THE IDENTIFICATION AND TESTING OF GROUNDWATER SOURCES FOR COMMUNAL WATER SUPPLY VILLAGE OF VARS, ONTARIO

PRELIMINARY DRAFT
(FOR DISCUSSION PURPOSES ONLY)

Prepared for:

McNeely Engineering Ltd.

Prepared by:

Water and Earth Science Associates Ltd.
Box 430, Carp, Ontario, Canada, K0A 1L0.

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1.0 INTRODUCTION

Water and Earth Science Associates Limited was contracted by McNeely Engineering Limited on behalf of the Township of Cumberland to conduct a water supply source identification study and testing program for a communal water supply development for the Village of Vars. Background research of MOE well records and the geological literature had identified a glaciofluvial complex located approximately 3 kilometers east of the village as a likely target area (Figure 1).

Work on Vars water supply project has spanned a 4 year period. As indicated in Table 1, Phase 1 of the investigation consisted of a background study and mapping program, while Phase II consisted of a more detailed testing program. Phase III involved the water treatability study.

TABLE 1: VARS WATER SUPPLY STUDY

Phase I	Water supply source identification 1986 (Background study) Source investigation and testing 1986-87 (Mapping program)
Phase IIa	Source quantification and testing 1987 (Test well program)
Phase IIb	Water Quality Verification Testing 1990 (Test well program)
Phase III	Water supply treatability study 1990

This report presents the results of the first two phases of the program. Phase III can be found under a separate cover (WESA, 1990b).

2.0 METHODS OF ANALYSIS

During Phase I, potential aquifer sites which were identified during the background research and the site reconnaissance, were investigated through a geological and hydrogeological mapping program of these sites. Preliminary mapping of the Cumberland Township included observation of natural and man-made exposures in gravel pits and river banks located along the glaciofluvial complex. As most farms and residences along the glaciofluvial complex rely on shallow dug wells which are not usually recorded in MOE well log files, well log information in these areas was largely unavailable. Stereo air photographs were examined to determine the location and width of the glaciofluvial deposits identified as the prime drilling

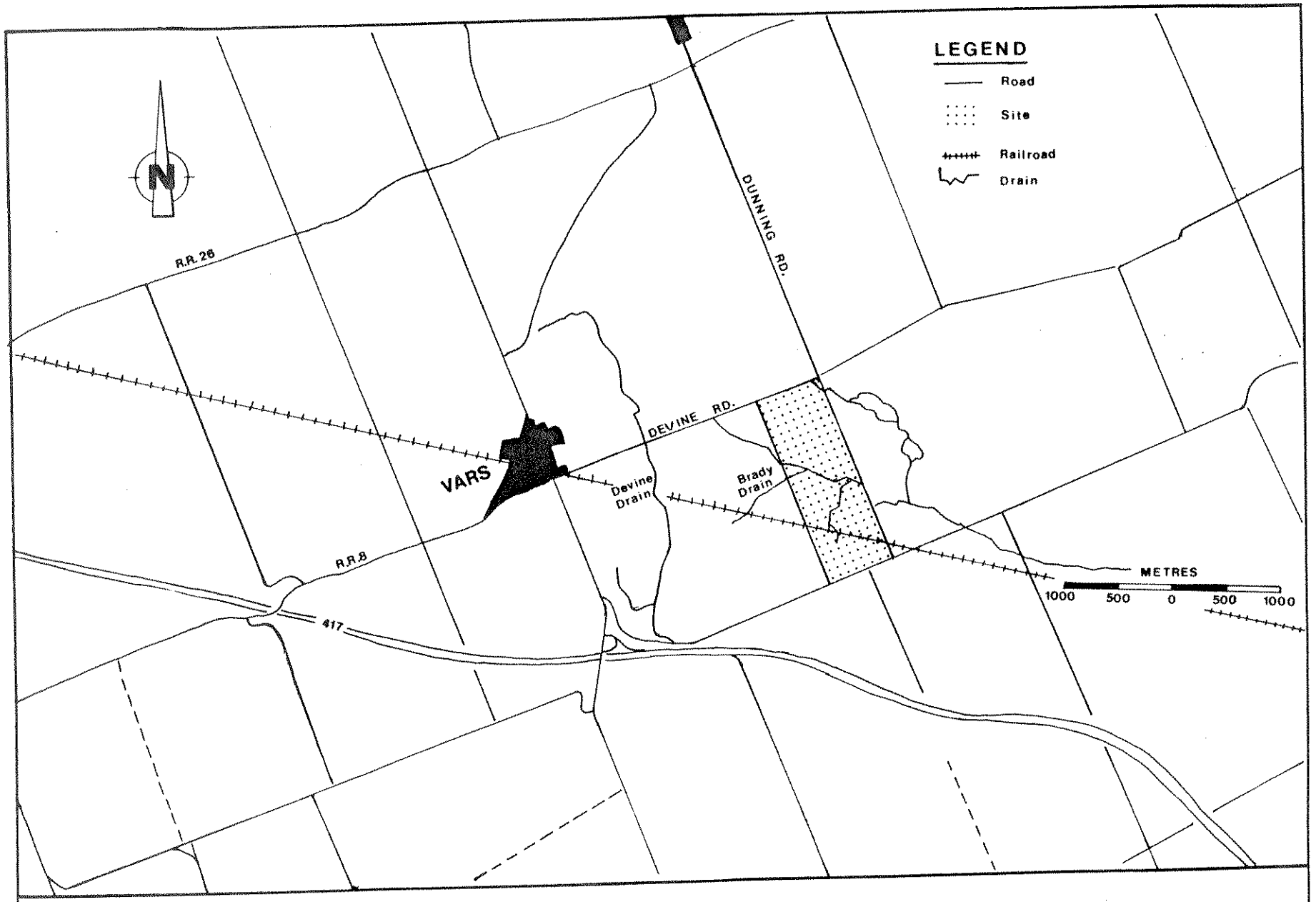

FIGURE I

LOCATION MAP

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targets for water supply development on a communal scale. The results of a geophysical survey completed by the Ministry of Natural Resources were reviewed as were the internal WESA files detailing the morphology, location and orientation of the esker sand and gravel deposits in Eastern Ontario. Valuable unpublished information was also obtained from representatives of the MNR regarding the location of the buried glaciofluvial deposits in the area (Gorrell, 1987).

During the reconnaissance mapping program, eighty-six test holes were drilled, by either a truck mounted CME 75 or a track mounted CME 55 hollowstem drill rig. The reconnaissance drilling program covered most of the countryside east and north of Vars towards Leonard, Ontario. The program was successful in identifying a number of target locations. The screening criteria used in this identification included: the permeability of the deposit, the thickness of the saturated deposit, the recharge potential of the site, the proximity and character of potential contaminant sources, and the pipe line distance to Vars.

Samples of the unconsolidated surficial materials drilled were obtained by split spoon sampler test holes for later examination.

Selected drill holes were instrumented with piezometers for later use as hydraulic head monitors. Geologic, hydrogeologic and instrumentation details are compiled in Appendix A. The locations of the test holes and the piezometers are shown on Figure 2.

Geologic information was compiled in the form of cross-sections, isopach thickness maps, and test hole logs. After the completion of a level survey, the exact locations and actual elevation of the tops of the piezometer casings were determined and tied together to a common datum.

Hydraulic heads were obtained from the piezometer network to establish natural groundwater gradient fields and the recharge/discharge regime of the glaciofluvial complex was determined.

An initial potential water supply location was identified 7.5 km south of Leonard, Ontario. However, the expense of piping the water to Vars warranted further investigation closer to Vars. A small area just southwest of Vars was investigated in early March of 1987 with no success.

In late 1987, new geophysical information was provided by the Ministry of Natural Resources which showed that a very narrow extension of the glaciofluvial deposit was located south of the Devine Road and east of Vars. This area was test drilled in May and June of 1987.

The Phase IIa study included the determination of the optimum location and design of a 200 mm (nominal 8 inch) diameter naturally gravel packed test well capable of producing a minimum of 7.6 - 11.4 l/s (100-150 IGPM) of potable water. The optimal location was optioned by the Township of Cumberland prior to testing. The well was installed and tested for yield, efficiency, and water quality. Interference effects and a long term appraisal of safe perennial yield, recharge, and water quality were also calculated. The Test Well 1 site was located close to the Devine Road. This site was chosen for its potential to provide substantial yield without interfering with the neighbouring domestic and agricultural water supplies.

The test well was installed by Olympic Drilling Co. Ltd. a local drilling contractor with considerable experience in large scale water supply well drilling. A 29T cable tool drill rig was used to install the well to a depth of 22.25 metres (73 feet). A 200 mm telescoping stainless steel wire wrap screen was installed by the pull-back method. The interval from 18.28 metres to 20.73 metres (60 to 68 feet) below ground surface was screened. The screen was designed during the drilling and included analyses of the grain size distribution of the aquifer materials by a suction bailer. A #100 slot size screen opening was selected. The test well configuration is as shown on Figure 3. This test well was designed so that if successful it could be used as a standby pumping facility at a later date with minor modification. If unsuccessful, the stainless steel screen could be recovered.

After drilling, the well was developed by compressed air surging and over pumping with the shaft line turbine pump installed for testing purposes. The well was developed until essentially sand free.

The aquifer testing program undertaken included an initial step discharge pumping test. The well was pumped incrementally at discharges of 7.58 l/s, 15.15 l/s, 30.30 l/s, 38.86 l/s (100 IGPM, 200 IGPM, 300 IGPM, 400 IGPM, 513 IGPM) for periods up to 30 minutes each. Discharge was measured with an orifice weir and manometer. Test data can be found in Appendix B. Pumped water from all testing was discharged through a 300 foot pipeline into the bush northeast of the test well. A deposit of clay and silt up to 6 metres thick overlies and hydraulically isolates the aquifer from surface infiltration at this location. Drainage of the water is away from the crest of the aquifer.

A constant discharge aquifer test was conducted at the conclusion of recovery of water levels after the step discharge test. The aquifer test spanned a period of 72 hours and a

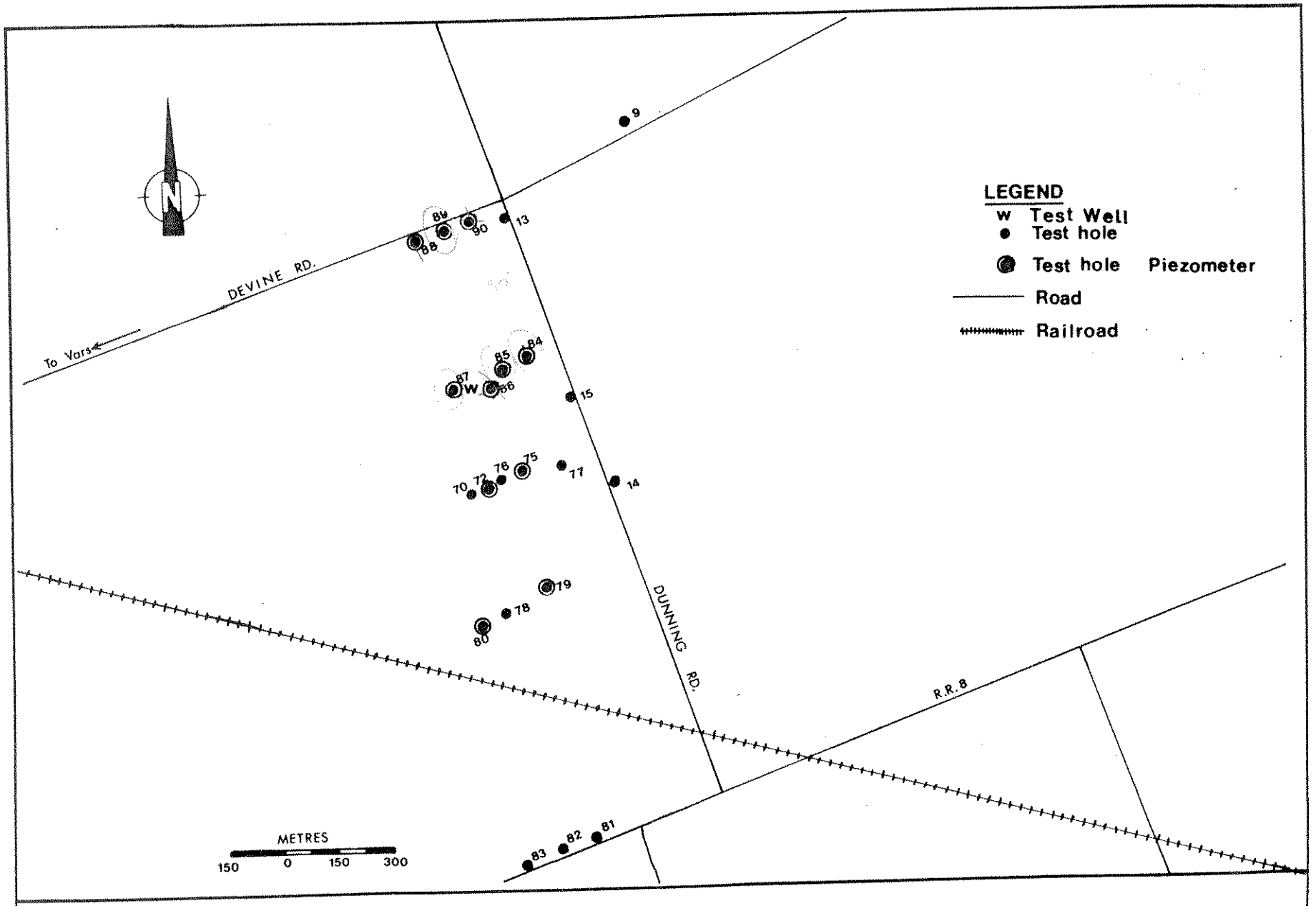

FIGURE 2
MONITORING NETWORK MAP

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FIGURE 3

RECORD OF TEST HOLE

DESIGNATION: TW1

COMPLETION DATE: September 25, 1987

PROJECT: VARS COMMUNAL WATER SUPPLY

PROJECT NO.: 1293

DRILLING METHODS: CABLE TOOL

SUPERVISOR: TAMI SUGARMAN

DRILLING CONTRACTOR: OLYMPIC DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0					Suction Bailer		
0.61		SAND - Silty, fine grained					
2		SILT AND CLAY - Grey green silt and grey clay, fine grained sand present in first few metres		Cement grout between 30 cm and 20 cm casing			
4						Sample 1	54.8-6.1 m
6							
8						Sample 2	9.75 m
9.75							
10		CLAY AND GRAVEL - granule and pebble gravel with silt and clay matrix; minor sand				Sample 3	10.97m
10.97						Sample 4	11.48m
12		GRAVEL - coarse grained sand, loosely packed with granule and pebble sized gravel (rounded to subrounded). At 11.9-12.2 m cobble sized gravel is encountered; silty matrix near top of gravel, gradually silt matrix decreases with depth				Sample 5	11.9 - 12.2 m
						Sample 6	13.1 m
14						Sample 7	13.7 m
						Sample 8	14.6 m
						Sample 9	15.4 m
16				20 cm (8")		Sample10	16.76m
						Sample11	17.7 m
18						Sample12	18.2 m
18.28		GRAVEL - granules and very coarse grained sand with rounded to subrounded pebbles and cobbles (10-12 cm in diameter). No silt matrix.		2.4 m (8') of 100 slot screen (19.7 cm 7 3/4")		Sample13	19.8 m
20						Sample14	20.7 m
				19.7 cm (7 3/4")		Sample15	21.9 m
22							
22.2		TILL - very hard competent till and boulders. End of hole at 22.2 m (73 ft.).					
24							

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constant discharge of 26.5 l/s (350 IGPM) was maintained throughout. The drawdown of piezometric levels in the pumping well and 11 monitors was measured by means of an electric tape.

The recovery of the system was continually monitored for 24 hours after the pump was shut down. Water levels were checked once more at the 42 hour mark after the pump was shut off. The drawdown and recovery data are contained in Appendix C-1.

The chemical and bacteriological quality of the water was monitored during the course of the constant discharge aquifer test. Samples were obtained at regular intervals by established protocols. Samples for bacterial analysis were submitted to Kopp Labs of Ottawa and the Ministry of Health Laboratory. Samples for chemical analyses were submitted to Bondar-Clegg and Company of Ottawa. Other water quality parameters such as pesticides, herbicides, PCB, volatile organics GC/MS (US EPA 624) and total phenolics were analysed by Mann Testing Inc. of Mississauga Ontario. Completed analytical reports are contained in Appendix D-1.

A draft report was prepared and submitted in 1987 to the M.O.E. Regional office in Kingston for review.

Work on this project was reinitiated in April 1990 at the request of McNeely Engineering Ltd. Phase IIb of the study involved the re-pumping of the water supply test well to collect water samples for the treatability test program and to address water quality concerns identified by the Ontario Ministry of the Environment (MOE) in their report review dated March 23, 1988 and in telephone conversations with the M.O.E. Regional office in Kingston in May of 1990 (pers. comm. Mr. Frank Crossley, see Appendix E).

In May 1990 the test well was pumped at the design discharge of 26.5 l/s (350 IGPM) for a period of 72 hours. The drawdown of piezometric levels in the aquifer was measured with an electric tape in the pumping well and four of the monitoring piezometers. Physical analysis of the retest was restricted to a brief comparison between the 1987 and the 1990 data and was completed to ensure consistency in the performance of the aquifer (drawdown data are contained in Appendix C-2).

A strict quality assurance and quality control (QA/QC) program was followed during this phase of sampling to alleviate difficulties previously observed in the water quality data. A submersible pump was used for pumping the well. All equipment was precleaned before installation. Teflon tape was used on all connecting joints of the discharge pipe. Duplicate samples were collected at each sampling interval and triples were collected at the 72 hr interval. All bottles and caps were rinsed 6x with

sample water before the sample was collected. All samples requiring pretreatment were prepared under controlled conditions the laboratory. A complete analytical suite as stipulated on Tables 1, 1A, 2, and 3 (MOE, 1984) were undertaken with a number of additions. In addition to the analysis of trihalomethanes, as required by the MOE, additional analyses for volatile organic compounds (VOC) were undertaken. The USEPA 624 sampling and analytical protocol was followed for the VOC's.

One complete suite of analyses, including VOC's, were provided by Areco Canada Inc. of Nepean, Ontario. Interlaboratory quality control checks were conducted on duplicate samples taken at the 72 hr sampling episode for Ur, Fe, colour, turbidity, TOC, bacti, phenol and analyzed at Accutest Laboratories of Nepean. A duplicate VOC sample was sent to Novalab in Lachine Quebec. Travel blanks were prepared and shipped with all samples. Complete analytical reports are contained in Appendix D-2.

3.0 *RESULTS*

3.1 Topography and Drainage

The glaciofluvial complex in the study area is completely buried in most areas, and has no surface relief except near testhole 78, where a slight rise is noted. Where the sands and gravels reach the surface along the crest of the deposit, recharging precipitation is able to infiltrate rapidly into the underlying permeable formation. However, most of the sands and gravels (on the flanks) are overlain by a clayey silt unit and prevents infiltration of precipitation. The glacial fluvial deposit is drained on its western edge by the north/south oriented Devine Drain. The Brady drainage ditch cuts across the study site about midway between the Devine Rd. and Regional Road # 8 at test wells 70 and 71 and appears to flow southeast. A second ditch begins on the southwest side of the complex and cuts northeastward to the deposits eastern edge near the road.

3.2 Geology

The study area is underlain by Paleozoic bedrock of the upper Ordovician period described by Wilson (1946) as the Carlsbad Formation. The formation consists of layered bioclastic limestone which is medium grey colour on freshly broken surfaces and buff to reddish brown on a weathered surface.

The water in this unit is characteristically sulphurous and exhibits elevated concentrations of iron.

The bedrock in the study area is overlaid by a succession of Wisconsinian Epoch glacial, glaciofluvial and glaciomarine unconsolidated sediments. A clayey sandy, calcarious compact till directly overlies the bedrock throughout the study area. This unit is fairly thin, with the maximum thickness of 1.6 m at test well 72.

Melt water derived glaciofluvial deposits were deposited by the receding glacial ice. These deposits are oriented north-south and appear as esker and buried esker morphologies at at least five locations in this part of the province. These deposits are being utilized or are destined to be used as municipal water supplies at at least four locations in eastern Ontario. The Vars study area lies on one such esker deposit which is believed to be a continuation of the same unit identified at Sarsfield and Leonard, and it appears to extend across the Highway 417 into the County of Russell. The water supplies for the municipalities of Embrun and Chesterville are developed into this unit to the south. The distances between the centres of pumping of these water supplies are large enough that interference is not considered to be an issue. The complex varies between 15.2 m and 30.5 m in width, and has an average thickness of 23.8 m in the study area.

The esker body appears to be coarser grained along the main axis but shows significant but less transmissive connection to sand deposits flanking the main core or axis of the deposit. The most transmissive part of the water bearing unit appears to have an average saturated thickness of 13 m. The deposit reached its maximum thickness near the test hole, at 21.6 m (78 ft). The base of the unit lies on a relatively impermeable basal till. The upper surface of the esker outcrops in only a few places and is usually covered by a clayey silt unit. This impermeable unit acts as a barrier to surface contamination, yet also results in reduced recharge capabilities.

The esker is bounded on both sides by a silty glaciomarine clay deposit of Champlain Sea origin. This unit characteristically has a low permeability. The entire complex is overlain by a variable thickness of fine to medium grained silty sand. This is described as a regressive sequence by Terasmae (1965) and is made up of material derived from higher topographic sites in the area through water washing and winnowing by the Champlain Sea. The sand reaches a thickness of up to 5.5 m at test hole 87 on the Bray property.

3.3 Physical Hydrogeology

The background geological and hydrogeological appraisal (Phase 1 Activities) identified two areas with water supply potential. Both of these areas were located in the glaciofluvial deposits east of Vars. The deposit to the southeast of the

village and south of the Devine road was selected as the primary drilling target for Phase 2, the detailed hydrogeological assessment.

3.3.1 Test Drilling

Test drilling results indicated that a narrow 15 to 30 metre wide body of esker sands and gravels were present south of the Devine Road approximately 3 km east of the village of vars (Figure 2). The narrow width of the deposit was compensated for by a significant thickness on the order of 20 metres at the proposed test well site. The sands and gravels outcrop along the axis of the esker and thereby present some significant recharge potential especially to the north of the proposed test well site.

The core of the esker body provides a high transmissivity pathway for recharge derived from areas to the north and south of the test well site. The less permeable sands flanking the main esker body serve as recharge and storage reservoirs for the system. A plot of the thickness of the water bearing deposit is shown in Figure 4.

3.3.2 Aquifer Testing - 1987 Program

Step Discharge Test

The results of the five step, step discharge test indicate that the test well, although not particularly efficient, was capable of producing test flows in excess of the proposed design flow of 11.3 l/s (150 IGPM). Data and calculations after Jacob-Rorabough are contained in Appendix B. Results of this imperial method were unsatisfactory at a discharge of 26.51 l/s (350 IGPM). An efficiency of 5.5 % was calculated for a discharge of 26.51 l/s. This does not correspond to the observed drawdown or the efficiency calculated by other more direct means. A calculation of well efficiency obtained from a comparison of the theoretical versus the actual drawdown yielded an efficiency of 37.7 % at a discharge of 26.51 l/s at 72 hours. This value is also believed to be very conservative given the bounded nature of the aquifer.

Constant Discharge Aquifer Test

The test well was pumped at a discharge of 26.51 l/s (350 IGPM) for a period of 72 hours. Data and Calculations are contained in Appendix C. Results of calculations of the aquifer hydraulic parameters are contained on Table 2.

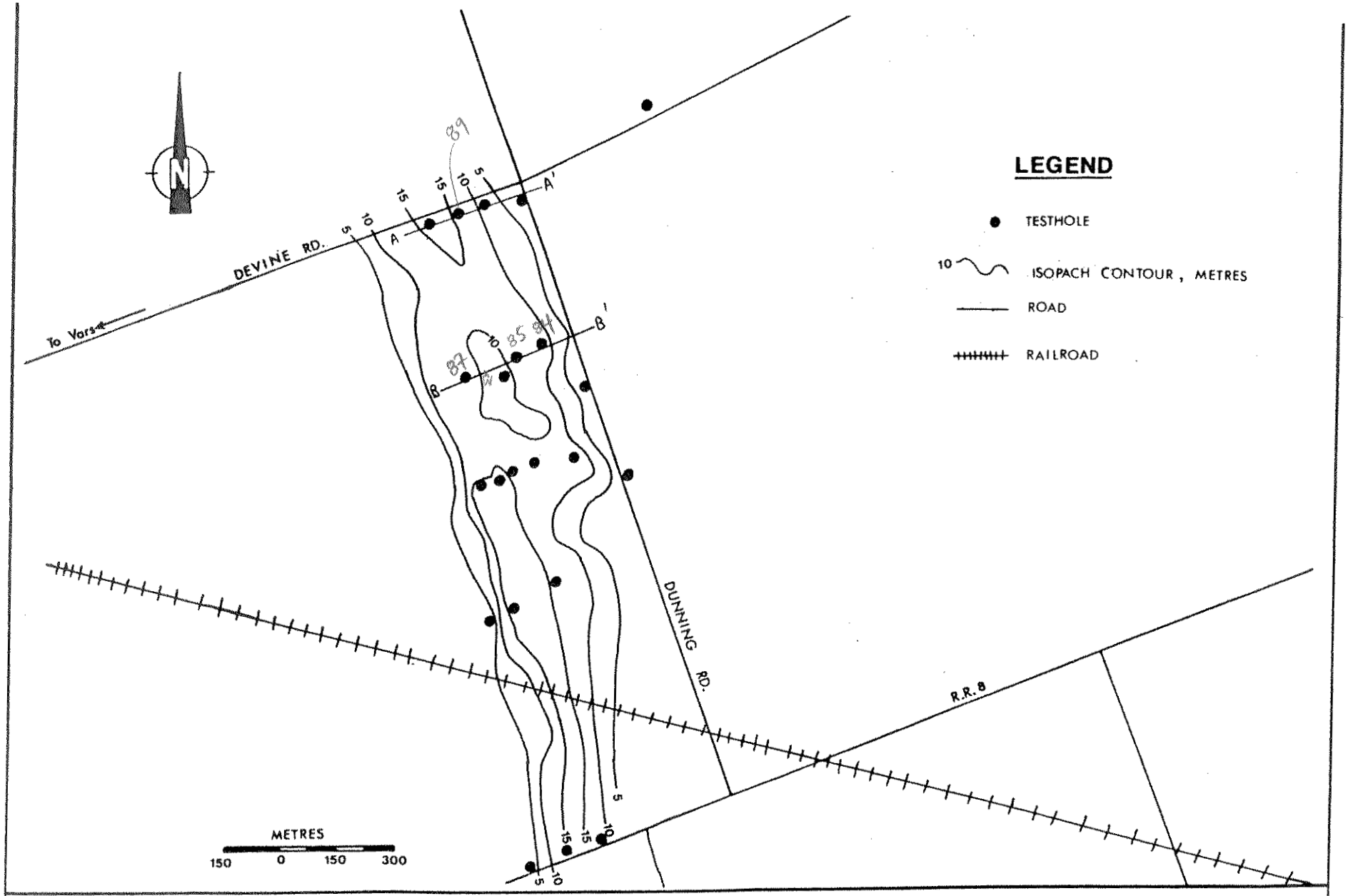

FIGURE 4
ISOPACH THICKNESS MAP OF WATERBEARING ZONE

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TABLE 2: AQUIFER PARAMETER SUMMARY

	radial distance from pumping well (m)	Transmissivities (m^2/day) Jacob Drawdown	Jacob Recovery	Storativity (dimensionless) Jacob Drawdown
TW1	0.1	806.4	1233.3	--------
TH87	3.5	822.2	1148.8	11.8
P72	277.5	1326.9	901.8	5.25×10^{-3}
P88	435	1075.0	-----	1.09×10^{-2}
P89	450	814.2	1198.0	1.38×10^{-3}
P80	667	814.2	1270.6	1.6×10^{-3}

Examination of the drawdown curves and the calculated storativities indicates that the aquifer behaves hydraulically as a confined unit with significant negative boundary conditions. The boundary condition effects are most likely felt in very early time given the high transmissivities found in the aquifer core and the short distances present. Calculated storativities on the order of 1.5 X 10-3 appear to be representative. Measurable drawdowns were recorded in piezometers at large radial distances from the pumping well immediately after the start of pumping. This is indicative of a high transmissivity medium. Hydraulic response of the piezometers located outside of the highly transmissive core of the esker is slower but non the less shows hydraulic connection to the core. This connection is delayed, and in the case of the transition from pumping to recovery the heads in these piezometers never do catch up to the drawdown in piezometers developed into the transmissive core of the deposit. A transmissivity on the order of 1000 m2/day was calculated for the transmissive core of the esker deposit, and used for later calculation of long term yield and well interference.

Aquifer Recovery Test

Water levels were observed and recorded for a 24 hour period at the conclusion of the 72 hours of continuous pumping of the aquifer. The same observation points as those used during pumping were employed. Heads in the aquifer recovered in the vicinity of the test well to within 0.5 metres of the original static condition with in this time period. Recovery in the piezometers located off the axis of the esker showed either no recovery or a recovery that was time lagged. This was in response to a transient head condition in the less permeable deposits during the latter stages of pumping and continued drawdown in these materials during recovery. The transmissivities calculated from the recovery data are significantly higher that those derived from the drawdown test in the pumping well. This discrepancy is attributed to the effects

of well efficiency. The recovery data also exhibits less influence from the negative boundary conditions experienced during the pumping phase of the program.

3.3.3 Aquifer Testing - 1990 Program

The static measurements in the pumping well and the four observation wells were recorded prior to the start-up of the pumping test. The step test and recovery test was not repeated. A monitoring program consistent with the previous testing interval was established in the pumping well during the continuous discharge test. Observation wells were monitored at regular intervals. The results can be found in Appendix C-2. Table 3 is a summary of the physical test data.

TABLE 3: 1990 DISCHARGE TEST DATA

Well	Static (M)	72 hr Reading (M)	Drawdown (M)
TW1	3.47	4.90	1.43
OW87	3.18	4.10	0.92
OW85	3.82	4.38	0.56
OW84	3.94	3.99	0.05
OW89	3.94	4.72	0.78

Figure 5 represents the log time versus drawdown plot for the pumping well (TW1) data. An overlay of this plot on the 1987 data (Figure 6) reveals that the hydraulic response of the aquifer was comparable for both continuous discharge tests. The static level recorded in the 1990 test was higher due to seasonal variations in the piezometric surface.

3.4 Groundwater Quality

An assessment of water quality was completed at the end of the 1987 pumping program. The results of the analysis are recorded below. The request for an analysis of the treatability of the water supply necessitated the test well be repumped in May 1990. At that time additional water samples were collected in order to re-test the concentrations of specific geochemical parameters of concern as requested by the Ministry of the Environment.

FIGURE 5: Jacob Curve - 1987 Discharge Test

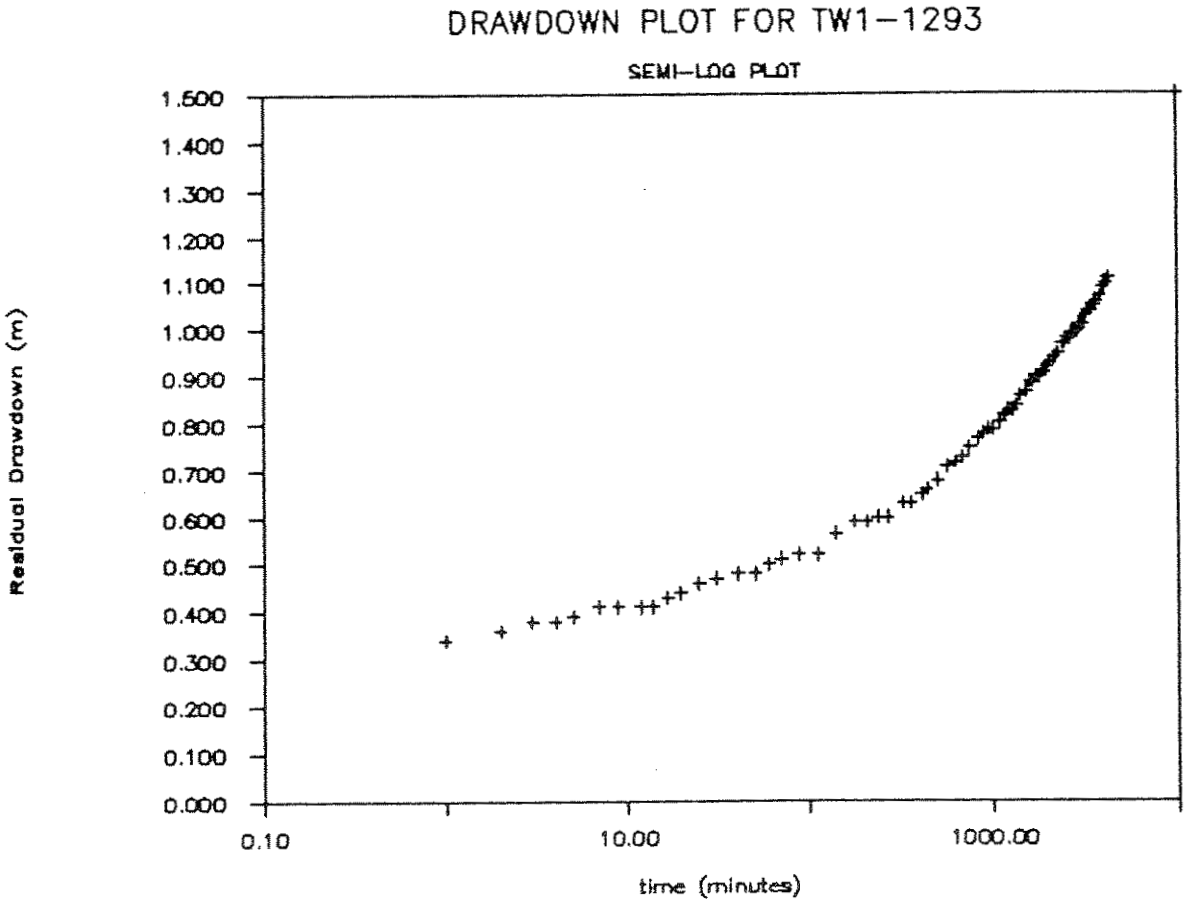
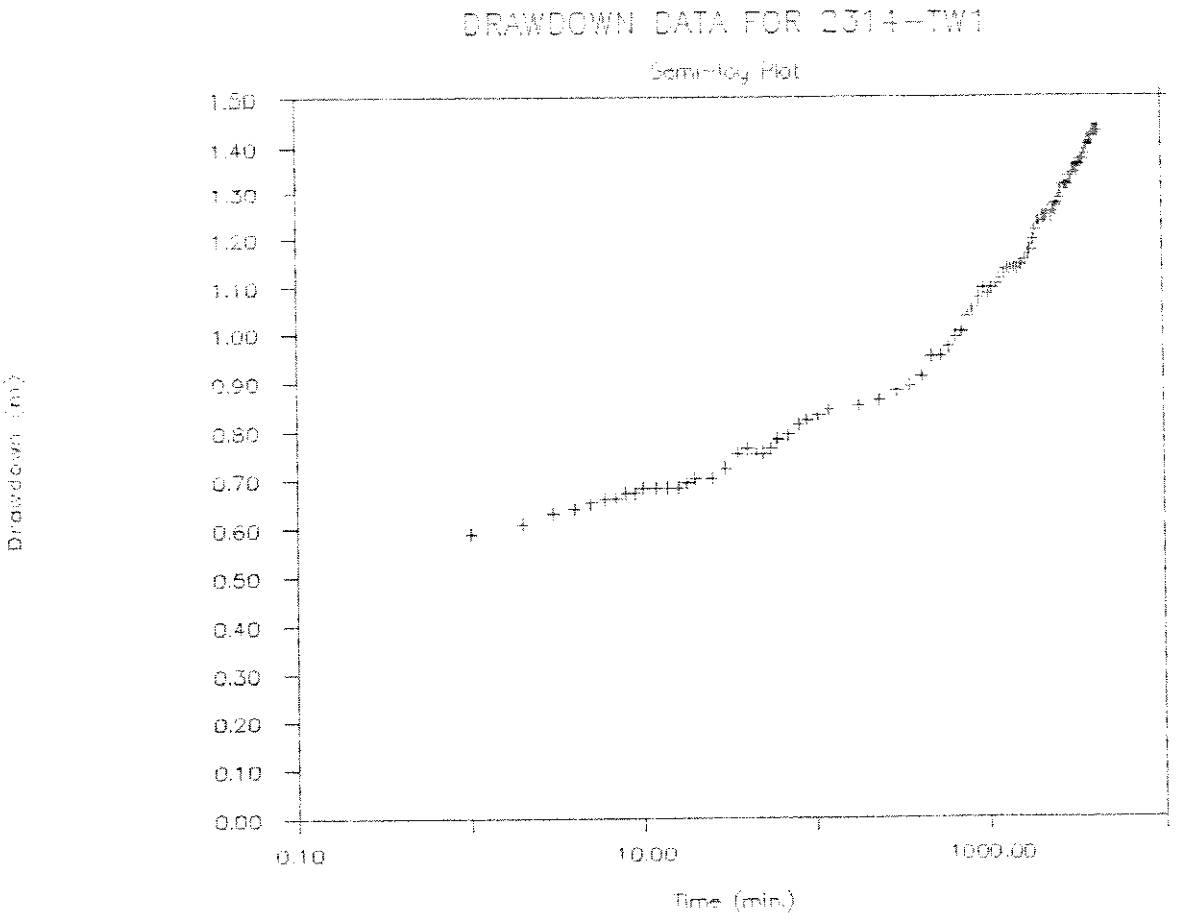
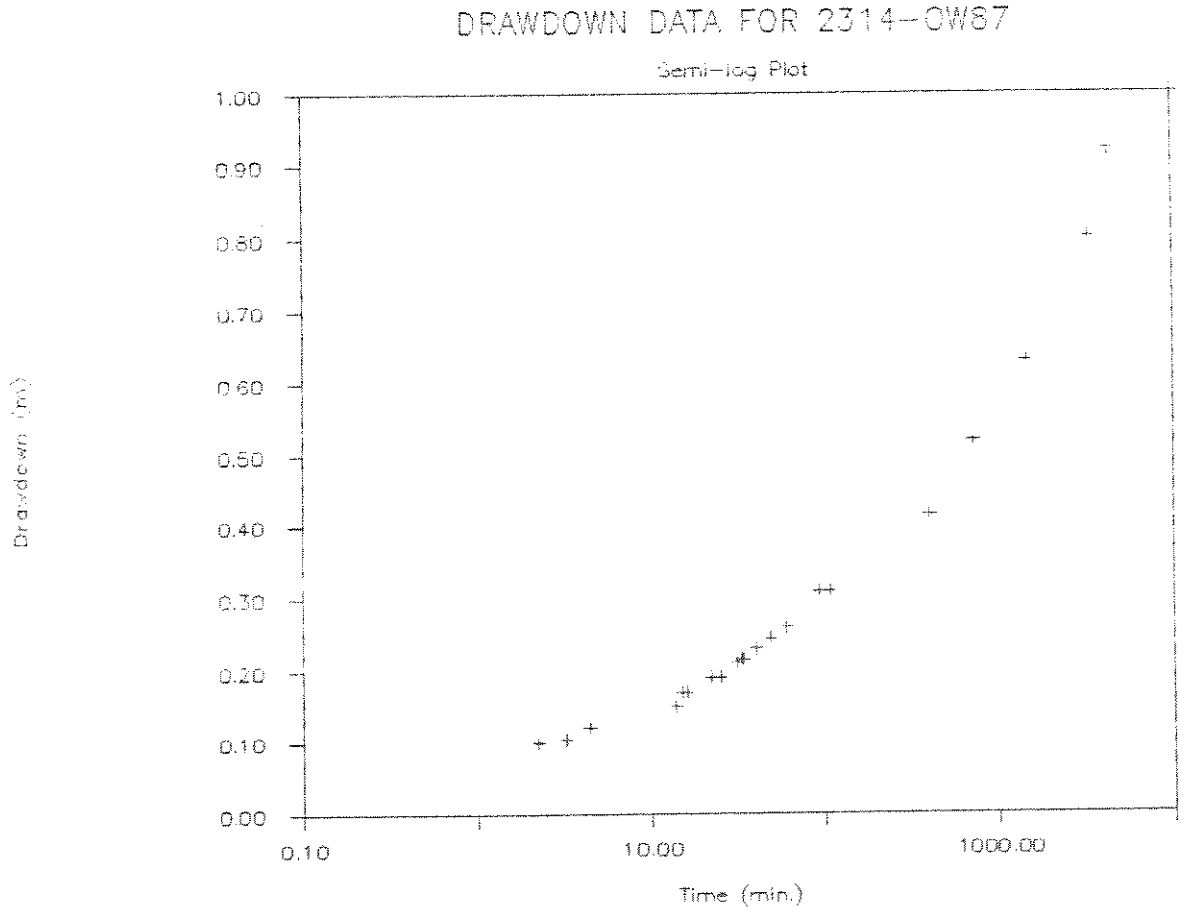


FIGURE 6: Jacob Curve - 1990 Discharge Test





3.4.1 Chemical Quality Test Program - 1987

The following water samples were sent to the indicated labs for analysis:

Bondar Clegg and Company Ltd., Ottawa

- major ions: 12,24,36,48,60,72 hour and pond water
- trace metals: 12,24,36,48,60,72 hour
- phenols: 24,48,72 hour
- radionuclides: 72 hour

KOPP Clinical Laboratories, Ottawa

- bacteria: 24, 72 hour and pond water

Ministry of Health Labs

- bacteria: 24,48,72 hour

Mann Testing Laboratories

- volatile and non-volatile organics, pesticides and USEPA 624, 625 priority pollutants: 72 hour

All analytical reports for the analyses performed are contained in Appendix D-1 and are summarized in Table 4 below.

TABLE 4: MAJOR ION AND TRACE METAL GEOCHEMISTRY SUMMARY

All values are in ppm unless otherwise noted.

Parameter	12 hour	24 hour	36 hour	48 hour	60 hour	72 hour
pH	7.96	8.09	8.08	8.01	8.03	7.93
Ca	45	45	40	42	42	43
Mg	9	9	8	9	8	8
Na	17	17	17	17	17	17
K	2	2	3	3	2	2
Ba	0.34	0.35	0.32	0.31	0.31	0.28
Hardness	150	150	133	142	138	141
Cl	3	3	3	2	2	2
SO_4	2	2	3	2	2	2
Alk	160	157	164	163	163	161
F	0.21	0.20	0.20	0.20	0.20	0.20
PO_4	0.10	<0.10	0.10	<0.10	0.10	<0.10
As	<0.01	0.01	0.01	0.02	0.02	0.02
B	0.04	0.04	0.05	0.05	0.05	0.06

$N-NH_3$	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
$N-NO_3$	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
$N-NO_2$	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
H_2S		<0.10		<0.10		<0.10
CN	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Phen		<0.002		<0.002		<0.002
Total Fe	0.53	0.50	0.50	0.53	0.49	0.48
Mn	0.05	0.05	0.04	0.04	0.04	0.05
Zn	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
U*	<0.01	<0.01	0.80	0.75	0.70	0.70
Se	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cd	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ag	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Hg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TDS	210	213	207	201	194	184
Cond(umhos)	300	300	320	300	290	290
Colour(UNT)	25	21	16	18	12	15
Turb (NTU)	1.5	0.9	1.2	1.7	1.6	1.6

*U - values in ppb

	Ca	Mg	Na	K	Alk	Cl	SO_4	Tot Fe	$N-NH_3$	$N-NO_2$	TDS
Pond Water	12	3	2	1	37	1	9	0.22	<0.10	<0.10	67

Bacteria

All bacteria samples tested negative for indicator types with the exception of the sample obtained from the pond which had a total coliform count of 53 col/100 ml.

Volatile Organics

The volatile organics scan revealed the presence of the following compounds:

- chloromethane
- dichloromethane
- trichlorofluoromethane
- chloroform
- benzene
- toluene
- ethyl benzene
- P & M xylene
- O-xylene

Dichloromethane, chloroform and benzene were, however, also detected in the lab water blank. As these constituents are measured at part per billion levels, it is not unusual for samples to erroneously register positive results. All of the above parameters are at concentrations just above minimum detection limits and are well below MOE water quality objectives.

Pesticides and Herbicides

All samples tested 'not detected' for pesticide and herbicide analysis.

3.4.2. Chemical Quality Test Program - 1990

Water samples were collected for analysis at 1, 6, 12, 24, 48, and 72 hr intervals. Areco Canada Inc. laboratories of Nepean conducted the analysis for the complete communal water well suite as well as the USEPA 624 suite for volatile organic compounds (VOC). The parameters analyzed for at each of the sampling intervals are listed below.

1 hour sample

hardness	ammonia
alkalinity	TKN (Total Kjeldahl nitrogen)
iron (total)	nitrate
chloride	nitrite
pH	sulphate
fluoride	phenols
conductivity	sulphide gas
sodium	turbidity
calcium	TOC
potassium	uranium
magnesium	colour

BTXe
Bacti (Tot. col., Faecal col., Faecal strep., background)

6, 12, 24, and 48 hour samples

uranium
colour
turbidity
TOC
BTXe
H_2S

72 hour sample

arsenic	barium
boron	cadmium
chromium	cyanide (free)
fluoride	lead
mercury	nitrate (as N)
nitrite (as N)	nitrilotriacetic acid (NTA)

Pesticides
- aldrin + dieldrin
- carbaryl
- chlordane
- DDT
- diazinon
- endrin
- heptachlor + heptachlor epoxide
- lindane
- methoxychlor
- methyl parathion
- parathion
- toxaphene
- 2,4-D
- 2,4,5-TP

Radionuclides
- cesium-137
- iodine-131
- radium-226
- strontium-90
- tritium

selenium
silver
turbidity
bacti suite
polychlorinated biphenyls
uranium
H_2S gas
chloride
colour
copper
iron
manganese
methane
odour
organic nitrogen
phenols
sulphate
sulphide
taste
temperature
total dissolved solids
total organic carbon
zinc

VOC's as per (USEPA Method 624)

Analytical reports from the respective laboratories are contained in Appendix D-2. A summary of the parameters that were of concern to the Ministry of the Environment are shown in Table 5 below. All values are reported in ppm unless otherwise noted.

TABLE 5: 1990 GEOCHEMICAL SUMMARY

Parameters	1 Hr	6 Hr	12 Hr	24 Hr	48 Hr	72 Hr
Fe	0.738	N.A.	N.A.	0.716	0.741	0.008(f) 0.731(u)
Turb. (NTU)	6	6	6	5	5	5
colour (UNT)	25	21	23	25	25	25
H_2S (ppb)	0.107	0.097	0.070	0.067	0.008(np)	0.066
U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TOC	5	6	7	6	6	5
Benzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ethylbenzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
m,p-Xylene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
EPA 624	N.A.	N.A.	N.A.	ND	N.A.	ND

Quality Control Test Results - 72 Hr. Sample

Novalab, Lachine Quebec
EPA 624 ND

Accutest, Nepean Ontario

Fe (Tot.)	0.67 (f)
phenols	<0.002
Turb. (NTU)	<1.0
colour (UNT	32
Ur (ppb)	<0.01
TOC	5.7

(f) - filtered sample
(u) - unfiltered sample
(np) - sample not pretreated with preservative
N.A. - not analysed
ND - not detected

A discrepancy in the filtered Fe (Tot.) results warranted a retest on the sample duplicates. The samples from the 1Hr, 6Hr, 12Hr, 48Hr, and 72Hr sessions that had been filtered and acidified on site were split. One half of the sample was sent to the Areco Canada Inc. laboratory and the remaining half was delivered to the Accutest Ltd. laboratory. The results are as follows;

Laboratory	1HR	6HR	12HR	48HR	72HR
Accutest(ppm)	0.69	0.73	0.73	0.72	0.72
Areco(ppm)	0.395	0.260	0.278	0.233	0.240

The Areco Canada Inc. results are within M.O.E. water quality objectives where as the Accutest Laboratories Ltd. data are slightly above the ministry objectives.

4.0 DISCUSSION OF RESULTS

4.1 Water Supply Potential

The glaciofluvial complex situated east of Vars appears to satisfy three of the hydrogeological conditions necessary to meet the water supply demands of the community. These points are listed below and described in subsequent sections.

- The local transmissivity will provide sufficient flow of groundwater to a production well developed at the test well site.

- The water can be extracted by a conventional well design.

- There appears to be a sufficient aquifer extent with associated recharge area to provide for a long term supply.

The aquifer is capable of producing a short term yield to a series of production facilities in excess of the 26.51 l/s (350 IGPM) at which it was tested. The theoretical aquifer yield calculated for the test well is on the order of 68.18 l/s (900 IGPM) over a 20 year design life. The detailed calculation is contained in Appendix F. This estimate is conservative and does not account for seasonal variations in recharge. The aquifer is capable of transmitting this volume of water down its length under an imposed gradient from a production well. The production well would derive recharge from both the north and the south as well as leakage from above and the less permeable bounding deposits.

The 1990 pump test induced a similar hydraulic response in the aquifer as the 1987 test.

4.2 Well Interference

Calculations of well interference are contained in Appendix F. The results, shown in Table 6, indicate that at 1000 metres from a potential production site, an interference of 0.67 metres would be anticipated at a production rate of 11.36 l/s (150 IGPM). This calculation is based on the assumption that both the pumping well and the well that is potentially subject to interference are screened through the same hydrostratigraphic unit. Wells east and west of the esker do not fulfill this condition.

Little significant depression of groundwater piezometric surfaces in the aquifer outside of the immediate area of the well head is forecast. No impact on adjacent water supplies is expected.

TABLE 6: WELL INTERFERENCE RESULTS (IN METRES)

Radius (M)	150 IGPM	300 IGPM
100	1.03	2.06
500	0.78	1.56
1000	0.67	1.34

Table 7 contains the well drilling and pumping data from wells within 1 km of the Test Well site. Most of the residences and farms in the area draw water from the bedrock aquifer. Overburden wells are often unreported and do not appear in the M.O.E. A survey of wells in the immediate area revealed that a number of shallow dug wells have been developed into the sand unit overlying the clay silt aquitard. This shallow unconfined aquifer would not appear to be hydraulically connected to the water supply aquifer into which the test well is developed. No interference is anticipated. No complaints were received from surrounding property owners during either pump tests.

4.3 Groundwater Quality

The geochemical data listed in Table 5 meets the MOE drinking water objectives for all parameters except for colour, turbidity and iron.

The elevated colour concentrations detected are not uncommon for this type of glaciofluvial deposit, especially those located close to a surface water body in a forested area. This is especially true when the environment is reducing as indicated here. It is believed that colloidal iron is the source of the colour and is associated with the organic components found in the water as indicated by the TOC. The colour turbidity and iron may most likely be removed by treatment. The type of treatment and its cost effectiveness may best be appraised by a complete treatability analysis. An extensive treatability testing program was conducted on the water supply during the Phase III study. The results and conclusions of that study are discussed in a separate report.

To aid in the final well design, the groundwater chemistry results were used in an adapted equilibrium-based speciation model. The model determines the corrosivity or

TABLE 7: MOE WELL DATA

WELL	CON	LOT	EASTING	NORTHING	SURFACE ELEV	DRILL DATE	CSG DIA	KIND OF WATER	WATER FOUND	STATIC LEVEL	PUMPED LEVEL	TEST RATE	TEST TIME	WATER USE	OWNER GEOLOGIC LOG	DEPTH OF OVBDN	DEPTH OF WELL
1	4	25	475030	5022840	255	03/55	4	FR	70	14	18	4	1/00	ST	FAUBERT A WHIT CLAY 43 SHLE 84	43	84
2	4	25	476030	5023680	250	09/71	5	FR	66	25	50	10	1/00	DO	D'AOUST ANDRE YLLW TPSL 18 BLUE CLAY 50 BLCK GRVL MSND 60 BLCK GRVL 62 BLCK ROCK 67	62	67
3	4	28	475650	5021325	245	04/55	4	FR	88	0				STDO	FAUBERT T WHIT CLAY 23 BLCK SHLE 88	23	88
4	5	26	473910	5022275	250	01/67	5	FR	69	20	55	5	1/00	DO	THIELE B MSND 15 CLAY 35 GRVL 48 BLCK SHLE 71	48	71
5	5	26	474050	5022390	250	10/62	4	FR	40	5	9	3	2/00	DO	ST LOUIS H CLAY TPSL 20 SHLE 48	20	48
6	5	26	474060	5022340	250	08/65	5	FR	60 66	22	32	5	1/00	DO	GAGNE C MSND 6 CLA7Y 38 GRVL 38 SHLE 67	38	67
7	5	26	474100	5022400	250	09/62	4	FR	40	6	9	3	2/00	DO	LAVIGNE A CLAY TPSL 19 BLCK SHLE 46	19	46
8	5	26	474100	5022400	250	09/62	4	FR	43	5	9	3	2/00	DO	LANTHIER H CLAY TPSL 11 BLCK SHLE 45	11	45
9	5	26	474240	5022400	250	10/66	4	FR	70	10	70	10	0/30	STDO	ST LOUIS F TPSL SAND 15 QSND 40 BLUE CLAY SAND 60 SAND GRVL 69 ROCK 88	69	88
10	5	28	475500	5021325	250	06/72	6	FR	155	15	160		1/00	CO	INNES D YLLW SAND 4 GREY CLAY 23 SAND 72 GRVL SAND 73 SHLE 160	73	160

scaling potential of water pumped from the well. It therefore has implications for the life of the well screen. The results of a model run are shown in Appendix D-1. Calculations indicate that the water is mildly corrosive with a Ryznar Index of 7.7. The model also indicates that the pumped waters are supersaturated with respect to calcium carbonate and some minor encrustation is expected to occur on the well screen.

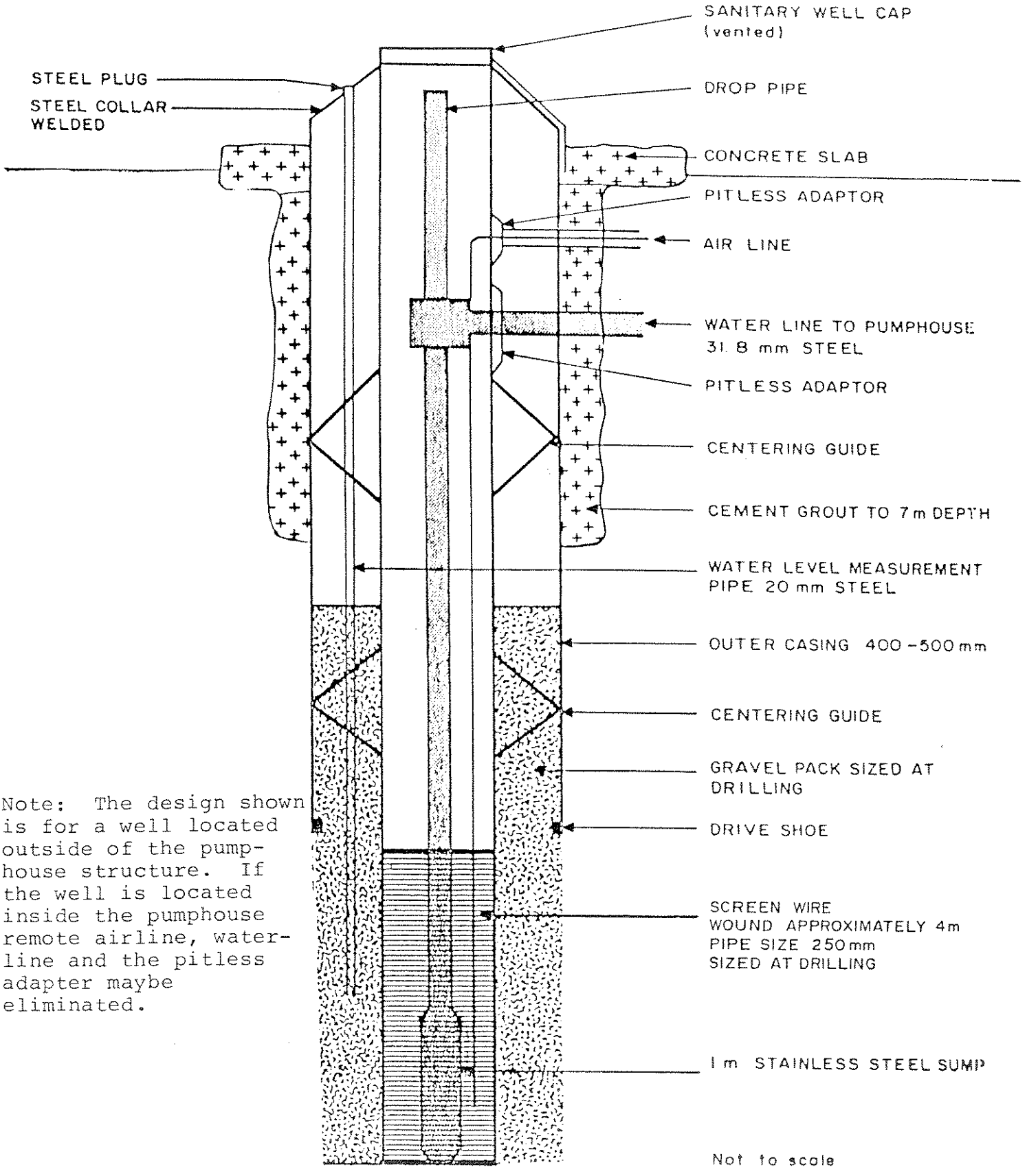
A review of potential conflicting land uses was undertaken during the course of the investigation. Features such as landfills, sewage lagoons and major transportation routes and other point sources of contaminants were identified. The most significant source of contamination in the area was identified as a small scale farming operation located south of the site. Most of the activities which are associated with water supply contamination are located on the flanks of the esker deposit and therefore isolated by the impermeable clay silt materials. Information to date suggests that, as a result of the hydrogeologically favorable location of the site, no significant conflicts are expected.

Some limited land use control should be exercised by the municipality to protect the well head area. This is generally referred to in the hydrogeological literature as a "well head protection zone". The mechanism by which a municipality institutes such a recommendation may be decided by the municipality in conjunction with their planners. These types of measures are more prevalent in the United States than in Canada and a search for precedent may prove to be valuable.

5.0 PRODUCTION WELL DESIGN AND WELL MAINTENANCE

Information obtained during the drilling, aquifer testing, and geochemical analyses of the groundwater from the test well were used to formulate the final production well design.

The test well was a natural gravel packed well and required 16 hours of developing. A well efficiency of 37.7% at a pumping rate of 26.52 l/s (350 IGPM) was calculated. However, for the production well, a large diameter 250 mm well is preferred. A number of alternatives are available for this well. An artificial gravel packed well (500mm X 250mm) well is preferred in areas where the formation is interbedded. Such a design incorporates a rounded silica gravel pack, sized to the formation, between the 500 mm hole and the 250 mm stainless steel screen. Such a design would be capable of producing in excess of 26.52 l/s (350 IGPM) at a high efficiency. The proposed well design is included in Figure 7.



Note: The design shown is for a well located outside of the pump-house structure. If the well is located inside the pumphouse remote airline, water-line and the pitless adapter maybe eliminated.

FIGURE 7

PROPOSED WELL DESIGN

It is probable that the installation of a naturally developed well screen is technically feasible at this location. This type of design is less expensive, tends to be more easily developed and if properly designed may be expected to perform as efficiently over the long term as a gravel packed well. Details of the completion are similar to the gravel pack well with the exception of the elimination of the gravel pack and the requirement for different screen design criteria and much more rigorous aquifer material textural and grain size testing. A multi slot size screen design is often the result. MOE policy may restrict the use of this type of well design in a Southern Ontario application.

Regardless of the well design chosen, the final production well may be incorporated into a pump house with a shaft line turbine pump and surface motor or, alternatively, it can be installed outside the pump house and treatment facility if submersible pumping equipment is used. The standby well may be also completed as a stand alone facility if completed with an electrical submersible pump, pitless adapter and above ground vented well head. Baker manufactures such a protective well cap. Minor modification to the existing test well will bring it up to standard.

The final design of the well screen is dependant on the hydrogeological conditions at the production site. This information is only determined at the time of drilling.

The water quality results indicate that in-well chlorination and treatment may be necessary. Precipitates will, with time, accumulate and reduce the overall performance and efficiency of the well. The maintenance program recommended for the production well should most likely include periodic acidification, followed by chlorination to remove precipitates. Maintenance should be undertaken by a qualified well driller/pump installer.

The maintenance schedule should be based on records of well efficiency and specific yield. The latter two factors will be calculated from weekly record of drawdown in the production well and proximal piezometers obtained by the pumping station maintenance staff or an automated system. The measurement water levels should ideally be conducted at the same time and the same day of every week, in order that demand side induced fluctuations in the system may be minimized. Data collected will also be useful in the appraisal of system expansion potential.

Care should be taken that the proper chlorine and acid concentrations are maintained during the cleaning process. Hackett and Lehr (1985) have suggested a free chlorine concentration of between 300 and 500 mg/l over an 18 hour contact time

was effective at killing iron bacteria. A 28% hydrochloric acid is also recommended. Hackett and Lehr (1985) also recommend that the chlorinated water be forced out into the aquifer to ensure proper cleaning of the formation around the well. A surge block will effectively force the water out and also help to physically break up the precipitates. Design of a maintenance schedule will be possible at the conclusion of the first year of operation.

The test well should be modified for use as a standby production well. This will include redevelopment, grouting of the casing and connection and minor well head modifications. The well may or may not be located inside a pump house depending on the final design.

6.0 CONCLUSIONS

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

1. A sand and gravel glaciofluvial complex is present 3 km south east of the village of Vars. A test well was completed approximately 700 metres south of the Devine Road in this complex.

2. The Aquifer consists of a narrow band of glacio-fluvial sands and gravels that have been identified in Sarsfield and Leonard to the north and have been traced to Hwy 417 to the south. The Esker is believed to extend further south into Russell Township. A course sand and gravel core runs the length of the deposit and varies in thickness especially north of the site near the Henn pit. The deposit is very relatively thick in the vicinity of the test well. The core of the esker is flanked by a less permeable sand deposit and then by a clay silt unit which, in the vicinity of the test well, confines the aquifer.

3. The aquifer has a demonstrated ability to produce in excess of the 26.51 l/s (350 IGPM) design yield required. Phase 2 testing was conducted at a discharge of 26.51 l/s. Theoretical yields were calculated in excess of 68.175 l/s (900 IGPM). At this time a safe perennial yield of 26.51 l/s (350 IGPM) is projected.

4. Depression of the water table or piezometric surface occurs at the site of any major groundwater withdrawal scheme. In the case of the Vars well site, the interference effects will be limited due to the fact that few wells are located close to the site. Water table depression due to pumping will most likely be unmeasureable beyond a radius of 500 metres at the projected the projected early system discharge rate of 11.36 l/s. The impact of increased discharge rates is not anticipated to be significant over the long term, for a discharge of up to 26.51 l/s (350 IGPM). Discharges over and above these levels must be investigated further. Little if any interference on neighbouring farm and domestic water supplies is expected. If such interference does occur it may be easily remedied through either deepening of the well or repair or resetting of the pump.

5. Water quality in the aquifer is superior to that found near or under the village of Vars and is acceptable for public water supply as dictated by the MOE health related criteria (MOE Water Quality Objectives (MOE, 1984). Turbidity in the test well (if used as a standby pumping facility) will improve with additional development and pumping. Turbidity in the production facility is also expected to be below the objective. Constituents in excess of MOE water quality objects are aesthetic in nature and are easily treated either at source or at the end user. These constituents include colour and TOC. The former may be improved through methods discussed in the treatability report found under a separate cover.

6. There does not appear to be any potential groundwater contamination sources in the immediate vicinity of the proposed production site. This status should be monitored and possibly some form of land use control be investigated by the municipality. Any spills or potential conflicts should be reported immediately. Access to the well site should be controlled. A provincial system for the immediate reporting of spills already exists, and should serve as an early warning system for the production site.

7.0 RECOMMENDATIONS

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

1. The aquifer should be used to meet the long term water supply needs for the village of Vars, with a potentially wider service area at some time in the future. Expansion of the water supply requirements placed on the aquifer, beyond those stated, should be accompanied with appropriate investigations and testing prior to detailed planning. Data collected during the early operation of the wells may be used to this end.

2. A 500 x 250 mm artificial gravel pack production well or 250 mm naturally developed well should be installed close to the test well. A separation distance of 10 metres would be sufficient. The well could produce the required 26.51 l/s (350 IGPM). Short term flows that exceed the 26.51 l/s are expected from this arrangement if accommodated by the appropriate pumping equipment.

3. A predevelopment survey of all wells within a one kilometre radius of the production site should be undertaken. In the event of a perceived groundwater interference problem at a later time, the well in question should be examined thoroughly and a short report of the condition of the well should be compared to the initial survey. Rural based water supplies in other municipalities have been subjected to substantial criticism, and their ultimate potential reduced due to public opposition and perceived conflicts. The cost of repairing and even replacing allegedly affected water supplies is small in comparison to operating in an adversarial atmosphere.

4. A treatability study under separate cover (WESA, 1990) should be referenced regarding the feasibility and costs associated with treatment of the water supply.

Respectfully submitted,

Tami J. Sugarman B.Sc.
Hydrogeologist

Roger M. Woeller, M.Sc.
Hydrogeologist

APPENDIX A

Geological Logs

FIGURE	RECORD OF TEST HOLE	DESIGNATION VW7O	COMPLETION DATE 5-6-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		TOPSOIL; sandy silt loam		NOT INSTRUMENTED	GRAB		
1.2		SAND; fine grained with minor silt matrix (~ 15%)					
4		SILT; grey slurry, minor sand content					
9.1		SILT; silt slurry with clay matrix					
12.2		CLAY; silty clurry with lenses of sand					
13.7		SILT; silt slurry with clay					
15.2		End of hole @ 15.24 m (50 ft.) Water encountered at 1.2 m (4 ft.)					

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FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 72	5-6-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING		
					TYPE	INTERVAL	N VALUE
0					GRAB		
0.76		TOPSOIL; sandy laom SILT; sandy content		Piezometer placed at 23.2 m (76 ft.). Piezometer tip is 0.45 m of slotted pipe			
2.1		SAND; silty medium grained sand and granular sized gravel					
3.0		SAND AND GRAVEL; fine to medium grained sand with pebble, cobble granule, gravel occasional boulder silt matrix (percentage unknown)					
12.8		GRAVEL AND SAND; granules and small pebble gravel with a sand matrix - silt content - intermittent cobbles					
22.2		TILL; rock fragments and pebble gravel, clayey till					
23.8		Bedrock refusal at 23.77 m (78 ft.) Water encountered at 0.76 m (2.5 ft.)					

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION VW 75	COMPLETION DATE 5-14-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0					GRAB		
		SAND; fine grained, silt (10-15%) rusty oxidized colour		1 1/4" PVC, slotted screen, placted at 23.57 m below the surface (77.3 ft.)			
1.5		SAND; fine grained, silty (10-15%)					
4.6		SAND; fine grained; clay and silt matrix					
5.3		SILT AND CLAY; slurry with minor sand content					
6.1		SILT AND CLAY; sandy, very fine grained					
7.6		SILT AND CLAY; stiffer than above with more silt first stone at 8.8 m (29 ft.)					
9.4		SAND AND SILT CLAY; interbedded sands and silty clays					
10.7		SAND; fine to medium grained grey quartz sand; unoxidized, unimodal; significant fine; silty fraction, low recovery occasional pebble					
21.6		SAND; coarser, medium to fine grained, fairly unimodal, medium; occasional stone					
22.8		GRAVEL AND SAND; medium grained sand and pebble gravel					
23.5		TILL; clayey sandy, rock fragment till silty					
23.8		Bedrock Refual at 23.8 m (28 ft.) Water encountered at 1.5 m (5 ft.)					

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 76	5-15-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
					GRAB		
0							
		SAND; silty, fine grained, (silt ~5-10%)		NOT INSTRUMENTED			
1.5		▽					
2		SILT AND CLAY; slurry with minor sand					
3.0		SILT AND CLAY; slurry, grey, very wet					
4							
6							
6.1		SILT AND CLAY; more stiff than before, increase in silt content, maybe some sandy content near 11.0 m (36 ft.)					
8							
10							
11.0		SAND; fine to medium grained sand					
12	12.1	SAND; fine to medium grained sand; occasional stone					
14							
15.2		SAND AND GRAVEL; medium to coarse grained with small pebbles and granules					
16							
18							
19.8		GRAVEL; granule sized gravel and very coarse grained sand matrix					
20							
22							
23.2							
23.5		TILL; clayey, stoney, sandy, silty till very hard, stiff					
24							
		End of hole at 23.5 m (78 ft.) Water encountered at 1.5 m (t ft.) Bedrock nearby					
26							
28							
30							

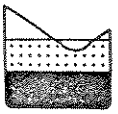

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FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 77	5-15-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0					GRAB		
		SAND; fine grained sand with ~5% silt		NOT INSTRUMENTED			
1.98		SAND AND CLAY; silty sand and clay mixture (clay is red and green colour). ▽					
4.9		SAND; silty (20-30%) very fine grained sand					
7.8		SAND; silty (5%) fine grained sand and occasional stone					
9.1		SAND AND GRAVEL; interbedded sand and large pebble, cobble gravel layers					
17.9		GRAVEL; first boulder at 17.9 m (59 ft.) boulder gravel and granules					
21.9		Till Boulder Till, unable to pass through Clay - very stiff and hard					
		End of hole at 21.9 m (72 ft.) Water encountered at ~3.0 m (~10 ft.) Bedrock nearby					

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FIGURE	RECORD OF TEST HOLE	DESIGNATION VW 78	COMPLETION DATE 5-15-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

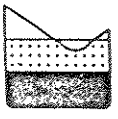
DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0					GRAB		
		SAND; fine grained golden brown; 5% silt		NOT INSTRUMENTED			
1.2		SAND AND GRAVEL; coarse grained sand with granules and pebbles occasional large stone					
2							
4							
6	▽						
6.1		GRAVEL; granule and pebble gravel in fine grained sand; minor silt, occasional large cobble					
8							
10							
12							
14							
16							
18							
20							
		Boulders at bottom					
21.6		Till; very stiff clay and sandy till					
22							
		End of hole at 21.6 m (71 ft.) Water encountered at ~6.1 m (20 ft.) moist above this point Bedrock nearby					
24							
26							
28							
30							

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 79	5-19-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0					GRAB		
0.6		SAND: fine grained, silty (~5% silt)		1 1/4" PVC SCH 40 slotted screen. Piezometer placted at 22.16 m (71.7 ft.)			
2		SAND; clayey, fine grained sand and silt matrix ▽					
3.0		CLAY; Champlain Sea clay, red and green minor sand content					
4		SILT AND CLAY; slurry; minor sand content at top of bed (3.0 m). Smooth clay & silt near 8.8 m.					
6							
8							
8.8		SAND; very fine to fine grained sand with silty content (silt ~15%) - stone at 19.2 m (63 ft.)					
10							
12							
14							
16							
18							
20							
22		sand and boulders					
22.5		TILL; sandy, very stiff clay and boulder till					
23.6		Bedrock refusal at 23.6 m (77 ft.) Water encountered at 2.4 - 2.7 m (8-9 ft.)					
24							
26							
28							
30							



WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 80	5-19-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0					GRAB		
0.6		ORGANIC SOIL		1 1/4" PVC SCM 40 slotted pipe Piezometer emplaced at 14.5 m (47.7 ft.)			
1.5		SAND; silty fine grained, orange oxidation; ~10% silt					
		CLAY; silty, with minor content of fine grained sand					
6.1		CLAY AND SILT; slurry, grey					
		increase in sand content near bottom					
11.3		SAND AND GRAVEL ; fine grained to medium grained sand and granule, pebble gravel					
12.1		SAND; loose sand with minor gravel content					
13.7		SAND; interbedded fine grained and fine to medium grained sand					
15.2		SAND AND GRAVEL; interbedded fine to medium grained sand and pebble granule gravel; main seam of gravel at 15.5 m (51 ft.)					
15.5		End of hole at 15.5 m (51 ft.) Water encountered within clay and silt layer however good supply is at 11.3 m (37 ft.)					

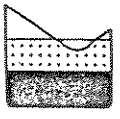
WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 81	5-20-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
					GRAB		
0							
0.1		TOPSOIL; sandy organic material		NOT INSTRUMENTED			
		CLAY; sand, oxidized					
1.5		CLAY; wet, Champlain Sea, red and green					
2							
4							
4.9		▽ SAND; very fine to fine grained; minor silt content ~5%					
6							
7.3		SAND AND SILT; very fine grained sand and silt slurry					
8							
9.1		SAND; very silty (~20%) fine to medium grained sand					
10							
12							
14							
16							
17.1		GRAVEL; stone at 12.1 m (56 ft.); fine to coarse grained sand and occasional pebble					
18							
19.2		GRAVEL AND SAND; very coarse grained sand and granules; few pebbles and cobbles					
20							
21.9							
22							
22.5		TILL; clayey, silty, rock fragment, stiff till					
24		Bedrock refusal at 22.5 m (74 ft.) Water encountered at 4.9 m (16.1 ft.)					
26							
28							
30							



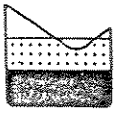
WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 82	5-20-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
					GRAB		
0							
0.15		TOPSOIL; organic material and fine sand		NOT INSTRUMENTED			
2		CLAY; Champlain Sea clay; red and green, smooth, boulder at 3.6 m (12 ft.)					
4							
5.2		SAND; fine to medium grained; smooth drilling					
6							
6.7		SAND AND GRAVEL; small boulder at 6.7 m (22 ft.) medium to coarse grained sand interbedded with layers of granule and pebble gravel - occasional cobble layer around 16.7 m (55 ft.)					
8							
10							
12							
14							
16							
16.8		GRAVEL; boulder at 16.8 m (55 ft); also medium to coarse grained sand with cobble and pebble gravel; granules					
18							
19.8		TILL; boulder, clay till, some silt and rock fragments					
20							
21.3		Bedrock refusal at 21.3 m (70 ft.) Water encoutered at 5.2 m (17 ft.)					
22							
24							
26							
28							
30							



WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 83	5-20-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING		
					TYPE	INTERVAL	N VALUE
					GRAB		
0							
0.15		TOPSOIL; sand and organic material		NOT INSTRUMENTED			
0.61		SAND; fine grained, silty, clayey sand					
2		CLAY; red and green Champlain Sea clay					
4							
6							
8							
9.1		▽					
10		SILT AND CLAY; layers of silt and clay with a minor sand content. Very wet slurry Sandy layer at 12.2-12.8 m					
12							
14							
14.9		SAND; fine grained, silty, grey, quartzic sand					
16							
18							
19.8		TILL; clay, stiff, bedrock fragment, sandy till					
20	20.1						
		Bedrock refusal at 20.1 m (66 ft.) Water encountered at 9.1 m (30 ft.)					
22							
24							
26							
28							
30							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 84	6-3-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		SAND; fine grained, silt matrix		Piezometer placted at 20.5 m (~67 ft.); 1 1/4" PVC, slotted	GRAB		
2							
3.65		SILT; grey slurry with clay matrix					
6							
8							
9.1		CLAY; soft Champlain Sea clay, red and green					
10							
12							
13.0		GRAVEL; granuler and odd pebble					
14							
15.2		SAND AND GRAVEL; fine to medium grained grey sand and occasional cobble, pebble					
16							
16.7		SAND; fine to medium grained, grey silty sand Boulder at 19.5 m					
18							
20							
22							
23.5		TILL; sandy, clayey, hard till					
23.8							
24		Refusal; boulder or bedrock at 23.8 m (78 ft.) Water encountered at ~3.35 m (11 ft.)					
26							
28							
30							

FIGURE	RECORD OF TEST HOLE	DESIGNATION VW 85	COMPLETION DATE 6-3-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		SAND; fine grained, boulder at 2.4 m (8 ft.) minor silt content		Piezometer; 1/1/4" PVC slotted tip; placed at 23.5 m (77 ft.)	GRAB		
4.6		GRAVEL; coarse grained sand or gravel layer					
5.5		SAND; fine grained, silty grey					
6.1		SILT; interbedded silt slurry and clay layers					
9.1		SAND; silty, dirty, fine grained sand					
12.5		SAND AND GRAVEL; interbedded, fine to medium grained sand and granule, occasional pebble, cobble, boulder gravel					
21.3		SAND; fine to medium grained sand, silty occasional pebble					
22.9		TILL; bedrock fragments, dirty sandy hard till					
23.5		Refusal at 23.5 m (77 ft.) Water encountered at ~1.5 m (5 ft.)					

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 86	6-4-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING		
					TYPE	INTERVAL	N VALUE
0		SAND; silty, golden brown		1 1/4" PVC, slotted piezometer placed at 23.3 m (76 ft.)	GRAB		
3.0		SILT; sandy, occasional pebble clayey slurry					
9.1		CLAY					
13.7		SILT AND CLAY					
16.8		SILT AND SAND					
18.3		SAND; silty, fine to medium grained					
24.4		End of hole at 24.4 m (80 ft.) Water encountered at 1.5 m (5 ft.) and 18.3 m (60 ft.)					

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION VW 87	COMPLETION DATE 6-4-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		SAND; fine grained, top few layers are oxidized rusty orange, rest is grey		Piezometer 1 1/4", slotted pipe placed at 23.7 m (~78 ft.). Screen is 0.47 m in length.			
5.5		SILT AND CLAY; silt slurry with layers of clay and clay matrix					
11.4		SAND AND GRAVEL; granule to pebble gravel and medium grained sany layers interbedded					
16.8		GRAVEL; granule to pebble, cobble gravel sand matrix					
24.7		TILL; clayey, bedrock fragment, sandy till End of hole at 25 m (82 ft.) Water encountered at 1.2 m (4 ft.)					

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION VW 88	COMPLETION DATE 6-6-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0							
0.46		ORGANIC PEAT SOIL		Piezometer placed at 22.9 m (75 ft.), 0.3 m slotted 1 1/4" screen, PVC			
		SAND; very fine to fine grained sand, light brown to grey					
2							
3.0		SILT AND CLAY; silt slurry with clay blobs and matrix					
4							
6							
8		Sandy layer at 9.1 m (30 ft.)					
9.7		GRAVEL LAYER; large cobbles or boulders, lag layer					
10.7		SAND; very compact, stiff drilling, granule layer at 11.9-12.2 m (39-40 ft.) medium to coarse grained					
12							
14							
15.2		GRAVEL AND SAND; coarse to medium grained sand and granule and pebble gravel					
16.7		SAND; medium to coarse grained gravel layer at 20.6 m (67.5 ft.)					
18							
20							
22							
24							
25.0		BOULDER LAYER					
25.7		TILL					
26.2		End of hole at 26.2 m (86 ft.) Water encountered at 1.5 m (5 ft.)					
28							
30							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 89	6-6-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		SAND; fine grained sand, oxidized to 1.8 m (6 ft.) orangey, golden brown, below 1.8 m grey stiff sand. Between 2.6-3.0 m sand with occasional pebble. From 20-4.6 m increase in silt content		Piezometer placed at 22.86 m (75 ft.), 1 1/4 " PVC slotted screen (~0.6 m long)			
4.6		SILT AND CLAY; sandy layer at 6.1 to 6.7 m (20-22 ft.)					
8.7		BOULDER GRAVEL AND SAND; interbedded, medium to coarse grained sand and granule, pebble, and possibly cobble gravel					
23.6		TILL; granule and bedrock fragment shale in clay and sand matrix					
24.1		End of hole at 24.1 m (79 ft.) Water encountered at 1.5 m (5 ft.)					

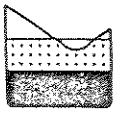
WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		VW 90	6-7-87

PROJECT VARS WATER SUPPLY
PROJECT NO. 1293

DRILLING METHODS HOLLOWSTEM AUGER CME 55 DRILL
SUPERVISOR TAMI SUGARMAN
DRILLING CONTRACTOR MARATHON DRILLING CO. LTD.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING		
					TYPE	INTERVAL	N VALUE
0							
0.3		ORGANIC SOIL		Piezometer placed at 22.5 m (73.8 ft.) 1 1/4" PVC pipe with 0.48 m slotted screen			
1.5		SAND; fine grained, silty sand, silt ~20%					
2		SILT AND CLAY; silt and clay lump slurry with minor sand Sand layer at 7.8-9.1 m (23.5-30 ft.)					
4							
6							
8							
9.1		CLAY					
10							
12							
12.2		CLAY AND SAND					
14							
15.5		SAND AND GRAVEL; medium to coarse grained sand interbedded with granule and pebble gravel layers (few cobbles near bottm)					
16							
18							
20							
22							
22.1		TILL					
22.9		End of hole at 22.9 m (75 ft.) Water encountered at 1.5 m (~5 ft.)					
24							
26							
28							
30							



WATER AND EARTH SCIENCE ASSOCIATES LTD.

APPENDIX B

Step Drawdown Test Data

AQUIFER TEST DATA JOB#1293 WELL#: TW 1

Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.30 m
Rad./dist. from pumping well:	0 m	Pump on:	06-10-87 15:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	06-10-87 18:00:00
Ground Elevation (masl):		Discharge rate:	100,200,300,400
Static Water Level (m):	4.36		513 IGPM

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
1.0	4.450	0.090	100	
2.0	4.425	0.065		
3.0	4.415	0.055		
4.0	4.430	0.070		
5.0	4.430	0.070		
6.0	4.435	0.075		
7.0	4.420	0.060		
8.0	4.420	0.060		
9.0	4.430	0.070		
10.0	4.430	0.070		
12.0	4.430	0.070		
14.0	4.430	0.070		
16.0	4.430	0.070		
18.0	4.430	0.070		
20.0	4.430	0.070		
22.0	4.430	0.070		
24.0	4.430	0.070		
26.0	4.430	0.070		
28.0	4.430	0.070		
30.0	4.430	0.070	200	
31.0	4.510	0.150		
32.0	4.510	0.150		
33.0	4.530	0.170		
34.0	4.525	0.165		
35.0	4.525	0.165		
36.0	4.530	0.170		
37.0	4.530	0.170		
38.0	4.530	0.170		
39.0	4.530	0.170		
40.0	4.530	0.170		
42.0	4.535	0.175		
44.0	4.535	0.175		
46.0	4.535	0.175		
48.0	4.535	0.175		
50.0	4.535	0.175		
52.0	4.540	0.180		
54.0	4.535	0.175		
56.0	4.540	0.180		
58.0	4.560	0.200		
60.0	4.570	0.210		

AQUIFER TEST DATA JOB#1293 WELL#: TW 1

Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.30 m
Rad./dist. from pumping well:	0 m	Pump on:	06-10-87 15:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	06-10-87 18:00:00
Ground Elevation (masl):		Discharge rate:	100,200,300,400
Static Water Level (m):	4.36		513 IGPM

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
61.0	4.705	0.345	300	
62.0	4.680	0.320		
63.0	4.720	0.360		
64.0	4.710	0.350		
65.0	4.710	0.350		
66.0	4.710	0.350		
67.0	4.710	0.350		
68.0	4.720	0.360		
69.0	4.720	0.360		
70.0	4.730	0.370		
72.0	4.730	0.370		
74.0	4.730	0.370		
76.0	4.730	0.370		
78.0	4.740	0.380		
80.0	4.730	0.370		
82.0	4.735	0.375		
84.0	4.740	0.380		
86.0	4.780	0.420		
88.0	4.745	0.385		
90.0	4.750	0.390		
91.0	4.910	0.550	400	
92.0	4.930	0.570		
93.0	4.940	0.580		
94.0	4.930	0.570		
95.0	4.930	0.570		
96.0	4.950	0.590		
97.0	4.950	0.590		
98.0	4.950	0.590		
99.0	4.950	0.590		
100.0	4.950	0.590		
102.0	4.950	0.590		
104.0	4.960	0.600		
106.0	4.960	0.600		
108.0	4.960	0.600		
110.0	4.965	0.605		
112.0	4.960	0.600		
114.0	4.970	0.610		
116.0	4.965	0.605		
118.0	4.970	0.610		
120.0	4.975	0.615		

AQUIFER TEST DATA JOB#1293 WELL#: TW 1

Type of aquifer test:	STEP TEST	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.30 m
Rad./dist. from pumping well:	0 m	Pump on:	06-10-87 15:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	06-10-87 18:00:00
Ground Elevation (masl):		Discharge rate:	100,200,300,400
Static Water Level (m):	4.36		513 IGPM

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
121.0	5.110	0.750	513	
122.0	5.110	0.750		
123.0	5.120	0.760		
124.0	5.120	0.760		
125.0	5.125	0.765		
126.0	5.125	0.765		
127.0	5.125	0.765		
128.0	5.130	0.770		
129.0	5.130	0.770		
130.0	5.130	0.770		
132.0	5.130	0.770		
134.0	5.135	0.775		
136.0	5.140	0.780		
138.0	5.140	0.780		
140.0	5.140	0.780		
142.0	5.145	0.785		
144.0	5.150	0.790		
146.0	5.155	0.795		
148.0	5.160	0.800		
150.0	5.165	0.805		
155.0	5.165	0.805		
160.0	5.170	0.810		
165.0	5.170	0.810		
170.0	5.175	0.815		
175.0	5.180	0.820		
180.0	5.185	0.825		<-PUMP OFF

AQUIFER TEST DATA JOB#1293 WELL#: TH87

Type of aquifer test:	STEP TEST	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.30 m
Rad./dist. from pumping well:	3.5 m	Pump on:	06-10-87 15:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	06-10-87 18:00:00
Ground Elevation (masl):		Discharge rate:	100,200,300,400
Static Water Level (m):	3.76		513 IGPM

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
1.0	3.800	0.040	100	
3.0	3.800	0.040		
5.0	3.800	0.040		
6.0	3.800	0.040		
7.0	3.800	0.040		
8.0	3.800	0.040		
9.0	3.800	0.040		
10.0	3.800	0.040		
12.0	3.830	0.070		
14.0	3.830	0.070		
16.0	3.830	0.070		
18.0	3.800	0.040		
20.0	3.800	0.040		
22.0	3.800	0.040		
24.0	3.800	0.040		
26.0	3.800	0.040		
28.0	3.800	0.040		
30.0	3.800	0.040	200	
31.0	3.820	0.060		
32.0	3.840	0.080		
33.0	3.840	0.080		
34.0	3.840	0.080		
35.0	3.850	0.090		
36.0	3.850	0.090		
37.0	3.850	0.090		
38.0	3.850	0.090		
39.0	3.850	0.090		
40.0	3.850	0.090		
42.0	3.860	0.100		
44.0	3.870	0.110		
46.0	3.870	0.110		
48.0	3.880	0.120		
50.0	3.880	0.120		
52.0	3.880	0.120		
54.0	3.880	0.120		
56.0	3.890	0.130		
58.0	3.890	0.130		
60.0	3.890	0.130		
61.0	3.890	0.130	300	
62.0	3.920	0.160		

AQUIFER TEST DATA JOB#1293 WELL#: TH87

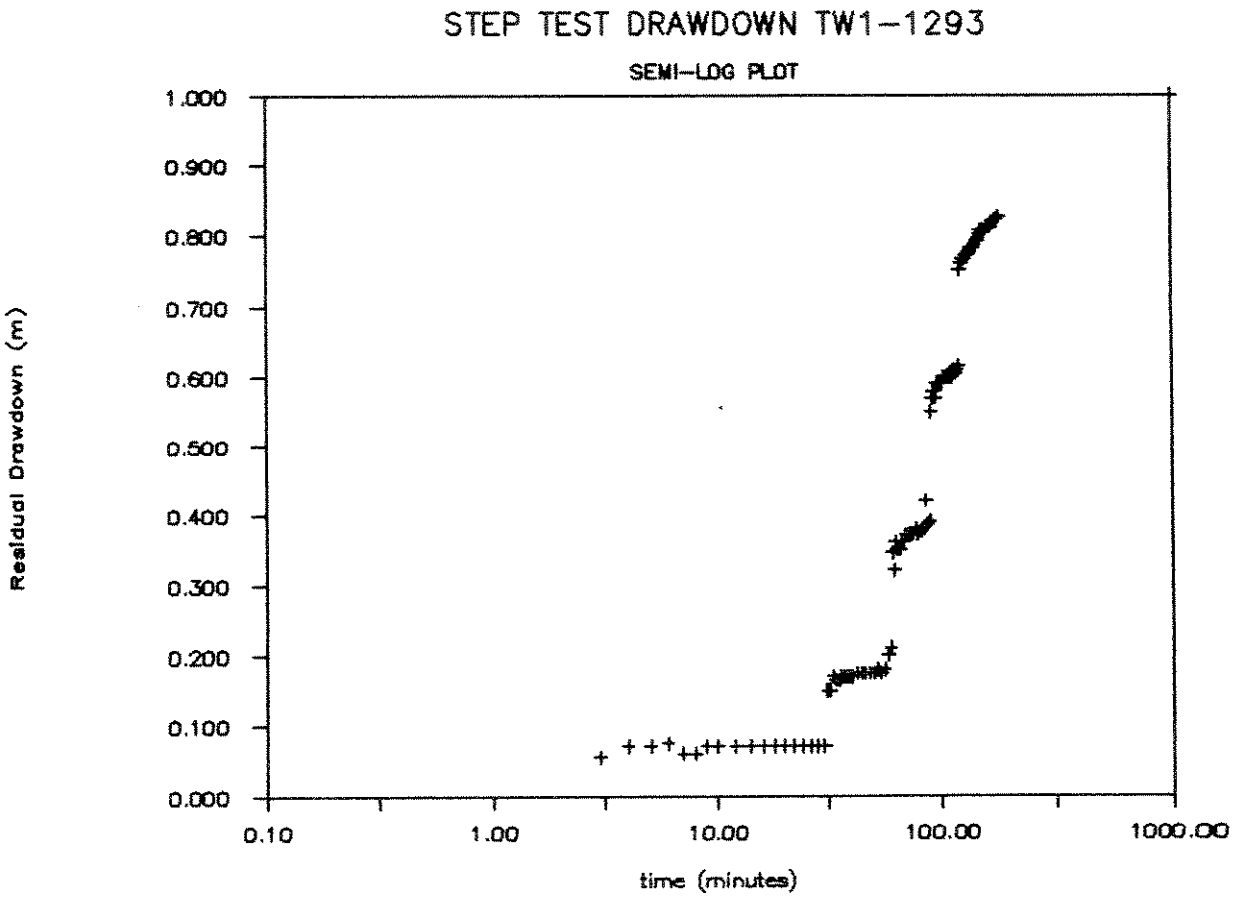
Type of aquifer test:	STEP TEST	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.30 m
Rad./dist. from pumping well:	3.5 m	Pump on:	06-10-87 15:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	06-10-87 18:00:00
Ground Elevation (masl):		Discharge rate:	100,200,300,400
Static Water Level (m):	3.76		513 IGPM

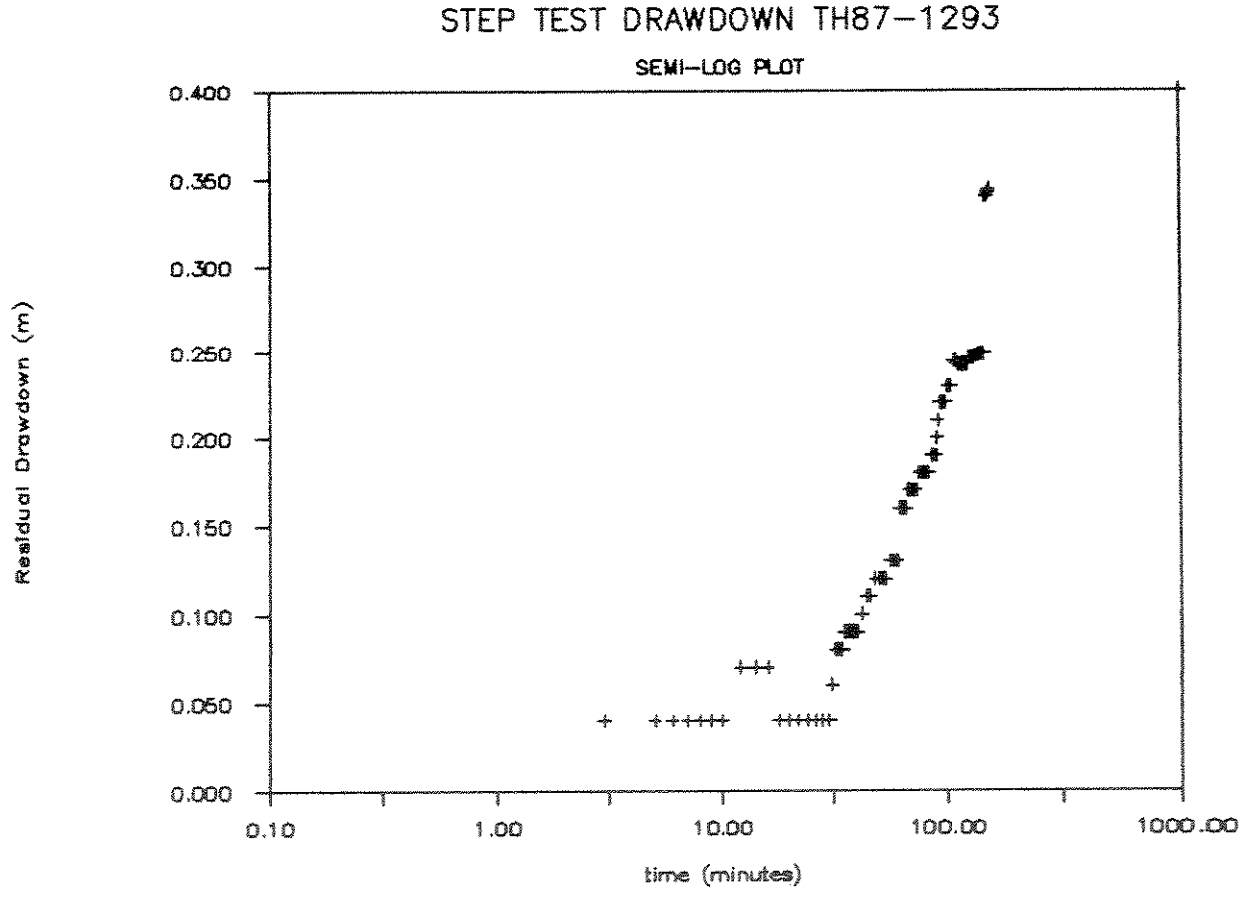
Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
63.0	3.920	0.160		
64.0	3.920	0.160		
65.0	3.920	0.160		
66.0	3.920	0.160		
67.0	3.920	0.160		
68.0	3.930	0.170		
69.0	3.930	0.170		
70.0	3.930	0.170		
72.0	3.930	0.170		
74.0	3.930	0.170		
76.0	3.940	0.180		
78.0	3.940	0.180		
80.0	3.940	0.180		
82.0	3.940	0.180		
84.0	3.940	0.180		
86.0	3.950	0.190		
88.0	3.950	0.190		
90.0	3.950	0.190		
91.0	3.960	0.200	400	
92.0	3.970	0.210		
93.0	3.980	0.220		
94.0	3.980	0.220		
95.0	3.980	0.220		
96.0	3.980	0.220		
97.0	3.980	0.220		
98.0	3.980	0.220		
99.0	3.980	0.220		
100.0	3.990	0.230		
102.0	3.990	0.230		
104.0	3.990	0.230		
106.0	4.005	0.245		
108.0	4.005	0.245		
110.0	4.003	0.243		
112.0	4.003	0.243		
114.0	4.003	0.243		
116.0	4.003	0.243		
118.0	4.003	0.243		
120.0	4.003	0.243		
121.0	4.003	0.243	513	
122.0	4.004	0.244		

AQUIFER TEST DATA JOB#1293 WELL#: TH87

Type of aquifer test:	STEP TEST	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.30 m
Rad./dist. from pumping well:	3.5 m	Pump on:	06-10-87 15:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	06-10-87 18:00:00
Ground Elevation (masl):		Discharge rate:	100,200,300,400
Static Water Level (m):	3.76		513 IGPM

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
123.0	4.007	0.247		
124.0	4.007	0.247		
125.0	4.007	0.247		
126.0	4.007	0.247		
127.0	4.007	0.247		
128.0	4.007	0.247		
129.0	4.007	0.247		
130.0	4.007	0.247		
132.0	4.008	0.248		
134.0	4.008	0.248		
136.0	4.008	0.248		
138.0	4.009	0.249		
140.0	4.009	0.249		
142.0	4.009	0.249		
144.0	4.009	0.249		
146.0	4.100	0.340		
148.0	4.100	0.340		
150.0	4.102	0.342		
152.0	4.104	0.344		
180.0				<-PUMP OFF


STEP TEST DRAWDOWN TW1-1293
SEMI-LOG PLOT
Residual Drawdown (m)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.10
1.00
10.00
100.00
1000.00
time (minutes)


STEP TEST DRAWDOWN TH87-1293
SEMI-LOG PLOT
Residual Drawdown (m)
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0.10
1.00
10.00
100.00
1000.00
time (minutes)

APPENDIX C

Aquifer Test Data and Calculations

C-1 1987 Test Program
C-2 1990 Test Program

C-1 1987 Test Program

AQUIFER TEST DATA JOB#1293 WELL#: TW 1

Type of aquifer test:	CONST.DISCHARGE	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	0 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	4.36	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
1.0	4.700	0.340	350	
2.0	4.720	0.360		<-weak H2S
3.0	4.740	0.380		odoyr
4.0	4.740	0.380		<-clear
5.0	4.750	0.390		
7.0	4.770	0.410		
9.0	4.770	0.410		
12.0	4.770	0.410		
14.0	4.770	0.410		
17.0	4.790	0.430		
20.0	4.800	0.440		
25.0	4.820	0.460		
31.0	4.830	0.470		
40.0	4.840	0.480		
50.0	4.840	0.480		
60.0	4.860	0.500		
70.0	4.870	0.510		
88.0	4.880	0.520		
112.5	4.880	0.520		
141.5	4.925	0.565		
180.0	4.950	0.590		
210.0	4.950	0.590		
243.0	4.960	0.600		
273.0	4.960	0.600		
332.0	4.990	0.630		
363.5	4.990	0.630		
420.0	5.010	0.650		
447.0	5.020	0.660		
510.0	5.040	0.680		<-disch.
572.0	5.070	0.710		broke, flow
630.0	5.080	0.720		back towards
693.0	5.090	0.730		well at v.
749.0	5.110	0.750		slow rate
839.0	5.130	0.770		
905.0	5.140	0.780		
960.0	5.150	0.790		<-disch.
1020.0	5.150	0.790		repaired
1110.0	5.165	0.805		<-still H2S
1170.0	5.180	0.820		odour
1227.0	5.190	0.830		

AQUIFER TEST DATA JOB#1293 WELL#: TW 1

Type of aquifer test:	CONST.DISCHARGE	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	0 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	4.36	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
1288.0	5.190	0.830		
1350.0	5.200	0.840		
1411.0	5.220	0.860		
1527.0	5.230	0.870		
1598.0	5.250	0.890		
1657.0	5.250	0.890		
1730.0	5.260	0.900		
1810.0	5.260	0.900		
1870.0	5.270	0.910		
1955.0	5.280	0.920		
2050.0	5.290	0.930		
2140.0	5.300	0.940		
2260.0	5.310	0.950		
2370.0	5.330	0.970		
2430.0	5.330	0.970		
2502.0	5.340	0.980		
2566.0	5.340	0.980		
2623.0	5.350	0.990		
2683.0	5.350	0.990		
2743.0	5.350	0.990		
2848.0	5.355	0.995		
2922.0	5.370	1.010		
2982.0	5.370	1.010		
3103.0	5.370	1.010		
3190.0	5.390	1.030		
3280.0	5.400	1.040		
3400.0	5.400	1.040		
3520.0	5.410	1.050		
3640.0	5.420	1.060		
3790.0	5.430	1.070		
3940.0	5.450	1.090		
4092.0	5.460	1.100		
4227.0	5.470	1.110		

AQUIFER TEST DATA JOB #1293 WELL#: TW 1

Type of aquifer test:	CONST. Q	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	0	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	4.36	Discharge rate:	350 IGPM

At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
1	4321.0	5.180	0.820
2	2161.0	5.120	0.760
3	1441.0	5.110	0.750
4	1081.0	5.110	0.750
5	865.0	5.100	0.740
6	721.0	5.100	0.740
7	618.1	5.100	0.740
8	541.0	5.100	0.740
9	481.0	5.095	0.735
10	433.0	5.090	0.730
12	361.0	5.090	0.730
14	309.6	5.085	0.725
16	271.0	5.080	0.720
18	241.0	5.080	0.720
20	217.0	5.075	0.715
22	197.4	5.070	0.710
24	181.0	5.060	0.700
26	167.2	5.060	0.700
28	155.3	5.055	0.695
30	145.0	5.050	0.690
35	124.4	5.040	0.680
40	109.0	5.035	0.675
45	97.0	5.035	0.675
50	87.4	5.030	0.670
55	79.5	5.020	0.660
60	73.0	5.020	0.660
70	62.7	5.015	0.655
80	55.0	5.010	0.650
90	49.0	5.005	0.645
100	44.2	5.000	0.640
110	40.3	5.000	0.640
120	37.0	5.000	0.640
178	25.3	4.975	0.615
214	21.2	4.975	0.615
280	16.4	4.935	0.575
307	15.1	4.930	0.570
360	13.0	4.920	0.560
407	11.6	4.910	0.550
449	10.6	4.900	0.540
493	9.8	4.890	0.530
546	8.9	4.875	0.515
598	8.2	4.870	0.510

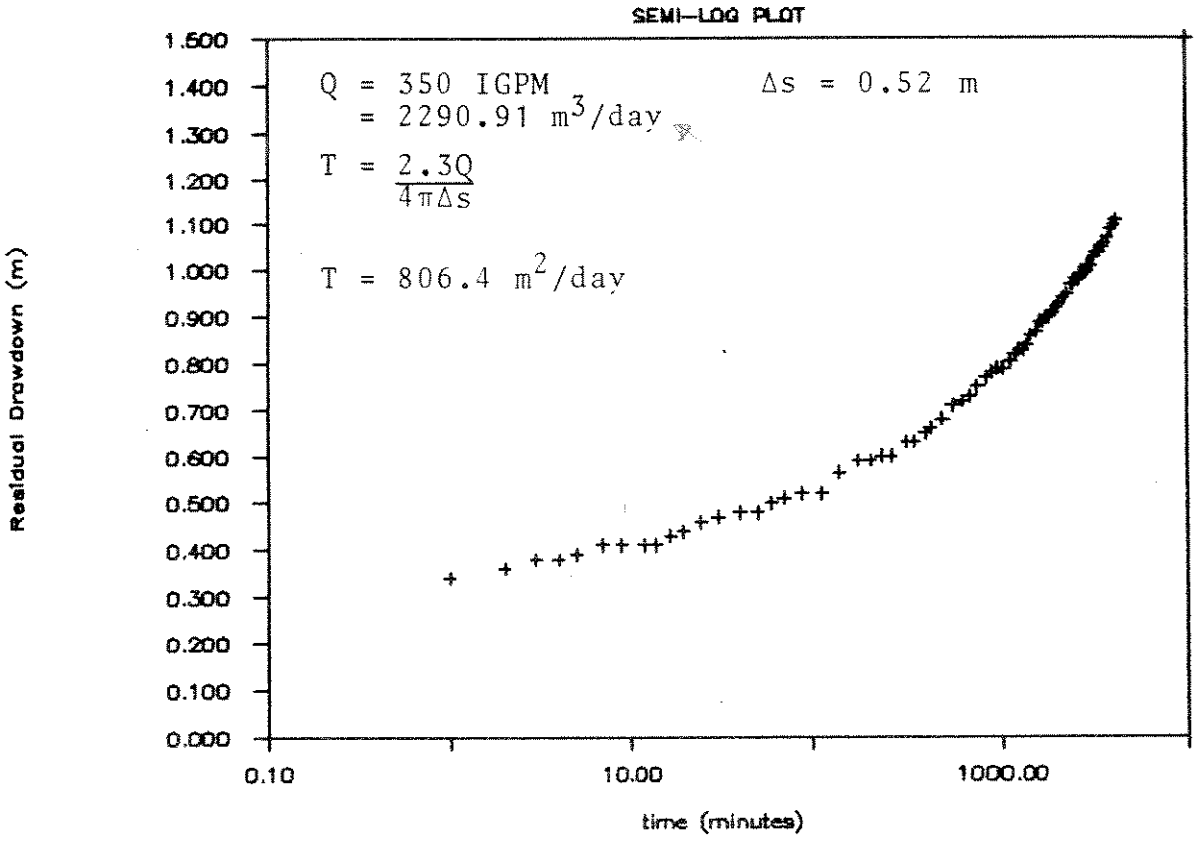
AQUIFER TEST DATA JOB #1293 WELL#: TW 1

Type of aquifer test:	CONST. Q	Well type:	PUMPING
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	0	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	4.36	Discharge rate:	350 IGPM

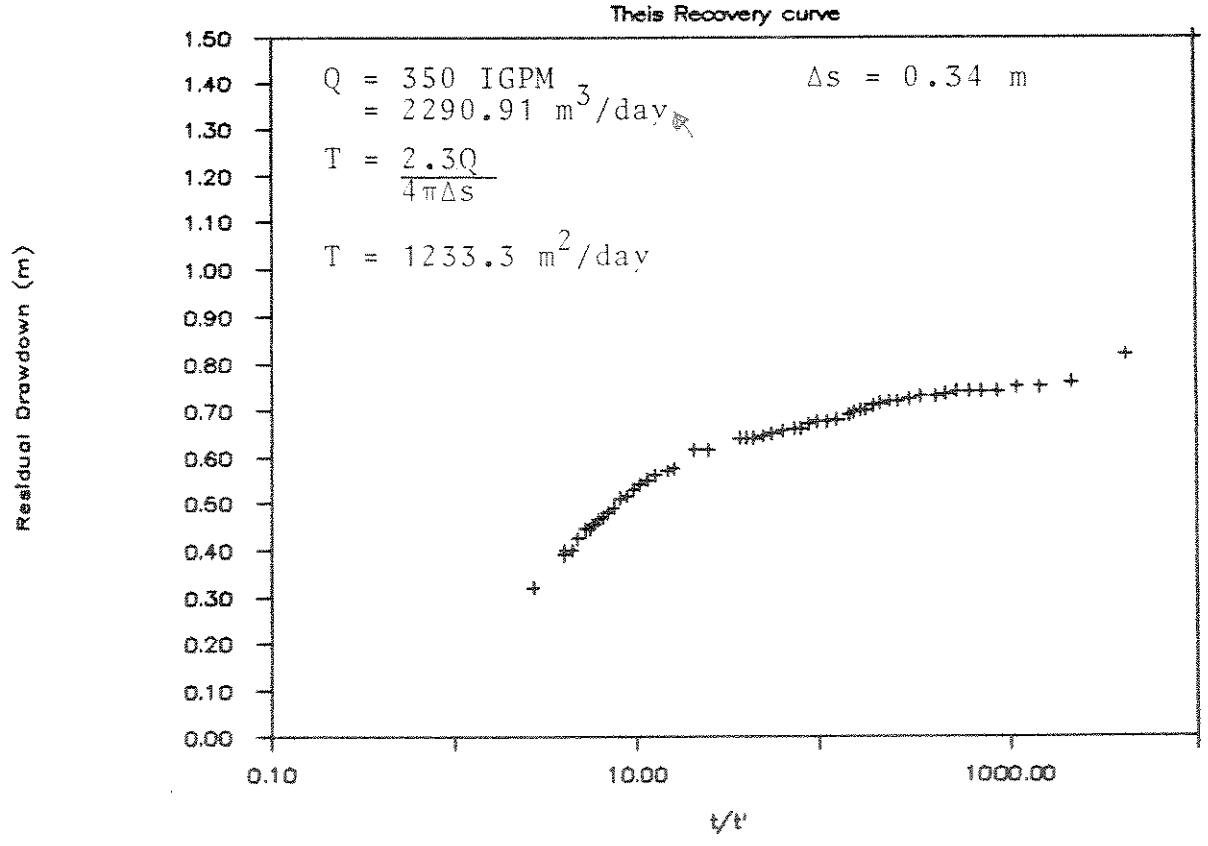
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
660	7.5	4.850	0.490
719	7.0	4.840	0.480
781	6.5	4.830	0.470
840	6.1	4.825	0.465
900	5.8	4.815	0.455
957	5.5	4.805	0.445
1016	5.3	4.805	0.445
1143	4.8	4.785	0.425
1259	4.4	4.760	0.400
1405	4.1	4.760	0.400
1440	4.0	4.750	0.390
2520	2.7	4.680	0.320

DRAWDOWN PLOT FOR TW1-1293



RECOVERY PLOT TW1-1293



AQUIFER TEST DATA JOB#1293 WELL#: TH87

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	3.5 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.73	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
6.0	3.860	0.130	350	
8.0	3.860	0.130		
10.0	3.880	0.150		
13.0	3.880	0.150		
15.0	3.890	0.160		
18.0	3.890	0.160		
21.0	3.900	0.170		
26.0	3.920	0.190		
30.0	3.920	0.190		
41.0	3.940	0.210		
51.0	3.940	0.210		
61.0	3.960	0.230		
71.0	3.970	0.240		
89.0	3.980	0.250		
113.5	4.010	0.280		
143.5	4.020	0.290		
181.0	4.040	0.310		
210.0	4.060	0.330		
244.0	4.065	0.335		
300.0	4.070	0.340		
333.0	4.100	0.370		
364.5	4.090	0.360		
420.0	4.120	0.390		
448.0	4.130	0.400		
511.0	4.150	0.420		
573.0	4.170	0.440		
631.0	4.180	0.450		
694.0	4.190	0.460		
751.0	4.210	0.480		
841.0	4.230	0.500		
906.0	4.240	0.510		
960.0	4.250	0.520		
1053.0	4.250	0.520		
1112.0	4.255	0.525		
1176.0	4.280	0.550		
1232.0	4.290	0.560		
1290.0	4.290	0.560		
1354.0	4.300	0.570		
1412.0	4.315	0.585		
1528.0	4.330	0.600		

AQUIFER TEST DATA JOB#1293 WELL#: TH87

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	3.5 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.73	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
1599.0	4.340	0.610		
1655.0	4.345	0.615		
1730.0	4.350	0.620		
1810.0	4.355	0.625		
1870.0	4.370	0.640		
1955.0	4.380	0.650		
2050.0	4.380	0.650		
2140.0	4.390	0.660		
2260.0	4.400	0.670		
2480.0	4.420	0.690		
2545.0	4.430	0.700		
2613.0	4.430	0.700		
2677.0	4.440	0.710		
2734.0	4.450	0.720		
2794.0	4.450	0.720		
2854.0	4.450	0.720		
2959.0	4.455	0.725		
3034.0	4.465	0.735		
3093.0	4.465	0.735		
3214.0	4.480	0.750		
3300.0	4.490	0.760		
3390.0	4.500	0.770		
3510.0	4.510	0.780		
3630.0	4.520	0.790		
3780.0	4.530	0.800		
3931.0	4.545	0.815		
4084.0	4.550	0.820		
4219.0	4.565	0.835		

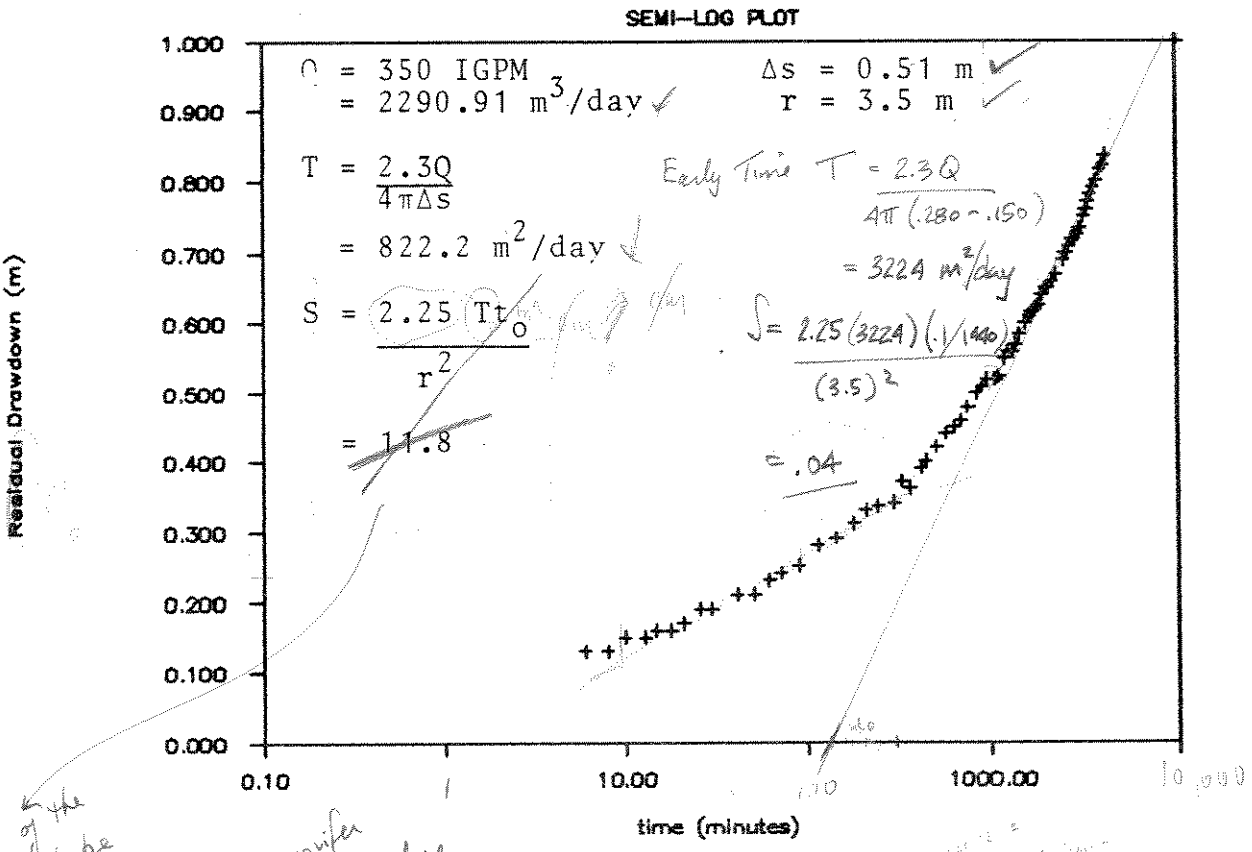
AQUIFER TEST DATA JOB #1293 WELL#: TH87

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	3.5 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	3.73	Discharge rate:	350 IGPM

At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
11	393.7	4.460	0.730
15	289.0	4.450	0.720
17	255.1	4.440	0.710
19	228.4	4.440	0.710
21	206.7	4.430	0.700
23	188.8	4.430	0.700
25	173.8	4.430	0.700
27	161.0	4.430	0.700
29	150.0	4.420	0.690
31	140.4	4.410	0.680
36	121.0	4.400	0.670
41	106.4	4.400	0.670
46	94.9	4.400	0.670
51	85.7	4.390	0.660
56	78.1	4.385	0.655
80	55.0	4.380	0.650
96	46.0	4.375	0.645
121	36.7	4.370	0.640
179	25.1	4.350	0.620
216	21.0	4.340	0.610
283	16.3	4.305	0.575
349	13.4	4.300	0.570
364	12.9	4.285	0.555
409	11.6	4.275	0.545
451	10.6	4.265	0.535
494	9.7	4.255	0.525
548	8.9	4.245	0.515
600	8.2	4.235	0.505
663	7.5	4.220	0.490
721	7.0	4.210	0.480
783	6.5	4.200	0.470
842	6.1	4.190	0.460
901	5.8	4.180	0.450
960	5.5	4.175	0.445
1018	5.2	4.175	0.445
1143	4.8	4.160	0.430
1261	4.4	4.140	0.410
1406	4.1	4.130	0.400
1440	4.0	4.130	0.400
2520	2.7	4.050	0.320

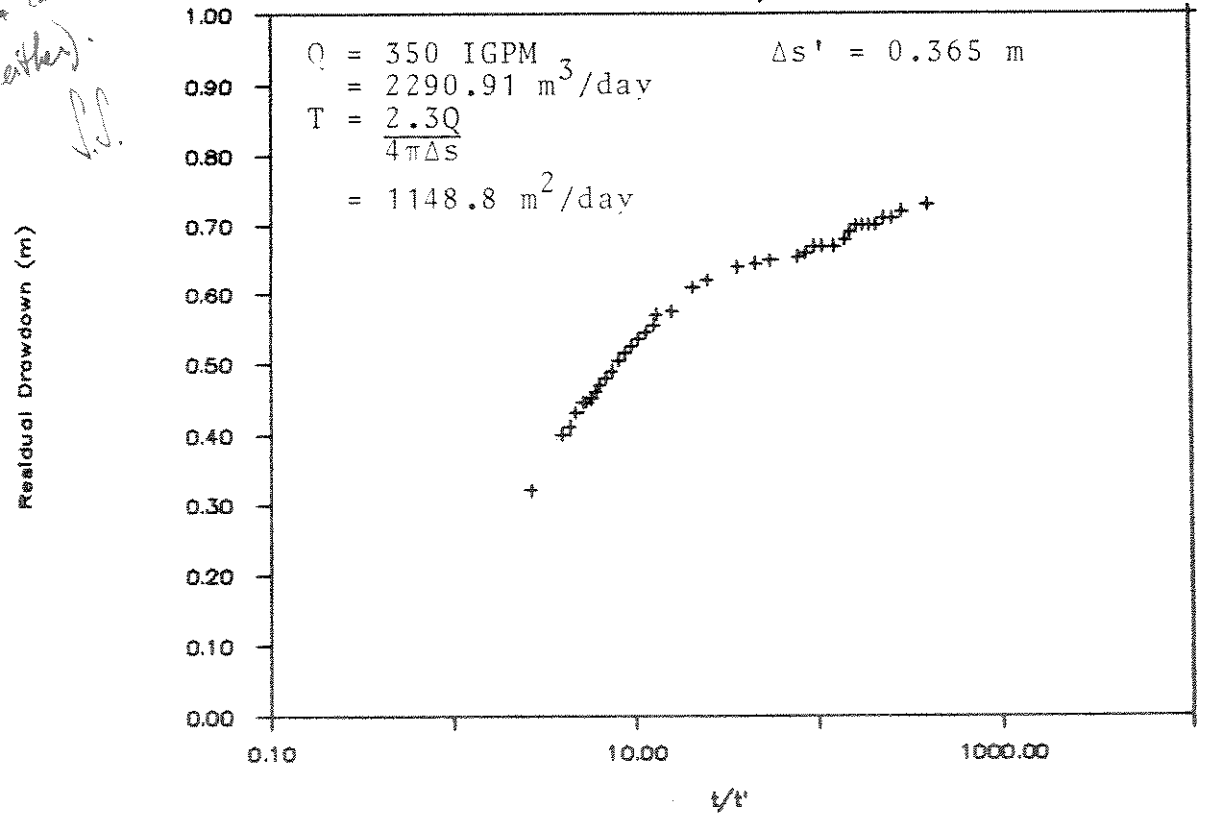
DRAWDOWN PLOT FOR TH87–1293



Storativity of the aquifer cannot be calculated @ a boundary. (Technically, T of aquifer cannot be calculated @ a boundary either).

V.V.

RECOVERY PLOT TH87–1293



AQUIFER TEST DATA JOB#1293 WELL#: P72

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	277.5 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	1.76	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
73.0	1.790	0.030	350	
107.0	1.840	0.080		
135.0	1.860	0.100		
166.0	1.870	0.110		
232.0	1.890	0.130		
301.0	1.905	0.145		
412.0	1.925	0.165		
470.0	1.950	0.190		
532.0	1.955	0.195		
645.0	1.960	0.200		
722.0	1.970	0.210		
855.0	1.970	0.210		
930.0	1.980	0.220		
1037.0	2.000	0.240		
1161.0	2.010	0.250		
1309.0	2.020	0.260		
1435.0	2.040	0.280		
1546.0	2.050	0.290		
1669.0	2.060	0.300		
1836.0	2.070	0.310		
1988.0	2.080	0.320		
2138.0	2.080	0.320		
2400.0	2.090	0.330		
2514.0	2.095	0.335		
2634.0	2.110	0.350		
2752.0	2.120	0.360		
2861.0	2.125	0.365		
2992.0	2.130	0.370		
3119.0	2.140	0.380		
3285.0	2.140	0.380		
3400.0	2.150	0.390		
3520.0	2.150	0.390		
3640.0	2.160	0.400		
3790.0	2.160	0.400		
3952.0	2.170	0.410		
4102.0	2.185	0.425		
4236.0	2.190	0.430		

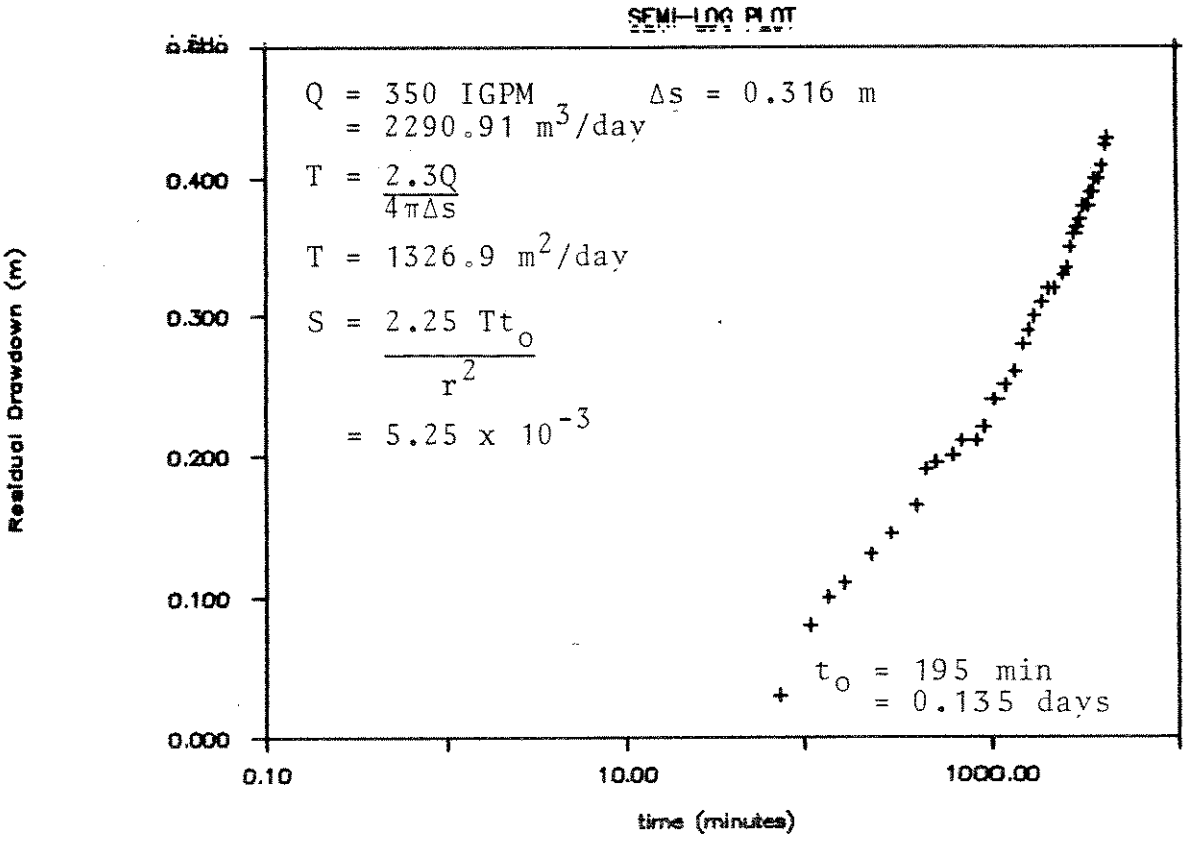
AQUIFER TEST DATA JOB #1293 WELL#: P72

Type of aquifer test: CONST. Q Well type: OBSERVATION
How Q Measured: ORIFICE WEIR Data type: RECOVERY
Distance from pumping well: 277.5 m Depth pump: 18.3 m
Meas. point for w. l.'s: T.O.C. Pump on: 07-10-87 16:00:00
Elevation of Measuring Pt.: Pump off: 10-10-87 16:00:00
Static Water Level: 1.76 Discharge rate: 350 IGPM

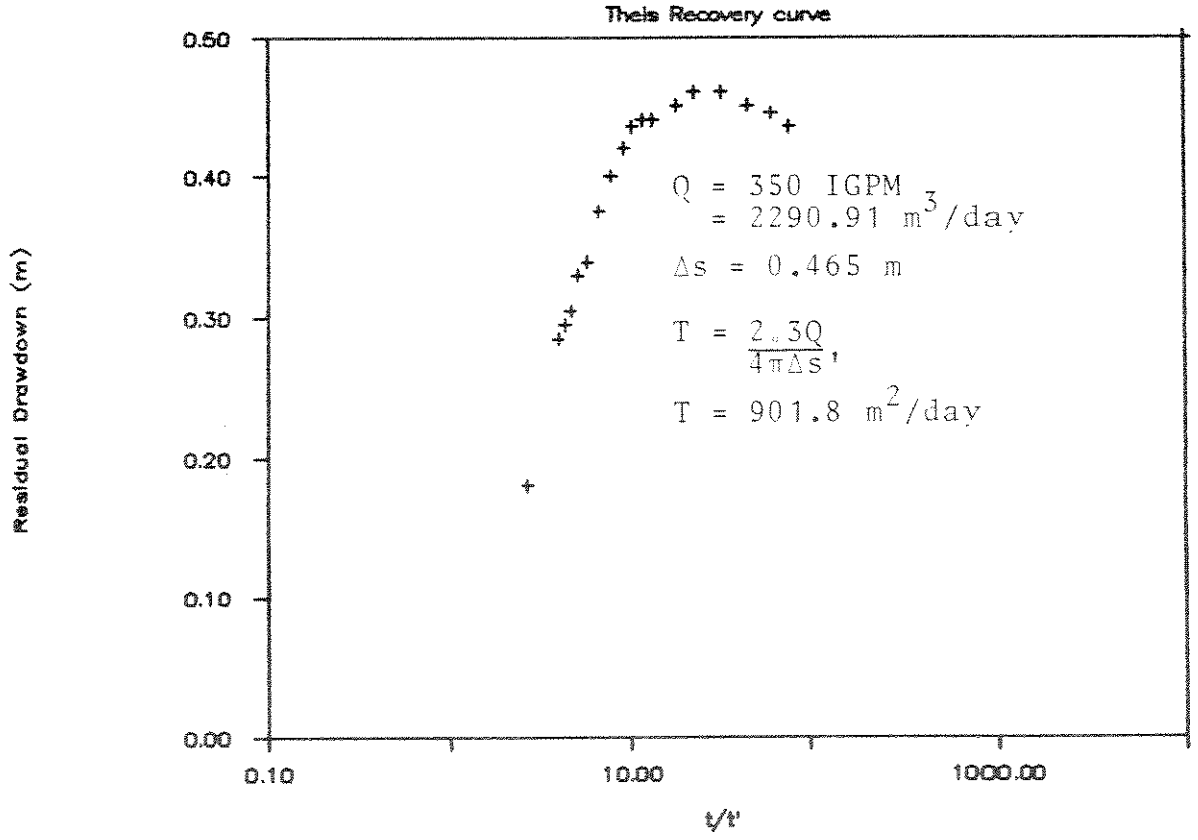
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
56	78.1	2.195	0.435
71	61.8	2.205	0.445
97	45.5	2.210	0.450
138	32.3	2.220	0.460
198	22.8	2.220	0.460
249	18.3	2.210	0.450
345	13.5	2.200	0.440
400	11.8	2.200	0.440
461	10.4	2.195	0.435
517	9.4	2.180	0.420
632	7.8	2.160	0.400
754	6.7	2.135	0.375
891	5.8	2.100	0.340
1046	5.1	2.090	0.330
1172	4.7	2.065	0.305
1289	4.4	2.055	0.295
1433	4.0	2.045	0.285
2547	2.7	1.940	0.180

DRAWDOWN PLOT FOR P72-1293



RECOVERY PLOT P72-1293



AQUIFER TEST DATA JOB#1293 WELL#: P75

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	292 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.38	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
71.0	3.415	0.035	350	
105.0	3.420	0.040		
134.0	3.430	0.050		
164.0	3.435	0.055		
230.0	3.450	0.070		
300.0	3.465	0.085		
410.0	3.485	0.105		
468.0	3.500	0.120		
534.0	3.510	0.130		
648.0	3.530	0.150		
760.0	3.540	0.160		
855.0	3.550	0.170		
950.0	3.560	0.180		
1027.0	3.580	0.200		
1161.0	3.585	0.205		
1308.0	3.610	0.230		
1435.0	3.625	0.245		
1676.0	3.640	0.260		
1679.0	3.650	0.270		
1847.0	3.670	0.290		
2000.0	3.690	0.310		
2140.0	3.700	0.320		
2520.0	3.720	0.340		
2632.0	3.740	0.360		
2752.0	3.740	0.360		
2871.0	3.750	0.370		
2859.0	3.760	0.380		
2991.0	3.780	0.400		
3113.0	3.780	0.400		
3285.0	3.790	0.410		
3400.0	3.790	0.410		
3520.0	3.810	0.430		
3640.0	3.820	0.440		
3810.0	3.830	0.450		
3948.0	3.845	0.465		
4100.0	3.850	0.470		
4235.0	3.865	0.485		

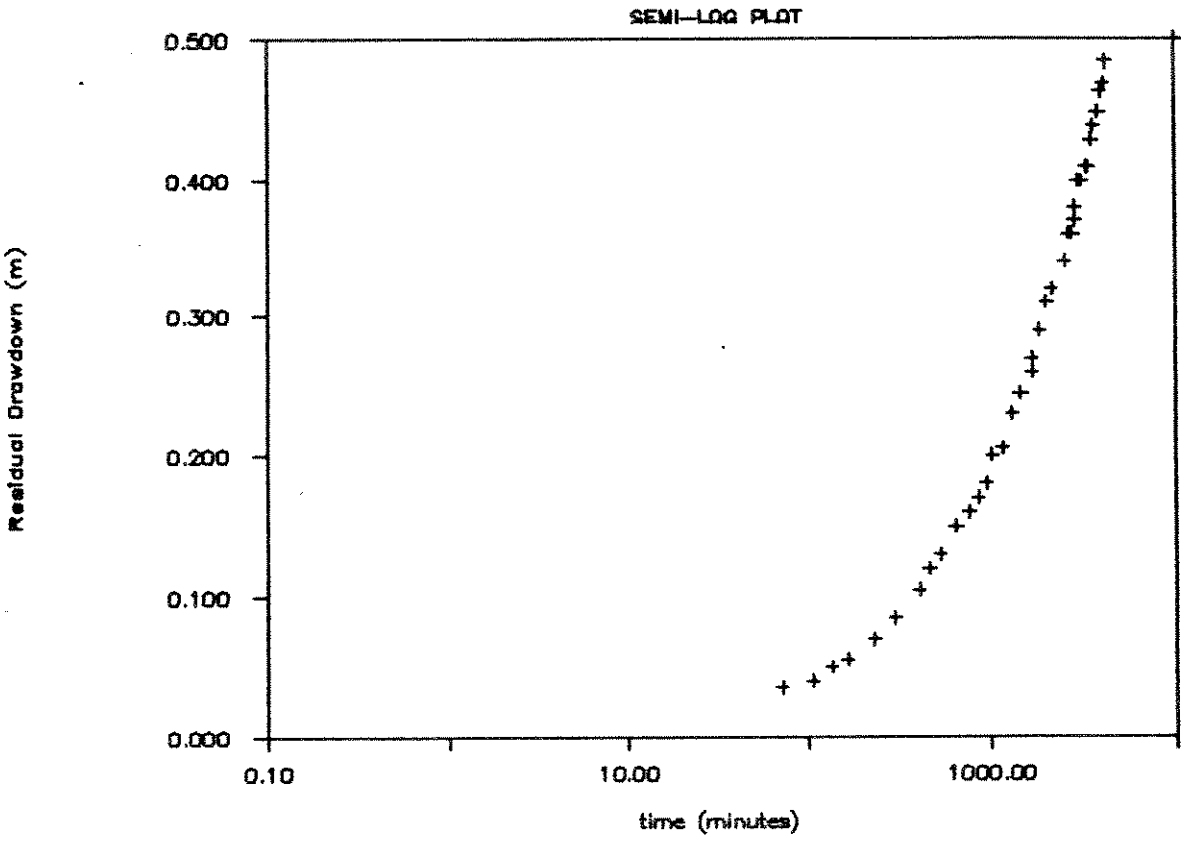
AQUIFER TEST DATA JOB #1293 WELL#: P75

Type of aquifer test: CONST. Q Well type: OBSERVATION
How Q Measured: ORIFICE WEIR Data type: RECOVERY
Distance from pumping well: 292 m Depth pump: 18.3 m
Meas. point for w. l.'s: T.O.C. Pump on: 07-10-87 16:00:00
Elevation of Measuring Pt.: Pump off: 10-10-87 16:00:00
Static Water Level: 3.38 Discharge rate: 350 IGPM

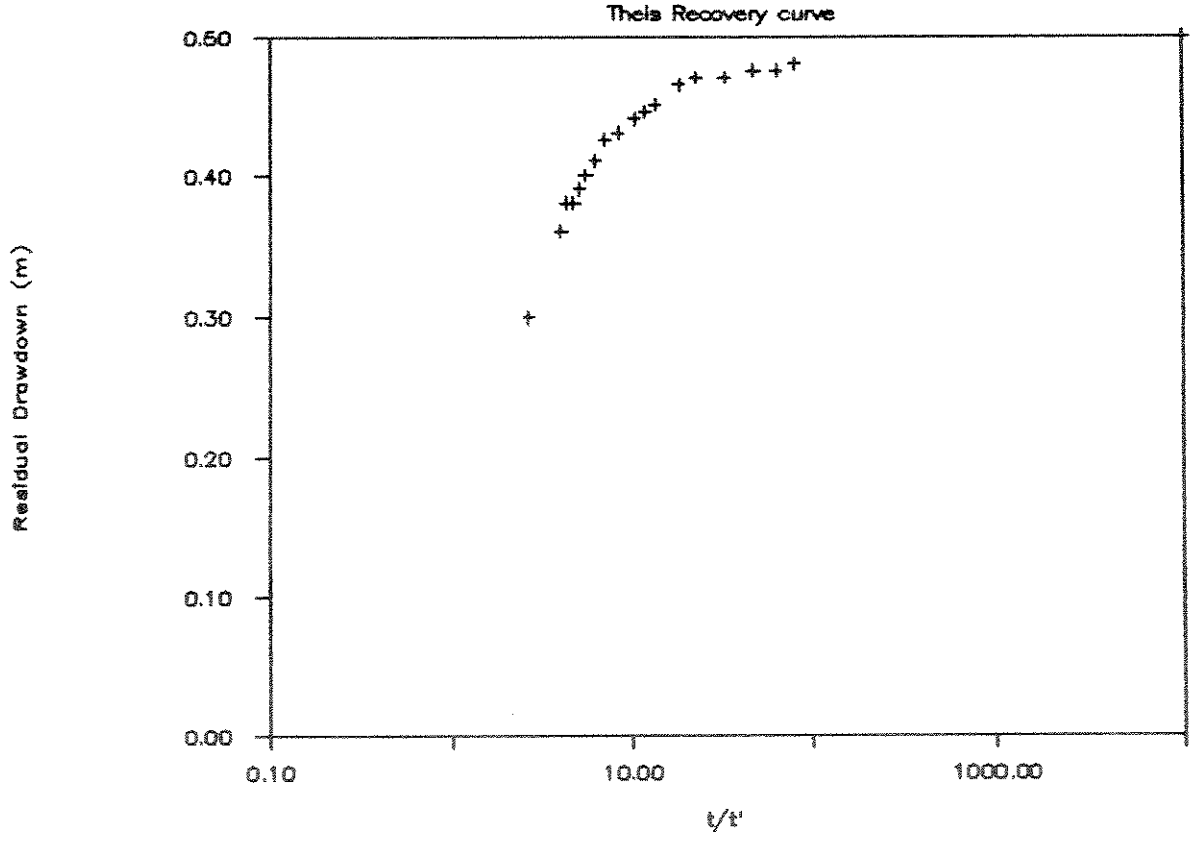
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
55	79.5	3.860	0.480
70	62.7	3.855	0.475
95	46.5	3.855	0.475
136	32.8	3.850	0.470
196	23.0	3.850	0.470
247	18.5	3.845	0.465
342	13.6	3.830	0.450
395	11.9	3.825	0.445
457	10.5	3.820	0.440
577	8.5	3.810	0.430
699	7.2	3.805	0.425
807	6.4	3.790	0.410
943	5.6	3.780	0.400
1032	5.2	3.770	0.390
1157	4.7	3.760	0.380
1274	4.4	3.760	0.380
1419	4.0	3.740	0.360
2535	2.7	3.680	0.300

DRAWDOWN PLOT FOR P75-1293



RECOVERY PLOT P75-1293



AQUIFER TEST DATA JOB#1293 WELL#: P79

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	602 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	2.19	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
173.0	2.230	0.040	350	
308.0	2.260	0.070		
419.0	2.270	0.080		
600.0	2.300	0.110		
825.0	2.320	0.130		
940.0	2.340	0.150		
1170.0	2.370	0.180		
1443.0	2.410	0.220		
1687.0	2.430	0.240		
1930.0	2.460	0.270		
2160.0	2.480	0.290		
2519.0	2.510	0.320		
2760.0	2.530	0.340		
2997.0	2.540	0.350		
3555.0	2.590	0.400		
3825.0	2.610	0.420		
4109.0	2.630	0.440		
4243.0	2.635	0.445		

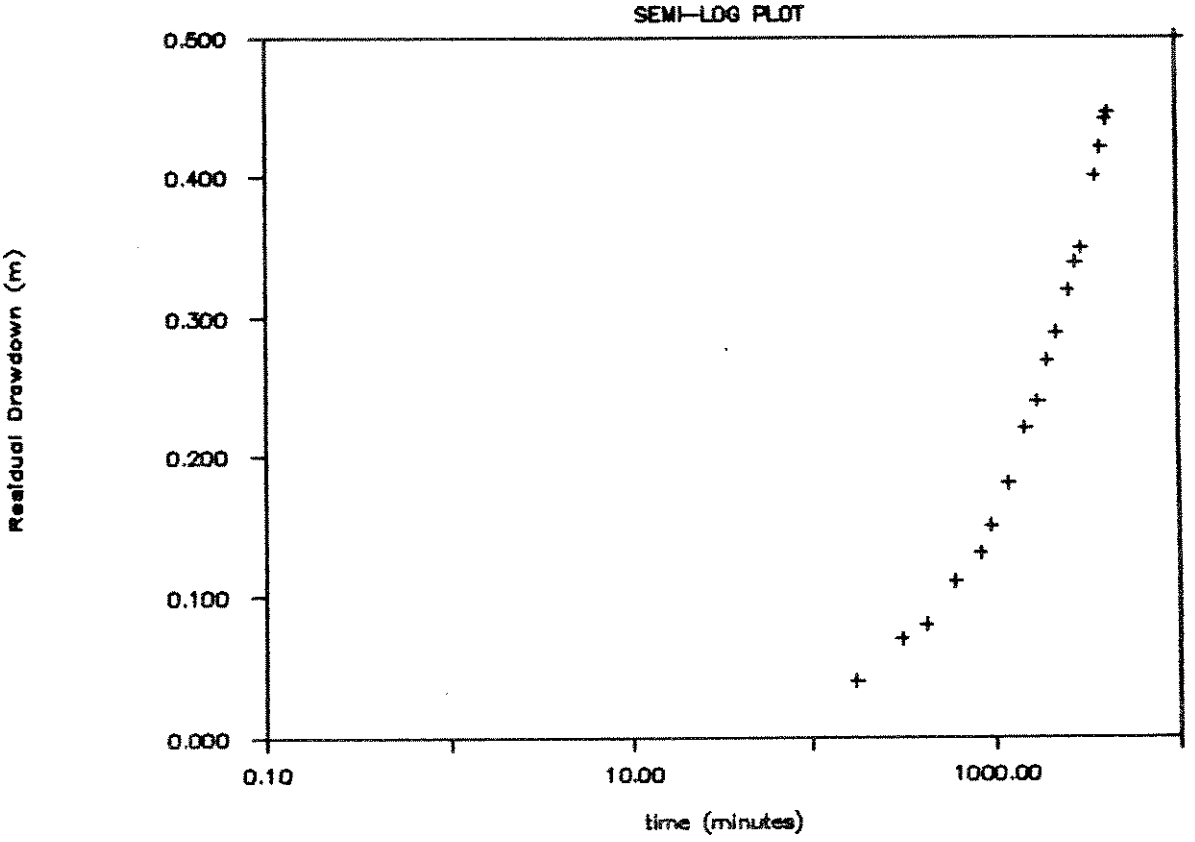
AQUIFER TEST DATA JOB #1293 WELL#: P79

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	602 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	2.19	Discharge rate:	350 IGPM

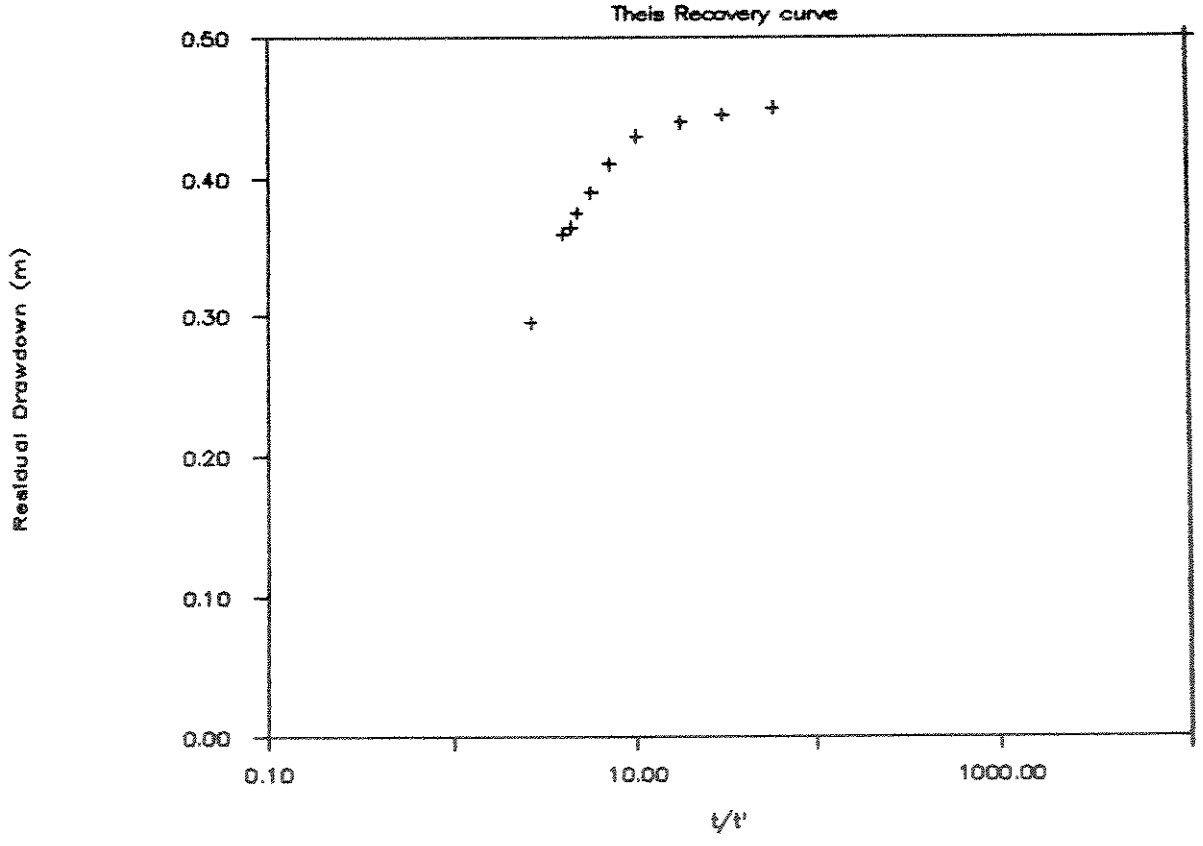
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
76	57.8	2.640	0.450
147	30.4	2.635	0.445
254	18.0	2.630	0.440
473	10.1	2.620	0.430
702	7.2	2.600	0.410
934	5.6	2.580	0.390
1167	4.7	2.565	0.375
1284	4.4	2.555	0.365
1484	3.9	2.550	0.360
2598	2.7	2.485	0.295

DRAWDOWN PLOT FOR P79-1293



RECOVERY PLOT P79-1293



AQUIFER TEST DATA JOB#1293 WELL#: P80

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	667 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.02	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
178.0	3.060	0.040	350	
312.0	3.090	0.070		
423.0	3.110	0.090		
605.0	3.130	0.110		
830.0	3.170	0.150		
935.0	3.200	0.180		
1173.0	3.215	0.195		
1446.0	3.250	0.230		
1681.0	3.275	0.255		
1920.0	3.300	0.280		
2165.0	3.320	0.300		
2522.0	3.360	0.340		
2763.0	3.385	0.365		
3001.0	3.400	0.380		
3555.0	3.430	0.410		
3825.0	3.450	0.430		
4113.0	3.480	0.460		
4246.0	3.490	0.470		

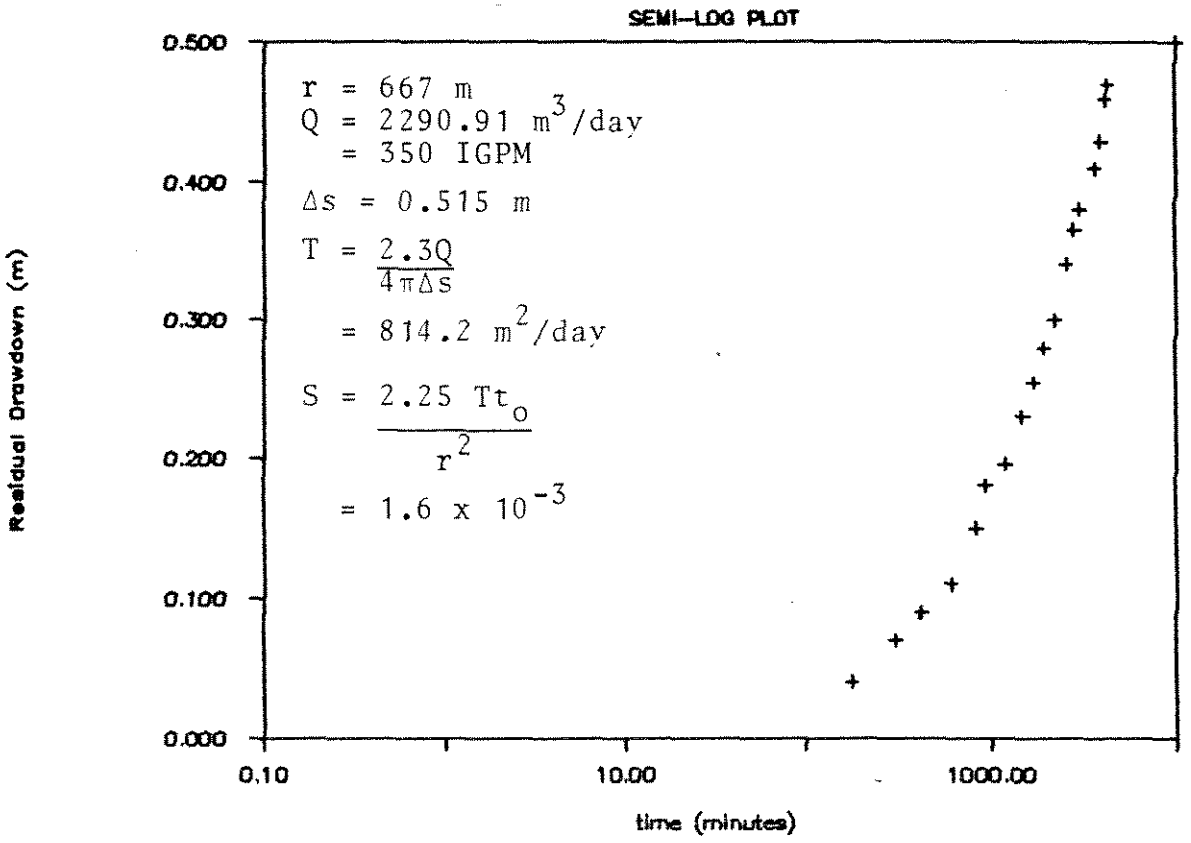
AQUIFER TEST DATA JOB #1293 WELL#: P80

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	667 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	3.02	Discharge rate:	350 IGPM

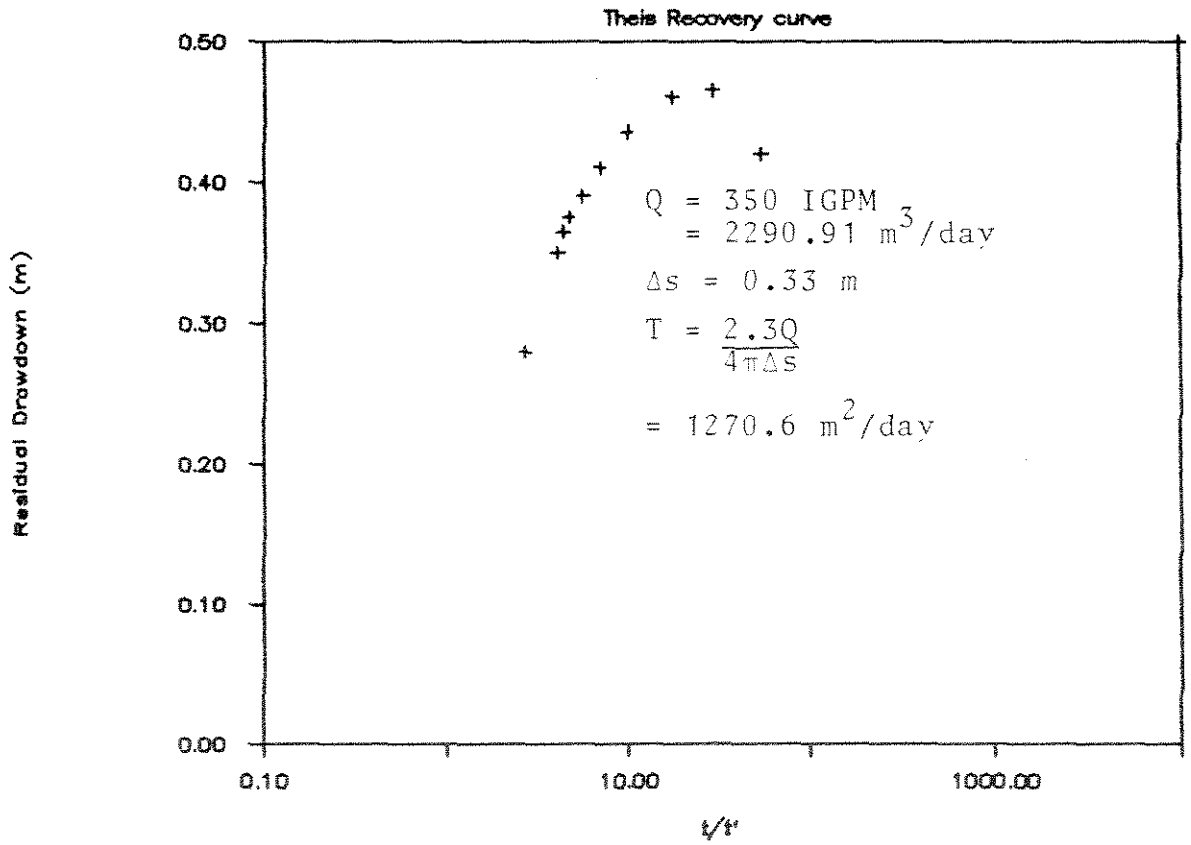
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
80	55.0	3.440	0.420
150	29.8	3.485	0.465
258	17.7	3.480	0.460
477	10.1	3.455	0.435
708	7.1	3.430	0.410
939	5.6	3.410	0.390
1170	4.7	3.395	0.375
1287	4.4	3.385	0.365
1431	4.0	3.370	0.350
2546	2.7	3.300	0.280

DRAWDOWN PLOT FOR P80–1293



RECOVERY PLOT P80–1293



AQUIFER TEST DATA JOB#1293 WELL#: P85

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	142 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	4.40	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
3.0	4.400	0.000	350	
9.0	4.400	0.000		
12.0	4.400	0.000		
15.0	4.400	0.000		
17.0	4.400	0.000		
20.0	4.400	0.000		
26.0	4.400	0.000		
31.0	4.400	0.000		
41.0	4.405	0.005		
51.0	4.405	0.005		
119.0	4.425	0.025		
150.0	4.430	0.030		
212.0	4.450	0.050		
272.0	4.455	0.055		
392.0	4.475	0.075		
453.0	4.475	0.075		
515.0	4.490	0.090		
595.0	4.500	0.100		
660.0	4.510	0.110		
760.0	4.530	0.130		
845.0	4.540	0.140		
910.0	4.550	0.150		
1048.0	4.570	0.170		
1145.0	4.560	0.160		
1295.0	4.585	0.185		
1423.0	4.605	0.205		
1523.0	4.610	0.210		
1624.0	4.630	0.230		
1827.0	4.640	0.240		
1962.0	4.660	0.260		
2103.0	4.670	0.270		
2245.0	4.680	0.280		
2380.0	4.690	0.290		
2498.0	4.700	0.300		
2618.0	4.715	0.315		
2738.0	4.720	0.320		
2844.0	4.730	0.330		
2977.0	4.740	0.340		
3099.0	4.750	0.350		
3275.0	4.760	0.360		

AQUIFER TEST DATA JOB#1293 WELL#: P85

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	142 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	4.40	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
3390.0	4.770	0.370		
3510.0	4.780	0.380		
3630.0	4.790	0.390		
3780.0	4.800	0.400		
3935.0	4.815	0.415		
4088.0	4.825	0.425		
4223.0	4.830	0.430		

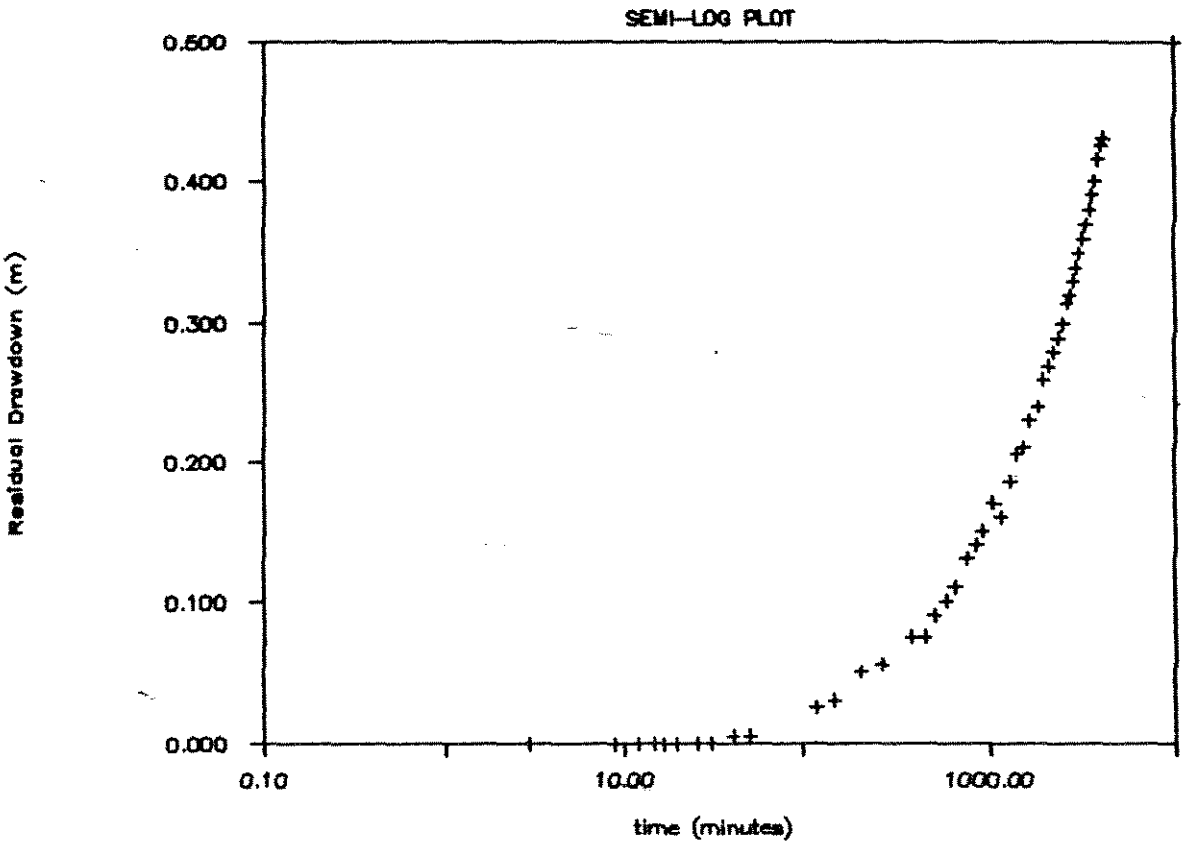
AQUIFER TEST DATA JOB #1293 WELL#: P85

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	142 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	4.4	Discharge rate:	350 IGPM

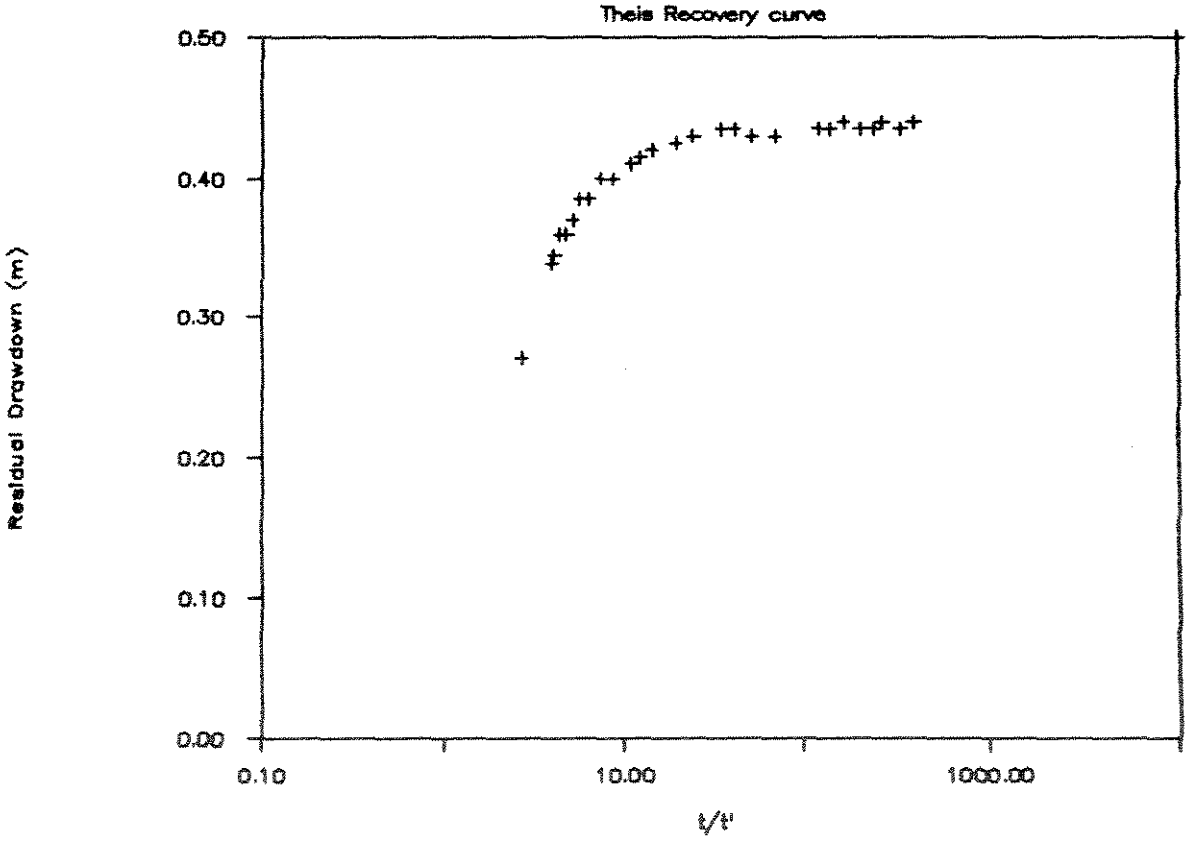
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
11	393.7	4.840	0.440
13	333.3	4.835	0.435
16	271.0	4.840	0.440
18	241.0	4.835	0.435
21	206.7	4.835	0.435
26	167.2	4.840	0.440
31	140.4	4.835	0.435
36	121.0	4.835	0.435
63	69.6	4.830	0.430
85	51.8	4.830	0.430
106	41.8	4.835	0.435
126	35.3	4.835	0.435
184	24.5	4.830	0.430
232	19.6	4.825	0.425
320	14.5	4.820	0.420
375	12.5	4.815	0.415
433	11.0	4.810	0.410
554	8.8	4.800	0.400
669	7.5	4.800	0.400
789	6.5	4.785	0.385
910	5.7	4.785	0.385
1028	5.2	4.770	0.370
1154	4.7	4.760	0.360
1272	4.4	4.760	0.360
1417	4.0	4.745	0.345
1453	4.0	4.740	0.340
2521	2.7	4.670	0.270

DRAWDOWN PLOT FOR P85-1293



RECOVERY PLOT P85-1293



AQUIFER TEST DATA JOB#1293 WELL#: P86

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	105 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.34	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
1.0	3.340	0.000	350	
2.0	3.340	0.000		
5.0	3.360	0.020		
7.0	3.370	0.030		
10.0	3.370	0.030		
13.0	3.380	0.040		
16.0	3.380	0.040		
18.0	3.390	0.050		
21.0	3.395	0.055		
25.0	3.400	0.060		
30.0	3.400	0.060		
35.0	3.400	0.060		
40.0	3.400	0.060		
45.0	3.405	0.065		
50.0	3.410	0.070		
117.0	3.440	0.100		
148.0	3.450	0.110		
209.0	3.470	0.130		
270.0	3.490	0.150		
390.0	3.510	0.170		
451.0	3.520	0.180		
508.0	3.530	0.190		
620.0	3.550	0.210		
670.0	3.550	0.210		
761.0	3.560	0.220		
846.0	3.580	0.240		
914.0	3.600	0.260		
1050.0	3.620	0.280		
1143.0	3.630	0.290		
1293.0	3.650	0.310		
1421.0	3.665	0.325		
1524.0	3.680	0.340		
1630.0	3.695	0.355		
1825.0	3.740	0.400		
1960.0	3.740	0.400		
2100.0	3.740	0.400		
2240.0	3.760	0.420		
2385.0	3.770	0.430		
2425.0	3.800	0.460		
2495.0	3.780	0.440		

AQUIFER TEST DATA JOB#1293 WELL#: P86

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	105 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.34	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
2617.0	3.785	0.445		
2739.0	3.795	0.455		
2842.0	3.800	0.460		
2975.0	3.810	0.470		
3098.0	3.820	0.480		
3260.0	3.830	0.490		
3390.0	3.840	0.500		
3510.0	3.850	0.510		
3630.0	3.860	0.520		
3780.0	3.870	0.530		
3933.0	3.890	0.550		
4086.0	3.900	0.560		
4221.0	3.905	0.565		

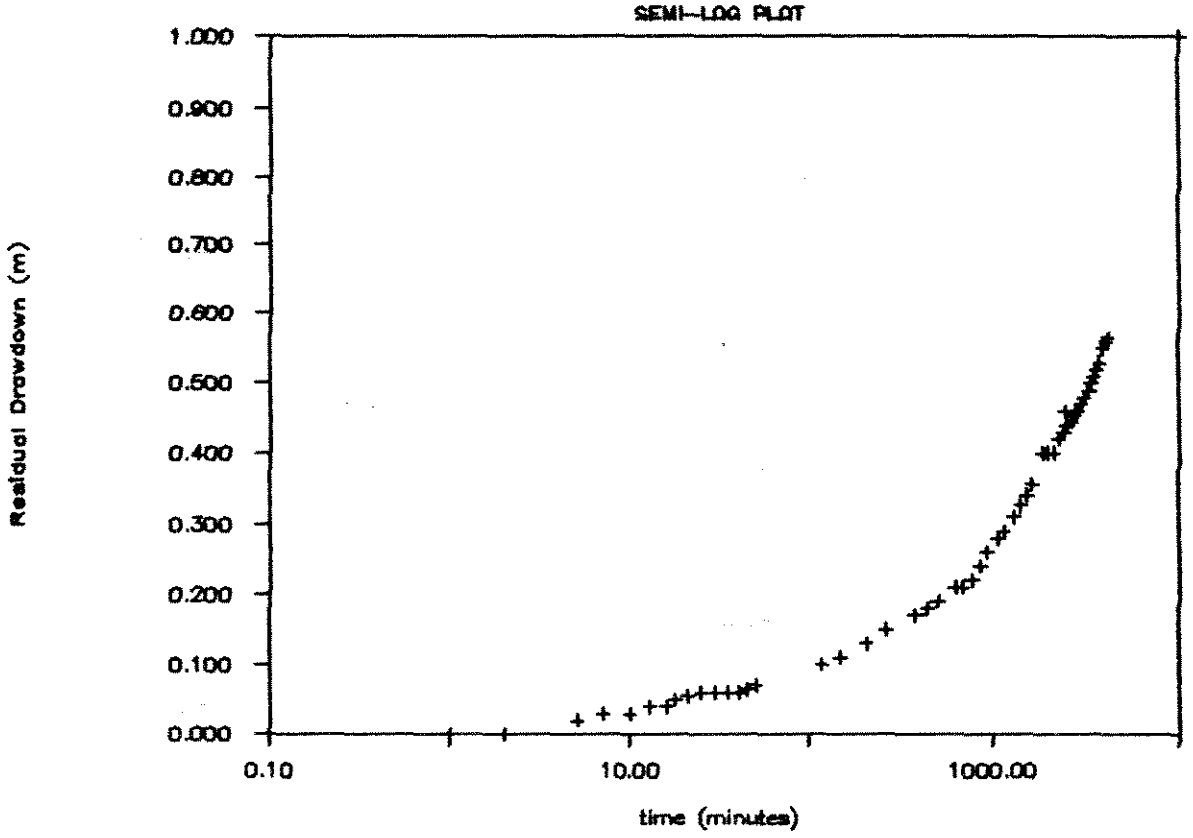
AQUIFER TEST DATA JOB #1293 WELL#: P86

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	105 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	3.34	Discharge rate:	350 IGPM

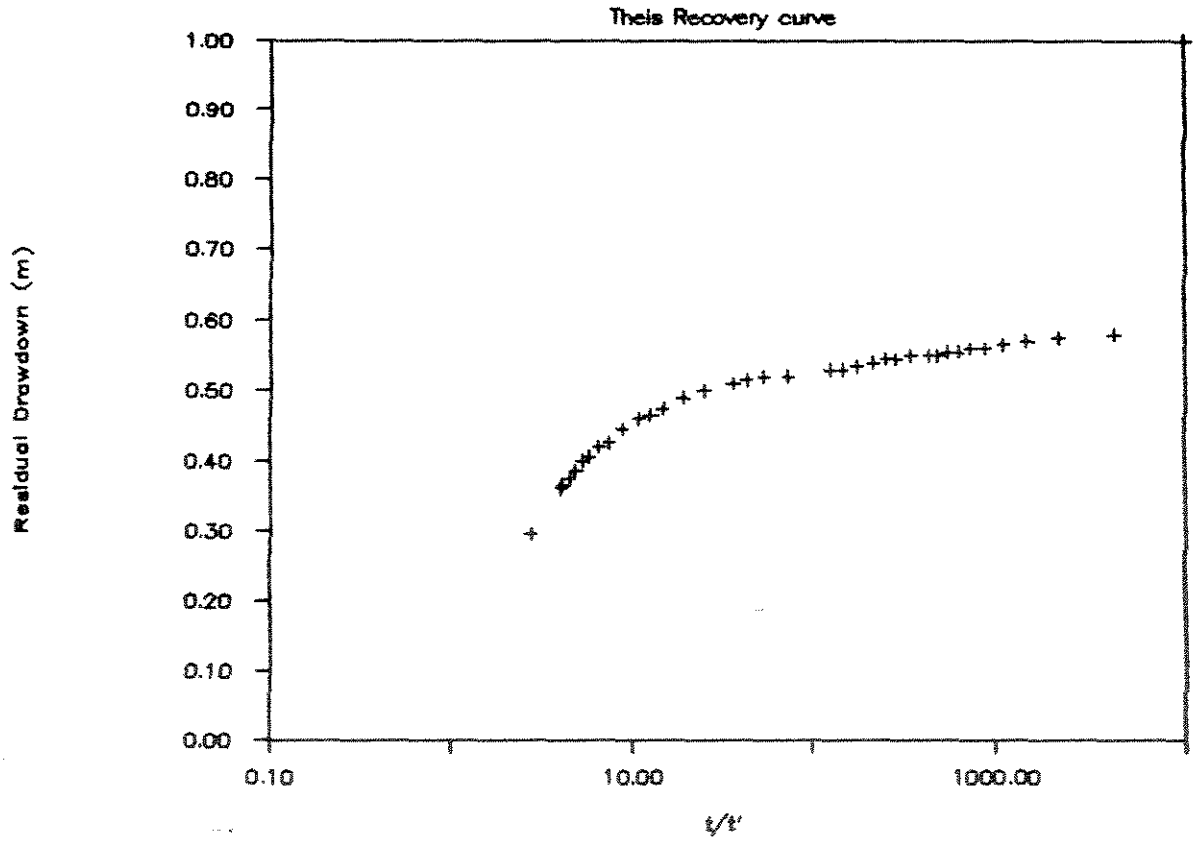
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
1	4321.0	3.920	0.580
2	2161.0	3.915	0.575
3	1441.0	3.910	0.570
4	1081.0	3.905	0.565
5	865.0	3.900	0.560
6	721.0	3.900	0.560
7	618.1	3.895	0.555
8	541.0	3.895	0.555
9	481.0	3.890	0.550
10	433.0	3.890	0.550
12.5	346.6	3.890	0.550
15	289.0	3.885	0.545
17	255.1	3.885	0.545
20	217.0	3.880	0.540
25	173.8	3.875	0.535
30	145.0	3.870	0.530
35	124.4	3.870	0.530
61	71.8	3.860	0.520
83	53.0	3.860	0.520
104	42.5	3.855	0.515
124	35.8	3.850	0.510
181	24.9	3.840	0.500
240	19.0	3.830	0.490
314	14.8	3.815	0.475
372	12.6	3.805	0.465
430	11.0	3.800	0.460
551	8.8	3.785	0.445
666	7.5	3.765	0.425
787	6.5	3.760	0.420
908	5.8	3.745	0.405
1020	5.2	3.740	0.400
1146	4.8	3.725	0.385
1264	4.4	3.715	0.375
1409	4.1	3.705	0.365
1451	4.0	3.700	0.360
2519	2.7	3.635	0.295

DRAWDOWN PLOT FOR P86-1293



RECOVERY PLOT P86-1293



AQUIFER TEST DATA JOB#1293 WELL#: P88

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	435 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.66	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
61.0	3.655	-0.005	350	
97.0	3.660	0.000		
125.0	3.675	0.015		
155.0	3.670	0.010		
219.0	3.675	0.015		
288.0	3.680	0.020		
398.0	3.695	0.035		
457.0	3.700	0.040		
522.0	3.705	0.045		
637.0	3.710	0.050		
781.0	3.710	0.050		
866.0	3.710	0.050		
966.0	3.720	0.060		
1016.0	3.720	0.060		
1150.0	3.720	0.060		
1298.0	3.730	0.070		
1426.0	3.735	0.075		
1536.0	3.740	0.080		
1669.0	3.745	0.085		
1840.0	3.760	0.100		
1990.0	3.760	0.100		
2130.0	3.760	0.100		
2395.0	3.770	0.110		
2501.0	3.780	0.120		
2622.0	3.785	0.125		
2741.0	3.795	0.135		
2847.0	3.805	0.145		
2980.0	3.810	0.150		
3103.0	3.820	0.160		
3280.0	3.830	0.170		
3390.0	3.830	0.170		
3510.0	3.840	0.180		
3630.0	3.850	0.190		
3780.0	3.860	0.200		
3938.0	3.850	0.190		
4091.0	3.860	0.200		
4226.0	3.870	0.210		

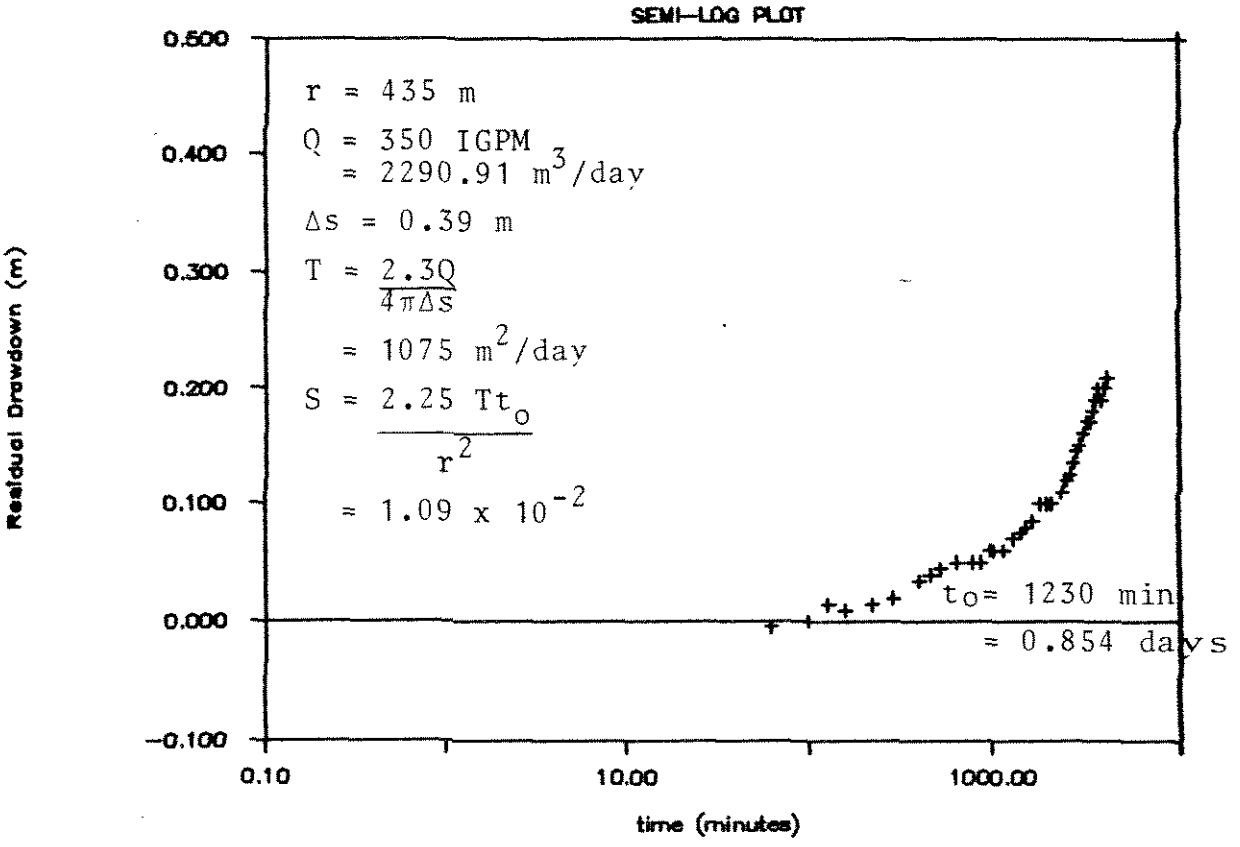
AQUIFER TEST DATA JOB #1293 WELL#: P88

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	435 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	3.66	Discharge rate:	350 IGPM

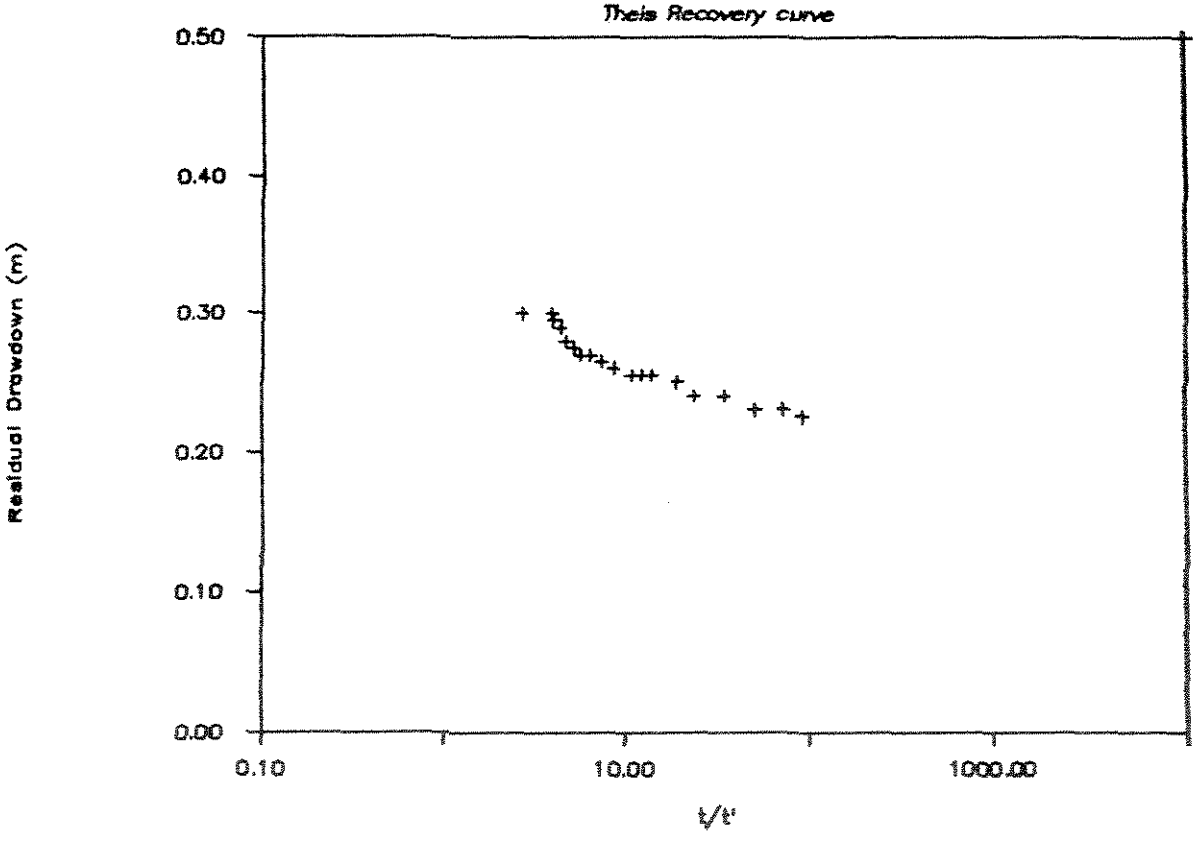
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
48	91.0	3.885	0.225
61	71.8	3.890	0.230
87	50.7	3.890	0.230
128	34.8	3.900	0.240
187	24.1	3.900	0.240
234	19.5	3.910	0.250
330	14.1	3.915	0.255
380	12.4	3.915	0.255
438	10.9	3.915	0.255
559	8.7	3.920	0.260
673	7.4	3.925	0.265
794	6.4	3.930	0.270
914	5.7	3.930	0.270
1025	5.2	3.935	0.275
1151	4.8	3.940	0.280
1262	4.4	3.950	0.290
1415	4.1	3.955	0.295
1457	4.0	3.960	0.300
2524	2.7	3.960	0.300

DRAWDOWN PLOT FOR P88–1293



RECOVERY PLOT P88–1293



AQUIFER TEST DATA JOB#1293 WELL#: P89

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	450 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	4.58	Length of Test:	72 HRS

Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
63.0	4.690	0.110	350	
98.0	4.715	0.135		
126.0	4.740	0.160		
157.0	4.755	0.175		
220.0	4.780	0.200		
290.0	4.800	0.220		
400.0	4.830	0.250		
460.0	4.845	0.265		
525.0	4.860	0.280		
635.0	4.880	0.300		
740.0	4.900	0.320		
865.0	4.920	0.340		
945.0	4.940	0.360		
1028.0	4.955	0.375		
1152.0	4.970	0.390		
1300.0	4.995	0.415		
1428.0	5.015	0.435		
1538.0	5.030	0.450		
1661.0	5.040	0.460		
1830.0	5.060	0.480		
1980.0	5.070	0.490		
2130.0	5.090	0.510		
2395.0	5.110	0.530		
2503.0	5.125	0.545		
2623.0	5.130	0.550		
2743.0	5.135	0.555		
2849.0	5.140	0.560		
2982.0	5.150	0.570		
3105.0	5.165	0.585		
3280.0	5.180	0.600		
3390.0	5.190	0.610		
3510.0	5.200	0.620		
3630.0	5.210	0.630		
3780.0	5.220	0.640		
3940.0	5.230	0.650		
4093.0	5.230	0.650		
4228.0	5.250	0.670		

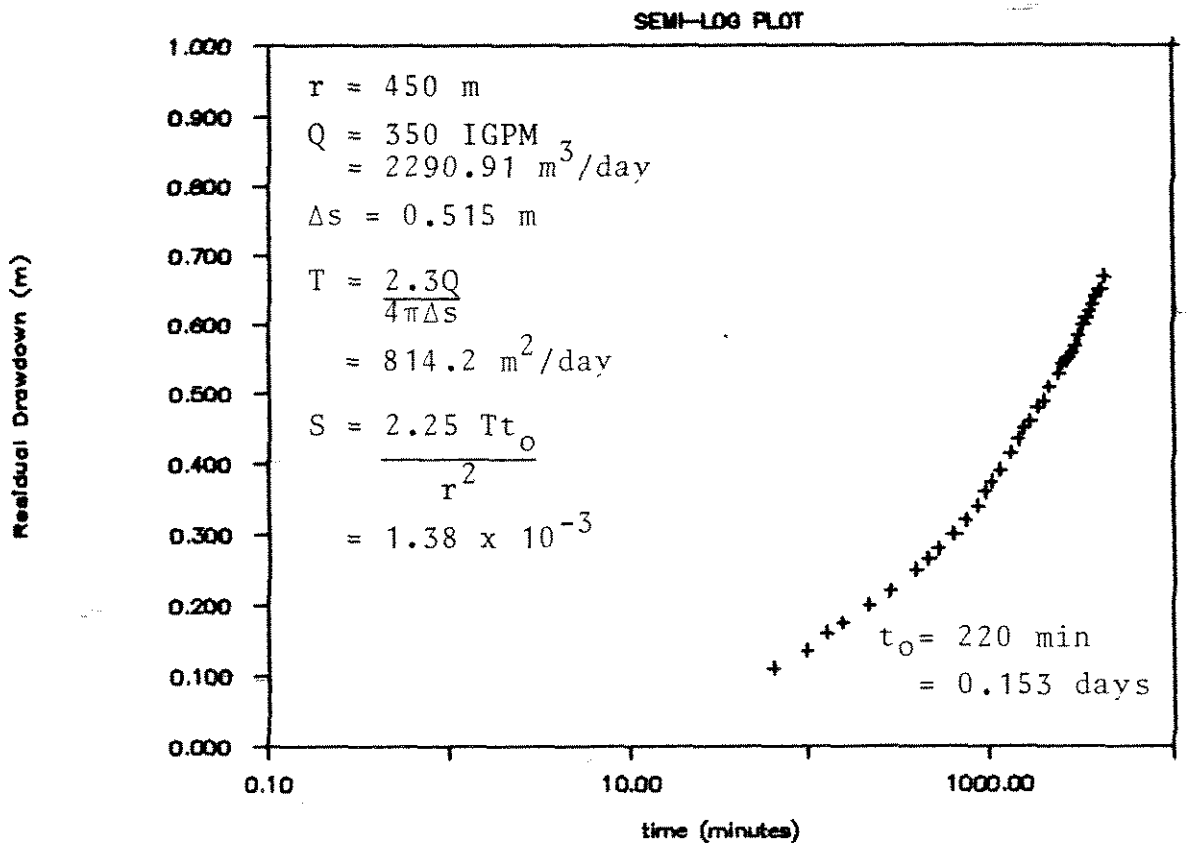
AQUIFER TEST DATA JOB #1293 WELL#: P89

Type of aquifer test:	CONST. Q	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	RECOVERY
Distance from pumping well:	450 m	Depth pump:	18.3 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	07-10-87 16:00:00
Elevation of Measuring Pt.:		Pump off:	10-10-87 16:00:00
Static Water Level:	4.58	Discharge rate:	350 IGPM

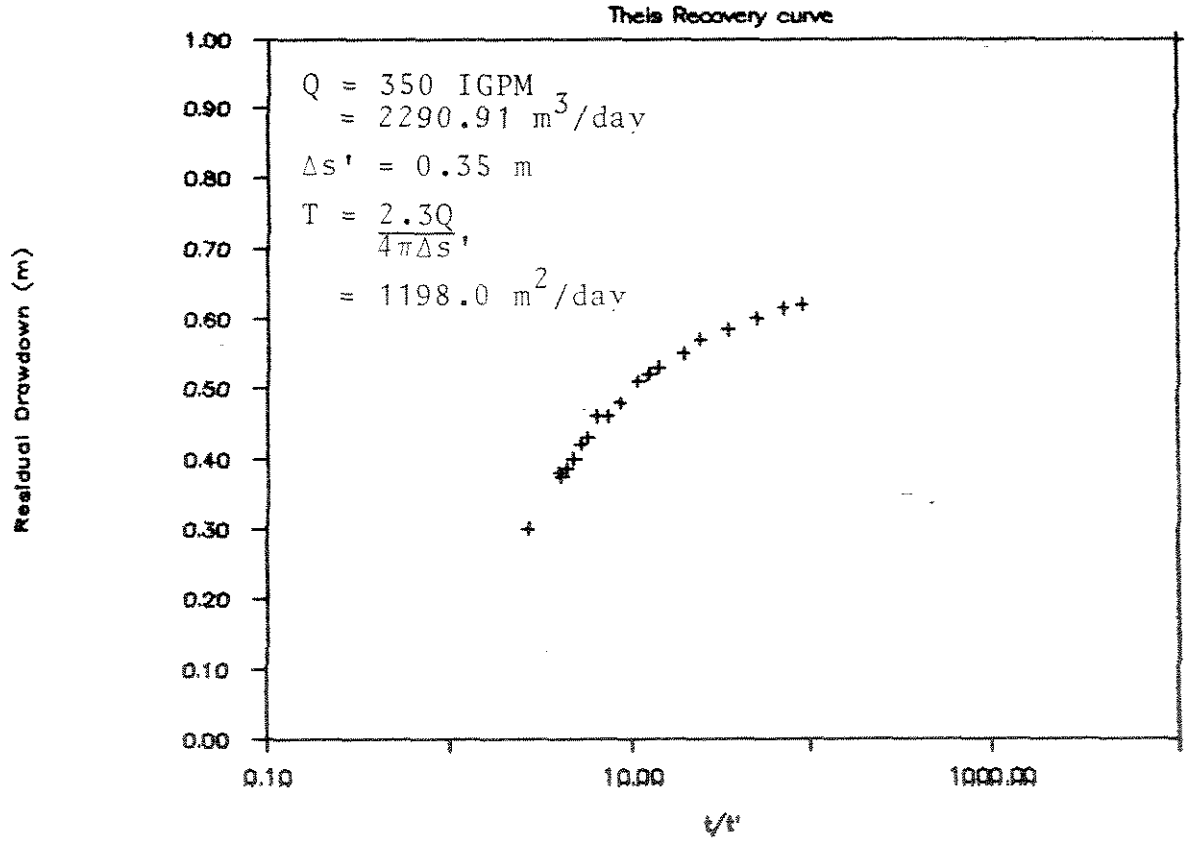
At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
49	89.2	5.200	0.620
63	69.6	5.195	*0.615*
89	49.5	5.180	0.600
130	34.2	5.165	0.585
189	23.9	5.150	0.570
236	19.3	5.130	0.550
332	14.0	5.110	0.530
380	12.4	5.100	0.520
440	10.8	5.090	0.510
561	8.7	5.060	0.480
676	7.4	5.040	0.460
797	6.4	5.040	0.460
920	5.7	5.010	0.430
1027	5.2	5.000	0.420
1153	4.7	4.980	0.400
1270	4.4	4.965	0.385
1416	4.1	4.955	0.375
1458	4.0	4.960	0.380
2526	2.7	*4.880*	*0.300*

DRAWDOWN PLOT FOR P89-1293



RECOVERY PLOT P89-1293



AQUIFER TEST DATA JOB#1293 WELL#: P90

Type of aquifer test:	CONST.DISCHARGE	Well type:	OBSERVATION
How Q Measured:	ORIFICE WEIR	Data type:	PUMPING
How w. l.'s measured:	W.L. TAPE	Depth pump:	18.3 m
Rad./dist. from pumping well:	480 m	Pump on:	07-10-87 16:00:00
Meas. point for w. l.'s(m):	T.O.C.	Pump off:	10-10-87 16:00:00
Ground Elevation (masl):		Discharge rate:	350 IGPM
Static Water Level (m):	3.46	Length of Test:	72 HRS

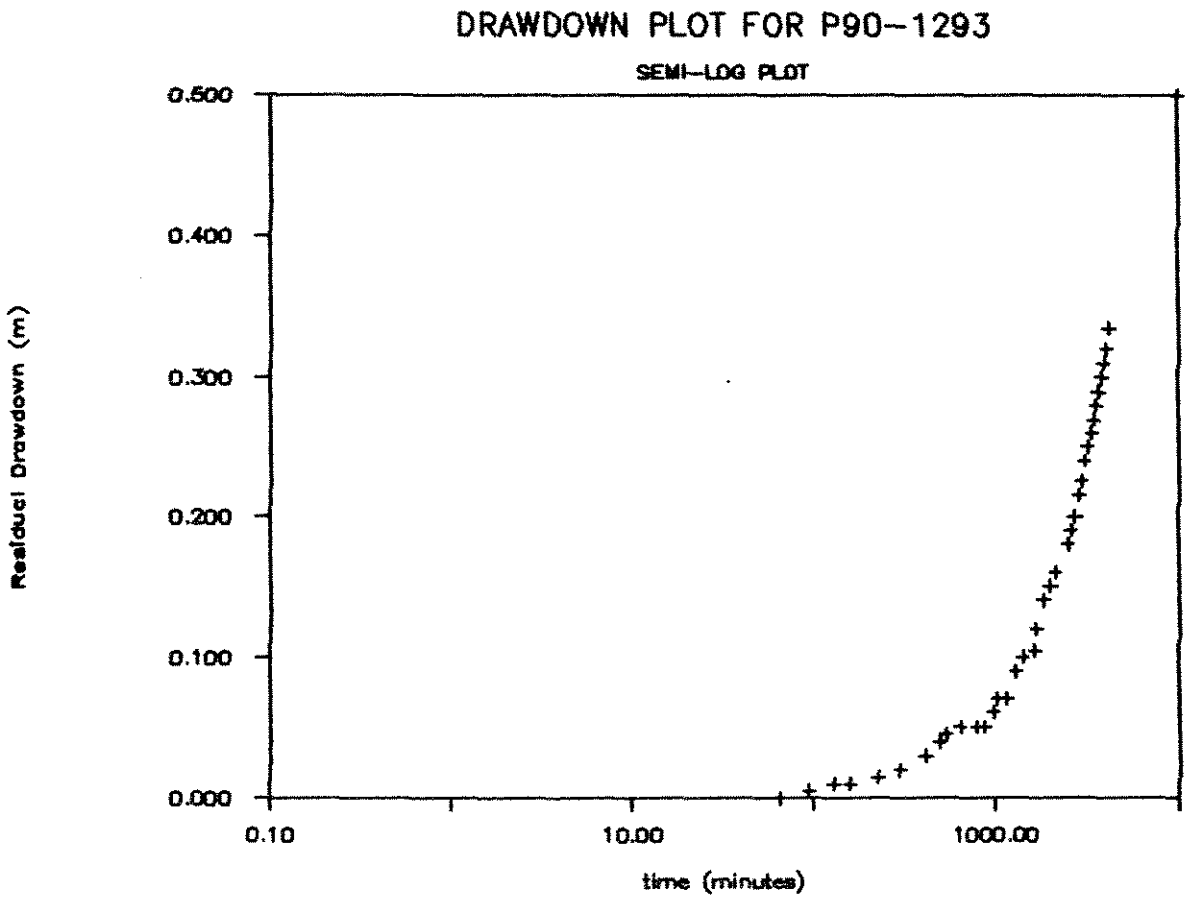
Time from start of test (minutes)	W.L. reading (m)	Residual Drawdown s (m)	Discharge rate Q (IGPM)	COMMENTS
64.0	3.460	0.000	350	
94.0	3.465	0.005		
129.0	3.470	0.010		
160.0	3.470	0.010		
224.0	3.475	0.015		
294.0	3.480	0.020		
405.0	3.490	0.030		
483.0	3.500	0.040		
527.0	3.505	0.045		
632.0	3.510	0.050		
780.0	3.510	0.050		
864.0	3.510	0.050		
964.0	3.520	0.060		
1021.0	3.530	0.070		
1153.0	3.530	0.070		
1303.0	3.550	0.090		
1430.0	3.560	0.100		
1671.0	3.565	0.105		
1674.0	3.580	0.120		
1835.0	3.600	0.140		
1990.0	3.610	0.150		
2140.0	3.620	0.160		
2515.0	3.640	0.180		
2626.0	3.650	0.190		
2747.0	3.660	0.200		
2866.0	3.675	0.215		
2973.0	3.685	0.225		
3106.0	3.700	0.240		
3228.0	3.710	0.250		
3400.0	3.720	0.260		
3510.0	3.730	0.270		
3630.0	3.740	0.280		
3750.0	3.750	0.290		
3900.0	3.760	0.300		
3943.0	3.770	0.310		
4096.0	3.780	0.320		
4231.0	3.795	0.335		

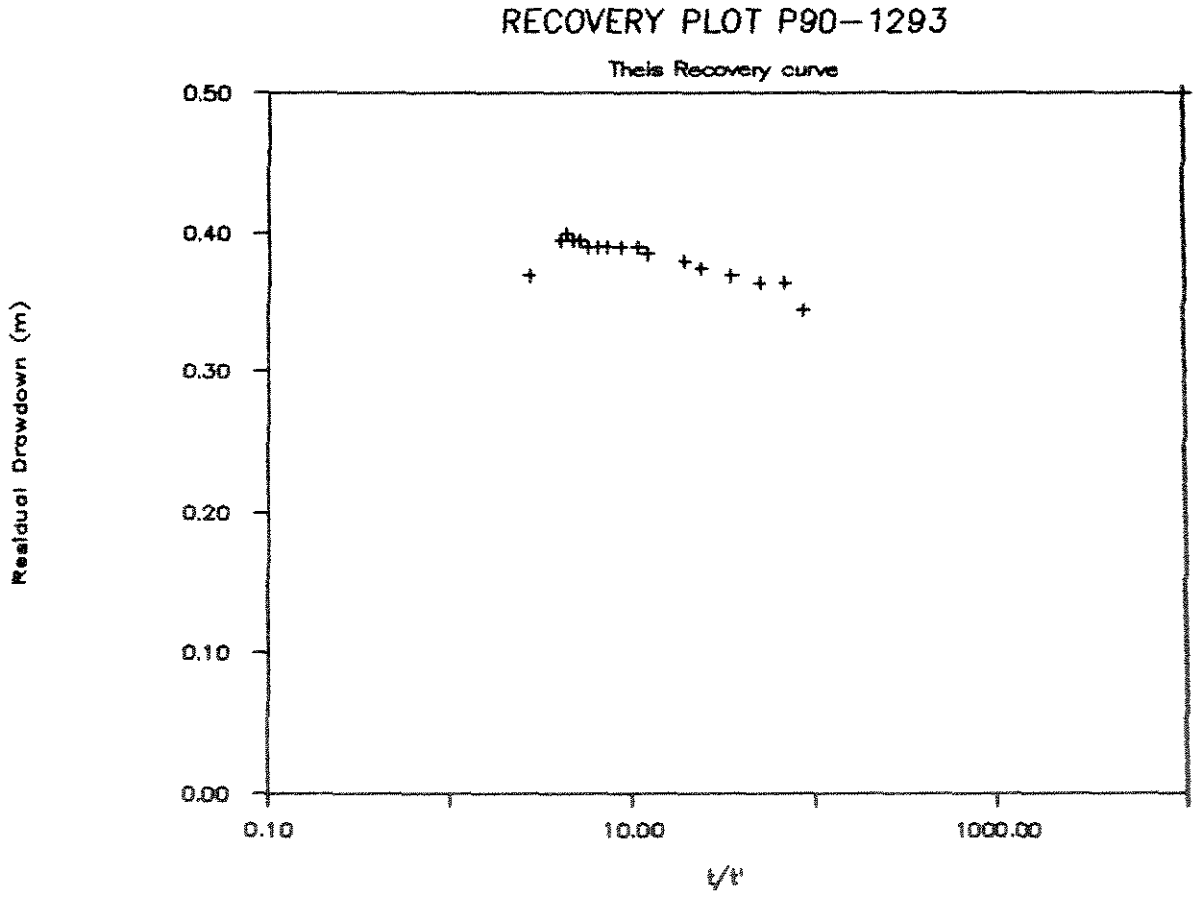
AQUIFER TEST DATA JOB #1293 WELL#: P90

Type of aquifer test: CONST. Q Well type: OBSERVATION
How Q Measured: ORIFICE WEIR Data type: RECOVERY
Distance from pumping well: 480 m Depth pump: 18.3 m
Meas. point for w. l.'s: T.O.C. Pump on: 07-10-87 16:00:00
Elevation of Measuring Pt.: Pump off: 10-10-87 16:00:00
Static Water Level: 3.46 Discharge rate: 350 IGPM

At t' = 0, t = 4320 Water Level Data

Time minutes	t/t'	w.l. (m)	Residual Drawdown
51	85.7	3.805	0.345
66	66.5	3.825	0.365
91	48.5	3.825	0.365
132	33.7	3.830	0.370
192	23.5	3.835	0.375
239	19.1	3.840	0.380
388	12.1	3.845	0.385
445	10.7	3.850	0.390
560	8.7	3.850	0.390
682	7.3	3.850	0.390
800	6.4	3.850	0.390
927	5.7	3.850	0.390
1030	5.2	3.855	0.395
1156	4.7	3.855	0.395
1273	4.4	3.860	0.400
1418	4.0	3.855	0.395
2529	2.7	3.830	0.370


DRAWDOWN PLOT FOR P90-1293
SEMI-LOG PLOT
Residual Drawdown (m)
0.500
0.400
0.300
0.200
0.100
0.000
0.10
10.00
1000.00
time (minutes)


RECOVERY PLOT P90-1293
Theis Recovery curve
Residual Drawdown (m)
0.50
0.40
0.30
0.20
0.10
0.00
0.10
10.00
1000.00
t/t'

Well Efficiency

$$T = \frac{2.3Q}{4\pi\Delta s}$$

$T = 1000\ m^2/day$ $\qquad$ $Q = 350$ IGPM $= 2290.91\ m^3/day$

$$\Delta s = \frac{2.3Q}{4\pi T}$$

$$= \frac{2.3(2290.91)}{4\pi(1000)}$$

$$= 0.419\ m$$

actual drawdown from 72 hour test = 1.11 m

$$W.E. = \frac{\text{theoretical drawdown}}{\text{actual drawdown}}$$

$$= \frac{0.419}{1.11}$$

$$= 37.7\%$$

C-2 1990 Test Program

AQUIFER TEST DATA WELL#: 2314-TW1

Type of aquifer test:	Constant Q	Well type:	Production
How Q Measured:	Weir	Data type:	Pumping
Distance from pumping well:	xxx	Depth pump:	15.8 m
Meas. point for W. L.'s:	T.O.C.	Pump on:	03/05/90 19h00
Elevation of Measuring Pt.:	xxx	Pump off:	06/05/90 19h00
Static Water Level:	3.47	Discharge rate:	350 igpm

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
1.00	4.06	0.59	350.00	
2.00	4.08	0.61		
3.00	4.10	0.63		
4.00	4.11	0.64		
5.00	4.12	0.65		
6.00	4.13	0.66		
7.00	4.13	0.66		
8.00	4.14	0.67		
9.00	4.14	0.67		
10.00	4.15	0.68		
12.00	4.15	0.68		Pump off for 1 min
14.00	4.15	0.68		
16.00	4.15	0.68		
18.00	4.16	0.69		
20.00	4.17	0.70		Pump off for 1 min
25.00	4.17	0.70		
30.00	4.19	0.72		
35.00	4.22	0.75		
40.00	4.23	0.76		
45.00	4.22	0.75		Pump off for 1 min
50.00	4.22	0.75		
55.00	4.23	0.76		
60.00	4.25	0.78		
70.00	4.26	0.79		
80.00	4.28	0.81		
90.00	4.29	0.82		
105.00	4.30	0.83		
120.00	4.31	0.84		
180.00	4.32	0.85		
240.00	4.33	0.86		
300.00	4.35	0.88		
360.00	4.36	0.89		
420.00	4.38	0.91		
480.00	4.42	0.95		
540.00	4.42	0.95		
600.00	4.44	0.97		
660.00	4.46	0.99		
720.00	4.47	1.00		
780.00	4.50	1.03		
840.00	4.52	1.05		
900.00	4.54	1.07		
960.00	4.56	1.09		

AQUIFER TEST DATA WELL#: 2314-TW1

Type of aquifer test:	Constant Q	Well type:	Production
How Q Measured:	Weir	Data type:	Pumping
Distance from pumping well:	xxx	Depth pump:	15.8 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	03/05/90 19h00
Elevation of Measuring Pt.:	xxx	Pump off:	06/05/90 19h00
Static Water Level:	3.47	Discharge rate:	350 igpm

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
1020.00	4.55	1.08		
1080.00	4.56	1.09		
1140.00	4.57	1.10		
1200.00	4.58	1.11		
1260.00	4.59	1.12		
1320.00	4.60	1.13		
1380.00	4.60	1.13		
1440.00	4.60	1.13		
1500.00	4.60	1.13		
1560.00	4.61	1.14		
1620.00	4.61	1.14		
1680.00	4.62	1.15		
1740.00	4.63	1.16		
1800.00	4.64	1.17		
1860.00	4.66	1.19		
1920.00	4.68	1.21		
1980.00	4.70	1.23		
2040.00	4.70	1.23		
2100.00	4.71	1.24		
2160.00	4.71	1.24		
2220.00	4.71	1.24		
2280.00	4.72	1.24		
2340.00	4.71	1.24		
2400.00	4.72	1.25		
2460.00	4.73	1.26		
2520.00	4.74	1.27		
2580.00	4.75	1.28		
2640.00	4.76	1.29		
2700.00	4.77	1.30		
2760.00	4.78	1.31		
2820.00	4.78	1.31		
2880.00	4.78	1.31		
2940.00	4.80	1.33		
3000.00	4.80	1.33		
3060.00	4.80	1.33		
3120.00	4.81	1.34		
3180.00	4.82	1.35		
3240.00	4.82	1.35		
3300.00	4.82	1.35		
3360.00	4.83	1.36		
3420.00	4.84	1.37		
3480.00	4.84	1.37		

AQUIFER TEST DATA

WELL#: 2314-TW1

Type of aquifer test:	Constant Q	Well type:	Production
How Q Measured:	Weir	Data type:	Pumping
Distance from pumping well:	xxx	Depth pump:	15.8 m
Meas. point for w. l.'s:	T.O.C.	Pump on:	03/05/90 19h00
Elevation of Measuring Pt.:	xxx	Pump off:	06/05/90 19h00
Static Water Level:	3.47	Discharge rate:	350 igpm

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)	Comments
3540.00	4.84	1.37		
3600.00	4.85	1.38		
3660.00	4.86	1.39		
3720.00	4.87	1.40		
3780.00	4.88	1.41		
3840.00	4.88	1.41		
3900.00	4.88	1.41		
3960.00	4.88	1.41		
4020.00	4.89	1.42		
4080.00	4.90	1.43		
4140.00	4.90	1.43		
4200.00	4.90	1.43		
4260.00	4.90	1.43		
4320.00	4.90	1.43		

AQUIFER TEST DATA WELL#: 2314-OW87

Type of aquifer test:	Constant Q	Well type:	Observation
How Q Measured:	Weir	Data type:	Pumping
Distance from pumping well:	2 m	Depth well:	55 ft.
Meas. point for w. l.'s:	T.O.C.	Pump on:	05-03-90 19h00
Elevation of Measuring Pt.:	xxx	Pump off:	05-06-90 19h00
Static Water Level:	3.18	Discharge rate:	350 igpm

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)
2.25	3.28	0.10	350.00
3.25	3.29	0.11	350.00
4.50	3.30	0.12	350.00
14.00	3.33	0.15	350.00
15.00	3.35	0.17	350.00
16.00	3.35	0.17	350.00
22.00	3.37	0.19	350.00
25.00	3.37	0.19	350.00
31.00	3.39	0.21	350.00
33.00	3.40	0.21	350.00
34.00	3.40	0.21	350.00
40.00	3.41	0.23	350.00
49.00	3.43	0.24	350.00
60.00	3.44	0.26	350.00
94.00	3.49	0.31	350.00
108.00	3.49	0.31	350.00
404.00	3.60	0.42	350.00
730.00	3.70	0.52	350.00
1470.00	3.81	0.63	350.00
3284.00	3.98	0.80	350.00
4321.00	4.10	0.92	350.00

AQUIFER TEST DATA WELL#: 2314-OW84

Type of aquifer test:	Constant Q	Well type:	Observation	
How Q Measured:	Bucket	Data type:	Pumping	
Distance from pumping well:	app. 200 m	Depth well:	55 ft.	
Meas. point for w. l.'s:	T.O.C.	Pump on:	05-03-90	19h00
Elevation of Measuring Pt.:	xxx	Pump off:	05-06-90	19h00
Static Water Level:	3.94	Discharge rate:	350 IGPM	

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)
9.50	3.94	0.00	350.00
103.00	3.94	0.00	350.00
413.00	3.94	0.00	350.00
726.00	3.94	0.00	350.00
1476.00	3.95	0.01	350.00
3290.00	3.97	0.03	350.00
4320.00	3.99	0.05	350.00

AQUIFER TEST DATA WELL#: 2314-OW85

Type of aquifer test:	Constant Q	Well type:	Observation	
How Q Measured:	Bucket	Data type:	Pumping	
Distance from pumping well:	142 m	Depth well:	55 ft.	
Meas. point for w. l.'s:	T.O.C.	Pump on:	05-03-90	19h00
Elevation of Measuring Pt.:	xxx	Pump off:	05-06-90	19h00
Static Water Level:	3.82	Discharge rate:	350 IGPM	

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)
7.75	3.82	0.00	350.00
19.00	3.83	0.01	350.00
28.00	3.83	0.01	350.00
37.00	3.84	0.02	350.00
46.00	3.84	0.02	350.00
100.00	3.86	0.04	350.00
412.00	3.92	0.10	350.00
725.00	3.98	0.16	350.00
1475.00	4.09	0.27	350.00
3289.00	4.25	0.43	350.00
4320.00	4.38	0.56	350.00

AQUIFER TEST DATA WELL#: 2314-OW89

Type of aquifer test:	Constant Q	Well type:	Observation	
How Q Measured:	Bucket	Data type:	Pumping	
Distance from pumping well:	450 m	Depth well:	55 ft.	
Meas. point for w. l.'s:	T.O.C.	Pump on:	05-03-90	19h00
Elevation of Measuring Pt.:	xxx	Pump off:	05-06-90	19h00
Static Water Level:	3.94	Discharge rate:	350 IGPM	

Time (min.)	Water Level (m)	Drawdown (m)	Discharge (i.g.p.m.)
105.00	3.94	0.00	350.00
420.00	4.25	0.31	350.00
720.00	4.34	0.40	350.00
1480.00	4.45	0.51	350.00
3296.00	4.62	0.68	350.00
4320.00	4.72	0.78	350.00

MANN TESTING LABORATORIES LTD.
5550 McADAM ROAD, MISSISSAUGA, ONTARIO L4Z 1P1
PHONE: 890-2555 • TELEX: 06-960496

CUSTOMER: Water & Earth Science Associates
Box 430
Carp, Ontario
K0A 1L0

REPORT #: 879021

CUSTOMER REF.#

ATTN: Ms. Tami Sugarman

DATE SUBMITTED: Oct. 27/87

CERTIFICATE OF ANALYSIS

Sample Description: **WATER**

Preparation: Samples were prepared as recommended in APHA Standard methods for the examination of water and wastewater, 16th Edition, 1985 or MOE Handbook of analytical methods for environmental samples, 1983.

Note: Additional information is available on request.

Methodology:

TOC - combustion and I.R. detector

Chemical Results: See Table 1.

DATE: Dec. 1, 1987

CERTIFIED BY:
ROY G. SMITH, C.CHEM.

GEN-H

CLIENT: WATER AND EARTH SCIENCE ASSOCIATES LIMITED
REF. NO.: 879021
TABLE: 1

CHEMICAL ANALYSIS - GENERAL
CONC = mg/L UNLESS OTHERWISE NOTED

CHEMICAL PARAMETERS	MDL (mg/L)	QA/QC (mg/L) EXP'T	QA/QC (mg/L) TRUE	1293 24 HRS S-1	1293 48 HRS S-2	1293 72 HRS S-3		
TOTAL ORGANIC CARBON	1			6	6	6		

MDL = INSTRUMENT/METHOD DETECTION LIMIT
NS = NON SUFFICIENT SAMPLE
-- = NO ANALYSIS REQUIRED

a= EPA WP 1083 ICAP 19/7
b= EPA WP 386 TRACE METALS - 1
c= NBS 1643b TRACE ELEMENTS IN WATER
d= EPA WP 1185+WS 378 MINERALS +NO3/F-6
e= OTHER

MANN TESTING LABORATORIES LTD.
5550 McADAM ROAD, MISSISSAUGA, ONTARIO L4Z 1P1
PHONE: 890-2555 • TELEX: 06-960496

February 12, 1988

Water & Earth Science Associates
P.O. Box 430
Carp, Ontario
KOA 1LO

Attention: Mr. Tami Sugarman

RE: PESTICIDE ANALYSIS
MANN #878958

Dear Mr. Sugarman:

Enclosed, please find the results of the analysis conducted on the samples received October 27, 1987.

An outline of the analytical methodology used in the analysis and copies of chromatograms are available upon request.

Should you have any further inquiries regarding these results, please do not hesitate to contact us directly.

Yours truly,

MANN TESTING LABORATORIES LTD.

T. Munshaw

Tim Munshaw, M.Sc.,C.Chem.
Manager, Environmental

TM/jh
Encl.

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
T. Munshaw
CHEMIST

8958-1

REQ. #309 REPORT
CONC. = ppb = ug/L

WATER AND EARTH SCIENCE
W.O. #878958

NITROGEN PHOSPHORUS HERBICIDES	MDL (ppb)	% RECOVERY	BLANK	1293-8-24 HR.	1293-9-48 HR.	1293-10-72 HR.
ALDRIN	0.7	89	--	--	--	--
DIELDRIN	0.7	92	--	--	--	--
ENDRIN	0.2	90	--	--	--	--
CHLORDANE	7.0	91	--	--	--	--
DDT	30.0	92	--	--	--	--
HEPTACHLOR	3.0	90	--	--	--	--
HEPTACHLOR EPOXIDE	3.0	89	--	--	--	--
LINDANE	4.0	88	--	--	--	--
METHOXYCHLOR	100.0	91	--	--	--	--
PCB'S	3.0	98	--	--	--	--
TOXAPHENE	5.0	93	--	--	--	--
CARBARYL	70.0	64	--	--	--	--
DIAZINON	2.0	87	--	--	--	--
METHYL PARATHION	7.0	99	--	--	--	--
PARATHION	35.0	93	--	--	--	--

MDL = METHOD DETECTION LIMIT
TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED

MANN TESTING LABORATORIES LTD.
5550 McADAM ROAD, MISSISSAUGA, ONTARIO L4Z 1P1
PHONE: 890-2555 • TELEX: 06-960496

March 16, 1988

Water and Earth Science Associates Ltd.
Box 430
Carp, Ontario
K0A 1L0

Attention: Mr. Tami Sugarman

RE: REG 309 PESTICIDE ANALYSIS
REVISED REPORT
MANN #878958

Dear Mr. Sugarman:

Enclosed, please find the results of the analysis conducted on the samples received February 27, 1988.

An outline of the analytical methodology used in the analysis and copies of chromatograms are available upon request.

Should you have any further inquiries regarding these results, please do not hesitate to contact us directly.

Yours truly,

MANN TESTING LABORATORIES LTD.

T Munshaw

Tim Munshaw, M.Sc.,C.Chem.
Manager, Environmental

TM/vs
Encl.

8958-1

REVISED REPORT

REQ. #309 REPORT
CONC. = ppb = ug/L

WATER AND EARTH SCIENCE
W.O. #878958

NITROGEN PHOSPHORUS HERBICIDES	MDL (ppb)	% RECOVERY	BLANK	1293-8-24 HR.	1293-9-48 HR.	1293-10-72 HR.
ALDRIN	0.7	89	--	--	--	--
DIELDRIN	0.7	92	--	--	--	--
ENDRIN	0.2	90	--	--	--	--
CHLORDANE	7.0	91	--	--	--	--
DDT	30.0	92	--	--	--	--
HEPTACHLOR	3.0	90	--	--	--	--
HEPTACHLOR EPOXIDE	3.0	89	--	--	--	--
LINDANE	4.0	88	--	--	--	--
METHOXYCHLOR	100.0	91	--	--	--	--
PCB'S	3.0	98	--	--	--	--
TOXAPHENE	5.0	93	--	--	--	--
2,4-D	100.0	97	--	--	--	--
2,4,5-TP (SILVEX)	10.0	95	--	--	--	--
CARBARYL	70.0	64	--	--	--	--
DIAZINON	2.0	87	--	--	--	--
METHYL PARATHION	7.0	99	--	--	--	--
PARATHION	35.0	93	--	--	--	--

MDL = METHOD DETECTION LIMIT
TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED

ANALYST: Eva Prang

Ontario

Ministry of Health / Ministère de la Santé — Laboratory Services Branch / Service de Laboratoire

Date Received / Date Reçue	Lab. No. / No. du Lab.

Bacteriological Analysis of Water / Analyse Bactériologique de l'eau

Sample taken by / Echantillon prélevé par	Location of supply (Lot, Con., Twp.) / Lieu de Prélèvement (Lot, Concession, Commune)	County	Date collected / Date du Prélèvement

Your name and return address must appear on all copies / Votre nom et votre adresse de retour doivent paraître sur toutes les copies.

Name / Nom
Street, R.R., Box No. / Rue, R.R., Casier Postal
City, Town / Ville
Province — Postal Code / Code Postal

☐ **Private Citizens:** check this box. Drinking water only. See reverse of report for interpretation.
Particuliers: cocher cette case. Eau potable seulement. Voir au verso pour interprétation.

Consult your local health unit for further information. / Pour les directives additionel consultez votre unité sanitaire local.

FOLD

SHADED AREAS FOR OFFICIAL AGENCIES ONLY
ZONE OMBRÉE RÉSERVÉE AUX AGENTS OFFICIELS

Non potable samples MUST be received within 6 hours if unrefrigerated or within 24 hours if refrigerated.

FOLD

CHECK APPROPRIATE BOXES / COCHER TOUTES LES CASES APPROPRIÉES

DRINKING WATER	NON-DRINKING WATER	COMMENTS
☐ Treated ☐ Non-treated	☐ Recreational ☐ Swimming Pool	
☐ Municipal	☐ Hydrotherapy Spa ☐ Sewage	
☐ Other Public	☐ Other:	
☐ Single Household		

BACTERIAL COUNT / NUMERATION DES BACTÉRIES
Based on 100 ml volume / Base sur un volume de 100 ml

Total Coliform / Totale des colibacilles	Faecal Coliform / Colibacilles Fecaux	Faecal Strep / Straptocoques Fecaux	BACTERIAL COUNT Based on 1.0 ml volume / APC
0	0		
Background	Paeruginosa	S.aureus	

Technician	Checked by	Date
		87.10.14

Ontario

Ministry of Health / Ministère de la Santé — Laboratory Services Branch / Service de Laboratoire

Date Received / Date Reçue	Lab. No. / No. du Lab.

Bacteriological Analysis of Water / Analyse Bactériologique de l'eau

Sample taken by / Echantillon prélevé par	Location of supply (Lot, Con., Twp) / Lieu de Prélèvement (Lot, Concession, Commune)	County	Date collected / Date du Prélèvement
PP	26, IV, Cumberland	R'MOC	Oct. 12/87

Your name and return address must appear on all copies / Votre nom et votre adresse de retour doivent paraître sur toutes les copies.

Name / Nom	
John Pratt	72 HRS
Street, R.R., Box No. / Rue, R.R., Casier Postal	
1152 HERON RD. APT 1	
City, Town / Ville	
OTTAWA	
Province	Postal Code / Code Postal
ONTARIO	K1V 6B3

☑ **Private Citizens:** check this box. Drinking water only. See reverse of report for interpretation.
Particuliers: cocher cette case. Eau potable seulement. Voir au verso pour interprétation.

Consult your local health unit for further information. / Pour les directives additionel consultez votre unité sanitaire local.

FOLD

SHADED AREAS FOR OFFICIAL AGENCIES ONLY
ZONE OMBRÉE RÉSERVÉE AUX AGENTS OFFICIELS

Non potable samples MUST be received within 6 hours if unrefrigerated or within 24 hours if refrigerated.

FOLD

CHECK APPROPRIATE BOXES / COCHER TOUTES LES CASES APPROPRIÉES

DRINKING WATER	NON-DRINKING WATER	COMMENTS
☐ Treated ☐ Non-treated	☐ Recreational ☐ Swimming Pool	
☐ Municipal	☐ Hydrotherapy Spa ☐ Sewage	
☐ Other Public	☐ Other:	
☐ Single Household		

BACTERIAL COUNT / NUMERATION DES BACTÉRIES
Based on 100 ml volume / Base sur un volume de 100 ml

Total Coliform / Totale des colibacilles	Faecal Coliform / Colibacilles Fecaux	Faecal Strep / Streptocoques Fecaux	BACTERIAL COUNT Based on 1.0 ml volume / APC
0	0		
Background	Paeruginosa	S aureus	

Technician	Checked by	Date
		87.10.14

Ministry of Health | Ministère de la Santé | Laboratory Services Branch | Service de Laboratoire

Ontario

Date Received / Date Reçue	Lab. No. / No. du Lab.
[illegible]	9910

Bacteriological Analysis of Water / Analyse Bactériologique de l'eau

Sample taken by / Echantillon prélevé par	Location of supply (Lot, Con., Twp.) / Lieu de Prélèvement (Lot, Concession, Commune)	County	Date collected / Date du Prélèvement
T. Sugarman	26 / V / CUMBERLAND	RMOC	oct 8/87

Your name and return address must appear on all copies / Votre nom et votre adresse de retour doivent paraître sur toutes les copies.

Name / Nom: MR. J BRAY 24

Street, R.R., Box No. / Rue, R.R., Casier Postal: 1157 HERON RD. APT 1

City, Town / Ville: OTTAWA

Province: ONTARIO

Postal Code / Code Postal: K1V 8B3

☑ **Private Citizens:** check this box. Drinking water only. See reverse of report for interpretation.

Particuliers: cocher cette case. Eau potable seulement. Voir au verso pour interprétation.

Consult your local health unit for further information. / Pour les directives additionel consultez votre unité sanitaire local.

FOLD

SHADED AREAS FOR OFFICIAL AGENCIES ONLY
ZONE OMBRÉE RÉSERVÉE AUX AGENTS OFFICIELS

Non potable samples MUST be received within 6 hours if unrefrigerated or within 24 hours if refrigerated.

FOLD

CHECK APPROPRIATE BOXES / COCHER TOUTES LES CASES APPROPRIÉES

DRINKING WATER	NON-DRINKING WATER	COMMENTS
☐ Treated ☐ Non-treated	☐ Recreational ☐ Swimming Pool	PUBL. HLTH. LAB. OTTAWA 287 OCT 14 09 24
☐ Municipal	☐ Hydrotherapy Spa ☐ Sewage	23262
☐ Other Public	☐ Other:	
☐ Single Household		

BACTERIAL COUNT / NUMERATION DES BACTÉRIES
Based on 100 ml volume / Base sur un volume de 100 ml

BACTERIAL COUNT Based on 1.0 ml volume

Total Coliform / Totale des colibacilles	Faecal Coliform / Colibacilles Fecaux	Faecal Strep / Straptocoques Fecaux	APC
0	0		
Background	Paeruginosa	S.aureus	

Technician	Checked by	Date
[signature]	[signature]	87.10.14

Clinical Laboratories

MICROBIAL MONITORING REPORT

INSTITUTION WATER & EARTH SCIENCES
DATE COLLECTED set up 13-10-87
DATE REPORTED 15-10-87
TECH SIGNATURE
PHONED

NO	SITE DESCRIPTION	LABORATORY REPORT					NOTES
LAB #	WATER ANALYSIS: as per water drinking standards	TOTAL COUNT	TOTAL COLIFORM	FAECAL COLIFORM	FAECAL STREPT.		
WESA #1	1293 12/10/87 POND	2col/ml	53col/100ml	absent	absent		
WESA #2	72 hrs 1293 12/10/87	0col/ml	0col/100ml	absent	absent		

KEY:
NG = No Growth
NSG = No Significant Growth
NFL = Normal Flora

CC = Colony Count
NP = Non pathogenic
PP = Potential pathogen
MG = Mixed growth non-pathogenic and potential pathogens

DRINKING WATER: TT = Total Count
TC = Total Coliform
FC = Faecal Coliform
FS = Faecal Strept.

The results contained in this report are only representative of the sample(s) received by our laboratory.
Interpretation of the results should include a consideration of the integrity of both the sampling technique and protocol.

Form MMR 5/83

Clinical Laboratories

MICROBIAL MONITORING REPORT

INSTITUTION Water & Earth Science Association
DATE COLLECTED set up 9-10-87
DATE REPORTED 13-10-87
TECH SIGNATURE
PHONED

* as per drinking water standards

NO	SITE DESCRIPTION	LABORATORY REPORT					NOTES
LAB #	Water Analysis	Total Count	Total Coliform	Faecal Coliform	Faecal Strept.		
WESA #3	24 hours. 1293. 8/10/87	2 col/ml	0 col/ml	absent	absent		

KEY:
NG = No Growth
NSG = No Significant Growth
NFL = Normal Flora

CC = Colony Count
NP = Non pathogenic
PP = Potential pathogen
MG = Mixed growth non-pathogenic and potential pathogens

DRINKING WATER: TT = Total Count
TC = Total Coliform
FC = Faecal Coliform
FS = Faecal Strept.

The results contained in this report are only representative of the sample(s) received by our laboratory.
Interpretation of the results should include a consideration of the integrity of both the sampling technique and protocol.

Form MMR 5/83

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 A 0.0005514219                                                        SHEET

.FDDDDDDDAGDDDDDDDAHDDDDDAIDDDDDAJDDDDDDAKDDDDDALDDDDDDDAMDDDDDDDANDDDD?
'LATION OF THE CARBONATE EQUILIBRIUM                            |                  3
                ---------------Activities---------------        |  Mass            3
ieter    Alk.        pH          After dol       After cal      |  Precip.         3
.lc'd  Const.      Const.        precip.         precip.        |  mg/L            3
                                                                                   3
-----------------------------------------------------------------------------
                  7.65E-04       7.65E-04        5.51E-04        |                  3
                  2.41E-04       2.41E-04        2.41E-04        |  Dolomite        3
 atm)*            1.67E-03       1.67E-03        1.67E-03        |         0        3
 CO3)3.01E-03     3.01E-03       3.01E-03        2.74E-03        |                  3
          8.00       8.00            8.00        .   7.96        |  Calcite         3
 (K)                  283  %ER      -1.1%          0.6%          |        29        3
 K1)*                7.74                                        |                  3
 K2)*               -2.13                                                           3
 K3)*               -4.27                          |adj. T(C)=            0         3
                         PCO2(atm)=3.16E-4          |adj. PCO2=     0.00E+00         3
 good for 6.4<pH<10.3                               |                               3
----------------------------------------------------|SI(DOL) =      -4.5E-02         3
 ) + H2O = H+ + HCO3-: K1                           |pH(s)   =          8.02         3
 (s) + H+ = Ca++ + HCO3-: K2                        |SI(CAL) =       2.4E-01         3
 CO3)2(s) + 2H+ = Ca++ + Mg++ + 2HCO3-: K3          |pH(s)   =          7.76         3
.MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMAIN>
   06:31 PM
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'CALCULATION OF THE RYZNAR STABILITY INDEX AND rH                      SHEET

'DDDYDDDDDDDDDDDDDDZDDDDDDDDAADDDDDDDABDDDDDDDACDDDDDDDADDDDDDDDAEDDDDDD?
 LATION OF THE RYZNAR STABILITY INDEX AND rH                                        3
.ed from Persons and Hart (1980) and Hasselbarth and Ludeman (1972)                 3
------------------------------------------------------------------------           3
                                    Ryznar                                         3
ieter                Value          Parameter   Value           PHs                3
                                                                                   3
-------------------------------------------------------------------------
 mg/L)             195.00                A       0.10                              3
 ess (CaCO3)       137.70                C       1.74              7.86            3
 (CaCO3)           163.00                D       2.22                              3
 rature (C)          8.00          8     B       2.42                              3
                     8.00                                                          3
                     0.50                                                          3
                     0.05                                                          3
                       20          * **********************************            3
 6>R.I.>7 corrosion -------> * Ryznar Index =          7.7         *               3
                              *                                     *               3
 gical Incrus. if:            *   rH  =                16.72        *               3
 > 0.3 mg/L,                  * **********************************                  3
 >-10mV +/- 20mV,                                                                  3
 > 14.5 +/- 1          These conditions apply to a well being pumped               3
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMAIN>
   06:34 PM
```

D-2 1990 Test Program

ARECO CANADA INC.

APPLIED RESEARCH DIVISION

28 CONCOURSE GATE
NEPEAN, ONTARIO
CANADA K2E 7T7
TEL. (613) 228-1145
FAX. (613) 228-1148

CUSTOMER: WATER & EARTH SCIENCE ASS CUSTOMER REF. #: Vars Water Supply

ATTN: ROGER WOELLER ORDER REF. #: 2314

REPORT #: 3151405 SAMPLE RECEIVED: May 4/90 and May 7/90

DATE SUBMITTED: May 14/90 & May 24/90

CERTIFICATE OF ANALYSIS

SAMPLE DESCRIPTION: VARS WATER SUPPLY - 2314-TW1

ANALYSIS PERFORMED: VARIOUS

INSTRUMENTATION: VARIOUS

RESULTS: SEE ATTACHED

CERTIFIED BY:
Greg Clarkin

WATER QUALITY ANALYSIS

ARECO CANADA INC. 28 CONCOURSE GATE, NEPEAN, ONTARIO K2E 7T7

Lab. Number	040590-1A
Sample I.D.	2314-TW1-1HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION	RESULTS
Colour (true)	1.0 TCU	25
Hardness ($CaCO_3$)	0.05 mg/l	128
Alkalinity ($CaCO_3$)	1.0 mg/l	175
Turbidity	1.0 NTU	6
Conductivity	uS/cm	340
pH	0.00 units	7.84
Chloride	0.01 mg/l	4.18
Fluoride	0.05 mg/l	<0.05
Sulphate	0.02 mg/l	3.21
Nitrate (N)	0.05 mg/l	<0.05
Nitrite (N)	0.05 mg/l	<0.05
Calcium	0.02 mg/l	38.8
Sodium	0.03 mg/l	22.4
Ammonia (N)	0.05 mg/l	<0.05
Potassium	0.01 mg/l	3.02
Iron	0.005 mg/l	0.738
Manganese	0.001 mg/l	0.056
Magnesium	0.02 mg/l	7.73
Hydrogen sulphide	0.006 mg/l	0.107
Phenols	0.002 mg/l	<0.002
Total Nitrogen (TKN)	0.1 mg/l	<0.1
Tannin/Lignin	0.1 mg/l	-
TOC	1 mg/l	5
DOC	1 mg/l	-
BOD	0.01 mg/l	-
Silica	0.015 mg/l	-
Coliform Count	per 100 ml	0
Fecal Count	per 100 ml	0
Fecal Strept.	per 100 ml	0
Background	per 100 ml	<10/ml
Uranium	0.1 ug/l	<0.1
Cation Sum	meq/l	3.62
Anion Sum	meq/l	3.68
% Difference	%	0.81
Ion Ratio		1.02
TDS (ion sum calculated)	mg/l	219
Conductivity (calc.)	umho/cm	350
SAR		0.86

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	040590-1A
Sample I.D.	2314-TW1-1HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Toluene	0.002	<0.002
Ethylbenzene	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS

ARECO CANADA INC. 28 CONCOURSE GATE, NEPEAN, ONTARIO K2E 7T7

Lab. Number	040590-1B
Sample I.D.	2314-TW1-6HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION	RESULTS
Colour (true)	1.0 TCU	21
Hardness ($CaCO_3$)	0.05 mg/l	-
Alkalinity ($CaCO_3$)	1.0 mg/l	-
Turbidity	1.0 NTU	6
Conductivity	uS/cm	-
pH	0.00 units	-
Chloride	0.01 mg/l	-
Fluoride	0.05 mg/l	-
Sulphate	0.02 mg/l	-
Nitrate (N)	0.05 mg/l	-
Nitrite (N)	0.05 mg/l	-
Calcium	0.02 mg/l	-
Sodium	0.03 mg/l	-
Ammonia (N)	0.05 mg/l	-
Potassium	0.01 mg/l	-
Iron	0.005 mg/l	-
Manganese	0.001 mg/l	-
Magnesium	0.02 mg/l	-
Hydrogen sulphide	0.006 mg/l	0.097
Phenols	0.002 mg/l	-
Total Nitrogen (TKN)	0.1 mg/l	-
Tannin/Lignin	0.1 mg/l	-
TOC	1 mg/l	6
DOC	1 mg/l	-
BOD	0.01 mg/l	-
Silica	0.015 mg/l	-
Coliform Count	per 100 ml	-
Fecal Count	per 100 ml	-
Fecal Strept.	per 100 ml	-
Background	per 100 ml	-
Uranium	0.1 ug/l	<0.1
Cation Sum	meq/l	-
Anion Sum	meq/l	-
% Difference	%	-
Ion Ratio		-
TDS (ion sum calculated)	mg/l	-
Conductivity (calc.)	umho/cm	-
SAR		-

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	040590-1B
Sample I.D.	2314-TW1-6HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Toluene	0.002	<0.002
Ethylbenzene	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS

ARECO CANADA INC. 28 CONCOURSE GATE, NEPEAN, ONTARIO K2E 7T7

Lab. Number	040590-1C
Sample I.D.	2314-TW1-12HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION	RESULTS
Colour (true)	1.0 TCU	23
Hardness ($CaCO_3$)	0.05 mg/l	-
Alkalinity ($CaCO_3$)	1.0 mg/l	-
Turbidity	1.0 NTU	6
Conductivity	uS/cm	-
pH	0.00 units	-
Chloride	0.01 mg/l	-
Fluoride	0.05 mg/l	-
Sulphate	0.02 mg/l	-
Nitrate (N)	0.05 mg/l	-
Nitrite (N)	0.05 mg/l	-
Calcium	0.02 mg/l	-
Sodium	0.03 mg/l	-
Ammonia (N)	0.05 mg/l	-
Potassium	0.01 mg/l	-
Iron	0.005 mg/l	-
Manganese	0.001 mg/l	-
Magnesium	0.02 mg/l	-
Hydrogen sulphide	0.006 mg/l	0.070
Phenols	0.002 mg/l	-
Total Nitrogen (TKN)	0.1 mg/l	-
Tannin/Lignin	0.1 mg/l	-
TOC	1 mg/l	7
DOC	1 mg/l	-
BOD	0.01 mg/l	-
Silica	0.015 mg/l	-
Coliform Count	per 100 ml	-
Fecal Count	per 100 ml	-
Fecal Strept.	per 100 ml	-
Background	per 100 ml	-
Uranium	0.1 ug/l	<0.1
Cation Sum	meq/l	-
Anion Sum	meq/l	-
% Difference	%	-
Ion Ratio		-
TDS (ion sum calculated)	mg/l	-
Conductivity (calc.)	umho/cm	-
SAR		-

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	040590-1C
Sample I.D.	2314-TW1-12HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Toluene	0.002	<0.002
Ethylbenzene	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS

ARECO CANADA INC. 28 CONCOURSE GATE, NEPEAN, ONTARIO K2E 7T7

Lab. Number	070590-2A
Sample I.D.	2314-TW1-24HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION	RESULTS
Colour (true)	1.0 TCU	25
Hardness ($CaCO_3$)	0.05 mg/l	-
Alkalinity ($CaCO_3$)	1.0 mg/l	-
Turbidity	1.0 NTU	5
Conductivity	uS/cm	-
pH	0.00 units	-
Chloride	0.01 mg/l	-
Fluoride	0.05 mg/l	-
Sulphate	0.02 mg/l	-
Nitrate (N)	0.05 mg/l	-
Nitrite (N)	0.05 mg/l	-
Calcium	0.02 mg/l	-
Sodium	0.03 mg/l	-
Ammonia (N)	0.05 mg/l	-
Potassium	0.01 mg/l	-
Iron	0.005 mg/l	0.716
Manganese	0.001 mg/l	-
Magnesium	0.02 mg/l	-
Hydrogen sulphide	0.006 mg/l	0.067
Phenols	0.002 mg/l	-
Total Nitrogen (TKN)	0.1 mg/l	-
Tannin/Lignin	0.1 mg/l	-
TOC	1 mg/l	6
DOC	1 mg/l	-
BOD	0.01 mg/l	-
Silica	0.015 mg/l	-
Coliform Count	per 100 ml	-
Fecal Count	per 100 ml	-
Fecal Strept.	per 100 ml	-
Background	per 100 ml	-
Uranium	0.1 ug/l	<0.1
Cation Sum	meq/l	-
Anion Sum	meq/l	-
% Difference	%	-
Ion Ratio		-
TDS (ion sum calculated)	mg/l	-
Conductivity (calc.)	umho/cm	-
SAR		-

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2A
Sample I.D.	2314-TW1-24HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Toluene	0.002	<0.002
Ethylbenzene	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2C
Sample I.D.	2314-TW1-24HR.
Clients Job Number	WESA P.O.#17774

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Bromodichloromethane	0.002	<0.002
Bromoform	0.002	<0.002
Bromomethane	0.002	<0.002
Carbon tetrachloride	0.002	<0.002
Chlorobenzene	0.002	<0.002
Chloroethane	0.002	<0.002
2-Chloroethylvinyl ether	0.002	<0.002
Chloroform	0.002	<0.002
Chloromethane	0.002	<0.002
Dibromochloromethane	0.002	<0.002
1,2-Dichlorobenzene	0.002	<0.002
1,3-Dichlorobenzene	0.002	<0.002
1,4-Dichlorobenzene	0.002	<0.002
1,2-Dichloroethane	0.002	<0.002
1,1-Dichloroetane	0.002	<0.002
1,1-Dichloroethylene	0.002	<0.002
trans-1,2-Dichloroethylene	0.002	<0.002
1,2-Dichloropropane	0.002	<0.002
cis-1,3-Dichloropropene	0.002	<0.002
trans-1,3-Dichloropropene	0.002	<0.002
Ethylbenzene	0.002	<0.002
Methylene chloride	0.002	<0.002
1,1,2,2-Tetrachloroethane	0.002	<0.002
Tetrachloroethylene	0.002	<0.002
Toluene	0.002	<0.002
1,1,1-Trichloroethane	0.002	<0.002
1,1,2-Trichloroethane	0.002	<0.002
Trichloroethylene	0.002	<0.002
Trichlorofluoromethane	0.002	<0.002
Vinyl chloride	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2D
Sample I.D.	2314-Travel blank
Clients Job Number	WESA P.O.#17774

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Bromodichloromethane	0.002	<0.002
Bromoform	0.002	0.004
Bromomethane	0.002	<0.002
Carbon tetrachloride	0.002	0.005
Chlorobenzene	0.002	<0.002
Chloroethane	0.002	<0.002
2-Chloroethylvinyl ether	0.002	<0.002
Chloroform	0.002	<0.002
Chloromethane	0.002	<0.002
Dibromochloromethane	0.002	<0.002
1,2-Dichlorobenzene	0.002	<0.002
1,3-Dichlorobenzene	0.002	<0.002
1,4-Dichlorobenzene	0.002	<0.002
1,2-Dichloroethane	0.002	<0.002
1,1-Dichloroetane	0.002	<0.002
1,1-Dichloroethylene	0.002	<0.002
trans-1,2-Dichloroethylene	0.002	<0.002
1,2-Dichloropropane	0.002	<0.002
cis-1,3-Dichloropropene	0.002	<0.002
trans-1,3-Dichloropropene	0.002	<0.002
Ethylbenzene	0.002	<0.002
Methylene chloride	0.002	<0.002
1,1,2,2-Tetrachloroethane	0.002	<0.002
Tetrachloroethylene	0.002	<0.002
Toluene	0.002	<0.002
1,1,1-Trichloroethane	0.002	<0.002
1,1,2-Trichloroethane	0.002	<0.002
Trichloroethylene	0.002	<0.002
Trichlorofluoromethane	0.002	<0.002
Vinyl chloride	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2B
Sample I.D.	2314-TW1-48HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Toluene	0.002	<0.002
Ethylbenzene	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

WATER QUALITY ANALYSIS

ARECO CANADA INC. 28 CONCOURSE GATE, NEPEAN, ONTARIO K2E 7T7

Lab. Number	070590-2B
Sample I.D.	2314-TW1-48HR.
Clients Job Number	WESA P.O.#17773

DETERMINATION	DETECTION	RESULTS
Colour (true)	1.0 TCU	25
Hardness ($CaCO_3$)	0.05 mg/l	-
Alkalinity ($CaCO_3$)	1.0 mg/l	-
Turbidity	1.0 NTU	5
Conductivity	uS/cm	-
pH	0.00 units	-
Chloride	0.01 mg/l	-
Fluoride	0.05 mg/l	-
Sulphate	0.02 mg/l	-
Nitrate (N)	0.05 mg/l	-
Nitrite (N)	0.05 mg/l	-
Calcium	0.02 mg/l	-
Sodium	0.03 mg/l	-
Ammonia (N)	0.05 mg/l	-
Potassium	0.01 mg/l	-
Iron	0.005 mg/l	0.741
Manganese	0.001 mg/l	-
Magnesium	0.02 mg/l	-
Hydrogen sulphide	0.006 mg/l	0.008* unpreserved
Phenols	0.002 mg/l	-
Total Nitrogen (TKN)	0.1 mg/l	-
Tannin/Lignin	0.1 mg/l	-
TOC	1 mg/l	6
DOC	1 mg/l	-
BOD	0.01 mg/l	-
Silica	0.015 mg/l	-
Coliform Count	per 100 ml	-
Fecal Count	per 100 ml	-
Fecal Strept.	per 100 ml	-
Background	per 100 ml	-
Uranium	0.1 ug/l	<0.1
Cation Sum	meq/l	-
Anion Sum	meq/l	-
% Difference	%	-
Ion Ratio		-
TDS (ion sum calculated)	mg/l	-
Conductivity (calc.)	umho/cm	-
SAR		-

TABLE 5, DRINKING WATER ANALYSIS

ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2C
Customer I.D.	2314-TW1-72HR.
Clients Job Number	P.O.# 17774

TABLE 1: Parameters Related to Health

PARAMETER	M.O.E. GUIDELINES	DETECTION LIMITS	RESULTS
Arsenic (ppm)	0.05	0.005	<0.005
Barium (ppm)	1.0	0.002	0.009
Boron (ppm)	5.0	0.005	0.010
Cadmium (ppm)	0.005	0.001	<0.001
Chromium (ppm)	0.05	0.001	<0.001
Cyanide (ppm)	0.2	0.02	<0.02
Fluoride (ppm)	2.4	0.05	<0.05
Lead (ppm)	0.05	0.005	<0.005
Mercury (ppm)	0.001	0.001	<0.001
Nitrate(N) (ppm)	10.0	0.05	0.10
Nitrite(N) (ppm)	1.0	0.05	<0.05
NTA (ppm)	0.05	0.02	<0.02
Pesticides			
Aldrin (ppb)	0.7	0.1	<0.1
Dieldrin (ppb)	0.7	0.05	<0.05
Carbaryl (ppb)	70	0.02	<0.02
Chlordane (ppb)	7	0.04	<0.4
DDT (ppb)	30	0.03	<0.03
Diazinon (ppb)	14	0.4	<0.4
Endrin (ppb)	0.2	0.02	<0.02
Heptachlor (ppb)	3	0.1	<0.1
Hep. epoxide (ppb)	3	0.1	<0.1
Lindane (ppb)	4	0.001	<0.001
Methoxychlor (ppb)	100	0.02	<0.02
Methyl Parathion (ppb)	7	0.2	<0.2
Parathion (ppb)	35	0.3	<0.3
Toxaphene (ppb)	5	5	<4
2,4-D (ppb)	100	0.3	<0.3
2,4,5-TP	10	0.2	<0.2

TABLE 1 continued...

Radionuclides (Becquerels/Litre)			
Tritium	-	100	<100
Cobalt-60	-	1	<1
Strontium-90	-	1	<1
Iodine-131	-	1	<1
Cesium-134	-	1	<1
Cesium-137	-	1	<1
Radium-226	-	0.1	<1
Trihalomethanes (ppm)			
Chloroform	0.35	0.002	<0.002
Dichlorobromomethane	0.35	0.002	<0.002
Chlorodibromomethane	0.35	0.002	<0.002
Bromoform	0.35	0.002	<0.002
Selenium (ppm)	0.01	0.005	<0.005
Silver (ppm)	0.05	0.001	<0.001
Turbidity (FTU)	1	1	5

TABLE 2: Parameters Related to Aesthetic Quality

PARAMETER	M.O.E. GUIDELINES	DETECTION LIMITS	RESULTS
Chloride (ppm)	250	0.01	3.79
Colour (TCU)	5	1	23
Copper (ppm)	1.0	0.001	<0.001
Iron (unfiltered) (ppm)	0.3	0.002	0.731
Iron (filtered)	0.3	0.002	0.008
Manganese (ppm)	0.05	0.001	0.001
Methane (ppm)	3 L/m^3	0.01	0.981
Odour	Inoffensive	-	Inoff.
Organic Nitrogen (ppm)	0.15	0.05	<0.05
Phenols (ppm)	0.002	0.002	<0.002
Sulphate (ppm)	500	0.02	3.53
Sulphide	Inoffensive	0.006	0.066
Taste	Inoffensive	-	Inoff.
TDS (caculated)	500		477
TOC (ppm)	5.0	1.0	5
Zinc (ppm)	5.0	0.001	0.002

FASCIMILE MESSAGE

TO: ...WATER & EARTH.....839-5376.....

...TAMI SUGARMAN.....

FROM: ARECO CANADA INC. 28 Concourse Gate, Nepean, Ont. Canada K2E 7T7

.....

DATE ...28/5/90.....

NUMBER OF PAGES: .....1+ 3.....

IF YOU HAVE ANY PROBLEMS RECEIVING THIS MESSAGE PLEASE CALL US FOR ASSISTANCE:

TELEPHONE: (613) 228-1145
FAX : (613) 228-1148

MESSAGE:

WATER QUALITY ANALYSIS
ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2C
Sample I.D.	2314-TW1-72HR.
Clients Job Number	WESA P.O.#17774

DETERMINATION	DETECTION (mg/L)	RESULTS (mg/L)
Benzene	0.002	<0.002
Bromodichloromethane	0.002	<0.002
Bromoform	0.002	<0.002
Bromomethane	0.002	<0.002
Carbon tetrachloride	0.002	<0.002
Chlorobenzene	0.002	<0.002
Chloroethane	0.002	<0.002
2-Chloroethylvinyl ether	0.002	<0.002
Chloroform	0.002	<0.002
Chloromethane	0.002	<0.002
Dibromochloromethane	0.002	<0.002
1,2-Dichlorobenzene	0.002	<0.002
1,3-Dichlorobenzene	0.002	<0.002
1,4-Dichlorobenzene	0.002	<0.002
1,2-Dichloroethane	0.002	<0.002
1,1-Dichloroetane	0.002	<0.002
1,1-Dichloroethylene	0.002	<0.002
trans-1,2-Dichloroethylene	0.002	<0.002
1,2-Dichloropropane	0.002	<0.002
cis-1,3-Dichloropropene	0.002	<0.002
trans-1,3-Dichloropropene	0.002	<0.002
Ethylbenzene	0.002	<0.002
Methylene chloride	0.002	<0.002
1,1,2,2-Tetrachloroethane	0.002	<0.002
Tetrachloroethylene	0.002	<0.002
Toluene	0.002	<0.002
1,1,1-Trichloroethane	0.002	<0.002
1,1,2-Trichloroethane	0.002	<0.002
Trichloroethylene	0.002	<0.002
Trichlorofluoromethane	0.002	<0.002
Vinyl chloride	0.002	<0.002
m,p-Xylene	0.002	<0.002
o-Xylene	0.002	<0.002

TABLE 5, DRINKING WATER ANALYSIS

ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO, K2E 7T7

Lab Number	070590-2C
Customer I.D.	2314-TW1-72HR.
Clients Job Number	P.O.# 17774

TABLE 1: Parameters Related to Health

PARAMETER	M.O.E. GUIDELINES	DETECTION LIMITS	RESULTS
Arsenic (ppm)	0.05	0.005	<0.005
Barium (ppm)	1.0	0.002	0.009
Boron (ppm)	5.0	0.005	0.010
Cadmium (ppm)	0.005	0.001	<0.001
Chromium (ppm)	0.05	0.001	<0.001
Cyanide (ppm)	0.2	0.02	<0.02
Fluoride (ppm)	2.4	0.05	<0.05
Lead (ppm)	0.05	0.005	<0.005
Mercury (ppm)	0.001	0.001	<0.001
Nitrate(N) (ppm)	10.0	0.05	0.10
Nitrite(N) (ppm)	1.0	0.05	<0.05
NTA (ppm)	0.05	0.02	<0.02
Pesticides			
Aldrin (ppb)	0.7	0.1	<0.1
Dieldrin (ppb)	0.7	0.05	<0.05
Carbaryl (ppb)	70	0.02	<0.02
Chlordane (ppb)	7	0.04	<0.4
DDT (ppb)	30	0.03	<0.03
Diazinon (ppb)	14	0.4	<0.4
Endrin (ppb)	0.2	0.02	<0.02
Heptachlor (ppb)	3	0.1	<0.1
Hep. epoxide (ppb)	3	0.1	<0.1
Lindane (ppb)	4	0.001	<0.001
Methoxychlor (ppb)	100	0.02	<0.02
Methyl Parathion (ppb)	7	0.2	<0.2
Parathion (ppb)	35	0.3	<0.3
Toxaphene (ppb)	5	5	<4
2,4-D (ppb)	100	0.3	<0.3
2,4,5-TP	10	0.2	<0.2

TABLE 1 continued...

Radionuclides (Becquerels/Litre)			
Tritium	-	100	<100
Cobalt-60	-	1	<1
Strontium-90	-	1	<1
Iodine-131	-	1	<1
Cesium-134	-	1	<1
Cesium-137	-	1	<1
Radium-226	-	0.1	<1
Trihalomethanes (ppm)			
Chloroform	0.35	0.002	<0.002
Dichlorobromomethane	0.35	0.002	<0.002
Chlorodibromomethane	0.35	0.002	<0.002
Bromoform	0.35	0.002	<0.002
Selenium (ppm)	0.01	0.005	<0.005
Silver (ppm)	0.05	0.001	<0.001
Uranium (ppb)		0.1	<0.1
Turbidity (FTU)	1	1	5

TABLE 2: Parameters Related to Aesthetic Quality

PARAMETER	M.O.E. GUIDELINES	DETECTION LIMITS	RESULTS
Chloride (ppm)	250	0.01	3.79
Colour (TCU)	5	1	23
Copper (ppm)	1.0	0.001	<0.001
Iron (unfiltered) (ppm)	0.3	0.002	0.731
Iron (filtered)	0.3	0.002	0.008
Manganese (ppm)	0.05	0.001	0.001
Methane (ppm)	3 L/m^3	0.01	0.981
Odour	Inoffensive	-	Inoff.
Organic Nitrogen (ppm)	0.15	0.05	<0.05
Phenols (ppm)	0.002	0.002	<0.002
Sulphate (ppm)	500	0.02	3.53
Sulphide	Inoffensive	0.006	0.066
Taste	Inoffensive	-	Inoff.
TDS (caculated)	500		477
TOC (ppm)	5.0	1.0	5
Zinc (ppm)	5.0	0.001	0.002

project 2314

900536

Water Earth & Science

CONCENTRATION OF VOLATILE PRIORITY POLLUTANTS IN WATER

ug/l

COMPOUND	2314-TU1 72HR	2314-Travel Blank	Blank								MDL
BENZENE	-	-	-								1
BROMODICHLOROMETHANE	-	-	-								1
BROMOFORM	-	-	-								2
BROMOMETHANE	-	-	-								10
CARBON TETRACHLORIDE	-	-	-								2
CHLOROBENZENE	-	-	-								1
CHLOROETHANE	-	-	-								10
2-CHLOROETHYL VINYL ETHER	-	-	-								10
CHLOROFORM	-	-	2.6								1
CHLOROMETHANE	-	-	-								10
DIBROMOCHLOROMETHANE	-	-	-								1
DIBROMOETHANE	-	-	-								4
1,2-DICHLOROBENZENE	-	-	-								1
1,3-DICHLOROBENZENE	-	-	-								1
1,4-DICHLOROBENZENE	-	-	-								1
1,1-DICHLOROETHYLENE	-	-	-								1
1,1-DICHLOROETHANE	-	-	-								1
1,2-DICHLOROETHANE	-	-	-								2
TRANS-1,2-DICHLOROETHYLENE	-	-	-								1
DICHLOROMETHANE	-	-	14								5
1,2-DICHLOROPROPANE	-	-	-								1
CIS-1,3-DICHLOROPROPENE	-	-	-								1
TRANS-1,3-DICHLOROPROPENE	-	-	-								1
ETHYLBENZENE	-	-	-								1
A-METHYLSTYRENE	-	-	-								1
METHYLSTYRENE ISOMERS	-	-	-								1
MESITYLENE	-	-	-								1
1,1,2,2-TETRACHLOROETHANE	-	-	-								2
TETRACHLOROETHYLENE	-	-	2.8								1
TOLUENE	-	-	3.3								2
1,1,1-TRICHLOROETHANE	-	-	-								2
1,1,2-TRICHLOROETHANE	-	-	-								1
TRICHLOROETHYLENE	-	-	-								1
TRICHLOROFLUOROMETHANE	-	-	-								2
M+P-XYLENE	-	-	-								2
O-XYLENE	-	-	-								1
VINYL CHLORIDE	-	-	-								5
OTHER AROMATIC COMPOUNDS	-	-	-								1

MDL = METHOD DETECTION LIMITS

Results had been corrected for the blank

OTHER AROMATIC COMPOUNDS = Total concentration of triaethylbenzenes using the response factor of mesitylene.

FASCIMILE MESSAGE

TO: TAMI SUGARMAN 839-5376

WE S A

FROM: ARECO CANADA INC. 28 Concourse Gate, Nepean, Ont. Canada K2E 7T7

DATE MAY 29/90

NUMBER OF PAGES: 1+2

IF YOU HAVE ANY PROBLEMS RECEIVING THIS MESSAGE PLEASE CALL US FOR ASSISTANCE:

TELEPHONE: (613) 228-1145
FAX : (613) 228-1148

MESSAGE:

ARECO CANADA INC.

APPLIED RESEARCH DIVISION

28 CONCOURSE GATE
NEPEAN, ONTARIO
CANADA K2E 7T7
TEL. (613) 228-1145
FAX. (613) 228-1148

CUSTOMER: WATER & EARTH SCIENCE ASSOC CUSTOMER REF. #:

ATTN: TAMI SUGARMAN ORDER REF. #: 2314

REPORT #: 3352905 SAMPLE RECEIVED: MAY 28/90

DATE SUBMITTED: MAY 29/90

CERTIFICATE OF ANALYSIS

SAMPLE DESCRIPTION: WATER

ANALYSIS PERFORMED: Fe

INSTRUMENTATION: IC

RESULTS: See attached

CERTIFIED BY:
Greg Clarkin

WATER QUALITY ANALYSIS

ARECO CANADA INC., 28 CONCOURSE GATE, NEPEAN, ONTARIO K2E 7T7

Lab Number	280590-5
Sample I.D.	Vars Water Supply
Clients Job Number	# 2314

SAMPLE DESCRIPTION	RESULTS Fe (ppm)
2314-1hr.	0.395
2314-6hrs.	0.260
2314-12hrs.	0.278
2314-48hrs.	0.233
2314-72hrs.	0.240

ACCUTEST LABORATORIES LTD.
146 Colonnade Rd., Suite 202, Nepean, Ontario K2E 7Y3 (613) 727-5692

LAB REPORT NO.: A0-0766

REPORT OF ANALYSES

Client: Water & Earth Science Assoc. Ltd.

Date: May 15, 1990

Attn: Ms. Tami Sugarman

Project: 2314

Parameter	Units	Sample	Sample	Sample	Sample	Sample
Fe	mg/L	0.67				
Mn	mg/L					
Hardness	mg/L $CaCO_3$					
Alkalinity	mg/L $CaCO_3$					
pH						
Conductivity	umhos					
F	mg/L					
Na	mg/L					
$N\text{-}NO_3$	mg/L					
$N\text{-}NO_2$	mg/L					
$N\text{-}NH_3$	mg/L					
SO_4	mg/L					
CL	mg/L					
Phenols	mg/L	<0.002				
Turbidity	NTU	<1.0				
Colour	Pt/Co Units	32				
Ca	mg/L					
Mg	mg/L					
Tannin & Lignin	mg/L					
Total Nitrogen	mg/L					
K	mg/L					
Uranium	mg/L	<0.01				
TOC	mg/L	5.7				

ANALYST

LAB REPORT NO.: A0 - 0766
Numéro de rapport:

ACCUTEST Laboratories Ltd.

146 Colonnade Road, Suite 202, Nepean, Ontario K2E 7Y3 (613) 727-5692

BACTERIOLOGICAL ASSESSMENT OF WATER
ÉVALUATION BACTÉRIOLOGIQUE DE L'EAU

NAME/NOM: TAMI SUGARMAN

COMPANY/SOCIÉTÉ: WESA

STREET, R.R., BOX NO./RUE, R.R., CASIER POSTAL | CITY, TOWN/VILLE

PROVINCE | POSTAL CODE/CODE POSTAL

TELEPHONE/TÉLÉPHONE
Area Code/Indicatif Régional: | Number/Numéro:

SAMPLE INFORMATION/RENSEIGNEMENTS SUR L'ÉCHANTILLON

Sample location/Lieu de prélèvement	Sample number/No. d'échantillon	Date collected/Date de prélèvement	Reference number/ No. de référence
VARS	2143 TW1-72 4R-B	06/05/90	2143

CHECK APPROPRIATE BOXES/COCHER LA CASE APPROPRIÉE

DRINKING WATER/EAU POTABLE

- ☐ Treated/Épurée
- ☒ Non-treated/Non-épurée
- ☐ Existing well/Puits existant
- ☐ New well/Nouveau puits

NON-DRINKING WATER/EAU NON POTABLE

- ☐ River/Rivière
- ☐ Pool/Piscine
- ☐ Sewage/Égout
- ☐ Lake/Lac
- ☐ Other/Autre

Specify: ____
Spécifiez:

SAMPLING INSTRUCTIONS
DIRECTIVES POUR LE PRÉLÈVEMENT

. Do NOT rinse sample container — it contains sodium thiosulphate preservative.
NE PAS rincer la bouteille car elle contient l'agent préservateur sodium thiosulphate de sodium.

. Water must run for 2 to 3 minutes before collecting sample.
Laisser couler l'eau pendant 2 ou 3 minutes avant de remplir la bouteille.

. Fill bottle to about ½ inch from the top.
Remplir la bouteille jusqu'à 2 cm du bouchon.

. Deliver sample to laboratory immediately. Refrigerate if possible.
Retourner l'échantillon immédiatement au laboratoire, réfrigéré si possible.

NOTE: Samples must be submitted to the laboratory within 48 hours of collection.
Non potable samples MUST be received within 6 hours if unrefrigerated or within 24 hours if refrigerated.

IMPORTANT: Les échantillons doivent arriver au laboratoire dans les 48 heures après le prélèvement; les échantillons d'eau non-potable doivent être retournés dans les 6 heures ou, si réfrigérés, dans les 24 heures qui suivent le prélèvement.

TEST RESULTS/RÉSULTATS DES TESTS

BACTERIAL COUNT/NUMÉRATION DES BACTÉRIES
Based on 100 ml volume/Basé sur un volume de 100 ml

Total coliform/ Total des colibacilles	Faecal Coliform/ Colibacilles Fécaux	Faecal Strep./ Streptocoques Fécaux	Background/ Teneurs de Fond
0	0	0	—

COMMENTS/REMARQUES

RESULT INTERPRETATION ON REVERSE
Interprétation des Résultats au verso

Date: May 10 /90

Analyst: [signature]
Technologue:

APPENDIX E

Correspondence

Ontario
Ministry of the Environment
Mini. :e de l'Environnement
Southeastern Region
Région du Sud-Est

Mailing Address
PO Box 820
Kingston Ontario
K7L 4X6

Adresse postale
C.P. 820
Kingston (Ontario)
K7L 4X6

133 Dalton Avenue
Kingston Ontario
K7K 6C2
613 549-4000

133, avenue Dalton
Kingston (Ontario)
K7K 6C2
613 549-4000

2 May 1990

Water and Earth Science Associates Limited
Box 430
CARP, Ontario
K0A 1Z0

Attention: Tami Sugarman

Dear Madam:

Re: Approval to Take Water Under Section 20 of the Ontario Water Resources Act as Requested by Your Application Dated April 30, 1990

Communal Test Well, Lots 26 and 27, Concession V
Cumberland Township

Test start date:		May 3rd, 1990
Type	:	Pumping Test
Rate	:	350 IGPM
Duration	:	Three Days

This letter constitutes approval to take water under Section 20 of the Ontario Water Resources Act. 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 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.

4) All water supplies adversely affected during the testing must be replaced with temporary water supplies until the testing has been completed and/or the affected water supplies are restored.

5) A report of the pumping test must be submitted to this Ministry.

6) When the water taken is discharged to a watercourse, the quality and temperature of the groundwater shall be substantially the same as the receiving stream to ensure that the stream's water quality, flora and fauna are not adversely affected by the discharge. If the rate of discharge is substantial, energy absorbing padding shall be used to prevent erosion. The rate of discharge shall be controlled to prevent downstream flooding and property damage.

7) The Ministry of the Environment must be advised of any intent to abandon the test well.

8) If the test well is abandoned or not used for any extended period of time, it shall be properly sealed to prevent any groundwater contamination.

The testing shall be carried out under these general conditions. The reason for the imposition of these conditions is to ensure that the water quality and quantity of all surface water, groundwater and water supplies in the area of the testing are protected.

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 63 of the Ontario Water Resources Act, as amended in 1983, provides that the Notice requiring the hearing shall state the portions of each Term or Condition in the approval in respect of which the hearing is required and the grounds on which you intend to rely at the hearing.

This approval is for the temporary taking only (3 days). If the well is put into service for an extended period of time, a Permit to Take Water will be required if the taking is in excess of 50,000 litres per day. This approval does not release you from

any legal liability or obligation imposed by law and should not be construed as 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.

Yours truly,

M.M. Holy, Chief
Approvals and Planning
Technical Support Section
Southeastern Region
PLS/sh

TELECOPIER COVER SHEET

MINISTRY OF THE ENVIRONMENT

133 Dalton Avenue
KINGSTON, Ontario

TO: Tani Sugarman

FROM: Frank Crossley

DATE: May 03/90

NUMBER OF PAGES: 4 (INCLUDING COVER PAGE)

IF YOU DO NOT RECEIVE THE TOTAL NUMBER OF PAGES SPECIFIED, OR IF YOU HAVE TROUBLE READING THE COPY, PLEASE CALL THE FOLLOWING NUMBER FOR ASSISTANCE.

TELEPHONE: (613) 549-4000

CONTACT: Mrs. C. Bishop

Contact - Phone call 1:30 pm May 3, 1990
Penny Sutcliffe - MOE

→ Message from F. Crossley: 'if you follow these guidelines + comments of letter of March 23/88 you should be fine with respect to ministry of environ requirements.

Received by T. Sugarman

Ministry of the Environment
Southeastern Region

Draft Copy

GUIDELINES FOR APPLICANTS TO THE APPROVALS AND PLANNING UNIT:

PUMPING TESTS AND THE DETERMINATION OF WATER QUALITY IN COMMUNAL WELLS

April, 1990

Objective

These guidelines relate to the establishment of the suitability of a well as a communal water supply. Site-specific characteristics not covered by these guidelines should also be addressed by the consultant. In general, it is up to the consultant to show that a well is capable of supplying sufficient water of acceptable quality on a long-term basis.

Note: Proponents of a communal water supply project should be advised that the project will probably require a Water Works Certificate of Approval (see section entitled "Legislation", below). Separate guidelines pertaining to various types of Water Works are available from the Approvals and Planning Unit. These guidelines may have a bearing on how the pumping tests and water quality determinations are carried out, and should therefore be used in conjunction with the present guidelines.

Well Hydraulics

Pumping tests should be carried out by a competent hydrogeological consultant.

Each pumping test should include:

- a preliminary step pumping test to determine an appropriate rate for the constant rate pumping test.

.....2

The last sampling should occur shortly before the end of the pumping test. This sample should be submitted to a qualified laboratory for analysis with respect to all of the Provincial Drinking Water Quality Objectives (refer to the Ministry of the Environment's "blue book": Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment, published 1978, revised 1984).

The hydrogeological consultant should establish the compliance of the proposed groundwater supply with the Provincial Drinking Water Quality Objectives. The consultant should also comment on any trends in the water quality data. The possibility of changes in water quality with time and with changes in the pumping rate should be considered with reference to the Drinking Water Objectives.

Legislation

The proponent should be informed that the Ministry of the Environment may require the following under the Ontario Water Resources Act:

- a Water Works Approval under Section 23 of the Act (refer to the Act to determine whether the characteristics of the water supply system make it subject to this requirement).

- a Permit To Take Water under Section 20 of the Act. The Permit would be required for the taking of more than a total of 50,000 litres in any 24-hour period for certain purposes, including pumping tests. Under the terms and conditions of this Permit, the proponent would be required to restore groundwater supplies that have been seriously interfered with.

C.Hammond
/mz

- the constant rate pumping test, starting from static water level conditions. Its duration should be a minimum of twenty-four hours. The pumping rate should deviate no more than 5% from the rate decided upon. Water levels should be monitored in the test well and any observation wells at a decreasing frequency best suited to provide a smooth fit on semi-log graph paper. During the pumping test waste water should be discharged at an appropriate distance from the test well to ensure artificial recharge does not occur.

- the monitoring of water level recovery, starting immediately after the pumping test. The recovery should be monitored in the test wells until 95% recovery of the original static water level conditions occurs. Recovery water levels should be monitored at a decreasing frequency best suited to provide a smooth fit on semi-log graph paper.

Using the data from the pumping and recovery tests the consultant should be able to assess with confidence the direction of groundwater flow, the aquifer's hydraulic properties, sustainable long term yields, the effect of interacting pumping cones of influence (in the case where more than one well is proposed), and the potential for interference with other water supplies in the area.

Water Quality

Chemical and bacteriological water quality sampling should be conducted at least twice during the pumping test to establish the potability of groundwater supplies. The first sampling should occur shortly after the beginning of the pumping test. This first sample should be submitted to a qualified laboratory for analysis for the following water quality parameters:

bacteriological - total coliform, fecal coliform, fecal streptococci and background;

chemical - hardness, alkalinity, iron, chloride, pH, fluoride, conductivity, sodium, calcium, potassium, magnesium, ammonia, total Kjeldahl nitrogen, nitrate, nitrite, sulphate, phenols and hydrogen sulphide gas.

.....3

APPENDIX F

Theoretical Aquifer Yield
and
Well Interference Calculations

THEORETICAL AQUIFER YIELD AND WELL INTERFERENCE CALCULATIONS

Theoretical Aquifer Yields

The theoretical aquifer yield can be calculated using the following formula:

$$Q_{max} = \frac{4\pi T\ \Delta s_{max}}{W(u)}$$

where Q_{max} = maximum discharge [m^3/day]
T = transmissivity [m^2/day]
Δs_{max} = maximum allowable drawdown [m]
$W(u)$ = well function [ ]

The well function is derived by means of well function tables that are based on the following:

$$u = \frac{r^2 S}{4Tt}$$

where r = radial distance from pumping well [m]
S = storativity [ ]
t = time since pumping began [days]

Tests done on the test well revealed the following aquifer parameters:

$T = 1000\ m^2/day$ $S = 0.0015$ $\Delta s_{max} = 13\ m$

For a 10 year design period the calculations are:

$$u = \frac{(0.1)^2(0.0015)}{4(1000)(3650)}$$

$$= 1.03 \times 10^{-12}$$

$W(u) = 27.0$

$$Q_{max} = \frac{4\pi(1000)(13)}{27.0} = 6050\ m^3/day = 924\ IGPM$$

For a 20 year design period the calculations are:

$$u = \frac{(0.1)^2(0.0015)}{4(1000)(7300)} = 5.14 \times 10^{-13}$$

$W(u) = 27.72$

$$Q_{max} = \frac{4\pi(1000)(13)}{27.72}$$

$$= 5893\ m^3/day$$

$$= 900\ IGPM$$

Well Interference

The same equations used to calculate aquifer yield can also be used to determine theoretical well interference data. Here, however, Q is kept constant and the drawdown is calculated for a 10 year time span.

The aquifer parameters of transmissivity and storativity have been shown to be

$T = 1000\ m^2/day$ $\qquad$ $S = 1.5 \times 10^{-3}$

Example calculation

$Q = 150$ IGPM $\qquad$ $r = 500$ m

$= 982\ m^3/day$

$$u = \frac{r^2 S}{4Tt}$$

$$= \frac{(500)^2 (1.5 \times 10^{-3})}{4(1000)(3650)}$$

$$= 2.57 \times 10^{-5}$$

Therefore $W(u) = 9.99$

$$\Delta s = \frac{Q\ W(u)}{4\pi T}$$

$$= \frac{982(9.99)}{4\pi(1000)}$$

$$= 0.78 \text{ m}$$

radius(m)	u	W(u)	150 IGPM	300 IGPM
100	1.03×10^{-6}	13.19	1.03	2.06
500	2.57×10^{-5}	9.99	0.78	1.56
1000	1.03×10^{-4}	8.60	0.67	1.34

ACCUTEST LABORATORIES LTD.
146 Colonnade Rd., Suite 202, Nepean, Ontario K2E 7Y3 (613) 727-5692

LAB REPORT NO.: A0-0884

REPORT OF ANALYSES

Client: Water & Earth Science Associates Ltd.

Date: May 30, 1990

Attention: T. Sugarman

Project: Vars water supply
2314

Parameter	Units	Sample 2314-1 hr	Sample 2314-6 hr	Sample 2314-12 hr	Sample 2314-48hr	Sample 2314-72hr
Fe (tot)	mg/L	0.69	0.73	0.73	0.72	0.72
Mn	mg/L					
Hardness	mg/L $CaCO_3$					
Alkalinity	mg/L $CaCO_3$					
pH						
Conductivity	umhos					
F	mg/L					
Na	mg/L					
N-NO_3	mg/L					
N-NO_2	mg/L					
N-NH_3	mg/L					
SO_4	mg/L					
CL	mg/L					
Phenols	mg/L					
Turbidity	NTU					
Colour	Pt/Co Units					
Ca	mg/L					
Mg	mg/L					
Tannin & Lignin	mg/L					
Total Nitrogen	mg/L					
K	mg/L					

ANALYST: