STUDY ON THE GROUNDWATER POTENTIAL EVALUATION AND MANAGEMENT PLAN FOR THE SOUTHEAST KALAHARI (STAMPRIET) ARTESIAN BASIN IN THE REPUBLIC OF NAMIBIA

Japan International Cooperation Agency

Pacific Consultants International

BOREHOLE FINAL REPORT

Borehole

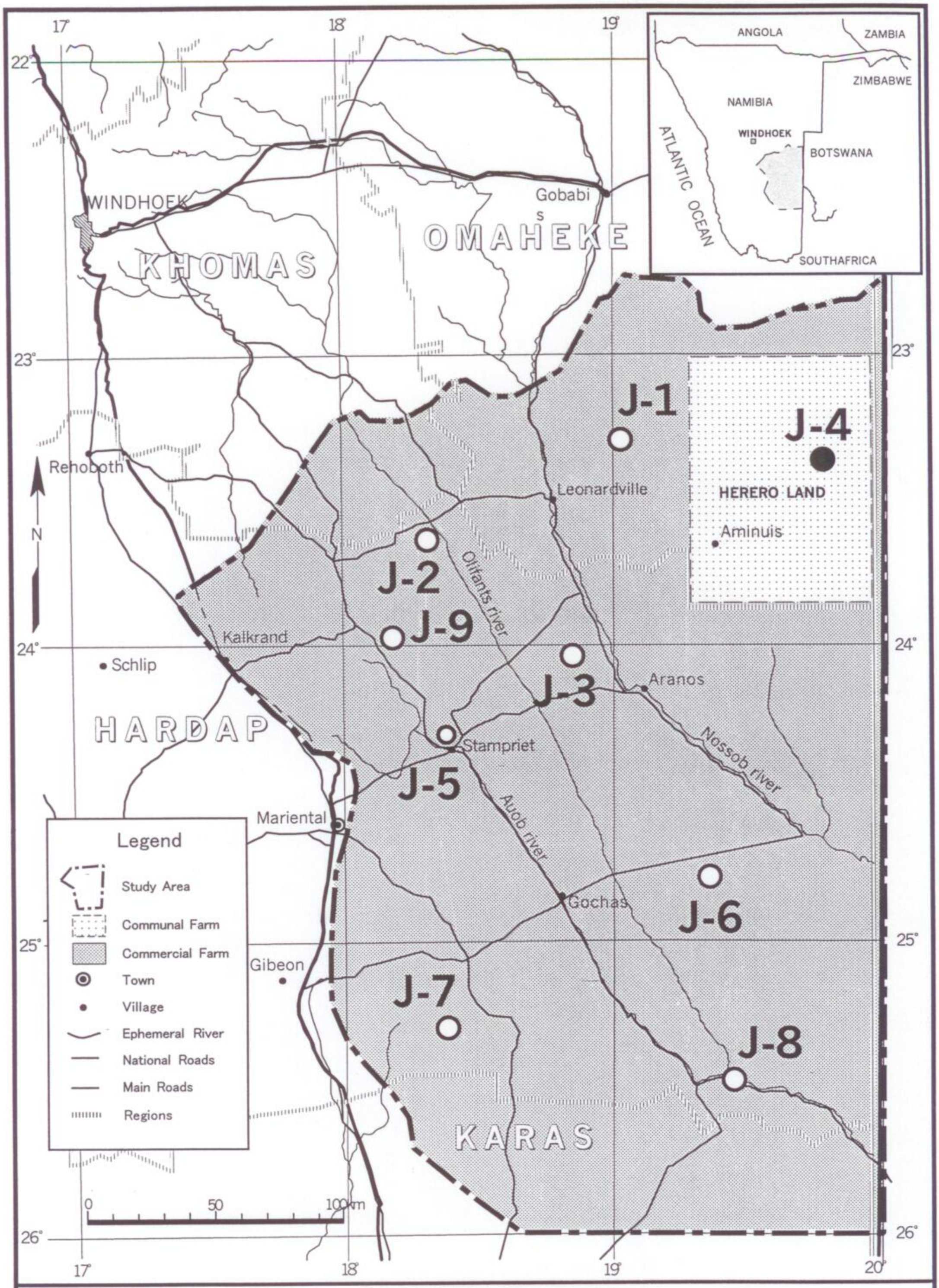
J4-N (WW 39847)

Okonyama L 330

METZGER PM DRILLING
P.O.Box 11733
Windhoek
Namibia

Windhoek

October 2000



Location Map of Test Boreholes

THE STUDY ON THE GROUNDWATER IN THE STAMPRIET ARTESIAN BASIN	JICA

Contents per Chapter

THE STUDY ON THE GROUNDWATER POTENTIAL EVALUATION AND MANAGEMENT PLAN IN THE SOUTHEAST KALAHARI (STAMPRIET) ARTESIAN BASIN

GEOLOGICAL BOREHOLE LOG

Aminius North East
Jica Reference : J - 4 - N
Date completed : 11 May 2000

WW 39847
S 23, 40105°
E 19, 62621°
Collar elev.: 1253 m

Depth below surface (m)	Section (m)	Lithology	Stratigraphy
0 - 2	2	Pale orange reddish **sand,** fine grained, sorted and rounded to sub-rounded	**KALAHARI**
2 - 6,5	4,5	Pale orange to yellowish fine grained **sand**, slightly cemented	
6,5 - 9,5	3	Dark reddish clay rich **sand**: quartz grains fine grained, rounded and embedded in a clayey matrix	
9,5 -12	2,5	Light grey to white **calcretized** fine to very fine **sandstone**	
12 - 14	2	Light brown - pinkish fine grained **calcrete** cemented **sandstone**	
14 - 16	2	Light grey to light pink **calcrete** cemented **conglomerate**.	
16 - 18,5	2,5	Highly weathered, calcrete cemented brownish **dolerite.**	**KAROO DOLERITE**
18,5 - 55	36,5	Greenish to slightly brownish weathered and oxidized **dolerite.** Drill-cuttings up to 15 mm. Calcareous on minor fracture plains.	
55 - 57,5	2,5	**Dolerite**, mostly hard, fine crystalline, dark greenish grey to black, with minor soft weathered horizons.	
57,5 - 58	0,5	Purplish brown **sandstone** baked to a quartzite, oxidized on fracture plains	**AUOB A 5**
58 - 64	6	Purplish fine to medium grained **sandstone**, glassy hard at 58 & 59 m (= non-porous) but fractured. From 60 m downwards porous.	
64 - 66	2	Light yellowish to light grey very fine-grained **sandstone**. Clayey matrix in drill-sample indicates thin soft shale horizon	
66 - 77	11	Light grey to white fine to coarse grained unsorted **sandstone**, non-calcareous, feldspathic in horizons, with muscovite in places and Fe-oxide on isolated quartz grains. Medium porosity.	
77 - 83	6	Light yellowish grey **sandstone,** fine to coarse grained (unsorted), prominent Fe-oxide staining at 79 m and ferrous concretions at 78 m. Coarse quartz grains sub-rounded.	
83 - 92	9	Light brown to white medium to coarse-grained **sandstone**, carbonaceous. Porous.	
92 - 93	1	Pinkish fine-grained feldspathic **sandstone,** contact to dark brown to black shale.	
93 - 94	1	Mixed sample: Layers of white, red, black and dirty	

		brown hydrating **shale**.	**AUOB A 4**
94 - 95	1	Mixed sample: Predominantly black and dark grey **mudstone / shale** with layers of red shale.	
95 - 96	1	**Mudstone / shale**, grey with layers of black..	
96 - 107,5	11,5	**Siltstone / very fine sandstone**, pale yellowish brown with thin reddish horizons. Calcareous at 97 & 98 m.	**AUOB A 3**
107,5 - 115	7,5	Pink to very light grey / white fine to medium grained **sandstone**, occasional biotite, calcareous to 112 m . Grain-size fining downwards.	
115 - 120	5	Light brown to reddish brown, fine to medium grained **sandstone**, calcareous in places with interbedded minor very fine sandstone.	
120 - 126,5	6,5	Light brown to white medium grained **sandstone**, calcareous and porous.	
126,5 - 130	3,5	Intercalated red **shale** and reddish medium grained **sandstone.**	
130 - 140	10	**Shale / siltstone**, colour ranges from olive green (130 - 133 m) to orange yellow (133 - 136 m) to a inter-layering of dark grey, white and red.	**AUOB A 2**
140 - 143	3	**Shale and siltstone** to very fine sandstone, light grey, non calcareous.	
143 - 154,5	11,5	**Shale / siltstone**. Shale dark grey to black, reddening at 154 m.	
154,5 - 171	16,5	Reddish brown fine to medium grained **sandstone** with inter-layered **minor shale** horizons.	**AUOB A 1**
171 - 183	12	Brown to yellowish medium grained **sandstone**, **minor shale**. Calcareous at 177 - 181 m.	
183 - 187	4	Light brown, changing to pale grey **siltstone**, with minor horizons of fine grained **sandstone.** Pale orange Fe-oxidation at 187 m in sandstone.	**UPPER MUKOROB**
187 - 196	9	**Mudstone / shale**, grey with minor white clay layers	
196 - 197	1	Pale grey **siltstone**.	
197 - 200	3	Pale grey **mudstone** with minor black shale	
200 - 235	35	Dark grey to black carbonaceous **shale and mudstone**: hydrating.	
235 - 240	5	Very fine grained **sandstone** with thin layer of coarse sandstone at 235 m and thin layers of grey and white **shale** at 235,5 m.	
240 - 251	11	Light grey **siltstone / sandy shale**, carbonaceous at 250 & 251 m.	
251 - 257	6	Light grey **shale** and / or intercalated **mudstone**.	
257 - 260	3	Fine to very fine grained light grey **sandstone**, calcareous in places.	
260 - 270	10	Light grey to grey **shale / siltstone** changing to pure shale at 270 m.	**LOWER MUKOROB**
270 - 280	10	Light grey **shale** carbonaceous at 271 m. Drop-stones at 271 - 272 m.	
280 - 290	10	Light grey **shale**, well laminated in places with drop-stones, rare but prominent at 287 m.	
290 - 297	7	Grey to dark grey **shale / mudstone** with thin	

		sandstone at 293, pyritiferous sandy horizon at 295 m.	
297 - 299	2	Light grey calcareous **sandstone**, fine to medium grained with low porosity. Well sorted.	
299 - 320	21	Dark grey to black **siltstone / shale** with occasional thin sandstone. Rare scattered pyrite from 310 – 320 m.	
320 - 329	9	Massive dark grey **mudstone**.	
329 - 332	3	Coarse (to medium) grained light grey **sandstone**. Grains generally well sorted and rounded. Porous. **Aquifer**.	**NOSSOB**
332 - 335	3	Fine grained **sandstone and shale**. Sandstone porous with abundant biotite.	
335 - 346	11	Medium to coarse grey **sandstone** with inter-layered grey **shale**. Biotite in sandstone. Shale layers more frequent towards 346 m.	
346 - 349	3	Light grey fine to medium **sandstone**, with light grey and white laminated shale at 348 m.	
349 - 350	1	Light grey **shale**.	
350 - 351	1	Fine to medium grained light grey **sandstone**, laminated.	
351 - 354	3	Fine grained to very fine grained grey sandstone / **mudstone** with **drop-stones** red & orange: quartzite and of granitic origin (?)	**BASEMENT (DWYKA ?)**
354 - 356 EOH	2	Grey **sandstone / grit** with abundant **drop-stones** and **pebbles**, well rounded.	

General Comment:

1. Drilling method was mud rotary, with the result that drill cuttings are extremely ground and careful washing is required before interpretation.
2. The horizon below 351 m could possibly be interpreted as the top part of the Dwyka Group.

This borehole was logged by F. Bockmuhl.

2. Penetration Record

Penetration Record J 4 N	
Depth (m)	Pen. Rate (min/m)
1	
	2.4
	2.5
10	3
	4.5
	2.75
	1.85
	4
	3.8
	3.3
	2.7
	2.45
20	2.7
	2.8
	2.8
	2.7
	3
	2.95
	3
	3.9
	4.5
	4.4
30	4.6
	5.25
	4.3
	4.5
	5.16
	4.85
	5.33
	6.25
	4.25
	6.16
40	6.5
	6.1
	5.33
	5.33
	6.3
	9.55
	5.33
	5.5
	8.16
	10.85
50	10.16
	7.5
	9.33
	6.5
	9.66

	7.25
	16
	3.16
	17.85
	14.25
60	
	18.33
	17.33
	13.16
	3.1
	4.33
	4.5
	3.9
	3.66
	3.85
70	3.75
	3.9
	4
	4.33
	3.85
	3.9
	4
80	3.5
	2.75
	3.5
	3
	3.15
	4.3
	5.3
	8.9
	24.4
	14.16
90	3.35
	4.6
	14.9
	16.1
	3.7
	6.6
	3.75
	2.75
	2.8
	3
100	2.35
	2.75
	2.4
	2.2
	2.33
	2
	1.95
	1.85
	3.35
110	3.4

	2.1
	1.95
	1.75
	2.35
	2
	3.3
	3.5
	2.65
	2.5
120	2.6
	3.1
	1.2
	3
	2.65
	2.75
	4.95
	4.3
	4.3
	4.2
	4.5
130	6
	6.45
	6.45
	5.45
	4.3
	4.5
	5.4
	6
	3.3
	5.4
140	4.9
	4.2
	2
	2.9
	4.9
	4.4
	4
	5.16
	5.33
	5.3
150	5.3
	6.9
	5.85
	5.45
	5.25
	3.66
	3
	2.1
	2.6
	3.25
160	3
	3.3
	3.2
	3.2
	2.85
	3
	3.3

	2.7
	2.85
	2.75
170	2.1
	2.85
	2.3
	2.25
	3.1
	3.15
	3.8
	3.1
	3.4
	3.9
180	2
	2.6
	3.8
	3.4
	2.33
	2.9
	6.26
	3.1
	3.9
190	4.7
	4.9
	3.6
	5.4
	40
	38.7
	36.8
	39
	38.9
200	
	2.33
	1.85
	1.85
	1.9
	1.9
	2
	3
	1.75
	1.4
210	1.7
	1.8
	2.1
	1.9
	1.6
	1.85
	2.16
	2
	2.4
	2
220	2.8
	1.9
	1.85

	2.1
	2.3
	2.16
	1.95
	2.1
	2.5
	2.25
230	2.5
	2.75
	1.75
	1.8
	1.7
	3
	3.1
	3.5
	3.33
240	3.6
	3.66
	3
	3.7
	3.33
	2.7
	3.7
	2.5
	2.8
	3.4
250	3.33
	4.5
	3.75
	3.85
	5.35
	5.2
	6.85
	5.5
	3.45
	5.85
260	6.5
	6.6
	6.35
	6.85
	4.9
	6.7
	4.9
	4.6
	4.5
	4.85
270	6.2
	11.4
	8.05
	7.5
	9.55
	7.45
	7.1
	15.25
	8

	8
280	8.2
	7.3
	6.75
	7.2
	7.1
	5.1
	5.1
	4.85
	5.75
	4.95
290	4.6
	4.65
	7.4
	5.65
	9.1
	5.9
	5.1
	6
	17.55
	6.2
300	6.1
	6.3
	6.6
	7.3
	5.75
	5.3
	6.05
	5.6
	5.8
	6.25
310	5.85
	5.75
	5.75
	6.1
	5.8
	5.85
	5.9
	6.1
	6
	5.75
320	6
	5
	4.7
	4.2
	5
	3.9
	4.85
	4.6
	4.85
330	3.7
	5.1
	3.6
	2.9

	2.4
	2.15
	2.25
	3.15
	3
340	2.75
	2.35
	2.35
	2.33
	2.3
	2.2
	4.1
	5.2
	4.3
	3.1
350	2.2
	2.25
	10.16
	9.3
	9.5
	18.25
	7.8
357	8.3

J4npen

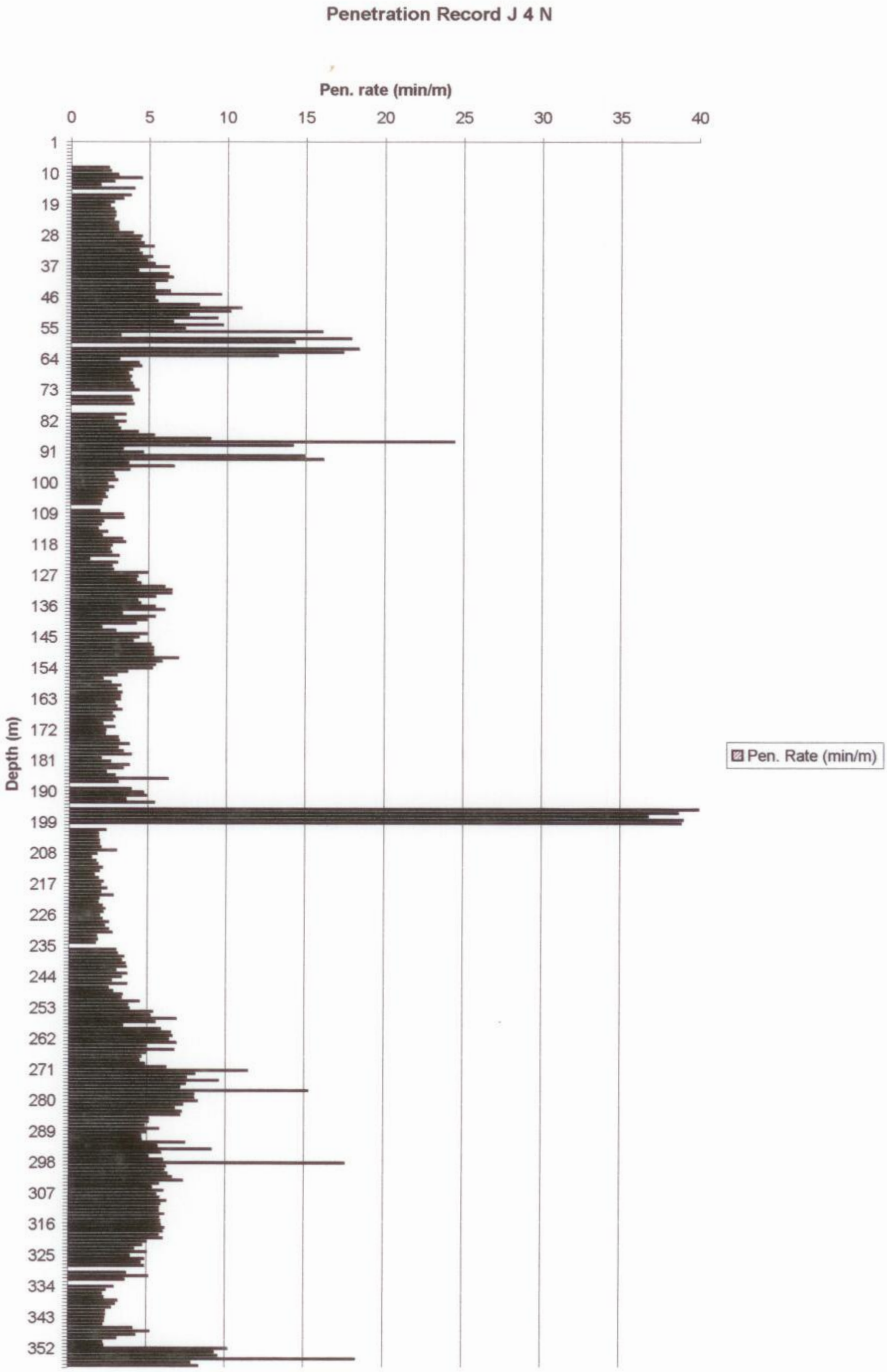


Chart1

3. Mud Rotary Drilling Log

THE STUDY ON THE GROUNDWATER POTENTIAL EVALUATION AND MANAGEMENT PLAN IN THE SOUTHEAST KALAHARI (STAMPRIET) ARTESIAN BASIN

MUD ROTARY DRILLING LOG

JICA REFERENCE: J 4 N LOCALITY: Aminius WW 39847 DATE: 26 April to 07 May 2000

TIME	DEPTH mbgl	MARSH FUNNEL TEST 1000 ml (sec)	MARSH FUNNEL TEST 500 ml (sec)	E. C. mS/cm	DENSITY	pH	TEMPERATURE ° C	COMMENT
14:03 (26/04)	6	32						
16:10	11	30		2.8				
18:00	31	30		2.72				
(27/04)	59	32 *29*		2.42 *2.71*			28.7 *23.9*	Start of geophysical logging *Water used for mixing*
12:45 (1/5)	205	32		2.8			28.2	
15:00	235	33 *29*		2.85 *2.7*			27.8 *22.8*	Start of geophysical logging *Water used for mixing*
10:00 (06/05)	265	30	20	2.8		10	29.5	
18:20	303							
08:00 (07/05)	304	29	19	2.83		10	23.9	
09:00	310	30	20	2.8		10	23.9	25 kg Cap 21 added
18:00	357	31 *72*	20	2.8 *2.8*		10 *8*	24.2 *19*	Before geoph. Logging *Water from tanker*

GENERAL REMARKS:

1. Geophysical logging was done in three steps: At diamater 12 ¼" to a depth of 59 m, followed at diameter 9 7/8" to a depth of 235 m and finally at ϕ 7 7/8"to the end of the borehole at depth 357 m.
2. Parameters for the samples were obtained from samples filtered through a fine sieve.
3. To obtain the electrical resistivity for the samples in Ω-m., the E.C., as S/m., should be inversed (1/x).

4. Geophysical Log and Casing Design

Poseidon Geophysics

(Reg. No. 93553)

CO. Poseidon Geophysics
WELL_I.D. WW 39847
PROJ.
LCN. Aminuis
STE. J 4
FILING No. J4N

CONSULTANT PACIFIC CONSULTANTS INTERNATIONAL

COMPANY METZGER PM DRILLING

PROJECT The Study on the Groundwater Potential Evaluation and Management Plan in the Southeast Kalahari (Stampriet) Artesian Basin

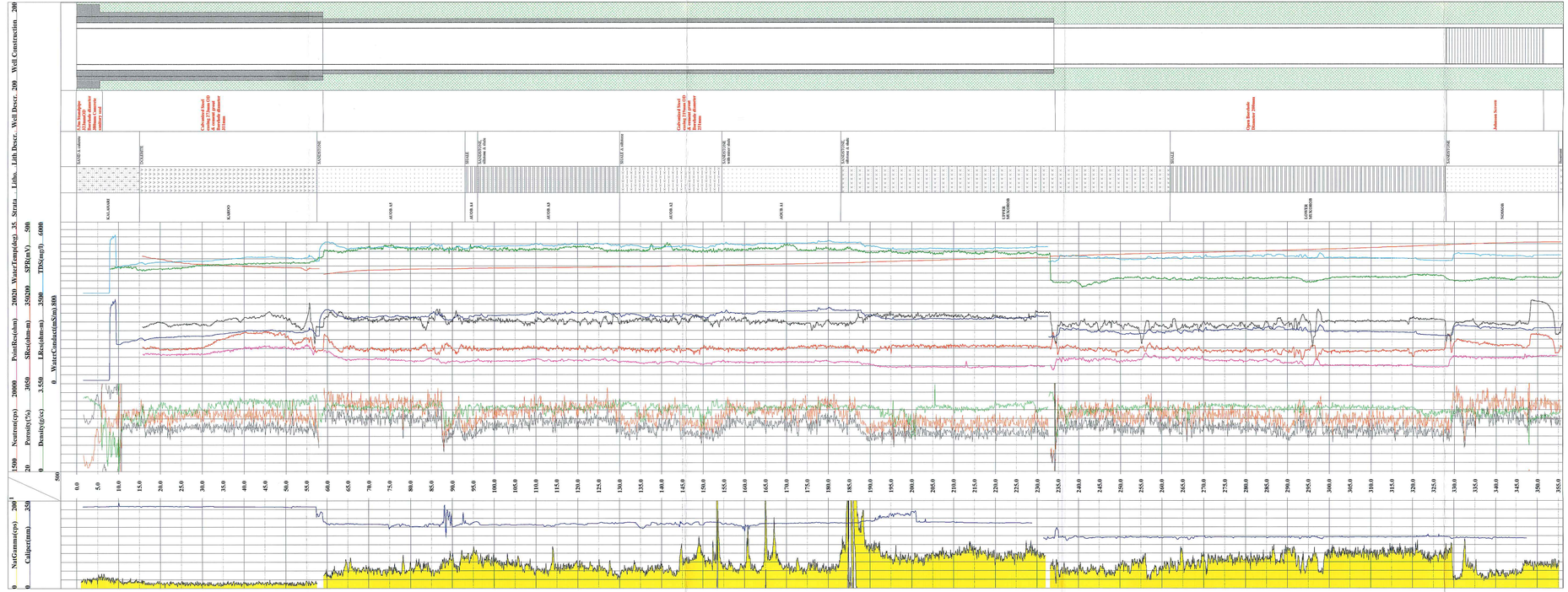
WELL ID J4N WW39847

LOCATION AMINUIS

COUNTRY REPUBLIC OF NAMIBIA

BH COORDINATES	S 23.40103 E 19.62621
COLLAR ELEVATION	1253m
LOG MEAS. FROM	Groundlevel
DRILLING MEAS. FROM	Groundlevel
DATE	08 May 2000
TYPE LOG	Physical Properties
DEPTH-DRILLER	356m
DEPTH-LOGGER	347.50m
BTM LOGGED INTERVAL	347.50m
TOP LOGGED INTERVAL	0.60m
PERMANENT DATUM	Groundlevel
RECORDED BY	Clemence Kambewu
WITNESSED BY	Frank Bokmuhl

JAPAN INTERNATIONAL COOPERATION AGENCY



5. Borehole Development Data

THE STUDY ON THE GROUNDWATER POTENTIAL EVALUATION AND MANAGEMENT PLAN IN THE SOUTHEAST KALAHARI (STAMPRIET) ARTESIAN BASIN

BOREHOLE DEVELOPMENT DATA

JICA REFERENCE: J 4 N LOCALITY: Okonyama, Aminius NE WW 39847 DATE: 12/05/2000 (starting)

TIME (actual)	P.I.D. (mbsu)	½ 90° V-Notch (mm)	Yield (m^3/h)	E.C. (mS/m)	Water Level (mbsu)	Remarks
19:00	240					Date 12/05/2000
20:00		90	6.12		23.00	
20:30		105	9		23.3	
22:00		95	7		23.4	Water still full of drilling fluid
04:00		96			22.5	Date 13/05/2000
08:00	240	102			36.7	Water milky
10:00		105	9		43.2	
11:00		100	7.92		44.7	
12:00		100			44.6	
13:00		98			44.7	Water milky
13:30						Allow RWL to recover until 13:45
13:45					18.1	
14:00		105	9		43.7	Allow to recover to 15:00
15:00					10.8	
16:00		97			42.7	
17:00		94	7		42.8	
18:00		106			43.13	Water very milky
19:00		107	9.5		43.15	
20:00		104			43.14	
21:00		104			43.27	

TIME (actual)	P.I.D. (mbsu)	½ 90° V-Notch (mm)	Yield (m^3/h)	E.C. (mS/m)	Water Level (mbsu)	Remarks
04:00	240	103			42.34	Date 14/05/2000
05:00		106			42.13	
06:00		108			43.18	
07:00		104			43.21	
08:00		106	9		43.18	
09:00	240	104			43.26	Water milky.
11:00	350				11.3	
12:00		110	10.08		36.3	
13:00		91	6.2		35.9	
14:00		72			36.6	
15:00		88			35.1	
16:00		104			36.41	
17:00		103			37.23	
18:00		104			37.51	
19:00		102			37.53	
20:00		103	8.5		38.63	
21:00		103			38.37	
03:00		100	7.92		45.2	Date 15/05/2000
07:00	350	103			46.83	Stop airlift. Observe recovery. Remove pipes.
13:00					10.17	
07:00					10.45	Date 16/05/00.

Remarks:

1. Airlift development was done on 12/05/2000 from 19:00 to 24:00 for a total of 5 hours.
2. On 13/05/2000 a total of 21 hours was continuously used for airlifting.

3. On 14/05/2000 another 21 hours of development by airlift was done.
4. Finally on 15/05/2000 airlifting was continued from 24:00 to 07:00 for continuous 7 hours.
5. This borehole was initially also developed by cable tool rig by means of bailing and plunging resulting in a regular surging through the screens.

6. Evaluation of Pumping Test

1. PUMPING TEST ANALYSIS

J4-N (WW39847) - Pumping well

J4-A (WW39846)- Observation well

J4-K (WW39845)- Observation well

1.1. Well Efficiency (Step draw down test) (Annex 1)

Well Efficiency was analysed by making use of the Jacob method for draw down data. Aquifer parameters used for the calculation of well efficiency were obtained from the evaluation results of the constant discharge test, which is discussed in **Section 1.2** below.

The well efficiencies at the range of pumping rates used during the step draw down test are summarised in **Table 1** below. Only four of the five steps were utilised for the evaluation of the borehole efficiency.

Table 1: J4-N; Borehole efficiency at various pumping rates

Borehole number	Step	Abstraction Rate [m^3/h]	Draw Down* [m]	Borehole Efficiency [%]
J4-N	1	5	12.0	79.7
	2	10	22.0	79.1
	3	15	29.7	78.5
	4	20	50.6	77.9

* at cut-off time Δt, after which well bore storage has no affect on the well performance

Data on the linear and non-linear well losses and skin factors as well as the efficient well radius are presented in **Annex 1.**

1.2. Constant Discharge Test Analysis (Annex 2 - 6)

The constant discharge draw down curve of abstraction borehole **J4-N** indicates leakage. For leaky aquifers, the Walton Hantush analysis method with draw down and recovery data was once again used to calculate the hydraulic conductivity of the aquifer and the aquitard **(Annex 2 & 3**).

Aquifer storativity was once again estimated due to the fact that the observation boreholes **J4-A** and **J4-K** are located in the Auob sandstone and Kalahari sediments respectively. During the duration of the constant discharge test, only a minor drop in the water level of the two observation boreholes at late times are observed. This scenario could be due to leakage caused by pressure release in the underlying Nossob confined aquifer or due to natural oscillations in the groundwater table (See **Annex 5**).

The occurrence of leakage into the Nossob aquifer during abstraction could be due to water derived from storage within the overlying aquitard. The results of the constant discharge analysis are summarised in **Table 2** below.

Table 2: Aquifer Parameters calculated for J4-N; Nossob sandstone

Borehole number	Analysis Method	T	s	k	S	Simulation model	Comments
		[m^2/day]	[m]	[cm/sec]	[-]		
J4-N	Walton-Hantush - draw down	7.01	50	$1,6 \times 10^{-4}$	$*5 \times 10^{-5}$	Hantush	*Storativity estimated - Observation borehole not located in the tested aquifer
	Walton-Hantush - recovery	7.60	50	$1,8 \times 10^{-4}$	$*5 \times 10^{-5}$		

The Hantush model for leaky condition from aquitard storage was used to simulate and verify the actual data and analysis approach of the constant discharge test. Simulation parameters summarised in **Table 2** were used in simulation of the actual pumping test data (See **Annex 4** for simulation results).

Annex 6 compares the draw down results of the pumping borehole **J4-N** and observation boreholes **J4-A** and **J4-K** and it is clear that pumping from the Nossob sandstone did not have much of an influence on the Auob sandstone and Kalahari aquifers.

The radius of influence (R) was estimated after SICHARDT (1928) using the equation:

$R = 3000 \times s \times K_f^{1/2}$

$R = 3000 \times 55.3 \times 1.3 \times 10^{-3} = \underline{223\ m}$

where

R = Radius of influence

s = Draw down in abstraction borehole at end of pumping

K_f = Permeability of the aquifer

The equation is approximately correct for unconfined aquifers. In case of a confined aquifer the radius of influence most probably larger and the 223 m are considered to be the minimum value.

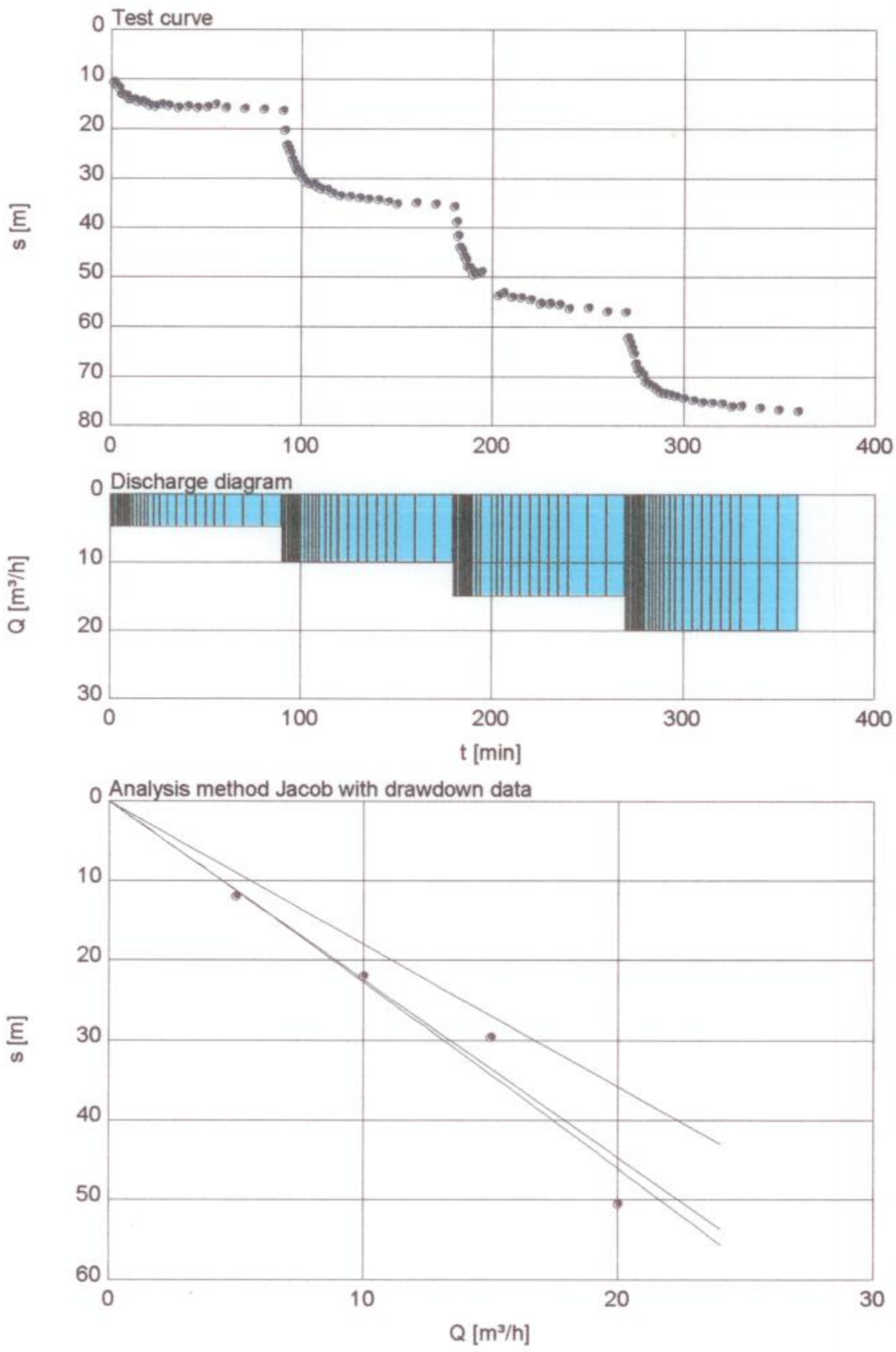
A proper evaluation of R (and storativity S) will only be possible once reliable data from observation wells, penetrating the same aquifer as the pumped well, are available.

Groundwater Study in the Stampriet Artesian Basin

Evaluation of Test Pumping Data

Step test analysis

Pumped well J4-N



Borehole, well & aquifer

Drilled:	
Latitude:	
Longitude:	
Elevation:	1100 [m]
Depth:	
Stick up:	0.00 [m]
Bh. radius:	0.1 [m]
Casing radius:	0.075 [m]
RWL:	10.22 [m]
max.drawdown:	77.12 [m]
Aq.type:	confined
Aq.thickness:	50.00 [m]
Stratigraphy:	Nossob Sandstone
Lithology:	Sandstone

Test running

Start:10/07/2000 21:05:11	
Dis.dur.:	360 [min]
Av.dis.:	12.5 [m³/h]
Max.dis.:	20 [m³/h]
Min.dis.:	5 [m³/h]
Total dis.:	75 [m³]
Crew:	Metzger_PM
Supervisior:	PCI

Results

Well performance:

s: (B1+B2)*Q+C*Q²

Linear aquifer loss B1:	1.79
Linear well loss B2:	0.44
Non-linear well loss C:	3.5E-3

	Q [m³/h]	s [m]	Eff [%]
Step 1:	5.00	12.0	79.7
Step 2:	10.0	22.0	79.1
Step 3:	15.0	29.7	78.5
Step 4:	20.0	50.6	77.9

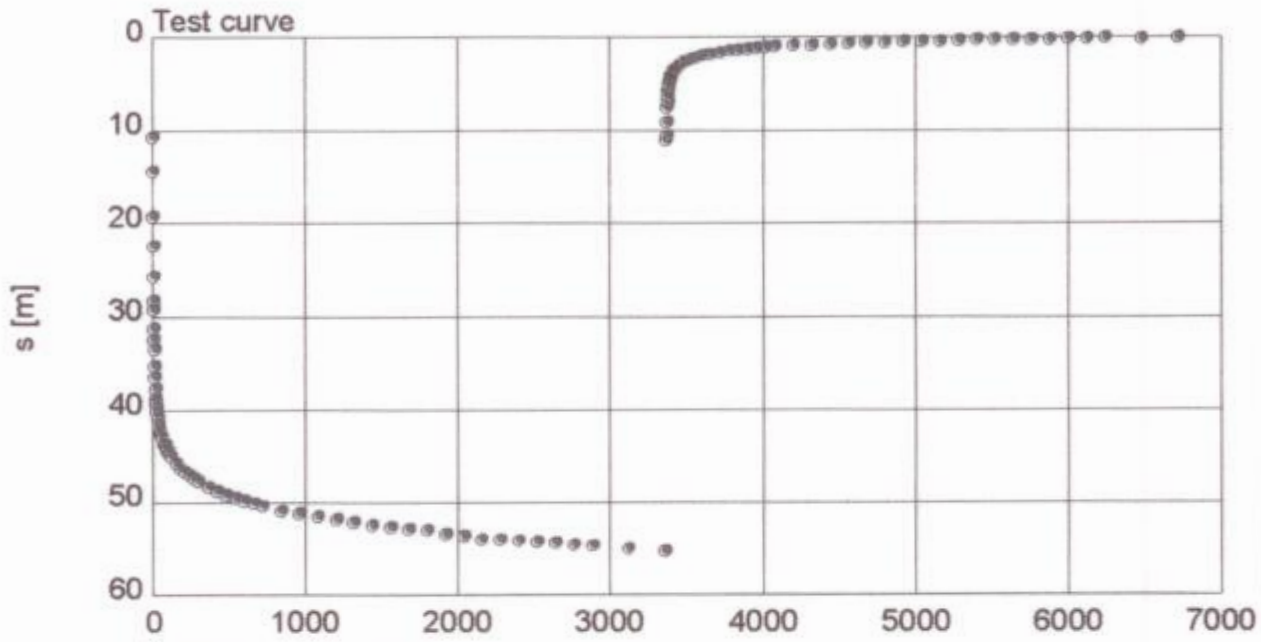
Linear skin factor:	0.86 [-]
Non-linear skin factor:	0.16 [d/m³]
Effective well radius:	3.7E-2 [m]

Groundwater Study in the Stampriet Artesian Basin

Evaluation of Test Pumping Data

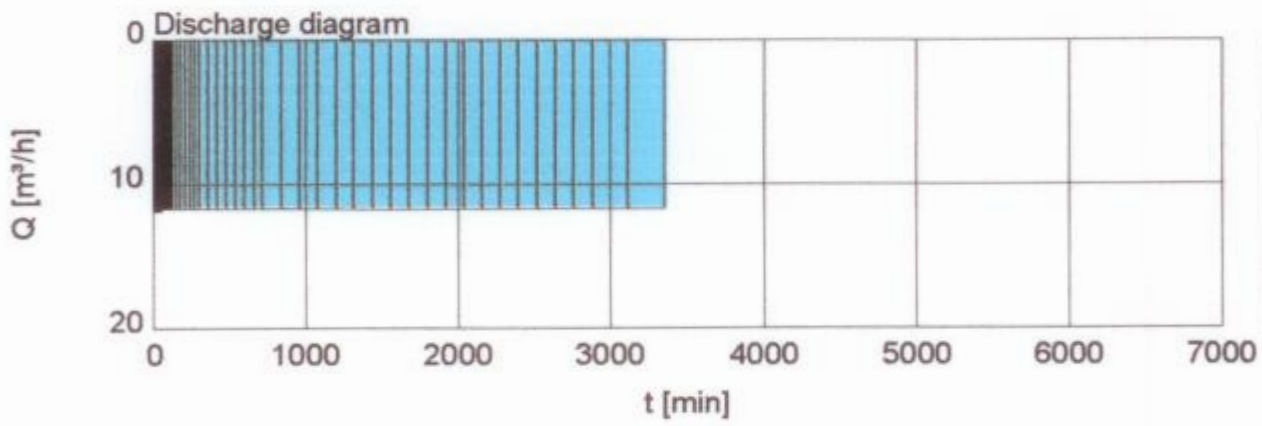
Test pumping analysis

Pumped well J4-N



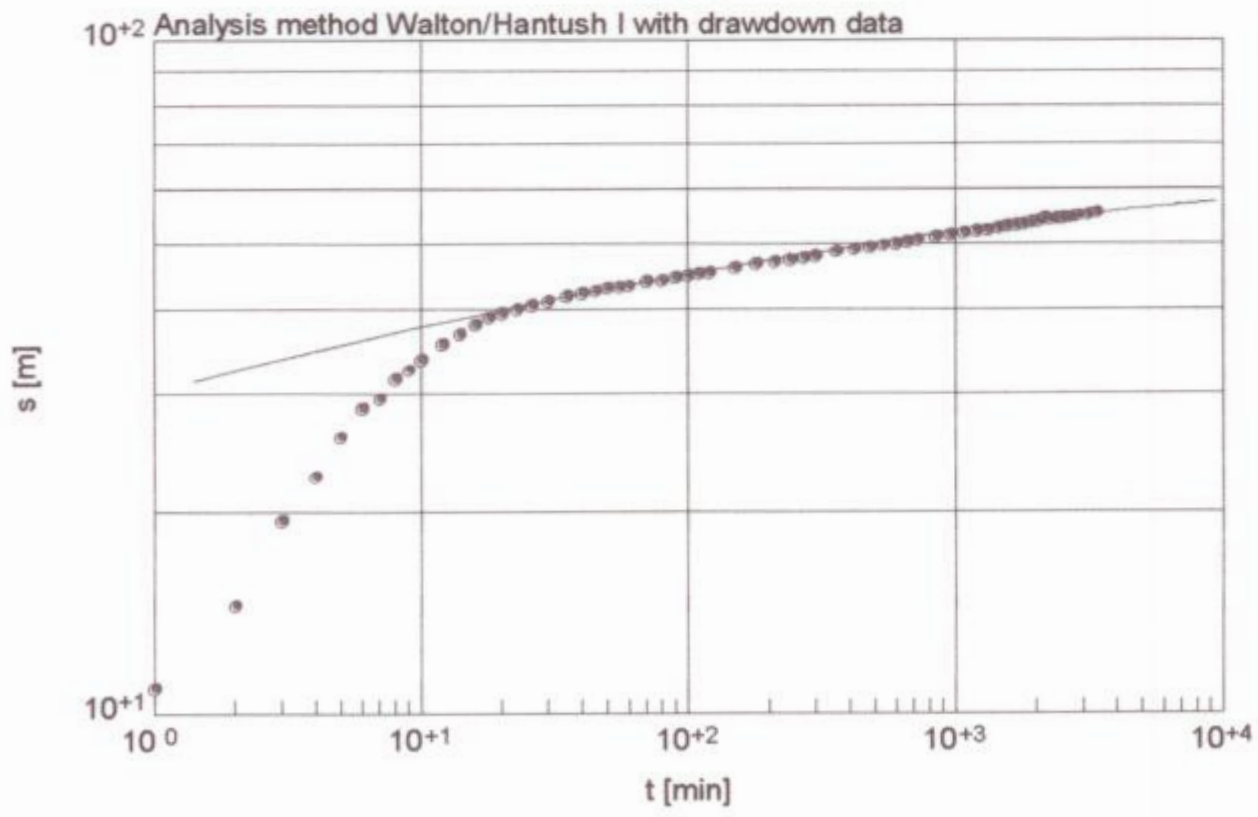
Borehole, well & aquifer

Drilled:	
Latitude:	
Longitude:	
Elevation:	1100 [m]
Depth:	
Stick up:	0.00 [m]
Bh. radius:	0.1 [m]
Casing radius:	0.075 [m]
RWL:	10.63 [m]
max.drawdown:	77.12 [m]
Aq.type:	confined
Aq.thickness:	50.00 [m]
Stratigraphy:	Nossob Sandstone
Lithology:	Sandstone



Test running

Start:	10/07/2000 21:15:23
Dis.dur.:	3360 [min]
Av.dis.:	11.8 [m³/h]
Max.dis.:	12 [m³/h]
Min.dis.:	11.8 [m³/h]
Total dis.:	661 [m³]
Crew:	Metzger_PM
Supervisior:	PCI



Results

Match parameter:	
Q:	11.8 [m³/h]
t:	407 [min]
s:	41.1 [m]
1/u:	8.67E6 [-]
W(u,r/B):	12.8 [-]
Aquifer parameter:	
T:	7.01 [m²/d]
k:	0.14 [m/d]
Boundary parameter:	
B:	800 [m]
m´:	50 [m]
k´:	0.000548 [m/d]

Date 02/10/00 prepared by BIWAC

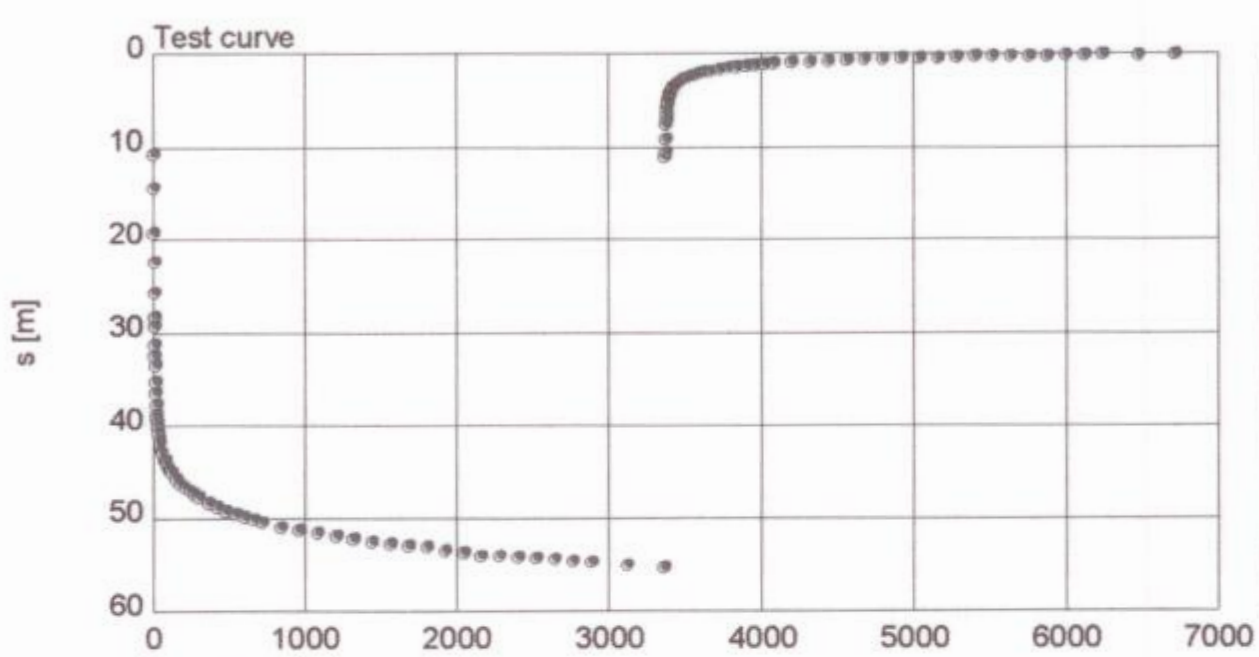
Annex 2

Groundwater Study in the Stampriet Artesian Basin

Evaluation of Test Pumping Data

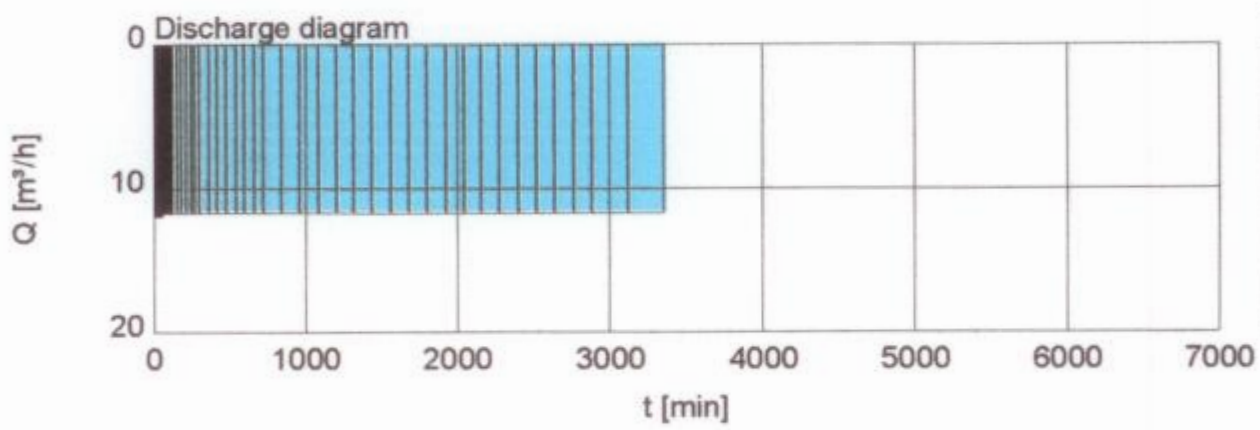
Test pumping analysis

Pumped well J4-N



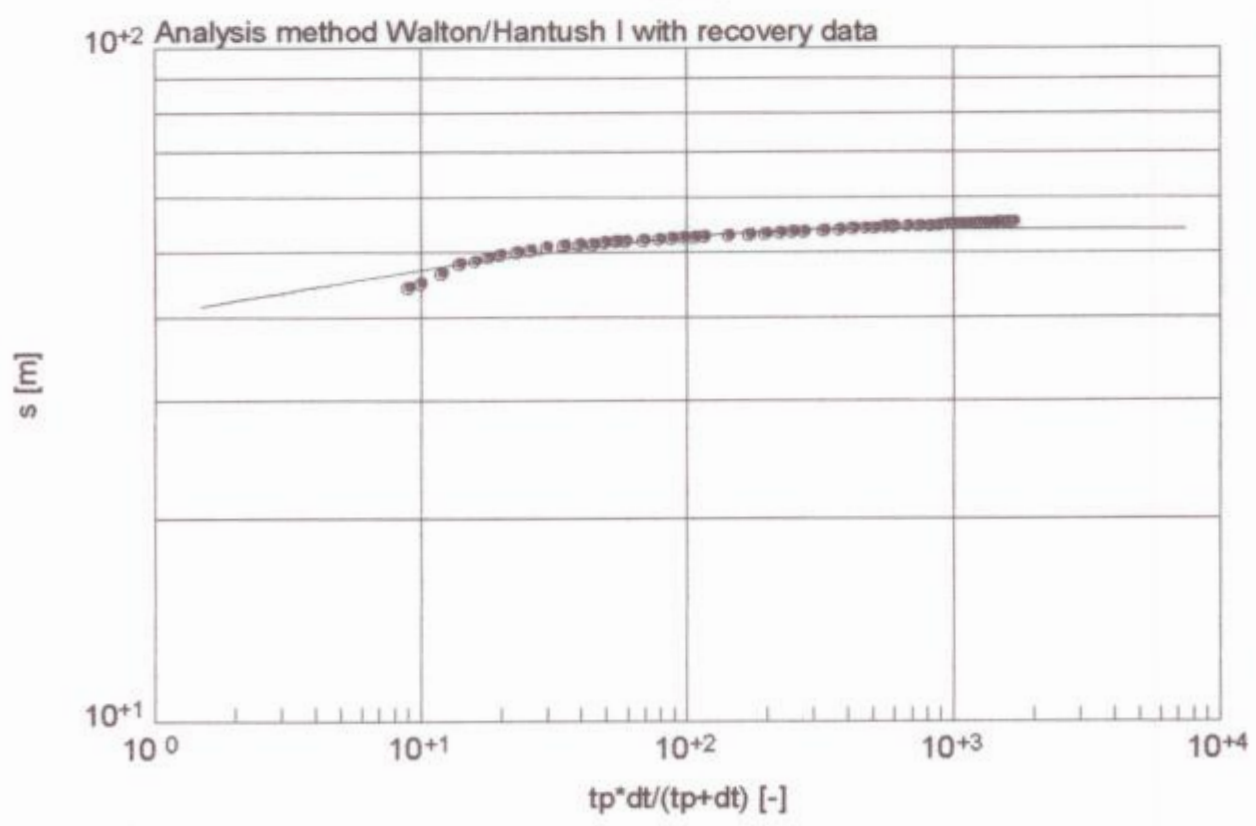
Borehole, well & aquifer

Drilled:	
Latitude:	
Longitude:	
Elevation:	1100 [m]
Depth:	
Stick up:	0.00 [m]
Bh. radius:	0.1 [m]
Casing radius:	0.075 [m]
RWL:	10.63 [m]
max.drawdown:	55.31 [m]
Aq.type:	confined
Aq.thickness:	50.00 [m]
Stratigraphy:	Nossob Sandstone
Lithology:	Sandstone



Test running

Start:	10/07/2000 21:15:23
Dis.dur.:	3360 [min]
Av.dis.:	11.8 [m³/h]
Max.dis.:	12 [m³/h]
Min.dis.:	11.8 [m³/h]
Total dis.:	661 [m³]
Crew:	Metzger_PM
Supervisior:	PCI



Results

Match parameter:	
Q:	11.8 [m³/h]
t:	593 [min]
s:	31.4 [m]
1/u:	7.98E8 [-]
W(u,r/B):	10.6 [-]
Aquifer parameter:	
T:	7.6 [m²/d]
k:	0.152 [m/d]
Boundary parameter:	
B:	800 [m]
m':	50 [m]
k':	0.000594 [m/d]

Date 02/10/00 prepared by BIWAC

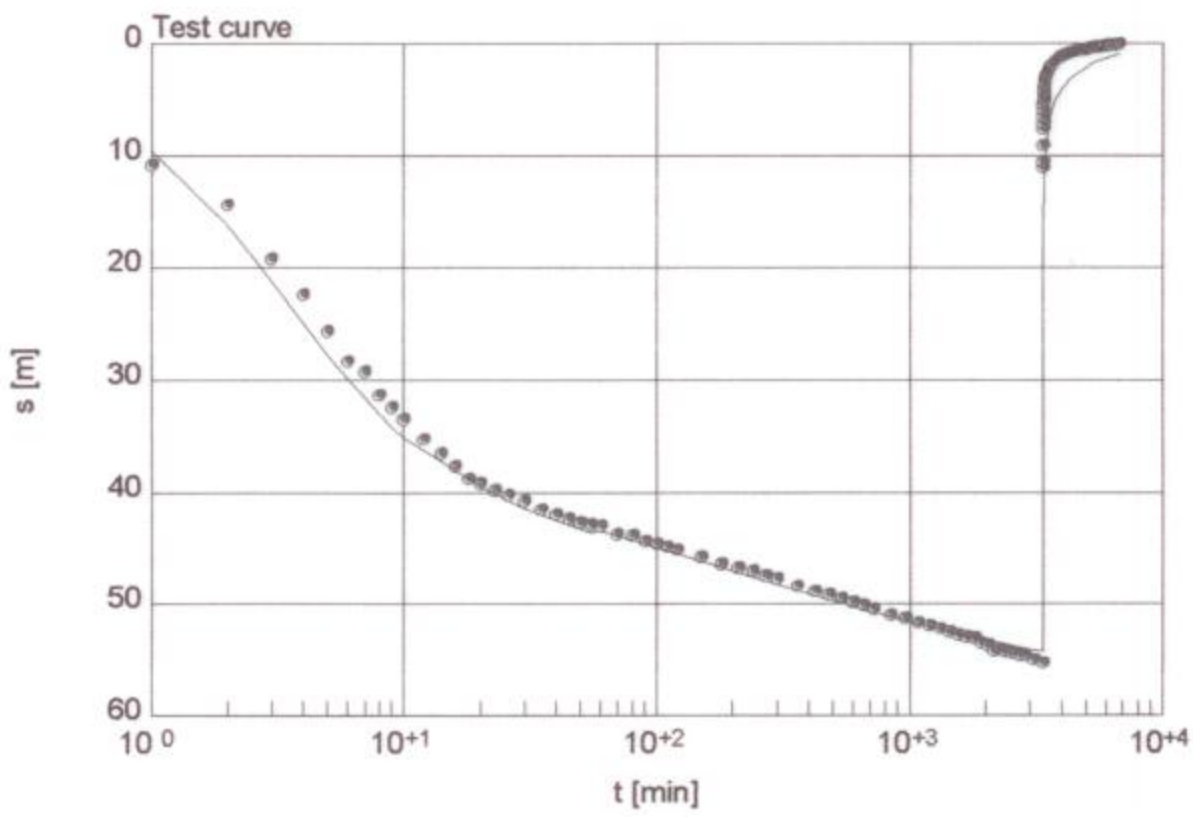
Annex 3

Groundwater Study in the Stampriet Artesian Basin

Evaluation of Test Pumping Data

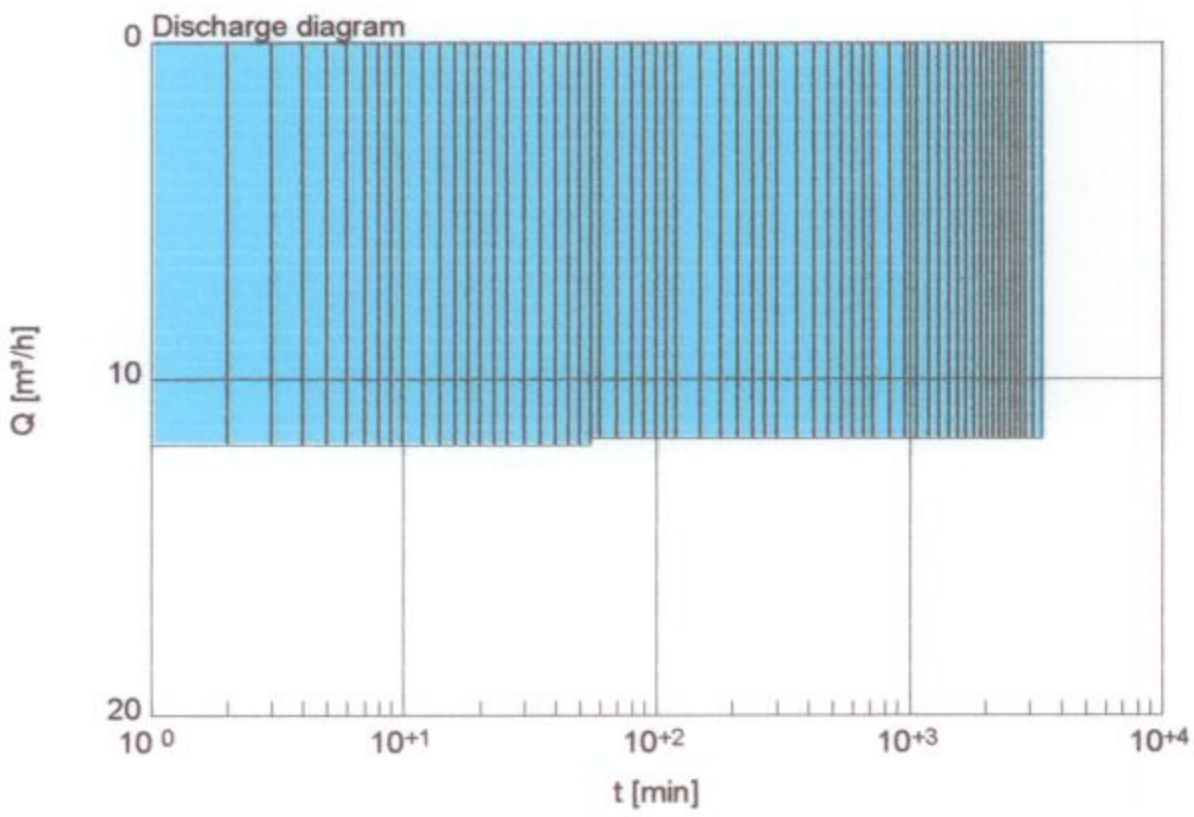
Test pumping diagnosis

Pumped well J4-N



Remarks

Simulation of the actual recorded draw down using the Hantush model for leaky aquifers.



Discharge info

Dis.dur.:3360 [min]
tcorr: 3361 [min]

Av.dis.: 11.80 [m³/h]
max.dis.:12.00 [m³/h]
min.dis.:11.80 [m³/h]
Qn: 11.80 [m³/h]

Dis.sum: 661 [m³]

Date 02/10/00 prepared by BIWAC

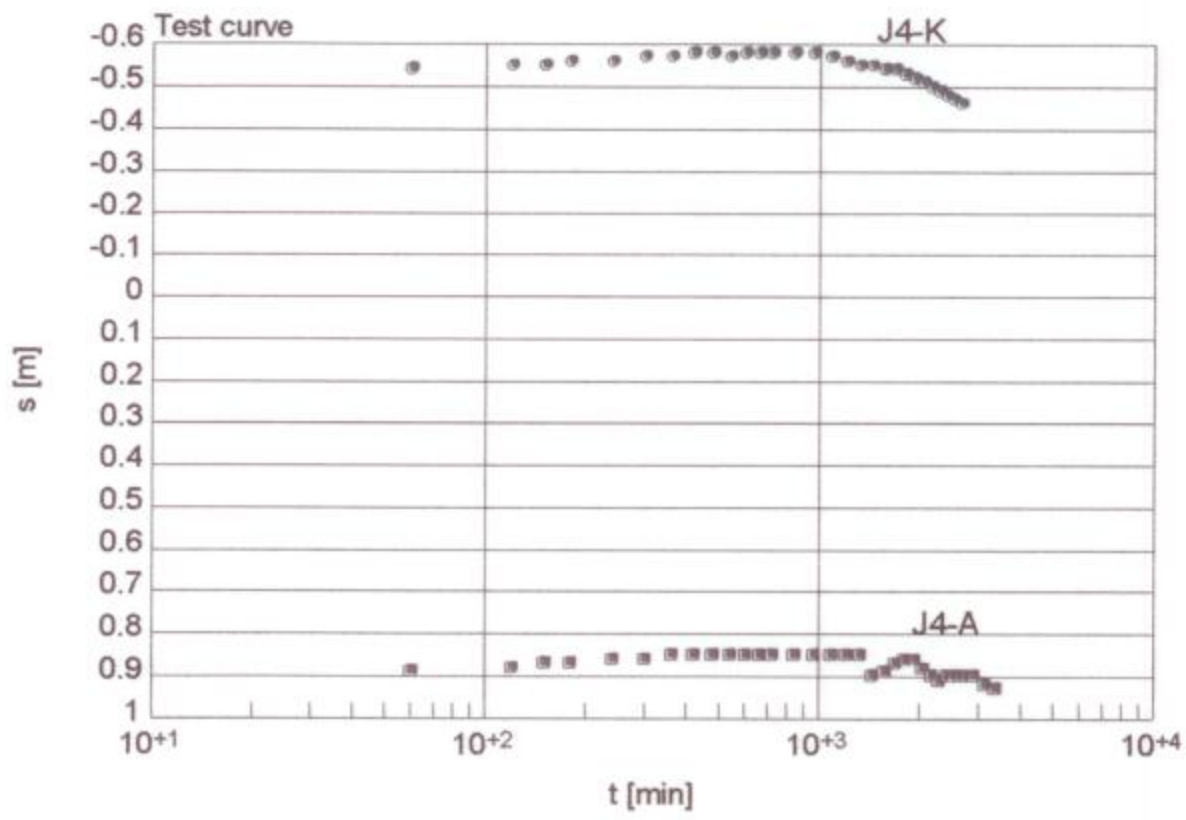
Annex 4

Groundwater Study in the Stampriet Artesian Basin

Evaluation of Test Pumping Data

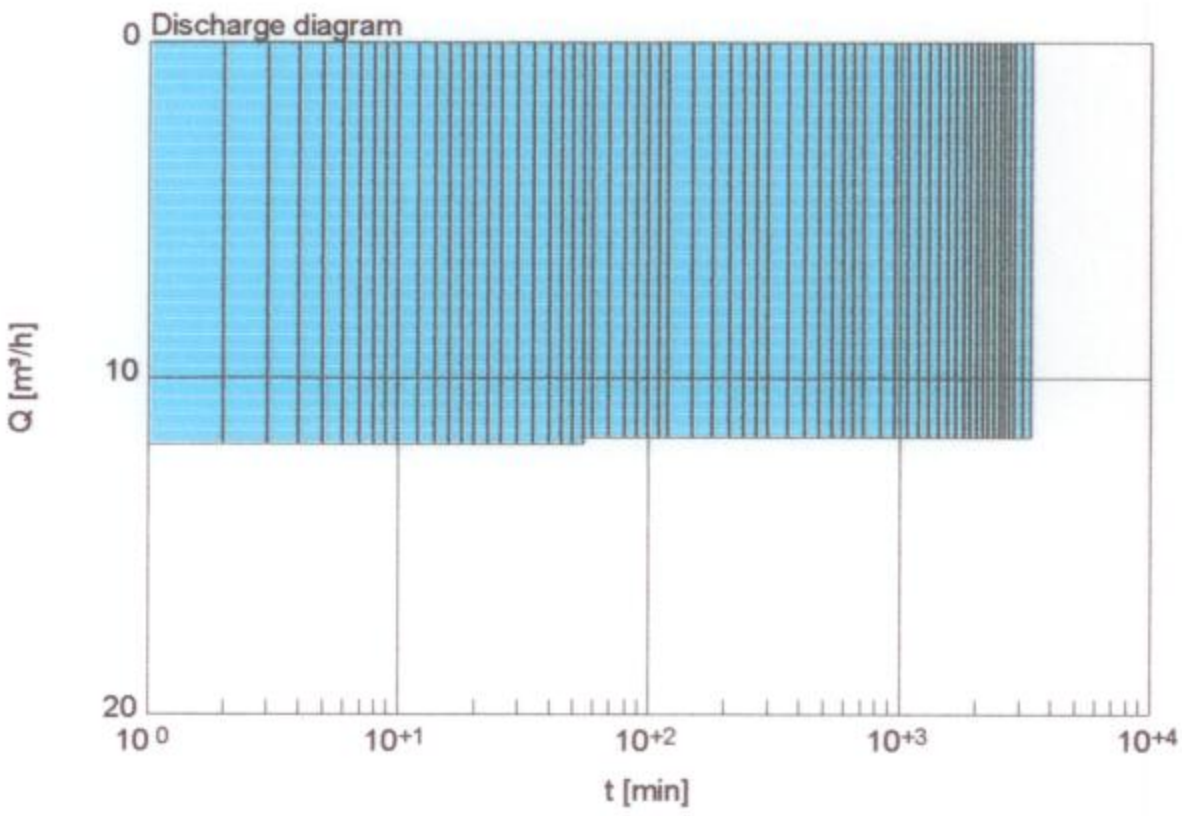
Test pumping diagnosis

Pumped well J4-N



Remarks

Both observation boreholes J4-A and J4-K are situated within different aquifers and none of the boreholes are directly influenced by abstraction. A drop in the late time water levels can however be observed. This could be due to leakage or natural oscilations in the groundwater table.



Discharge info

Dis.dur.:3360 [min]
tcorr: 3361 [min]

Av.dis.: 11.80 [m³/h]
max.dis.:12.00 [m³/h]
min.dis.:0 [m³/h]
Qn: 0.00E+00 [m³/h]

Dis.sum: 661 [m³]

Distance to observation borehole: J4-A = 69 m; J4-K = 129 m

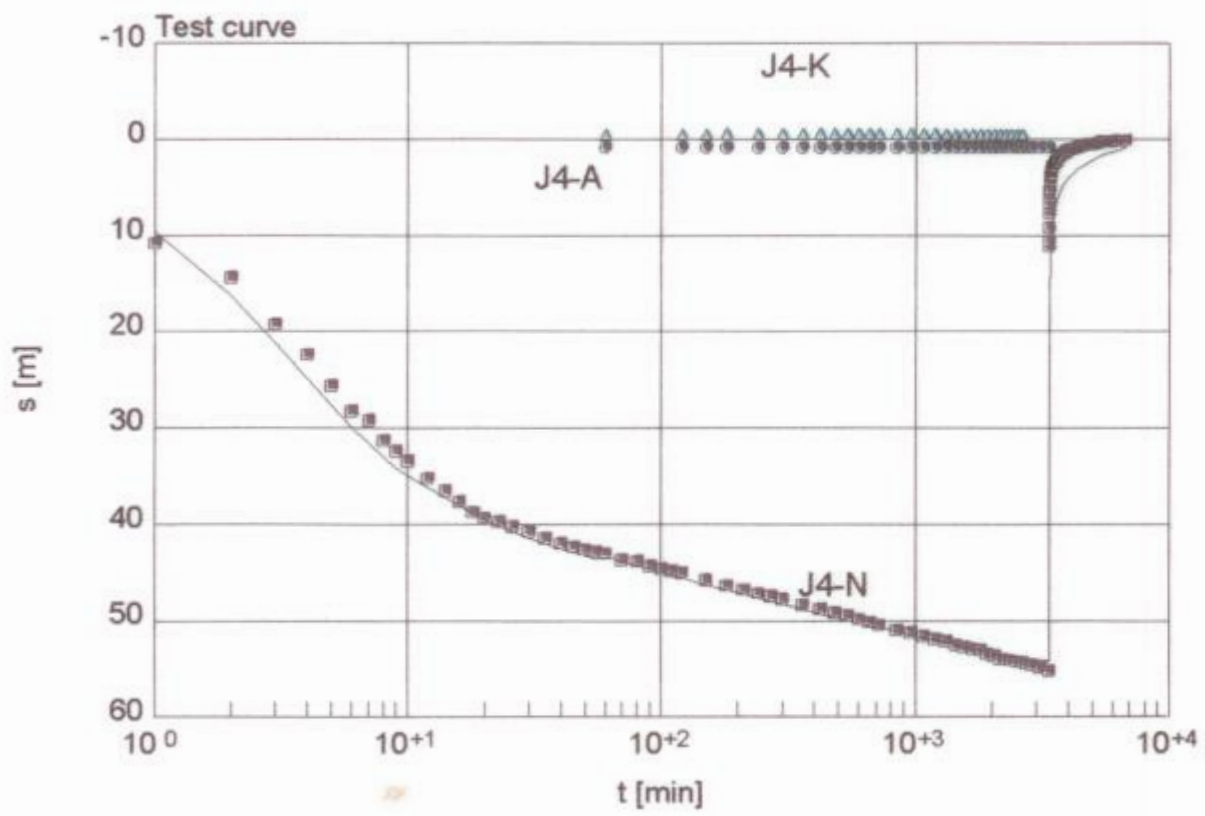
Date 02/10/00 prepared by BIWAC	Annex 5

Groundwater Study in the Stampriet Artesian Basin

Evaluation of Test Pumping Data

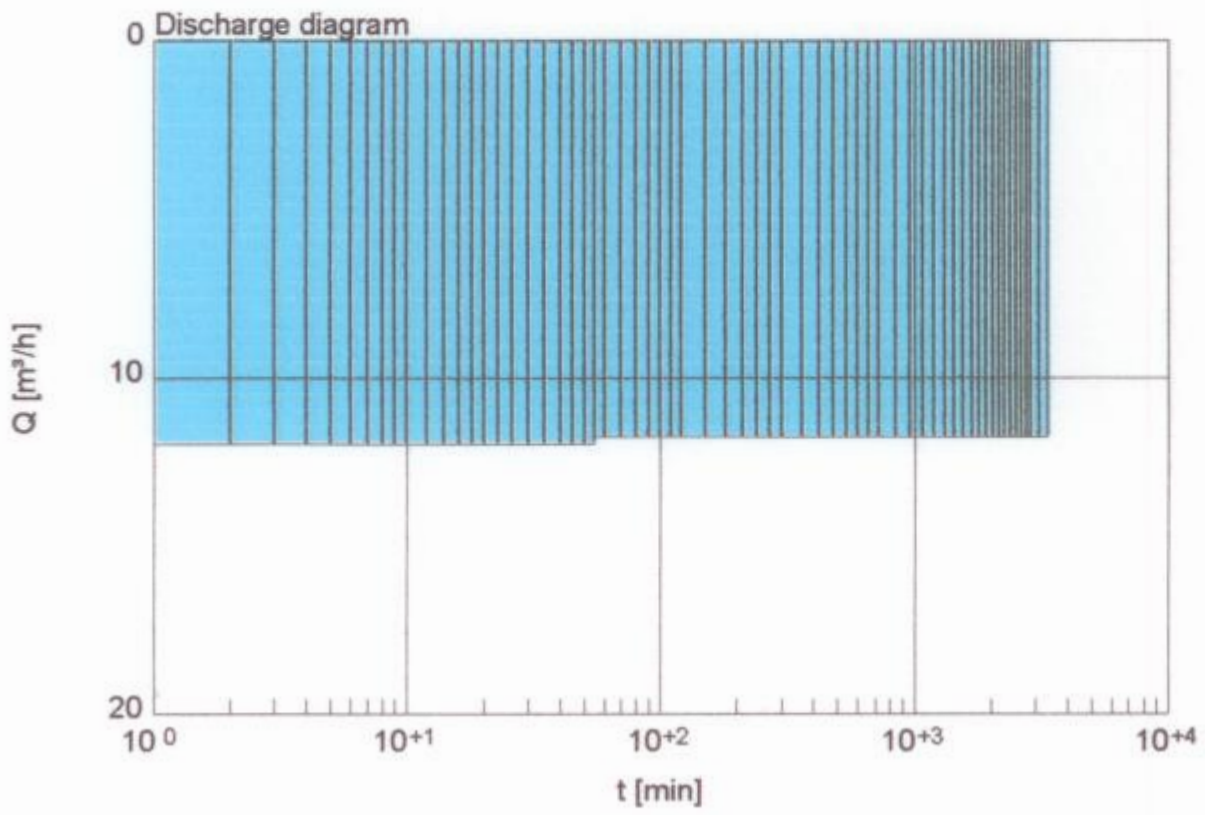
Step test diagnosis

Pumped well J4-N



Remarks

Merged data of abstraction borehole J4-N and observation boreholes J4-A and J4-K.



Discharge info

Dis.dur.:360 [min]
tcorr: 200 [min]

Av.dis.: 12.50 [m³/h]
max.dis.:20.00 [m³/h]
min.dis.:5.00 [m³/h]
Qn: 20.00 [m³/h]

Dis.sum: 75.00 [m³]

Distance to observation borehole: J4-A = 69 m; J4-K = 129 m

Date 02/10/00 prepared by BIWAC	Annex 6

7. Water Level Recorder Installation

THE STUDY ON THE GROUNDWATER POTENTIAL EVALUATION AND MANAGEMENT PLAN IN THE SOUTHEAST KALAHARI (STAMPRIET) ARTESIAN BASIN

INSTALLATION OF SEBA FLOATERS

JICA REFERENCE: J 4 N LOCALITY: Okonyama, Aminuis

WW 39847

1. **Serial Number of floater**: 4493
2. **Date installed**: 18/09/00
3. **Rest Water Level when installed**: 7.48 mbsu
4. **Distance from stick-up to logger**: 5.0 m
5. **Distance from logger to water level**: 2.48 m
6. **Cut off**: 5.0 m (0.91 + 4.11)