Code for Q2-value; -1 means Q2< lower measurement limit, 0 means measured value within the meausurement limits, 1 means Q2>upper measurement limit.
h0f	m.a.s.l.	Measured initial hydraulic head distribution along the borehole before pumping
h1f	m.a.s.l.	Measured hydraulic head distribution along the borehole during the first flow period.
h2f	m.a.s.l.	Measured hydraulic head distribution along the borehole during the second flow period.
TD	m**2/s	Transmissivity of section or flow anomaly based on 2D model for evaluation of formation properties of the test section based on PFL-DIFF.
Value type-TD		Code for TD -value; -1 means TD < lower measurement limit, 0 means evaluated value within the meausurement limits, 1 means TD >upper measurement limit.
TD-measl-L-practical	m**2/s	Estimated practical measurement limit for evaluated TD. If the estimated TD equals TD-measlim, the actual TD is considered to be equal or less than TD-measlim.
TD-measl-U	m**2/s	Upper measurement limit for evaluated TD. If the estimated TD equals TD-measlim, the actual TD is considered to be equal or grater than TD-measlim.
hi	m	Calculated natural freshwater head for test section or flow anomaly (undisturbed conditions)
Value type-hi		Code for hi-value; -1 means hi< lower measurement limit, 0 means measured value within the meausurement limits, 1 means hi>upper measurement limit.
Tew	centigrade	Measured borehole fluid temperature in the test section during difference flow logging
ECw	mS/m, S/m	Measured electric conductivity of the borehole fluid in the test section during difference flow logging
TDSw	mg/L	Total salinity of the fluid in the test section representative for the evaluated parameters based on EC.
bi	m	Estimated thickness of flow anomaly or, alternatively the step length used in the overlapping logging
Li	m	Length along the borehole to inferred flow anomaly during overlapping flow logging
Tef	ºC	Measured fracture-specific fluid temperature in flow anomaly during difference flow logging
ECf	mS/m	Measured fracture-specific electric conductivity (EC) of the fluid in flow anomaly during difference flow logging
TDSf	mg/L	Total salinity of the fluid in the test section representative for the evaluated parameters based on EC.
tf	s	Duration of fracture-specific EC-measurement in flow anomaly
references		SKB report No for reports describing data and evaluation
comments		Short comment to the evaluated parameters