

## Appendix C-2

### IWS Groundwater Investigation in East Basin (1970)

**Appendix C-2a**  
**IWS Groundwater Investigation Report (1971)**

INTERNATIONAL WATER SUPPLY, LTD.

342 Bayview Drive

BOX 310

Barrie

Ontario

ABSTRACT

REPORT OF GROUNDWATER INVESTIGATION  
EAST FIELD  
PUBLIC UTILITIES COMMISSION  
SAULT STE. MARIE

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- C
- O
- P
- Y
- (1) The investigation's purpose was to determine the potential groundwater supply available east of Highway 17 North.
  - (2) The available data was assembled and reviewed. Several exploratory test wells were drilled, pumping tests conducted, and the results analysed.
  - (3) Two aquifers were identified. The lower aquifer will support an ultimate perennial yield of 5 MGD. The upper aquifer cannot be evaluated, based on the data collected to date.
  - (4) Sites for a 1.0 to 1.5 MGD well on Queen Street east, and a 1.5 to 2.5 MGD well development on Dacey Road, were established.
  - (5) Preliminary indications of chemical quality are good, but more complete sampling will be required at the time of well development.
  - (6) The ultimate yield of the aquifer could be raised following development and production of a permanent well, and after additional exploration.

*D.R. Turnbull*  
D.R. TURNBULL, P. Eng.

Barrie, Ontario,  
January 12th, 1971.

INTERNATIONAL WATER SUPPLY, LTD.

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REPORT OF GROUNDWATER INVESTIGATION  
EAST FIELD  
PUBLIC UTILITIES COMMISSION  
SAULT STE. MARIE

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(A) OBJECTIVE:

C The 1970 Groundwater Investigation Program was carried out to establish the potential groundwater supply east of Highway 17 North. The program included evaluation of existing data and exploratory drilling, to locate permanent well sites and determine the ultimate yield of the East Field.

(B) EXISTING DATA:

O No major groundwater sources have been developed in the East Field - therefore, no production data is available for reference. Logs of local wells were assembled, but their locations are not well distributed in the area under investigation. General aquifer\* characteristics in Sault Ste. Marie have been examined in 1963 and 1966, but with specific relation to the Goulais Avenue and Steelton Wells, of the West Field.

P However, the concept of aquifer performance in the West Field can be applied to the lower aquifer in the East Field, because of similarities in the aquifer geometry. Performance of the upper aquifer in the East Field will require a different approach, since it appears to be a shallow water table type, with probable river recharge.

Y(C) TEST DRILLING:

TW 4/66, from an earlier program, and TW's 2/70 to 4/70, located on Drawing C70525A, were drilled and electric logged, with results as shown on Drawings A71035 to A71039. Screens were set as noted, to establish Transmissibility\* of the permeable formations. Water samples were checked for chemical quality.

\*Aquifer - Formation that will transmit or store water.

\*Transmissibility - a measure of an aquifer's ability to transmit water, expressed as Imperial Gallons Per Day Per Foot of Aquifer Width.

GROUNDWATER INVESTIGATION  
EAST FIELD, SAULT STE. MARIE PUC

(C) TEST DRILLING: Cont'd:

Preliminary data at TW 3/70 was encouraging, and a short aquifer test was conducted. The results are discussed in a later section.

At TW 4/70, screens were set in the upper and lower aquifers, but formation fines produced high well losses, making further testing unwarranted.

C  
 O  
 TW 5/70 penetrated several marginal formations, but the major aquifer was encountered from 294' to 391'. Isolation of three permeable zones in the lower aquifer was attempted, and each zone was individually tested. Specific capacities\* were high, and a 24-hour aquifer test was conducted in the sandstone formation from 363' to 391', plus shorter tests in the upper portion of the sandstone, and in the overlying sands and gravels.

P  
 Based on local logs and the results of test drilling, the bedrock surface was contoured on Drawing C70525A. The elevations, logs and locations of the local wells are unconfirmed. However, the general features of the bedrock surface can be recognized. Vertical sections are shown on Drawings B71040, B71041 and B71042, and here again, the data may not be precise, but the general structure is apparent.

(D) AQUIFER ANALYSIS:

Y  
 (i) TW 2/70:

Drawing A71043 is a plot of recovery versus time after pumping 20 IGM from the sand and gravel aquifer overlying the sandstone bedrock. The static level of 4/5' and the top of the aquifer at 82' provide about 77.5' of available drawdown. However, the low Transmissibility of 1700 IG/D/Ft. of the formation makes this area unsuitable for major development.

(ii) TW 3/70:

With the top of the aquifer at 140' and a static level of 2', the available drawdown is 138'. The aquifer thickness is at least 28', since total penetration was prevented by high mud losses.

\*Specific capacities - Well capacity per foot of drawdown, generally IGM/Ft.

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(D) AQUIFER ANALYSIS: Cont'd:

(ii) TW 3/70:cont'd:

C Drawing A71044 is the drawdown-time plot showing a high specific capacity at 43 IGM. We compute the Transmissibility to be 56,700 IG/D/Ft. and the Permeability, 2000 IG/D/Ft. The aquifer at this location is suitable for development of a high capacity well.

O (iii) TW 4/70:

The lower aquifer starts in poorly sorted sand and gravel at 151', and is hydraulically connected to the underlying sandstone. Drilling was stopped at 216', as the bedrock permeability was minimal. Static level is above ground level, but it was impossible to conduct a proper aquifer test because of a low and unstable pumping rate.

P The upper aquifer is comprised of fine to medium sand, and extends from 20' to 114', but the material is too fine at this site to produce suitable quantities of water.

Y (iv) TW 5/70:

The thinness of the upper aquifer and the distance from the recharge boundary (St. Mary's River) do not justify additional testing at this site.

The lower aquifer was tested at three levels, with the regional characteristics established by a 24-hour test at 315 IGM from open hole in the sandstone between 363' and 391'. Drawings A71046, A71047 and A71048 are drawdown-time plots at the different levels. Drawing A71049 is the drawdown-distance plot of the 24-hour test.

The sand and gravel, and the two levels of sandstone tested, are interconnected, and after a short time will perform as a single hydraulic unit, 97' thick. The aquifer is artesian and the available drawdown at TW 5/70 is 250'. Specific capacity in the sand and gravel, and to 363' in the sandstone, is higher than in the lower sandstone interval.

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(D) AQUIFER ANALYSIS: Cont'd:

(iv) TW 5/70: Cont'd:

Local Transmissibility is in the order of 75,000 IG/D/Ft, but nearby boundaries, after one day's pumpage, reduce the indicated Transmissibility to 9000 IG/D/Ft.

(E) GENERAL AQUIFER CONCEPT:

The lower aquifer is similar to conditions in the West Field, and combines a sand and gravel layer of varying thickness and permeability, with the porous upper portion of the underlying sandstone bedrock. Artesian conditions are created by a thick bed of impermeable clay deposited over the sand and gravel.

Present data suggests a pre-glacial channel in the sandstone, trending west to east, with the deepest point at elevation 231', above sea level. The valley character produces the boundary effects noted previously, during the 24-hour aquifer test.

With groundwater development nil, the aquifer is recharged by the thick beach deposits of sand and gravel laid against the south side of the Precambrian bedrock that outcrops north of Sault Ste. Marie. The average groundwater gradient between the recharge area and the St. Mary's River is 0.01 ft/ft, but the gradient between 5/70 and the river is only 0.003 ft/ft, which would suggest improved Transmissibility down gradient of TW 5/70.

When aquifer levels are lowered by production, recharge from the uplands will be supplemented by recharge from the river, as the gradient reverses.

The details of the upper aquifer along the North shore are not as well developed. This aquifer will also drain into the river, but any permanent groundwater development should be close to the river, as landward recharge will be much less than recharge from the river.

**GROUNDWATER INVESTIGATION  
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**(F) YIELD:**

C The ultimate perennial yield of the East Field will be limited by the amount of recharge available. Recharge from the river could be significant when aquifer levels are lowered enough to reverse the natural gradient. The data collected to date does not permit a quantitative estimate of the amount available. Recharge from the uplands area, which is currently bleeding to waste, could support a perennial extraction of 5 MGD from a series of wells. The perennial yield of a properly constructed permanent well near TW 3/70 would range from a minimum of 1.0 MGD to 1.5 MGD maximum. Development at TW 5/70 could require more than one well, but the yield at this site ranges from a minimum of 1.5 MGD up to a maximum of 2.5 MGD.

**(G) QUALITY:**

O Water samples from TW's 3/70 and 5/70 were chemically analysed, and the sampled quality is as follows:

P Total Hardness	-	less than 70 ppm
Alkalinity	-	less than 70 ppm
Chlorides	-	less than 10 ppm
Phenols	-	none detected
Total Iron	-	trace to less than 0.5 ppm
pH	-	approximately 7.8

Y Generally, the chemical quality is excellent, and no form of treatment is indicated, except chlorination as a safeguard. Phenols were not detected, but based on the experience in the West Field, provision should be made for suitable modifications when designing chlorination facilities, should phenols develop. The results of the iron analysis may be misleading, since field measurement and laboratory analysis did not agree. A thorough sampling program would be required at the time of well development.

**(H) FIELD DEVELOPMENT:**

The sequence of development of the East Field involves three phases as follows:

- (i) Permanent Well Construction in the area of TW 3/70. The depth of character of the formation and the proximity to the river make this site the preferred location for initial development of the aquifer.



GROUNDWATER INVESTIGATION  
EAST FIELD, SAULT STE. MARIE PUC

(H) FIELD DEVELOPMENT: Cont'd:

(i) Cont'd:

C Since only one test well has been drilled in this area, the location of the permanent well should be within 500' of TW 3/70, and a second test well would be required, regardless of location. Construction of a single well designed to produce a maximum 1.5 MGD would follow test drilling. The permanent well should be tested for an extended period at the maximum rate, to expand the present knowledge of the aquifer performance.

O (ii) Permanent Well Construction near TW 5/70. Greater depth and construction problems at this site increase the difficulty for development. The offset of the permanent well from TW 5/70 should not exceed 500', and at least one test well would be required at this site. Two wells should be considered for maximum development of this location.

P (iii) Additional Exploratory Drilling. Reliable information about the extent and condition of the lower aquifer is limited, due to the depth of the aquifer. Several test holes should be drilled north of Highway 17, to outline the bedrock valley and to check the presence of the overlying sand and gravel.

Y Further test drilling, east of TW 5/70 along Highway 17 and east of TW 4/70 along the river, is required.

(iv) Exploration of the Upper Aquifer. Additional test wells should be drilled along the north shore of the river, east of TW 4/70. Evaluation of this aquifer will require spoon sampling, and any positive site will require an array of observation wells, to determine the recharge characteristics of the river bed.

(I) CONCLUSIONS:

Two aquifers have been identified in the East Field. The data collected to date indicates an ultimate perennial yield of 5 MGD would be available from the lower aquifer. Well sites capable of developing a minimum of 2.5 MGD have been established on Queen Street east, and on Dacey Road.

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EAST FIELD, SAULT STE. MARIE PUC

(I) CONCLUSIONS: Cont'd:

The ultimate yield of the aquifer could be increased following construction and operation of one or more permanent wells and further exploratory drilling.

Initial exploratory work in the upper aquifer is inconclusive, and further investigation would be required, to determine the potential yield and to locate permanent well sites.

C

*D. R. Turnbull*  
D. R. TURNBULL, P. Eng.

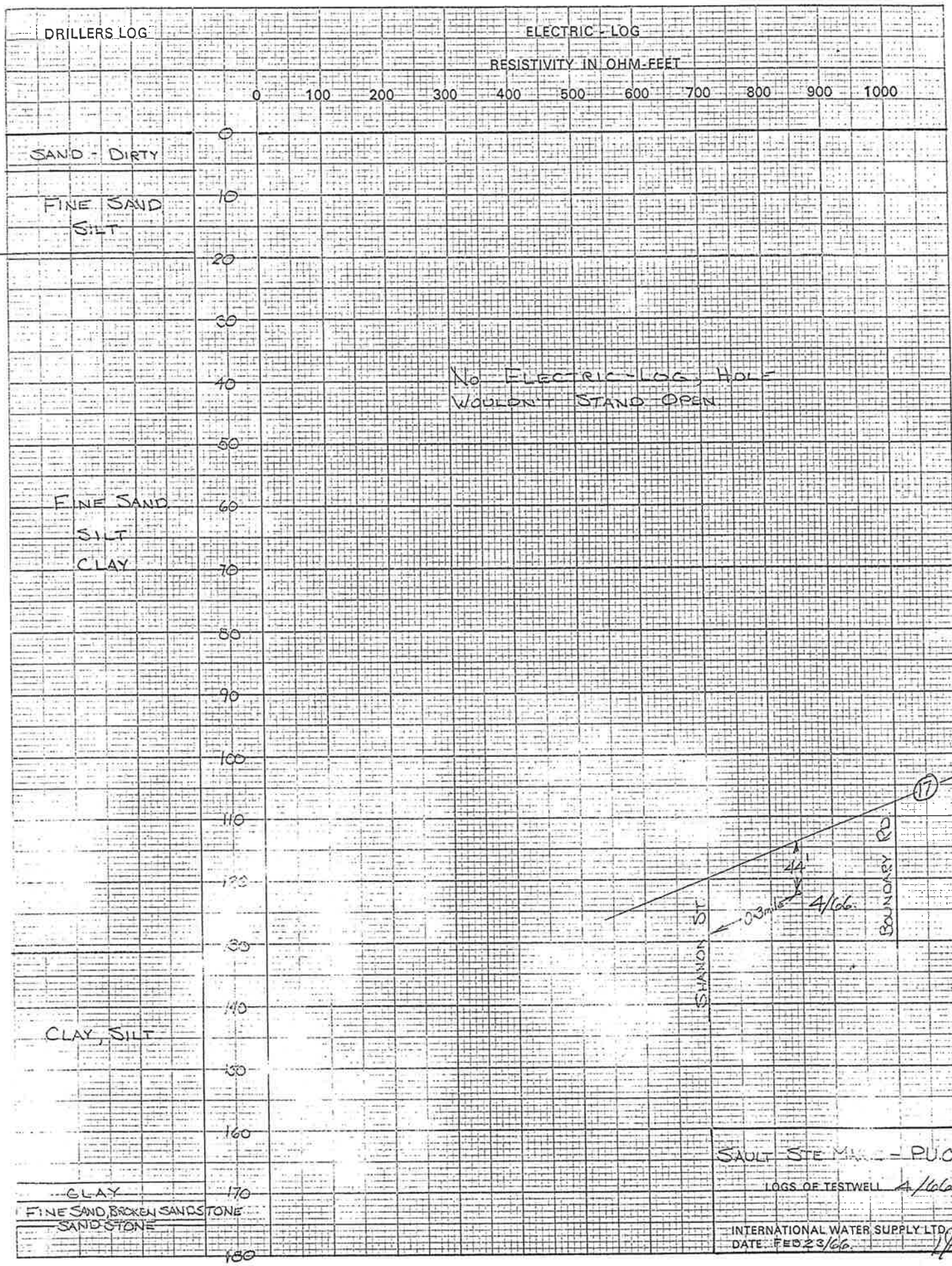
O

Barrie, Ontario,  
January 12th, 1971.

P ble

Y

G.S.-12 G  
 10 X 10 TO THE 1/2 INCH  
 MADE IN CANADA



SAULT STE MARIE - PUC  
 LOGS OF TESTWELL 4/66  
 INTERNATIONAL WATER SUPPLY LTD  
 DATE FEB 23/66

A71035

DRILLERS LOG

ELECTRIC - LOG

DRILLER: 7" Ø  
 HOLE DIAM: R. STEPH  
 ELEVATION: 588.06

RESISTIVITY IN OHM-Feet

0 100 200 300 400 500 600 700 800 900 1000

FILL - GRAVEL + BOULDER

S.L.T.  
 GRAY

① MUD RECORD

84' to 93' 4" MUD.  
 95' to 103' 2" MUD.  
 103' to 107' 2" MUD.

② STATIC LEVEL 4.44 (AUG 21 - 0700)

PUMPING LEVEL 33.99 @ 20 GPM - 4 HRS

WATER CLOUDY - SOME SAND

APPARENT TRANSMISSIBILITY 1700 cm<sup>2</sup>/d

CLAY

Red

BOULDER

SAND FINE TO COARSE  
 GRAVEL BOULDER  
 BOULDER

SAND FINE TO COARSE  
 GRAVEL BOULDER

"DITTO"

~~ROCK SANDSTONE~~  
~~SANDSTONE~~  
 SANDSTONE

PULLED

2" 1 1/4"

92'

103'

ATLAS

DRAKE  
 18 CLARK CR.

2170  
 QUEEN ST.

(IWS) INTERNATIONAL WATER SUPPLY LTD.

LOGS OF TESTWELL 2170  
 SAULT STE MARIE P.O.C  
 SITE E

AUG 1970

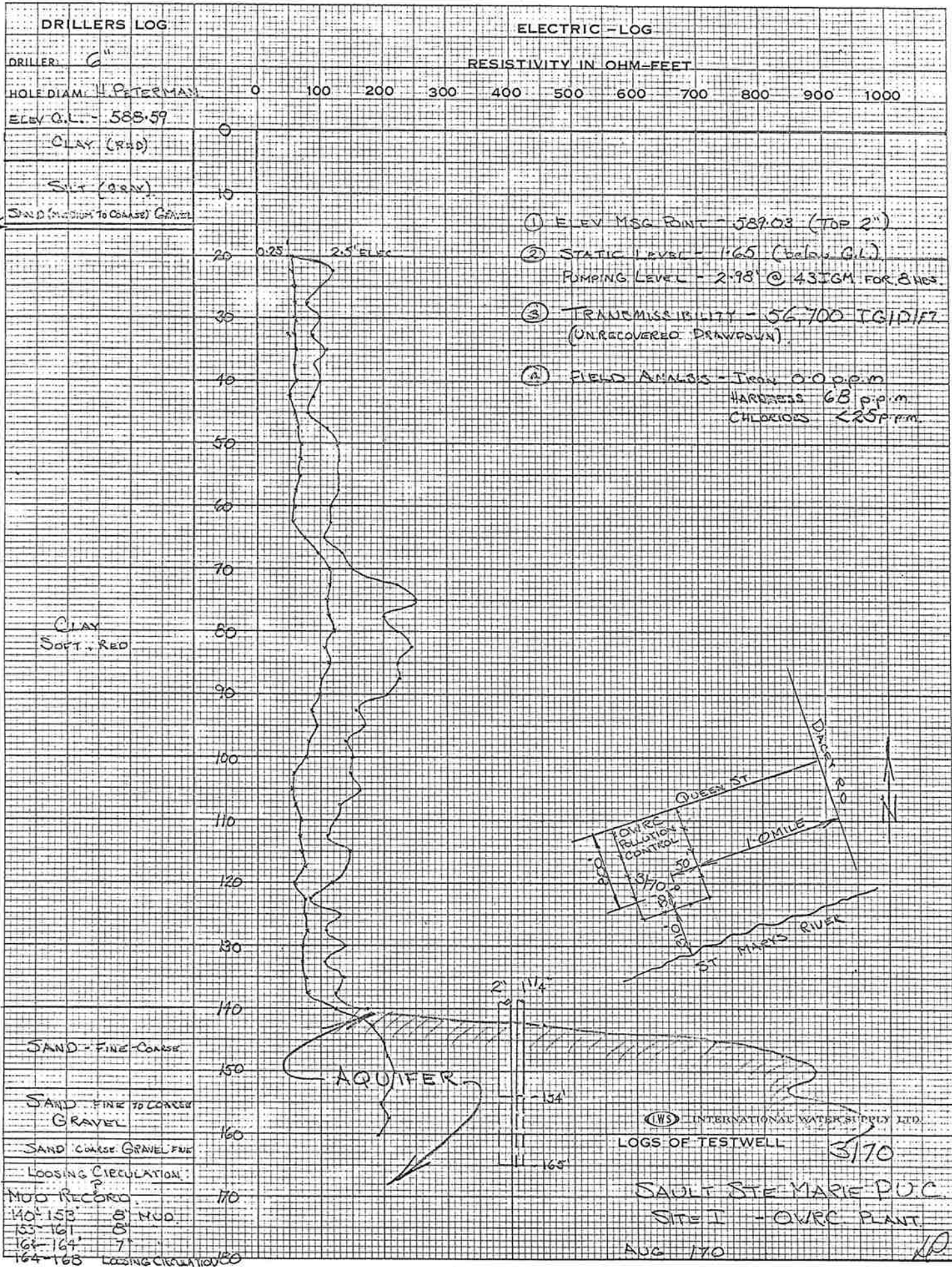
KP

A71036.

G9-12G IWS #3  
 10 x 10 TO THE 1/2 INCH  
 MADE IN CANADA

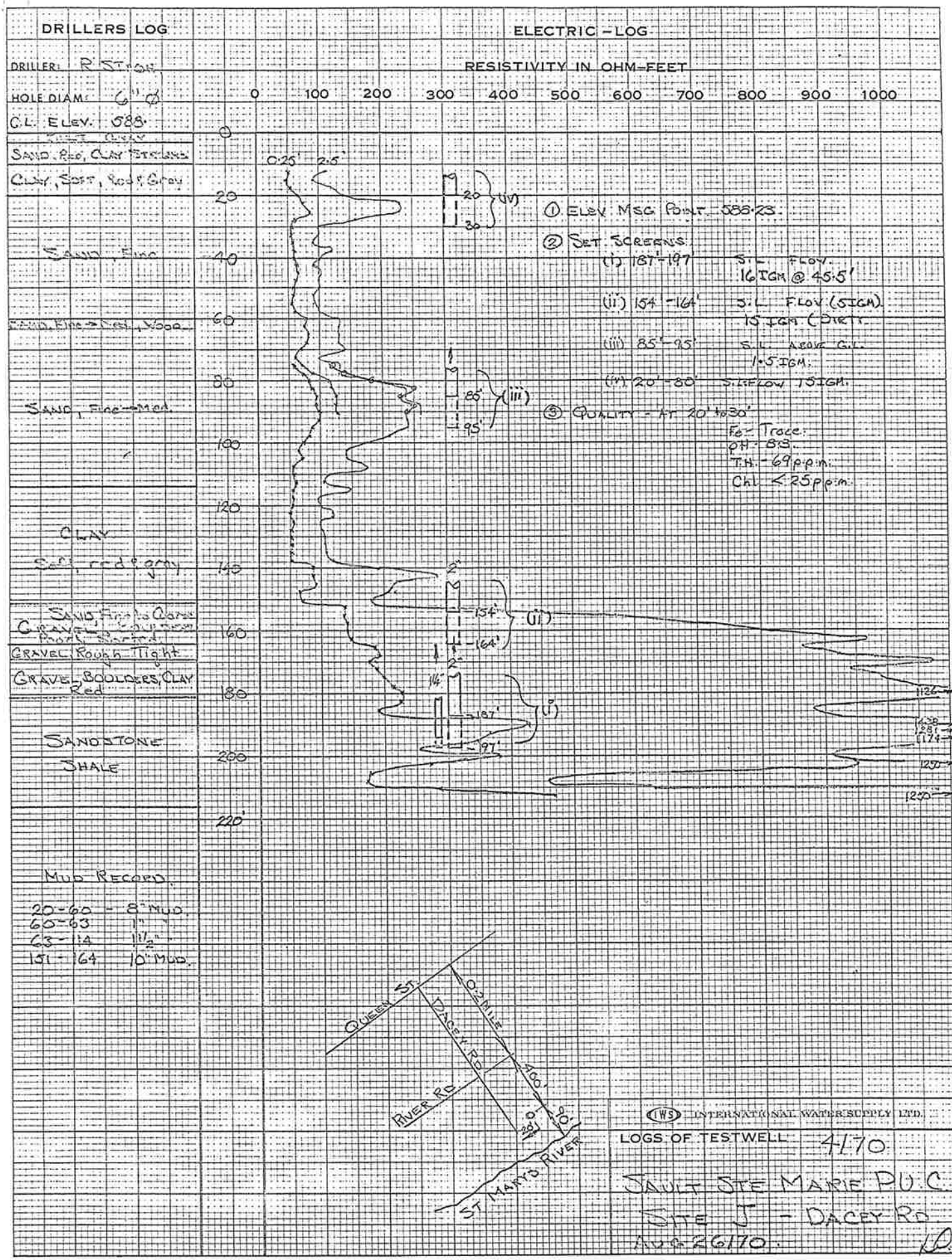


G9-12G IWS #3  
 10 x 10 TO THE 1/2 INCH  
 MADE IN CANADA

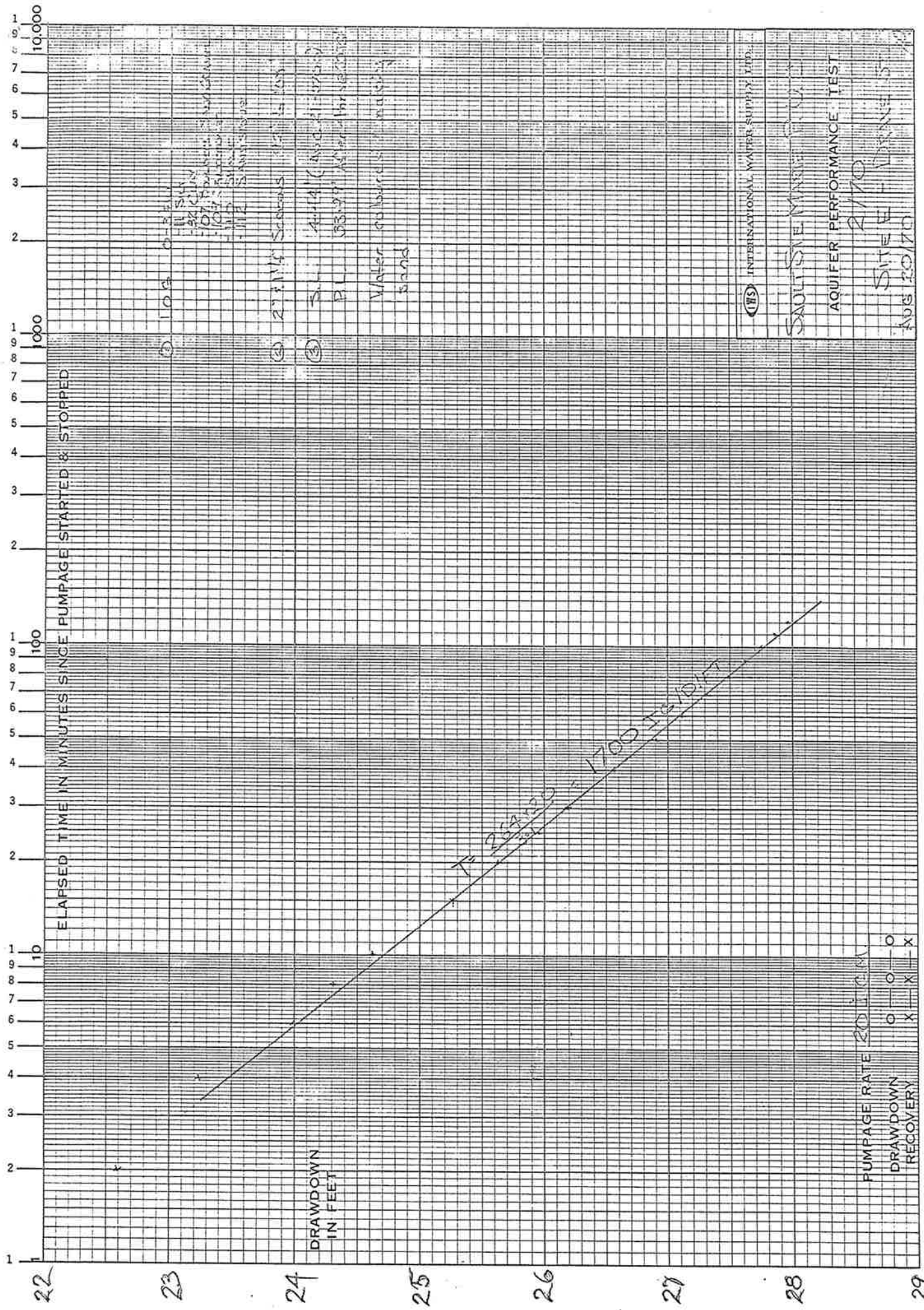


A71037

G9-12G IWS #3  
10 x 10 TO THE 1/2 INCH  
MADE IN CANADA

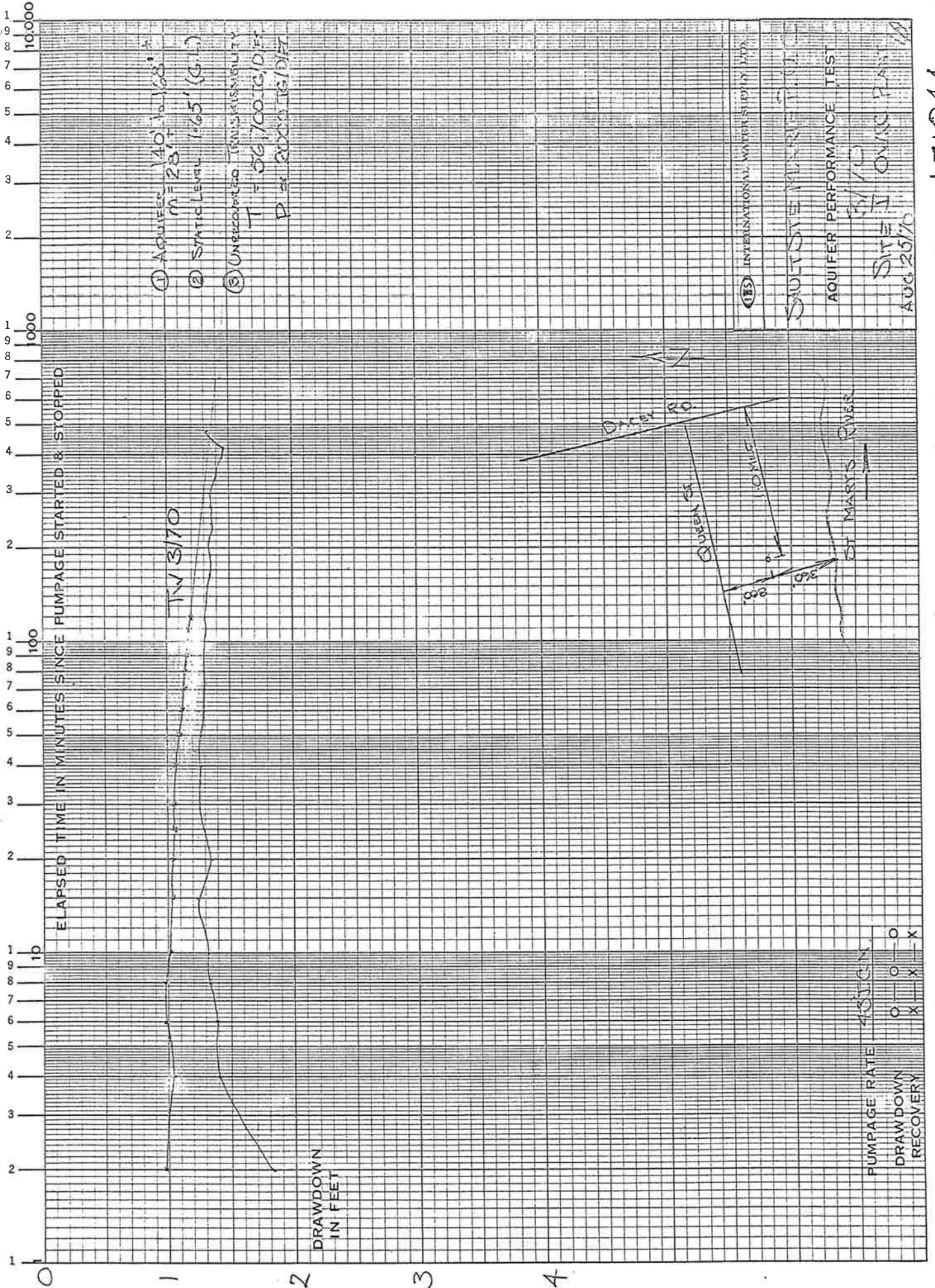


A71038



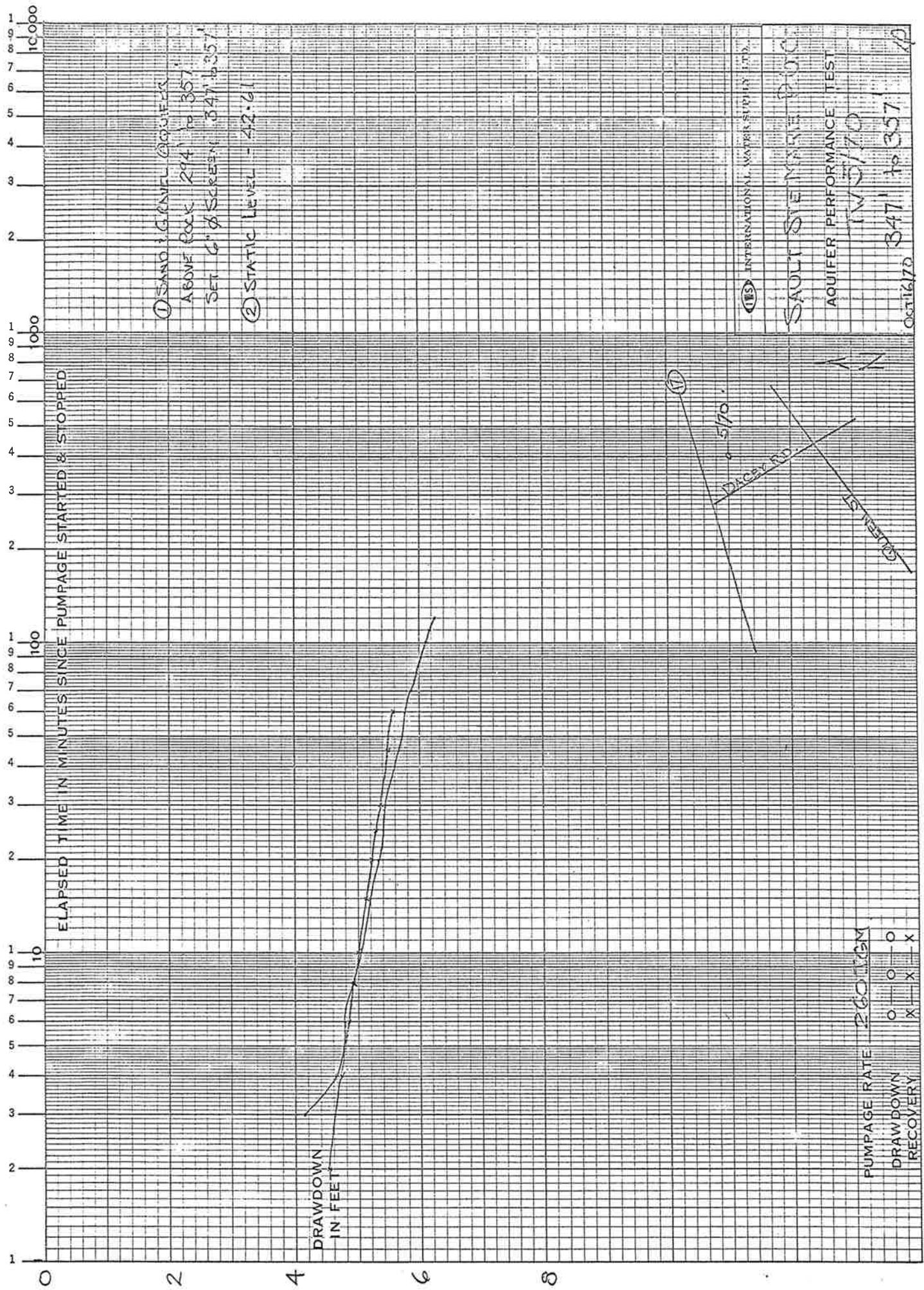
INTERNATIONAL WATER SUPPLY LTD.  
SAULTS NE MINE P.L.L.C.  
AQUIFER PERFORMANCE TEST  
2/70  
SITE E - LINES 5  
AUG 20/70

A71043



A71044



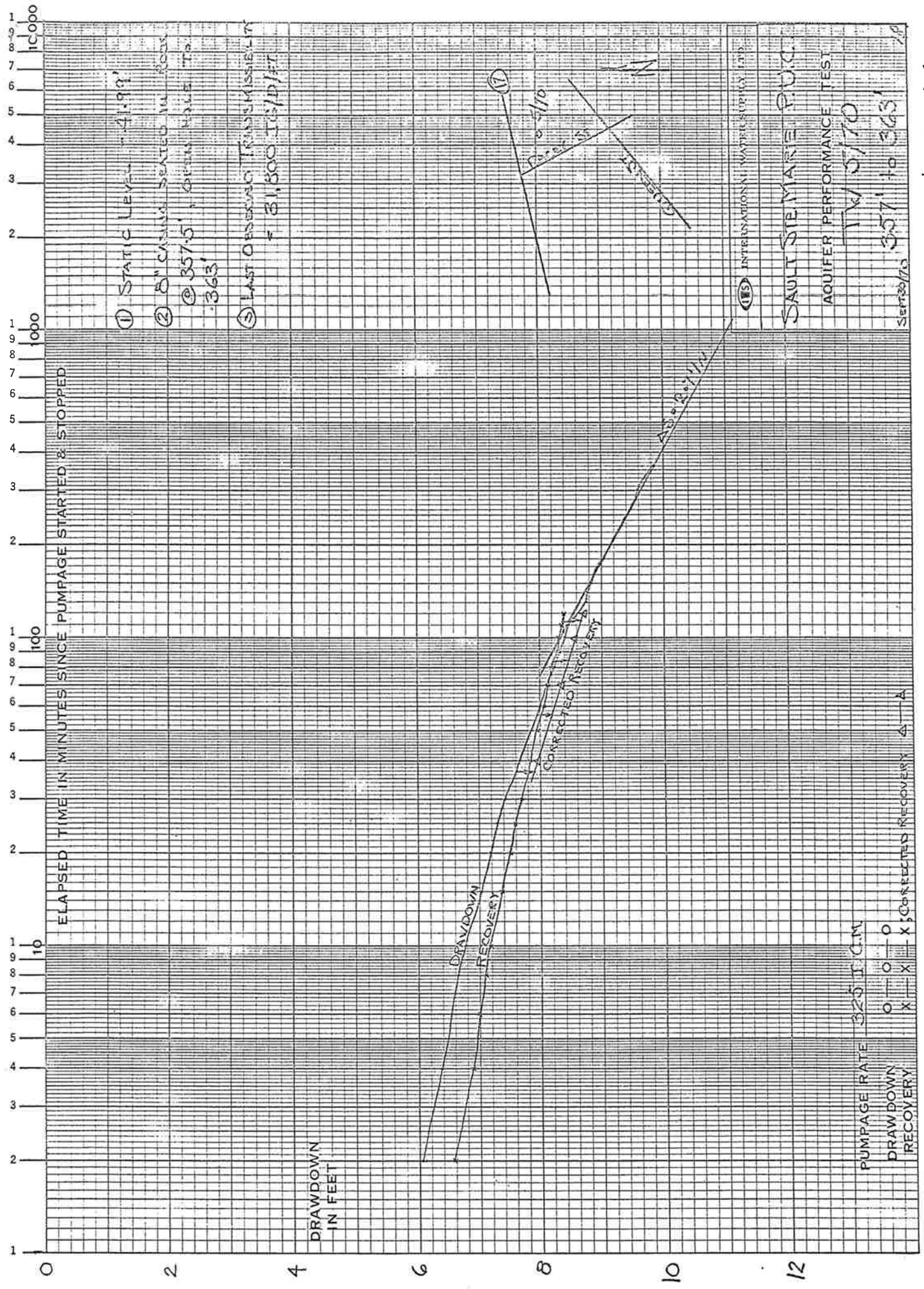


① SAND & GRAVEL AQUIFER  
ABOVE ROCK 294' to 357'  
SET 6" Ø SCREEN 347' to 357'

② STATIC LEVEL - 42.61

INTERNATIONAL WATER SUPPLY LTD.  
SAULT STEPHENIE P.Q.C.  
AQUIFER PERFORMANCE TEST  
T.M. 5/70  
347' to 357'  
05/16/70

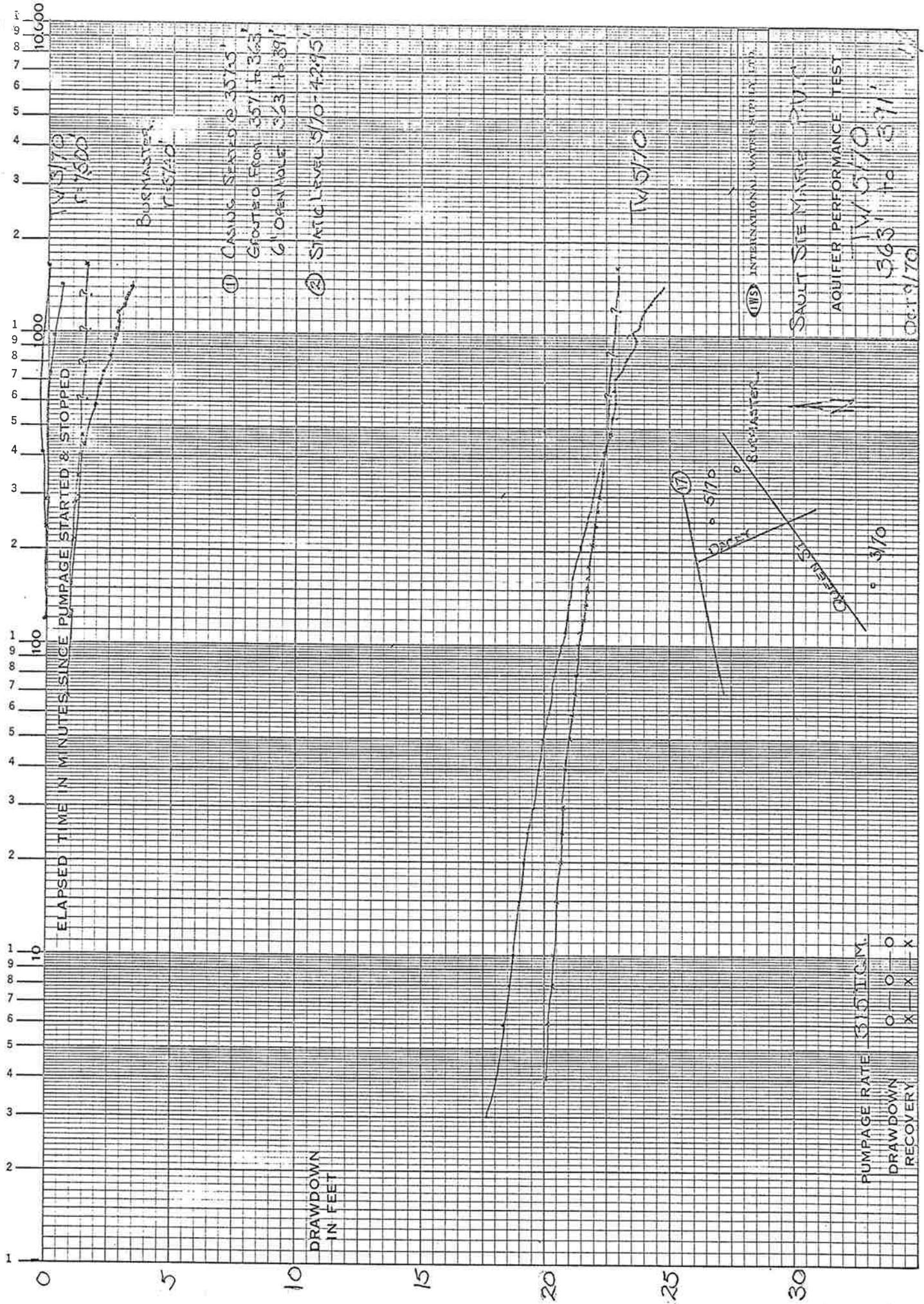
PUMPAGE RATE 260 LCM  
DRAWDOWN 0 - 0 - 0  
RECOVERY X - X - X

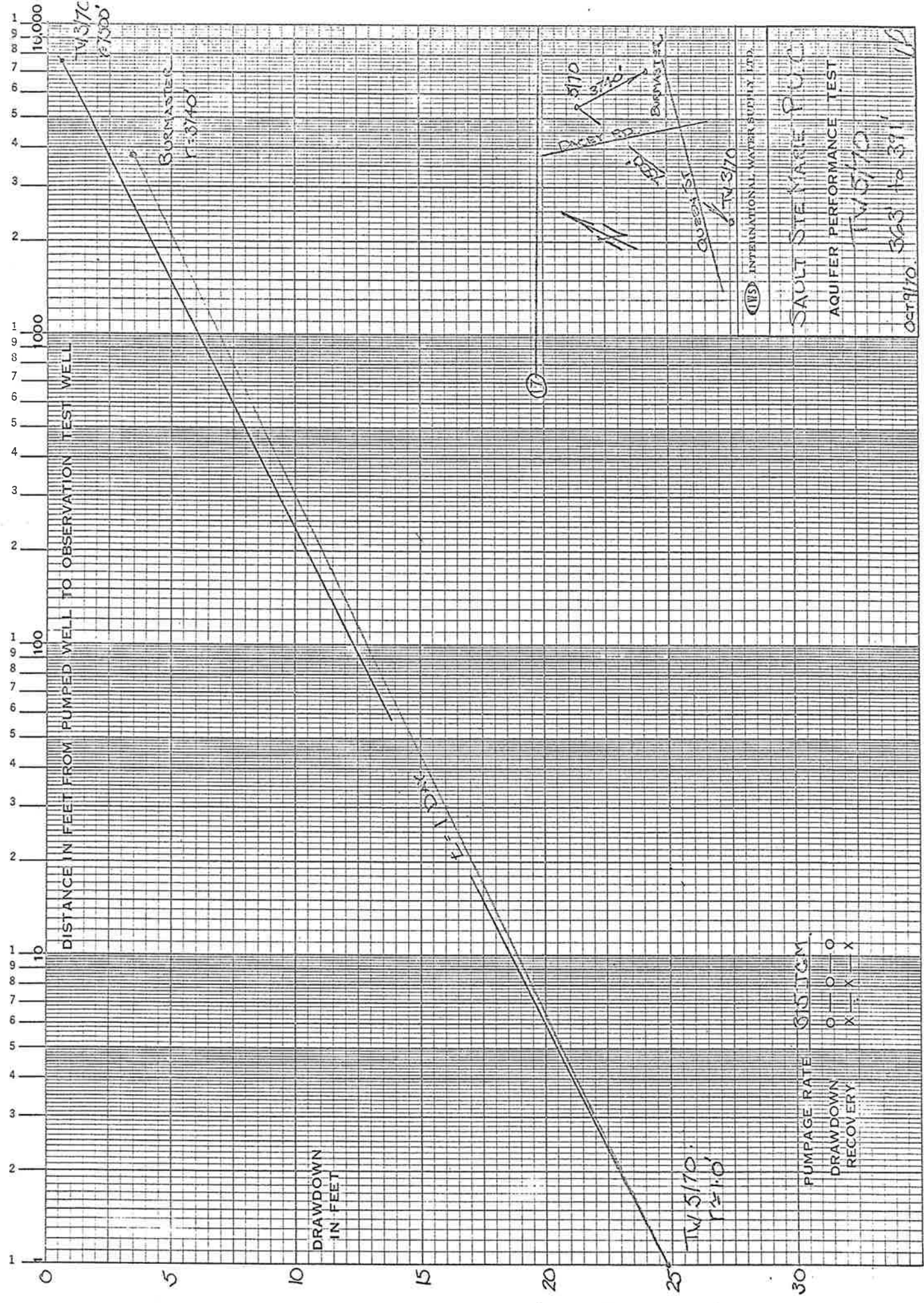


- ① STATIC LEVEL = 41.99'
- ② 8" CASING SEALED IN ROCK @ 357.5', GROUND WALE IS 363'
- ③ LAST OBSERVED TRANSMISSION = 81,500 I.G./D/FT

INTERNATIONAL WATER SUPPLY LTD.  
SAULT STE MARIE P.Q.C.  
AQUIFER PERFORMANCE TEST  
TW 5/70  
357' to 363'  
Sems/70

PUMPAGE RATE 320 I.C.M.  
DRAWDOWN 0 — 0 — 0  
RECOVERY X — X — X; CORRECTED RECOVERY Δ — Δ





PUMPAGE RATE	0	10	100	1000
DRAWDOWN	0	0	0	0
RECOVERY	X	X	X	X

IWS INTERNATIONAL WATER SUPPLY, LTD.  
SAULT STE MARIE PUL  
AQUIFER PERFORMANCE TEST  
TW 5/70  
363' to 391'  
OCT 9/70

DRILLER R. STROM

HOLE NO. 97 1/2, 77 1/2, 6 1/4"

ELEV. GROUND - 636.11

SAND, SILT.

SAND Fine.

SAND Fine to Coarse

SAND, Fine to Coarse, GRAVEL, FINE

CLAY

SAND, Fine to Coarse, GRAVEL, FINE

CLAY

SAND Fine

CLAY Streaks

CLAY

CLAY Red & Gray

CLAY Red.

SAND, Fine to Med, Picked

BOULDER, Round

SAND, Fine to Med, Picked

SAND GRAVEL, Fine to Coarse

SILT, SAND, FINE

SAND, GRAVEL, Fine to Coarse

SAND, FINE, GRAVEL Picked

SANDSTONE GRAVEL

SANDSTONE & SHALE Layered.

MUD RECORD.

5' to 27' Took 5" Mud.

27' - 53' " 8"

53' - 56' " 4"

63' - 75' " 4"

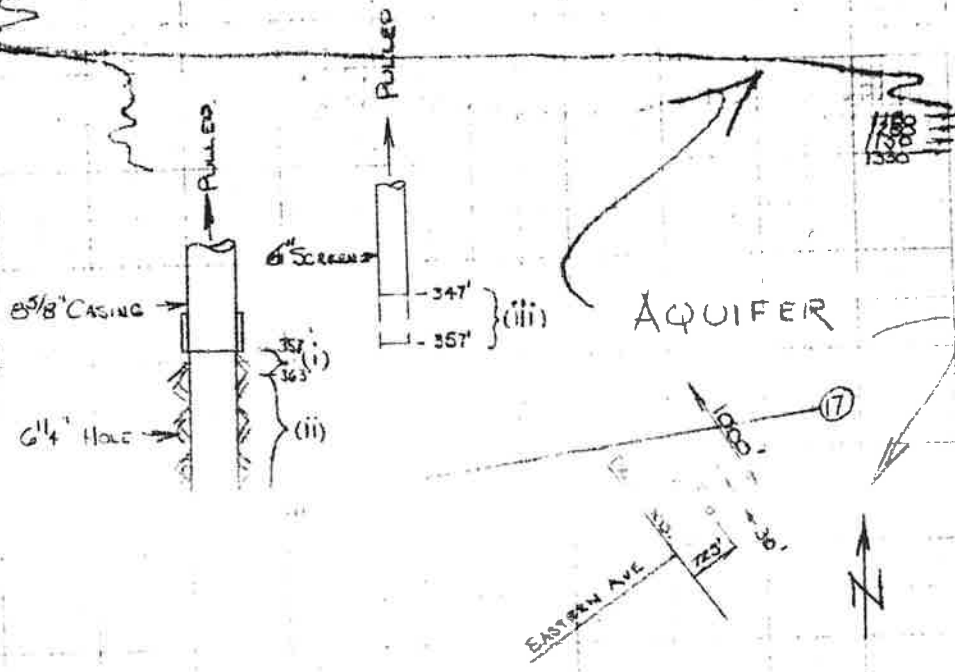
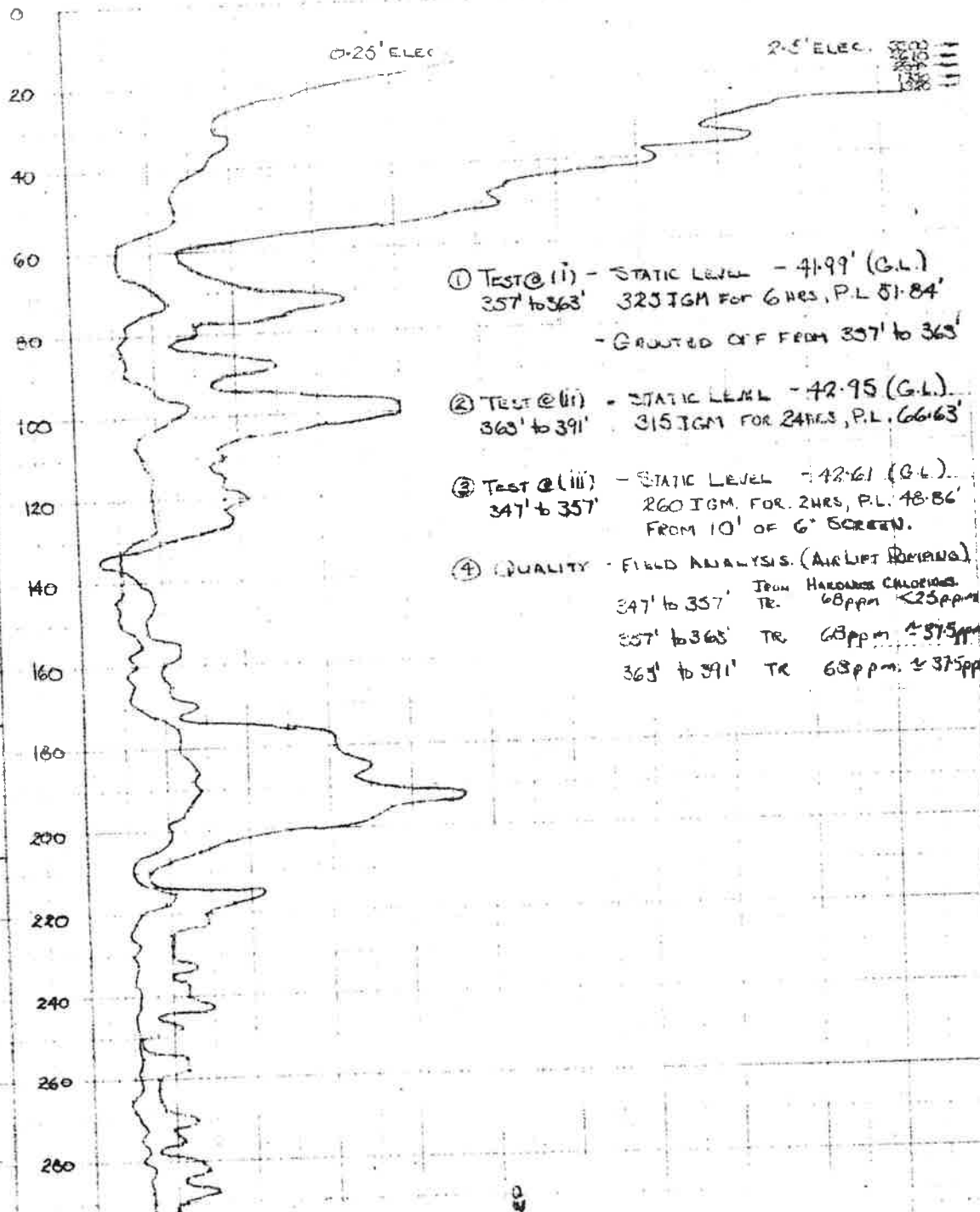
81' - 130' " 4"

294' - 311' " 2"

311' - 314' " 1"

314' - 320' " 2"

320' - 323' 24" HEAVY



(1WS) ...

LOGS OF TESTWELL 5/70

SAULT STE MARIE PUC

SITE F - FINNISH CLUB

OCT 7/70

A71039

## Appendix C-2b

### IWS Pumping Test in Test Well TW5/70 (1970)

## IWS Pumping Tests in Test Wells, 1970

### Distance-Drawdown Data, Pumping Test in TW5/70

Well	Distance from TW5/70, r (m)	Well Intake Depth (m)		Geological Unit	Drawdowns (m)
		Top	Bottom		
TW5/70	0.08	110.6	119.2	Sandstone	7.53
Burmaster Residential Well	1140	NA	NA	NA	1.07
TW3/70	2286	46.9	50.3	Sand, gravel	0.17

**Notes:**

Pumping test was done by International Water Supply Ltd. (IWS) in October 1970.

Test Well TW5/70 was pumped for 1 day at a rate of 315 l/gpm.

# IWS Pumping Tests in Test Wells, 1970

## Semi-Log Distance-Drawdown Analysis, Pumping Test of TW5/70

