CONSTRUCTION AND TESTING OF A PRODUCTION WELL for the VILLAGE OF CRYSLER TOWNSHIP OF FINCH, ONTARIO

Prepared for:

Kostuch Engineering Limited
801-1290 Old Innes Road
Ottawa, Ontario K1B 5M6

Prepared by:

Water and Earth Science Associates Ltd.
Box 430, Carp, Ontario KOA ILO

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1.0 INTRODUCTION

Water and Earth Science Associates Limited (WESA) was contracted by Kostuch Engineering Limited to provide hydrogeological services for the construction and testing of a water supply production well for the Village of Crysler, Township of Finch. The well construction site is located approximately 5 kilometres east of the Village of Crysler on part of Lot 20, Concession IX, in the Township of Finch (Figure 1). A site plan showing the location of the new production well (PW1), the stand-by well constructed in 1986 (TW27), and the nearby monitoring wells is presented as Figure 2.

1.1 TERMS OF REFERENCE

The terms of reference for this project follow the guidelines established by the Ontario Ministry of Environment and Energy (MOEE) Water Supply Branch. Specifically, the objectives of the work program are:

1) To construct a communal water supply production well to be later used as a full scale production facility, in compliance with the specifications of the Ontario Water Resources Act as pertaining to water wells (Ontario Regulation 612/84).

2) To conduct aquifer testing of the completed well to determine both the well efficiency and the potential long term yield of the production well.

3) To assess the chemical and bacteriological water quality of the production well water supply with respect to the list of drinking water objectives specified for communal water supplies.

4) To identify any site control measures necessary for protection of the well water quality.

Construction and testing of the production well was completed by Olympic Drilling Company Ltd. of Ottawa, who were successful in their contract bid. Supervision of well construction and testing was provided by the technical staff of WESA. Geochemical and bacteriological analysis of well water samples were performed by Accutest Laboratories Ltd. of Nepean, Ontario.

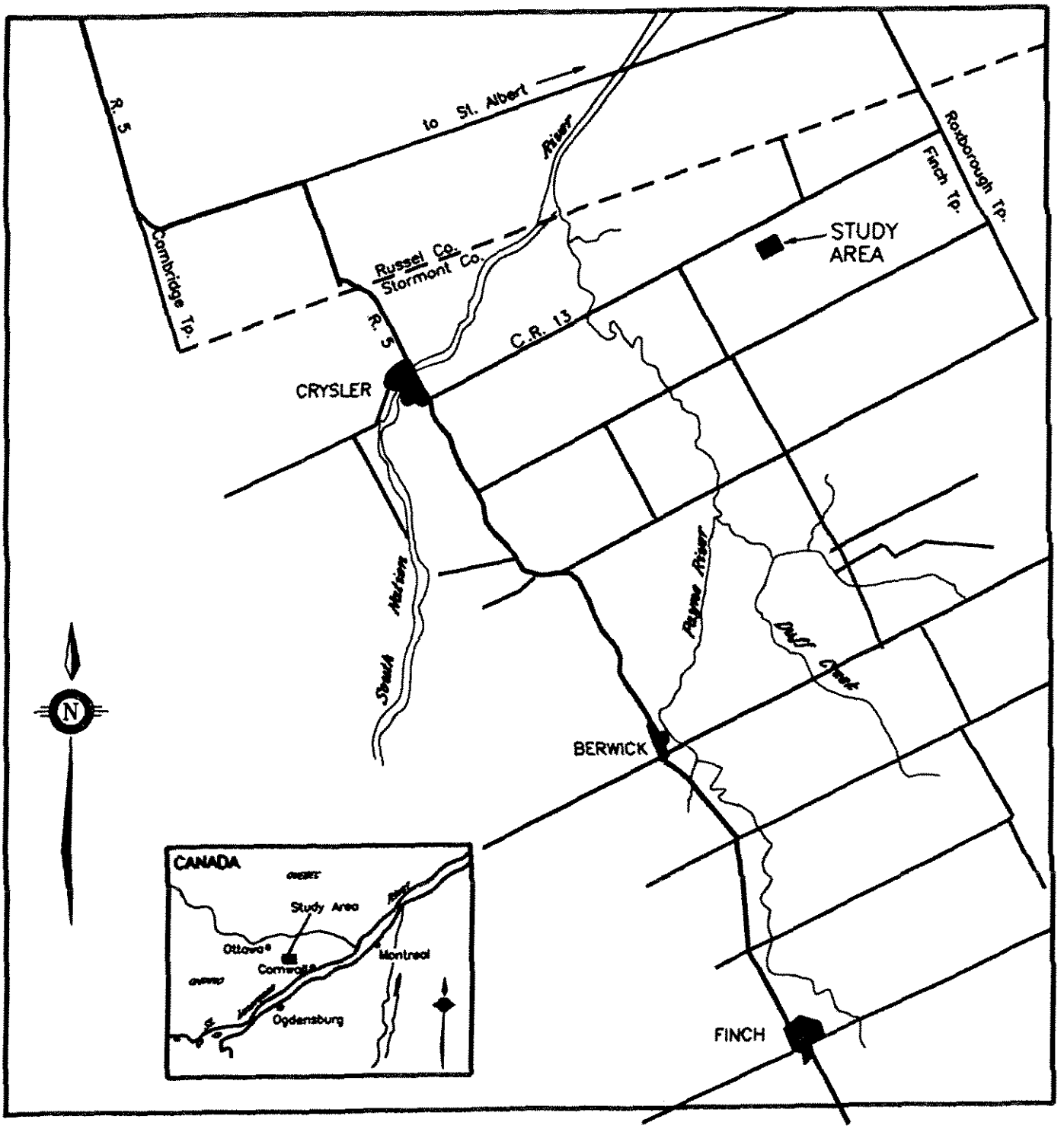

FIGURE: 1

0 1 2

KILOMETRES

SITE LOCATION

CRYSLER PRODUCTION WELL
TOWNSHIP OF FINCH

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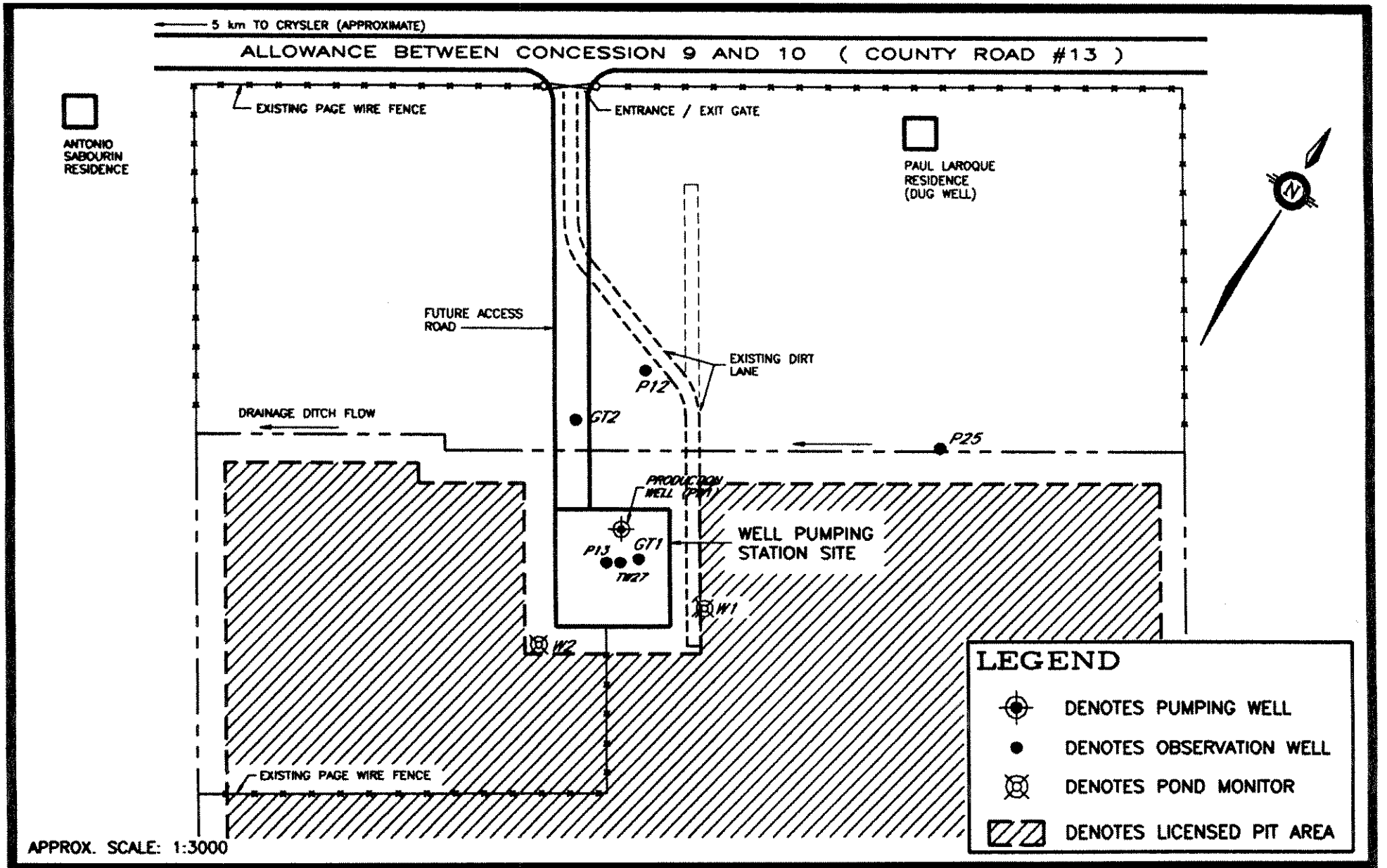

FIGURE: 2

SITE PLAN

CRYSLER PRODUCTION WELL
TOWNSHIP OF FINCH

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1.2 STUDY BACKGROUND

In 1981, the Ministry of Environment carried out a water pollution survey of domestic wells in the Village of Crysler. The results of the survey indicated a large percentage of water supplies in the village were unsatifactory with respect to to the Ministry's drinking water objectives for chemical and bacteriological water quality. These findings initiated the undertaking of a number of studies by Water and Earth Science Associates Ltd.(on behalf of Kostuch Engineering Ltd.) to investigate the water quality problem and to examine alternatives for communal water supply. A chronology of the Village of Crysler water supply study is summarized in Table 1.

TABLE 1 - CRYSLER WATER SUPPLY STUDY CHRONOLOGY

PHASE 1	**Private Services Funding Program**	**1981-1982**
PHASE 2	**Water Supply Source Identification (Background Study)**	**1983**
PHASE 3	**Source Investigation and Testing (Mapping Program)**	**1983-1984**
PHASE 4	**Source Quantification and Testing (Test Well Program)**	**1986, 1990, 1991**
PHASE 5	**Production Well Construction**	**1993**

The findings of the 1982 Private Services Funding Program (Phase 1) indicated that the shallow unconfined nature of the aquifer and the use of poor well construction techniques (e.g.improper grouting) had led to the impact of private septic systems on village water supplies. The investigation of deeper (bedrock) aquifers in the village indicated poor natural groundwater quality. The study concluded that the remediation and treatment of the water quality problems was not feasible and that an alternative water supply should be investigated. The findings from the Phase 1 study are described in detail in:

WESA, November 1982: Hydrogeological Investigation, Village of Crysler, Private Services Funding Program. Prepared for Ontario Ministry of the Environment.

Preliminary investigation for a communal production well site located outside of the village was carried out between 1983 and 1984 (Phase 2 and Phase 3). Geological and hydrogeological mapping was conducted for an 8 kilometre radius surrounding the Village of Crysler. A buried esker aquifer situated 5 kilometers east of the village was identified and chosen as a key target area. The lateral extent of the esker deposit was delineated through the excavation of test pits and the drilling of test holes. Water quality testing of formation water indicated the presence of a potable water supply.

A test well (TW27) was completed in the esker aquifer in 1986 (Phase 4). Aquifer testing and potability sampling of the test well indicated that a communal water supply of adequate yield and water quality could be constructed on the site. Findings from the Phase 2, Phase 3, and Phase 4 studies are described in further detail in:

WESA, September 1986: Crysler Water Supply Test Drilling Program. Prepared for Kostuch Engineering Ltd., and

WESA, July 1991: Addendum to Crysler Water Supply Test Drilling Program, Report dated September 1986. Prepared for Kostuch Engineering Ltd.

The final phase of the water supply study program, "the construction and testing of a production well," is described within this report.

2.0 SITE CHARACTERIZATION

The following section provides a summary of the general characteristics of the Village of Crysler production well site. Further detail on the site physiography can be found in the WESA, September 1986 report.

2.1 TOPOGRAPHY AND DRAINAGE

The Crysler production well site is located on the north end of an operating sand pit (Figure 2). Surface topography is generally flat between the well site and County Road 13 to the north. A shallow drainage ditch crosses the site, approximately 50 metres north of the production well (PW1). The ditch drains westward and off site.

The natural surface topography to the south of the production well site has been modified by pit operations. Pit excavation has created several large ponds and a number of large sand and gravel piles. The license for the pit authorizes the eventual extraction of materials to a depth of 6 metres below the local water table.

2.2 GEOLOGY

The buried esker ridge underlying the production well site consists of melt water derived glaciofluvial sand and gravel deposits that coarsen toward the core of the esker body. The complex has a north-south trending axis that has been traced in varying form to the south of the Village of Finch, a distance of some 16 kilometers. In the study area, the complex is approximately 700 metres wide and has an average thickness of 12.7 metres.

Located to the east and west of the esker deposit are offshore marine deposits of blue-grey clay and silt. These deposits overly the flanks of the buried esker ridge, thinning out toward the complex core. A shallow clay layer is present on the production well site, to the west and northwest of the production well.

Underlying the buried esker ridge deposit is a thin (0 to 2.5 metres thick) discontinuous calcareous, silty, compact till. The till directly overlies the grey shaley limestone bedrock of the Ottawa Formation (Williams, 1985). Both till plain and bedrock outcrop are visible approximately 1 kilometre east of the production well site.

2.3 REGIONAL HYDROGEOLOGY

Two aquifers are utilized within the study region. Characteristicly, wells completed in the local bedrock aquifer produce low yields and poor water quality. However, those farms and residences situated over the buried esker ridge complex obtain high yields and excellent water quality from shallow dug well installations. Field investigation and site specific mapping of the area has identified the buried esker ridge aquifer as an excellent target area for water supply development.

The hydrogeology of the buried esker ridge aquifer is described in detail in the WESA, 1986 report and is summarized in the following points:

1) The aquifer is generally unconfined in nature, although clay overlies the flanks of the complex.

2) Potentiometric head data obtained from piezometers completed in the aquifer indicate a groundwater flow direction to the north.

3) The largest area of the sand and gravel aquifer is located to the south (upgradient) of the production well site, indicating excellent long term aquifer recharge.

4) The aquifer is exposed in the sand pit operation, located upgradient from the production well site. Controls on pit operation and neighbouring land use is necessary for the protection of the aquifer water quality.

3.0 WELL CONSTRUCTION AND DEVELOPMENT

The location of the production well installation is shown on Figure 2. The well was constructed 19.2 metres north-northeast of the standby well (TW27). A schematic of the as-built construction of the production well is shown in Figure 3. Work specifications for the well construction are attached as Appendix A.

Churn drill (cable tool) drilling methods were used in construction of the well. A 750 mm (30 ") working casing was installed in the hole to a 7.6 metre depth to provide for a pressure grouting annulus. The 500 mm (20") casing was inserted into the working casing and driven to the compact till surface at a 12.2 metre (40 ft.) depth. A 3.05 metre (10') length of 250 mm (nominal 10") stainless steel wire-wrap well screen welded on to 250 mm (10") well casing was installed inside the 500 mm (20") casing using centering guides. A 1/4 inch x 1/2 inch silica gravel pack was placed around the screen and a water measurement pipe (piezometer) was installed. The 500 mm (20") casing was then pulled back to a depth of 9.14 metres, exposing the screen and gravel pack to the formation.

FIGURE: 3

AS-BUILT DIAGRAM

DESIGNATION	COMPLETION DATE
PW1	May 19, 1993

PROJECT: Crysler Production Well

PROJECT NO.: 3013

DRILLING METHODS: Cable Tool (Churn Drill)

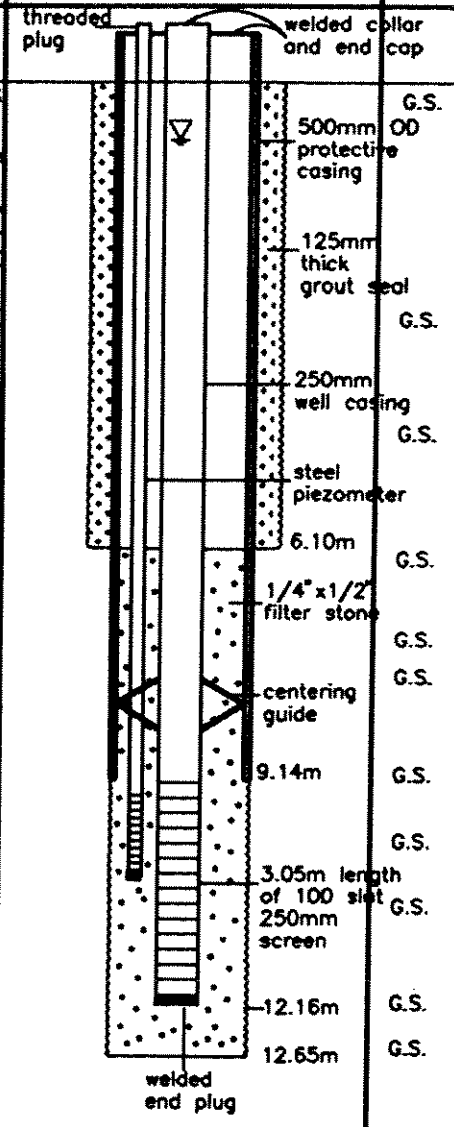
SUPERVISOR: R. Hillier

DRILLING CONTRACTOR: Olympic Drilling Co. Ltd.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY
0	72.89 masl	
1		0 – 3.0m Sand – light brown medium to fine grained
2		
3		
4		3.0 – 4.6m Sand – minor clay layer
5		4.6 – 6.1m Grey Sand – pebbles & cobbles
6		
7		6.1 – 7.6m Sand, gravel, stones
8		7.6 – 8.5m Sand, medium grained
9		8.5 – 12.5m Gravel – stones, some coarse sand
10		
11		
12		
13		12.5 – 12.8m Till – silty sand matrix
		12.8m End of Hole
14		
15		
16		
17		

LOG

INSTRUMENTATION



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Well development was conducted for a period of 52 hours. The well was initially developed for 22 hours using stop-start screen backwashing and air lift methods. A shaft line turbine pump was then used to stop-start pump the well at discharge rates up to 34 l/s (450 IGPM) for the remainder of development.

Sand free testing was conducted at various stages in well development. The tests involved collecting one litre water samples in a clear glass container and observing for sand grains in the water after pump startup. The well was determined to be essentially sand free at the design flow rate of 22.7 l/s (300 IGPM) after 52 hours of well development. Sand free tests conducted at higher flow rates indicated that further well development may be required if startup pumping rates in excess of 22.7 l/s (300 IGPM) are proposed in the future.

Upon completion of aquifer testing of the well (section 4.0), the well annulus was pressure grouted and the 750 mm (30") working casing was removed. The finished height of the 500 mm (20") outer well casing is approximately 0.74 metres above ground surface. The finished height of the 250 mm (10") inner well casing is approximately 0.77 metres above ground surface.

4.0 WELL TESTING PROGRAM

The aquifer testing program involved conducting an initial step discharge aquifer test, followed by a 72 hour constant rate discharge test, and then a 24 hour recovery test. Water was pumped using a shaft line turbine pump. The discharge rate was measured with a 101.6 mm X 151.4 mm (4 inch X 6 inch) orifice weir. Water was discharged 110 metres (350') away from the well head into an offsite flowing drainage ditch that is situated over clay till. Water levels in the pumping well and in proximal observation wells were measured with an electric water level sounding tape. Water levels in nearby ponds were also monitored during the tests. Instrumentation logs for observation wells TW27, P13, P12, and P25 are included in the WESA, 1986 report. Instrumentation logs for the two geotechnical holes (GT1 and GT2) used as observation wells are included in Appendix B. A copy of the MOEE 'permit to take water' is also contained in Appendix B. Results from the aquifer tests are described below.

4.1 Step Discharge Aquifer Test

The step discharge aquifer test was conducted on May 10, 1993. The test was carried out in five discharge steps: 11.4 l/s (150 IGPM), 17.0 l/s (225 IGPM), 22.7 l/s (300 IGPM), 28.4 l/s (375 IGPM) and 34.1 l/s (450 IGPM). Each step was 60 minutes in length. Each step was initiated upon the completion of the previous step without allowing for aquifer recovery. Step test data and the Jacob method data analysis is provided in Appendix C. The results of the step discharge test indicated that the production well was capable of producing yields in excess of the proposed design flow of 22.7 l/s (300 IGPM).

4.2 Constant Discharge Aquifer Test

The 72 hour constant rate discharge test was conducted between May 12, 1993 and May 15, 1993. The well was pumped at a constant discharge of 22.7 l/s (300 IGPM). The water level drawdown was monitored in the pumping well, the six observation wells (TW27, P13, GT1, GT2, P12, and P25), and at two pond level monitors (W1, W2). Several water levels were also obtained in wells P5 and P6 at the south end of the sand pit, however, no water table response was observed. Monitoring locations are shown on Figure 2. A summary of static level and drawdown data is presented below in Table 2.

TABLE 2: CONSTANT DISCHARGE TEST DATA SUMMARY

DISCHARGE RATE - 22.7 l/sec (300 IGPM)

WELL NUMBER	RADIAL DIST. FROM PUMPING WELL (M)	STATIC WATER LEVEL ELEVATION (MASL)	DRAWDOWN AFTER 72 HRS PUMPING (M)	W.L. ELEV. AFTER 72 HRS PUMPING (MASL)
PW1	0	72.15	2.12	70.03
GT1	18.3	72.17	1.04	71.07
P13	19.1	72.17	0.90	71.27
TW27	19.2	72.11	0.92	71.25
GT2	84	72.05	0.18	71.87
P12	140	72.03	0.13	71.90
P25	190	72.62	0.04	72.58
W1*	67	72.64	0.04	72.60
W2*	80	72.29	>0.03	<72.31

* Pond water level monitoring point

The static water level data in Table 2 verifies that the natural groundwater flow direction on site (before pumping) is to the north. After 72 hours of pumping, the cone of influence from the pumping well was observed 140 metres (P12) north of the production well. The drawdowns observed at P25, W1, and W2 suggest a natural drop in the site water table of approximately 0.04 metres during the course of the test.

Upon completion of the 72 hour constant discharge test, aquifer recovery was monitored for a period of twenty-four hours. Ninety-two per cent recovery in the production well was observed during this time.

All aquifer test data and data analysis is contained in Appendix B. Calculated aquifer transmissivities and storativities are summarized in Table 3.

TABLE 3: AQUIFER ANALYSIS SUMMARY

WELL #	DATA TYPE	CALCULATED TRANSMISSIVITY (m^2/day)	CALCULATED STORATIVITY	RADIAL DISTANCE (m)
PW1	Drawdown	734	---	---
PW1	Recovery	678	---	---
TW27	Drawdown	899	0.095	19.2
TW27	Recovery	749	0.0044	19.2
P13	Drawdown	856	0.117	19.1
P13	Recovery	719	0.0048	19.1
GT1	Drawdown	817	0.072	18.3
GT1	Recovery	642	0.007	18.3
GT2	Drawdown	2643	0.006	84
GT2	Recovery	---	---	84
P12	Drawdown	2875	0.071	140
P12	Recovery	8986	---	140

The calculated transmissivities (650 to 900 m^2/day) and storativities (0.1 to 0.001) for the aquifer are very close in magnitude to the aquifer test results in the WESA, 1986 study. The results indicate a highly transmissive aquifer with a high specific yield. Aquifers of this type produce a shallow, but wide drawdown cone around a pumping well.

Analysis of the semi-log plots of drawdown data in Appendix C show a break in the slope of the drawdown curve for each monitoring point during the first day of pumping. This negative boundary response may be indicative of the pumping drawdown cone extending laterally through the esker complex, encountering geologic materials of lower hydraulic conductivity (fining of the sediments) along the flanks of the esker deposit.

A conservative estimate of the aquifer transmissivity is 678 m2/day. An average calculated storativity on the order of 1.0 X 10-2 appears to be representative of this aquifer at this location. These values are used later in this report for the aquifer yield and well interference calculations.

4.3 Water Quality

The chemical and bacteriological quality of the production well water was monitored during the course of the constant discharge aquifer test. Samples for lab analysis were obtained at the 24 hour, 48 hour, and 72 hour test intervals using MOEE and USEPA approved sampling protocol. The 24 hour and 48 hour samples were analysed for bacteria and a suite of key drinking water parameters. The 72 hour sample was analysed for bacteria and the complete MOEE parameter list for communal drinking water supplies (Summer, 1992). All laboratory results and drinking water objectives are presented in Table 4. A review of the data indicates that the only parameter that was detected above the drinking water objective was faecal coliform during the 72 hour sampling interval. Also notable in the data is that chromium (a health parameter) was detected 'at' the objective limit of 0.05 mg/l.

In addition to lab analysis of water samples, field measurements for turbidity, temperature, and pH were obtained at various times during the 72 hour constant discharge test. This data is reported in the comments column of the drawdown data sheets for PW1 in Appendix C. Turbidity measurements were consistently below the water quality objective of 1 NTU. Water temperature ranged from 7 to 8 degrees celsius. Measurements for pH ranged from 7.35 to 7.6.

TABLE 4 – WATER QUALITY RESULTS – CRYSLER PRODUCTION WELL

Parameter	Units	MDL	MAC	IMAC	AO	ODWO	24 hr	48 hr	72 hr	TW27 4-07-86
Iron	mg/l	0.01				0.3	0.03	0.1	0.04	0.2
Manganese	mg/l	0.01				0.05	0.01	ND	ND	<0.01
Hardness	g/l CaCO	1				80–100	175	162	167	
Alkalinity	g/l CaCO	1				500	141	136	139	128
pH						6.5–8.5	8.23	7.96	7.9	
Conductivity	umhos/cm	3					343	351	341	
Fluoride	mg/l	0.01	1.5				0.06	0.06	0.06	<0.08
Sodium	mg/l	1				200	2	3	2	3
N–NO3	mg/l	0.1	10				0.6	0.49	0.45	3.41
N–NO2	mg/l	0.1	1				ND	ND	ND	0.03
N–NH3	mg/l	0.01					ND	ND	0.04	<0.1
Sulphate	mg/l	3				500	29	37	34	32
Chloride	mg/l	1				250	8	6	6	3
Phenols	mg/l	0.002	0.002				ND	ND	ND	<0.001
Turbidity	NTU	0.1	1				0.2	0.2	0.2	<1
Colour	Pt/Co unit	2				5	2	ND	ND	0.5
Calcium	mg/l	1					57	50	52	61
Magnesium	mg/l	1					8	9	9	8
Tannin & Lignin	mg/l	0.1					ND	ND	ND	
TKN	mg/l	0.01					0.12	0.05	0.11	
Potassium	mg/l	1					1	1	1	1
DOC	mg/l	0.2				5	0.9	0.4	0.4	
TDS	mg/l	1				500	200	200	200	213
Hydrogen Sulphide	mg/l	0.01				0.05	ND	ND	ND	
Organic Nitrogen	mg/l	0.01				0.15	0.12	0.05	0.07	<0.10
Chemical Oxygen Demand (COD)	mg/l	3					ND			
Bacteria										
Total Coliforms	cts/100ml		5				0	0	2	0
Faecal Coliforms	cts/100ml		0				0	0	2	0
Faecal Strepto–cocci	cts/100ml						2	0	2	0
E. Coli	cts/100ml		0				0	0	0	
Aerobic Plate Count	cts/1ml				500		11	3	142	
Metals										
Aluminum	mg/l	0.03				0.1			ND	
Arsenic	mg/l	0.01		0.025					ND	<0.01
Barium	mg/l	0.01		1					0.12	<0.1
Boron	mg/l	0.01		5					ND	<1
Cadmium	mg/l	0.002	0.005						ND	<0.005
Cyanide	mg/l	0.01	0.2						ND	<0.1

TABLE 4 CONT. – WATER QUALITY RESULTS – CRYSLER PRODUCTION WELL

Parameter	Units	MDL	MAC	IMAC	AO	ODWO	24 hr	48 hr	72 hr	TW27 4-07-86
Chromium	mg/l	0.01	0.05						0.05	<0.05
Copper	mg/l	0.01				1			ND	<0.01
Mercury	mg/l	0.001	0.001						ND	<0.001
Lead	mg/l	0.002	0.01						ND	<0.05
Selenium	mg/l	0.01	0.01						ND	<0.01
Uranium	mg/l	0.01	0.1						ND	<0.02
Zinc	mg/l	0.01				5			ND	0.03
Radionuclides										
Cesiums 137	Bq/l	1	50						ND	<0.5
Iodine 131	Bq/l	1	10						ND	<1
Radium 226	Bq/l	0.1	1						ND	<0.1
Strontium 90	Bq/l	1	10						ND	<0.5
Tritium	Bq/l	1000	40000						ND	<100
Alachlor	mg/l	0.005		0.005					ND	
Aldicarb	mg/l	0.0005	0.009						ND	
Aldrin & Dieldrin	mg/l	0.0007	0.0007						ND	ND
Atrazine	mg/l	0.005		0.06					ND	
Azinphos-methyl	mg/l	0.02	0.02						ND	
Bendiocarb	mg/l	0.03	0.04						ND	
Benzene	mg/l	0.0005	0.005						ND	0.0019
Benzo(a)pyrene	mg/l	0.00001	0.00001						ND	
Bromoxynil	mg/l	0.0005		0.005					ND	
Carbaryl	mg/l	0.07	0.09						ND	ND
Carbofuran	mg/l	0.0005	0.09						ND	
Carbon tetra-chloride	mg/l	0.0005	0.005						ND	ND
Chlordane	mg/l	0.007	0.007						ND	ND
Chlorpyrifos	mg/l	0.01	0.09						ND	
Cyanazine	mg/l	0.01		0.01					ND	
Diazinon	mg/l	0.01	0.02						ND	ND
Dicamba	mg/l	0.01	0.12						ND	
1,2-Dichloro-benzene	mg/l	0.0004	0.2		0.003				ND	
1,4-Dichloro-benzene	mg/l	0.0004	0.005		0.001				ND	
DDT	mg/l	0.03	0.03						ND	ND
1,2-Dichloro-ethane	mg/l	0.0005		0.005					ND	ND
Dichloromethane	mg/l	0.004	0.05						ND	0.0016

TABLE 4 CONT. – WATER QUALITY RESULTS – CRYSLER PRODUCTION WELL

Parameter	Units	MDL	MAC	IMAC	AO	ODWO	24 hr	48 hr	72 hr	TW27 4-07-86
2,4–Dichloro–phenol	mg/l	0.002	0.9		0.0003				ND	
2,4–D	mg/l	0.1	0.1						ND	ND
Diclofop–methyl	mg/l	0.009	0.009						ND	
Dimethoate	mg/l	0.005		0.02					ND	
Dioxins & Furans	Pg/l	15		15					ND	
Diquat	mg/l	0.01							ND	
Diuron	mg/l	0.1							ND	
Ethylbenzene	mg/l	0.0005			0.0024				ND	0.00024
Glyphosate	mg/l	0.1							ND	
Heptachlor + Heptachlor Epoxide	mg/l	0.003	0.003						ND	ND
Lindane	mg/l	0.004	0.004						ND	ND
Malathion	mg/l	0.005	0.19						ND	
Methoxychlor	mg/l	0.1	0.9						ND	ND
Metolachlor	mg/l	0.005		0.05					ND	
Metribuzin	mg/l	0.005	0.08						ND	
Monochloro–benzene	mg/l	0.0004	0.08		0.03				ND	
Nitrilotri–acetic Acid	mg/l		0.4						ND	
NDMA	mg/l	0.000005		0.000009					ND	
Paraquat	mg/l	0.01		0.01					ND	
Parathion	mg/l	0.01	0.05						ND	ND
Pentachloro–phenol	mg/l	0.002	0.06		0.03				ND	
Phorate	mg/l	0.002		0.002					ND	
Picloram	mg/l	0.02		0.19					ND	
PCB's	mg/l	0.003		0.003					ND	
Prometryne	mg/l	0.001		0.001					ND	
Simazine	mg/l	0.005		0.01					ND	
Temephos	mg/l	0.24		0.28					ND	
Terbufos	mg/l	0.001		0.001					ND	
2,3,4,6–Tetra–chlorophenol	mg/l	0.002	0.1		0.001				ND	
Toluene	mg/l	0.0005			0.024				ND	0.00086
Triallate	mg/l	0.01	0.23						ND	
Trichloro–ethylene	mg/l	0.0003	0.05						ND	ND

TABLE 4 CONT. – WATER QUALITY RESULTS – CRYSLER PRODUCTION WELL

Parameter	Units	MDL	MAC	IMAC	AO	ODWO	24 hr	48 hr	72 hr	TW27 4-07-86
2,4,6–Tri–chlorophenol	mg/l	0.002	0.005		0.002				ND	
2,4,5 TP	mg/l	0.28	0.28		0.02				ND	ND
Trifluralin	mg/l	0.005		0.045					ND	
Trihalo–methanes	mg/l	0.01	0.35						ND	
m/p Xylene	mg/l	0.001			0.3				ND	
O Xylene	mg/l	0.0005			0.3				ND	
Methane	L/m3	0.05			3				2.3	

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration (Health and Welfare Canada, 1991)
IMAC = Interim Maximum Acceptable Concentration (Health and Welfare Canada, 1991)
AO = Aesthetic Objective (Health and Welfare Canada, 1991)
ODWO = Ontario Drinking Water Objective (Ontario Ministry of Environment, Summer 1992)
ND = Not Detected (<MDL)
Blank = not analysed
Pg/L = picograms/litre

5.0 DISCUSSION OF RESULTS

5.1 WELL EFFICIENCY

Well efficiency is defined as the ratio of theoretical drawdown in a well (assuming the logarithmic distance-drawdown relationship is applicable all the way to the well face) to the actual observed drawdown. Applying the well function formula (Appendix D) to observation well TW27, a theoretical drawdown of 0.89 metres in 72 hours (at 22.7 l/s) is predicted. The actual measured drawdown in TW27 was 0.92 metres during the constant discharge test. Therefore, a 97% well efficiency is calculated. Based on this result and the high aquifer yields obtained, a satisfactory well efficiency is indicated.

5.2 THEORETICAL AQUIFER YIELD, SAFE PERENNIAL YIELD, AND INTAKE VELOCITY LIMITATIONS

Theoretical aquifer yields were calculated for a ten year and twenty year period (Appendix D). Values for a ten year design period for aquifer yield were calculated to be 36.1 l/s (474 IGPM). For a twenty year period the theoretical aquifer yield is 35.2 l/s (464 IGPM). The calculated safe perennial yield for the production well is 40.2 l/s (531 IGPM). These estimates assume a 100 % efficient well and do not account for seasonal variations in recharge. A factor of safety using these values is recommended for final design.

To prevent corrosion and wear in a well screen, the theoretical entrance velocity should not exceed 0.03 m/sec (0.1 ft/s). For the 100 slot 3.05 metre (10') long production well screen (1.2 m^2 intake area), well discharge should not exceed 36.5 l/s (482 IGPM).

5.3 WELL INTERFERENCE

Well interference calculations were carried out at the design yield (22.7 l/s) for a 1 year and a 10 year period of time (Appendix D). The results for a 10 year period are summarized in Table 5.

TABLE 5: THEORETICAL WELL INTERFERENCE (AFTER 10 YEARS PUMPING)

RADIAL DISTANCE IN METRES	DRAWDOWN IN METRES (Q = 300 IGPM, 1964 m^3/day)
0.25 (PW1)	5.28
19.2 (TW27)	3.28
140 (P12)	2.36
300 (Laroque dug well)	2.01
1000	1.46

Several domestic dug wells are situated within the theoretical cone of influence of the production well. The closest dug well is situated approximately 300 metres from the production well. Because the core of the esker is largely a linear feature, impact to the north and south is anticipated to be of first concern. The level of indicated well interference should be acceptable from a water supply perspective.

5.4 GROUNDWATER QUALITY

The geochemical data for the production well (Table 4) meets the MOEE drinking water objectives for all parameters except faecal coliform. The level of chromium (a health parameter) was detected 'at' the drinking water objective of 0.05 mg/l. These parameters were analysed for well TW27 in 1986 and did not exceed the guidelines at that time. Since these parameters are marginal with respect to the guidelines, additional sampling for these parameters is recommended.

Excavation equipment and dump trucks associated with the sand pit operation were observed to cross the production well site within metres of the production well and the standby well (TW27). A potential for sand production due to ground vibrations exists for the shallow screened production wells. Measures to prevent ground vibration in the vicinity of the wells should be enforced.

5.5 Well Head Protection

The long term water quality of overburden aquifers is generally regarded as good, however, a number of considerations are warranted. The Crysler production well site aquifer system is recharge dominated and therefore prone to groundwater degradation due to various pollutants from the surface (spills, agricultural activities, septic effluent, etc.) if they occur. Flow rates in this type of system are slow and a considerable time lag exists between the time that the contaminant enters the ground and the time that it impacts on the well. Most of the activities which are associated with water supply contamination (farming practices) are located on the flanks of the esker deposit and therefore the aquifer is isolated by the impermeable clay silt materials. However, direct discharge from these properties into the ponded waters in the licensed sand pit, may potentially impact the production well water supply.

Details of a preliminary communal water supply monitoring program was prepared by WESA in August 1990. Many of the observation piezometers included in the monitoring program have since been destroyed by sand pit operations. Upgrading of this document in a 'Well head protection plan' is recommended.

The 'Well Head Protection Plan' should carefully control future development in the aquifer recharge area. Long term groundwater and surface water sampling on the perimeter of the production well site will be required to monitor for degradation in water quality. Monitoring of sand pit operations will be required to ensure that aquifer dewatering and contamination due to carelessness in site operation does not occur. A quick response mechanism in the event of a spill on site will be required to prevent the potentially disastrous results on the village water supply.

6.0 CONCLUSIONS

The following conclusions have been derived from the work conducted in this study.

1. A production well has been successfully completed in a sand and gravel glaciofluvial complex located 5 kilometres east of the Village of Crysler. The construction of the well is in compliance with the specifications of the Ontario Water Resources Act as pertaining to water wells (Ontario Regulation 612/84).

2. Aquifer testing of the production well indicates that the well is capable of providing a sand free water supply at a long term yield of 22.7 l/s (300 IGPM). Well efficiency is deemed to be satisfactory. Little, if any notable interference on neighbouring farm and domestic water supplies is expected at the design yield of the well.

3. Water quality of the production well is excellent. The geochemical data for the production well meets the MOEE drinking water objectives for all parameters except faecal coliform. The level of chromium (a health parameter) was detected 'at' the drinking water objective of 0.05 mg/l. Since these parameters are marginal with respect to the guidelines, additional sampling for these parameters is recommended.

4. Control measures on the nature of development and landuse activities in the recharge area of the site aquifer will be necessary for protection of the production well water quality.

7.0 RECOMMENDATIONS

The following recommendations have been formulated based on the results of the study.

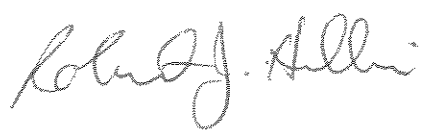
1. Sand free testing of the production well indicates essentially sand free conditions at a maximum flow rate of 22.7 l/s (300 IGPM). Sand free tests conducted at higher rates indicate sand production immediately after startup of pumping. Additional well development is recommended if startup rates in excess of 22.7 l/s (300 IGPM) are proposed in the future.

2. Controls on vehicle traffic (from sand pit operations) in the vicinity of the production wells is recommended to prevent possible sand production in the wells due to ground vibration.

3. Resampling of the production well for bacteriological analysis and chromium should be conducted. Results from this sampling will help to verify or refute the findings in this report.

5. A well head protection plan should be developed for the Crysler well field over the longer term to protect and maximize the Townships use of the groundwater resource. Over the short term while such a plan is being developed, an arbitrary protection zone regulating development that may place the aquifer at risk should be instituted. An initial protection zone defined by an area 500 metres wide on either side of the axis of the esker and 2 kilometres north and south of the well site should be enforced.

Respectfully submitted,



Robert J. Hillier, B.Sc.
Hydrogeologist

Roger M. Woeller, M.Sc.
Hydrogeologist

8.0 REFERENCES

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APPENDIX A

WELL CONSTRUCTION AND TESTING SPECIFICATIONS FOR CONTRACTOR

Well Construction and Testing Specifications

1) Scope of Work

The Contractor shall perform all of the Work required to carry out the drilling of a production well.

The objective of the program is to complete one well with a safe perennial yield of 1365 L/min (300 IGPM).

2) Location

The general location of the work is in the area as shown on Figure 2 The well shall be drilled at a site selected by the Hydrogeologist.

3) *Description of Pilot Hole Program*

The purpose of this phase of the program is to confirm the hydrologic suitability and the water-yielding properties of the local formations. One production well shall be located approximately 25 metres to the east of test well TW27 at a site selected by the Hydrogeologist. The production well shall be within the property limits. One (1) pilot test hole shall be drilled to a depth of approximately 14 metres.

4) Specifications for Pilot Test Hole

Formation Sampling

Samples of materials encountered in drilling shall be collected by the Contractor at intervals of at least 0.9 m (3 ft.) through the aquifer zone. In testing the overburden, the Contractor generally will be required to collect representative samples of any favourable aquifer materials and shall have the necessary sieve analyses performed to aid in the selection of the well screen and gravel pack. Duplicate samples of at least 500 grams (1.1 pounds) shall be bagged, properly coded and provided to the Hydrogeologist.

Formation Logging

A complete and accurate log of all the materials penetrated by the test hole shall be kept by the Contractor.

Test Hole

The test hole designed to obtain the representative formation samples shall have a nominal diameter of at least 125 mm.

5) Description of Well Construction Program

After completion of the pilot hole program, the Contractor shall proceed with the construction of one (1) 500 mm by 254 mm gravel packed production well, or, otherwise, formally request the suspension of the project in writing, indicating reasons why the project may not proceed to completion of the Contract yield objectives.

The well shall be constructed in a manner that will ensure protection of the sanitary and chemical quality of the water and conserve the hydrostatic head of the aquifer. Casing shall be set round, plumb and true to line in accordance with the specified tolerances. All work and material shall conform to current A.W.W.A. "A 100-84-Standard for Water Wells" and with the Ministry of the Environment's Well Regulation 612/84, or subsequent amendment, and shall be subject to the approval of the Hydrogeologist. Modifications to the well specifications to meet local conditions encountered by the Contractor during well construction may be made only on the written order of the Hydrogeologist.

The Contractor shall carry out an aquifer test and obtain all measurements from the pumping well and observation wells designated by the Hydrogeologist. The Contractor shall submit the field reports to the Hydrogeologist. Accessible existing wells shall be monitored by the Contractor during the test. Discharge water shall be conveyed in a manner that will not cause damage.

The Hydrogeologist shall be present on site during the well construction and development and supervise grain size analyses on representative aquifer materials to select an appropriate screen, provide on-site supervision of all test pumping, analyze the test data and submit a written report at the completion of the work to Kostuch Engineering Limited.

The Hydrogeologist shall collect the well water samples for chemical and bacterial analysis during the pumping test in sample bottles provided by the laboratory.

The Contractor shall be responsible for preparing the sites for drilling including the supply and rough grading of materials required to maintain access roads and a suitable base for drilling equipment.

Existing wells in the vicinity (1.5 km radius) of the drilling operations shall be monitored during the well drilling and development programme by the Contractor. If wells are not accessible to the Contractor or the Contractor is of the opinion that monitoring is not required for reasons of physical hydrogeology only, the Contractor may petition the Hydrogeologist to eliminate individual adjacent wells from the list of monitored wells. A decision to eliminate wells must first be approved by the Hydrogeologist.

The Contractor shall be responsible for providing a temporary supply of 4500 litres/household of potable water. A plan for compensation (ie. immediate delivery of water) shall be worked out ahead of time by the Contractor, and approved in writing by the Hydrogeologist, in order to minimize the delay should it be necessary to provide water for a landowner.

Landowners whose water service is temporarily affected by construction practices (ie. de-watering operations and/or the release of groundwater) shall have water made available to them at the expense of the Contractor until groundwater conditions return to normal following the pumping tests.

6) Detailed Well Construction (Figure 4)

A. Components of Well

The well shall consists of the following principal items.

a) Casing

Casing tube used hereunder shall be prime quality and shall have the following specifications:

i) Outer Casing

500 mm (20 in.) OD nominal protective casing.

II) Inner Casing

Diameter	*	254 mm (10 in.) ID
Material	*	new, low carbon steel complying with ASTM specification A-120.
Thickness (Min)	*	9.53 mm (0.375 in.)
Joints	*	Steel joints to be welded or threaded couplings
Drive Shoe	*	Of approved type if casing is to be driven

b) Screen

A commercially manufactured well screen of new material of the following minimum specifications shall be furnished and installed opposite the most favourable parts of the aquifer:

Diameter:	254 mm (10 in.) nominal
Length:	minimum 3.0 m (10 ft.)
Material:	Type 304 Stainless Steel

Type: Wire wound pipe size continuous slot design

Openings: The size of the openings shall be determined in accordance with the character of the materials found in the water bearing strata. The theoretical entrance velocity shall not exceed 0.03 m/sec. (0.1 ft./sec.). The shape of the openings or slots shall be so designed as to prevent clogging and shall be free from jagged edges or irregularities that will accelerate corrosion.

Strength: The screen shall have adequate strength to resist the external forces that will be applied after it is installed and to minimize the likelihood of damage during installation. The screen must have no change of alignment at any of its joints after installation.

Fitting: The bottom of the screen shall be closed with a stainless steel plate to prevent the entry of foreign material. The Contractor shall provide and install any other fittings which may be required for the proper construction of the well.

c) Cement Grout

The protective casing shall be grouted in place, from ground surface to a minimum depth of 7.6 m. The grout seal shall have a thickness of 125 mm (5 in.) to provide a sanitary seal and to prevent the movement of water outside the casing.

The grout mixture shall comprise Portland Cement and water. The cement weight is to be approximately 5.4 kg per 3.8 litres (ie. not more than 1 cubic meter water for every cubic meter of cement). Sufficient cement is to be used to ensure cement returns to surface. Any changes in the grout mixture and use of special admixtures are to be approved by the Hydrogeologist.

d) Gravel Pack

The gravel shall be clean, rounded, water-washed silica gravel, free from silt, clay and other deleterious material. The size shall be determined by the Contractor and reviewed by the Hydrogeologist after samples of the aquifer have been obtained and analyzed. The Contractor shall submit a sample of the gravel pack material to the Hydrogeologist for review. Sufficient gravel shall be furnished for initial gravelling of the well and such additional gravel as the well may take during swabbing and developing. Fluid viscosity should be maintained as low as possible during the installation of the gravel pack.

Installation of the gravel pack shall be by the tremie pipe method. The Contractor shall ensure that the gravel pack is not plugged or bridged during installation.

The gravel pack shall have a minimum thickness of 125 mm (5 in.) and shall extend at least 3.0 m (10 ft.) above the screen following the completion of the well.

B. Pumping Equipment

The Contractor shall furnish and install all necessary equipment for the completion of pumping tests, which equipment shall be capable of operating at a constant rate of up to 1365 L/min (300 IGPM) for a period of not less than seventy-two (72) hours. The Contractor shall provide for the diversion of pumped water to a discharge point located approximately 200 metres from the well head. A minimum of 300 metres of overland pipe will be required for this purpose.

C. Method of Grouting

The mixture, method of mixing, and consistency of grout shall be approved by the Hydrogeologist. Before proceeding with the placing of the grout the Contractor shall secure the Hydrogeologist's approval of the method he proposes to use. No method will be approved that does not specify the forcing of grout from the bottom of the space to be grouted toward the top. A suitable cement retainer, packer, or plug shall be provided at the bottom of the space to be grouted.

D. Capping

At all times during the progress of the work, the Contractor shall protect each well constructed under the Contract in such a manner as to prevent the entrance of foreign matter into the well. Upon completion, the Contractor shall install a welded steel plate on the protective casing on each well, to the satisfaction of the Hydrogeologist. The casing shall extend 0.67 m (2 ft.) above the original ground surface.

E. Sealing Abandoned Holes

If a hole has to be abandoned, it shall be sealed in a manner subject to the approval of the Hydrogeologist that will eliminate physical hazard, prevent contamination of groundwater, conserve yield and hydrostatic head of the aquifer, and prevent intermingling of potable and non-potable waters.

The abandoned hole shall be sealed as follows:

i) Backfill opposite and one metre above any water bearing zone with clean sand and gravel.

ii) Backfill above clean sand and gravel with one metre of bentonite.

iii) Backfill remainder of hole with fine grained soil or cuttings to two metres from ground surface.

iv) Backfill with bentonite from two metres below ground surface to ground surface.

Concrete grouting may be required depending on conditions found in the hole. If the hole has to be abandoned because of negligence on the Contractor's part, no payment will be allowed for sealing the hole.

F. Testing for Plumbness and Alignment

The Contractor shall furnish all labour, tools and equipment to demonstrate the degree of plumbness and alignment of any well to be considered as a production well.

The divergence from plumbness shall not exceed 2/3 the inside diameter of the protective casing per 30 m of depth.

The alignment and roundness shall be such as to permit the free passage in the protective casing of either a 6.0 m (20 ft.) length of pipe, or a 6.0 m (20 ft.) dummy, having an outside diameter 12.7 mm (0.5 in.) less than the inside diameter of the hole to the anticipated pump setting.

If the well fails to meet these specifications, the plumbness and alignment shall be corrected by the Contractor at his expense and should he fail to correct such faulty alignment or plumbness, the Hydrogeologist may refuse to accept the well. The well will then be abandoned by the Contractor according to Ministry of the Environment specifications (Facts sheet titled "Recommended Methods for Plugging Abandoned Water Wells", September 1986) and Ontario Regulation 612/84 (section 21), at the Contractor's expense.

7) *Well and Aquifer Testing Programs*

When, in the opinion of the Hydrogeologist, a well has encountered a suitable aquifer which meets the yield specifications, the Contractor shall conduct a pumping test, in the presence of the Hydrogeologist to:

i) Determine the hydrogeological conditions of the aquifer.
ii) Determine the safe yield of the production well.
iii) Determine the efficiency of the production well.
iv) Determine the effects the test well will have on existing wells within the interpreted area of influence.

The Contractor shall notify the Hydrogeologist 24 hours in advance of any capacity or aquifer test. The Contractor shall have a minimum of two men available to keep a record of the water levels in the pumped well and in specified observation wells before, during and after the pumping periods at intervals determined by the Contractor and approved by the Hydrogeologist.

The rate of discharge for the pumping tests shall be measured with a circular orifice weir. A valve shall be placed in the discharge line of the pipe to provide control of the pumping rate during testing and to provide a sampling port. A check valve shall also be provided to prevent water in the discharge line from draining back into the well once the pump is turned off.

The Contractor shall provide on site supervision of the pumping test to the satisfaction of the Hydrogeologist.

Sand Free Test

The well will be developed by compressed air surging or comparable method approved by the Contractor until essentially sand free. The contractor will demonstrate the sand free character of the water with an appropriate test subject to approval by the Hydrogeologist. The well must have a turbidity content at or below the provincial drinking water standard.

Step-Drawdown Test

The Contractor shall carry out a step-drawdown pumping test on each well encountering a suitable aquifer, to determine the amount of the well loss and the hydraulic efficiency of the well. The well shall be continuously pumped at a minimum of five increments, commencing with the lowest and ending with the highest. The pumping rates and the period of pumping at each rate shall be determined by the Hydrogeologist. It is anticipated that a step-drawdown test should not exceed six (6) hours duration.

A minimum well efficiency of 80% as calculated by the Hydrogeologist is required. Well efficiency will be calculated at the production yield of the well at the conclusion of 72 hours of continuous pumping.

Continuous Drawdown Aquifer Test

The Contractor shall conduct a pumping test to determine the aquifer response, the aquifer hydraulic coefficients, the safe yield of the aquifer and the well operating characteristics. The Contractor shall notify the Hydrogeologist when the well or wells are to be tested. The test shall be continuous at the specified yield, for a period of seventy-two (72) hours and shall be conducted in a manner acceptable by the Hydrogeologist. Continued pumping of a well in excess of the specified duration may be required by the Contractor as required by the Hydrogeologist, dependent on the observed pumping test trend. The hydrogeologist will undertake the calculations of the above parameters with the data furnished by the Contractor.

Water levels in the pumped well and in the adjacent observation wells shall be recorded by the Contractor before, during and after the pumping period at intervals approved by the Hydrogeologist. The Contractor shall take water-level readings during the recovery for a period of at least one-quarter of the pumping time (24 hours) or until 90% recovery has been attained. The electric depth gauge method shall be used to measure water levels. Rates of flow during the pumping tests shall be measured and recorded when each water level measurement is taken. Unusual chemical qualities of taste or odour in the well water shall be recorded by the Contractor and brought to the attention of the Hydrogeologist by the Contractor. In fact the Contractor

shall comment on the observed absence or presence of hydrogen sulphide or methane gas during the pumping test and shall undertake adequate testing and sampling to evaluate the gas concentration and volume per cubic meter of pumped water for subsequent determination of acceptable gas removal system.

Water Sampling and Quality Control

Water samples will be collected in duplicate by the Hydrogeologist at each sampling interval. All bottles and caps (except for pre-treated bottles and bottles for organic constituent analyses) will be rinsed six times with the sample before the sample is collected. All bottles will be supplied by the laboratory. Travel blanks are to be used for the volatile and PCB's samples to monitor any outside contamination.

Provisions will be made, by the Hydrogeologist, for the completion of field tests for the following parameters;

Turbidity, temperature, taste, odour, and pH.

Well water samples for chemical and bacterial analysis shall be collected by the Hydrogeologist at intervals specified as follows;

24 (twenty-four), 48 (forty-eight), and 72 (seventy-two) hour marks.

Aborted Pumping Test

Whenever continuous pumping at a uniform rate has been specified, failure of pump operation for a period greater than one percent of the elapsed pumping time shall require suspension of the test until the water level in the pumped well has recovered to its original level. Recovery shall be considered "complete" after the well has been allowed to rest for a period of a least equal to the elapsed pumping time of the aborted test except that if any three successive water level measurements spaced at least 20 minutes apart show no further rise in the water level in the pumped well, the test may be resumed immediately. The Hydrogeologist shall be the sole judge as to whether this latter condition exists. The contractor will restart the test and run it to full completion. The cost of the aborted test will be born by the Contractor.

Location of Discharge

Discharge water from the production wells shall be conducted by hose or pipe from the well sites in a manner that ensures no damage by flooding or erosion is caused. Pumped water from all testing will be discharged 300 metres (1000 feet) from the well head at a municipal drain.

8) Other Matters

Well Disinfection

After the well has been constructed it shall be thoroughly cleaned, by the Contractor, of all foreign substances. The casing shall be swabbed thoroughly, using alkalis if necessary, to remove oil, grease, or joint dope. Each well shall be disinfected, by the Contractor, with a chlorine solution before and after the pumping tests of such volume and strength and shall be so applied that a concentration of at least 250 mg/l of chlorine will be obtained in all parts of the well. Chlorine solutions shall be prepared and applied in a manner satisfactory to the Hydrogeologist and shall remain in the well for a period of at least two hours.

APPENDIX B

GEOTECH BOREHOLE LOGS (GT1 AND GT2) AND PERMIT TO TAKE WATER

Log of Borehole BH. 112 GT 1

Trow

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Rock Core
Field Vane Test
Natural Moisture
Plastic & Liquid Limit
Undrained Triaxial at 0
Overburden Pressure 15 @ 6
% Strain at Failure 10
Penetrometer
Water Level: Est.: Measured: Perched:

Project Geotechnical Investigation. Dwg. No. 1

Contract No. 2, Well site.

Chrysler,, Ontario. Project No. R1065A/G

Hole location and datum see Drawing No. 1

GWL	SYMBOL	Soil Description	Depth Below Grade m	DEPTH m
		Topsoil 100mm	0.1	0
		Silty Sand fine to medium grained, brown, frozen in the upper 1.0m depth (compact).		
		- becoming wet and grey below 1.2m depth.		1
		- Running wet Sand in the augers at 2.3m depth.		2
		- becoming dense and with some gravel below 3.9m depth.		3
		Terminated at 4.3m depth	4.3	4

N Value 20 40 60 80
Shear Strength 50 100 kPa
Natural Moisture Content and Atterberg Limits % Dry Weight 10 20 30
Natural Unit Weight kN/m³

NOTES:
1. Borehole data requires interpretation assistance from Trow before use by others
2. Boreholes drilled on March 19, 1993 using a track mounted CME-550 drill rig equipped with continuous flight hollow stem auger equipment to a termination depth at 4.3m.
3. A 19mm Slotted standpipe was installed to 4.6m depth.
4. See Notes on Sample Descriptions
5. This Drawing to be read with Trow Consulting

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
1 hr	1.1	4.3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1			
2			
3			
4			

Notes:

Log of Borehole BH. 111 GT2

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Rock Core
Field Vane Test
Natural Moisture
Plastic & Liquid Limit
Undrained Triaxial at Overburden Pressure 15 5
% Strain at Failure 10
Penetrometer
Water Level: Est.: Measured: Perched:

Project Geotechnical Investigation. Dwg. No. 2
Contract No. 2, Well site.
Chrysler, Ontario. Project No 31065A-3
Hole location and datum see Drawing No. 1

GWL	SYMBOL	Soil Description	Depth Below Grade m	DEPTH
		Topsoil 125mm	0.1	0
		Silty Sand fine to medium grained, brown, frozen in the upper 0.5m depth (compact). - becoming wet and grey below 0.75m depth.		1
		Silty Sand to Sandy Silt oxidized stains, wet, grey (compact).	1.5	2
		Terminated at 3.0m depth	3.0	3

N Value 20 40 60 80
Shear Strength 50 100 kPa
Natural Moisture Content and Atterberg Limits % Dry Weight 10 20 30

NOTES:
1. Borehole data requires interpretation assistance from Trow before use by others
2. Borehole drilled on March 19, 1993 using a track mounted CME-550 drill rig equipped with continuous flight hollow stem auger equipment to a termination depth at 3.0m.
3. A 13mm Slotted standpipe was installed to 3.0m depth.
4. See Notes on Sample Descriptions
5. This Drawing to be read with Trow Consulting

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
1 Hr	.76	3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1			
2			
3			
4			

Notes:

Ontario Ministry of the Environment and Energy
Ministère de l'Environnement et de l'Énergie

Southeastern Region
Région du Sud-Est
1-800/267-0975 Fax: 613/548-6908

Mailing Address
PO Box 820
Kingston, Ontario
K7L 4X6

Adresse postale
CP 820
Kingston (Ontario)
K7L 4X6

133 Dalton Avenue
Kingston, Ontario
K7K 6C2
613 / 549-4000
1 / 800 / 267-0974
Fax No. 613 / 548-6908

133, avenue Dalton
Kingston (Ontario)
K7K 6C2
613 / 549-4000
1 / 800 / 267-0974
Télécopieur: 613 / 548-6908

7 May 1993

Robert J. Hillier
Water and Earth Science Associates Ltd.
Box 430
CARP, Ontario
K0A 1L0

Dear Sir:

Re: Approval to Take Water Under Section 34 of the Ontario Water Resources Act as Requested by Your Letter and Application Dated May 5, 1993

Purpose :	Pumping Test
Location :	Village of Crysler Communal Production Well Village of Crysler, Township of Finch
No. Wells:	One (1)
Test date:	May-June 1993
Max. Rate:	66 Litres Per Minute (300 Imperial Gallons Per Minute)
Duration :	72 Hours

This letter constitutes approval to take water under Section 34 of the Ontario Water Resources Act. Pursuant to Section 101 of the Ontario Water Resources Act you are hereby notified that this approval is subject to the following conditions:

1) The pumping rate and period of pumping must not exceed the total water withdrawal requested without the approval of this Ministry.

2) All supply wells within 300 metres of the test well(s) shall be located and monitored for water quality and water levels prior to test pumping. Water level drawdown during pumping and recovery after pumping shall also be monitored.

   The well owners must be contacted and permission obtained to access their well at least 10 days prior to the test pumping. If the owner agrees, water level and quality sampling shall be carried out. The accessibility of the well is the responsibility of the owner. If the owner does not agree to the testing, the owner's refusal should be recorded.

3) All well supply water and surface discharge problems associated with the testing must be reported to this Ministry.

This approval does not release you from any legal liability or obligation and remains in force subject to all limitations, requirements and liabilities imposed by law. It shall not be construed as estopping or limiting any legal claims or rights of action that any person, including the Crown in Right of Ontario or any agency thereof, has or may have against you, your officers, employees, agents and your contractors.

You may, by written notice served upon me and the Environmental Appeal Board within 15 days after receipt of this approval, require a hearing by the Board. Section 101 of the Ontario Water Resources Act, R.S.O. 1990, C. 0.40, as amended, provides that the Notice requiring the hearing shall state:

1) The portion of each Term or Condition in the approval in respect of which the hearing is required, and;

2) The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these statutory requirements, the Notice should include:

3) The name of the appellant;
4) The address of the appellant;
5) The date of the Approval;
6) The name of the Director;
7) The municipality within which the taking is located;

and the Notice should be signed and dated by the appellant.

This Notice should be served upon:

The Secretary
Environmental Appeal Board
112 St. Clair Ave. West
5th Floor
Toronto, Ontario
M4V 1N3

The Director
Section 34, O.W.R.A.
Ministry of Environment and Energy
133 Dalton Avenue, Box 820
Kingston, Ontario
K7L 4X6

If you have any questions concerning the approval or wish to request an amendment or an extension please contact Penny Sutcliffe at this office.

Yours truly,

R. Farnsworth, Director
Section 34, R.S.O. 1990
Ontario Water Resources Act
Ministry of Environment and Energy
PLS/sh

APPENDIX C

AQUIFER TEST DATA AND CALCULATIONS

AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:	Orif. Weir	Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 10-5-93	12:30
Elev. of Meas. point(mASL)):		Pump off: 10-5-93	17:30
Static Water Level(m):	1.46	Discharge rate:	STEP

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
0.25	1.85	0.39	150	
0.50	1.85	0.39		
1.00	1.85	0.39		
1.50	1.86	0.40		
2.00	1.86	0.40		
2.50	1.86	0.40		
3.00	1.86	0.40		
4.00	1.86	0.40		
5.00	1.86	0.40		
6.00	1.87	0.41		
7.00	1.87	0.41		
8.00	1.88	0.42		
9.00	1.88	0.42		
10.00	1.88	0.42		
12.00	1.89	0.43		
14.00	1.90	0.44		
16.00	1.90	0.44		
18.00	1.90	0.44		
20.00	1.90	0.44		
25.00	1.90	0.44		
30.00	1.91	0.45		
35.00	1.92	0.46		
40.00	1.92	0.46		
45.00	1.92	0.46		
50.00	1.92	0.46		
55.00	1.92	0.46		
59.00	1.93	0.47		
60.00	1.94	0.48	225	
60.50	2.00	0.54		
61.00	2.04	0.58		
61.50	2.24	0.78		
62.00	2.26	0.80		
62.50	2.26	0.80		
63.00	2.26	0.80		
64.00	2.29	0.83		

AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:		Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 10-5-93	12:30
Elev. of Meas. point(mASL)):		Pump off: 10-5-93	17:30
Static Water Level(m):	1.46	Discharge rate:	STEP

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
65.00	2.29	0.83		
66.00	2.29	0.83		
67.00	2.28	0.82		
68.00	2.29	0.83		
69.00	2.29	0.83		
70.00	2.29	0.83		
72.00	2.30	0.84		
74.00	2.30	0.84		
76.00	2.31	0.85		
78.00	2.32	0.86		
80.00	2.32	0.86		
85.00	2.32	0.86		
90.00	2.33	0.87		
95.00	2.33	0.87		
100.00	2.34	0.88		
105.00	2.35	0.89		
110.00	2.36	0.90		
115.00	2.36	0.90		
119.00	2.36	0.90		
120.00	2.37	0.91	300	
120.50	2.70	1.24		
121.00	2.71	1.25		
121.50	2.75	1.29		
122.00	2.75	1.29		
123.00	2.76	1.30		
124.00	2.76	1.30		
125.00	2.76	1.30		
126.00	2.76	1.30		
127.00	2.77	1.31		
128.00	2.77	1.31		
129.00	2.78	1.32		
130.00	2.78	1.32		
132.00	2.78	1.32		
134.00	2.78	1.32		
136.00	2.79	1.33		

AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:		Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 10-5-93	12:30
Elev. of Meas. point(mASL)):		Pump off: 10-5-93	17:30
Static Water Level(m):	1.46	Discharge rate:	STEP

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
138.00	2.78	1.32		
140.00	2.78	1.32		
145.00	2.79	1.33		
150.00	2.80	1.34		
155.00	2.81	1.35		
160.00	2.81	1.35		
165.00	2.82	1.36		
170.00	2.83	1.37		
175.00	2.83	1.37		
179.00	2.84	1.38		
180.00	2.85	1.39	375	
180.50	3.21	1.75		
181.00	3.27	1.81		
181.50	3.30	1.84		
182.00	3.32	1.86		
183.00	3.33	1.87		
184.00	3.36	1.90		
185.00	3.36	1.90		
186.00	3.36	1.90		
187.00	3.36	1.90		
188.00	3.37	1.91		
189.00	3.36	1.90		
190.00	3.38	1.92		
192.00	3.41	1.95		
194.00	3.39	1.93		
196.00	3.39	1.93		
198.00	3.40	1.94		
200.00	3.42	1.96		
205.00	3.42	1.96		
210.00	3.43	1.97		
215.00	3.44	1.98		
220.00	3.46	2.00		
225.00	3.46	2.00		
230.00	3.48	2.02		
235.00	3.49	2.03		

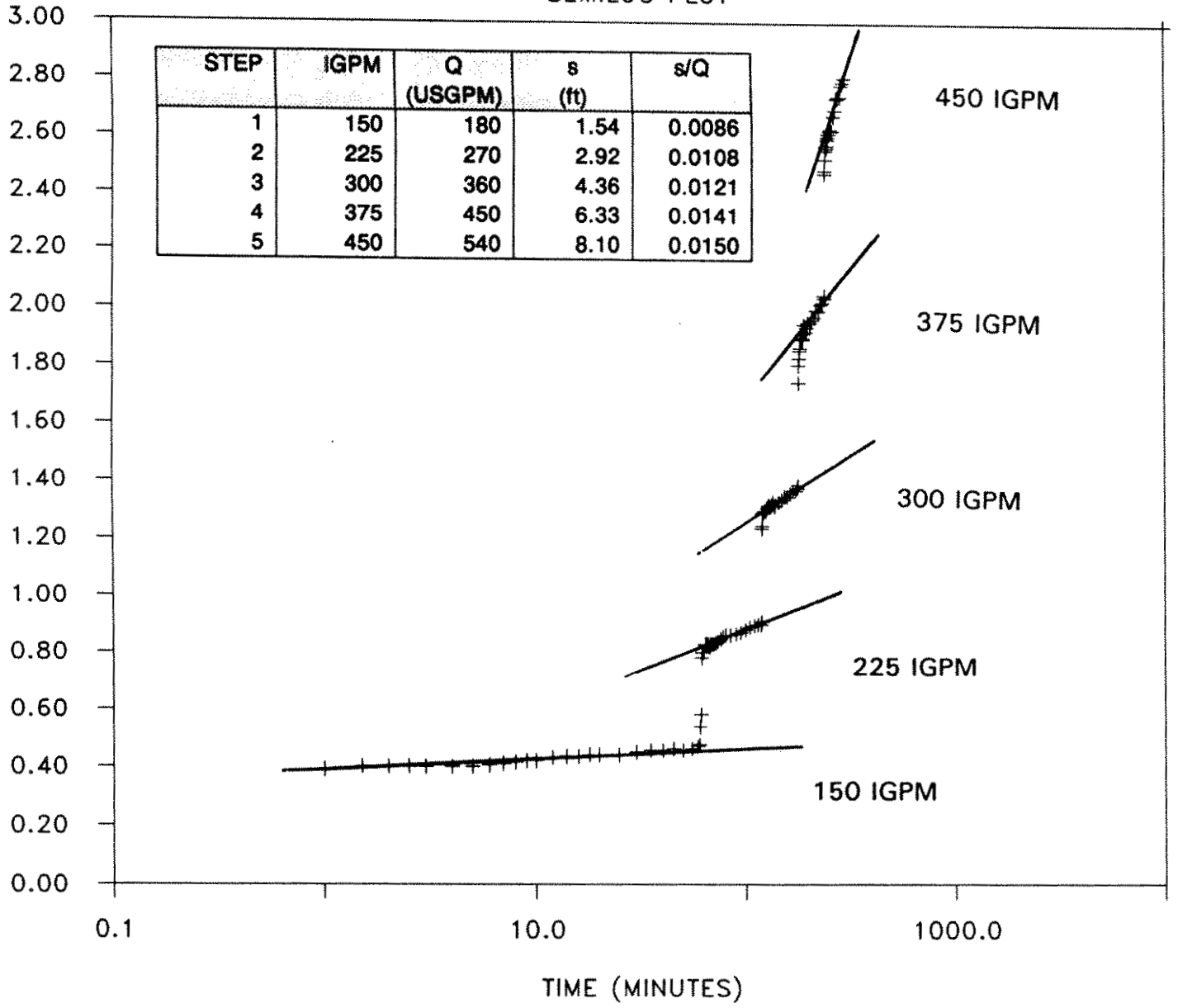
AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:		Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 10-5-93	12:30
Elev. of Meas. point(mASL)):		Pump off: 10-5-93	17:30
Static Water Level(m):	1.46	Discharge rate:	STEP

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
239.00	3.50	2.04		
240.00	3.51	2.05	450	
240.50	3.94	2.48		
241.00	3.95	2.49		
241.50	3.99	2.53		
242.00	4.02	2.56		
243.00	4.04	2.58		
244.00	4.03	2.57		
245.00	4.04	2.58		
246.00	4.03	2.57		
247.00	4.04	2.58		
248.00	4.06	2.60		
249.00	4.07	2.61		
250.00	4.08	2.62		
252.00	4.08	2.62		
254.00	4.09	2.63		
256.00	4.10	2.64		
258.00	4.09	2.63		
260.00	4.09	2.63		
265.00	4.14	2.68		
270.00	4.16	2.70		
275.00	4.20	2.74		
280.00	4.21	2.75		
285.00	4.21	2.75		
290.00	4.25	2.79		
295.00	4.26	2.80		
300.00	4.27	2.81		

STEP TEST PW1

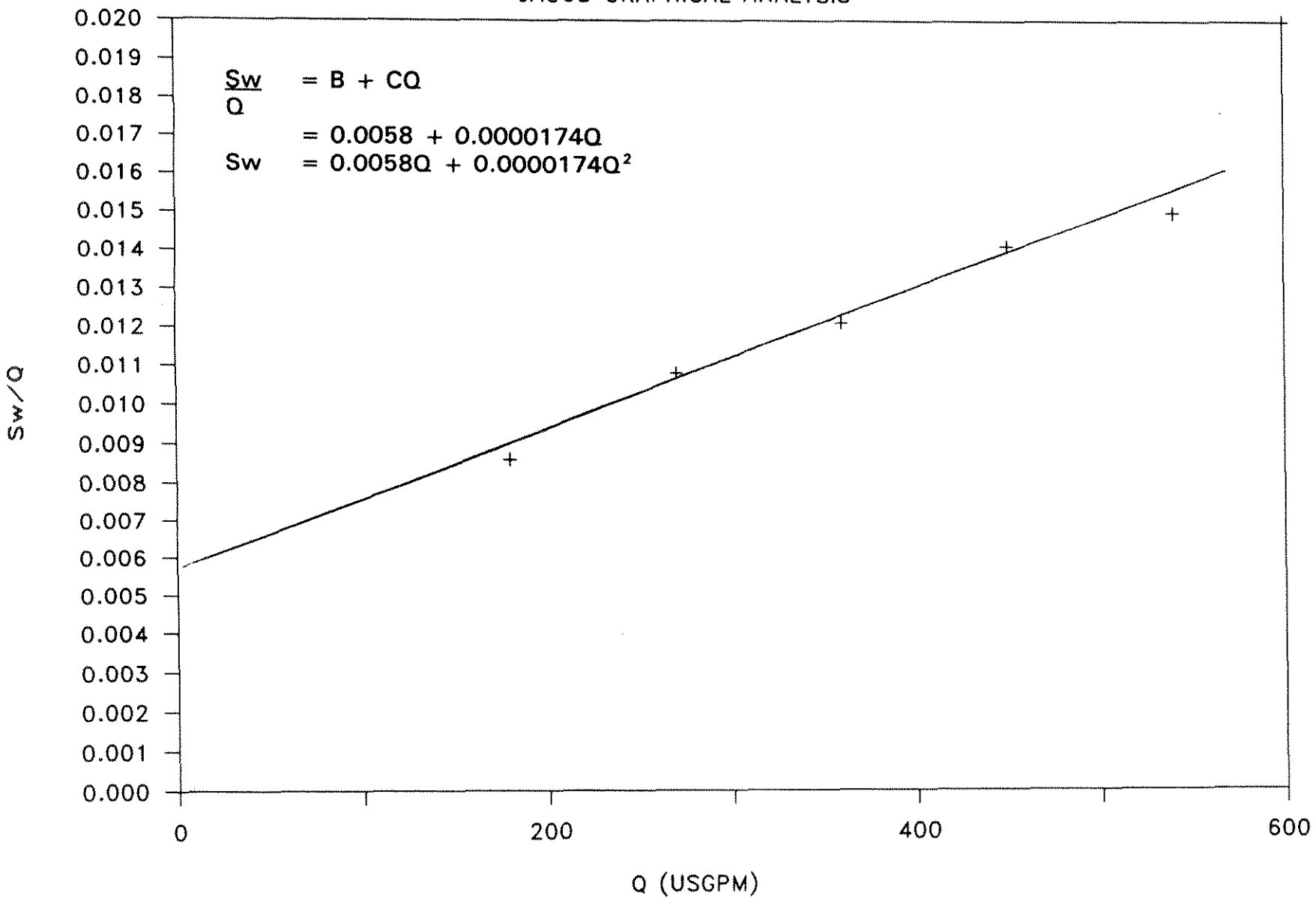
SEMILOG PLOT

STEP	IGPM	Q (USGPM)	s (ft)	s/Q
1	150	180	1.54	0.0086
2	225	270	2.92	0.0108
3	300	360	4.36	0.0121
4	375	450	6.33	0.0141
5	450	540	8.10	0.0150



STEP TEST ANALYSIS

JACOB GRAPHICAL ANALYSIS



AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	CONSTANT	Well type:	PUMPING
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.65	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.50	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
0.50	2.44	0.94	300	
1.00	2.49	0.99		
1.50	2.55	1.05		
2.00	2.57	1.07		
2.50	2.56	1.06		
3.00	2.57	1.07		
4.00	2.59	1.09		
5.00	2.61	1.11		
6.00	2.62	1.12		
7.00	2.66	1.15		
8.00	2.65	1.15		
9.00	2.66	1.15		
10.00	2.67	1.17		
12.00	2.67	1.17		
14.00	2.68	1.18		
16.00	2.71	1.21		
18.00	2.71	1.21		
20.00	2.72	1.22		
25.00	2.75	1.25		
30.00	2.77	1.27		
35.00	2.78	1.28		
40.00	2.79	1.29		<-Ph 7.35
45.00	2.82	1.32		Turb 0.90
50.00	2.83	1.33		Temp 8 C
55.00	2.84	1.34		
60.00	2.85	1.35		
65.00	2.85	1.35		
70.00	2.86	1.36		
75.00	2.88	1.38		
80.00	2.90	1.40		
85.00	2.91	1.41		
90.00	2.91	1.41		
95.00	2.92	1.42		
100.00	2.93	1.43		

AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	CONSTANT	Well type:	PUMPING
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.65	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.50	Discharge rate:	300 IGPM

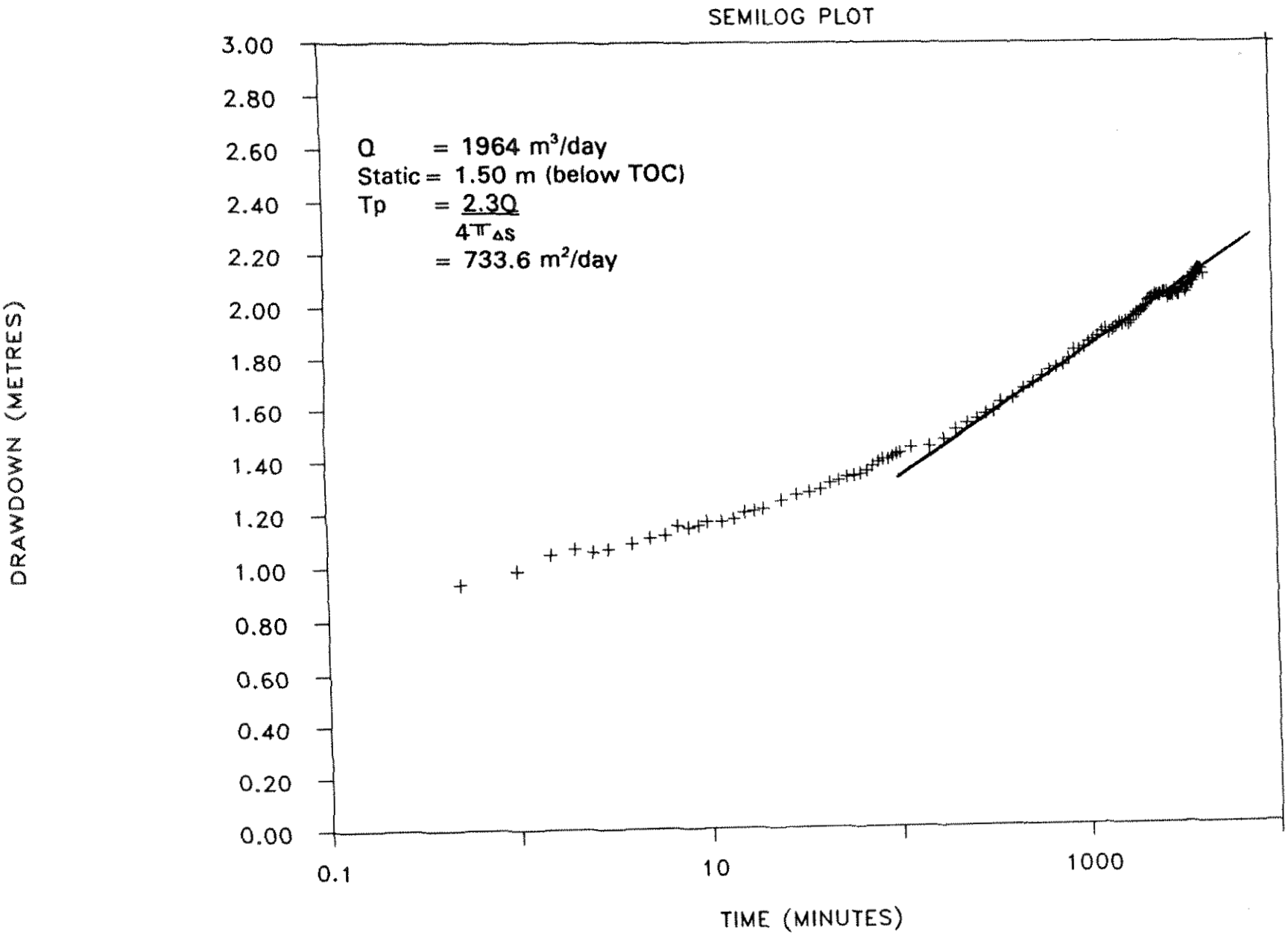
Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
105.00	2.93	1.43		
120.00	2.95	1.45		
150.00	2.96	1.46		
180.00	2.98	1.48		
210.00	3.02	1.52		
240.00	3.05	1.55		
270.00	3.06	1.56		<-pH 7.6
300.00	3.08	1.58		turb 0.65
330.00	3.09	1.59		temp 7 C
360.00	3.13	1.63		
420.00	3.14	1.64		
480.00	3.18	1.68		
540.00	3.20	1.70		
600.00	3.23	1.73		
660.00	3.25	1.75		
720.00	3.26	1.76		
780.00	3.27	1.77		
840.00	3.30	1.80		
900.00	3.33	1.83		
960.00	3.33	1.83		
1020.00	3.34	1.84		
1080.00	3.36	1.86		
1140.00	3.37	1.87		
1200.00	3.38	1.88		
1260.00	3.40	1.90		
1320.00	3.41	1.91		
1380.00	3.40	1.90		
1440.00	3.41	1.91		
1500.00	3.42	1.92		
1560.00	3.44	1.94		
1620.00	3.43	1.93		
1680.00	3.44	1.94		
1740.00	3.43	1.93		<-pH 7.45
1800.00	3.44	1.94		turb 0.60
1860.00	3.46	1.96		temp 7.5 C

AQUIFER TEST DATA	JOB#3013		WELL#: PW1	
Type of aquifer test:	CONSTANT	Well type:	PUMPING	
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN	
Dist. from pumping well(m):	0	Depth pump(m):	6.5	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00	
Elev. of Meas. point(mASL)):	73.65	Pump off:15-5-93	9:00.00	
Static Water Level(m):	1.50	Discharge rate:	300 IGPM	Comments
(min.)	(m)		(m) (i.g.p.m.)	
1920.00	3.47		1.97	
1980.00	3.47		1.97	
2040.00	3.48		1.98	
2100.00	3.49		1.99	
2160.00	3.50		2.00	
2220.00	3.52		2.02	
2280.00	3.53		2.03	
2340.00	3.53		2.03	
2400.00	3.54		2.04	
2460.00	3.54		2.04	
2520.00	3.54		2.04	
2580.00	3.54		2.04	
2640.00	3.55		2.05	
2700.00	3.55		2.05	
2760.00	3.55		2.05	
2820.00	3.53		2.03	<-pH 7.40
2880.00	3.54		2.04	turb 0.55
2940.00	3.54		2.04	temp 7.5 C
3000.00	3.54		2.04	
3060.00	3.56		2.06	
3120.00	3.55		2.05	
3180.00	3.54		2.04	
3240.00	3.54		2.04	
3300.00	3.57		2.07	
3360.00	3.57		2.07	
3420.00	3.58		2.08	
3480.00	3.55		2.05	
3540.00	3.56		2.06	
3600.00	3.57		2.07	
3660.00	3.60		2.10	
3720.00	3.59		2.09	
3780.00	3.59		2.09	
3840.00	3.60		2.10	
3900.00	3.61		2.11	
3960.00	3.62		2.12	
4020.00	3.63		2.13	

AQUIFER TEST DATA	JOB#3013		WELL#: PW1
Type of aquifer test:	CONSTANT	Well type:	PUMPING
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.65	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.50	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
4080.00	3.64	2.14		
4140.00	3.64	2.14		
4200.00	3.64	2.14		
4260.00	3.64	2.14		
4320.00	3.62	2.12		

PUMPING WELL PW1 - DRAWDOWN



AQUIFER TEST DATA	JOB#3013	WELL#:	TW27
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	19.2	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.56	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.39	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
0.50	1.42	0.03	300	
1.00	1.42	0.03		
1.50	1.43	0.04		
2.00	1.43	0.04		
2.50	1.44	0.05		
3.00	1.44	0.05		
4.00	1.44	0.05		
5.00	1.44	0.05		
6.00	1.45	0.06		
7.00	1.45	0.06		
8.00	1.46	0.07		
9.00	1.46	0.07		
10.00	1.47	0.08		
12.00	1.47	0.08		
14.00	1.48	0.09		
16.00	1.48	0.09		
18.00	1.49	0.10		
20.00	1.50	0.11		
25.00	1.51	0.12		
35.00	1.54	0.15		
40.00	1.54	0.15		
45.00	1.55	0.16		
50.00	1.56	0.17		
55.00	1.58	0.19		
60.00	1.58	0.19		
65.00	1.59	0.20		
70.00	1.60	0.21		
75.00	1.60	0.21		
80.00	1.61	0.22		
85.00	1.62	0.23		
90.00	1.63	0.24		
107.00	1.65	0.26		
120.00	1.66	0.27		
150.00	1.69	0.30		
180.00	1.73	0.34		
210.00	1.75	0.36		

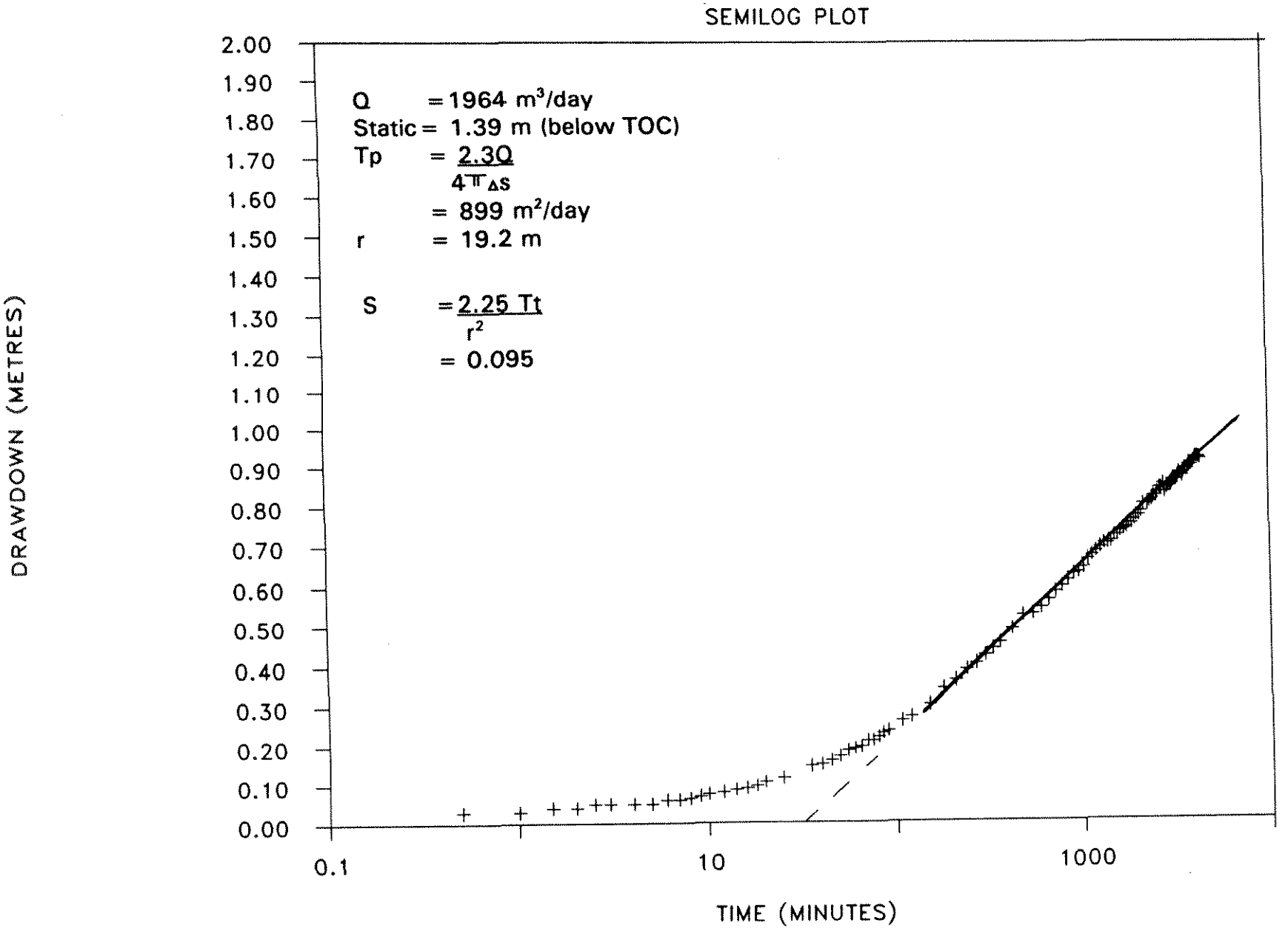
AQUIFER TEST DATA	JOB#3013	WELL#:	TW27
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	19.2	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.56	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.39	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
240.00	1.78	0.39		
270.00	1.79	0.40		
300.00	1.81	0.42		
330.00	1.83	0.44		
360.00	1.84	0.45		
420.00	1.88	0.49		
480.00	1.91	0.52		
540.00	1.92	0.53		
600.00	1.93	0.54		
660.00	1.95	0.56		
720.00	1.97	0.58		
780.00	1.99	0.60		
840.00	2.00	0.61		
900.00	2.02	0.63		
960.00	2.02	0.63		
1020.00	2.03	0.64		
1080.00	2.05	0.66		
1140.00	2.06	0.67		
1200.00	2.07	0.68		
1260.00	2.08	0.69		
1320.00	2.09	0.70		
1380.00	2.09	0.70		
1440.00	2.10	0.71		
1500.00	2.11	0.72		
1560.00	2.11	0.72		
1620.00	2.12	0.73		
1680.00	2.13	0.74		
1740.00	2.13	0.74		
1800.00	2.14	0.75		
1860.00	2.14	0.75		
1920.00	2.15	0.76		
1980.00	2.16	0.77		
2040.00	2.16	0.77		
2100.00	2.17	0.78		
2160.00	2.19	0.80		

AQUIFER TEST DATA			WELL#: TW27	
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION	
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN	
Dist. from pumping well(m):	19.2	Depth pump(m):		
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00	
Elev. of Meas. point(mASL)):	73.56	Pump off:15-5-93	9:00.00	
Static Water Level(m):	1.39	Discharge rate:	300 IGPM	Comments

(min.)		(m)	(i.g.p.m.)
2280.00	2.19	0.80	
2340.00	2.20	0.81	
2400.00	2.20	0.81	
2460.00	2.21	0.82	
2520.00	2.21	0.82	
2580.00	2.22	0.83	
2640.00	2.23	0.84	
2700.00	2.23	0.84	
2760.00	2.24	0.85	
2820.00	2.22	0.83	
2880.00	2.23	0.84	
2940.00	2.24	0.85	
3000.00	2.24	0.85	
3060.00	2.24	0.85	
3120.00	2.25	0.86	
3180.00	2.25	0.86	
3240.00	2.25	0.86	
3300.00	2.26	0.87	
3360.00	2.27	0.88	
3420.00	2.27	0.88	
3480.00	2.26	0.87	
3540.00	2.27	0.88	
3600.00	2.28	0.89	
3660.00	2.28	0.89	
3720.00	2.28	0.89	
3780.00	2.29	0.90	
3840.00	2.29	0.90	
3900.00	2.29	0.90	
3960.00	2.30	0.91	
4020.00	2.30	0.91	
4080.00	2.31	0.92	
4140.00	2.31	0.92	
4200.00	2.31	0.92	
4260.00	2.31	0.92	
4320.00	2.31	0.92	

OBSERVATION WELL TW27 - DRAWDOWN



AQUIFER TEST DATA	JOB#3013	WELL#:	P13
Type of aquifer test:	CONSTANT	Well type:	PUMPING
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	19.1	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.81	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.64	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
0.50	1.63	-0.01	300	
4.50	1.69	0.05		
5.50	1.69	0.05		
6.50	1.69	0.05		
7.50	1.70	0.06		
8.50	1.70	0.06		
9.50	1.70	0.06		
10.50	1.71	0.07		
12.00	1.71	0.07		
14.00	1.72	0.08		
16.00	1.72	0.08		
18.00	1.73	0.09		
20.00	1.74	0.10		
25.00	1.75	0.11		
35.00	1.78	0.14		
40.00	1.79	0.15		
45.00	1.80	0.16		
50.00	1.80	0.16		
55.00	1.81	0.17		
60.00	1.82	0.18		
65.00	1.85	0.21		
70.00	1.84	0.20		
75.00	1.85	0.21		
80.00	1.86	0.22		
85.00	1.86	0.22		
90.00	1.87	0.23		
108.00	1.89	0.25		
120.00	1.90	0.26		
150.00	1.94	0.30		
180.00	1.96	0.32		
210.00	1.99	0.35		
240.00	2.01	0.37		
270.00	2.04	0.40		
300.00	2.06	0.42		
330.00	2.07	0.43		
360.00	2.09	0.45		

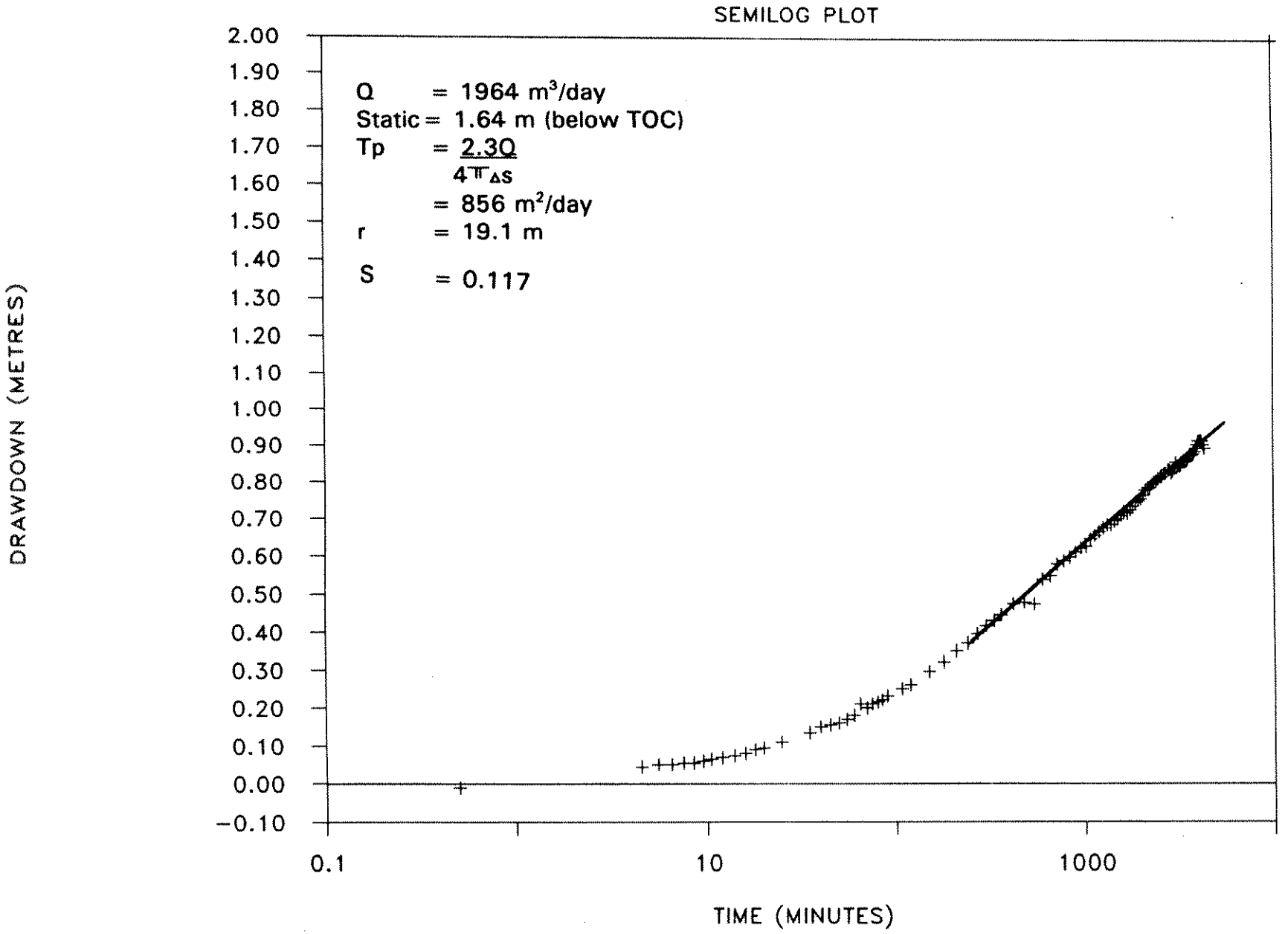
AQUIFER TEST DATA	JOB#3013	WELL#:	P13
Type of aquifer test:	CONSTANT	Well type:	PUMPING
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	19.1	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.81	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.64	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
420.00	2.12	0.48		
480.00	2.12	0.48		
540.00	2.12	0.48		
600.00	2.18	0.54		
660.00	2.19	0.55		
720.00	2.22	0.58		
780.00	2.23	0.59		
840.00	2.24	0.60		
900.00	2.26	0.62		
960.00	2.27	0.63		
1020.00	2.27	0.63		
1080.00	2.29	0.65		
1140.00	2.30	0.66		
1200.00	2.31	0.67		
1260.00	2.32	0.68		
1320.00	2.33	0.69		
1380.00	2.33	0.69		
1440.00	2.34	0.70		
1500.00	2.35	0.71		
1560.00	2.36	0.72		
1620.00	2.37	0.73		
1680.00	2.36	0.72		
1740.00	2.37	0.73		
1800.00	2.38	0.74		
1860.00	2.39	0.75		
1920.00	2.40	0.76		
1980.00	2.40	0.76		
2040.00	2.41	0.77		
2100.00	2.43	0.79		
2160.00	2.43	0.79		
2220.00	2.43	0.79		
2280.00	2.44	0.80		
2340.00	2.45	0.81		
2400.00	2.45	0.81		
2460.00	2.46	0.82		
2520.00	2.46	0.82		

AQUIFER TEST DATA			WELL#: P13	
Type of aquifer test:	CONSTANT	Well type:	PUMPING	
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN	
Dist. from pumping well(m):	19.1	Depth pump(m):		
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00	
Elev. of Meas. point(mASL)):	73.81	Pump off:15-5-93	9:00.00	
Static Water Level(m):	1.64	Discharge rate:	300 IGPM	Comments

(min.)	(m)	(m)	(i.g.p.m.)
2580.00	2.46	0.82	
2640.00	2.47	0.83	
2700.00	2.47	0.83	
2760.00	2.48	0.84	
2820.00	2.48	0.84	
2880.00	2.47	0.83	
2940.00	2.48	0.84	
3000.00	2.49	0.85	
3060.00	2.50	0.86	
3120.00	2.49	0.85	
3180.00	2.49	0.85	
3240.00	2.49	0.85	
3300.00	2.50	0.86	
3360.00	2.50	0.86	
3420.00	2.50	0.86	
3480.00	2.51	0.87	
3540.00	2.51	0.87	
3600.00	2.52	0.88	
3660.00	2.52	0.88	
3720.00	2.52	0.88	
3780.00	2.53	0.89	
3840.00	2.53	0.89	
3900.00	2.54	0.90	
3960.00	2.55	0.91	
4020.00	2.56	0.92	
4080.00	2.56	0.92	
4140.00	2.56	0.92	
4200.00	2.56	0.92	
4260.00	2.55	0.91	
4320.00	2.54	0.90	

OBSERVATION WELL P13 - DRAWDOWN



AQUIFER TEST DATA	JOB#3013	WELL#:	GT1
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	18.3	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.99	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.88	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
3.50	1.87	-0.01	300	
4.50	1.86	-0.02		
5.50	1.85	-0.03		
6.50	1.86	-0.02		
7.50	1.88	0.00		
8.50	1.90	0.02		
9.50	1.91	0.03		
11.00	1.91	0.03		
13.00	1.91	0.03		
15.00	1.92	0.04		
17.00	1.93	0.05		
19.00	1.94	0.06		
21.00	1.96	0.08		
30.00	2.01	0.13		
35.00	2.03	0.15		
42.00	2.08	0.20		
46.00	2.07	0.19		
50.00	2.08	0.20		
55.00	2.08	0.20		
60.00	2.10	0.22		
65.00	2.11	0.23		
70.00	2.12	0.24		
75.00	2.13	0.25		
80.00	2.14	0.25		
85.00	2.14	0.25		
90.00	2.15	0.27		
122.00	2.21	0.33		
150.00	2.22	0.34		
180.00	2.28	0.40		
210.00	2.30	0.42		
240.00	2.34	0.46		
270.00	2.35	0.47		
300.00	2.37	0.49		
330.00	2.42	0.54		
420.00	2.45	0.57		
480.00	2.46	0.58		

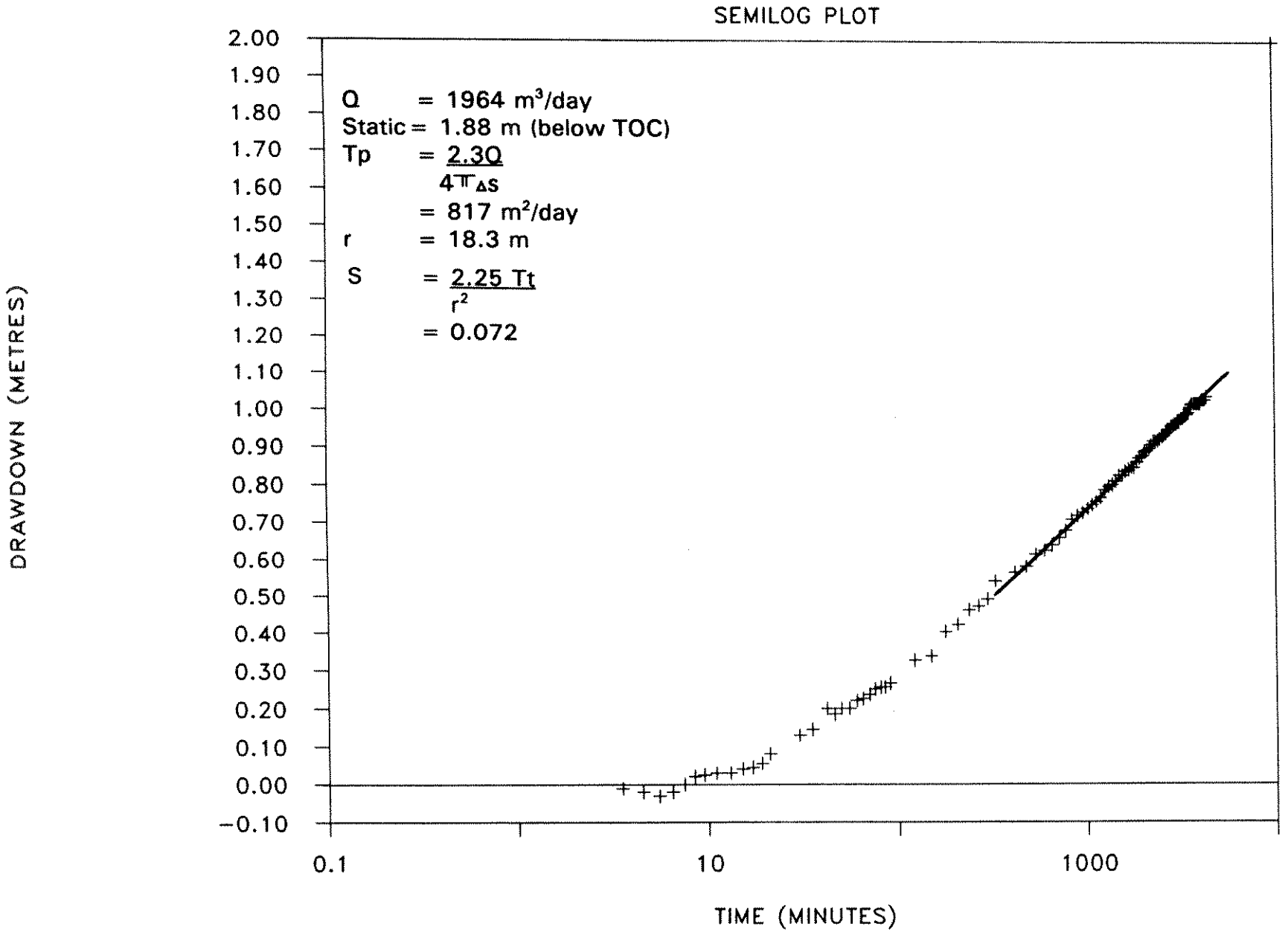
AQUIFER TEST DATA	JOB#3013	WELL#:	GT1
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	18.3	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.99	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.88	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
540.00	2.50	0.62		
600.00	2.51	0.63		
660.00	2.52	0.64		
720.00	2.54	0.66		
780.00	2.56	0.68		
840.00	2.59	0.71		
900.00	2.60	0.72		
960.00	2.61	0.73		
1020.00	2.62	0.74		
1080.00	2.63	0.75		
1140.00	2.64	0.76		
1200.00	2.65	0.77		
1260.00	2.67	0.79		
1320.00	2.68	0.80		
1380.00	2.69	0.81		
1440.00	2.70	0.82		
1500.00	2.71	0.83		
1560.00	2.71	0.83		
1620.00	2.72	0.84		
1680.00	2.73	0.85		
1740.00	2.73	0.85		
1800.00	2.73	0.85		
1860.00	2.75	0.87		
1920.00	2.76	0.88		
1980.00	2.76	0.88		
2040.00	2.77	0.89		
2100.00	2.78	0.90		
2160.00	2.78	0.90		
2220.00	2.79	0.91		
2280.00	2.80	0.92		
2340.00	2.80	0.92		
2400.00	2.80	0.92		

AQUIFER TEST DATA	JOB#3013	WELL#:	GT1
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	0	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):		Pump off:15-5-93	9:00.00
Static Water Level(m):	1.88	Discharge rate:	300 IGPM Comments

(min.)	(m)	(m)	(i.g.p.m.)
2460.00	2.81	0.93	
2520.00	2.81	0.93	
2580.00	2.82	0.94	
2640.00	2.82	0.94	
2700.00	2.83	0.95	
2760.00	2.83	0.95	
2820.00	2.84	0.96	
2880.00	2.84	0.96	
2940.00	2.85	0.97	
3000.00	2.85	0.97	
3060.00	2.85	0.97	
3120.00	2.85	0.97	
3180.00	2.86	0.98	
3240.00	2.86	0.98	
3300.00	2.87	0.99	
3360.00	2.87	0.99	
3420.00	2.87	0.99	
3480.00	2.88	1.00	
3540.00	2.89	1.01	
3600.00	2.90	1.02	
3660.00	2.90	1.02	
3720.00	2.90	1.02	
3780.00	2.90	1.02	
3840.00	2.90	1.02	
3900.00	2.90	1.02	
3960.00	2.90	1.02	
4020.00	2.90	1.02	
4080.00	2.91	1.03	
4140.00	2.91	1.03	
4200.00	2.91	1.03	
4260.00	2.91	1.03	
4320.00	2.92	1.04	

OBSERVATION WELL GT1 - DRAWDOWN



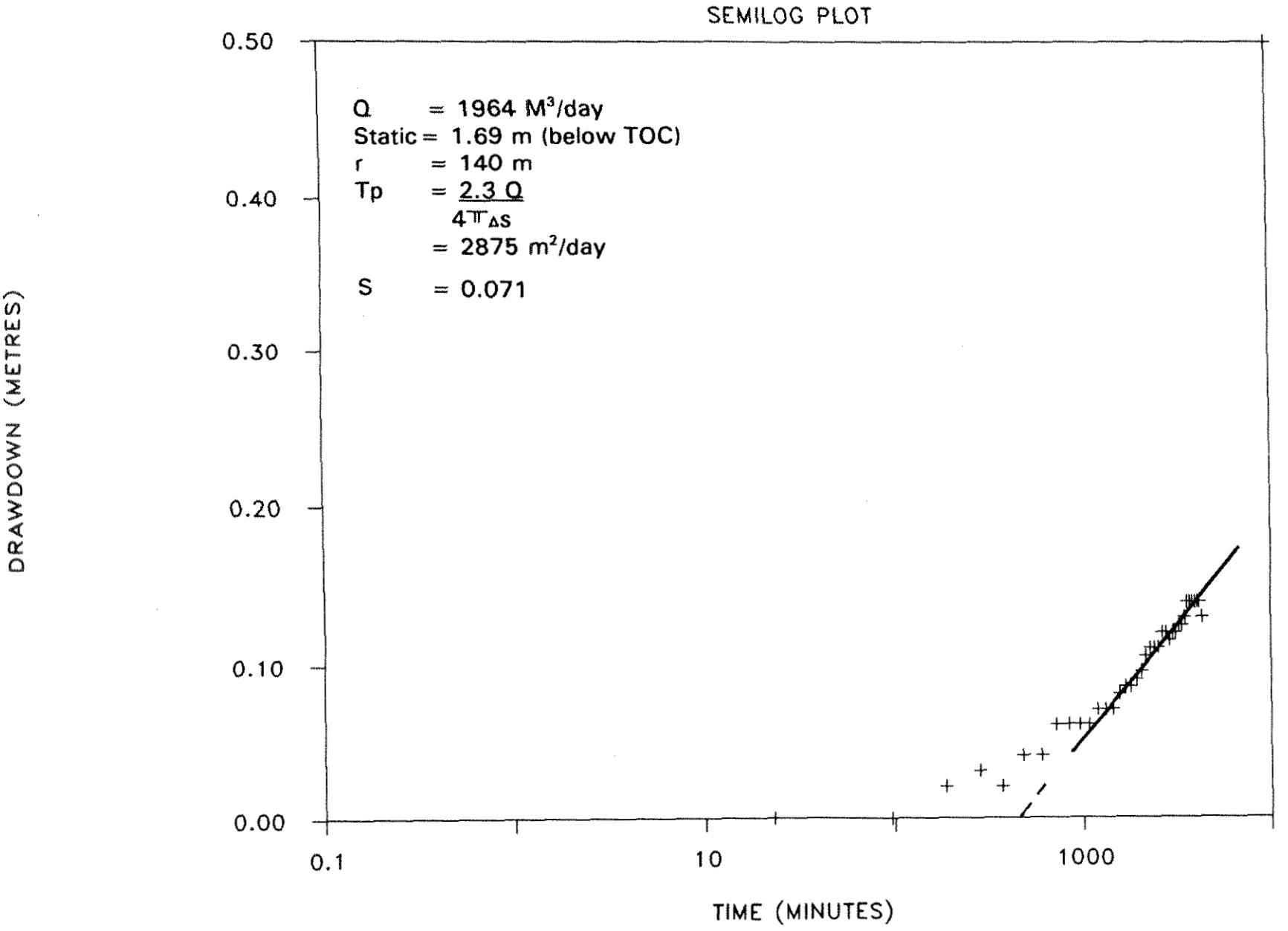
AQUIFER TEST DATA	JOB#3013	WELL#:	P12
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	140	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.72	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.69	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
23.00	1.69	0.00	300	
96.00	1.69	0.00		
188.00	1.71	0.02		
284.00	1.72	0.03		
373.00	1.71	0.02		
480.00	1.73	0.04		
600.00	1.73	0.04		
720.00	1.75	0.06		
840.00	1.75	0.06		
960.00	1.75	0.06		
1080.00	1.75	0.06		
1200.00	1.76	0.07		
1320.00	1.76	0.07		
1440.00	1.76	0.07		
1560.00	1.77	0.08		
1680.00	1.78	0.08		
1800.00	1.78	0.08		
1920.00	1.78	0.09		
2040.00	1.79	0.09		
2160.00	1.80	0.11		
2280.00	1.80	0.11		
2400.00	1.80	0.11		
2520.00	1.80	0.11		
2640.00	1.81	0.12		
2760.00	1.81	0.12		
2880.00	1.81	0.12		
3000.00	1.81	0.12		
3120.00	1.81	0.12		
3240.00	1.82	0.13		
3360.00	1.82	0.13		
3480.00	1.82	0.13		
3600.00	1.83	0.14		
3720.00	1.83	0.14		
3840.00	1.83	0.14		
3960.00	1.83	0.14		
4080.00	1.83	0.14		

AQUIFER TEST DATA	JOB#3013	WELL#:	P12
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	140	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	73.72	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.69	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
4200.00	1.83	0.14		
4320.00	1.82	0.13		

OBSERVATION WELL P12 - DRAWDOWN



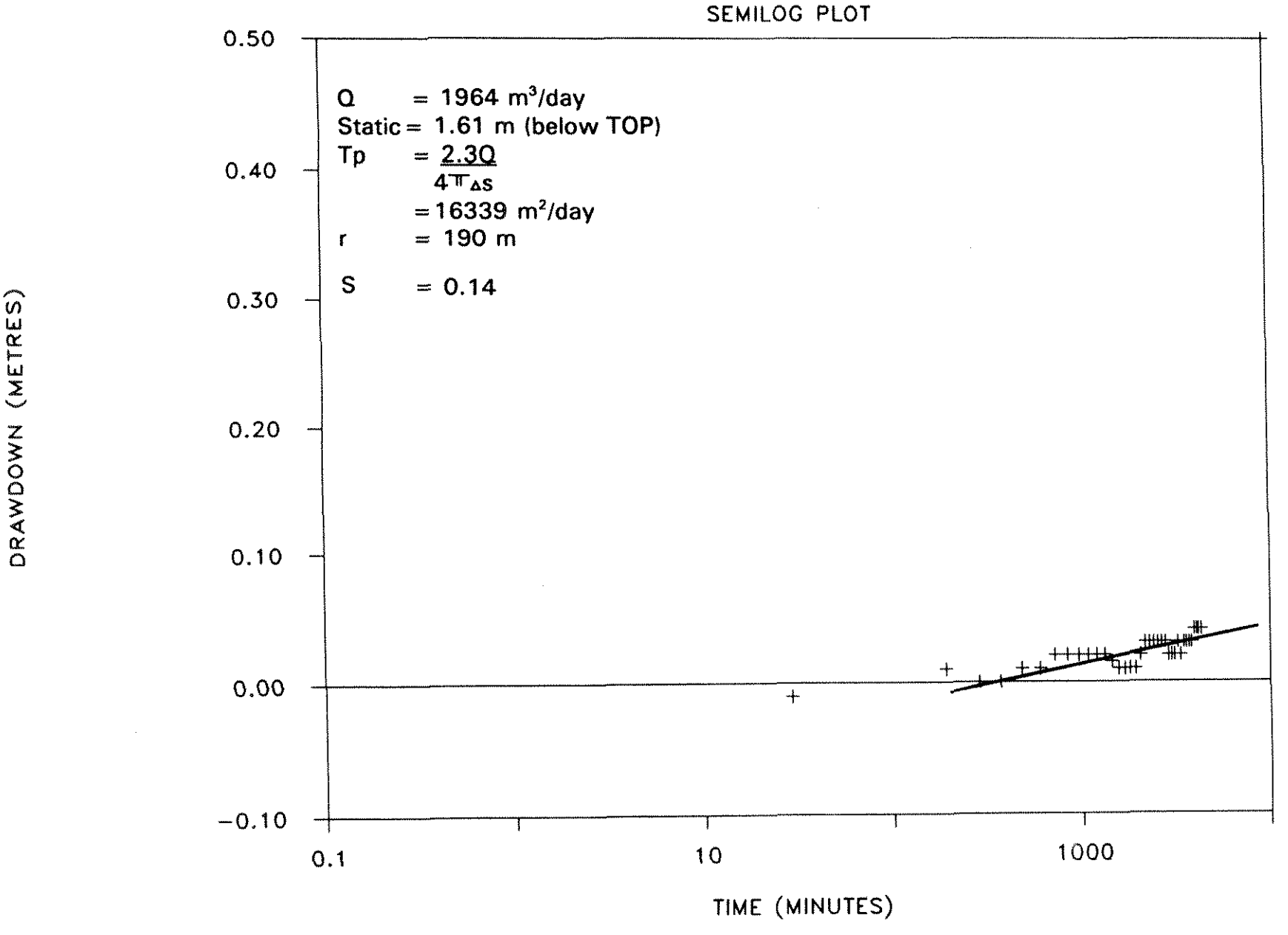
AQUIFER TEST DATA	JOB#3013	WELL#:	P25
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	190	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	74.23	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.61	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
29.00	1.60	-0.01	300	
191.00	1.62	0.01		
285.00	1.61	0.00		
369.00	1.61	0.00		
480.00	1.62	0.01		
600.00	1.62	0.01		
720.00	1.63	0.02		
840.00	1.63	0.02		
960.00	1.63	0.02		
1080.00	1.63	0.02		
1200.00	1.63	0.02		
1320.00	1.63	0.02		
1440.00	1.63	0.01		
1560.00	1.62	0.01		
1680.00	1.62	0.01		
1800.00	1.62	0.01		
1920.00	1.62	0.01		
2040.00	1.63	0.02		
2160.00	1.64	0.03		
2280.00	1.64	0.03		
2400.00	1.64	0.03		
2520.00	1.64	0.03		
2640.00	1.64	0.03		
2760.00	1.64	0.03		
2880.00	1.63	0.02		
3000.00	1.63	0.02		
3120.00	1.63	0.02		
3240.00	1.64	0.03		
3360.00	1.63	0.02		
3480.00	1.64	0.03		
3600.00	1.64	0.03		
3720.00	1.64	0.03		
3840.00	1.64	0.03		
3960.00	1.65	0.04		
4080.00	1.65	0.04		

AQUIFER TEST DATA	JOB#3013	WELL#:	P25
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	190	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	74.23	Pump off:15-5-93	9:00.00
Static Water Level(m):	1.61	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
4200.00	1.65	0.04		
4320.00	1.65	0.04		

OBSERVATION WELL P25 - DRAWDOWN



AQUIFER TEST DATA	JOB#3013	WELL#:	GT2
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	84	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	74.75	Pump off:15-5-93	9:00.00
Static Water Level(m):	2.70	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
33.00	2.74	0.04	300	
97.00	2.74	0.04		
127.00	2.77	0.06		
281.00	2.78	0.08		
377.00	2.80	0.10		
480.00	2.80	0.09		
600.00	2.80	0.10		
720.00	2.80	0.09		
840.00	2.80	0.10		
960.00	2.80	0.09		
1080.00	2.81	0.11		
1200.00	2.82	0.12		
1320.00	2.84	0.14		
1440.00	2.81	0.11		
1560.00	2.83	0.13		
1680.00	2.84	0.13		
1800.00	2.84	0.14		
1920.00	2.83	0.13		
2040.00	2.84	0.14		
2160.00	2.84	0.14		
2280.00	2.85	0.15		
2400.00	2.86	0.16		
2520.00	2.86	0.16		
2640.00	2.87	0.17		
2760.00	2.87	0.17		
2880.00	2.88	0.17		
3000.00	2.88	0.18		
3120.00	2.89	0.19		
3240.00	2.89	0.19		
3360.00	2.89	0.19		
3480.00	2.88	0.18		
3600.00	2.89	0.19		
3720.00	2.88	0.18		
3840.00	2.88	0.18		
3960.00	2.88	0.18		
4080.00	2.88	0.18		

AQUIFER TEST DATA	JOB#3013	WELL#:	PW1
Type of aquifer test:	Constant Q	Well type:	PUMPING
How Q Measured:	ORIF. WEIR	Data type:	RECOVERY
Distance from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.65	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.50	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

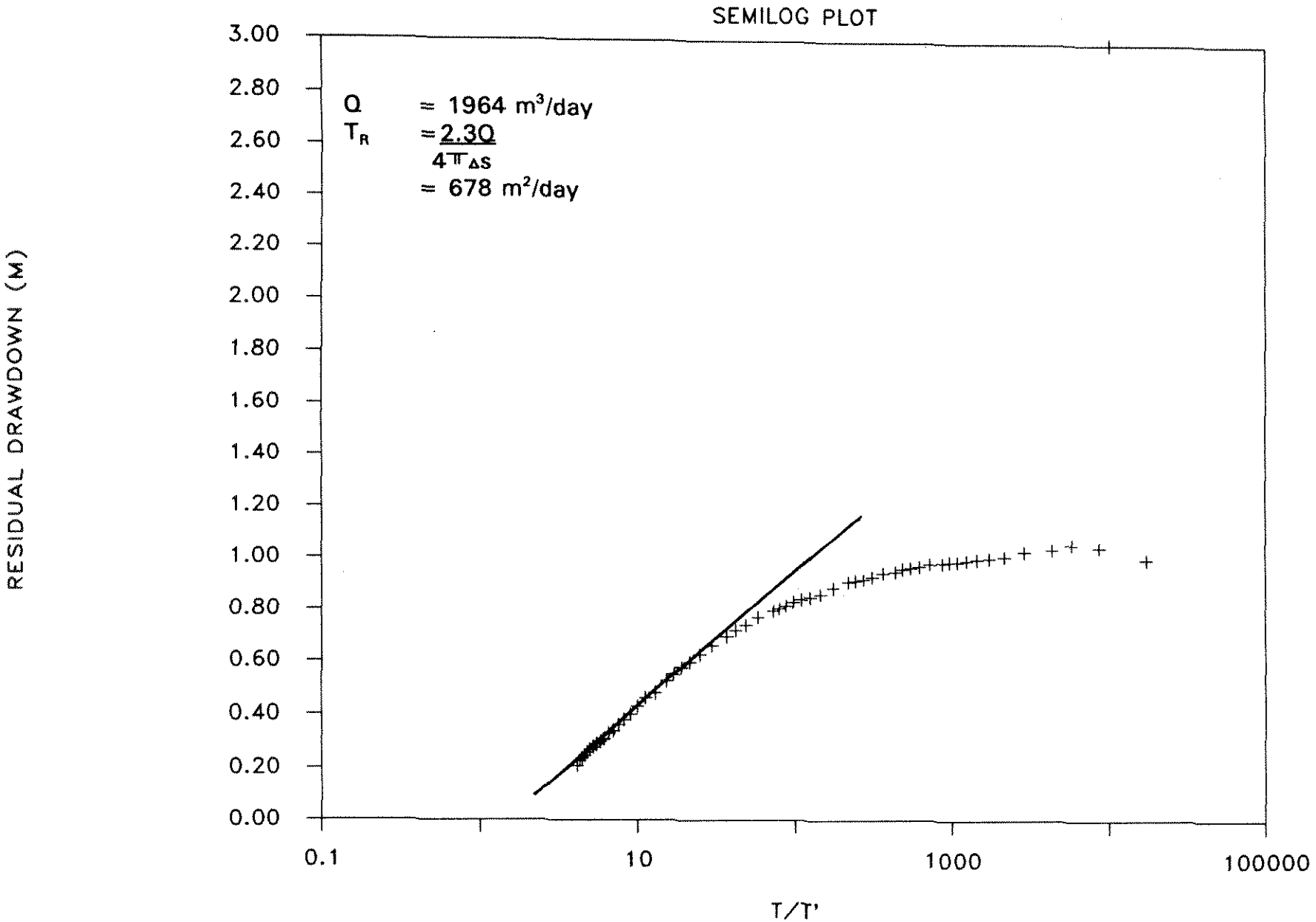
Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
0.25	17281.00	2.50	1.00	
0.50	8641.00	2.55	1.05	
0.75	5761.00	2.56	1.06	
1.00	4321.00	2.54	1.04	
1.50	2881.00	2.53	1.03	
2.00	2161.00	2.51	1.01	
2.50	1729.00	2.51	1.01	
3.00	1441.00	2.50	1.00	
3.50	1235.29	2.50	1.00	
4.00	1081.00	2.49	0.99	
4.50	961.00	2.49	0.99	
5.00	865.00	2.49	0.99	
6.00	721.00	2.48	0.98	
7.00	618.14	2.47	0.97	
8.00	541.00	2.47	0.97	
9.00	481.00	2.46	0.96	
10.00	433.00	2.45	0.95	
12.00	361.00	2.45	0.94	
14.00	309.57	2.43	0.93	
16.00	271.00	2.42	0.92	
18.00	241.00	2.42	0.92	
20.00	217.00	2.41	0.91	
25.00	173.80	2.39	0.88	
30.00	145.00	2.36	0.86	
35.00	124.43	2.35	0.85	
40.00	109.00	2.34	0.84	
45.00	97.00	2.33	0.83	
50.00	87.40	2.32	0.82	
55.00	79.55	2.31	0.81	
60.00	73.00	2.30	0.80	
75.00	58.60	2.27	0.77	
90.00	49.00	2.24	0.74	
105.00	42.14	2.22	0.72	

AQUIFER TEST DATA	JOB#3013		WELL#: PW1
Type of aquifer test:	Constant Q	Well type:	PUMPING
How Q Measured:	ORIF. WEIR	Data type:	RECOVERY
Distance from pumping well(m):	0	Depth pump(m):	6.5
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.65	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.50	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
120.00	37.00	2.20	0.69	
150.00	29.80	2.16	0.66	
180.00	25.00	2.13	0.63	
210.00	21.57	2.10	0.60	
240.00	19.00	2.08	0.58	
270.00	17.00	2.05	0.55	
300.00	15.40	2.03	0.52	
360.00	13.00	1.98	0.48	
420.00	11.29	1.96	0.46	
480.00	10.00	1.93	0.43	
540.00	9.00	1.90	0.40	
600.00	8.20	1.88	0.38	
660.00	7.55	1.86	0.36	
720.00	7.00	1.84	0.34	
780.00	6.54	1.83	0.33	
840.00	6.14	1.81	0.31	
900.00	5.80	1.80	0.30	
960.00	5.50	1.79	0.29	
1020.00	5.24	1.78	0.28	
1080.00	5.00	1.77	0.27	
1140.00	4.79	1.76	0.26	
1200.00	4.60	1.75	0.25	
1260.00	4.43	1.74	0.24	
1320.00	4.27	1.73	0.23	
1380.00	4.13	1.71	0.21	

PUMPING WELL PW1 - RECOVERY



AQUIFER TEST DATA	JOB#3013		WELL#: TW27
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	19.2	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.56	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.39	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

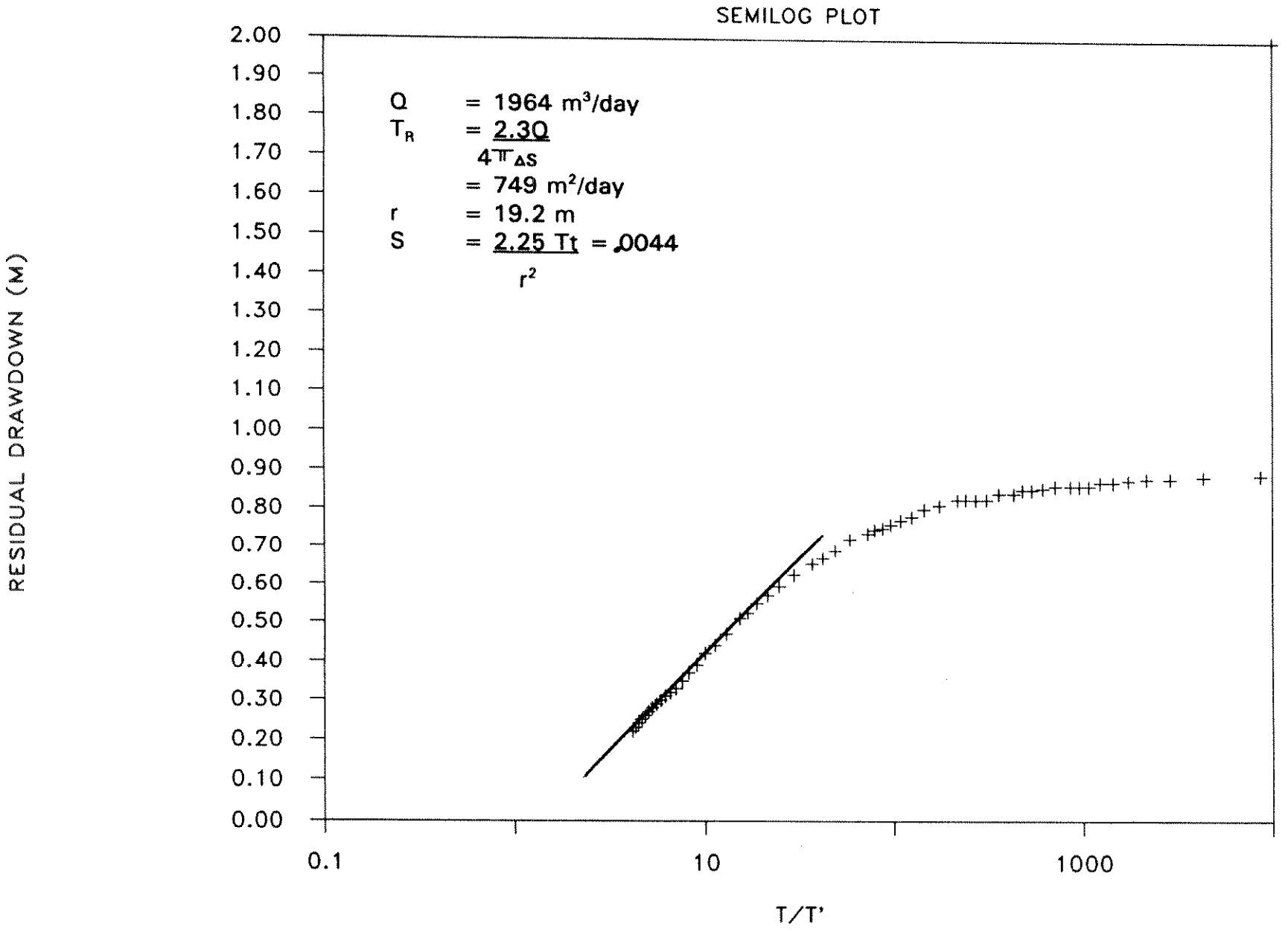
Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
0.50	8641.00	2.28	0.89	
1.00	4321.00	2.28	0.89	
1.50	2881.00	2.27	0.88	
2.00	2161.00	2.27	0.88	
2.50	1729.00	2.27	0.88	
3.00	1441.00	2.26	0.87	
3.50	1235.29	2.26	0.87	
4.00	1081.00	2.25	0.86	
4.50	961.00	2.25	0.86	
5.00	865.00	2.25	0.86	
6.00	721.00	2.25	0.86	
7.00	618.14	2.25	0.86	
8.00	541.00	2.24	0.85	
9.00	481.00	2.24	0.85	
10.00	433.00	2.23	0.84	
12.00	361.00	2.23	0.84	
14.00	309.57	2.22	0.83	
16.00	271.00	2.22	0.83	
18.00	241.00	2.22	0.83	
20.00	217.00	2.22	0.83	
25.00	173.80	2.20	0.81	
30.00	145.00	2.19	0.80	
35.00	124.43	2.17	0.78	
40.00	109.00	2.16	0.77	
45.00	97.00	2.15	0.76	
50.00	87.40	2.14	0.75	
55.00	79.55	2.14	0.75	
60.00	73.00	2.13	0.74	
75.00	58.60	2.11	0.72	
90.00	49.00	2.08	0.69	
105.00	42.14	2.06	0.67	

AQUIFER TEST DATA	JOB#3013	WELL#:	TW27
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	19.2	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.56	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.39	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
120.00	37.00	2.05	0.66	
150.00	29.80	2.02	0.63	
180.00	25.00	1.99	0.60	
210.00	21.57	1.96	0.57	
240.00	19.00	1.94	0.55	
270.00	17.00	1.92	0.53	
300.00	15.40	1.90	0.51	
360.00	13.00	1.86	0.47	
420.00	11.29	1.83	0.44	
480.00	10.00	1.81	0.42	
540.00	9.00	1.78	0.39	
600.00	8.20	1.76	0.37	
660.00	7.55	1.74	0.35	
720.00	7.00	1.72	0.33	
780.00	6.54	1.71	0.32	
840.00	6.14	1.70	0.31	
900.00	5.80	1.69	0.30	
960.00	5.50	1.68	0.29	
1020.00	5.24	1.67	0.28	
1080.00	5.00	1.66	0.27	
1140.00	4.79	1.65	0.26	
1200.00	4.60	1.64	0.25	
1260.00	4.43	1.63	0.24	
1320.00	4.27	1.62	0.23	
1380.00	4.13	1.61	0.22	

OBSERVATION WELL TW27 - RECOVERY



AQUIFER TEST DATA	JOB#3013	WELL#:	P13
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	19.1	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.81	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.64	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

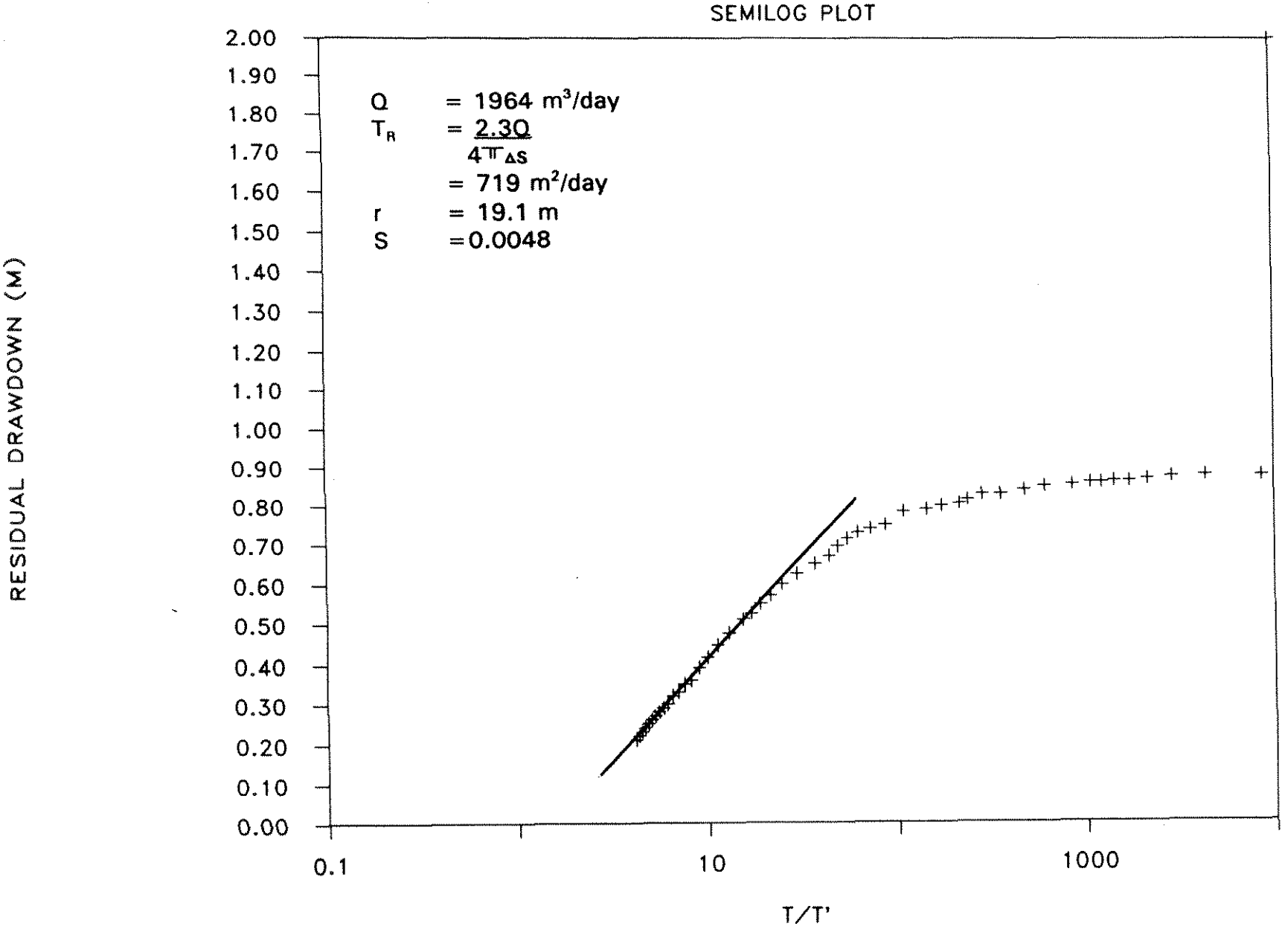
Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
0.50	8641.00	2.52	0.88	
1.00	4321.00	2.52	0.88	
1.50	2881.00	2.52	0.88	
2.00	2161.00	2.51	0.87	
2.50	1729.00	2.51	0.87	
3.00	1441.00	2.51	0.87	
3.50	1235.29	2.50	0.86	
4.00	1081.00	2.50	0.86	
5.00	865.00	2.50	0.86	
7.00	618.14	2.49	0.85	
9.00	481.00	2.48	0.84	
12.00	361.00	2.47	0.83	
15.00	289.00	2.47	0.83	
18.00	241.00	2.46	0.82	
20.00	217.00	2.45	0.81	
25.00	173.80	2.44	0.80	
30.00	145.00	2.43	0.79	
40.00	109.00	2.43	0.79	
50.00	87.40	2.39	0.75	
60.00	73.00	2.38	0.74	
70.00	62.71	2.37	0.73	
80.00	55.00	2.36	0.72	
90.00	49.00	2.34	0.70	
100.00	44.20	2.31	0.67	
120.00	37.00	2.29	0.65	
150.00	29.80	2.27	0.63	
180.00	25.00	2.24	0.60	
210.00	21.57	2.21	0.57	
240.00	19.00	2.19	0.55	
270.00	17.00	2.17	0.53	
300.00	15.40	2.15	0.51	
360.00	13.00	2.12	0.48	
420.00	11.29	2.09	0.45	

AQUIFER TEST DATA	JOB#3013	WELL#:	P13
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	19.1	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.81	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.64	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
480.00	10.00	2.06	0.42	
540.00	9.00	2.03	0.39	
600.00	8.20	2.00	0.36	
660.00	7.55	1.99	0.35	
720.00	7.00	1.97	0.33	
780.00	6.54	1.96	0.32	
840.00	6.14	1.94	0.30	
900.00	5.80	1.93	0.29	
960.00	5.50	1.92	0.28	
1020.00	5.24	1.91	0.27	
1080.00	5.00	1.90	0.26	
1140.00	4.79	1.89	0.25	
1200.00	4.60	1.88	0.24	
1260.00	4.43	1.87	0.23	
1320.00	4.27	1.86	0.22	
1380.00	4.13	1.85	0.21	

OBSERVATION WELL P13 - RECOVERY



AQUIFER TEST DATA	JOB#3013	WELL#:	GT1
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	18.3	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.99	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.88	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

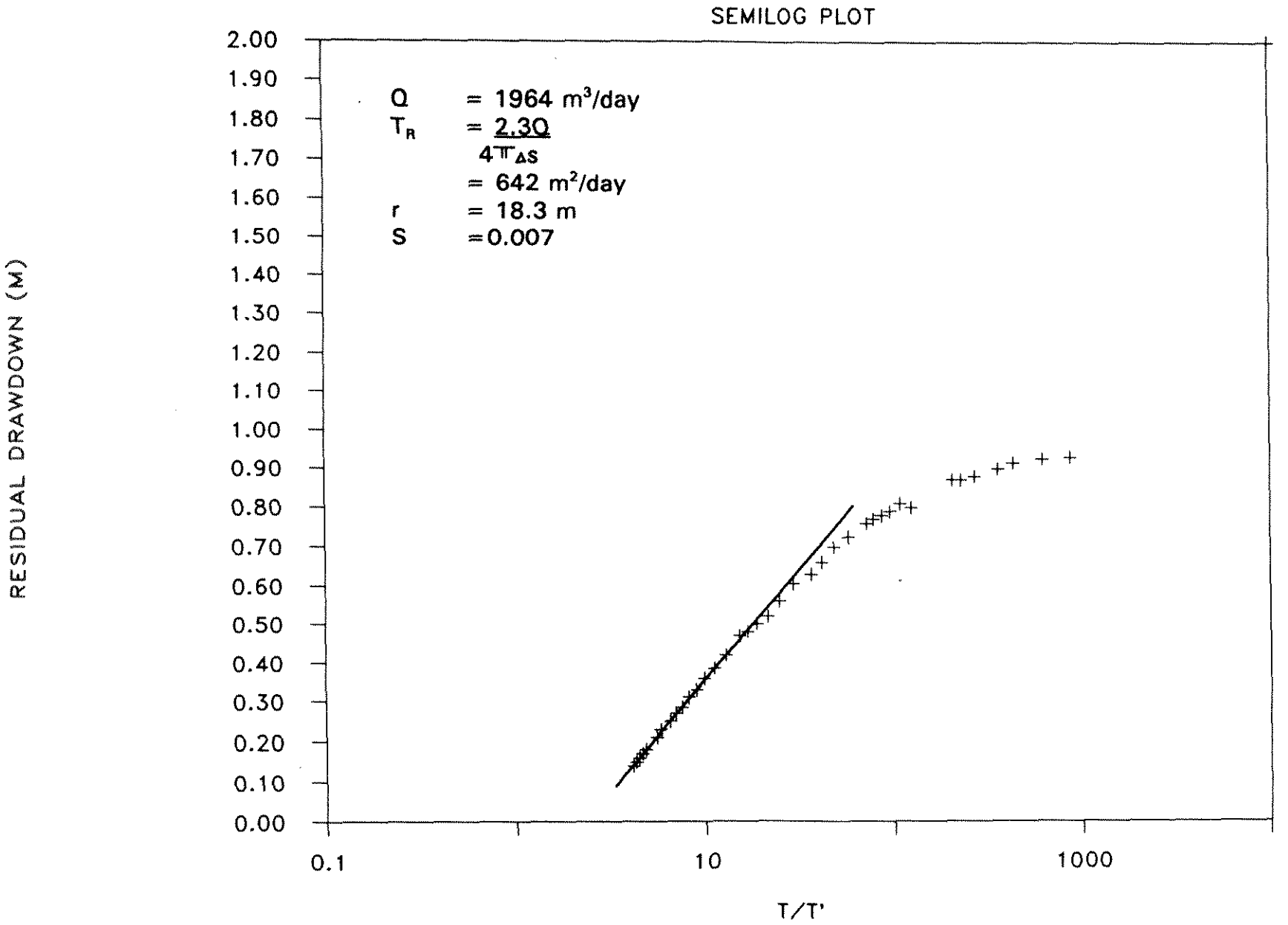
Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
5.00	865.00	2.81	0.93	
7.00	618.14	2.81	0.93	
10.00	433.00	2.80	0.92	
12.00	361.00	2.78	0.90	
16.00	271.00	2.76	0.88	
19.00	228.37	2.75	0.87	
21.00	206.71	2.75	0.87	
35.00	124.43	2.68	0.80	
40.00	109.00	2.69	0.81	
45.00	97.00	2.67	0.79	
50.00	87.40	2.66	0.78	
55.00	79.55	2.65	0.77	
60.00	73.00	2.64	0.76	
75.00	58.60	2.61	0.73	
90.00	49.00	2.58	0.70	
105.00	42.14	2.54	0.66	
120.00	37.00	2.51	0.63	
150.00	29.80	2.49	0.61	
180.00	25.00	2.44	0.56	
210.00	21.57	2.40	0.52	
240.00	19.00	2.38	0.50	
270.00	17.00	2.36	0.48	
300.00	15.40	2.35	0.47	
360.00	13.00	2.30	0.42	
420.00	11.29	2.27	0.39	
480.00	10.00	2.24	0.36	
540.00	9.00	2.21	0.33	
600.00	8.20	2.19	0.31	
660.00	7.55	2.17	0.29	
720.00	7.00	2.15	0.27	
780.00	6.54	2.13	0.25	
900.00	5.80	2.11	0.23	

AQUIFER TEST DATA	JOB#3013		WELL#: GT1
Type of aquifer test:	Constant Q	*Well type:*	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	18.3	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.99	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.88	*Discharge rate:*	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
960.00	5.50	2.09	0.21	
1080.00	2.76	2.07	0.19	
1140.00	4.79	2.06	0.18	
1200.00	4.60	2.05	0.17	
1260.00	4.43	2.04	0.16	
1320.00	4.27	2.03	0.15	
1380.00	4.13	2.02	0.14	

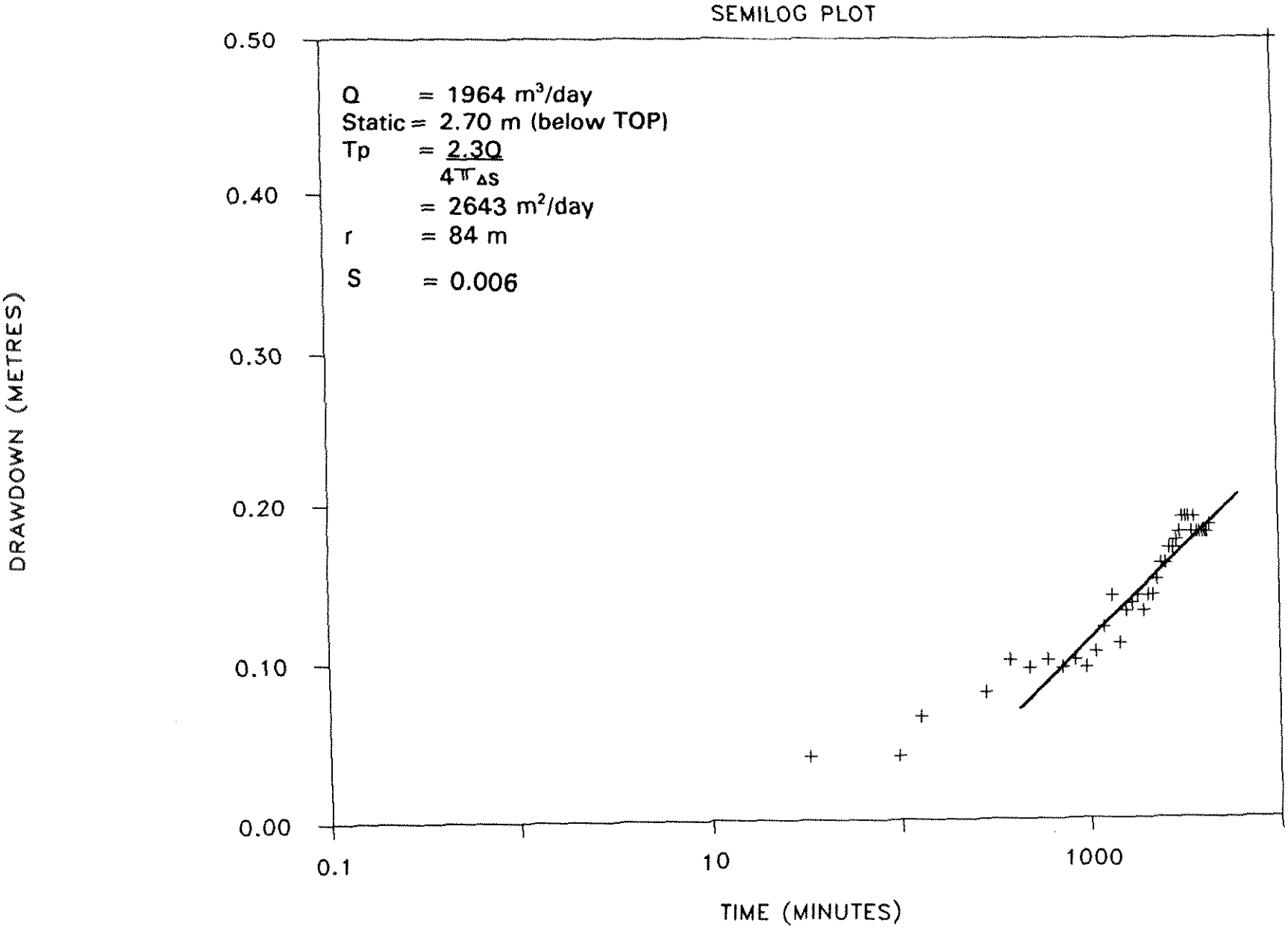
OBSERVATION WELL GT1 - RECOVERY



AQUIFER TEST DATA	JOB#3013	WELL#:	GT2
Type of aquifer test:	CONSTANT	Well type:	OBSERVATION
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	84	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00.00
Elev. of Meas. point(mASL)):	74.75	Pump off:15-5-93	9:00.00
Static Water Level(m):	2.70	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
4200.00	2.88	0.18		
4320.00	2.89	0.18		

OBSERVATION WELL GT2 - DRAWDOWN



AQUIFER TEST DATA	JOB#3013	WELL#:	W1
Type of aquifer test:	CONSTANT	Well type:	POND
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	67	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Static level(mASL)):	72.64	Pump off:15-5-93	9:00.00
Static Water Level(m):	0.63	Discharge rate:	300 IGPM

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
100.00	0.63	0.00	300	
188.00	0.63	0.00		
384.00	0.63	0.01		
480.00	0.63	0.01		
600.00	0.62	0.01		
1440.00	0.62	0.02		
1560.00	0.61	0.02		
1800.00	0.61	0.63		
1920.00	0.61	0.63		
2040.00	0.61	0.63		
2880.00	0.59	0.63		
3000.00	0.59	0.63		
3120.00	0.59	0.63		
3240.00	0.58	0.63		
3360.00	0.59	0.63		
3480.00	0.59	0.63		

AQUIFER TEST DATA	JOB#3013	WELL#:	W2
Type of aquifer test:	CONSTANT	Well type:	POND
How Q Measured:	ORIF.WEIR	Data type:	DRAWDOWN
Dist. from pumping well(m):	80	Depth pump(m):	
Meas. point for w. l.'s:	T.O.C.	Pump on: 12-5-93	9:00.00
Elev. of Static level(mASL)):	72.29	Pump off:15-5-93	9:00.00
Static Water Level(m):	0.42	Discharge rate:	300 IGPM

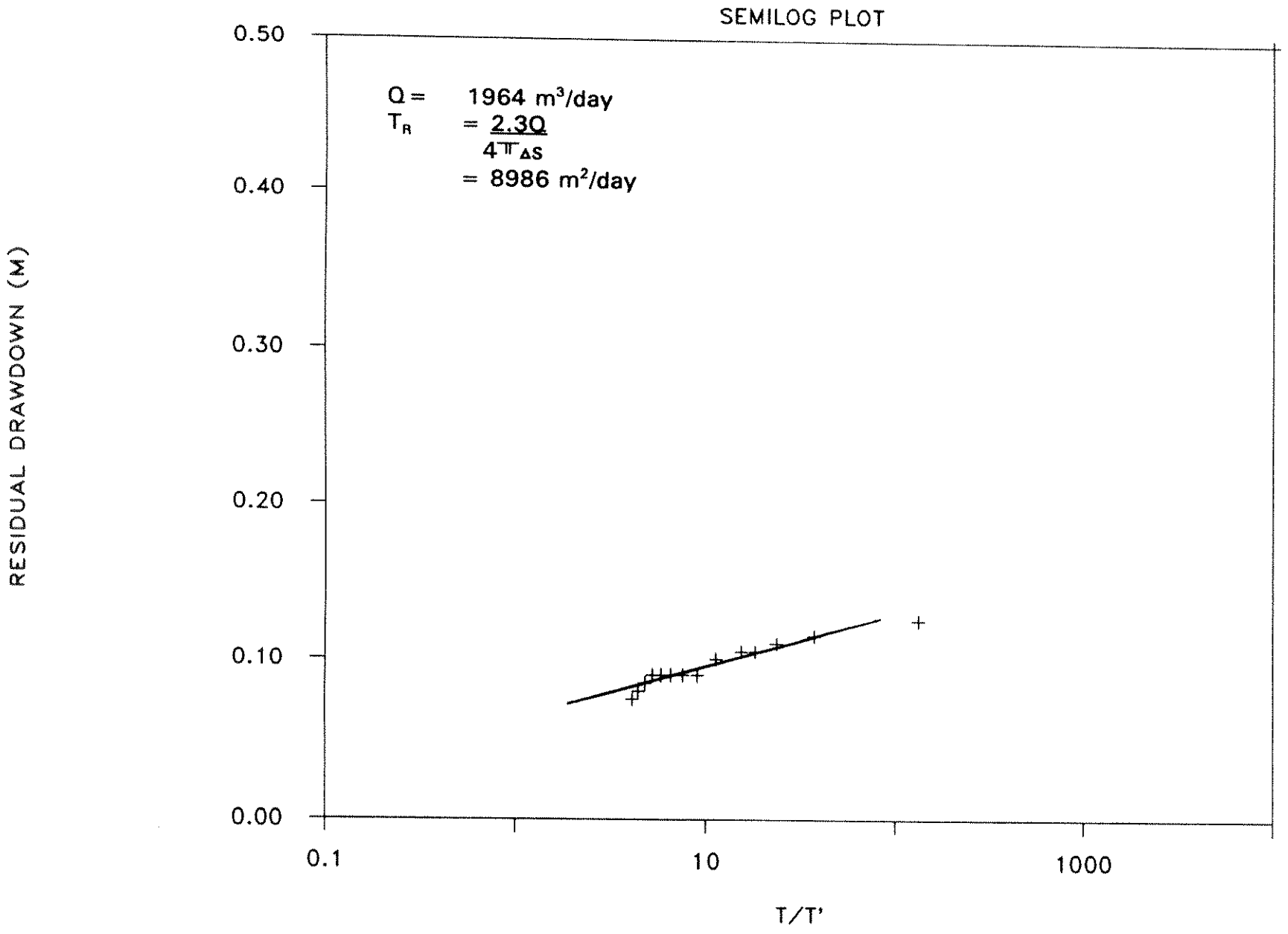
Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
100.00	0.42	0.005	300	
188.00	0.41	0.010		
384.00	0.41	0.015		
480.00	0.40	0.020		
600.00	0.40	0.020		
1440.00	DRY			

AQUIFER TEST DATA	JOB#3013	WELL#:	P12
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	140	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	73.72	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.69	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
33.00	131.91	1.82	0.13	
119.00	37.30	1.81	0.12	
191.00	23.62	1.80	0.11	
250.00	18.28	1.80	0.11	
300.00	15.40	1.80	0.11	
420.00	11.29	1.79	0.10	
540.00	9.00	1.78	0.09	
660.00	7.55	1.78	0.09	
780.00	6.54	1.78	0.09	
900.00	5.80	1.78	0.09	
1020.00	5.24	1.78	0.09	
1140.00	4.79	1.78	0.08	
1260.00	4.43	1.77	0.08	
1380.00	4.13	1.77	0.07	

OBSERVATION WELL P12 - RECOVERY

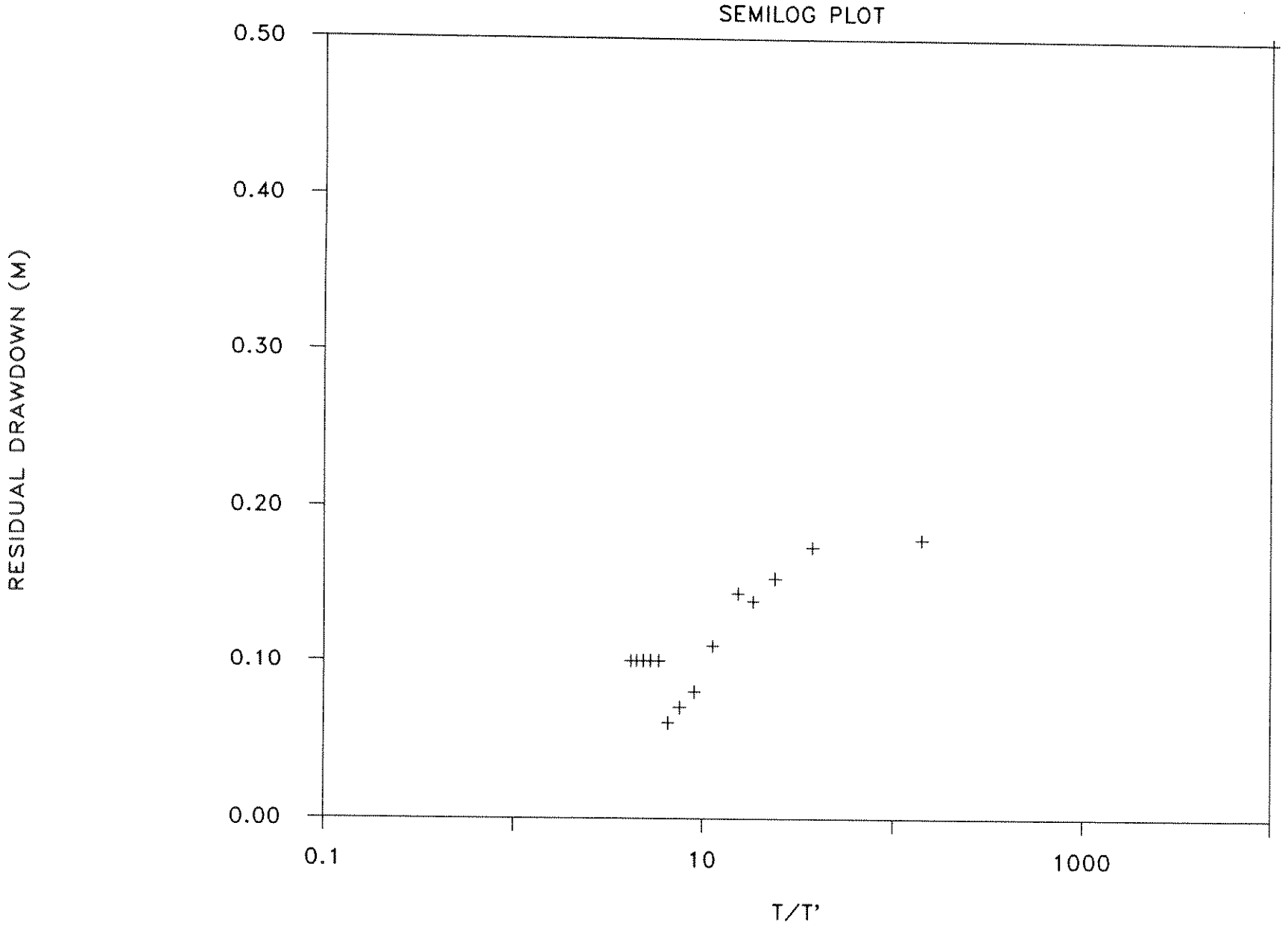


AQUIFER TEST DATA	JOB#3013	WELL#:	GT2
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	84	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	74.75	Pump off:15-5-93	9:00 AM
Static Water Level(m):	2.70	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
31.00	140.35	2.88	0.18	
118.00	37.61	2.88	0.17	
188.00	23.98	2.86	0.15	
248.00	18.42	2.84	0.14	
300.00	15.40	2.85	0.15	
420.00	11.29	2.81	0.11	
540.00	9.00	2.78	0.08	
660.00	7.55	2.77	0.07	
780.00	6.54	2.76	0.06	
900.00	5.80	2.80	0.10	
1020.00	5.24	2.80	0.10	
1140.00	4.79	2.80	0.10	
1260.00	4.43	2.80	0.10	
1380.00	4.13	2.80	0.10	

OBSERVATION WELL GT2 - RECOVERY

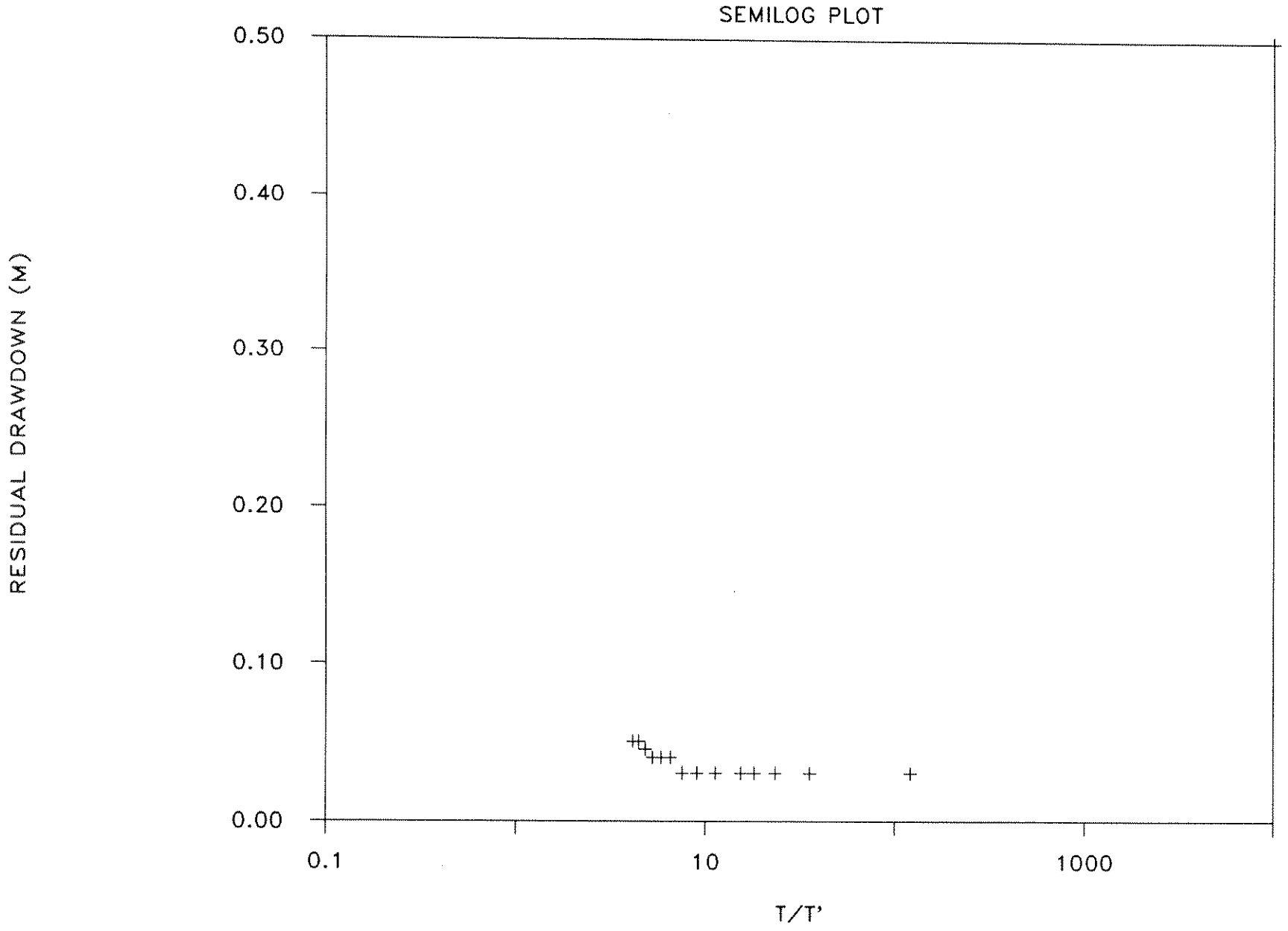


AQUIFER TEST DATA	JOB#3013	WELL#:	P25
Type of aquifer test:	Constant Q	Well type:	OBSERVATION
How Q Measured:		Data type:	RECOVERY
Distance from pumping well(m):	190	Depth pump(m):	
Meas. point for w. l.'s:	T.O.P.	Pump on: 12-5-93	9:00 AM
Elev.of Meas. Point (mASL):	74.23	Pump off:15-5-93	9:00 AM
Static Water Level(m):	1.61	Discharge rate:	300 IGPM

At t' = 0, t = 4320.00

Time (min.)	t/t'	Water Level (m)	Residual Drawdown(m)	Comments
36.00	121.00	1.64	0.03	
124.00	35.84	1.64	0.03	
193.00	23.38	1.64	0.03	
253.00	18.08	1.64	0.03	
300.00	15.40	1.64	0.03	
420.00	11.29	1.64	0.03	
540.00	9.00	1.64	0.03	
660.00	7.55	1.64	0.03	
780.00	6.54	1.65	0.04	
900.00	5.80	1.65	0.04	
1020.00	5.24	1.65	0.04	
1140.00	4.79	1.66	0.04	
1260.00	4.43	1.66	0.05	
1380.00	4.13	1.66	0.05	

OBSERVATION WELL P25 - RECOVERY



APPENDIX D

THEORETICAL AQUIFER YIELD
and
WELL INTERFERENCE CALCULATIONS

Using Theis Nonequilibrium Equation:

$$u = \frac{r^2 S}{4Tt} \qquad Q(max) = \frac{4\pi T(s_0 - s)}{W(u)}$$

$T = 678\ m^2/day$
$s_0 - s = 8.4$ *metres* = *maximum* allowable drawdown
$S = 1.0 \times 10^{-2}$ (average from data)
$r = 0.25$ metres

Theoretical Aquifer Yields, Well Interference, and Well Efficiency Calculations

(a) Theoretical Aquifer Yields :

(1) 10 year design yield:

for $t = 3650$ days

$u = 6.31 \times 10^{-11}$

$W(u) = 22.91$

$Q(max) = 3124\ m^3/day$ (477 igpm) (36.1 l/s)

(2) 20 year design yield:

for $t = 7305$ days

$u = 3.15 \times 10^{-11}$

$W(u) = 23.59$

$Q(max) = 3034\ m^3/day$ (464 igpm) (35.2 l/s)

(3) Safe perennial yield (365 days):

$Q(max) = 3472\ m^3/day$ (531 igpm) (40.2 l/s)

(b) Theoretical Well Interference Calculations:

Calculations based on a 1 year period (365 days).
$T = 678\ m^2/day$

$$S = 1 \times 10^{-2}$$

$$s(\text{drawdown}) = \frac{Q(Wu)}{4\pi T}$$

The Table following shows drawdown for various radial distances from PW1 in 1 year of pumping at a discharge rate of 300 IGPM (22.7 l/s) (1964 m^3/day).

Drawdown of Observation Wells (one year period)

RADIUS (m)	**u**	**W(u)**	**s(m)**
0.25 (PW1)	6.3×10^{-10}	20.61	4.75
18.3 (GT1)	3.4×10^{-6}	12.01	2.76
19.2 (TW27)	3.7×10^{-6}	11.93	2.75
84 (GT2)	7.1×10^{-5}	8.98	2.07
140 (P12)	2.0×10^{-4}	7.94	1.83
190 (P25)	3.6×10^{-4}	7.35	1.69
300 (Laroque dug well)	9.1×10^{-4}	6.43	1.48
1000	1.0×10^{-2}	4.04	0.93

The Table following shows drawdown for various radial distances from PW1 after 10 years of pumping at a discharge rate of 300 IGPM (22.7 l/s) (1964 m^3/day).

Drawdown of Observation Wells (*ten year period*)

RADIUS (m)	u	W(u)	s(m)
0.25 (PW1)	6.3×10^{-11}	22.91	5.28
18.3 (GT1)	3.4×10^{-7}	14.32	3.30
19.2 (TW27)	3.7×10^{-7}	14.23	3.28
84 (GT2)	7.1×10^{-6}	11.28	2.60
140 (P12)	2.0×10^{-5}	10.24	2.36
190 (P25)	3.6×10^{-5}	9.65	2.22
300 (Laroque dug well)	9.1×10^{-5}	8.73	2.01
1000	1.0×10^{-3}	6.33	1.46

c) Well Efficiency(Using TW27)

t = 3 days
T = 899 m^2/day
Q = 1964 m^3/day
S = 0.095
r = 19.2 m

Therefore u = 3.25×10^{-3}, W(u) = 5.15

Theoretical drawdown in TW27 = 0.89m
Actual drawdown in TW27 = 0.92m

Well Efficiency = Theoretical/ Actual = 97 %

APPENDIX E

WATER QUALITY LAB REPORTS

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0950
DATE: May 26,1993
DATE SUBMITTED: May 13,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	Sample 24 hr. Production Well	Sample	Sample	Sample	Sample
Fe	mg/L	0.01	0.03				
Mn	mg/L	0.01	0.01				
Hardness	mg/L CaCO3	1	175				
Alkalinity	mg/L CaCO3	1	141				
pH			8.23				
Conductivity	umhos/cm	3	343				
F	mg/L	0.01	0.06				
Na	mg/L	1	2				
N-NO3	mg/L	0.1	0.60				
N-NO2	mg/L	0.1	nd				
N-NH3	mg/L	0.01	nd				
SO4	mg/L	3	29				
Cl	mg/L	1	8				
Phenols	mg/L	0.002	nd				
Turbidity	NTU	0.1	0.2				
Colour	Pt/Co units	2	2				
Ca	mg/L	1	57				
Mg	mg/L	1	8				
Tannin & Lignin	mg/L	0.1	nd				
Total Kjeldahl Nitrogen	mg/L	0.01	0.12				
K	mg/L	1	1				
TOC	mg/L	0.2	0.9				
TDS	mg/L	1	200				
H2S	mg/L	0.01	nd				
Ion Balance			0.99				

ND = Not Detected (<MDL)

MDL = Method Detection Limit

COMMENT:

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0950
DATE: May 26,1993
DATE SUBMITTED: May 13,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	Sample	Sample	Sample	Sample	Sample
			24 hr. Production Well				
Total Coliforms	cts/100mls		0				
Faecal Coliforms	cts/100mls		0				
Faecal Streptococci	cts/100mls		2				
E.Coli	cts/100mls		0				
Standard Plate Count (48hrs)	cts/1ml		11				
COD	mg/L	3	nd				

ND = Not Detected (<MDL)

MDL = Method Detection Limit

COMMENT:

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O. Box 430, Carp, Ontario K0A 1L0 (613) 839-3053

CHAIN OF CUSTODY RECORD

Record No. : 0926 C

SHIPPED TO:(Laboratory) Accutest laboratories

PROJECT FILE NO. : WESA 30192.3

SAMPLER:(Signature) [signature]

SAMPLE NO.	COLLECTION DATE	COLLECTION TIME	# OF CONTAINERS	SAMPLE MATRIX	ANALYTICAL SEQUENCE	DESIRED TURN-AROUND TIME	TEST(S) REQUESTED (X): Subdivisions Supply Inorganics 24h	COMMENTS
PRODUCTION WELL	130593	9:00	6	W		5	X	Inorganics Phenols Metals H_2S Microbiology TKN NB COD TOC

ANTICIPATED CHEMICAL HAZARDS: —

METHOD OF SHIPMENT: Courier (Air) ☐ Courier (Land) ☐ Other ☒

SHIPPED BY: WESA STAFF PAS

REPORT TO: (Project Manager) KSB HILLIER

TYPE OF REPORT: Detailed ☐ Summary ☒

FAX PRELIMINARY RESULTS: Yes ☒ No ☐

SPECIAL REQUESTS:

RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY:(Signature)	DATE	TIME
[signature]	130593	10:30	[signature]	May 13/93	10.30 am
RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY:(Signature)	DATE	TIME
RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY LAB: (Signature)	DATE	TIME

MATRIX: AIR = A; SOIL = S; WATER = W; OTHER = O

TURN-AROUND TIME: RUSH = R; 48-HOUR = T; 5-DAY = F; STANDARD = S

GENERAL CONDITION OF COOLER:

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0968
DATE: June 2,1993
DATE SUBMITTED: May 14,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	Sample	Sample	Sample	Sample	Sample
			Production Well 48hrs.				
Fe	mg/L	0.01	0.10				
Mn	mg/L	0.01	nd				
Hardness	mg/L CaCO3	1	162				
Alkalinity	mg/L CaCO3	1	136				
pH			7.96				
Conductivity	umhos/cm	3	351				
F	mg/L	0.01	0.06				
Na	mg/L	1	3				
N-NO3	mg/L	0.1	0.49				
N-NO2	mg/L	0.1	nd				
N-NH3	mg/L	0.01	nd				
SO4	mg/L	3	37				
Cl	mg/L	1	6				
Phenols	mg/L	0.002	nd				
Turbidity	NTU	0.1	0.2				
Colour	Pt/Co units	2	nd				
Ca	mg/L	1	50				
Mg	mg/L	1	9				
Tannin & Lignin	mg/L	0.1	nd				
Total Kjeldahl Nitrogen	mg/L	0.01	0.05				
K	mg/L	1	1				
TOC	mg/L	0.2	0.4				
TDS	mg/L	1	200				
H2S	mg/L	0.01	nd				
Ion Balance			0.93				

ND = Not Detected (<MDL) MDL = Method Detection Limit

COMMENT:

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0968
DATE: June 2,1993
DATE SUBMITTED: May 14,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	Sample	Sample	Sample	Sample	Sample
			Production Well 48hrs.				
Total Coliforms	cts/100mls		0				
Faecal Coliforms	cts/100mls		0				
Faecal Streptococci	cts/100mls		0				
E.Coli	cts/100mls		0				
Standard Plate Count (48hrs)	cts/1ml		3				

ND = Not Detected (<MDL) MDL = Method Detection Limit

COMMENT:

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O. Box 430, Carp, Ontario K0A 1L0 (613) 839-3053

CHAIN OF CUSTODY RECORD

Record No. : 1880 c

SHIPPED TO:(Laboratory) Accutest labs.

PROJECT FILE NO. : WESA 3013

SAMPLER:(Signature)

SAMPLE NO.	COLLECTION DATE	COLLECTION TIME	# OF CONTAINERS	SAMPLE MATRIX	ANALYTICAL SEQUENCE	DESIRED TURN-AROUND TIME	TEST(S) REQUESTED (X)	COMMENTS
PRODUCTION WELL	14/05/93	9:00	6	W			1	INORGANICS Phenols Metals H2S Microbiology TKN NH3 NO3 TOC

ANTICIPATED CHEMICAL HAZARDS: —

METHOD OF SHIPMENT: Courier (Air) ☐ Courier (Land) ☐ Other ☒

SHIPPED BY: WESA STAFF PAS

REPORT TO: (Project Manager) ROB HILLIER

TYPE OF REPORT: Detailed ☐ Summary ☒

FAX PRELIMINARY RESULTS: Yes ☒ No ☐

SPECIAL REQUESTS:

RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY:(Signature)	DATE	TIME
	14/05/93	10:15		14/05/93	10:15 am
RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY:(Signature)	DATE	TIME
RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY LAB: (Signature)	DATE	TIME

MATRIX: AIR = A; SOIL = S; WATER = W; OTHER = O

TURN-AROUND TIME: RUSH = R; 48-HOUR = T; 5-DAY = F; STANDARD = S

GENERAL CONDITION OF COOLER:

White: Lab (to be returned to WESA) Yellow: Lab (files) Pink: WESA sampler

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc. Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0992
DATE: June 16, 1993
DATE SUBMITTED: May 16,1993
PROJECT: 3013

SAMPLE MATRIX: WATER 72 hr

PARAMETER	UNITS	MDL	MAC	Chemical/ Physical objectives			Sample PAS 05/15/93 9.00
Fe	mg/L	0.01		0.30			0.04
Mn	mg/L	0.01		0.05			nd
Hardness	mg/L CaCO3	1		80-100			167
Alkalinity	mg/L CaCO3	1		500			139
pH				6.5-8.5			7.90
Conductivity	umhos/cm	3					341
F	mg/L	0.01	1.5				0.06
Na	mg/L	1		200			2
N-NO3	mg/L	0.1	10.0				0.45
N-NO2	mg/L	0.1	1.0				nd
N-NH3	mg/L	0.01					0.04
SO4	mg/L	3		500			34
Cl	mg/L	1		250			6
Phenols	mg/L	0.002	0.002				nd
Turbidity	NTU	0.1	1.0				0.2
Colour	Pt/Co units	2		5			nd
Ca	mg/L	1					52
Mg	mg/L	1					9
Tannin & Lignin	mg/L	0.1					nd
Total Kjeldahl Nitrogen	mg/L	0.01					0.11
K	mg/L	1					1
DOC	mg/L	0.2		5.0			0.4
TDS	mg/L	1		500			200
H2S	mg/L	0.01		0.05			nd
Organic Nitrogen	mg/L	0.01		0.15			0.07
Ion Balance							0.94

ND = Not Detected (<MDL)

COMMENT:

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration
IMAC= Interim Maximum Acceptable Concentration
AO = Aesthetic Objectives
Pg/L = picograms/litre Toxic Equivalents

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R.Hillier

LAB REPORT NO: A3-0992
DATE: June 16,1993
DATE SUBMITTED: May 16,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	MAC	IMAC	Chemical/ Physical Objectives		Sample PAS 05/15/93 9.00
Al	mg/L	0.03			0.1		nd
As	mg/L	0.01		0.025			nd
Ba	mg/L	0.01		1.0			0.12
B	mg/L	0.01		5.0			nd
Cd	mg/L	0.002	0.005				nd
CN-	mg/L	0.01	0.2				nd
Cr	mg/L	0.01	0.05				0.05
Cu	mg/L	0.01			1.0		nd
Hg	mg/L	0.001	0.001				nd
Pb	mg/L	0.002	0.01				nd
Se	mg/L	0.01	0.01				nd
U	mg/L	0.01	0.1				nd
Zn	mg/L	0.01			5.0		nd
Radionuclides							
Cs 137	Bq/L	1	50				nd
I 131	Bq/L	1	10				nd
Ra 226	Bq/L	0.1	1				nd
Sr 90	Bq/L	1	10				nd
Tritium	Bq/L	1000	40000				nd

ND = Not Detected (<MDL)

COMMENT:

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration
IMAC= Interim Maximum Acceptable Concentration
AO = Aesthetic Objectives
Pg/L = picograms/litre Toxic Equivalents

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R.Hillier

LAB REPORT NO: A3-0992
DATE: June 16,1993
DATE SUBMITTED: May 16,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	MAC	IMAC	AO		Sample PAS 05/15/93 9.00
Total Coliforms	cts/100mls		5				2
Faecal Coliforms	cts/100mls		0				2
Faecal Streptococci	cts/100mls						2
E.Coli	cts/100mls		0				0
Aerobic Plate Count	cts/1ml				500		142

ND = Not Detected (<MDL)

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration
IMAC= Interim Maximum Acceptable Concentration
AO = Aesthetic Objectives
Pg/L = picograms/litre Toxic Equivalents

COMMENT:

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0992
DATE: June 16,1993
DATE SUBMITTED: May 16,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	MAC	IMAC	AO		Sample PAS 05/15/93 9.00
Alachlor	mg/L	0.005		0.005			nd
Aldicarb	mg/L	0.0005	0.009				nd
Aldrin & Dieldrin	mg/L	0.0007	0.0007				nd
Atrazine	mg/L	0.005		0.06			nd
Azinphos-methyl	mg/L	0.02	0.02				nd
Bendiocarb	mg/L	0.04	0.04				nd
Benzene	mg/L	0.0005	0.005				nd
Benzo(a)pyrene	mg/L	0.00001	0.00001				nd
Bromoxynil	mg/L	0.005		0.005			nd
Carbaryl	mg/L	0.07	0.09				nd
Carbofuran	mg/L	0.05	0.09				nd
Carbon Tetrachloride	mg/L	0.0005	0.005				nd
Chlordane	mg/L	0.007	0.007				nd
Chlorpyrifos	mg/L	0.09	0.09				nd
Cyanazine	mg/L	0.01		0.01			nd
Diazinon	mg/L	0.01	0.02				nd
Dicamba	mg/L	0.12	0.12				nd
1,2-Dichlorobenzene	mg/L	0.0004	0.2		0.003		nd
1,4-Dichlorobenzene	mg/L	0.0004	0.005		0.001		nd
DDT	mg/L	0.01	0.03				nd
1,2-Dichloroethane	mg/L	0.0005		0.005			nd
Dichloromethane	mg/L	0.004	0.05				nd
2,4-Dichlorophenol	mg/L	0.01	0.9		0.0003		nd
2,4-D	mg/L	0.02	0.1				nd
Diclofop-methyl	mg/L	0.009	0.009				nd
Dimethoate	mg/L	0.005		0.02			nd

ND = Not Detected (<MDL)

COMMENT:

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration
IMAC= Interim Maximum Acceptable Concentration
AO = Aesthetic Objectives
Pg/L = picograms/litre Toxic Equivalents

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0992
DATE: June 16,1993
DATE SUBMITTED: May 16,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	MAC	IMAC	AO		Sample PAS 05/15/93 9.00
Dioxins & Furans	Pg/L	15		15			nd
Diquat	mg/L	0.004	0.07				nd
Diuron	mg/L	0.1	0.15				nd
Ethylbenzene	mg/L	0.0005			0.0024		nd
Glyphosate	mg/L	0.1		0.28			nd
Heptachlor +							nd
Heptachlor Epoxide	mg/L	0.003	0.003				nd
Lindane	mg/L	0.004	0.004				nd
Malathion	mg/L	0.005	0.19				nd
Methoxychlor	mg/L	0.1	0.9				nd
Metolachlor	mg/L	0.005		0.05			nd
Metribuzin	mg/L	0.005	0.08				nd
Monochlorobenzene	mg/L	0.0004	0.08		0.03		nd
Nitrilotriacetic Acid	mg/L	0.05	0.4				nd
NDMA	mg/L	0.000005		0.000009			nd
Paraquat	mg/L	0.004		0.01			nd
Parathion	mg/L	0.01	0.05				nd
Pentachlorophenol	mg/L	0.01	0.06		0.03		nd
Phorate	mg/L	0.002		0.002			nd
Picloram	mg/L	0.02		0.19			nd
PCB's	mg/L	0.003		0.003			nd
Prometryne	mg/L	0.001		0.001			nd
Simazine	mg/L	0.005		0.01			nd
Temephos	mg/L	0.28		0.28			nd
Terbufos	mg/L	0.001		0.001			nd
2,3,4,6-Tetrachlorophenol	mg/L	0.01	0.1		0.001		nd
Toluene	mg/L	0.0005			0.024		nd

ND = Not Detected (<MDL)

COMMENT:

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration
IMAC= Interim Maximum Acceptable Concentration
AO = *Aesthetic Objectives*
Pg/L = picograms/litre Toxic Equivalents

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

ACCUTEST LABORATORIES LTD.

REPORT OF ANALYSES

Client: Water & Earth Sc.Assoc.

Attention: R. Hillier

LAB REPORT NO: A3-0992
DATE: June 16,1993
DATE SUBMITTED: May 16,1993
PROJECT: 3013

SAMPLE MATRIX: WATER

PARAMETER	UNITS	MDL	MAC	IMAC	AO		Sample PAS 05/15/93 9.00
Triallate	mg/L	0.01	0.23				nd
Trichloroethylene	mg/L	0.0003	0.05				nd
2,4,6-Trichlorophenol	mg/L	0.005	0.005		0.002		nd
2,4,5 TP	mg/L	0.28	0.28		0.02		nd
Trifluralin	mg/L	0.005		0.045			nd
Trihalomethanes	mg/L	0.01	0.35				nd
m/p Xylene	mg/L	0.001			0.3		nd
o Xylene	mg/L	0.0005			0.3		nd
Methane	L/m^3	3			3		2.3

ND = Not Detected (<MDL)

COMMENT:

MDL = Method Detection Limit
MAC = Maximum Acceptable Concentration
IMAC= Interim Maximum Acceptable Concentration
AO = Aesthetic Objectives
Pg/L = picograms/litre Toxic Equivalents

ANALYST: _____

146 Colonnade Road, Unit 8, Nepean, Ontario K2E 7Y1 Tel:(613)727-5692 Fax:(613)727-5222

WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O. Box 430, Carp, Ontario K0A 1L0 (613) 839-3053

CHAIN OF CUSTODY RECORD

Record No. : 1838C

SHIPPED TO:(Laboratory) ACCUTEST LABORATORIES

PROJECT FILE NO. : WESA 3013

SAMPLER:(Signature) [signature]

SAMPLE NO.	COLLECTION DATE	COLLECTION TIME	# OF CONTAINERS	SAMPLE MATRIX	ANALYTICAL SEQUENCE	DESIRED TURN-AROUND TIME	TEST(S) REQUESTED (X): Volatiles (+40 ml amber coal amber)	Organics 9 x 1L Amber	Inorganics (1 x 1L)	Trihalomethanes	Microbiology	Radionuclides			COMMENTS
PRODUCTION WELL	15/05/93	9:00	21	W		S	X	X	X	X	X	X			
CDWQ 72 h															

ANTICIPATED CHEMICAL HAZARDS: —

METHOD OF SHIPMENT: Courier (Air) ☐ Courier (Land) ☐ Other ☑

SHIPPED BY: WESA STAFF BH

REPORT TO: (Project Manager) ROB HILLIER

TYPE OF REPORT: Detailed ☐ Summary ☑

FAX PRELIMINARY RESULTS: Yes ☑ No ☐

SPECIAL REQUESTS:

RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY:(Signature)	DATE	TIME
[signature]	MAY 15/93	1145 hr	LEFT IN PETER HAUCNA'S GARAGE	MAY 15/93	1145 hr
RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY:(Signature)	DATE	TIME
RELINQUISHED:(Signature)	DATE	TIME	RECEIVED BY LAB: (Signature)	DATE	TIME

MATRIX: AIR = A; SOIL = S; WATER = W; OTHER = O

TURN-AROUND TIME: RUSH = R; 48-HOUR = T; 5-DAY = F; STANDARD = S

GENERAL CONDITION OF COOLER:

White: Lab (to be returned to WESA) Yellow: Lab (file) Pink: WESA sampler