GROUND-WATER DIVISION
WATER INVESTIGATIONS BRANCH
B.C. WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES

January 1966

Files: 0239015/0260140

NOTES ON DRILLING AND TESTING OF MASSET TEST WELL

INTRODUCTION

General

Mr. R.G. Hanson, Chairman of the Village of Masset, in a letter to the Deputy Minister of Water Resources, dated February 22nd, 1965, file 0260140, enquired about the possibility of this Department searching for a water supply for Masset. Mr. Hanson was informed that I would be in the Port Clements area late in March (see my memo on Port Clements well, files 0243107, 0239015) and would visit the Masset area in order to have a preliminary look at the geology and to see whether there would be any chance of drilling a successful well. After completing a preliminary investigation at Masset, I 'phoned Mr. Livingston and recommended that drilling could be carried out at one or more sites (see Fig. 3). We agreed that the first hole should be at a location close to the community, and that additional test holes, unless they could be done at very low cost, should await an economic feasibility study.

Mr. Livingston advised the Departmental Comptroller (April 8th, 1965, file 0260140) that there would be a definite advantage in getting G. & G. Well Drilling Ltd, to do the test hole at Masset. G. & G. were at that time drilling at Port Clements and consequently there would be a substantial saving in transportation costs if G. & G. were given the drilling contract. They were subsequently awarded the contract and drilling commenced at Masset on April 25th, 1965. A pump test was run on the completed well on May 13th and 14th at maximum pump capacity of 310 U.S. gallons per minute or 258 Imperial gallons per minute. Field tests on the water quality were carried out at the well site and showed a high iron content in the water (see Appendix IV).

The Water Resources Service paid $500 towards transport costs for the drill to MacMillan, Bloedel and Powell River Company who financed the transport of drill equipment to the Queen Charlotte Islands and the drilling of the Port Clements well.

The Village of Masset subsequently purchased the well for $1,528.35, being the cost of materials and standby time only. A breakdown of costs on the project is listed as follows:

2 . . . .

Cost of installed materials and standby time:

16 feet of #80 and #70 slot (stainless) screen and fittings @ $ 67.00 per foot	$ 1,072.00
31 feet of 8-inch pipe at $5.00	$ 155.00
5% Tax on materials ($1,227.00)	$ 61.35
Standby time (8 hours waiting for screen delivery and 16 hours delay in making available a bulldozer) 24 hours at $10.00 per hour	$ 240.00
Total ...	$ 1,528.35

Drilling costs, etc:

Transportation costs agreed on with MacMillan-Bloedel & Powell River	$ 500.00
Transportation of crew to and from site	$ 175.00
Drilling costs - hourly work 169 hours @ $14.00 per hour	$ 2,366.00
Pumping and pump development - 48 hours @ $12.00 per hour	$ 576.00
Room and board for drill crew	$ 407.60
Miscellaneous expenses	$ 51.00
Total ...	$ 4,075.60

Total cost of well .... $ 5,603.95

Water Supply Requirements for Village of Masset

No detailed study has yet been made of the water requirements for the Village of Masset. Using the figure supplied by Mr. Hanson of 150 possible connections at the present time, plus an estimated requirement of 25 gallons per minute for the local cannery, I would very roughly calculate the water requirements as follows:

150 connections at	500 Imp. gallons a day	75,000 Imperial gallons a day
Cannery	25 Imp. gallons per min.	36,000 Imperial gallons a day
Existing average daily demand		111,000 Imperial gallons a day or 77 Imperial gallons per minute

A possible peak demand of, say 1.5 x 77 ....115 Imperial gallons per minute

Location

The Village of Masset is located at the north end of Graham Island, Queen Charlotte Islands, near the entrance to Masset Sound (see Figs. 1-3). The well locations are shown on Figs. 2 and 3. The well and access road are located on Lots 16, 17 and 18 (?) of Block 32, District Lot 361, Plan 1032, Queen Charlotte District. The Superintendent of Lands advises a reserve has been established on Department records covering these lots (letter of June 14th, file 0260140).

3 . . . .

Sι ace Water Supplies

There are small creeks with poor quality water close to Masset. These are reported to dry up in the summer and are considered unsuitable as a source of supply for the Village of Masset.

WELL CONSTRUCTION AND DEVELOPMENT PROCEDURES

The location of the Masset well site is shown on Figs. 2 and 3. Water was first encountered at 20 feet, see Appendix II, with a static level of 12½ feet. The hole was drilled down to 88 feet. Samples of the drill cuttings between 20 and 44 feet were sent by air to Victoria, on May 1st, and size analyses were run by the Department of Highways, see Appendix II. G. & G. Well Drilling advised that the screen slot size selected on the basis of the size analyses results could not be obtained locally and would have to be ordered from the factory in Minnesota. This would have meant a delay of some days and involved an expense of several hundred dollars for standby time for crew and drilling rig. G. & G., however, finally obtained locally in Vancouver and in Seattle, a five-foot section of 80 slot screen and a 10-foot section of 70 slot screen, both screens were made of stainless steel and from the size analyses results were quite suitable for the Masset well. In the absence of Mr. Livingston, I agreed verbally to an increase of $80.00 over the contract price for the 16 feet of screen needed, as I felt this price increase to be justified under the circumstances.

The bottom of the screen was placed at a depth of 46 feet, 4 inches, in the test hole. The five-foot section of 80 slot screc 'as placed at the bottom and the 10-foot section of 70 slot above this. Thirty-one feet of 8-inch casing was left in the hole.

Except for a gravel sample at 38 feet which contained up to 40% sand, all gravel samples between 30 feet and 44 feet contained less than 30% sand, and minor silts. Most samples contained some pebbles over one inch in diameter. On the basis of the size analyses results, the screen was placed between 30 and 46 feet. The screen slot size would only allow the sand fraction, up to 30% of formation material, to pass through during well development. Surging was carried out on the well for three days until no further sand and fines came through the well screen.

PUMP TEST AND RESULTS (For conclusions - see end of this section)

General Description of Procedures and Equipment Used

The pump used for the test was the same one used for the Port Clements well pump test - a vertical turbine type, equipped with a three-inch orifice attached to a four-inch pipe. A steady flow was maintained of 310 U.S. gallons per minute or 258 Imperial gallons per minute which was measured by the orifice method described on page 152, Water Well Handbook.

An atte...pt was made to eliminate the possibility of surface leakage to the aquifer from the water being pumped out of the well. A ditch was dug, at the Village of Masset's expense, north from the well site to Delkatla Inlet (see Fig. 3). This ditch was subsequently lined in part with plastic sheeting. During the pump test, flow measurements made by a triangular notch weir at the north end of the ditch were compared with the well flow and showed only negligible losses along the trench.

The maximum capacity of the pump was limited the equipment available to a little over 300 U.S. gallons per minute or 258 Imperial gallons per minute.

After a preliminary test, it was decided to run the pump at 310 U.S. or 258 Imperial gallons per minute for a "constant rate test". Two nearby domestic wells were utilized during the test and arrangements were made with the owners to not use these wells during the pump test and recovery reading period. A map showing the location and distance of the Masset test well from the observation wells is shown on Fig. 4. These were unfortunately the nearest wells that could be used for observation purposes. Pump test data is tabulated in Appendix III.

Discussion of Results

1) Coefficient of Transmissibility (T)

The coefficient of transmissibility (T) of the aquifer was calculated by several methods, and an average value found for T = 2.45 10^5 Imperial gallons per day per foot width. The results are tabulated below.

Non-equilibrium method (see Fig. 5).

For observation well #1: T = 2.88 x 10^5 Imperial gallons per day per foot width
For observation well #2: T = 2.60 x 10^5 Imperial gallons per day per foot width.

Modified non-equilibrium method of Jacob (see Figs. 6-8)

For Masset test well (av.value: T = 2.16 x 10^5 Imp. gallons per day per foot width.
For observation well #1: T = 2.32 x 10^5 Imp. gallons per day per foot width.
For observation well #2: T = 2.59 x 10^5 Imp. gallons per day per foot width.

Non-equilibrium (recovery) method (see Fig. 9)

For observation well #1: T = 3.86 x 10^5 Imperial gallons per day per foot width.
For observation well #2: T = 1.51 x 10^5 Imperial gallons per day per foot width.

Theis Recovery Method (see Figs 10-12)

For Masset test well : T = 2.08 x 10^5 Imperial gallons per day per foot width.
For observation well #1: T = 2.59 x 10^5 Imperial gallons per day per foot width.
For observation well #2: T = 1.90 x 10^5 Imperial gallons per day per foot width.

2) Coefficient of Storage (S)

The coefficient of storage (S) of the aquifer was calculated by several methods also, and an average value found for S = 0.039. (Values for Q used in this calculation being in Imperial gallons per minute). The (S) calculations are tabulated below.

Non-equilibrium method (see Fig. 5)

For observation well #1: S = 0.049
For observation well #2: S = 0.0178

Modified non-equilibrium method of Jacob (see figs. 7 and 8)

For observation well #1: S = 0.0735
For observation well #2: S = 0.01611

3) General Discussion

Despite the restrictive assumptions on which they are based, the non-equilibrium formula, modified non-equilibrium formula and recovery formula give comparable values for (T) coefficient of transmissibility. The value, (T) = 2.45 x 10^5 Imperial gallons per day per foot width, is large and indicates the permeable nature of the gravel aquifer.

The aquifer would probably best be described as a leaky artesian type. During drilling, water was encountered at 20 feet with a static of 12 feet approximately. The drill log indicates however, that the overlying formations are harder packed and considerably less permeable. This may help explain the value for the storage coefficient (=0.049). That is, a value somewhat less than that normal for water table aquifers but greater than the range normally expected for artesian aquifers.

4) Well Loss (sw)

The drawdown in the Masset well can be computed theoretically from the non-equilibrium formula. This computation however does not take into account drawdown due to well loss (sw) and partial penetration loss (sp). The difference between the actual drawdown measured in the Masset Well during the pump test, and the theoretical drawdown is taken to represent the components of well loss (sw) and partial penetration loss (sp) in the well.

Assuming a value for (T) - 2.45 x 10^5 Imperial gallons per day per foot width, S = 0.039, t = 1 day (1440 minutes), Q (well discharge) = 258 Imperial gallons per minute, then using a graphical solution of the exponential integral method of Theis, the theoretical drawdown in the Masset test well is calculated as 1.58 feet. The actual drawdown under test for the same values of time (t) and well discharge (Q) is 2.38 feet. The resulting well losses of 0.8 feet drawdown after one day are therefore relatively small in the Masset test well.

The theoretical drawdown in the test well was computed also for other values of Q (well discharge) and t (time). All results are tabulated below.

Q (discharge of well in Imperial gallons/minute)	t(Time in days since pumping started)	Theoretical drawdown in feet in Masset test well
115	1	0.70
115	100	0.95
258	1	1.58
258	100	2.15
1000	1	6.1
1000	100	8.3

5) Conclusions

Assuming a peak demand of 115 Imperial gallons per minute for Masset, then after 100 days of continuous pumping the theoretical drawdown would be 0.95 feet. If we accept a figure for well loss of 0.8 feet at this pumping rate, then with a static level in the well of 12.57 feet, the total drawdown in the well pumping at 115 Imperial gallons per minute for 100 days is estimated to be 14.32 feet below top of casing. As the top of the well screen is at a depth of 31 feet, the capacity of the test well is considerably in excess of the estimated peak demands which may be required by the Village of Masset.

A discussion of the surficial geology of the Masset area, log of the Masset test well and size analyses curves, pump test data, and water quality of the test well are included in Appendices I - IV attached. *

J.C. Foweraker

J.C. Foweraker
Geological Engineer
Ground-water Division

JCF/ls
attachs.

* For this information, and figures 1-12 see "Completed projects file" Ground Water Division.

APPENDIX I

NOTES ON THE SURFICIAL GEOLOGY OF THE MASSET AREA AND PROBLEMS INVOLVED IN THE SELECTION OF A TEST WELL SITE

Notes on the surficial geology and generalized glacial history from Port Clements to Masset, together with an interpretation of the drill log and samples of the Port Clements Well have been discussed in my memo of July 20th, 1965, (Files 0243107 and 0239015), and this information will not be repeated here.

The Village of Masset lies within an area of Graham Island designated as the "Queen Charlotte Lowlands" on the physiographic map (Fig. 1). The lowlands are underlain by flat, gently-dipping Tertiary marine shales, sands and sandstones, and commonly the low hills are found to be remnants of volcanic flows. Sutherland Brown (1960) considers the lowlands are properly part of the floor of Hecate Strait, raised slightly above present-day sea level. The lowlands are mantled with unconsolidated glacial gravels, sands and silts. The reworking of these deposits has provided one great beach along the whole of the shallow shoreline from Skidegate Inlet to Masset. Sutherland Brown has observed that prevailing southeast gales are eroding the east coast shore and driving the sands northward along the coast to build Rose Spit. Along the north coast from Rose Spit to Masset the main process is one of deposition in part caused by sand that is blown across the spit in dunes.

Masset Village and Masset Indian Village lie on the northeast side of Masset Harbour which is near the entrance to Masset Inlet. The Villages are underlain by gravel, sand and some silts, in part beach and bar deposits containing shells, and at Masset Indian Village in part on dune sands. Prominent bluffs exposed to the east of Masset contain over 100 feet of crossbedded fine light brown sands and some gravel. It is thought that this material was derived from melting ice to the south and west. Outside of Masset near Skaga Point, at an excavation made for causeway materials, there are exposed near sea level bouldery gravels which stand well, are firm, and show iron staining. These beds are overlain by an eight-foot sequence of very fine sands, showing near horizontal cross-bedding and containing lenses of haematite concentrations, and small lenses of gravel, (see photo). No till is exposed at the base of this section, but in the triangular area from Masset to Cape Ball to Rose Spit, Sutherland Brown and Nasmith (1962) found generally that till and stony marine clay do underlie the thick outwash deposits of sands and gravels, exposed particularly on the east coast.

Well records at Masset such as at the Naval Radio Station northeast of Masset Village (see fig. 2) are few. A testhole was reported to have been drilled here and encountered salt water at 150 feet. A later hole drilled by G. & G. Well Drilling in August, 1960, encountered the following:

Footage	Description
0 - 12	Fine sand with clay binder
12 - 14	Fine sand W.B.
14 - 15½	Coarse gravel and sand and clam shells - water bearing
15½ - 18	Coarse gravel, water-bearing
18 - 21	Medium coarse gravel, large percentage of shells, and some very fine sand.
21 - 23½	Fine gravel

Footage	Description
23½ - 24	Very fine silty sand - two feet core rise while bailing; casing goes down while drilling
24 - 27	Silted fine sand, water cannot run out of casing.
27 - 27½	Silted fine sand.
27½ - 28	Fine gravel and sand - water
28 - 30½	Fine heavily silted sand
30½ - 32	Fine silted sand and 50% clay

This log suggests that former beach deposits are present to the south of the north coast road. The absence of shells in the upper 14 feet consisting of fine sands and clay, could indicate a different mode of deposition for the topmost part of this section.

A successful well has now been dug in beach and dune sands for the Naval Radio Station (see B in Fig. 2). The water table is about (?) 12 feet from the surface and the quality is reported to be good.

The Naval Radio Station well and other wells dug at Masset Village along the beach front, and also the well dug for the Indian Villages in beach deposits - all these wells show that supplies of fresh water, probably of limited extent, do exist in the beach deposits at shallow depth floating on the salt water.

Further inland from the beach front area, most of the dug wells at Masset Village have poor quality water, with a high iron content. G. &. G. Well Drilling Ltd., drilled three holes for the Masset School and in one well encountered salty water at 64 feet. One well yielded 4-5 gallons per minute, but later became plugged with encrustation compounds, mostly iron. This deposit was later removed with a chemical cleaner.

Before test drilling commenced at the Masset test well site, several alternative drilling sites were considered (see Fig. 3) but these were ruled out because of a possible limited fresh water supply, or the danger of salt water intrusions under heavy pumping or on the distance from the community to the well site. The test site chosen on the east side of Masset is in gravel beach deposits, situated at the bottom of prominent bluffs composed predominantly of sand, where the possibilities of recharge should be good. The test site is also located close to the community, and to the bluffs where a possible gravity storage tank might be built.

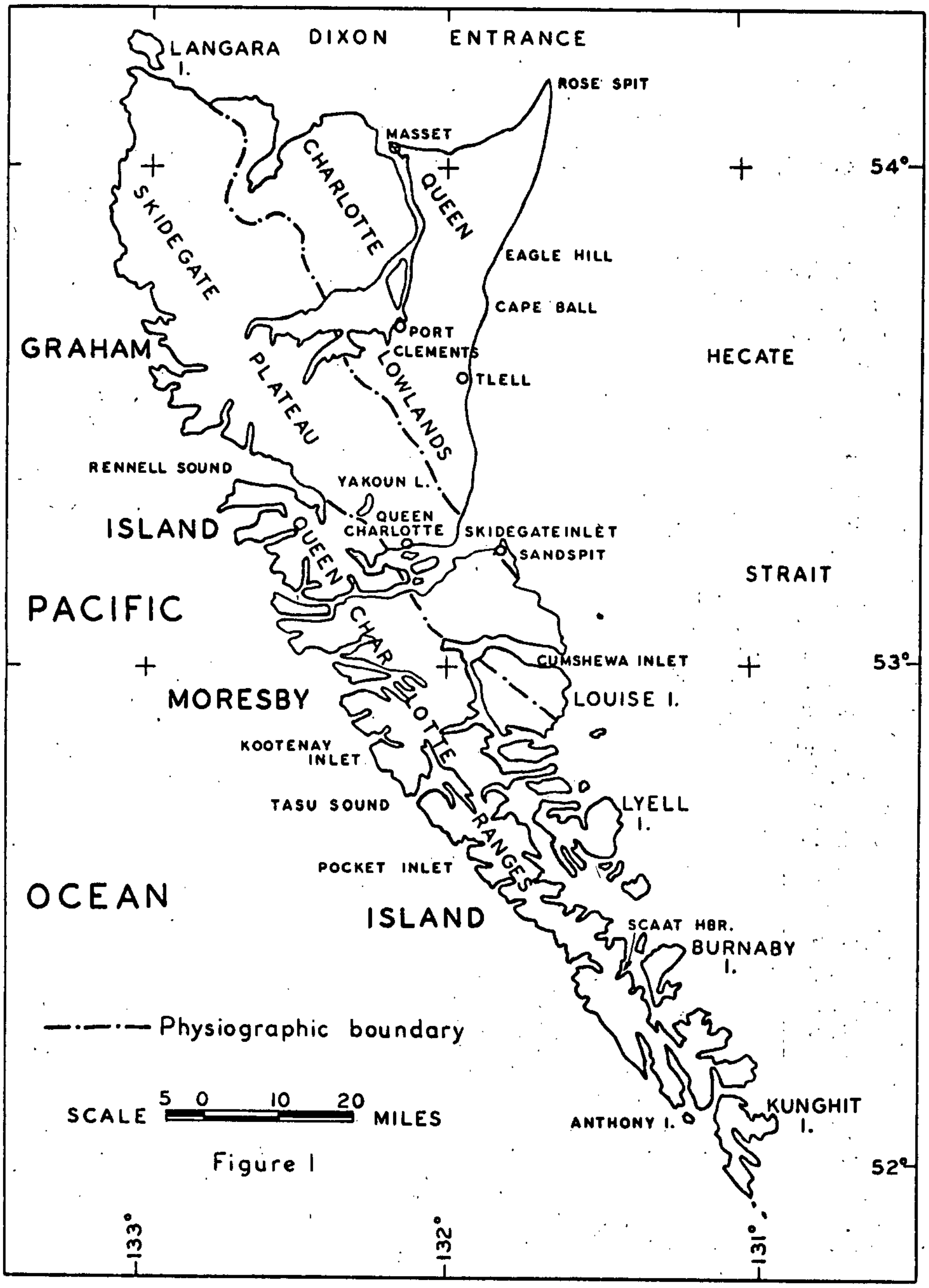


Figure I

Location Map and Physiographic Map.
Queen Charlotte Islands

WATER INVESTIGATIONS BRANCH

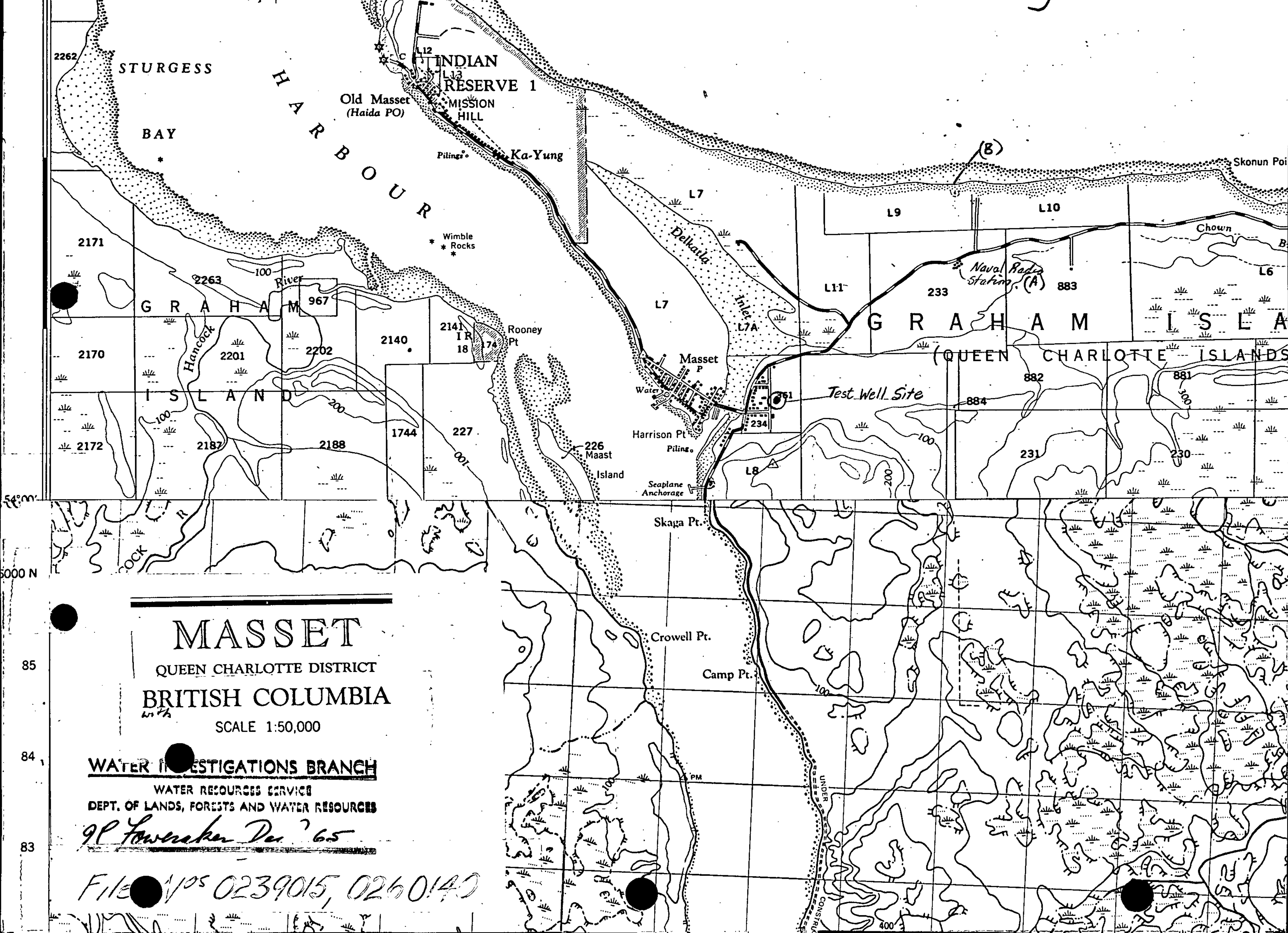
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES

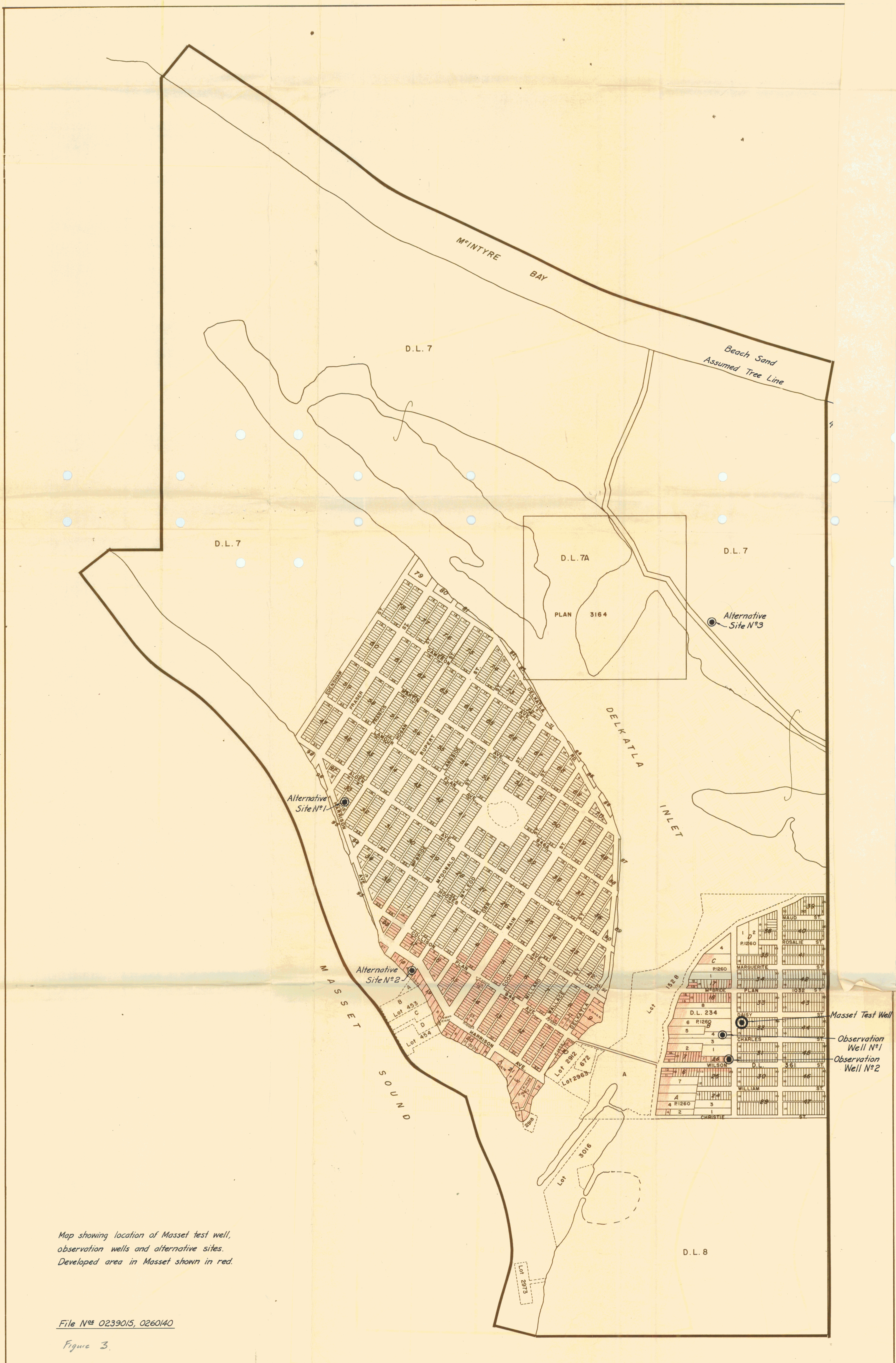
J.C. Foweraker Dec. '65

File N^os 0239015, 0260140

Figure 1

Figure 2


MASSET
QUEEN CHARLOTTE DISTRICT
BRITISH COLUMBIA
SCALE 1:50,000
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
File Nos 0239015, 0260140
Entry Point
Estrado Lagoon
STURGESS BAY
HARBOUR
INDIAN RESERVE 1
Old Masset
(Haida PO)
MISSION HILL
Ka-Yung
Wimble Rocks
Skonun Point
Naval Radio Station (A)
(B)
Delkatla Inlet
Masset
Test Well Site
Harrison Pt
Seaplane Anchorage
Maast Island
Rooney Pt
GRAHAM ISLAND
(QUEEN CHARLOTTE ISLANDS)
Chown
Hancock
River
Skaga Pt.
Crowell Pt.
Camp Pt.



Map showing location of Masset test well, observation wells and alternative sites. Developed area in Masset shown in red.

File Nos 0239015, 0260140

Figure 3.

VILLAGE of MASSET

REGIONAL PLANNING DIVISION : DEPT. of MUNICIPAL AFFAIRS : VICTORIA

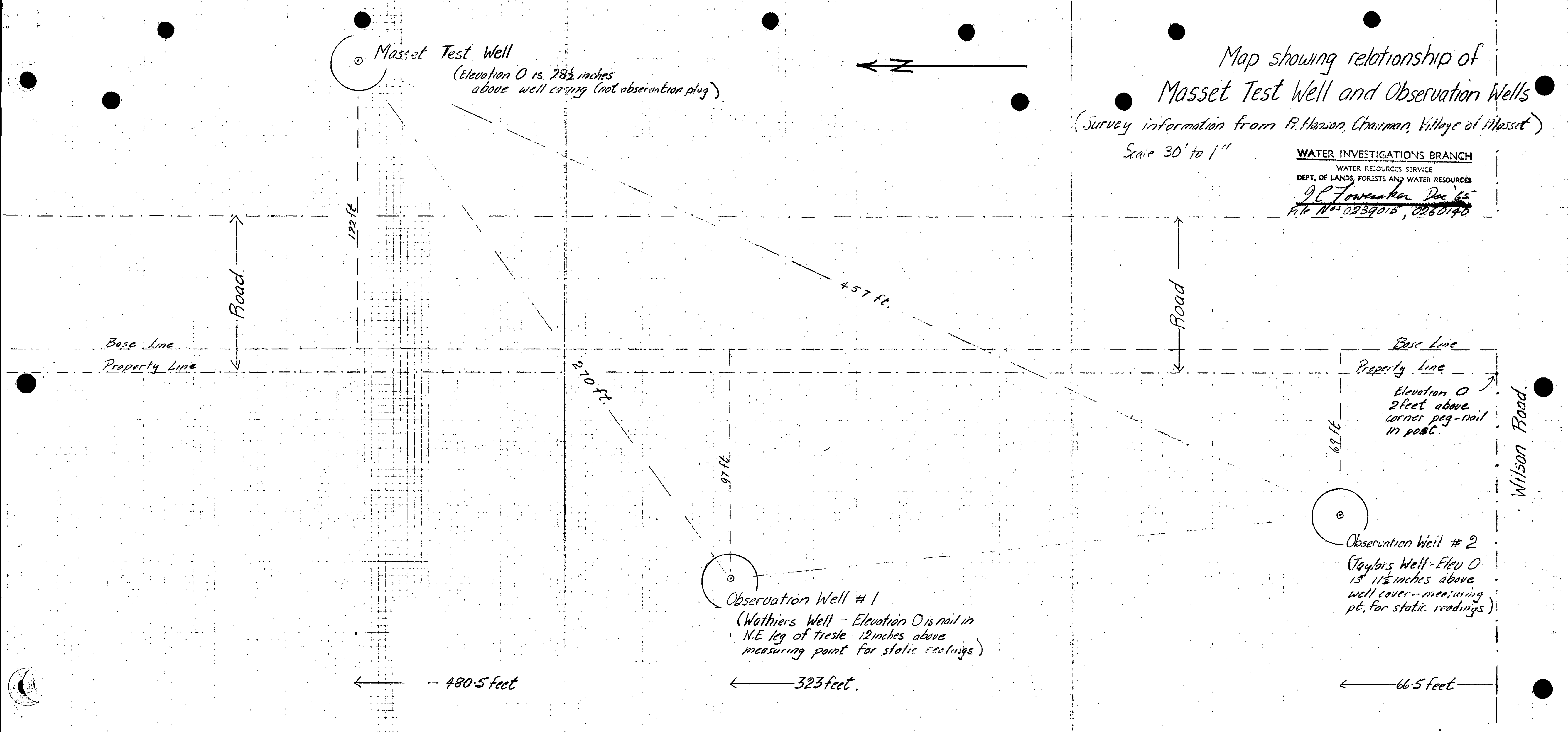
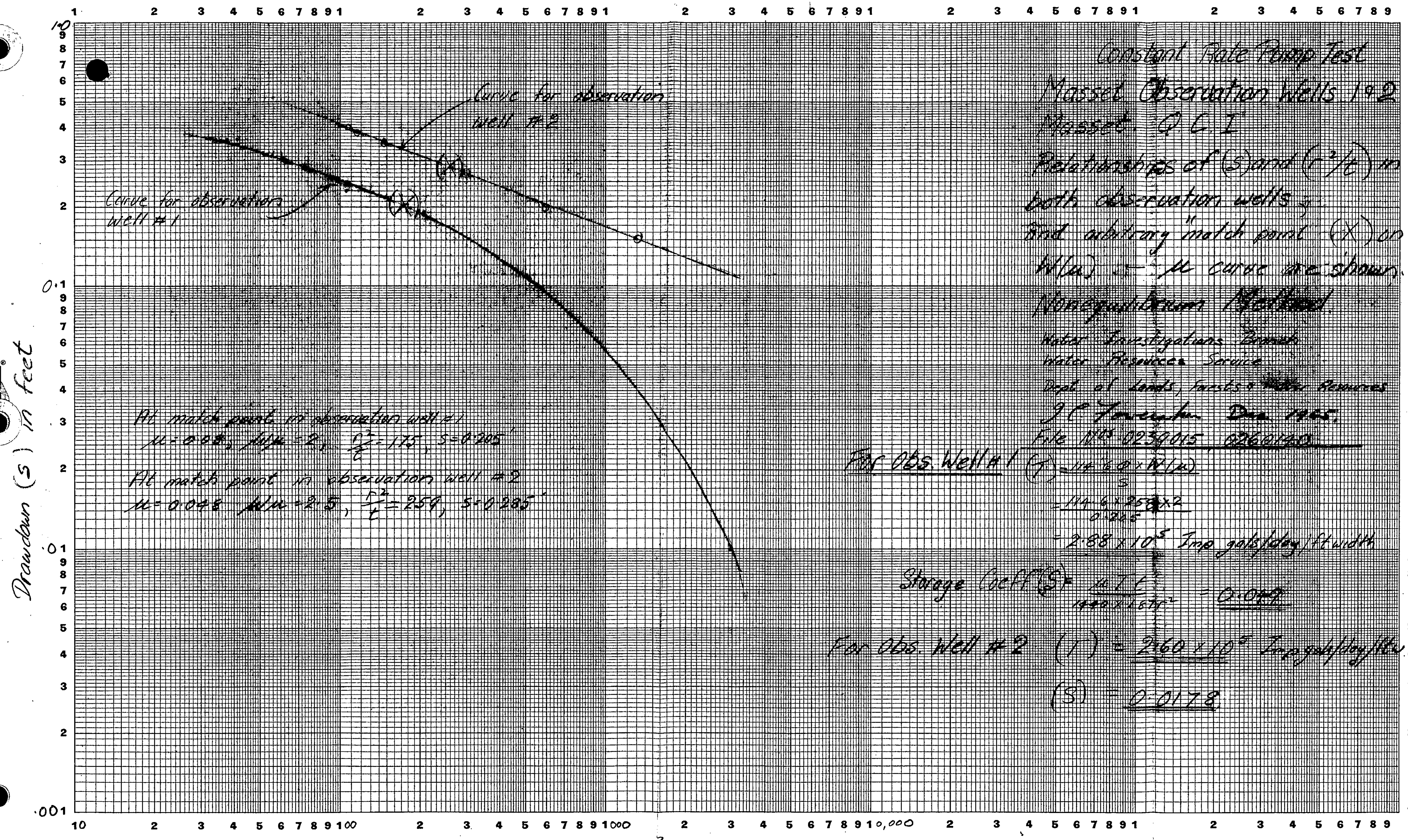

Map showing relationship of
Masset Test Well and Observation Wells
(Survey information from R. Hanson, Chairman, Village of Masset)
Scale 30' to 1"
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
File Nos 0239015, 0260140
Masset Test Well
(Elevation O is 28½ inches above well casing (not observation plug)
122 ft
Road
Base Line
Property Line
457 ft.
270 ft.
97 ft
69 ft
Road
Base Line
Property Line
Elevation O 2 feet above corner peg-nail in post.
Wilson Road.
Observation Well #1
(Wathiers Well - Elevation O is nail in N.E leg of tresle 12 inches above measuring point for static readings)
Observation Well # 2
(Taylors Well - Elev O is 11½ inches above well cover - measuring pt. for static readings)
480·5 feet
323 feet.
66·5 feet

Figure 4



Constant Rate Pump Test
Masset Observation Wells 1 & 2
Masset, Q.C.I.
Relationships of (s) and (r²/t) in both observation wells; and arbitrary "match point" (X) on W(u) — u curve are shown.
Nonequilibrium Method.
Water Investigations Branch
Water Resources Service
Dept. of Lands, Forests & Water Resources
Dec. 1965.
File Nos 0239015, 0260140
Curve for observation well #2
Curve for observation well #1
At match point in observation well #1
u = 0.03, W(u) = 2, r²/t = 175, s = 0.205'
At match point in observation well #2
u = 0.048, W(u) = 2.5, r²/t = 259, s = 0.285'
For Obs. Well #1 (T) = 114.6 Q × W(u) / s
= 114.6 × 258 × 2 / 0.205
= 2.88 × 10⁵ Imp. gals/day/ft width
Storage Coeff (S) = u T t / (1440 × 1.87 r²) = 0.049
For Obs. Well #2 (T) = 2.60 × 10⁵ Imp. gals/day/ft w
(S) = 0.0178
Drawdown (s) in feet
r²/t
t = time in days since start of pumping
r = distance in feet from test well

Figure 5

KEUFFEL & ESSER CO., N. Y. NO. 359H-71
Semi-Logarithmic, 3 Cycles × 10 to the inch, 5th lines accented.
MADE IN U. S. A.

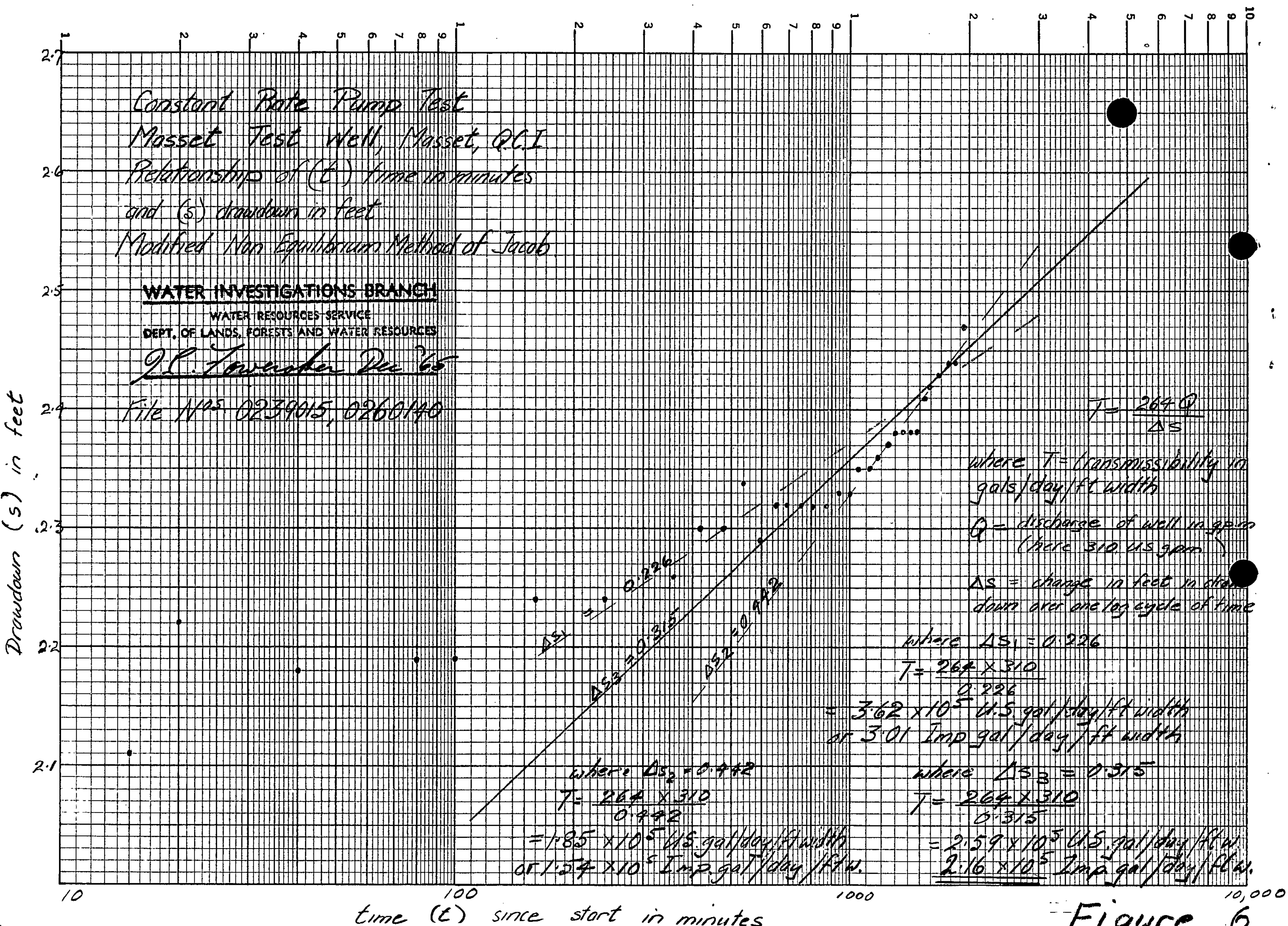
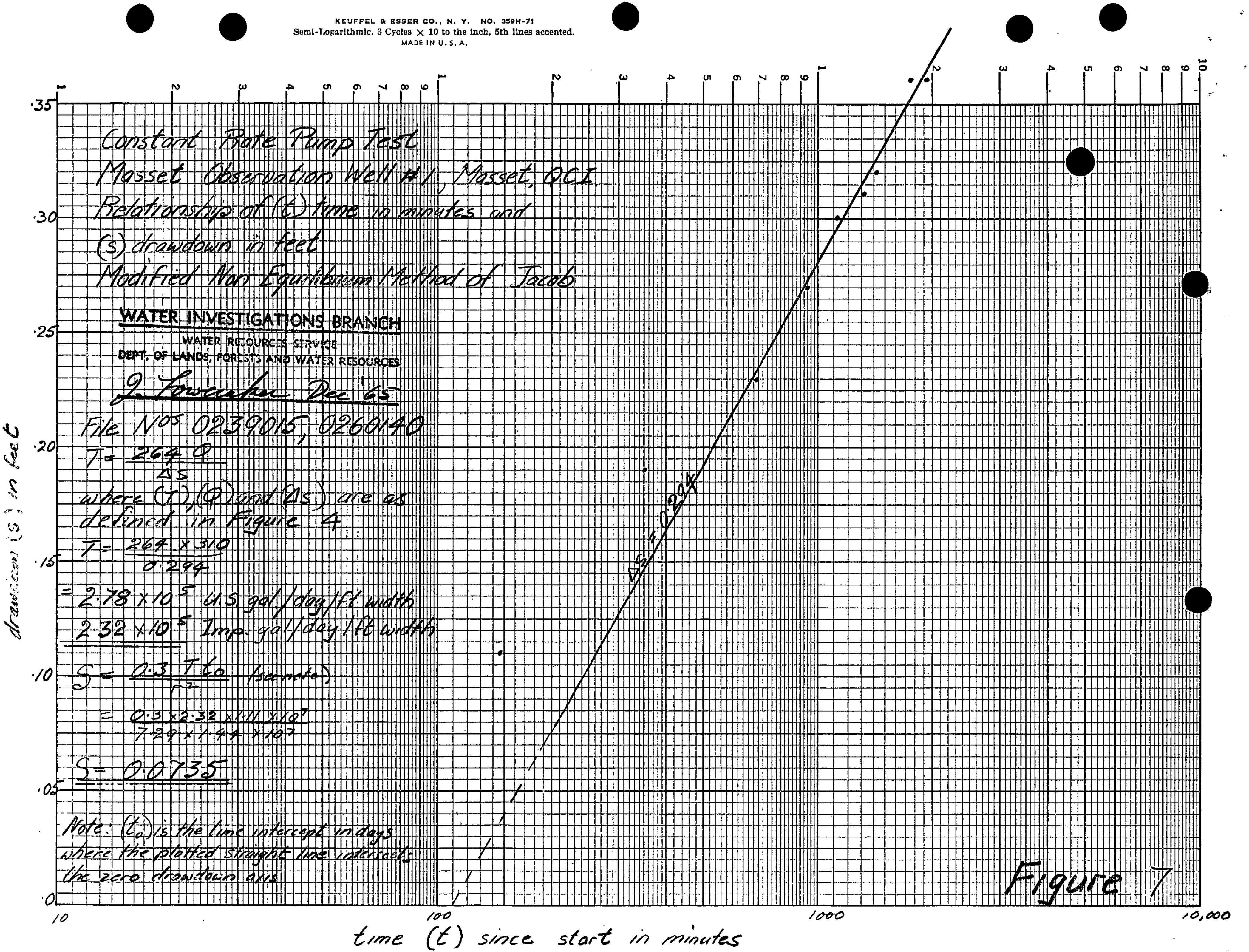


Figure 6


KEUFFEL & ESSER CO., N. Y. NO. 359H-71
Semi-Logarithmic, 3 Cycles × 10 to the inch, 5th lines accented.
MADE IN U. S. A.
Constant Rate Pump Test
Masset Observation Well #1, Masset, QCI.
Relationship of (t) time in minutes and
(s) drawdown in feet
Modified Non Equilibrium Method of Jacob
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
J. Foweraker Dec '65
File Nos 0239015, 0260140
T = 264 Q / Δs
where (T), (Q) and (Δs) are as defined in Figure 4
T = 264 × 310 / 0.294
= 2.78 × 10^5 U.S. gal/day/ft width
2.32 × 10^5 Imp. gal/day/ft width
S = 0.3 T t₀ / r² (see note)
= 0.3 × 2.32 × 1.11 × 10^7 / 7.29 × 1.44 × 10^7
S = 0.0735
Note: (t₀) is the time intercept in days where the plotted straight line intersects the zero drawdown axis
Δs = 0.294
drawdown (s) in feet
time (t) since start in minutes
10
100
1000
10,000
.35
.30
.25
.20
.15
.10
.05
0
Figure 7

KEUFFEL & ESSER CO., N. Y. NO. 359H-71
Semi-Logarithmic, 3 Cycles × 10 to the inch, 5th lines accented.
MADE IN U. S. A.

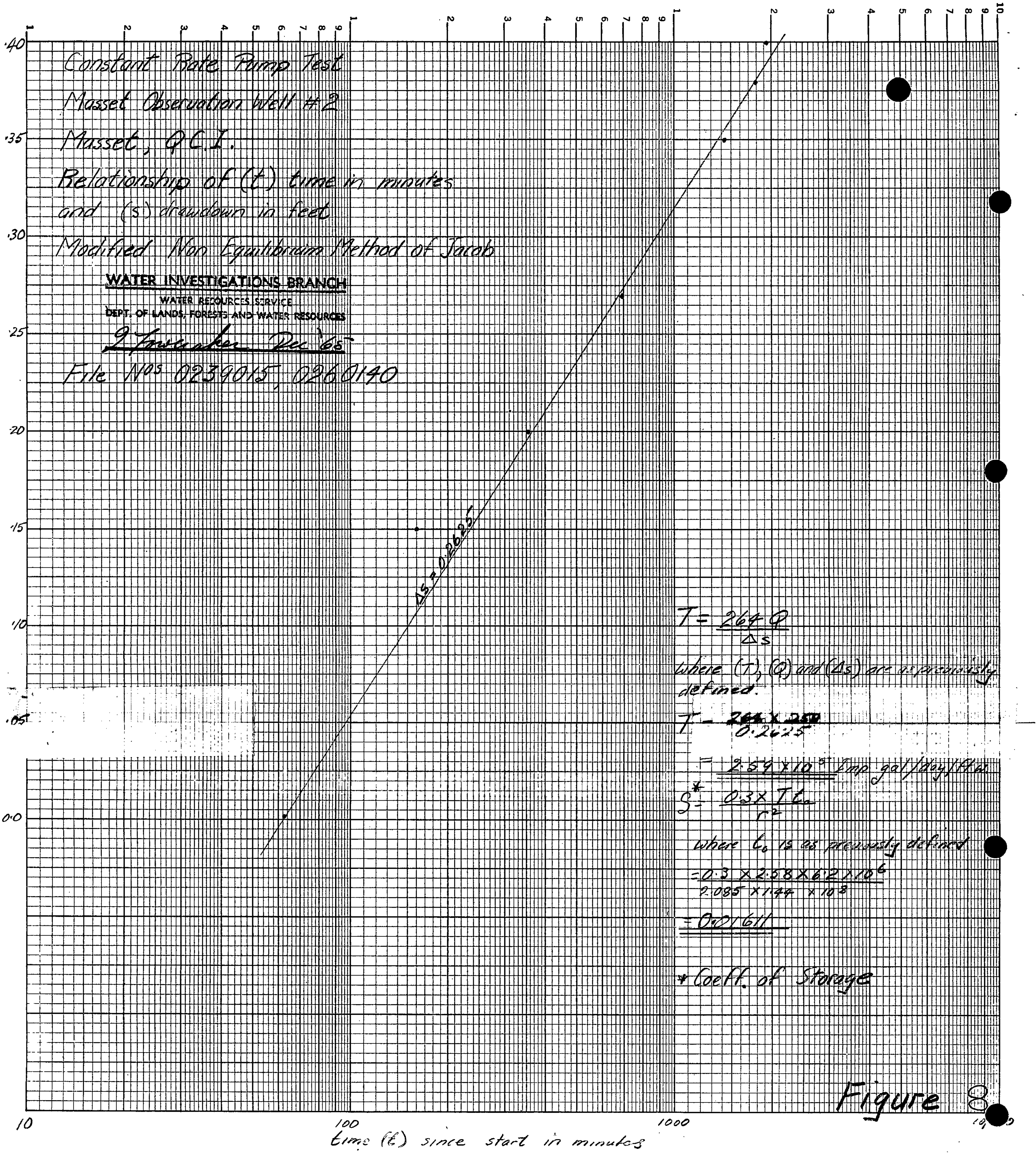


Figure 8

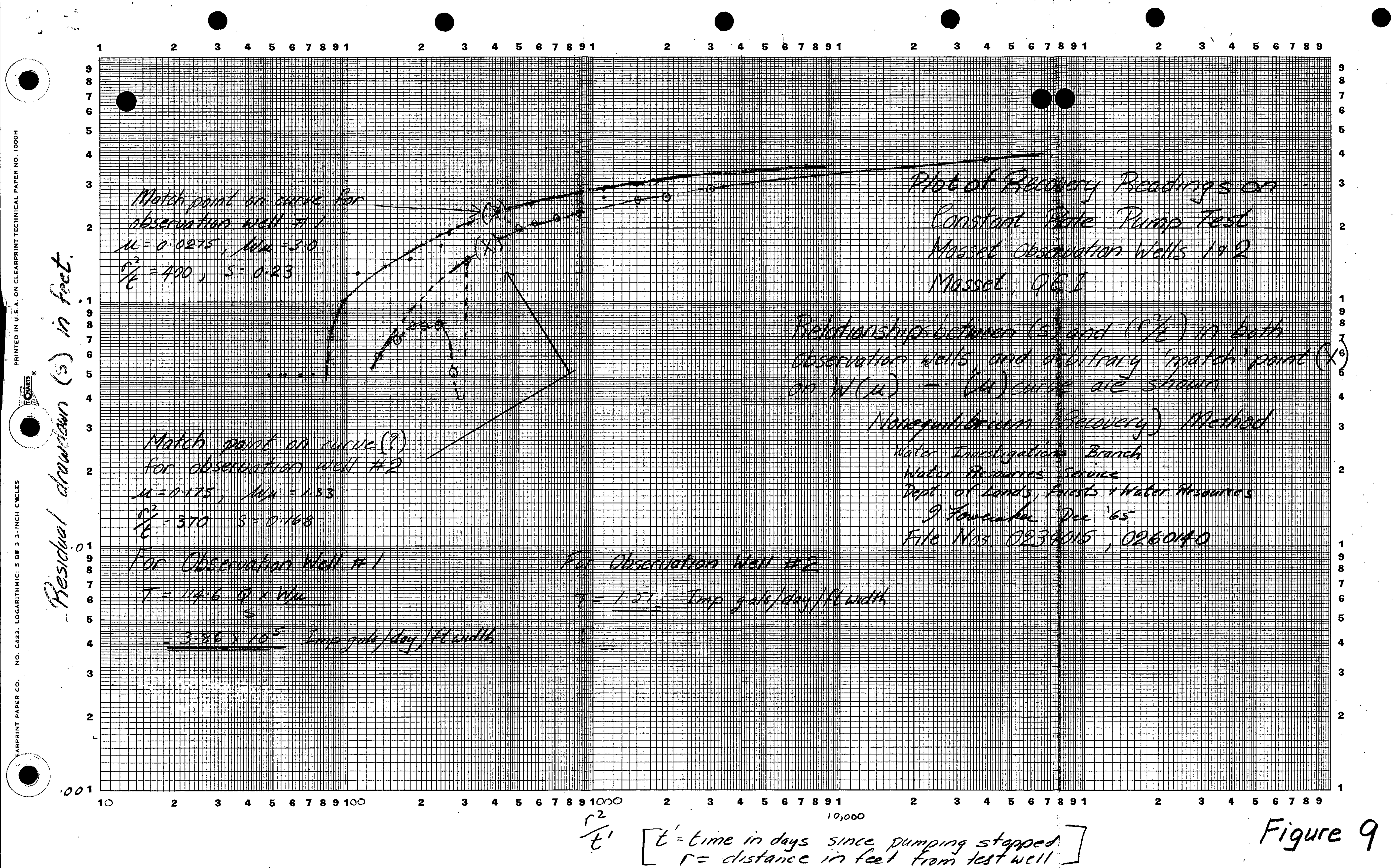

Match point on curve for observation well #1
u = 0.0275, Wu = 3.0
r²/t = 400, s = 0.23
Plot of Recovery Readings on
Constant Rate Pump Test
Masset Observation Wells 1 + 2
Masset, QCI
Relationships between (s) and (r²/t) in both observation wells, and arbitrary 'match' point (X) on W(u) – (u) curve are shown
Nonequilibrium (Recovery) Method
Water Investigations Branch
Water Resources Service
Dept. of Lands, Forests + Water Resources
J Foweraker Dec '65
File Nos. 0239015, 0260140
Match point on curve (?) for observation well #2
u = 0.175, Wu = 1.33
r²/t = 370 S = 0.168
For Observation Well #1
T = 114.6 Q x Wu / s
= 3.86 x 10⁵ Imp gals/day/ft width
For Observation Well #2
T = 1.51 Imp gals/day/ft width
Residual drawdown (s) in feet
.01
.001
10
100
1000
10,000
r²/t'
[t' = time in days since pumping stopped
r = distance in feet from test well]
PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1000H
CLEARPRINT PAPER CO. NO. C423. LOGARITHMIC: 5 BY 3 3-INCH CYCLES

Figure 9

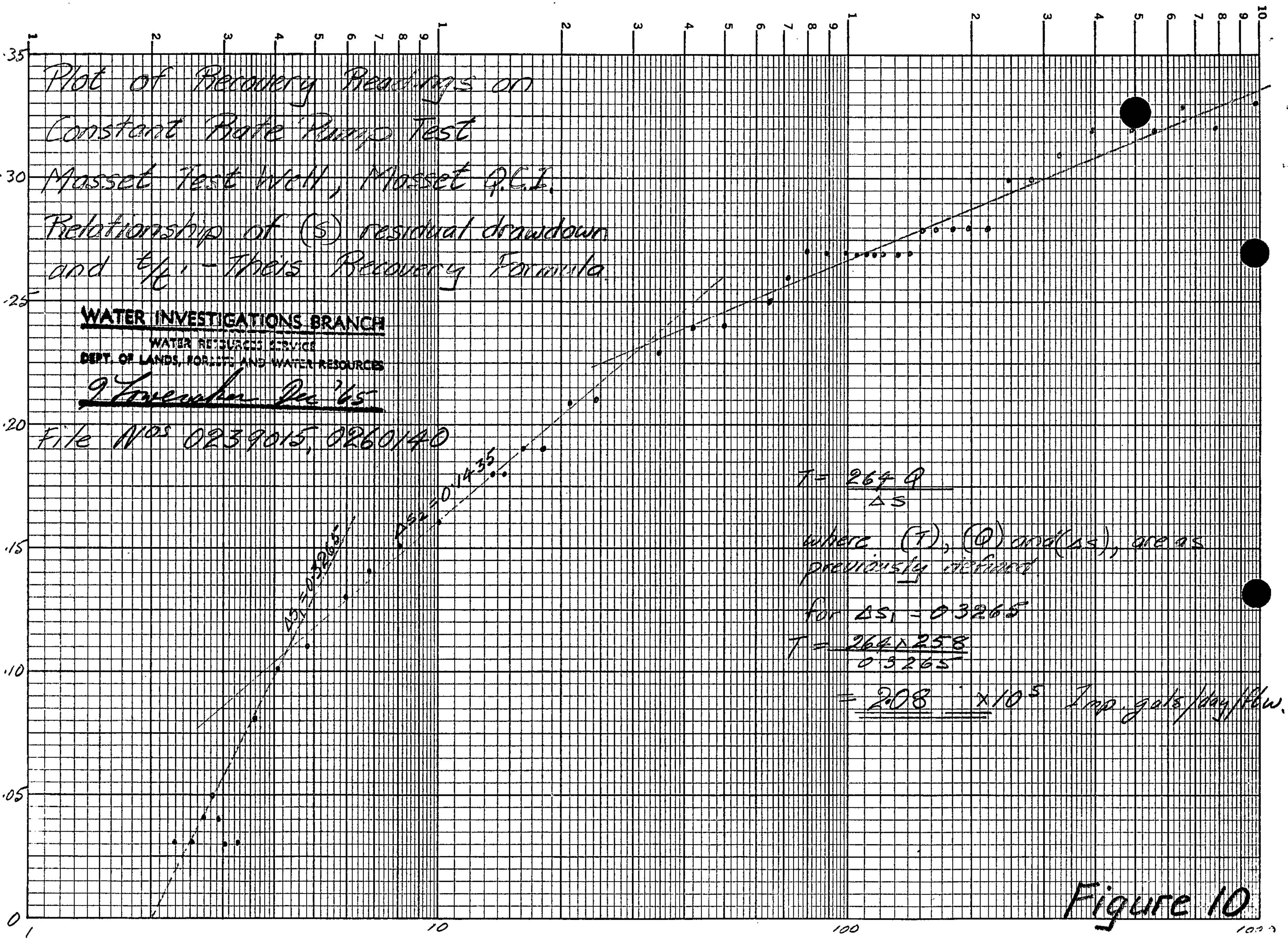

Plot of Recovery Readings on
Constant Rate Pump Test
Masset Test Well, Masset Q.C.I.
Relationship of (S) residual drawdown
and t/t' - Theis Recovery Formula
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
File N^os 0239015, 0260140
Δs = 0.03265
Δs = 0.1435
T = 264 Q / Δs
where (T), (Q) and (Δs), are as previously defined
for Δs₁ = 0.3265
T = 264 × 258 / 0.3265
= 2.08 × 10⁵ Imp. gals/day/ftw.
.35
.30
.25
.20
.15
.10
.05
0
1
10
100
1000

Figure 10

KEUFFEL & ESSER CO., N. Y. NO. 359H-71
Semi-Logarithmic, 3 Cycles × 10 to the inch, 5th lines accented.
MADE IN U. S. A.

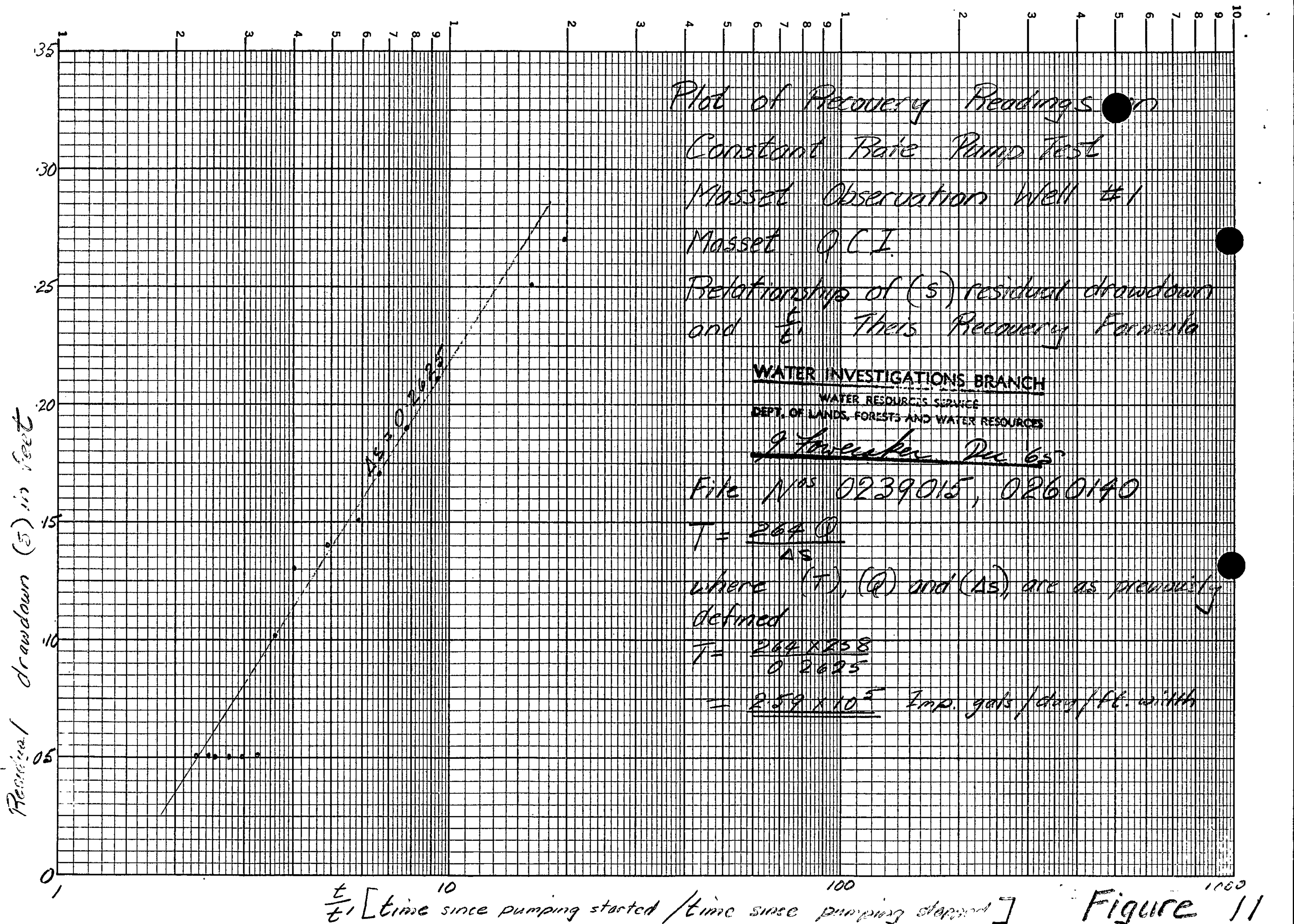
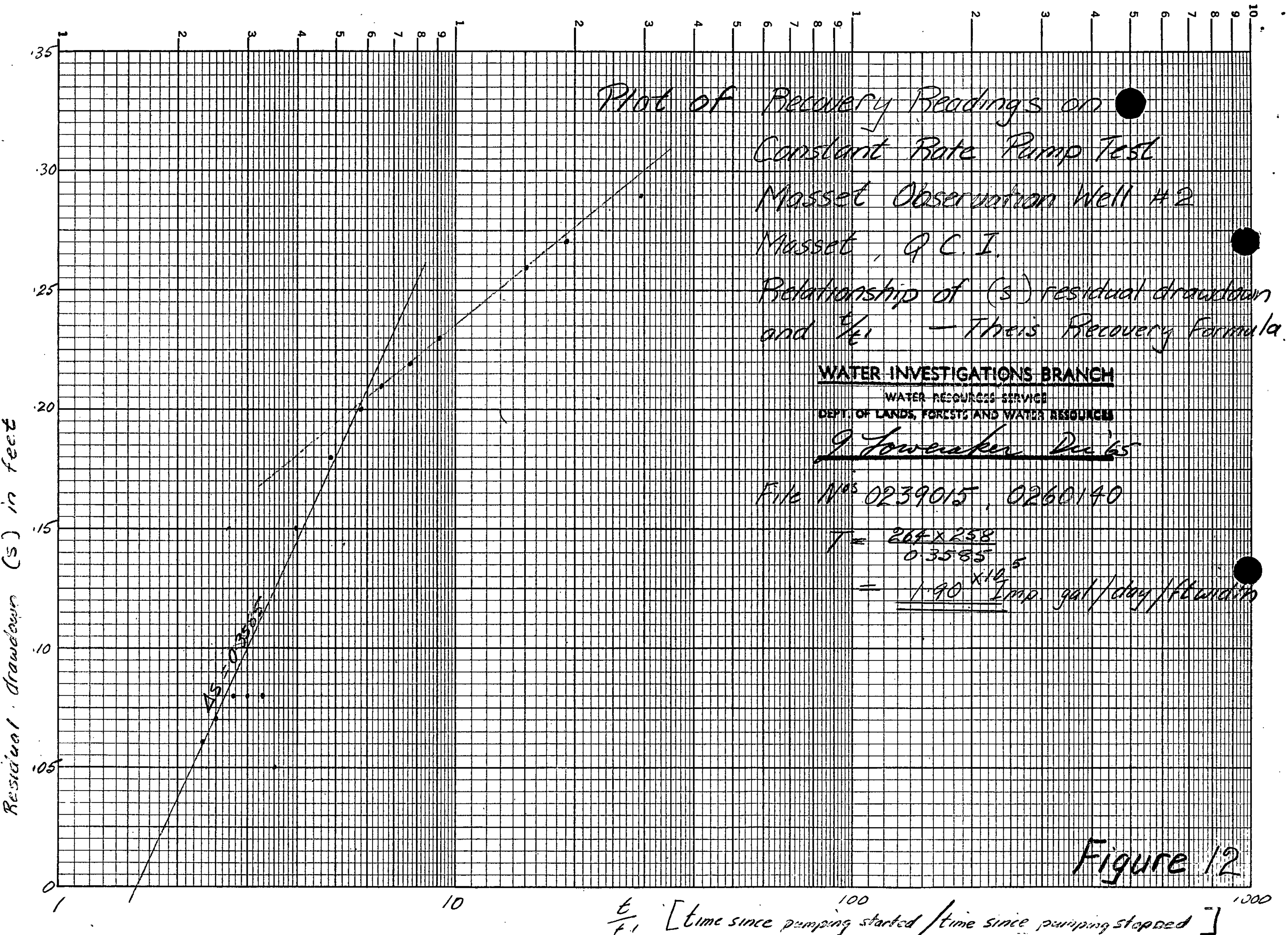


Figure 11

KEUFFEL & ESSER CO., N. Y. NO. 359H-71
Semi-Logarithmic, 3 Cycles × 10 to the inch, 5th lines accented.
MADE IN U. S. A.



APPENDIX II

DRILLER'S LOG OF THE MASSET TEST WELL

Samples of shells, silts, gravels, etc. held by Groundwater Division

Footage	Description
0 - 10	Hard-packed sand and coarse gravel, hard drilling and driving, no water
10 - 19	Hard-packed coarse gravel, no water.
19 - 21	Coarse gravel with water and clam shells.
21 - 24	Coarse gravel, clam shells, water
24 - 26	Fine grey sand, some gravel, silt, clam shells, water.
26 - 28	Coarse gravel and sand, silt, and water
28 - 30	Coarse gravel, sand, silt, clam shells, water.
30 - 32	Coarse gravel and sand, clam shells, silt. Unable to get a static reading as gravel and sand blowing up casing from four to six feet.
32 - 36	Pea gravel and coarse sand, materials blowing up casing as before.
36 - 38	Coarse gravel, a little coarse sand, clam shells, water.
38 - 46	Coarse sand and gravel, a few clam shells, water.
	At this depth a small pump test was run at 35 gallons per minute and samples were packed for shipment to Victoria for screen analysis.
46 - 48	Silty fine grey sand, a little gravel.
48 - 60	Silty fine grey sand, a little water seeping in, tight material.
60 - 72	Silty fine grey sand when driving casing anywhere from five feet to eight feet of core in casing. Sand seams to be hard packed. Very little water.
72 - 88	Fine grey sand and silt, a little water. Casing hard to drive five feet to 10 feet of core comes up casing when driving casing down. Casing hart to drive.
88	End of test hole. Casing pulled back to 50 feet.

APPENDIX III

CONSTANT RATE PUMP TEST DATA ON MASSET TEST WELL

Date of test: May 13th-14th, 1965
Time Start: 8:20 AM (May 13th)
Time Stop: 17:20 (May 14th)
Static: 12.57 feet
Pump discharge rate: 310 U.S. gpm
258 Imp. gpm

Time	Time (t) since start of pumping in minutes	Well Level Measure-ments	Draw-Down
13th May			
A.M.	Min.		
8:00	-	12.57	0.0
8:20	0	Start	-
8:21	01	14.68	2.11
8:22	02	14.72	2.15
8:23	03	14.67	
8:24	04	14.73	2.16
8:26	06	14.77	2.20
8:27	07	14.73	
8:29	09	14.74	
8:35	15	14.68	2.11
8:40	20	14.79	2.22
8:45	25	14.78	
8:50	30	14.79	
8:55	35	14.75	
9:00	40	14.75	2.18
9:20	60	14.73	
9:40	80	14.76	2.19
10:00	100	14.76	2.19
10:20	120	14.76	
10:40	140	14.76	
11:00	160	14.81	2.24
11:20	180	14:77	
11:40	200	14.79	
12:00		14.80	
P.M.			
12:20	240	14.81	2.24
12:40		14.81	
13:00		14.81	
13:20		14.79	
13:40		14.80	
14:00		14:83	2.26
14:20	360	14.83	2.26
14:40		14.83	2.26
15:00		14.87	2.30
15:20		14.87	
15:40	420	14.87	2.30
16:00		14.88	
16:20	480	14.87	2.30
16:40		14.83	
16:55		14.90	
17:00		14.90	
17:20	540	14.91	2.34
17:40		14.87	
18:00		14.87	
18:20	600	14.86	2.29

Time	Time (t) since start of pumping in minutes	Well Level Measurements	Draw-Down
18:20	600	14.86	2.29
18:40		14.87	
19:00		14.89	
19:20	660	14.89	2.32
19:40		14.89	
20:00	700	14.89	2.32
20:30		14.89	
21:00	760	14.89	2.32
21:30		14.89	
22:00	820	14.89	2.32
22:30		14.89	
23:00	880	14.89	2.32
23:30		14.89	
00:00	940	14.90	2.33
14th May			
00:30		14.90	
01:00	1000	14.90	2.33
01:30		14.91	
02:00	1060	14.92	2.35
02:30		14.92	
03:00	1120	14.92	2.35
03:30		14.92	
04:00	1180	14.93	2.36
04:30		14.93	
05:00	1240	14.94	2.37
05:30		14.95	
06:00	1300	14.95	2.38
06:30		14.95	
07:00	1360	14.95	2.38
07:30		14.97	
08:00	1420	14.95	2.38
08:30		14.94	
09:00	1480	14.95	2.38
09:30		14.95	
10:00	1540	14.98	2.41
10:30		14.99	
11:00	1600	14.99	2.42
11:30		14.99	
12:00	1660	15.00	2.43
P.M.			
12:30		15.00	
12:55		15.00	
13:30		15.00	
14:00	1780	15.01	2.44
14:30		15.01	
15:00	1840	15.01	2.44
15:30		15.03	
16:30		15.04	
17:00	1960	15.04	2.47
17:20	1980	Stop	

3 ...

RECOVERY READINGS FROM "CONSTANT RATE" PUMP TEST ON MASSET TEST WELL

Time	Time (t) since start of pumping in minutes	Well Level Measurements	Draw-Down	Time (t′) since pumping stopped in mins.	t/t′
14 May					
17:20	1980	stop		0.0	-
+ 10 sec.	1980.2	13.50	0.93	0.2	9901.0
17:20½	1980.5	12.75	0.18	0.5	3961
17:21	1981	12.90	0.33	1	1981
17:21½	1981.5	12.90	0.33	1.5	1321
17:22	1982	12.90	0.33	2	991
17:22½	1982.5	12.89	0.32	2.5	793
17:23	1983	12.90	0.33	3	661
17:23½	1983.5	12.89	0.32	3.5	566.7
17:24	1984	12.89	0.32	4	496
17:25	1985	12.89	0.32	5	397
17:26	1986	12.88	0.31	6	331
17:27	1987	12.87	0.30	7	283.8
17:28	1988	12.87	0.30	8	248.5
17:29	1989	12.85	0.28	9	221
17:30	1990	12.85	0.28	10	199
17:31	1991	12.85	0.28	11	181
17:32	1992	12.85	0.28	12	166
17:33	1993	12.85	0.28	13	153.3
17:34	1994	12.84	0.27	14	142.4
17:35	1995	12.84	0.27	15	133
17:36	1996	12.84	0.27	16	124.7
17:37	1997	12.84	0.27	17	117.5
17:38	1998	12.84	0.27	18	111.0
17:39	1999	12.84	0.27	19	105.2
17:40	2000	12.84	0.27	20	100
17:42½	2000½	12.84	0.27	22½	89
17:45	20005	12.84	0.27	25	80.2
17:48	2008	12.83	0.26	28	71.7
18:51	2011	12.82	0.25	31	64.9
18:00	2020	12.81	0.24	40	50.5
18:08	2028	12.81	0.24	48	42.2
18:18	2038	12.80	0.23	58	35.1
18:30	2050	12.80	0.23	70	29.28
18:45	2065	12.78	0.21	85	24.3
19:00	2080	12.78	0.21	100	20.80
19:15	2095	12.76	0.19	115	18.2
19:30	2110	12.76	0.19	130	16.23
19:45	2125	12.75	0.18	145	14.65
20:00	2140	12.75	0.18	160	13.37
21:00	2200	12.73	0.16	220	10.00
22:00	2260	12.72	0.15	280	8.07
23:00	2320	12.71	0.14	340	6.82
00:00	2380	1270	0.13	400	5.95

Time	Time (t) since start of pumping in minutes	Well Level Measurements	Draw-Down	Time (t′) since pumping stopped in mins.	t/t′
15 May					
02:00	2500	12.68	0.11	520	4.80
04:10	2630	12.67	0.10	650	4.05
06:00	2740	12.65	0.08	760	3.60
08:00	2860	12.60	0.03	880	3.25
09:00	2920	12.60	0.03	940	3.11
10:00	2980	12.61	0.04	1000	2.90
11:00	3040	12.62	0.05	1060	2.80
13:00	3160	12.61	0.04	1180	2.68
15:00	3280	12.60	0.03	13.00	2.52
19:00	3520	12.60	0.03	1540	2.28

DRAWDOWN READINGS TAKEN ON OBSERVATION WELL #1 DURING CONSTANT RATE PUMP TEST ON MASSET WELL

Static in Observation Well #1 13.31 feet
Distance (r) from Masset Test Well - 270 feet

Time	Time (t) since start of pumping in minutes	Well Level Measurements	Draw-Down	r^2/t
13 May				
08:00	-	13.31	0.00	
08:45	25	13.31	0.00	2917
10:45	145	13.42	0.11	503
14:10	350	13.50	0.19	208.5
19:50	690	13.54	0.23	105.5
00:00	940	13.58	0.27	77.7
14 May				
03:05	1125	13.61	0.30	64.8
06:20	1320	13.62	0.31	55.25
08:15	1435	13.63	0.32	50.80
14:10	1790	13.67	0.36	40.77
16:50	1950	13.67	0.36	37.40

DRAWDOWN READINGS TAKEN ON OBSERVATION WELL#2 DURING CONSTANT RATE PUMP TEST ON MASSET WELL

Static in Observation Well #2 13.15 feet
Distance (r) from Masset Test Well - 457 feet

13 May				
08:00	-	13.15	0.0	
11:00	160	13.30	0.15	1305
14:15	355	13.35	0.20	589
08:00	700	13.42	0.27	298.5
14 May				
08:20	1440	13.50	0.35	145
14:15	1795	13.53	0.38	116.4
16:50	1950	13.55	0.40	107.2

RECOVERY READINGS TAKEN ON OBSERVATION WELL #1

r = 270
$r^2 = 72,900$

Time	Time (t) since start of pumping in minutes	Well Level Measurements	Draw-Down	Time (t′) since pumping stopped in mins.	t/t'	r^2/t'
14 May						
	1980	stop				
17:30	1990	13.67	0.36	10	190	7290
18:26	2046	13.58	0.27	66	31	1104
19:05	2085	13.58	0.27	105	19.85	694
19:30	2110	13.56	0.25	130	16.23	561
21:15	2215	13.52	0.21	235	9.42	311
22:10	2270	13.50	0.19	290	7.82	251
23:10	2330	13.48	0.17	350	6.65	241
00:05	2385	13.46	0.15	405	5.88	180
15 May						
01:50	2490	13.45	0.14	510	4.88	143
04:20	2640	13.44	0.13	660	4.00	110.4
06:00	2740	13.41	0.10	760	3.60	96.0
08:00	2860	13.36	0.05	880	3.25	82.8
10:00	2980	13.36	0.05	1000	2.98	72.9
12:00	3100	13.36	0.05	1120	2.76	65.1
15:00	3280	13.36	0.05	1300	2.52	56.1
16:00	3340	13.36	0.05	1360	2.45	53.7
19:00	3520	13.36	0.05	1540	2.28	47.3
June 3						
22:00		13.28				

RECOVERY READINGS TAKEN ON OBSERVATION WELL #2

14 May						
17:35	1995	13.53	0.38	15	133	13,900
18:30	2050	13.44	0.29	70	29.28	2,990
19:10	2090	13.42	0.27	110	19.0	1,895
19:40	2120	13.41	0.26	140	15.1	1,490
21:20	2220	13.38	0.23	240	9.25	869
22:15	2275	13.37	0.22	295	7.71	707
23:20	2340	13.36	0.21	360	6.50	580
00:15	2395	13.35	0.20	415	5.77	502
15 May						
01:55	2495	13.33	0.18	515	4.84	405
04:30	2650	13.30	0.15	670	3.95	310
06:10	2750	13.20	0.05	770	3.57	270
08:00	2860	13.23	0.08	880	3.25	236.5
10:00	2980	13.23	0.08	1000	2.98	208.8
12:00	3100	13.23	0.08	1120	2.76	186.5
15:00	3280	13.22	0.07	1300	2.52	160.5
19:00	3520	13.21	0.06	1540	2.28	135.5
June 3 22:00		13.12				

APPENDIX IV

WATER QUALITY OF THE MASSET TEST WELL

Prior to the pump test, a sample of the water from the Masset well was tested and the following results obtained (see letter to Mr. Hanson, dated May 10th, 1965, file 0260140, 0242686).

Hardness	204 parts per million
Iron	0.5 - 2 parts per million
pH	8.2
Chlorine	65 parts per million

It was also suggested in the same letter that some form of treatment would be necessary to improve the water quality if the well should subsequently be purchased by the Village.

Water Samples, taken for Chemical Analysis at the Health Department Laboratories, during the pump test showed a total iron content (as Ferric iron) ranging from 5.7 to 8.4 parts per million (see chemical analyses report attached). This variation in iron content recorded in the water quality tests might in part be due to the amount of oxidation and settling out that was able to take place prior to the test being completed.

The water from the test well was discoloured a light brown where it was ponded in the outlet trench, and the colour units were found to exceed 70. However, in small samples, this colour is barely discernable. There was a faint odour of Hydrogen Sulphide (H_2S) from the water issuing from the pump orifice.

The results of the Health Department Laboratory bacteriological analyses on water samples collected from the Masset Well during the pump test showed in three cases out of four a positive coliform test. Precautions had been taken to prevent contamination. Subsequently, a sample was taken by the Skeena Health Unit and this showed the water to be uncontaminated (see bacteriological analyses attached).

The problem of water treatment and quality of water in the Masset well is only mentioned briefly here as the Division of Public Health Engineering, Department of Health Services, Victoria, are at the present time investigating possible methods of iron removal for the Masset test well water.

Information concerning four proposals dealing with this problem have been passed on to me by the Director, Mr. W. Bailey, Division of Public Health Engineering and a summary of this information has been included in my separate memo to you of January 10th, file 0183613.

It may also be necessary to formulate a method of treatment for the removal of incrustation compounds which may form on the well screen with time. This treatmentmay have to be included in a maintenance schedule for the well.

Your File 0260140/023901
Our File 72-5-4C
P.H.116

WATER SUPPLY REPORT

DATE June 22/65

SOURCE New Well Masset . . . . SATISFACTORY 0/5. . . UNSATISFACTORY . . .

RECOMMENDATIONS:

- [ ] 1. REPAIR OR INSTALL CRIBBING
- [ ] 2. REPAIR TOP
- [ ] 3. FOLLOW ENCLOSED CHLORINATION INSTRUCTI(
- [ ] 4. OTHER

WHEN RECOMMENDATIONS HAVE BEEN PROPERLY CARRIED OUT A FURTHER SAMPLE WILL BE TAKEN ON REQUEST.

REMARKS. This sample was taken by myself and I feel that it is representative of the source

SKEENA HEALTH UNIT
333 - 5th STREET
PRINCE RUPERT, B. C.

Dr. J. C. Foweraker
Dept. of Lands, Forests & Water Resources
Water Investigation Branch
Parliament Bldgs
Victoria BC

. . . N. B. Withers . . . . .
INSPECTOR
FOR MEDICAL HEALTH OFFICER

DIVISION OF LABORATORIES
Health Branch
828 West Tenth Aven
Vancouver 9, B. C.

Report Form L 76 (Rev. 11/61)

CHEMICAL ANALYSIS-RO INE

TO: D/Skeena Health Unit

Report No.: 851
Date Reported: 10-6-65
Date Received: 18-5-65

COPY T DIRECTOR, DIVISION OF PUBLIC HEALTH ENGINEERING.

Collector's Name: Village of Masset
Address: Masset, B.C.

Date Sampled: May 16, 1965
Time Sampled: 8:20 a.m.

Water Works System: Masset Test Well
Sampling Point: Pump Outlet
Source of Water: Well

Treatment: None

Test(s) done in field: None
Residual Chlorine:

Temperature (°C): pH:
Other:

Determinations Reported as mg/l unless noted otherwise.

Colour (in units)	Greater than 70	Alkalinity (as $CaCO_3$)	
Turbidity (in units)	7.8	Phenolphthalein	Nil
Temperature (°C) (on arrival)		Methyl Orange (total)	164
pH (in units) (on arrival)	7.4	Free Carbon Dioxide (as CO_2)(calculated)	
Total Solids	277	Hardness (as $CaCO_3$)	
Fixed Solids		Total	194
Volatile Solids (calculated)		Carbonate (temporary)(calculated)	
Dissolved Solids	269	Non-Carbonate (permanent)(calculated)	
Dissolved Solids (calculated)		Silica (as SiO_2)	19.8
Suspended Solids		Surfactants (as A.B.S.)	
~~Albuminoid~~ Organic Notrogen (as N)	0.05	Nitrite Nitrogen (as N)	0.001
Ammonia Nitrogen (as N)	0.03	Nitrate Nitrogen (as N)	Trace
Calcium (as Ca)	69.5	Bicarbonate (as CO_3)(calculated)	
Magnesium (as Mg)	5.0	Carbonate (as CO_3)(calculated)	
Iron (total) (as Ferric ion)	8.4	Sulphate (as SO_4)	*
Sodium (As Na)	11.0	Chloride (as Cl)	20.9
Potassium (As K)	1.0	Fluoride (as F)	Nil
Specific Conductance (m mhos)	352	Ortho-phosphate (as PO_4)	0.10
Dissolved Iron (As Ferric Ion)	4.6	Coliform Test	3/5

Remarks: * Color Interference

Water Bact. No. 5150

c.c. Dr.J.C. Foweraker, Geological Engineer
Ground Water Div. Water Resources Service, Victoria.

c.c. R.G. Hanson, Masset, B.C.

Analysed by: A.J. Lynch B.Sc.

DIVISION OF LABORATORIES
Health Branch
828 West Tenth Avenue
Vancouver 9, B. C.

Report Form L 76 (Rev. 11/61)

CHEMICAL ANALYSIS-ROUTINE

TO: D./Skeena H.U.

Report No.: 861A
Date Reported: 10-6-65
Date Received: 19-5-65

COPY TO DIRECTOR, DIVISION OF PUBLIC HEALTH ENGINEERING.

Collector's Name: Dr. J. C. Foweraker
Date Sampled: 14-5-65
Address: Ground Water Div. Water Resources, Victoria, B.C.
Time Sampled:

Water Works System: Masset Test Well
Sampling Point: Well Head
Source of Water: Ground Water
Treatment:

Test(s) done in field:
Residual Chlorine:
Temperature (°C):
pH:
Other:

Determinations Reported as mg/l unless noted otherwise.

Determination	Result	Determination	Result
Colour (in units)	Greater than 70	Alkalinity (as $CaCO_3$)	
Turbidity (in units)	2.5	Phenolphthalein	Nil
Temperature (°C) (on arrival)		Methyl Orange (total)	173
pH (in units) (on arrival)	6.6	Free Carbon Dioxide (as CO_2)(calculated)	
Total Solids	276	Hardness (as $CaCO_3$)	
Fixed Solids		Total	191
Volatile Solids (calculated)		Carbonate (temporary)(calculated)	
Dissolved Solids	265	Non-Carbonate (permanent)(calculated)	
Dissolved Solids (calculated)		Silica (as SiO_2)	22
Suspended Solids		Surfactants (as A.B.S.)	Nil
Organic ~~Albuminoid~~ Nitrogen (as N)	*	Nitrite Nitrogen (as N)	*
Ammonia Nitrogen (as N)	*	Nitrate Nitrogen (as N)	
Calcium (as Ca)	68.3	Bicarbonate (as CO_3)(calculated)	
Magnesium (as Mg)	4.8	Carbonate (as CO_3)(calculated)	
Iron (total) (as Ferric ion)	5.7	Sulphate (as SO_4)	**
Sodium (as Na)	13	Chloride (as Cl)	19.7
Potassium (as K)	2.0	Fluoride (as F)	
Specific Conductance	352	Ortho-phosphate (as PO_4)	0.10 ~~0.6~~
Dissolved Iron (as Ferric ion)	5.7		

Remarks: * Too long in transit
** Colour Interference

cc. Dr.J.C. Foweraker, Geological Engineer, Ground Water Div., Water Resources Service, Victoria, B.C.

Analysed by: A.J. Lynch, B. Sc.