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July 20, 65

Port Clements Well

0243107
0239015

INTRODUCTION

General

Port Clements Improvement District (see letter dated June 30, 1964, file 0243107) requested the B.C. Water Resources Service to carry out an engineering study for a water supply system for Port Clements. This study was made by Mr. C.K. Harman, former Water Rights Branch District Engineer at Prince George, (see memo dated October 16, file 0243107). In this memo, Mr. Harman states that MacMillan, Bloedel & Powell River Company representatives had indicated last year to the Trustees of the Improvement District that they planned to build several homes in the Port Clements District, and that these homes would require full water and sewage service. Further, the Company had indicated they would be willing to pay part of the cost of having the water system put into the town. Mr. Harman considered the advantages of a ground-water source over the available surface sources were considerable both from an economic and water quality standpoint.

Mr. Harman discussed the Port Clements ground water possibilities with me; we also met and discussed the matter with Dr. Sutherland Brown of the B.C. Department of Mines, who has been carrying out geological mapping of the Queen Charlotte Islands. In later discussions between Mr. Livingston, myself, and Mr. J.B. Rawsthorne, Project Engineer, MacMillan, Bloedel and Powell River Limited, Mr. Rawsthorne indicated that his Company were planning to go ahead with a limited test drilling program early in 1965. Mr. Livingston indicated that a geological engineer would be present in the area during this drilling program to give assistance. Drilling commenced March 17, and the Port Clements well was completed April 13, 1965.

Water Supply Requirements for Port Clements

Mr. Harman estimated the possible requirements as follows:

Existing average daily demand for present population of 200 - 29,600 Igad or 20.5 Igpm

Add possible near future development - MacMillan, Bloedel	
houses 15 @ 500 gad	- 7,500 Igad
- Hotel to replace burned out one	- 3,000 Igad
Total immediate future requirements	- 40,100 Igad or 28 Igpm
Or a peak demand of 2.5 x 28	- 70 Igpm

Location

Port Clements is situated near the south-east corner of Masset Inlet, Graham Island (see location map, figure 1). The well location is shown on the 1:50,000 map (figure 2). The topography of the area is subdued and in the Port Clements area, less than 100 feet in elevation.

Surface Water Supplies

There are three small streams near the town which drain toward the north. Firstly, Kumdis Creek, which drains a muskeg area south-west of Port Clements and flows into Masset Inlet about 1½ miles east of the townsite. Cohoe Creek, which flows into the Yakoun River near its mouth. Unfortunately, the location of these streams 1½ miles from district boundaries and the poor quality of this water, make both these streams unsuitable as a source of water supply from both an economic and water quality standpoint. Thirdly, there is Rennie Creek, which also drains a small muskeg area south-west of the town between Kumdis and Cohoe Creeks and would have been the best surface source for a water supply. Water quality is, however, poor. (Mr. Harman considered that Rennie Creek could not be considered adequate for the district's needs, unless sufficient storage could be provided to satisfy the district's requirements for a minimum of several months.)

For description of geology of the area, see Appendix I.

WELL CONSTRUCTION AND DEVELOPMENT PROCEDURES

General

The available supply of 10 inch casing in the Port Clements well was exhausted at 147 feet and the drill continued the hole by "open hole" drilling to 175 feet. It was then decided that before proceeding with further drilling, a screen would be rented and a pump test carried out within the water bearing sands and silts, located between 119 and 150 feet. A bailing test was also run at this point and the results indicated an aquifer of poor transmissibility. Samples between 119 and 150 feet were sent to Mr. Rawsthorne in Vancouver for sieve size analysis. Duplicate samples were dried in the cookhouse oven at Juskatla camp and sieved and weighed with the help of the driller and his assistant.

Results of the sieve analysis are included in Appendix II. The results showed that between 119-130 feet the sand was a medium to coarse grain size and between 130-150 feet a medium grain size sand. The sieve analysis indicated a slightly coarse fraction in the top ten feet of the aquifer, however, the driller had reported exceptionally slow recovery after bailing in this top section and also considerable silt and clay in the matrix and in lenses, which was lost from the samples collected due to the bailer sampling method.

The driller reported the main flow of ground water came in the 130-150 feet sections. Initially, it was decided that we would test the 130-150 feet section. A 20 feet 8 inch diameter screen was set between 130 and 150 feet where the maximum flow had been concentrated. The lower ten feet of screen being Johnson Everdure slot size 18 (.018 inches) bottoming at 150 feet and the upper 10 feet section being Everdure #20 slot (.02 inches).

Well development with the surge block was quickly replaced by pump development or pump surge development, because the fine aquifer silts began to block and bridge over the screen, reducing the ground water flow into the well. The pump development cleared out very little sand and it was decided that an attempt would be made to develop the well by jetting. MacMillan, Bloedel & Powell River Company personnel at Juskatla made available pipe and a fire truck, capable of delivering over 100 g.p.m. at over 100 p.s.i. Mr. Rawsthorne and I agreed in a radio-telephone conversation that an effort should be made to further develop the well by this method - Mr. Rawsthorne also informed Mr. Livingston of this decision. Jetting commenced on the 6th of April and it was terminated on the 9th of April, when it became apparent that the amount of sand and silts coming through had practically ceased. After discussing the situation with Mr. Rawsthorne, it was agreed that well development would stop and that a pump test would be run.

PUMP TEST AND RESULTS

General Description of Procedures and Equipment Used

The pump installed for the test was a vertical turbine type, which is normally used for capacities of over 15-20 g.p.m. As the well was tested at capacities of less than 22 g.p.m., difficulty was experienced in throttling back the engine and holding the pump to a steady rate. Checks, however, were made frequently on the pumping rate, and the results tabulated and averaged. As the well discharge was too small to measure by the orifice method, the flow was determined by filling measured containers.

Two types of pump tests were run. Firstly, a 12-hour "step draw-down" test to determine the characteristics of the well itself, and secondly, a "constant rate" test to determine the transmissibility characteristics of the aquifer. The constant rate test was to have been of 24 hours duration but unfortunately the pump broke down after 8 hours and 40 minutes of the scheduled 24 hours test. However, the driller, Mr. Harold Herbert, was present when the breakdown occurred and he commenced taking recovery readings nine minutes after the breakdown. Prior to this time, the driller attempted unsuccessfully to start the pump. On arriving back at the site, I took over the recording of the recovery readings from Mr. Herbert.

The 'step draw-down' pump test data are tabulated in Appendix III and the 'constant rate' pump test data and the recovery readings are tabulated in Appendix IV.

Discussion of Results

1) Coefficient of Transmissibility

In the step draw-down test the pump was run for 4 hours at an average rate of 6.7 g.p.m. A plot of the draw-down against time in minutes since start of pumping, as shown in Figure #3. Coefficient of transmissibility 'T' of the aquifer was calculated by Jacob's modified non-equilibrium method as 514 gal./day/ft. width. Actual draw-down in the well reached 31.62 feet (55.42 feet below top of casing) immediatly prior to increasing the pumping rate. The total available draw-down to the top of the screen being approximately 105 feet.

The pump was next run for 4 hours at an average rate of 14.2 g.p.m. From Figure #3, the coefficient of transmissibility 'T' of the aquifer was calculated by Jacob's method as 883 gal./day/ft. width. Actual draw-down in the well reached 58 feet immediately prior to increasing the pumping rate again. The pump was finally run for 4 hours at an average rate of 21.6 g.p.m. and the actual draw-down in the well reached 91 feet just before the pump was shut off.

The constant rate test was run the following day at an average rate of 15.5 g.p.m. The coefficient of transmissibility 'T' of the aquifer was calculated by Jacob's modified non-equilibrium method (Figure #4) to be 2,185 gal./day/ft. width on the results of the draw-down readings during pumping.

Finally, using the recovery readings, 'T' was calculated by the Theis non-equilibrium recovery formula to be 1,365 gal./day/ft. width (see Figure #5).

ii) Assumptions made in the Theis non-equilibrium formula

Both Jacob's modified non-equilibrium formula and the Theis recovery formula are true for large values of 't' (time since pumping began) and for smaller values of 'r' (distance in feet from the discharging well to the point of observation). In the 'step draw-down' test the value of 'T' could be suspected as insufficient time elapsed at each pumping rate for a true equilibrium condition to be established. However, even if we accept a range from 900 to 2,200 gal./day/ft. width for 'T', these values are very small compared to values of 'T' exceeding $1x10^6$ in some aquifers. The transmissibility of the aquifer is therefore low, and for the following computations, a value for T = 1,300 gal./day/ft. width has been taken.

A restrictive assumption of the Theis non-equilibrium method (which is pertinent in the case of the Port Clements aquifer) is that the aquifer is homogeneous and isotropic. The log of the Port Clements aquifer indicates that there is considerable silt within the matrix and concentrated in thin beds within the aquifer. It is also quite likely that the water-bearing permeable sands are concentrated in a few layers within the whole 'aquifer' sections. Another restrictive assumption of the Theis formula is that the aquifer has infinite aerial extent. In the case of the Port Clements well, the area extent is not known. It is also assumed that the well penetrates and receives water from the entire thickness of the aquifer. This is not so in the Port Clements well. (Jacob 1945 describes adjustments for this).

The methods for determining aquifer constants and predicting aquifer performance then are very useful, but their limitations should be recognized.

iii) Well loss (s_w) and partial penetration loss (s_p)

Draw-down (s) in a production well can be computed by the non-equilibrium formula with the exception, however, of draw-down due to well loss (s_w), and partial penetration loss (s_p). The difference between the actual draw-down in the Port Clements well and the theoretical draw-down computed from the aforementioned integral method of Theis, has been taken to represent the components of well loss (s_w), and partial penetration loss (s_p) in the well. The relationship of these two components (s_w), and (s_p) to discharge (Q) from the well is shown in Figure 6. The table in Appendix V shows the increments of draw-down ($\Delta s_w + \Delta s_p$), produced from regular increases in the rate of pumping (ΔQ).

Well loss (s_w) may be represented approximately by the following equations (Jacob 1946).

$$s_w = CQ^2 \quad - (1)$$

where s_w = well loss in feet
C = well loss constant, in sec.^{2}/ft.^{5}
Q = discharge in cfs

The value of C in (1) was computed as 1.26 x 10^4, sec.^{2}/ft.^{5} from the 'step draw-down' test data using the following equation of Jacob (1946):

$$C = \frac{(\Delta d_3/\Delta Q_3) - (\Delta d_2/\Delta Q_2)}{\Delta Q_2 + \Delta Q_3}$$

Δd_2 and Δd_3 represent the second and third increments of draw-down (26.2 feet and 33.8 feet respectively) produced by increases ΔQ_2 and ΔQ_3 (7.5 gpm and 7.4 gpm respectively) in the rate of pumping. (See Figure 3).

(The second pumping period $\Delta d_1/\Delta Q_1$ was greater than $\Delta d_2/\Delta Q_2$ and a solution for these two steps was not possible. This could be attributed to well development during this period of pumping).

Well loss (s_w), was computed from (1) as: 18.2 feet where Q = 14.2 gpm
and 42.1 feet where Q = 21.6 gpm

In Figures 7 and 8, the draw-down of the well and the draw-down in the vicinity of the well are computed at time (T) = 100 days. This period has been selected as representing the most likely extent of any prolonged summer dry period when the well could be pumping fairly continuously at a high capacity.

In Figure 8, the lower curve represents a pumping rate for the Port Clements well of 12½ gpm at t = 100 days. The theoretical draw-down (s) at the well itself is 19.8 feet (no allowance being made for s_w and s_p). The actual draw-down (from Figure 7) is 58 feet. At a distance of 100 feet from the well, the theoretical draw-down (s) is 11.5 feet. At a distance of 1,000 feet from the well, the theoretical draw-down is 6.4 feet. If a second identical well is placed 100 feet from the Port Clements well and pumped at the same rate (12½ gpm) as the Port Clements well, it would theoretically, if the aquifer and other conditions remained the same, cause a draw-down in the Port Clements well (due to well interference) of 11.5 feet (see Figure 8). The combined draw-down in the Port Clements well would then be 11.5 feet and 58 feet = 69.5 feet. A draw-down of 69.5 feet represents approximately 66 2/3% of the total draw-down in the Port Clements well. It is suggested here that if a second well is drilled in the Port Clements area, that the distance from the Port Clements well need not be as great as 1,000 feet, indeed the difference in drawdown due to well interference between a well spacing of 100 feet and 1,000 feet is theoretically 5.1 feet.

I would suggest that if a second well is drilled for Port Clements that it could be sited possibly as close as 100 feet from the first well. If similar conditions were encountered in the second well, theoretically both wells could be pumped at 12½ gpm and allowing for well interference between the two wells, the total draw-down theoretically would not exceed 2/3 of the total draw-down in each well.

It is also recommended that if a second well be drilled in the Port Clements area, it should be drilled to a greater depth in order to find out if there are deeper unconsolidated fresh water-bearing sands. The screen length should, if necessary, be considerably longer than in the present Port Clements well, in order to penetrate a greater thickness of aquifer.

NOTES ON THE STATIC LEVEL FLUCTUATIONS IN THE PORT CLEMENTS WELL

Between April 14 and 22, 1965 records of static level readings were taken in the Port Clements well by Juskatla Camp personnel and these readings are tabulated in Appendix VI. There is no apparent correlation between high tides and high static level readings, in fact, the reverse would seem to hold. There is, however, a correlation between the static level and diurnal variations in atmospheric pressure. Normally, atmospheric pressure will fall slowly from dawn until 9:00 or 10:00 A.M., after which time it will remain steady for an hour or two, and then it will rise, at first slowly and later by 1:00 or 2:00 P.M., more rapidly until between 4:00 and 6:00 P.M., when it will again change and begin to fall. The regular curve of diurnal barometric variation is more or less modified by local fluctuations in atmospheric pressure such as winds and storms, and this factor may account for the anomalous higher reading in the A.M. on April 15 and the lower reading in the P.M. on April 20 (see Appendix V).

NOTES ON THE WATER QUALITY OF THE PORT CLEMENTS WELL

Results of a bacteriological coliform test made on samples of the well water at the completion of the pump test resulted in a 5/5 rating. This will mean the water will have to be re-tested. I phoned Mr. Rawsthorne of MacMillan, Bloedel on April 27 and advised him to have the analyses re-run. I suggested that a 1-gallon bottle of bleach be poured down the well and sluiced down the sides of the casing and left to stand overnight. Next day, the well could be pumped out by small jet pump and the sample again taken when the bleach was removed and the water became clear again. It would seem unlikely that artesian water in this locality and at this depth under such a thickness of tills and clays could contain harmful bacteria.

The chemical analysis shows that the water is very hard, 212 ppm. It may be necessary to soften the water. The full analysis is tabulated in Appendix 6.

J.C.F.

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JCF/alg

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APPENDIX I SURFICIAL GEOLOGY OF THE PORT CLEMENTS TO MASSET AREA

Port Clements lies within an area of Graham Island designated as the "Queen Charlotte Lowlands" on the physiographic map (Figure 1). In general, 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.

From the little surficial geological information available, there was some indication prior to drilling that the test hole at Port Clements might encounter water-bearing unconsolidated Upper Tertiary-Miocene sands lying beneath the Pleistocene deposits. Records of an oil test hole drilled near Griffith Point south of Masset, showed 550 feet of unconsolidated sands, pebbly sands and some silty clays. Dr. Sutherland Brown considers that the top 200 feet only are of Pleistocene age. He has also noted poorly lithified sands with minor shale or clay and some pebbly or shelly sands along the lower Yakoun River near Port Clements, and along Massett Sound from Collison Point north to the Watun River. These beds, which contain fossils of (?) Late Pliocene age, grade upward into stoney claystones that are probably glacial marine drift.

Holland and Nasmith (1958, P.5) describe exposures along Masset Inlet and in road cuts along the Masset - Port Clements road that show the Pleistocene sequence consists of marine clays and sands which grade upward into outwash sands and gravel, overlain at the surface by a thin mantle of basal till on which forest soils and muskeg deposits have formed. Sutherland Brown and Nasmith (1962, P.214) found that commonly two tills are evident with somewhat differing characteristics. At low elevations, they found the lower till is rudely stratified and is evidently a stony marine clay or till. They find outwash sands and gravels overlying the tills.

During the present investigations, a thin mantle of till was found overlying sands in road cut exposures on the Port Clements - Masset road. These exposures were very close to an ice contact zone outlined by Sutherland Brown (see Figure #1 and Photo #1). Within this ice contact zone are several road cut exposures of typical ice contact deposits (see Photo #2).

On the east side of Masset Sound, 1,000 yards south-east of Griffith Point, within the ice contact zone, the following composite section is exposed.

5 - 6 feet of 'till' - has the appearance of a very dirty, hard, compact gravel, however, it appears to be conformable with the topography.

25-35 feet of sands, silts, silty gravels which show some stratification.

70 feet till complex - variable.

At one exposure, 20 feet of stony clay lie at the top of the till complex, elsewhere in the till complex there are contorted beds probably from ice movement.

North of the ice contact front, along the east side of Masset Sound, are some poor road cut exposures which show sands over clayey silts containing stones - marine stony "clays." From the north again, near Masset, there are thick exposures of outwash sand and gravel covering the underlying beds.

A fifty-foot section of 'till complex' overlain by sand and rusty gravels is exposed in the road cut on the west side of the Mamin River near Juskatla, west of Port Clements. The till complex varies considerably in lithology from section to section, however, the following is fairly typical of the sections.

10 feet	(or more) rusty gravels with sand.
8 feet	weathered till with angular blocks.
2-3 feet	dirty gravels less consolidated than most tills - brown in colour.
2-3 feet	bedded brown sands, silts with contorted bedding at bottom.
6-10 feet	grey sandy silt interbeds, compact, stands well.
10-20 feet	till, very hard and compact, includes some silt lenses and a sandy, compact, gravelly till at the base of the sections.

In the Port Clements area itself, the till complex overlies stony marine 'clays' and in the Port Clements well, sands and silts containing organic matter of possible (?) Pliocene age are found below the 'clays'.

A brief interpretation of the Port Clements well log is as follows:

0-40 feet	Till complex
40-119 feet	Marine drift-stony clay.
119-175 "	(?) Pre-glacial Pliocene sands, silts and clays.

It is quite possible that all of the above sequence should be included within the Pleistocene, however, the presence at 150-170 feet of pieces of wood now brittle and black indicate an older age than Pleistocene for this part of the section. The samples almost certainly appear too old to date by radio carbon methods. See Appendix II for a copy of the driller's log an interpretation of this log, notes on drill samples, and sieve size analyses curves and summary of this data.

Geological evidence from the well log, aerial photographs, and from exposures in the Port Clements to Masset area indicate ice movement from the south. According to Sutherland Brown and Naismith, all the ice traversing the islands was generated on the islands. On Graham Island, the ice moved outward and northward from the general height of land. Till complex deposits and also marine drift at lower elevations were deposited during this period. During the waning stage of this ice movement, thick outwash gravels and sands were deposited within the triangular area of north-east Graham Island defined by Masset, Eagle Hill and Rose Spit. Ice contact features were formed along a wide zone (See Figure 1) during a period of stagnation and still stand of the ice. Till overlying sands near the ice contact zone (see Photo #1) may represent a small local readvance of the ice front.

NOTES ON SEA LEVEL CHANGES

Holland and Naismith (1958, P.5) consider Masset Sound to have been carved at a time when sea level was about 75 feet lower than it is at present.

There is also a great deal of evidence for a 25 foot rise in sea level after the main glaciation. In coastal sections, ice groovings in bedrock have been obliterated for 25 feet above sea level due to marine erosion at a higher sea level. Evidence for higher post glacial beaches up to 30 feet above present sea level are found on the north and east coasts of Graham Island. In several places, however, wind-blown sand dunes have been built to higher elevations.

On the Port Clements-Masset Road at the road bridge near the mouth of the Watun River, there is a section of horizontal well bedded silty sands, sandy silts and clays containing shells, exposed in a road cut about 20-25 feet above river level (see Photograph #3). These deposits could represent old estuarine deposits formed during the post-glacial high sea level.

This section has since been cut through by the present Watun River. The following section is exposed in this road cut (see also Photograph #3).

6 feet very fine grey and light brown silty sand layered and horizontal.

1 foot horizontally bedded grey sandy silt (at the base of this is one 8" boulder - probably rafted in).

1 foot grey compacted silt with shells and stones, mainly concentrated in horizontal thin beds (sample taken).

3 feet brown silty sands containing shells (sample taken).

Thin gravelly beds at bottom overlying brown silty sands.

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APPENDIX II - LOG OF PORT CLEMENTS WELL

Footage	Drillers' Log	Footage	Interpretation of Log and samples.	Log in brief
0 - 4	Oxidized till (brownish)	0 - 18	Till	
4 - 14	Bluish grey till like "springy and tough"			
14 - 18	Till			
18 - 31	Stony clay	18 - 31	Till or stony clay	Till
31 - 35	Sand and gravel with clay lenses and some old vegetation*, water-bearing static 5', bailed-slow recovery	31 - 40	Water-bearing sands & assorted gravels with some silt & clay lenses (?outwash)	Complex
35 - 40	Sand & gravel with clay lenses			
40 - 82	Clay with silt lenses	40 - 85	Grey clay-silt no stones	Marine drift
82 - 108	Clay with silt lenses	85 - 119	Grey "stony clay" (with brownish horizon from 108-112)	(Stony clay)
108 - 112	Brown heavy clay			
112 - 119	Stony clay			
119 - 135	Hard-packed sand with clay balls and lenses water-bearing* * static 28 feet.	119 - 130	Coarse firm sand, containing silt lenses - water-bearing but driller reported slow recovery	Pre-glacial(?)
135 - 140	Hard-packed sand with clay lenses	130 - 150	Medium grain size firm sand containing silts - water-bearing	Pliocene (?) sands, silts and clays.
150 - 170	Hard-packed silty sand with clay balls; some wood and vegetations in this formation	150 - 170	Medium grain-size sand contains considerable silt, "wood" samples - drilled open hole	
170 - 175	Clay	170 - 175	Grey silty-clay to clay-silt	

* cannot be readily identified in sample taken at this horizon.

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NOTES ON DRILLING SAMPLES FROM PORT CLEMENTS WELL

Depth of sample in feet	Description of sample
4	Till, grey, contains stones, "grit", breaks down.
14	Silty clay, liquified, contains "grit", till-like.
27	Grey silt, contains "grit".
31	Fine - medium-grained sand - sorting fair.
33	Coarse assorted shaped and sized gravel, some rounded pebbles, silt coating on pebbles. (Driller reported considerable silt and clay at this horizon also).
35	Grey, dirty (silty) assorted sized gravel (dark mafic pebbles) Note: Samples 31-35 kept but vegetation cannot be readily identified at this horizon.
37	Similar to sample at 35 feet with additional "grits" and fine sand matrix.
39	Assorted gravel and sand with pebbles to $1\frac{1}{2}$-inch diameter. (Driller reported considerable silt and clay at this horizon).
60	Grey, clay-silt, no stones - liquified.
80	Grey clay-silt, some "grit" in this sample.
90	Stony "clay" - grey soft plastic clay silt with stones to $\frac{3}{4}$-inch diameter.
100	Stony "clay" - silt with a few pebbles.
108	Brown stony "clay" - soft dense silty clay to clay silt; plastic (rolls into small thread) contains stones.
	Stony "clay" - grey silts, soft when moist, malleable, some pebbles.
119 - 130	Medium to coarse sand (driller reported slow recovery after bailing, also considerable silt and clay in the matrix and in lenses - but this was lost from samples).
130 - 150	Medium grain-size sand; water-bearing and containing silt and clay as reported above.

SUMMARIZED RESULTS OF SIEVE ANALYSES MADE ON SAMPLES FROM 119 FEET TO 150 FEET (see also table and cumulative frequency grain-size curves).

	Coast Eldridge Results (diameter in inches)	Field hand-Sieved Results (diameter in inches)
119 -130	50% passing 0.018-0.022 (median 0.019)	50% passing 0.02 -0.023 (median 0.021)
	60% passing 0.020-0.025	60% passing 0.023
132 -139	50% passing .013- .016 (median .014)	50% passing .016- .020 (median .018)
	60% passing .016- .018	60% passing .017- .022
141 -150	50% passing .012- .015 (median .013)	50% passing .011- .018 (median .014)
	60% passing .014- .018	60% passing .013- .020

150 - 170 "Wood" collected from this horizon is very black and brittle and according to Mr. C. Halstead (G.S.C.) would be too old for dating by radio carbon methods. Mr. Halstead considers this material of possible Tertiary age.

170 - 175 Grey silt-clay; a few stones, possibly from further up.

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TABULATED RESULTS OF HAND SIEVE ANALYSIS MADE IN THE FIELD (see also cumulative curves)

Sample depth in feet	Cumulative weight and cumulative weight %	Sieve No. - U.S. Standard Sieve Series						
		10	16	30	50	100	200	PAN
		Screen opening in inches						
		0.078	0.047	0.023	.012	.006	.003	-
119	Wt.	10	23.7	349.2	687.8	706.5	709.4	720.2
	% Ret.	1.4	3.3	48.5	95.4	98.2	98.4	100
	% Pass.	98.6	96.7	51.5	4.6	1.8	1.6	-
122	Wt.	1.1	13.5	210.5	641.3	709.0	718.1	726.5
	% Ret.	.15	1.85	28.9	88.3	97.5	98.8	100
	% Pass.	99.85	98.15	71.1	11.7	2.5	1.2	-
125	Wt.	1.0	3.90	199.1	645.1	709.5	716.6	722.1
	% Ret.	0.14	0.5	27.6	89.4	98.3	99.3	100
	% Pass.	99.86	99.5	72.4	10.6	1.7	0.7	-
128	Wt.	-	1.75	201.4	664.6	733.3	739.5	744.7
	% Ret.	-	0.2	27.1	89.3	98.6	99.3	100
	% Pass.		99.8	72.9	10.7	1.4	0.7	-
130	Wt.	8.0	23	269.9	644.85	681.45	686.5	694.8
	% Ret.	1.1	3.3	38.9	92.8	98.2	98.8	100
	% Pass.	98.9	96.7	61.1	7.2	1.8	1.2	-
132	Wt.	4.4	19.8	253.1	787.5	874.1	883.7	898.2
	% Ret.	0.5	2.2	28.2	86.5	96.2	98.3	100
	% Pass.	99.5	97.8	71.8	13.5	3.8	1.7	-
135	Wt.	1.4	4.4	135.2	606.6	700.6	709.7	716.7
	% Ret.	.19	.6	18.8	84.7	97.8	99.3	100
	% Pass.	99.81	99.4	81.2	15.3	2.2	0.7	-
137	Wt.	11.5	22.2	164.7	468.8	675.5	693.9	714.3
	% Ret.	1.61	3.11	23.1	65.7	94.5	97.2	100
	% Pass.	98.39	96.89	76.9	34.3	5.5	2.8	-

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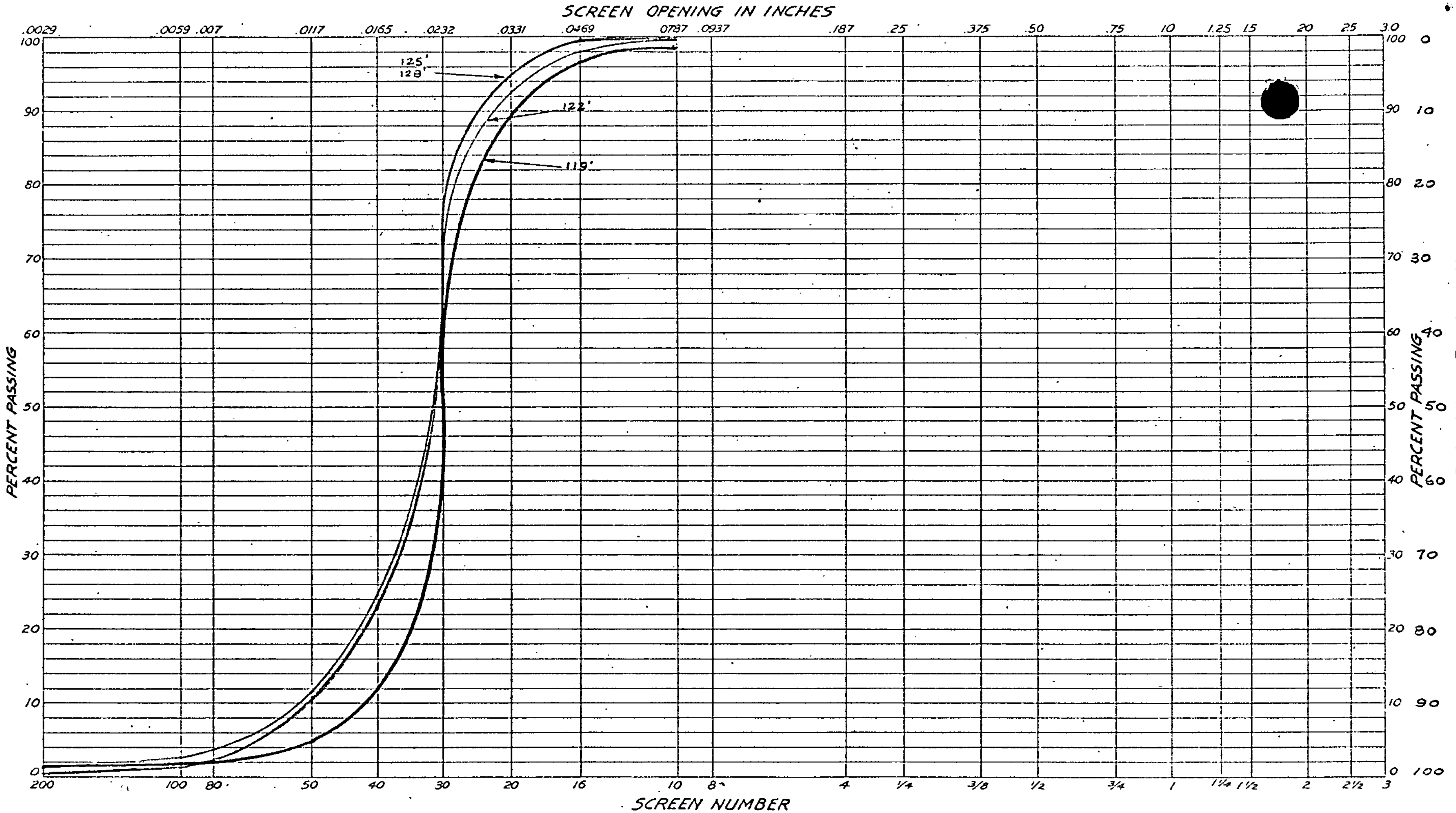
Sample Depth in feet	Cumulative weight and cumulative weight %	Sieve No. - U.S. Standard Sieve Series 10	16	30	50	100	200	PAN
139	Wt.	6.6	16.7	130.4	441.9	618.2	637.3	654.3
	% Ret.	1.0	2.5	19.9	67.6	94.5	97.5	100
	% Pass.	99.0	97.5	80.1	32.4	5.5	2.5	-
141	Wt.	1.90	4.7	72.5	404.3	580.8	600	609.7
	% Ret.	.30	0.8	11.9	66.2	95.2	98.4	100
	% Pass.	99.70	99.2	88.1	33.8	4.8	1.6	-
143	Wt.	9	18.6	144.4	503.2	634.6	645.6	650
	% Ret.	1.4	2.9	22.2	77.4	97.7	99.4	100
	% Pass.	98.6	97.1	77.8	22.6	2.3	0.6	-
146	Wt.	4.3	15.4	166.7	479.4	564.4	574.5	579.5
	% Ret.	.7	2.7	28.8	82.8	97.5	99.2	100
	% Pass.	99.3	97.3	71.2	17.2	2.5	0.8	-
150	Wt.	1.7	9.3	56.9	240	471.9	511.6	526.2
	% Ret.	.3	1.8	10.8	45.6	89.7	97.3	100
	% Pass.	99.7	98.2	89.2	54.4	10.3	2.7	-

H. 187

AGGREGATE CHART

DEPT. OF HIGHWAYS OF B.C.



SAMPLE NO.					SAMPLE NO.				
PASSING	RET. ON	LBS.	%	TOTAL % PASSING	PASSING	RET. ON	LBS.	%	TOTAL % PASSING

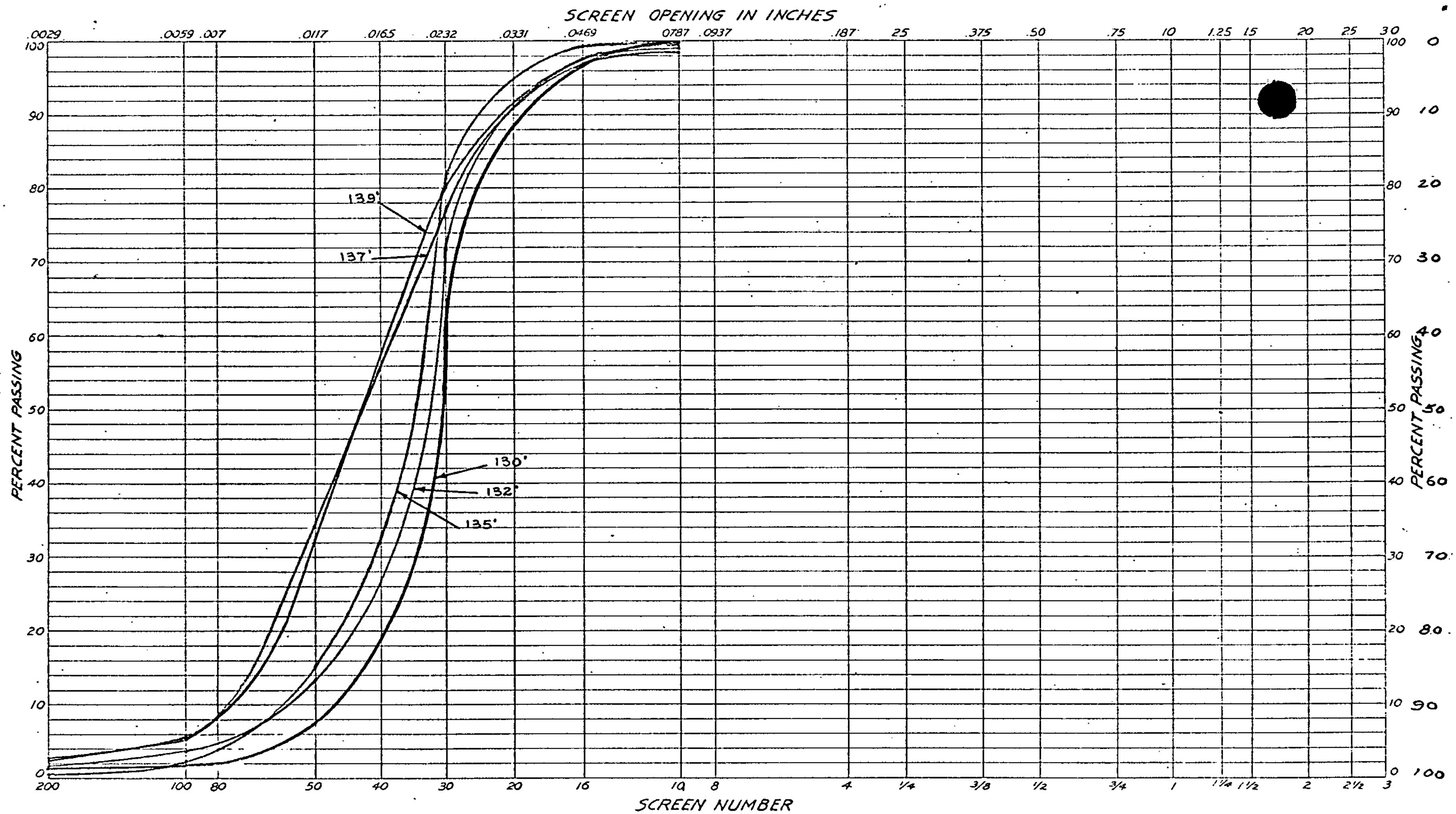
IDENTIFICATION	
PROJECT NO.	
SECTION	119' to 128'
LOCATION	Port Clements, Q.C.I
STATION PLACED	
SAMPLE OF	
SAMPLED BY	DATE
SCREEN ANALYSIS BY	DATE
— 119' — 122' — 125' — 128'	
FILE No. 0243107 0239015	

0

H. 187

AGGREGATE CHART

DEPT. OF HIGHWAYS OF B.C.



SAMPLE NO.					SAMPLE NO.				
PASSING	RET. ON	LBS.	%	TOTAL % PASSING	PASSING	RET. ON	LBS.	%	TOTAL % PASSING

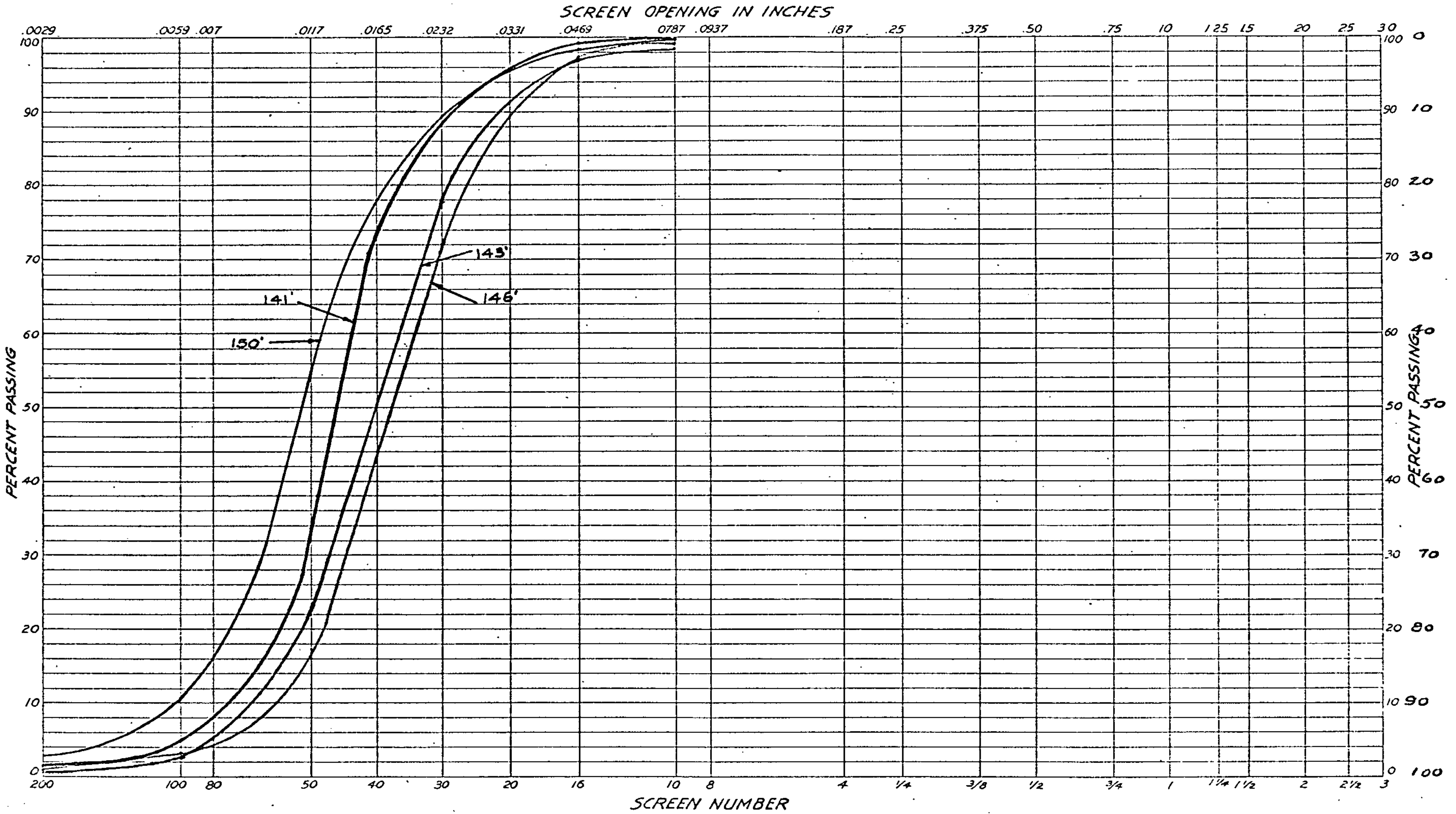
IDENTIFICATION	
PROJECT NO.	
SECTION	130' to 139'
LOCATION	PORT CLEMENTS, Q.C.I.
STATION PLACED	
SAMPLE OF	
SAMPLED BY	DATE
SCREEN ANALYSIS BY	DATE
— 130' — 132' — 135' — 137' — 139'	
FILE NO. 0243107 0239015	

0

H. 187

AGGREGATE CHART

DEPT. OF HIGHWAYS OF B.C.

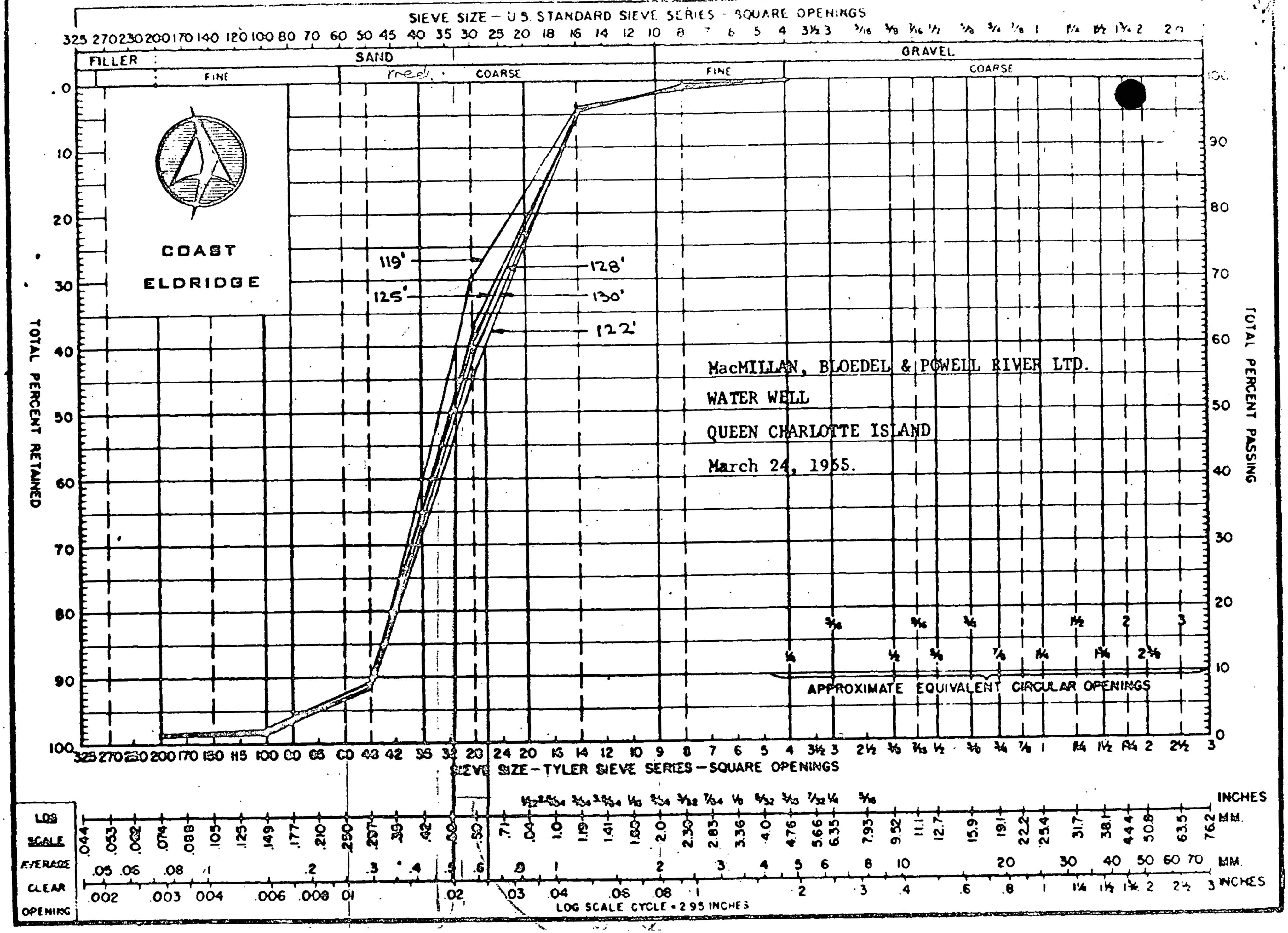


SAMPLE NO.					SAMPLE NO.				
PASSING	RET. ON	LBS.	%	TOTAL % PASSING	PASSING	RET. ON	LBS.	%	TOTAL % PASSING

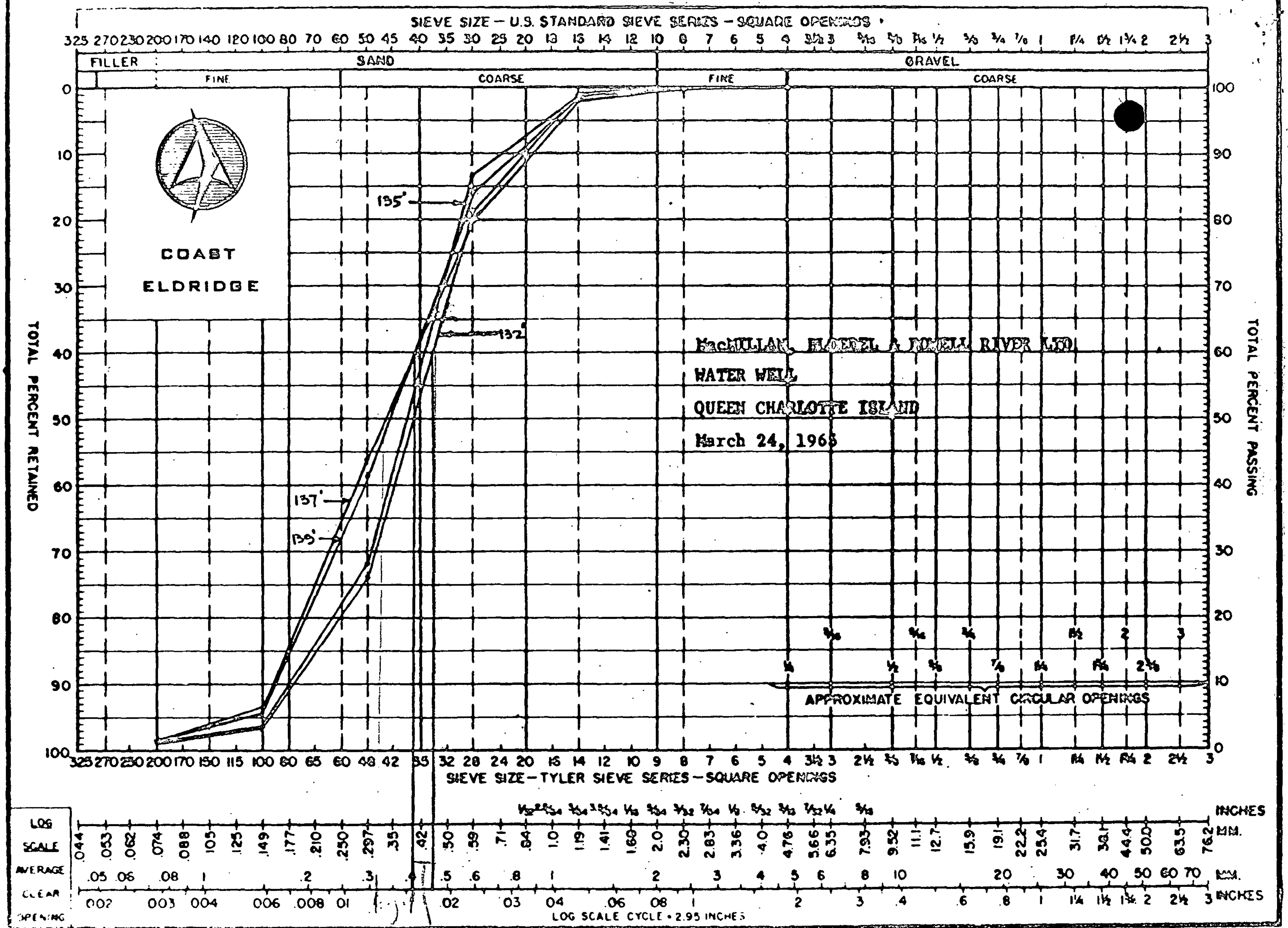
0

IDENTIFICATION	
PROJECT NO.	
SECTION	141' to 150'
LOCATION	PORT CLEMENTS Q.C.I.
STATION PLACED	
SAMPLE OF	
SAMPLED BY	DATE
SCREEN ANALYSIS BY	DATE
— 141' — 143' — 146' — 150'	
FILE NO. 0243107 0239015	

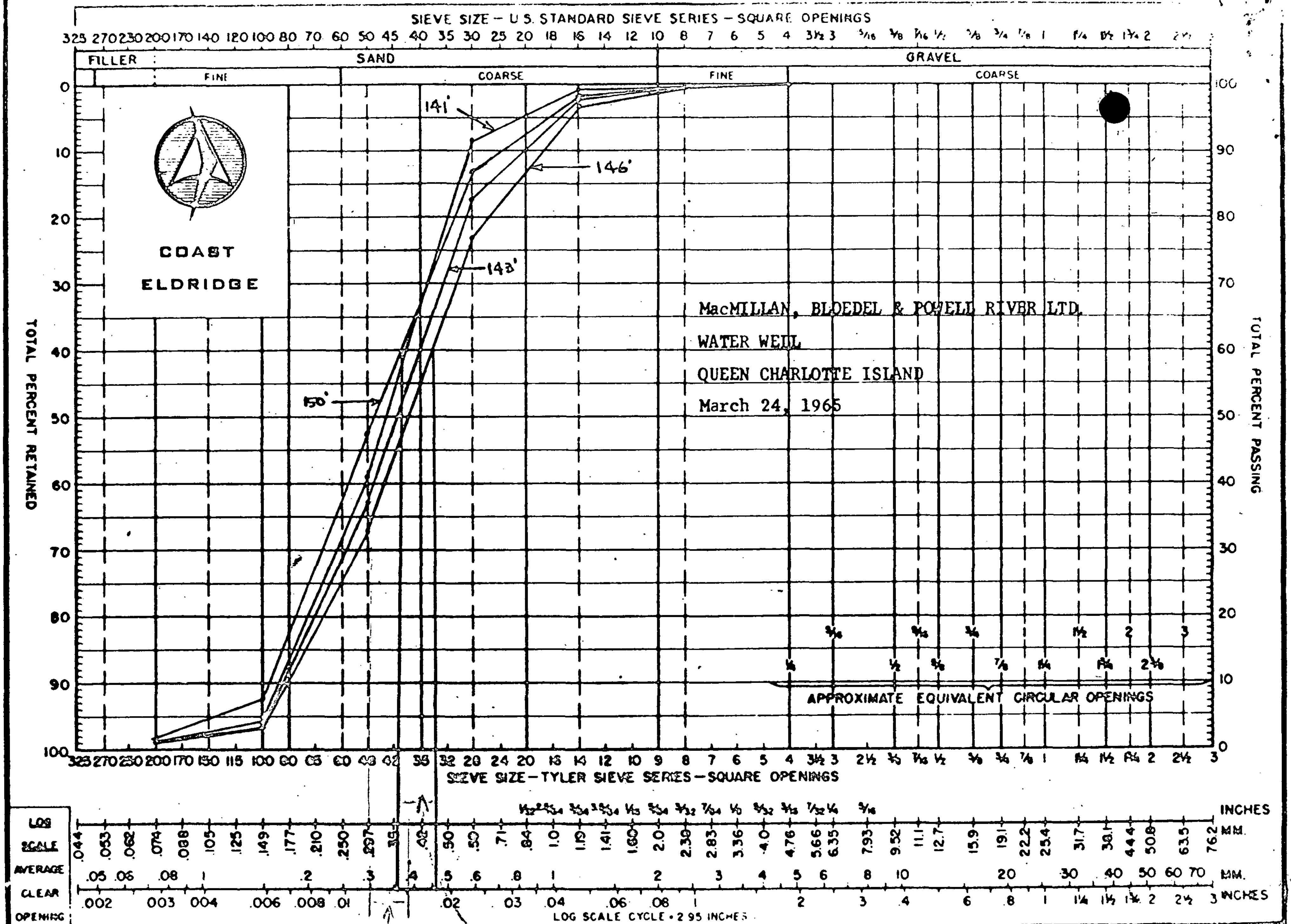
GRADING CHART FOR AGGREGATES AND BITUMINOUS MIXTURES



GRADING CHART FOR AGGREGATES AND BITUMINOUS MIXTURES



GRADING CHART FOR AGGREGATES AND BITUMINOUS MIXTURES



Mr. V. Raudsepp July 20th, 1965

APPENDIX III - PORT CLEMENTS WELL - "STEP DRAWDOWN" PUMP TEST DATA - Step #1

Date of test - April 10th, 1965
Time start - 8:15
Time stop - 20:05
Static - 23.80 ft.
Pump discharge rate for step 1 - 6.7 gpm (Imp).

Time	Time (t) since start of pumping in mins.	Well level measurements	Drawdown
8:15	Start	-	
8:16	1	29.00	5.2
8:18	3	38.05	14.25
8:19	4	38.45	14.65
8:21	6	42.62	18.82
8:22	7	42.50	
8:23	8	42.35	
8:25	10	42.41	18.61
8:27	12	42.90	
8:28	13	43.64	19.84
8:29	14	48.91	25.11
8:31	16	41.46	17.66
8:34	19	45.81	
8:36	21	45.43	21.63
8:37	22	45.18	
8:39	24	45.55	
8:41	27	46.20	22.40
8:43	28	46.54	22.74
8:46	31	45.58	
8:49	34	45.95	22.15
8:52	37	44.38	
8:55	40	44.17	
8:58	43	53.50	29.70
8:59	44	54.65	
9:01	46	54.56	
9:04	49	53.88	30.08
9:06	51	53.70	
9:09	54	52.91	29.11
9:11	56	55.00	31.20
9:13	58	54.25	30.45
9:17	62	54.35	
9:20	65	54.02	30.22
9:24	69	53.63	
9:27	72	54.27	
9:30	75	54.06	30.26
9:34	79	54.74	
9:40	85	54.05	30.25
9:43	88	50.92	27.12
9:48	93	53.50	29.70
9:58	103	54.32	
10:04	109	54.20	30.40
10:12	117	54.42	
10:26	131	53.85	

Time	Time (t) since start of pumping	Well level measurements	Drawdown
10:26	131	53.85	
10:36	141	54.35	30.55
10:44	149	54.75	
10:52	157	54.90	31.10
10:59	164	54.76	30.96
11:10	175	54.60	30.80
11:18	183	54.95	31.15
11:39	204	55.84	32.04
12:01	226	55.42	31.62

Step #2

Pump discharge rate for Step #2
14.2 gpm (Imp.)

Time	Time (t) since start of pumping	Well level measurements	Drawdown
12:14	239	57.30	33.50
12:17	242	59.90	36.1
12:19	244	63.57	39.77
12:20	245	66.37	42.57
12:22	247	68.10	44.30
12:23	248	69.31	45.51
12:25	250	69.56	45.76
12:26	251	70.22	46.42
12:28	253	71.98	48.18
12:29	254	73.00	
12:31	256	74.75	50.95
12:33	258	76.2	52.40
12:34	259	76.52	
12:35	260	76.84	53.04
12:37	262	27.23	53.43
12:38	263	77.27	
12:41	266	77.31	53.51
12:43	268	77.73	
12:47	272	77.71	53.91
12:50	275	78.02	54.22
12:52	277	77.90	
12:53	278	77.84	
12:55	280	78.66	54.86
12:56	281	79.24	55.44
12:57	282	79.46	
12:58	283	79.70	55.90
12:59	284	79.83	56.03
12:03	287	79.94	56.14
13:03	288	80.12	56.32
13:05	290	80.15	
12:07	292	80.21	56.41
13:10	295	80.52	
13:13	298	80.59	56.79
13:18	303	80.75	

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Time	Time (t) since start of pumping	Well level measurements	Drawdown
13:18	303	80.75	
13:29	314	80.70	
13:39	324	80.68	
13:54	339	80.71	56.91
14:09	354	80.90	57.10
14:19	364	81.92	
14:29	374	81.50	57.70
14:41	386	81.71	57.91
14:50	395	82.05	58.25
15:00	405	82.09	
15:11	416	81.7	57.90
15:22	427	81.69	57.89
15:31	436	81.79	57.99
15:42	447	81.30	57.5
16:08	473	81.70	57.9
16:13	478	81.79	57.99

<u>Step #3</u>

Pump discharge rate for Step #3
21.6 gpm (Imp).

Time	Time (t) since start of pumping	Well level measurements	Drawdown
16:15	480	85.46	61.66
16:16	481	86.89	63.09
16:17	482	87.83	64.03
16:18	483	88.43	64.63
16:19	484	89.51	65.71
16:20	485	90.75	66.95
16:21	486	92.20	68.40
16:24	489	94.30	70.5
16:25	490	96.29	72.49
16:27	492	97.15	73.35
16:28	493	97.62	73.82
16:30	495	97.66	
16:31	496	98.12	74.32
16:33	498	98.17	
16:34	499	98.38	74.58
16:36	501	98.68	
16:39	504	102.83	79.03
16:40	505	102.95	79.15
16:42	507	103.71	
16:44	509	104.50	80.70
16:45	510	105.28	
16:46	511	105.71	
16:47	512	105.79	81.99
16:48	513	106.51	82.71
16:50	515	106.93	83.13
16:52	517	107.25	
16:53	518	107.29	84.49
16:55	520	107.41	
16:56	521	107.54	83.74

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Time	Time (t) since start of pumping	Well level measurements	Drawdown
16:56	521	107.54	83.74
16:59	523	107.97	
17:02	527	108.19	84.39
17:05	530	108.45	
17:08	533	108.65	
17:10	535	108.80	85.00
17:13	538	108.80	
17:17	542	109.67	
17:22	547	109.70	85.90
17:25	550	109.71	
17:30	555	110.10	86.3
17:35	560	110.26	
17:40	565	110.60	86.80
17:47	572	110.76	
17:55	580	111.16	87.36
18:00	585	111.83	
18:05	590	112.12	88.32
18:10	595	112.39	
18:15	600	112.49	
18:20	605	112.68	88.88
18:30	615	113.31	
18:35	620	114.04	90.24
18:45	630	114.22	
18:55	640	114.33	
19:05	650	115.00	91.20
19:11	656	115.31	
19:18	663	116.45	
12:21	666	116.15	92.35
19:23	668	116.50	
19:24	669	115.76	91.96
19:26	671	115.43	91.63
19:28	673	115.24	91.44
19:30	675	115.52	91.72
19:35	680	114.35	90.55
19:38	683	112.[illegible]0	88.60
19:43	688	115.67	91.87
19:48	693	117.10	93.30
19:51	696	116.50	92.70
19:54	699	115.84	92.04
19:57	702	112.77	88.97
19:58	703	113.00	89.20
20:02	707	114.80	91.00
20:05	STOP		

Mr. V. Raudsepp July 20th, 1965

APPENDIX IV - (PORT CLEMENTS WELL) "CONSTANT RATE" PUMP TEST DATA

Date of test April 11th, 1965
Time Start - 9:00
Time Stop - 17:40
Static - 24.67 feet
Pump discharge rate 15.5 gpm

Time	Time (t) since start of pumping in mins.	Well Level Measurements	Drawdown
9:03	3	48.45	23.78
9:08	8	59.35	34.68
9:10	10	61.92	37.25
9:11	11	64.95	40.28
9:12	12	66.28	41.61
9:13	13	67.45	42.78
9:15	15	69.10	44.43
9:16	16	71.27	46.60
9:17	17	72.43	47.76
9:18	18	73.92	49.25
9:19	19	75.13	
9:20	20	75.71	51.04
9:21	21	76.37	
9:22	22	76.88	52.21
9:23	23	77.46	
9:24	24	77.85	53.18
9:25	25	78.26	
9:26	26	78.83	54.16
9:27	27	79.33	
9:28	28	79.67	
9:29	29	80.22	55.55
9:30	30	80.68	
9:31	31	81.00	56.33
9:32	32	81.47	
9:33	33	81.55	
9:34	34	81.79	57.12
9:35	35	81.95	
9:36	36	82.15	
9:37	37	82.30	57.63
9:38	38	82.50	
9:39	39	82.67	
9:41	41	82.82	
9:43	43	83.32	58.65
9:45	45	83.68	59.01
9:47	47	84.71	60.04
9:50	50	85.77	61.10
9:51	51	85.86	
9:52	52	86.20	61.53
9:53	53	86.57	
9:54	54	86.89	62.22
9:55	55	87.11	62.44
9:56	56	86.09	
9:58	58	85.79	61.12
9:59	59	86.05	

Mr. V. Raudsepp July 20th, 1965

Time	Time (t) since start of pumping in mins.	Well Level Measurements	Drawdown
9:59	59	86.05	
10:00	60	86.20	61;53
10:04	64	86.83	62.16
10:14	74	89.93	65.26
10:16	76	90.15	
10:17	77	90.13	65.46
10:20	80	90.30	
10:23	83	90.40	65.73
10:27	87	90.86	
10:33	93	90.27	65.60
10:35	95	90.40	
10:40	100	90.50	65.83
10:46	106	89.58	
10:57	117	90.21	
11:05	125	90.22	65.55
11:11	131	90.90	66.23
11:16	136	91.39	
11:18	138	90.93	65.91
11:28	148	91.68	67.01
11:40	160	92.14	67.47
12:00	180	92.53	67.86
12:29	209	93.09	68.42
13:00	240	92.53	67.86
13:30	270	91.75	67.08
14:00	300	91.23	66.56
14:30	330	91.81	67.14
15:00	360	91.70	67.03
15:30	390	91.39	66.72
16:00	420	91.80	67.13
16:30	450	91.67	67.00
17:00	480	91.39	66.72
17:30	510	91.68	67.01
17:40			

Mr. V. Raudsepp July 20th, 1965

RECOVERY READINGS FROM "CONSTANT RATE" PUMP TEST

Time	Well Level Measurements	Drawdown	Time (t) since start of pumping (in mins.)	Time (t′) since pumping stopped (in mins.)	t / t′
					April 11th/65
17:40			520	0	
17:49	45.50	20.83	529	9	58.77
17:50	43.47	18.80	530	10	53.00
17:51	42.87	18.20	531	11	48.27
17:52	41.59	16.92	532	12	44.33
17:53	40.59	15.92	533	13	41.00
17:54	39.62	14.95	534	14	38.14
17:55	38.91	14.24	535	15	35.66
17:56	38.18	13.51	536	16	33.50
17:57	37.44	12.77	537	17	31.59
17:58	36.83	12.16	538	18	29.88
17:59	36.210	11.54	539	19	28.36
18:00	35.69	11.02	540	20	27.00
18:05	33.26	8.59	545	25	21.80
18:10	31.81	7.14	550	30	18.33
18:15	30.61	5.94	555	35	15.86
18:20	29.78	5.11	560	40	14.00
18:28	29.07	4.40	568	48	11.83
18:30	28.81	4.14	570	50	11.40
18:32	28.68	4.01	572	52	11.00
18:34	28.45	3.78	574	54	10.63
18:37	28.25	3.58	577	57	10.12
18:41	28.00	3.33	581	61	9.52
18:47	27.70	3.03	587	67	8.76
18:52	27.46	2.79	592	72	8.22
18:55	27.35	2.68	595	75	7.93
18:58	27.28	2.61	598	78	7.66
19:00	27.22	2.55	600	80	7.50
19:03	27.16	2.49	603	83	7.26
19:05	27.08	2.41	605	85	7.12
19:10	26.97	2.30	610	90	6.77
19:16	26.82	2.15	616	96	6.41
19:26	26.63	1.96	626	106	5.90
19:30	26.58	1.91	630	111	5.67
19:35	26.52	1.85	635	115	5.52
19:40	26.44	1.77	640	120	5.33
19:45	26.39	1.72	645	125	5.16
19:50	26.33	1.66	650	130	5.00
20:00	26.31	1.64	660	140	4.71
20:15	26.13	1.46	675	155	4.35
20:35	26.03	1.36	695	175	3.97
21:01	25.81	1.14	721	201	3.59

Mr. V. Raudsepp July 20th, 1965

Time	Well Level Measurements	Drawdown	Time (t) since start of pumping (in mins.)	Time (t′) since pumping stopped (in mins.)	$\frac{t}{t'}$	
21:01	25.81	1.14	721	201	3.59	
21:30	25.69	1.02	750	230	3.26	
22:00	25.53	0.86	780	260	3.00	
22:33	25.43	0.76	783	293	2.67	
23:01	25.34	0.67	841	321	2.61	
23:52	25.21	0.54	892	372	2.39	
						April 12th/65
1:00	25.09	0.42	960	440	2.18	
6:55	24.84	0.17	1315	795	1.65	
8:00	24.83	0.16	1380	860	1.60	
9:00	24.82	0.15	1440	920	1.56	
10:00	24.78	0.11	1500	980	1.53	
11:00	24.72	0.05	1560	1040	1.50	
12:00	24.66	+0.01	1620	1100	1.47	
12:13	24.66	+0.01	1633	1113	1.46	
13:00	24.61	+0.06	1680	1160	1.44	
14:00	24.51	+0.16	1740	1260	1.38	
15:00	24.43	+0.24	1800	1360	1.32	
22:00	24.64	+0.03	2220	1700	1.30	

APPENDIX IV - PORT CLEMENTS WELL - TABLE SHOWING INCREMENTS OF DRAWDOWN ($\Delta sw + \Delta sp$) DUE TO WELL LOSS AND PARTIAL PENETRATION LOSS PRODUCED FROM REGULAR INCREASES IN THE RATE OF PUMPING (ΔQ)

ΔQ in gpm (Imp.)	$\Delta sw + \Delta sp$ in feet
5 - 6	1.75
6 - 7	2.0
7 - 8	2.0
8 - 9	2.25
9 - 10	2.25
10 - 11	2.25
11 - 12	2.25
12 - 13	2.7
13 - 14	2.75
14 - 15	2.9

(Note: 15.1 gpm = 66-2/3% of the total available drawdown in the well).

15 - 16	3.1
16 - 17	3.3
17 - 18	3.5
18 - 19	3.5
19 - 20	3.5
20 - 21	3.8
21 - 22	4.5
22 - 23	5.0

Mr. V. Raudsepp July 20th, 1965

APPENDIX VI - PORT CLEMENTS WELL - TABLE OF STATIC LEVEL FLUCTUATIONS IN WELL AND OTHER DATA (SEE TEXT)

Date	Time	Static level in well in feet (measured from top of casing)	Static level (in feet) wrt mean level of 24.20 feet	Tide Tables Hrs. : Mins.	Tide Tables Tide in ft. above datum	High or low tide w.r.t. mean sea level at time of static readings.
				11 : 54	14.4	
Apr.14/65	3:00 pm	24.58	+0.38	18 : 09	3.1	-
				6 : 38	2.6	
Apr.15/65	9:40 am	24.44	+0.24*	12 : 41	14.5	-
				12 : 41	14.5	
Apr.15/65	3:00 pm	24.44	+0.24	18 : 46	3.5	-
				7 : 18	2.1	
Apr.16/65	9:00 am	24.15	-0.05	12 : 23	14.2	-
Apr.16/65	3:00 pm	24.31	+0.11	13 : 23	14.2	high
Apr.17/65	9:45 am	24.05	-0.15	7 : 57	1.9	low
Apr.17/65	3:00 pm	24.30	+0.10	14 : 06	13.8	high
Apr.18/65	9:05 am	23.97	-0.23	8 : 34	2.1	low
Apr.18/65	3:00 pm	24.35	+0.15	14 : 46	13.3	high
Apr.19/65	9:00 am	23.89	-0.31	9 : 12	2.6	low
Apr.19/65	3:00 pm	24.25	+0.05	15 : 29	12.7	high
Apr.20/65	9:00 am	23.75	-0.45	9 : 52	3.3	low
Apr.20/65	2:00 pm	24.07	-0.13*	9 : 52	3.3	-
				16 : 14	12.1	
				10 : 35	4.0	
Apr.21/65	3:25 pm	24.23	+0.03	17 : 07	11.5	-
Apr.22/65	9:00 am	24.04	-0.16	11 : 27	4.7	Low
				11 : 27	4.7	
Apr.22/65	3:05 pm	24.25	+0.05	18 : 17	11.0	-

DIVISION OF LABORATORIES
Health Branch
828 West Tenth A[illegible]ue
Vancouver 9, [illegible]

Report Form L5 (Rev. 4-61)

APPENDIX VII

WATER BACTERIOLOGY

To . Dr. J. C. Foweraker,
Ground Water Division,
Parliament Buildings,
Victoria, B.C.

Date . 20-4-65
Lab. No. . 3987
Date Received . 15-4-65

SPECIMEN	Standard Plate Count per ml.		Coliform Test		
	20° c	35° c	0.1 ml.	1 ml.	10 ml.
Port Clements - Queen Charlotte Is.					5/5

DEPT. OF LANDS FORESTS AND WATER RESOURCES
WATER RES.
APR 21 1?65
MAIL ROOM
VICTORIA, B.C.

a-L

Copy to: DEPUTY MINISTER OF HEALTH ✓

For Interpretation of Laboratory Results see "Standard Methods for the Examination of Water and Wastewater," Eleventh Edition, 1960, A.P.H.A., A.W.W.A., W.P.C.F.

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

Report Form L 76 (Rev. 11/61)

APPENDIX VII (cont.)

CHEMICAL ANALYSIS-ROUTINE

TO: D/UIHU
Courtenay

Report No.: 825
Date Reported: 26-5-65
Date Received: 15-4-65

COPY TO: DIRECTOR, DIVISION OF PUBLIC HEALTH ENGINEERING.

Collector's Name: Dr. J.C. Foweraker
Address: Ground Water Division, Parliament Buildings, Victoria
Date Sampled: 13-4-65
Time Sampled: - -

Water Works System: New well for housing developement
Treatment: None
Sampling Point: Test pump, Port Clements
Source of Water: 60 foot aquifer, adjacent to Highway's Repair Shop

Test(s) done in field: None indicated
Temperature (^{o}C):
pH:
Residual Chlorine:
Other:

Determinations Reported as mg/l unless noted otherwise.

Colour (in units)	greater than 70	Alkalinity (as $CaCO_3$)	
Turbidity (in units)	7.0	Phenolphthalein	Nil
Temperature (^{o}C) (on arrival)		Methyl Orange (total)	290
pH (in units) (on arrival)	7.9	Free Carbon Dioxide (as CO_2)(calculated)	
Total Solids	384	Hardness (as $CaCO_3$)	
Fixed Solids		Total	212
Volatile Solids (calculated)		Carbonate (temporary)(calculated)	
Dissolved Solids	361	Non-Carbonate (permanent)(calculated)	
Dissolved Solids (calculated)		Silica (as SiO_2)	17.5
Suspended Solids		Surfactants (as A.B.S.)	Nil
~~xxxxxxxxx~~ Organic Notrogen (as N)	0.06	Nitrite Nitrogen (as N)	0.002
Ammonia Nitrogen (as N)	0.31	Nitrate Nitrogen (as N)	0.02
Calcium (as Ca)	51.5	Bicarbonate (as CO_3)(calculated)	
Magnesium (as Mg)	20.0	Carbonate (as CO_3)(calculated)	
Iron (total) (as Ferric ion)	1.16	Sulphate (as SO_4)	*
Sodium (as Na)	66	Chloride (as Cl)	1.5
Potassium (as K)	4	Fluoride (as F)	Nil
Specific Conductance (m mhos)	550	Ortho-phosphate (as PO_4)	3.6
		Coliform Test Water Bact. #3987	5/5

Remarks:
* Colour interference

c.c. Dr. J.C. Foweraker, Ground Water Division
Parliament Buildings, Victoria, B.C.

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

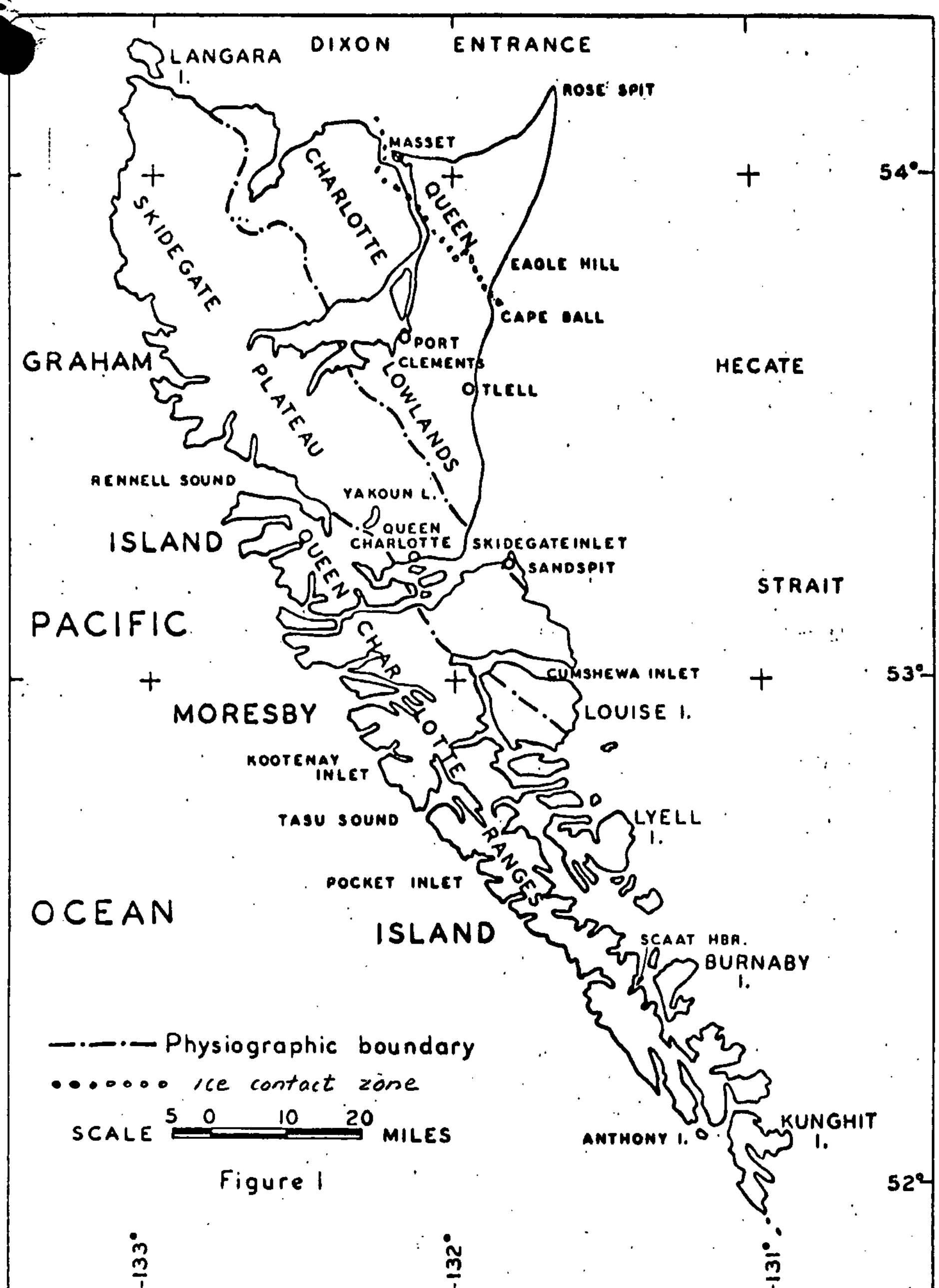


Figure I

Location Map and Physiographic Map, Queen Charlotte Islands

WATER INVESTIGATIONS BRANCH

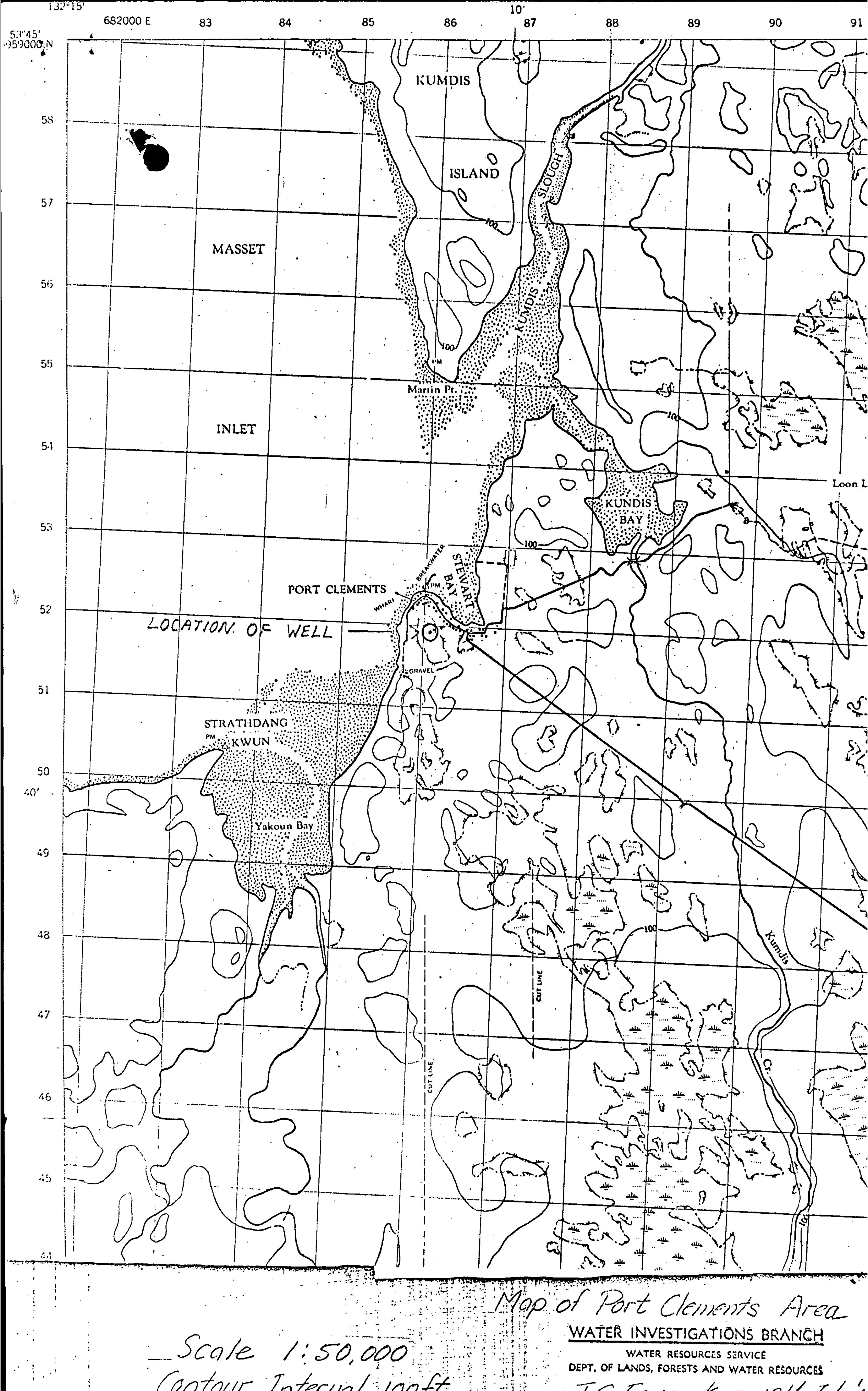
WATER RESOURCES SERVICE

DEPT. OF LANDS, FORESTS AND WATER RESOURCES

J. C. Foweraker 19th July '65

File Nos 0243107, 0239015

FIGURE 1



Map of Port Clements Area

WATER INVESTIGATIONS BRANCH

WATER RESOURCES SERVICE

DEPT. OF LANDS, FORESTS AND WATER RESOURCES

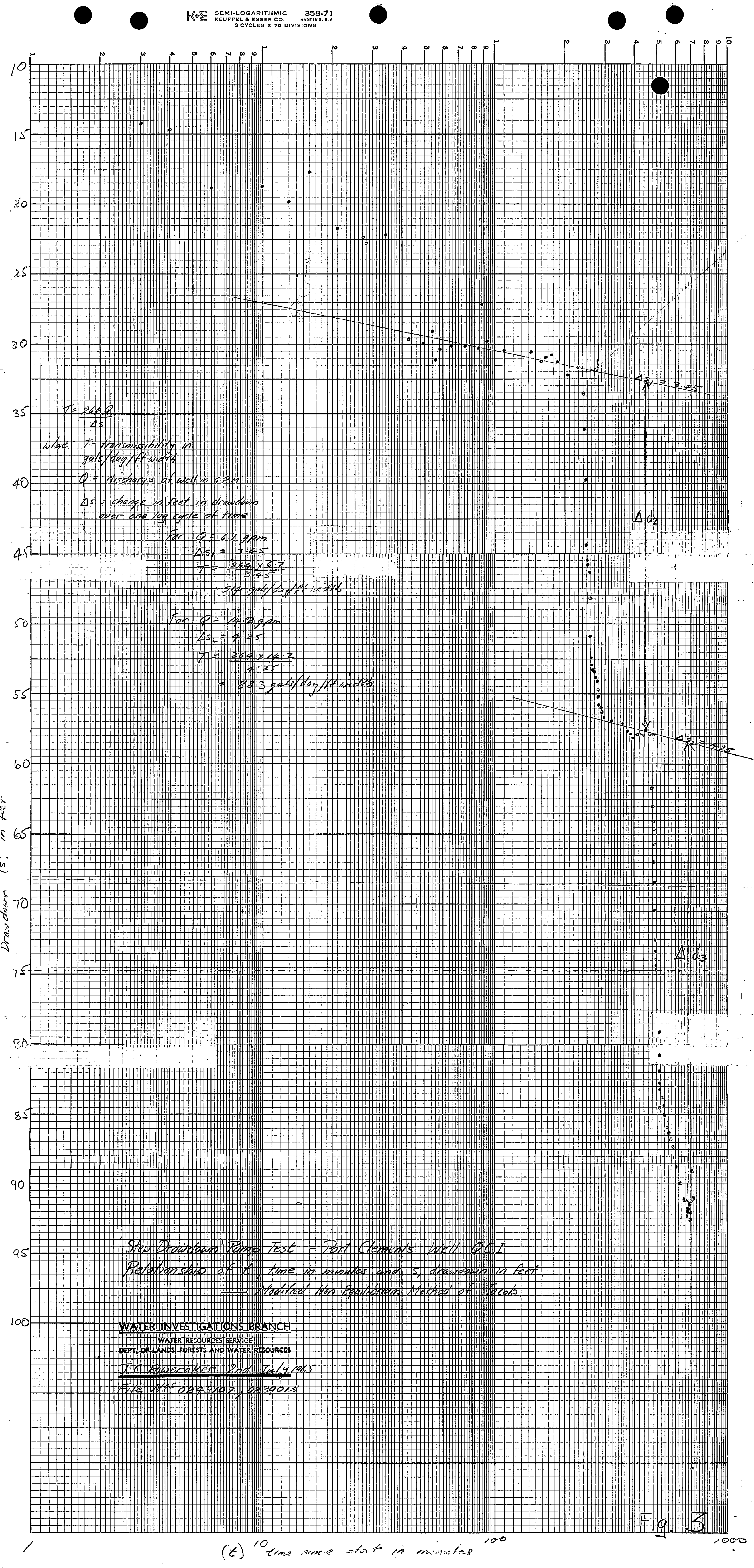
J.C. Foweraker 12th July '6[illegible]

File N^os 0243107, 0239015

Scale 1:50,000

Contour Interval 100ft

FIGURE 2



K+E SEMI-LOGARITHMIC 358-71
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 70 DIVISIONS
$\Delta s_1 = 3.45$
Δd_2
$\Delta s_2 = 4.25$
Δd_3
$T = \frac{264 Q}{\Delta s}$
where T = transmissibility in gals/day/ft width
Q = discharge of well in G.P.M.
Δs = change in feet in drawdown over one log cycle of time
For Q = 6.7 gpm
$\Delta s_1 = 3.45$
$T = \frac{264 \times 6.7}{3.45}$
= 514 gals/day/ft width
For Q = 14.2 gpm
$\Delta s_2 = 4.25$
$T = \frac{264 \times 14.2}{4.25}$
= 883 gals/day/ft width
'Step Drawdown' Pump Test - Port Clements Well. Q.C.I.
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.C. Foweraker 2nd July 1965
File Nos 0293107, 0239015
Drawdown (s) in feet
(t) time since start in minutes
1
10
100
1000
Fig. 3

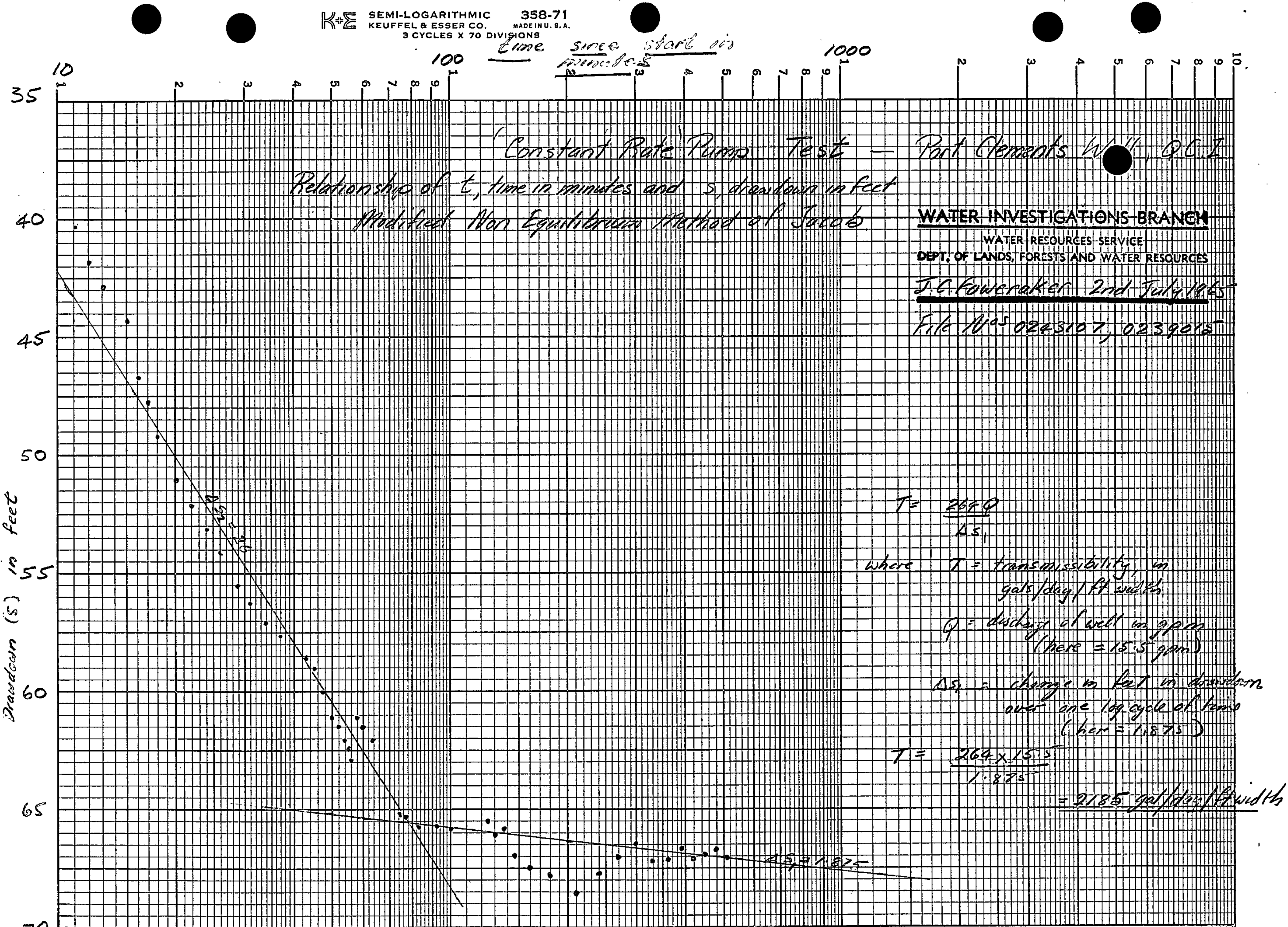
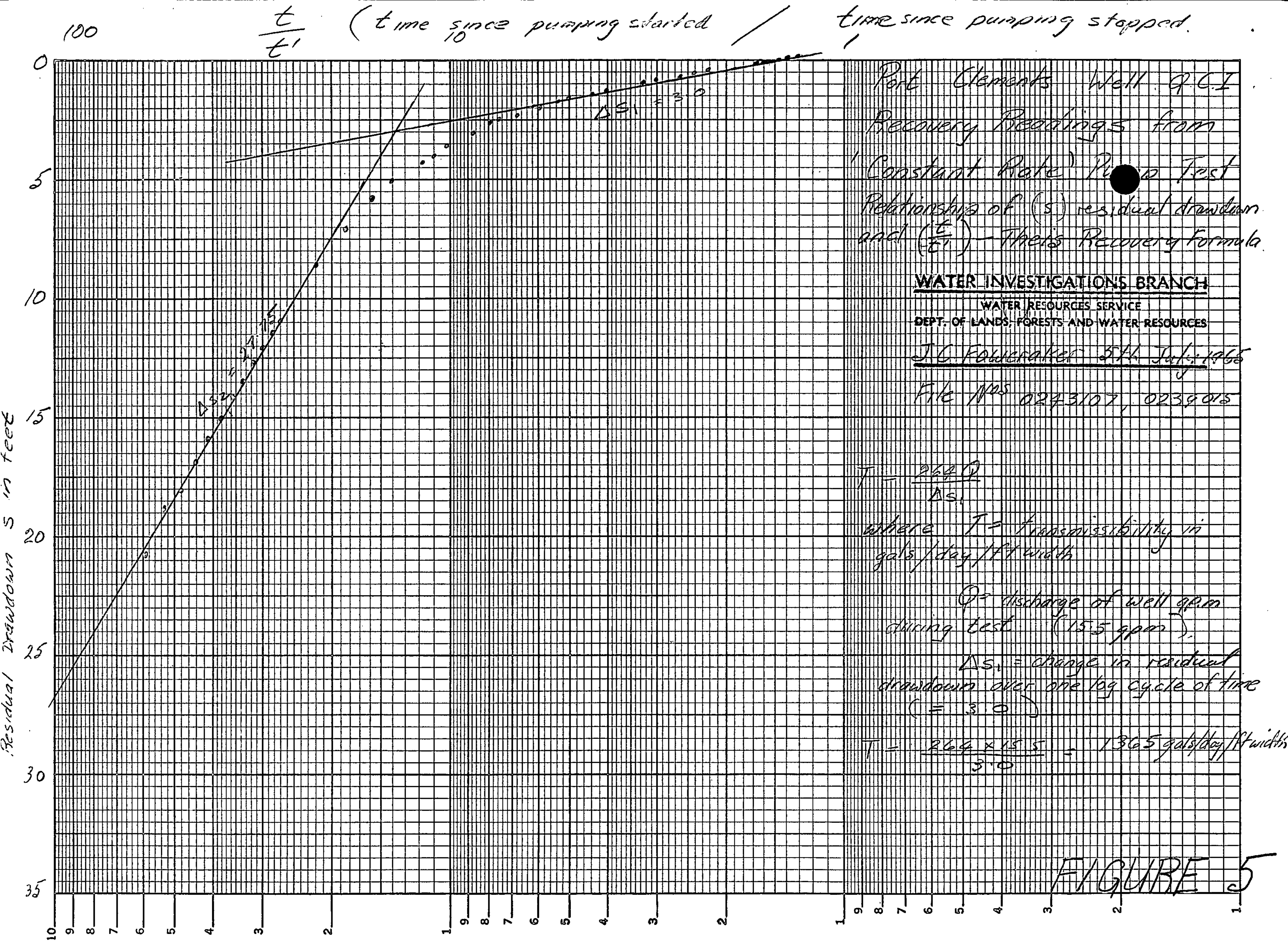

K+E SEMI-LOGARITHMIC 358-71
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 70 DIVISIONS
time since start in minutes
10
100
1000
Constant Rate Pump Test — Port Clements Well, QCI
Relationship of t, time in minutes and s, drawdown in feet
Modified Non Equilibrium Method of Jacob
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
J.C. Foweraker 2nd July 1965
File Nos 0243107, 0239015
Drawdown (s) in feet
35
40
45
50
55
60
65
70
Δs = 20
Δs1 = 1.875
T = 264Q / Δs1
where T = transmissibility, in gals/day/ft width
Q = discharge of well in gpm (here = 15.5 gpm)
Δs1 = change in feet in drawdown over one log cycle of time (here = 1.875)
T = 264 x 15.5 / 1.875
= 2185 gal/day/ft width

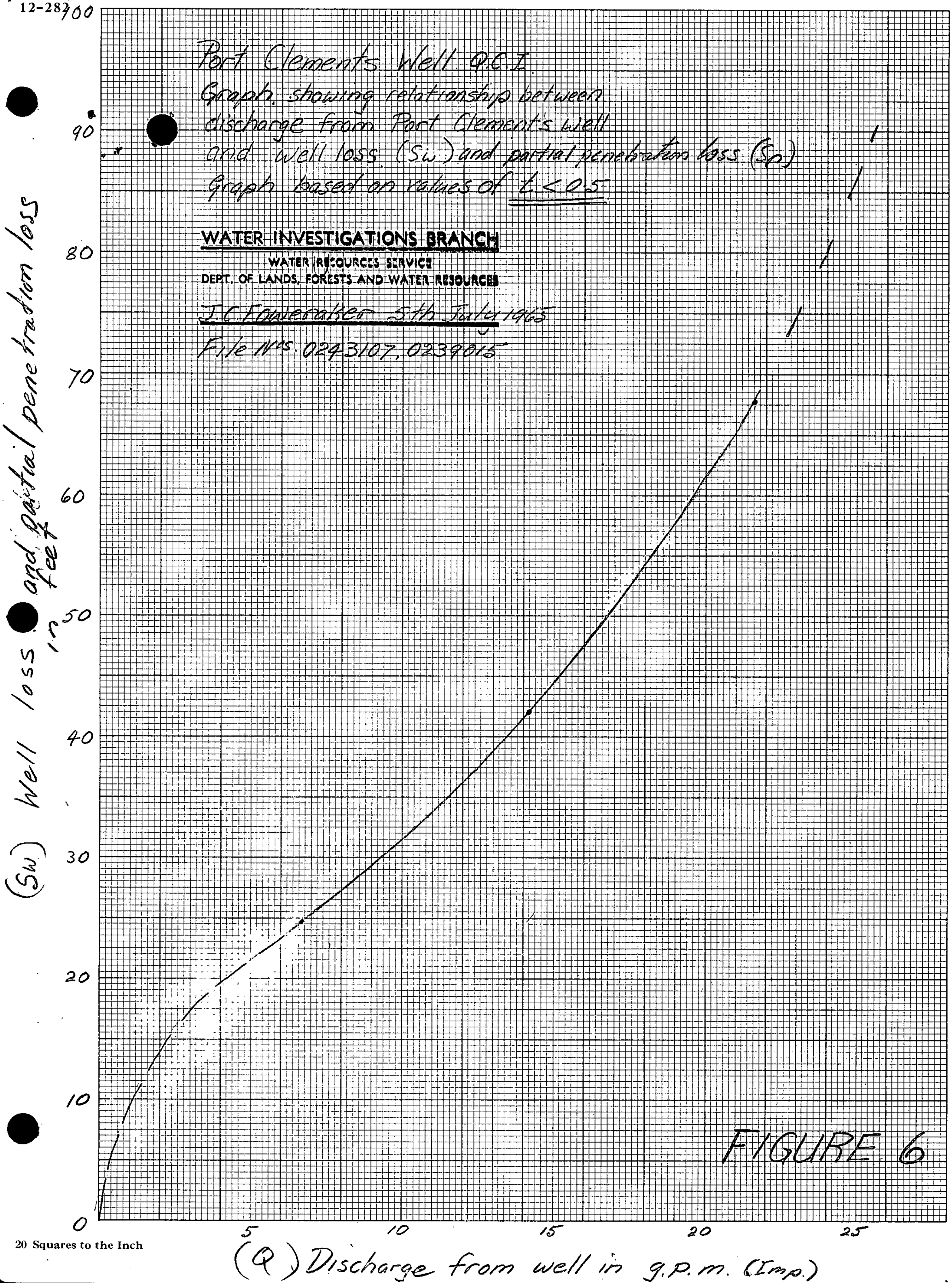
FIGURE 4



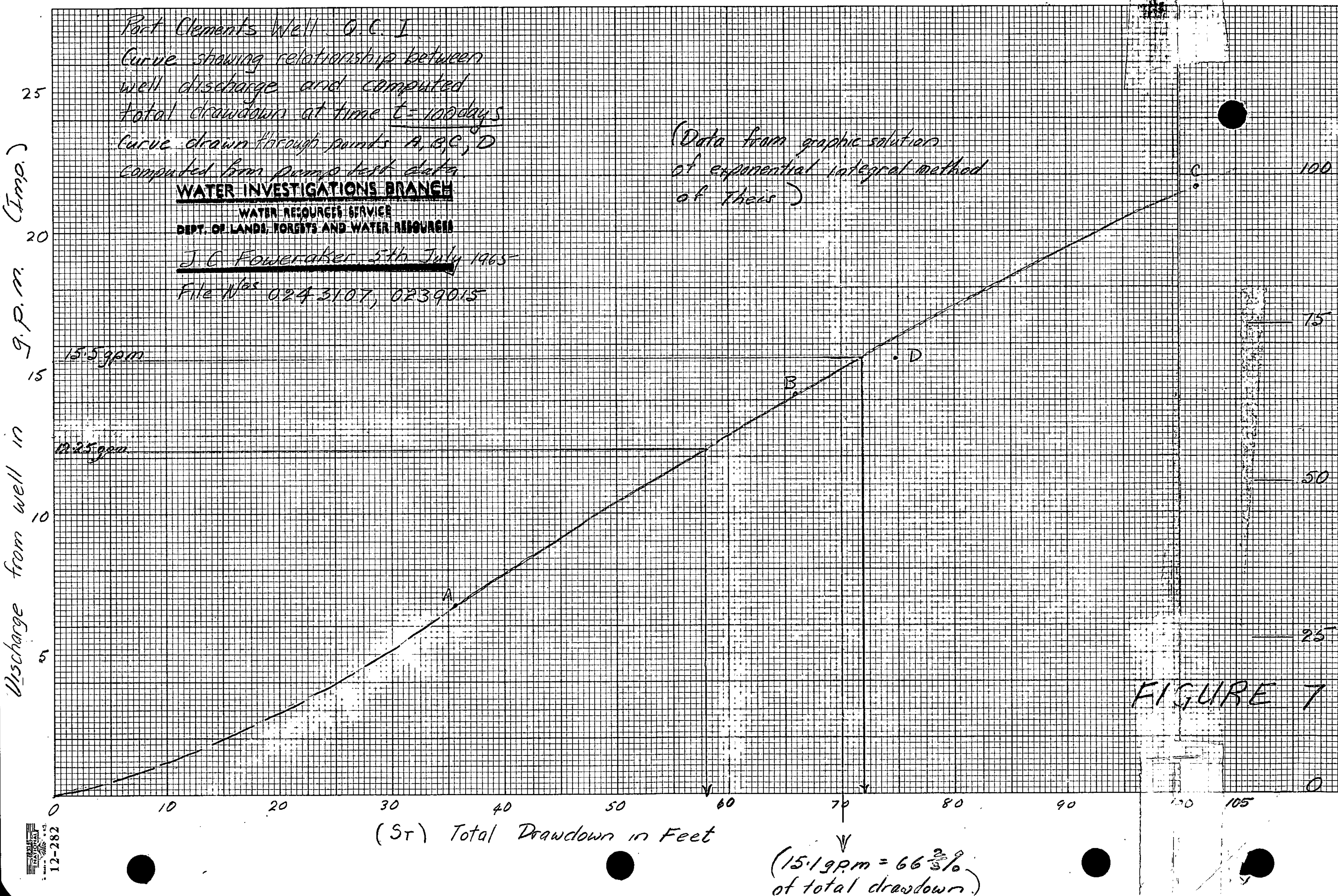
t/t' (time since pumping started / time since pumping stopped.
Residual Drawdown s in feet
0
5
10
15
20
25
30
35
100
10
1
Δs₁ = 3.0
Δs₂
Port Clements Well Q.C.I.
Recovery Readings from
'Constant Rate' Pump Test
Relationship of (s) residual drawdown
and (t/t') — Theis Recovery Formula
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
J C Foweraker 5th July 1965
File Nos 0243107, 0239015
T = 264Q/Δs₁
where T = transmissibility in gals/day/ft width
Q = discharge of well gpm during test (15.5 gpm).
Δs₁ = change in residual drawdown over one log cycle of time (= 3.0)
T = (264 × 15.5)/3.0 = 1365 gals/day/ft width

FIGURE 5

12-282



20 Squares to the Inch



12-282 NATIONAL

20 Squares to the Inch

When r=1000
s (12.25 gpm curve) = 11.40
s (12.8 ...) 11.95

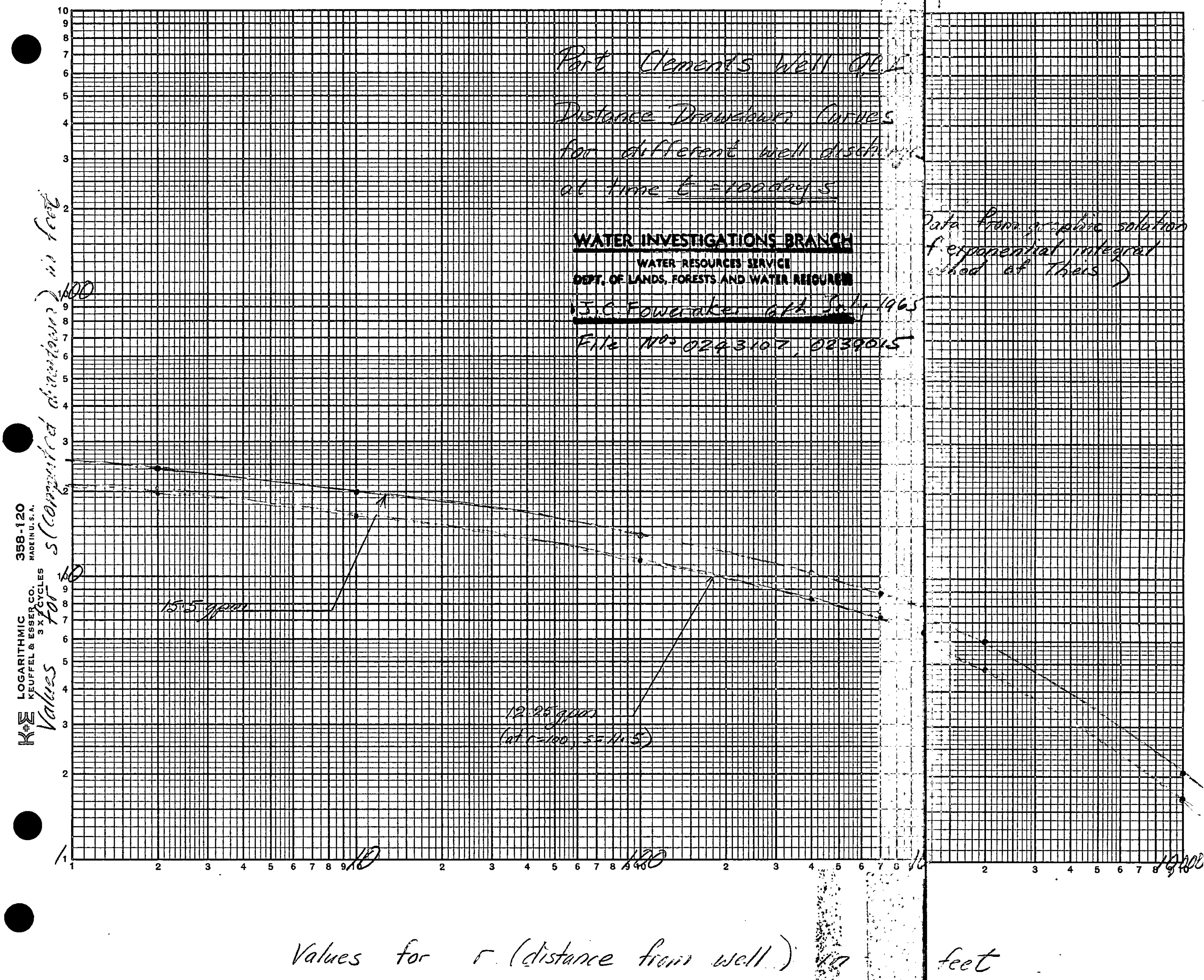


FIGURE 8

PHOTO N°1

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

J.C. Foweraker 20th July 1965

File N^os 0243107, 0239015
(Port Clements Well - Appendix 1)

PHOTO N°2

WATER INVESTIGATIONS BRANCH
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DEPT. OF LANDS, FORESTS AND WATER RESOURCES

J. C. Foweraker 20th July 1965
File N^os 0243107, 0239015
(Port Clements Well - Appendix 1)

PHOTO N°3

J.C. Foweraker 20th July 1965
File N^os 0243107, 0239015
(Port Clements Well - Appendix 1)