CERTIFICATION OF WATER QUANTITY AND QUALITY FOR A RURAL SUBDIVISION AT 8541 GAGLARDI STREET IN THE DISTRICT OF MISSION

(District of Mission Subdivision Application S90-07 and File PRF-15-40)

Prepared for

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Prepared by

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DECEMBER 13, 1990

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December 13, 1990

Mr. & Mrs. M. Manzer
8611 Gaglardi Street, R.R. 2
MISSION, B. C. V2V 4H9

Subject: **Certification of Water Quantity and Quality for a Rural Subdivision at 8541 Gaglardi Street in the District of Mission**
District of Mission Subdivision Application S90-07 and File PRF-15-40

Dear Mr. & Mrs. Manzer:

This letter is further to recent telephone discussions between Darlene Manzer and Ann Badry, Hydrogeologist of Pacific Hydrology Consultants Ltd., and between Darlene Manzer and Ed. Livingston, P. Eng., of Pacific Hydrology.

Background information concerning the subject subdivision at 8541 Gaglardi Street is contained in our previous letter-report dated September 10, 1990 on the subject "Hydrogeologic Evaluation in Regard to Disposal of Wastewater and Storm Water on a Proposed Subdivision at 8611 Gaglardi Street in the District of Mission". As shown above, in the subject of this letter, the address of the rural subdivision should be given as 8541 Gaglardi Street and not 8611 as earlier identified.

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1.0 INTRODUCTION

The purpose of this letter-report is to present information which confirms that an existing well drilled in 1974 on Lot 2, the northern lot to be created from the proposed subdivision of Lot 7, D.L. 436, Group 1, Plan 9965, New Westminster District, and three new wells, one on Lot 1, and two on Lot 3, will "... provide a quantity of water not less than 2500 litre/day per parcel and provide a sustained yield of 9 litres per minute for a minimum of four hours", as required under District of Mission Bylaw No. 2203-1990. This letter also discusses the quality of groundwaters yielded by the wells and provides the required hydrogeologic impact assessment with respect to:

(i) Impact of each proposed well on neighbour wells both within and adjacent to the proposed subdivision, and

(ii) Long term impact of the proposed wells on the source aquifer.

The topographic setting of the Manzer Subdivision is shown on Figure 1 in Appendix A and the subdivision layout is shown on Figure 2. These diagrams are those contained in the previous report of September 10 concerning wastewater disposal. As mentioned above, proposed Lot 3 contains two drilled wells; both of the wells have been tested for compliance with District of Mission Bylaw No. 2203-1990 and the results are discussed in this letter.

The four wells on the proposed Manzer Subdivision are all drilled rock wells in sandstone and shale. Details concerning the individual wells are summarized in the table on the following page. The approximate (unsurveyed) locations of the wells are shown on Figure 2 (Appendix A).

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Table 1. Details About Drilled Wells on Proposed Manzer Subdivision

Well	Lot	Total Depth m (ft)	Static Water Level m (ft)	Location of Main Water-bearing Fracture m (ft)	Remarks
1-1974	2	62.2 (204)	7.32 (24.00) (10/15/90)	62.2 (204)	3.0 m (10 ft) of 150 mm (6") diameter casing through overburden; small water-bearing fracture at 24.4 m (80 ft).
1-1990	3	82.3 (270)	38.26 (125.50) (11/26/90)	79.3 - 80.8 (260 - 265)	3.0 m (10 ft) of 150 mm (6") diameter casing through overburden; small water-bearing fracture at 42.7 m (140 ft).
2-1990	3	76.2 (250)	21.24 (69.67) (11/26/90)	74.7 (245)	0.9 m (3 ft) of 150 mm (6") diameter casing through weathered bedrock at surface; small water-bearing fracture at 69.5 m (228 ft).
3-1990	1	63.4 (208)	16.36 (53.67) (11/26/90)	59.45 - 60.4 (195 - 198)	16.8 m (55 ft) of 150 mm (6") diameter casing through overburden; minor water-bearing fractures from 19.8 to 21.3 m (65 to 70 ft).

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2.0 HYDROGEOLOGY

The proposed Manzer Subdivision, which is located between Gaglardi Street and Silverdale Road, is in an area of shallow bedrock. According to Geological Survey of Canada Map 1485A, **Surficial Geology Mission British Columbia**, the surficial cover in the area of the Subdivision consists of "sandy till and substratified drift, 2 to 10 m thick". Local dug wells north of the subject property obtain water from these sediments. In the four drilled wells on the proposed Manzer Subdivision, the thickness of overburden ranged from an absence of overburden at Well No. 2-1990 (in the northeast corner of proposed Lot 3) to 16.8 m (55 ft) of overburden at Well No. 3-1990 at the north end of proposed Lot 1; the thick overburden at Well No. 3-1990 is likely associated with the valley of the small creek in the northwestern corner of the Subdivision.

As shown on the J.M.C. Wade & Associates Ltd. Plan 2596 of the proposed subdivision, the subject Property partially surrounds a prominent outcrop in the northeast corner of Lot 3. A small south-flowing creek crosses the northwest corner of the Property. The existing buildings, consisting of a house and a garage, are on Lot 3, south of the original drilled well. The septic tank and drain field for the existing residence are located southeast of the house. Since its construction in 1974, the well on Lot 2 is reported by the Manzers to have supplied the domestic needs of the existing house on the new Lot 3 and there have been no shortages or problems with the well. Even so, this well, identified as No. 1-1974, was tested to better evaluate its capacity and to confirm compliance with District of Mission Bylaw No. 2203-1990.

3.0 WELL CAPACITY

To assess their capability to satisfy District of Mission Bylaw 2203-1990, the four Wells on the proposed Manzer Subdivision were pump tested by A & H Construction Ltd.; the Well on proposed Lot 2 (1-1974) was tested on October 15 and 16, using the installed submersible pump discharging through a water meter to the creek. Wells 1-1990, 2-1990 and 3-1990 were tested on November 26 and 27 by simultaneous pumping of all three. Pumping rates were confirmed by timing the filling of a container of known volume. Data collected during the tests are included with this letter-report as Appendix B.

Well No. 1-1974 on Lot 2

The 24 hour pumping test of Well No. 1-1974 was started at 10:30 a.m. on October 15 at a rate of 36.3 L/min (8 igpm); this rate was decreased to 15.90 L/min ($3\frac{1}{2}$ igpm) in several steps in the first 90 minutes of the test. Pumping continued at a rate of 15.9 L/min from 90 minutes to 630 minutes, at which time the rate was further reduced to 11.35 L/min ($2\frac{1}{2}$ igpm); pumping continued at a rate of 11.35 L/min to the end of the test at 1440 minutes (24 hours). As shown on Figure 3 (Page B - 9), the drawdown was nearly constant for the last nine hours of the test, showing that water was moving into the well through rock fractures at the same rate as it was being pumped out.

Following the termination of pumping at 10:30 a.m. on October 16, the recovery of the water level in Well No. 1-1974 was only observed for 90 minutes. However, by this time, the recovery was about 77% complete and still rising rapidly. The fairly rapid recovery shows that the fracture system which yields water to the Well is continually recharged, even at the time of minimum groundwater conditions at the end of the summer drought. Figure 4 (Page B - 10) shows that complete recovery to the pre-pumping static level will occur.

Well No. 1-1990 on Lot 3

The pumping test of Well No. 1-1990 began at 11:00 a.m. on November 26 at a rate of 36.3 L/min (8 igpm); this rate declined to 27.25 L/min (6 igpm) by 12 minutes after the start and, at 40 minutes after the start, the rate was reduced to 15.9 L/min (3½ igpm). Pumping continued at a rate of 15.9 L/min to the termination of pumping at 1575 minutes (1.1 days). The discharge water from the test was conveyed over the bank southwest of the Well toward Silverdale Road drainage. At the final rate of 15.9 L/min, the pumping water level continued to recover as shown on the plot of the drawdown data (Figure 5, Page B - 11), showing that the fracture system intersected by the well is capable of yielding water at a rate in excess of 15.9 L/min.

Following the termination of pumping at 1:15 p.m. on November 27, the recovery of the water level in Well No. 1-1990 was observed for 105 minutes, by which time the water level had recovered to within 5% of the pre-pumping static level. The plot of the recovery data (Figure 6, Page B - 12) confirms that complete recovery will occur.

Well No. 2-1990 on Lot 3

The pumping test of Well No. 2-1990 began on November 26 at 12:00 noon at a rate of 36.3 L/min (8 igpm) which continued until 90 minutes after the start when the rate declined to 27.25 L/min (6 igpm) for the duration of the 1.08 day (1560 minute) test period. The discharge water from the test was conveyed toward the creek in the northeast corner of the proposed Subdivison. At the final rate of 27.25 L/min, an approximately stable pumping water level was achieved showing that water was entering the well at the same rate as it was being pumped out. The response of the water level in Well No. 2-1990 to pumping is shown on Figure 7 (Page B - 13).

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Following the termination of pumping at 2:00 p.m. on November 27, the recovery of the water level in Well No. 2-1990 was observed for 120 minutes. At the end of this period, the water level had only recovered 28%. However, as shown on Figure 8 (Page B - 14) there is every reason to believe that complete recovery will occur.

Well No. 3-1990 on Lot 1

The pumping test of Well No. 3-1990 began at 1:00 p.m. on November 26 at a rate of 20.4 L/min ($4\frac{1}{2}$ igpm); pumping continued at 20.4 L/min until 60 minutes after the start when the rate was reduced slightly to 18.2 L/min (4 igpm). When the rate was checked on November 27 after 1440 minutes of pumping, it had further declined to 13.6 L/min (3 igpm) but, as shown on Figure 9 (Page B - 15), the pumping water level recovered between 120 and 1440 minutes when pumping at a rate between 18.2 and 13.6 L/min (4 and 3 igpm). The discharge water from the test of Well No. 3-1990 was conveyed into the creek valley.

Following the termination of pumping of Well No. 3-1990, the water level had recovered to within about 47% of the prepumping static water level in 120 minutes; Figure 10 (Page B - 16) shows that complete recovery will occur.

All things considered, we have no hesitation in certifying the four Wells on the three lots of the proposed Manzer Subdivision as being capable of yielding 9 L/min for four hours and 2500 litres per day, as specified under District of Mission Bylaw 2203-1990.

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4.0 GROUNDWATER QUALITY

Appendix C contains the following documentation concerning analyses of water samples from the four wells on the proposed Manzer Subdivision:

1. A certificate from JB Laboratories Ltd. dated October 5, 1990 and identified as JB1439P930 11976, for water from Well No. 1-1974 on Lot 2.

2. Certificates from Norwest Labs for the three recently constructed Wells on Lots 1 and 3, as follows:

   - Norwest Lab Number 907133, Work Order Number 1395, dated 11-30-1990 for groundwater from Well No. 1-1990 (Lot 3);

   - Norwest Lab Number 907134, Work Order Number 1395, dated 11-30-1990 for groundwater from Well No. 2-1990 (Lot 3);

   - Norwest lab Number 907135, Work Order Number 1395, dated 11-30-1990 for groundwater from Well No. 3-1990 (Lot 1);

The groundwaters yielded by all wells are generally similar in that they are all sodium + calcium/bicarbonate type waters and, because sodium is the dominant cation, all waters are relatively soft. There are, however, significant differences in total mineralization, with the water from Well No. 1-1974 on Lot 2 the least mineralized, at a total dissolved solids content of 125 mg/L, and the water from Well No. 3-1990 on Lot 1 the most highly mineralized, at a total dissolved solids content of 197 mg/L.

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Attention is drawn to the sodium and iron contents of the various waters.

Well No.	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Iron (mg/L)	Sodium (mg/L)
1-1974	125		<0.10	21
1-1990	167	6	0.40	58
2-1990	143	8	0.50	55
3-1990	197	38	0.20	59

As shown, the iron content of the water from Well No. 1-1974 is very low but iron in the waters from at least two of the new wells exceed the drinking water guideline of 0.3 mg/L, which is established for aesthetic reasons in that elevated levels of iron may result in staining of laundry and plumbing fixtures and deposit coatings in piping. Considering that the three new wells had only been drilled a short time prior to the time of the pump testing, it seems likely that the apparent elevated iron content may be at least partly due to adsorption on particulate matter; if so, both turbidity and iron will decline with longer pumping. In any case, iron treatment is now relatively straightforward and inexpensive.

Attention is drawn to the sodium content of all of the waters; it is at or in excess of the 20 mg/L threshold of concern for those on sodium-restricted diets.

Total coliform bacteria were absent or low in waters from all four wells and thus the waters from all wells satisfy B.C. Ministry of Health guidelines.

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A & H Construction Ltd. noted a slight sulphur odour in the discharge water from Wells No. 1-1990 and No. 2-1990 but stated that they did not consider it to be very serious. Aeration is the most effective method for dissipating this odour, which, in any case, is not an health concern.

5.0 HYDROGEOLOGIC IMPACT ASSESSMENT

As previously discussed, the static water levels in the drilled wells are all in the bedrock a substantial distance below the bottom of the overburden sediments; therefore, use of the wells would not interfere with dug wells obtaining water from a shallow perched system associated with the Creek that crosses the northwest part of the Subdivision.

As shown in the table on Page 3, the locations of the main water-bearing fractures are at different depths in the wells. When drilling into fractured rock, where the extent and/or distribution of rock fractures cannot be predicted, experience shows that wells which are located very close together often do not obtain water from an interconnected fracture system and therefore do not have any effect on each other; this has been shown to be the case for the Wells on the proposed Manzer Subdivision. The three new Wells, in spite of being pumped simultaneously, did not interfere nor did they have any effect on the Well on Lot 2. Further, the recovery of the water level in each Well following the termination of pumping was significantly different, confirming that the fracture systems are not interconnected. In the prevailing situation, where the lots are a minimum 0.36 hectare (0.9 acres) in size, use of the drilled wells are unlikely to have any impact on existing drilled and/or dug wells in the area, as each well is only able to withdraw a small portion of the large quantity of water moving through the rock under the site.

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6.0 SUMMARY AND CONCLUSIONS

1. The four drilled wells proposed as sources of domestic water for the three lots of the rural Manzer Subdivision of Lot 7, D.L. 436, Group 1, Plan 9965, New Westminister District, can clearly "...provide a quantity of water not less than 2500 litres/day..." and a sustained yield of 9 litres per minute for a minimum of four hours, as required by District of Mission Bylaw No. 2203-1990.

2. Simultaneous testing of the three new wells on the proposed Manzer Subdivision, during which the existing well on Lot 2 was monitored, did not show any interference between wells. This confirms the unpredictability of fracture networks in rock wells. Further, these four wells, which are located at the discharge end for groundwater flow originating on the mountain to the northeast, intercept only a small portion of the total groundwater flowing toward the regional discharge end of the system in the Fraser River Valley bottom.

3. Water analyses carried by JB Laboratories Ltd. and Norwest Labs show that the groundwaters from the four drilled wells will provide potable water to the three lots of the proposed Subdivision.

4. Under the prevailing circumstances, the four drilled wells on the Manzer Subdivision will not have any negative impacts on existing drilled wells within the Subdivision, on existing drilled and/or dug wells in the area, or on the source aquifers.

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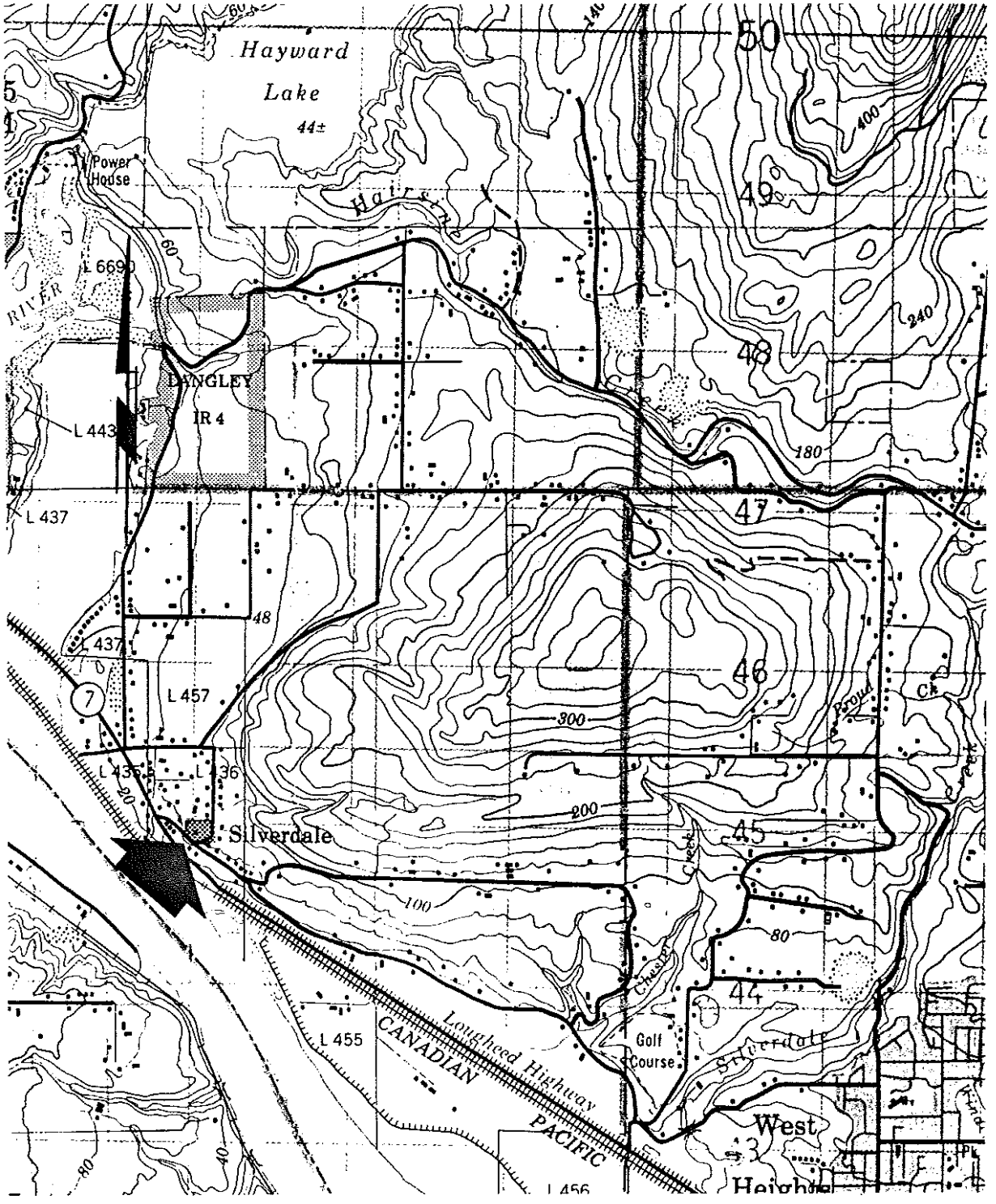
APPENDIX A

AREA LOCATION MAP AND SUBDIVISION PLAN

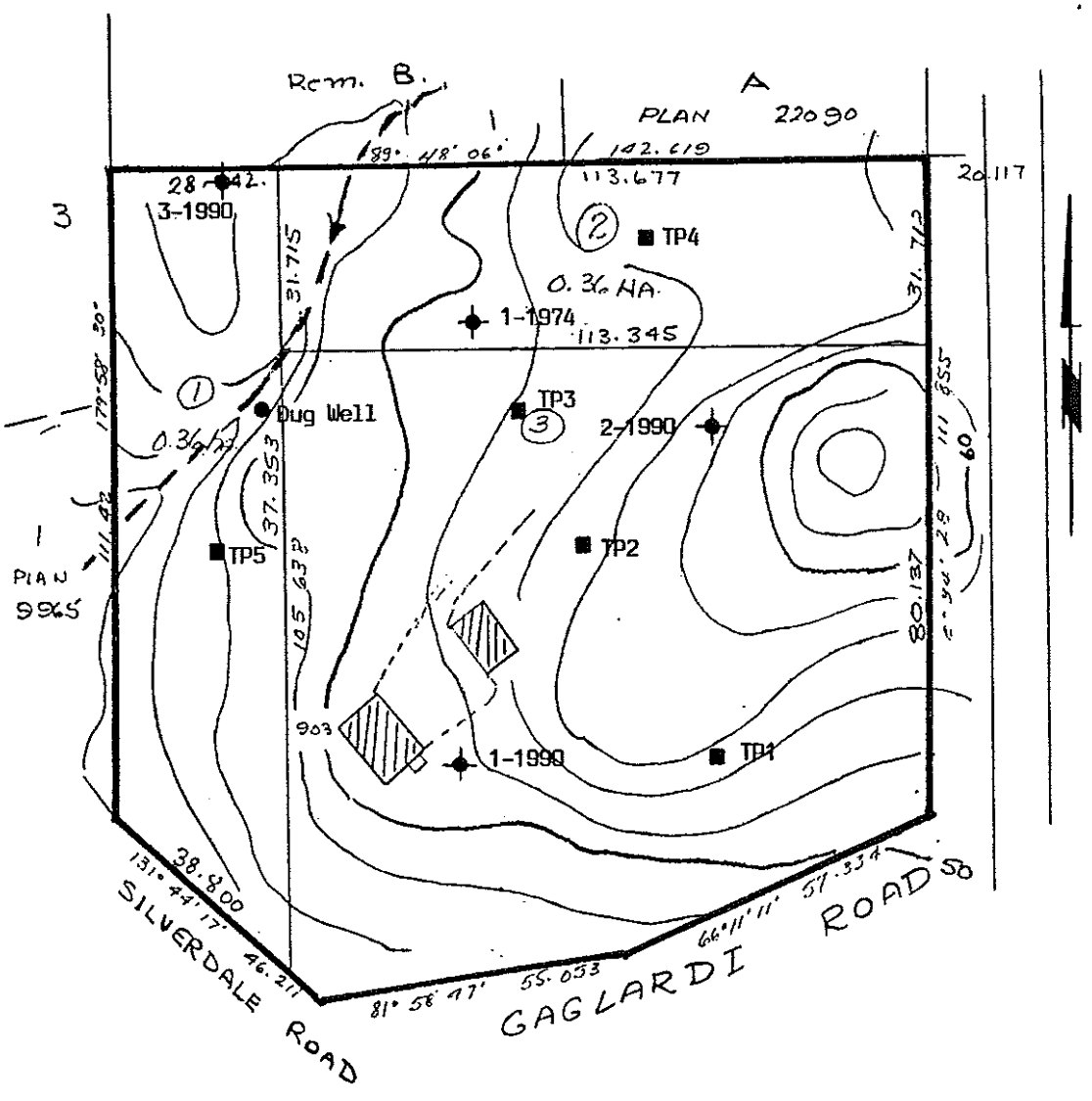
FIGURE 1	AREA LOCATION MAP - PROPOSED MANZER SUBDIVISION AT 8541 GAGLARDI STREET



Notes:

1. The base map is 1:50,000 scale topographic map N.T.S. 92G/1, **Mission**, enlarged to a scale of approximately 1:39,000.
2. ▮ indicates the location of the proposed Manzer Subdivision.

FIGURE 2	WELL & TEST PIT LOCATIONS ON PROPOSED MANZER SUBDIVISION AT 8541 GAGLARDI STREET



Notes:

1. The base map is J.M.C. Wade & Associates Plan M2569 of scale 1:1000, reduced to an approximate scale of 1:1300; contour interval is two metres.
2. ——— defines the boundary of the proposed Subdivision.
3. ■ TP1 marks the approximate (unsurveyed) location of a test pit.
4. ● ✦ marks the approximate (unsurveyed) respective location of a dug and drilled well.

APPENDIX B

PUMPING TEST DATA AND PLOTS

PUMP TEST – DRAWDOWN DATA

15/16	OCTOBER	1990
DAY	MONTH	YEAR

CONTRACTOR A & H Construction Ltd.

PROJECT MANZER – DISTRICT OF MISSION SUBDIVISION APPLICATION 90-07

Location 8541 Gaglardi Street

Well on Proposed Lot 2 (No. 1-1974) Pumping Rate (Q) See below

Datum Point Top of well casing Elevation of Datum Point –

Static Water Level 24.00 ft (7.317 m) Well Details 204 ft (62.2 m) drilled rock well

TIME HR.	TIME MIN.	ELAPSED TIME t (MIN.)	DISTANCE TO WATER	DRAWDOWN (ft)		METER READING (igals)	PUMPING RATE	REMARKS
							(igpm)	
10	30		24.00			13640		Static level; start.
10	31	1	27.17	3.17				
10	32	2	30.67	6.67				
10	33	3	34.00	10.00				
10	34	4	36.50	12.50				
10	35	5	37.67	13.67			8	
10	40	10	49.83	25.83				
10	45	15	61.50	37.50				
10	50	20	73.92	49.92				
11	00	30	85.25	61.25			7	Reduce rate.
11	30	60	146.25	122.25			6	
12	00	90	182.50	158.50			5	Reduce rate.
13	00	150	180.33	156.33			3½	
17	00	390	184.00	160.00			3½	
21	00	630	183.50	159.50			3½	Reduce rate.
16/08	00	1290	163.00	139.00			2½	
10	00	1410	168.00	144.00				
10	30	1440	168.17	144.17		17080		Stop pump.

PUMP TEST – RECOVERY DATA

16	OCTOBER	1990
DAY	MONTH	YEAR

PROJECT MANZER - DISTRICT OF MISSION SUBDIVISION APPLICATION 90-07

Well on Proposed Lot 2 (No. 1-1974)

Datum Point Top of well casing Elevation of Datum Point -

Static Water Level 24.00 ft (7.317 m) Final Drawdown 144.17 ft (43.954 m)

TIME		ELAPSED TIME SINCE PUMPING STARTED	ELAPSED TIME SINCE PUMPING STOPPED	RATIO (t/t')	DISTANCE TO WATER	RESIDUAL DRAWDOWN (ft)		REMARKS
HR.	MIN.	t (min.)	t' (min.)					
10	30	1440			168.17	144.17		
10	31	1441	1	1441	166.67	142.67		
10	32	1442	2	721	165.17	141.17		
10	33	1443	3	481	164.25	140.25		
10	34	1444	4	361	162.83	138.83		
10	35	1445	5	289	161.50	137.50		
10	40	1450	10	145	153.17	129.17		
10	45	1455	15	97	146.67	122.67		
10	50	1460	20	73	137.25	113.25		
11	00	1470	30	49	119.50	95.50		
11	30	1500	60	25	111.67	87.67		
12	00	1530	90	17	57.67	33.67		

PUMP TEST – DRAWDOWN DATA

26/27	NOVEMBER	1990
DAY	MONTH	YEAR

CONTRACTOR A & H Construction Ltd.

PROJECT MANZER - DISTRICT OF MISSION SUBDIVISION APPLICATION 90-07

Location 8541 Gaglardi Street

Well No. 1-1990 Pumping Rate (Q) See below

Datum Point Top of well casing Elevation of Datum Point 1½ ft above ground level

Static Water Level 126.50 ft Well Details 270 ft (82.3 m) drilled rock well

TIME		ELAPSED TIME	DISTANCE TO WATER	DRAWDOWN (ft)			PUMPING RATE	REMARKS
HR.	MIN.	t (MIN.)					(igpm)	
11	00		126.50					Static level; start.
								Discharge water clear,
11	01	1	132.17	5.67			8	slight cuttings.
11	02	2	140.50	14.00				
11	03	3	141.92	15.42				
11	04	4	143.83	17.33				
11	05	5	145.17	18.67				
11	06	6	147.50	21.00				
11	07	7	149.83	23.33				
11	08	8	151.50	25.00				
11	09	9	153.75	27.25				
11	10	10	156.00	29.50				
11	12	12	160.67	34.17			6	
11	14	14	163.33	36.83				
11	16	16	167.17	40.67				
11	18	18	170.04	43.54				
11	20	20	173.04	46.54				
11	25	25	180.33	53.83				
11	30	30	186.17	59.67			6	
11	35	35	191.08	64.58				
11	40	40	195.83	69.33				Reduce rate slightly.
11	45	45	195.17	68.67			3½	
11	50	50	192.92	66.42				
12	00	60	190.67	64.17			3½	
12	30	90	175.25	48.75				
13	00	120	165.33	38.83				
13	30	150	160.08	33.58			3½	
27/13	15	1575	158.17	31.67				Stop pump.

PUMP TEST – RECOVERY DATA

27	NOVEMBER	1990
DAY	MONTH	YEAR

PROJECT MANZER - DISTRICT OF MISSION SUBDIVISION APPLICATION 90-07

Well No. 1-1990

Datum Point Top of well casing Elevation of Datum Point 1½ ft above ground level

Static Water Level 126.50 ft (38.57 m) Final Drawdown 31.67 ft (9.65 m)

TIME		ELAPSED TIME SINCE PUMPING STARTED	ELAPSED TIME SINCE PUMPING STOPPED	RATIO (t/t')	DISTANCE TO WATER	RESIDUAL DRAWDOWN (ft)		REMARKS
HR.	MIN.	t (min.)	t' (min.)					
13	15	1575			158.17	31.67		Stop pump.
13	16	1576	1	1576	157.67	31.17		
13	17	1577	2	788.5	156.17	29.67		
13	18	1578	3	526.0	154.67	28.17		
13	19	1579	4	394.75	153.42	26.92		
13	20	1580	5	316.0	152.67	26.17		
13	21	1581	6	263.5	150.92	24.42		
13	22	1582	7	226.0	149.92	23.42		
13	23	1583	8	197.9	148.83	22.33		
13	24	1584	9	176.0	148.00	21.50		
13	25	1585	10	158.5	147.17	20.67		
13	27	1587	12	132.25	145.71	19.21		
13	29	1589	14	113.2	144.33	17.83		
13	31	1591	16	99.4	142.50	16.00		
13	33	1593	18	88.5	141.17	14.67		
13	35	1595	20	79.75	140.04	13.54		
13	45	1605	30	53.5	137.17	10.67		
13	50	1610	35	46.0	134.92	8.42		
13	55	1615	40	40.4	133.83	7.33		
14	00	1620	45	36.0	132.50	6.00		
14	05	1625	50	32.5	131.92	5.42		
14	15	1635	60	27.25	130.17	3.67		
15	00	1680	105	16.0	127.92	1.42		

PUMP TEST – DRAWDOWN DATA

26/27	NOVEMBER	1990
DAY	MONTH	YEAR

CONTRACTOR A & H Construction Ltd.

PROJECT MANZER – DISTRICT OF MISSION SUBDIVISION APPLICATION S90-07

Location 8541 Gaglardi Street

Well No. 2-1990 Pumping Rate (Q) See below

Datum Point Top of well casing Elevation of Datum Point 1½ ft above ground

Static Water Level 69.67 ft (21.24 m) Well Details 250 ft (76.22 m) drilled rock well

TIME		ELAPSED TIME	DISTANCE TO WATER	DRAWDOWN (ft)			PUMPING RATE	REMARKS
HR.	MIN.	t (MIN.)						
12	00		69.67				(igpm)	Static level; start.
12	01	1	71.25	1.58				Discharge water clean
								with slight silt.
12	02	2	72.83	3.16				
12	03	3	75.00	5.33				
12	04	4	78.83	9.16				
12	05	5	81.17	11.20				
12	06	6	83.00	13.33				
12	07	7	84.83	15.16				
12	08	8	86.50	16.83				
12	09	9	87.58	17.91			8	
12	10	10	88.50	18.83				
12	12	12	90.00	20.33				
12	14	14	91.75	22.08				
12	16	16	93.04	23.37				
12	18	18	95.00	25.33				
12	20	20	97.04	27.37				
12	25	25	98.17	28.50				
12	30	30	101.67	32.00				
12	35	35	104.08	34.41				
12	40	40	104.50	34.83				
12	45	45	105.25	35.58				
12	50	50	108.17	38.50				
13	00	60	112.83	43.16				
13	30	90	118.17	48.50			6	
14	00	120	125.00	55.33				
18	00	360	133.00	63.33			6	
27/14	00	1560	133.33	63.66				Stop pump.

PUMP TEST – RECOVERY DATA

27	NOVEMBER	1990
DAY	MONTH	YEAR

PROJECT MANZER - DISTRICT OF MISSION SUBDIVISION APPLICATION S90-07

Well No. 2-1990

Datum Point Top of well casing Elevation of Datum Point 1½ ft above ground

Static Water Level 69.67 ft (21.24 m) Final Drawdown 63.66 ft (19.41 m)

TIME		ELAPSED TIME SINCE PUMPING STARTED	ELAPSED TIME SINCE PUMPING STOPPED	RATIO (t/t')	DISTANCE TO WATER	RESIDUAL DRAWDOWN (ft)		REMARKS
HR.	MIN.	t (min.)	t' (min.)					
14	00	1560			133.33	63.66		Stop pump.
14	02	1562	2	781	132.17	62.50		
14	03	1563	3	521	131.00	61.33		
14	04	1564	4	391	130.08	60.41		
14	05	1565	5	313	129.17	59.50		
14	06	1566	6	261	128.17	58.50		
14	07	1567	7	223.9	127.08	57.41		
14	08	1568	8	196.0	125.75	56.08		
14	09	1569	9	174.3	125.08	55.41		
14	10	1570	10	157.0	124.33	54.66		
14	12	1572	12	131.0	121.67	52.00		
14	14	1574	14	112.4	119.75	50.08		
14	16	1576	16	98.5	118.83	49.16		
14	18	1578	18	87.7	118.08	48.41		
14	20	1580	20	79.0	117.33	47.66		
14	25	1585	25	63.4	116.92	47.25		
14	30	1590	30	53.0	116.58	46.91		
14	35	1595	35	45.6	116.42	46.75		
14	40	1600	40	40.0	116.25	46.58		
14	45	1605	45	35.7	115.92	46.25		
14	50	1610	50	32.2	115.67	46.00		
15	00	1620	60	27.0	115.42	45.75		

PUMP TEST – DRAWDOWN DATA

26/27	NOVEMBER	1990
DAY	MONTH	YEAR

CONTRACTOR A & H Construction Ltd.

PROJECT MANZER – DISTRICT OF MISSION SUBDIVISION APPLICATION 590-07

Location 8541 Gaglardi Street

Well No. 3-1990 Pumping Rate (Q) See below

Datum Point Top of well casing Elevation of Datum Point 0.33 ft above ground

Static Water Level 53.67 ft (16.36 m) Well Details 208 ft (63.41 m) drilled rock well

TIME HR.	TIME MIN.	ELAPSED TIME t (MIN.)	DISTANCE TO WATER	DRAWDOWN (ft)			PUMPING RATE (igpm)	REMARKS
13	00		53.67					Static level; start.
13	01	1						
13	02	2	64.08	10.41			4	
13	03	3	67.00	13.33				
13	04	4	68.42	14.75				
13	05	5	70.17	16.50				
13	06	6	71.00	17.33				
13	07	7	71.75	18.08				
13	08	8	72.50	18.83				
13	09	9	73.50	19.83			4½	
13	10	10	74.00	20.33				
13	12	12	74.67	21.00				
13	14	14	76.25	22.58				
13	16	16	78.17	24.50				
13	18	18	81.92	28.25				
13	20	20	84.04	30.37				
13	25	25	87.25	33.58				
13	30	30	94.08	40.41			4½	
13	35	35	98.17	44.50				
13	40	40	101.08	47.41				
13	45	45	105.00	51.33				
13	50	50	105.04	51.37				
14	00	60	105.00	51.33				
14	30	90	101.67	48.00			4	
15	00	120	99.00	45.33				
27/13	00	1440	87.33	33.66			3	Stop pump.

PUMP TEST – RECOVERY DATA

PROJECT MANZER - DISTRICT OF MISSION SUBDIVISION APPLICATION S90-07

27	NOVEMBER	1990
DAY	MONTH	YEAR

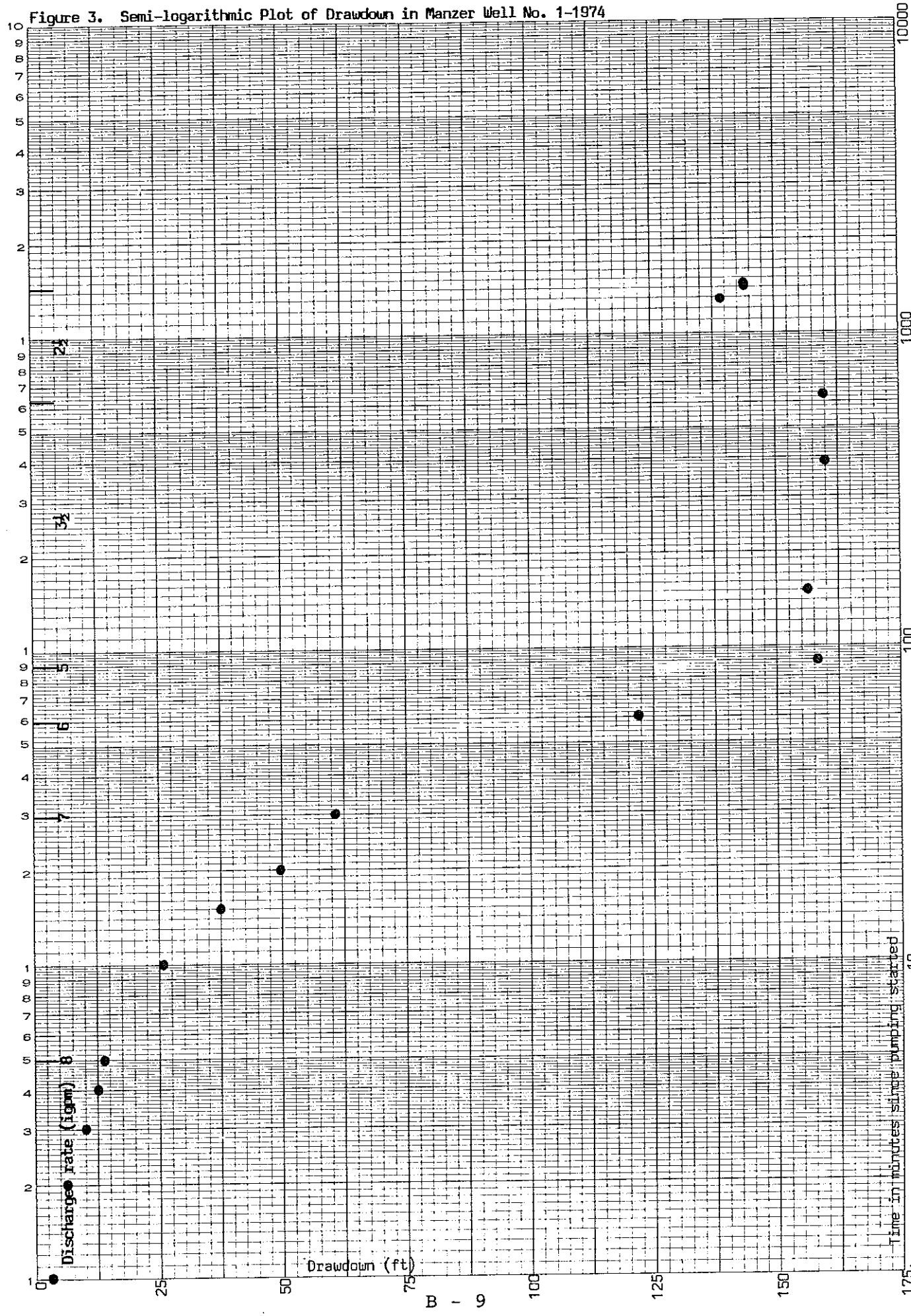
Well No. 3-1990

Datum Point Top of well casing Elevation of Datum Point 0.33 ft above ground

Static Water Level 53.67 ft (16.36 m) Final Drawdown 33.66 ft (10.26 m)

TIME		ELAPSED TIME SINCE PUMPING STARTED	ELAPSED TIME SINCE PUMPING STOPPED	RATIO (t/t')	DISTANCE TO WATER	RESIDUAL DRAWDOWN (ft)		REMARKS
HR.	MIN.	t (min.)	t' (min.)					
13	00	1440			87.33	33.66		Stop pump.
13	01	1441	1	1441	86.58	32.91		
13	02	1442	2	721	86.08	32.41		
13	03	1443	3	481	85.625	31.955		
13	04	1444	4	361	85.04	31.37		
13	05	1445	5	289	84.58	31.13		
13	06	1446	6	241	84.17	30.50		
13	07	1447	7	206.7	83.875	30.205		
13	08	1448	8	181	83.46	29.79		
13	09	1449	9	161	83.08	29.41		
13	10	1450	10	145	82.04	28.37		
13	12	1452	12	121	81.42	27.75		
13	14	1454	14	103.9	80.83	27.16		
13	16	1456	16	91	80.04	26.37		
13	18	1458	18	81	79.50	25.83		
13	20	1460	20	73	78.92	25.25		
13	25	1465	25	58.6	77.75	24.08		
13	30	1470	30	49	76.92	23.25		
13	35	1475	35	42.1	76.17	22.50		
13	40	1480	40	37	75.75	22.08		
13	45	1485	45	33	75.83	22.16		
13	50	1490	50	29.8	75.08	21.41		
14	00	1500	60	25	74.50	20.83		
14	30	1530	90	17	72.67	19.00		
15	00	1560	120	13	71.50	17.83		

Figure 3. Semi-logarithmic Plot of Drawdown in Manzer Well No. 1-1974



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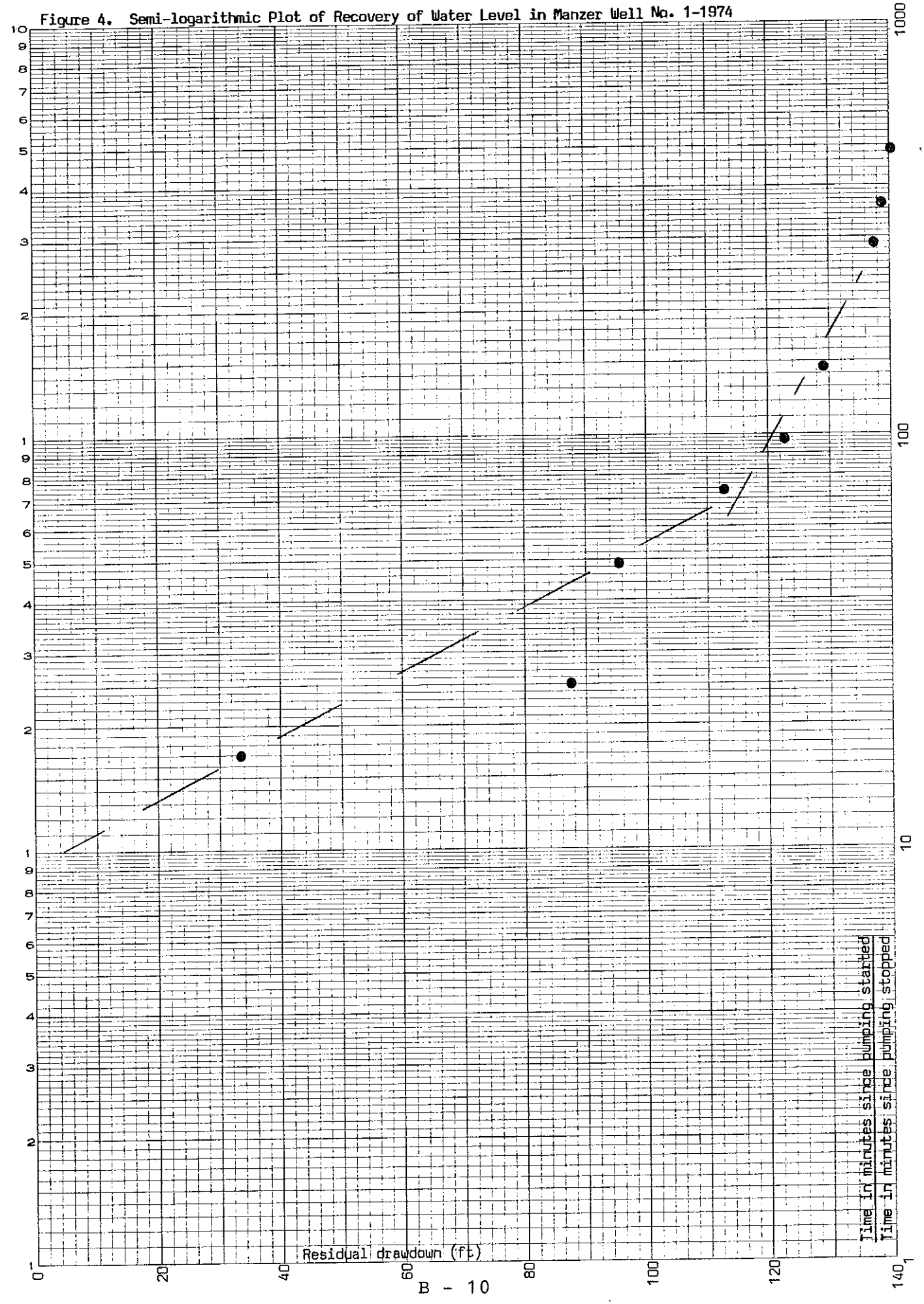
4 CYCLES X 10 DIVISIONS PER INCH

Figure 4. Semi-logarithmic Plot of Recovery of Water Level in Manzer Well No. 1-1974



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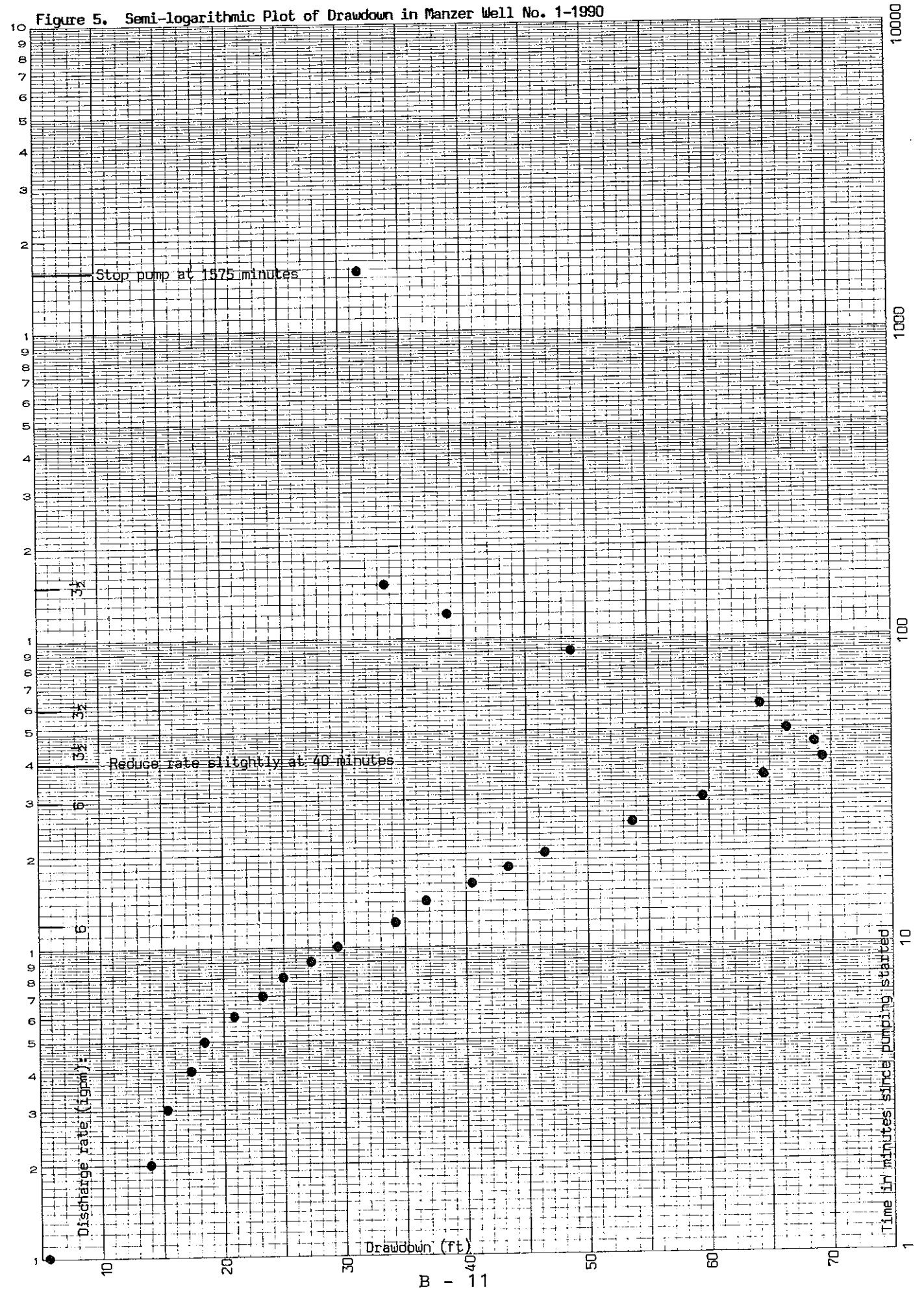
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

Figure 5. Semi-logarithmic Plot of Drawdown in Manzer Well No. 1-1990



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SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH

Figure 6. Semi-logarithmic Plot of Recovery of Water Level in Manzer Well No. 1-1990

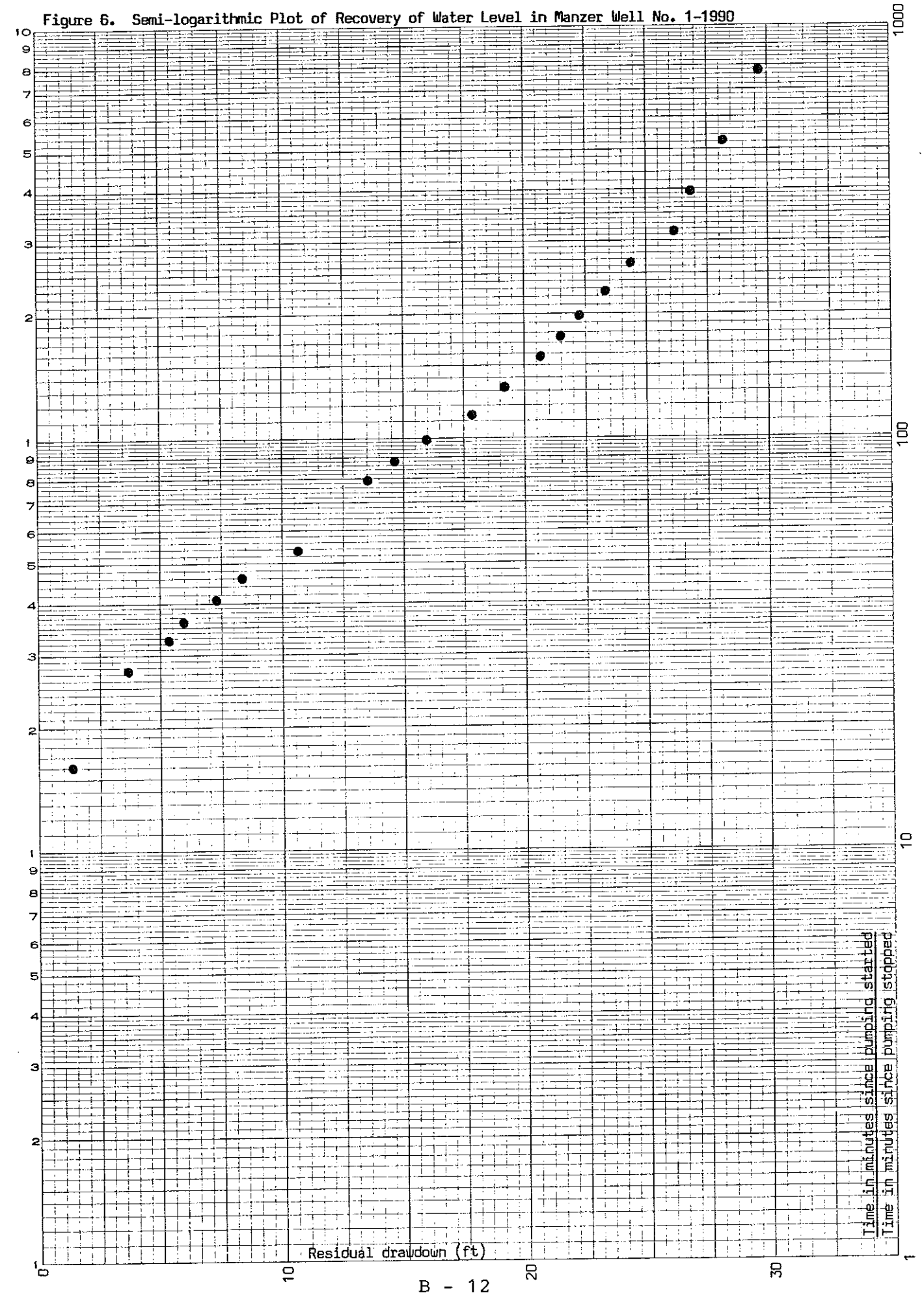
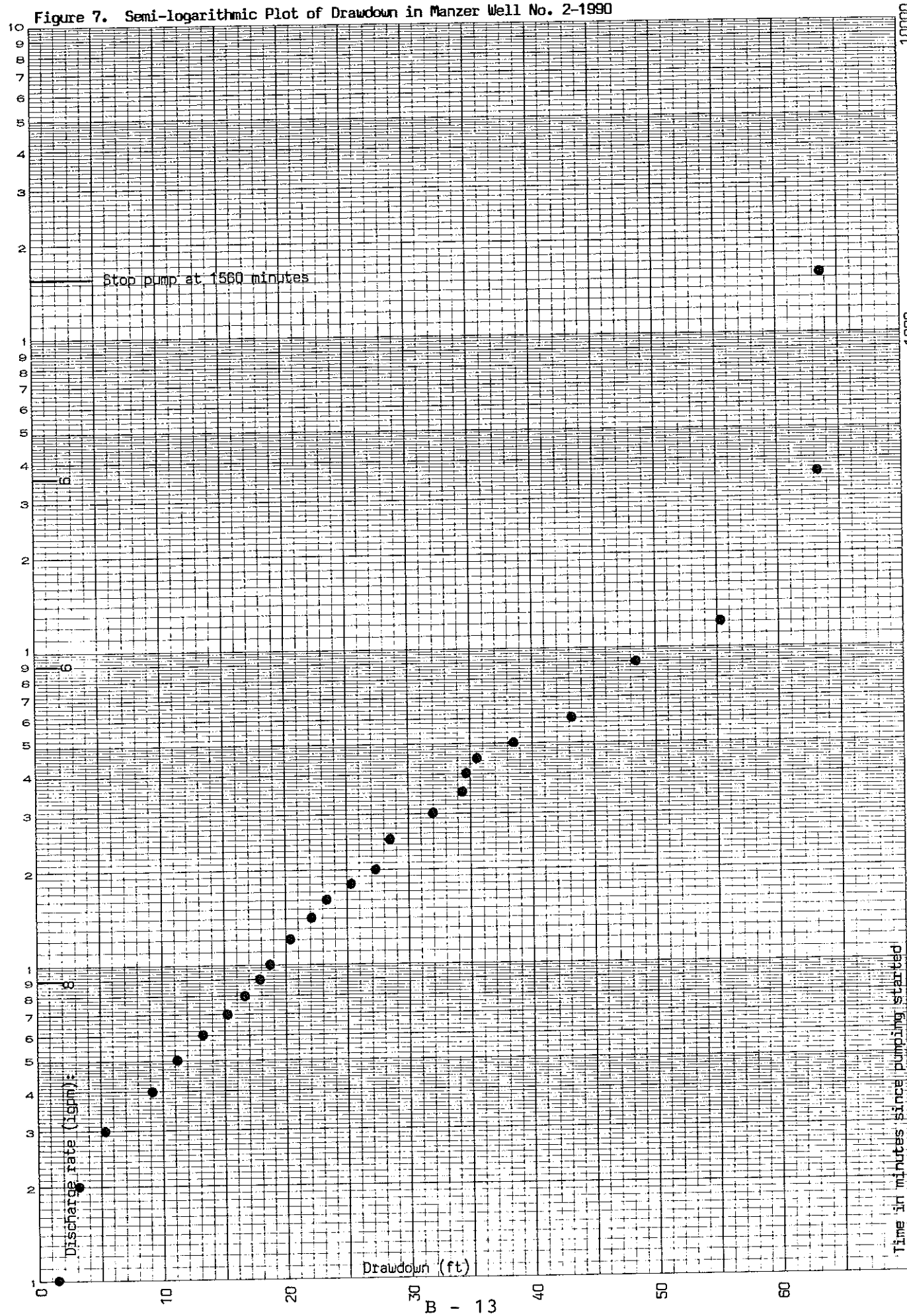


Figure 7. Semi-logarithmic Plot of Drawdown in Manzer Well No. 2-1990



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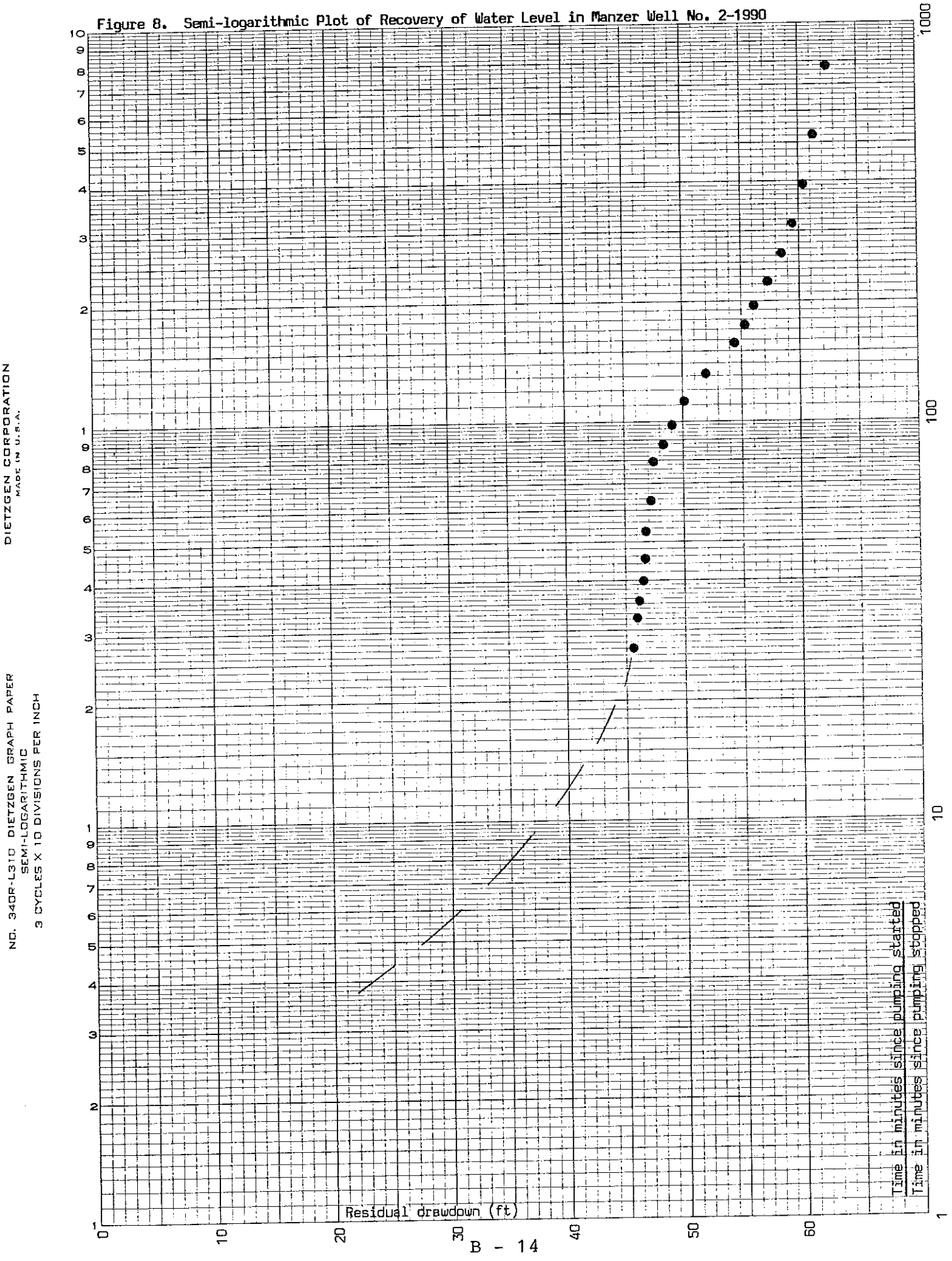
SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH

Figure 8. Semi-logarithmic Plot of Recovery of Water Level in Manzer Well No. 2-1990



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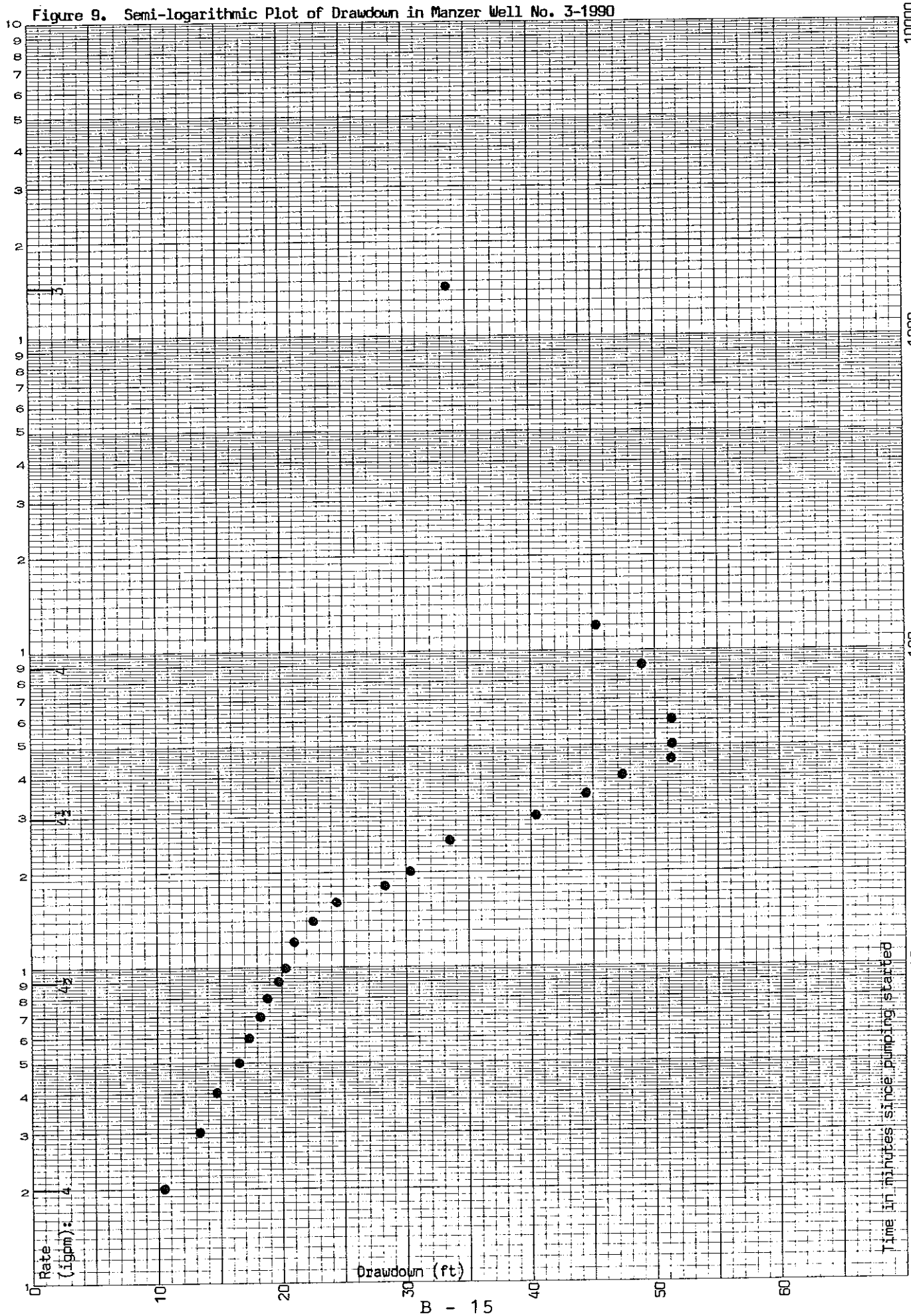
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

Figure 9. Semi-logarithmic Plot of Drawdown in Manzer Well No. 3-1990



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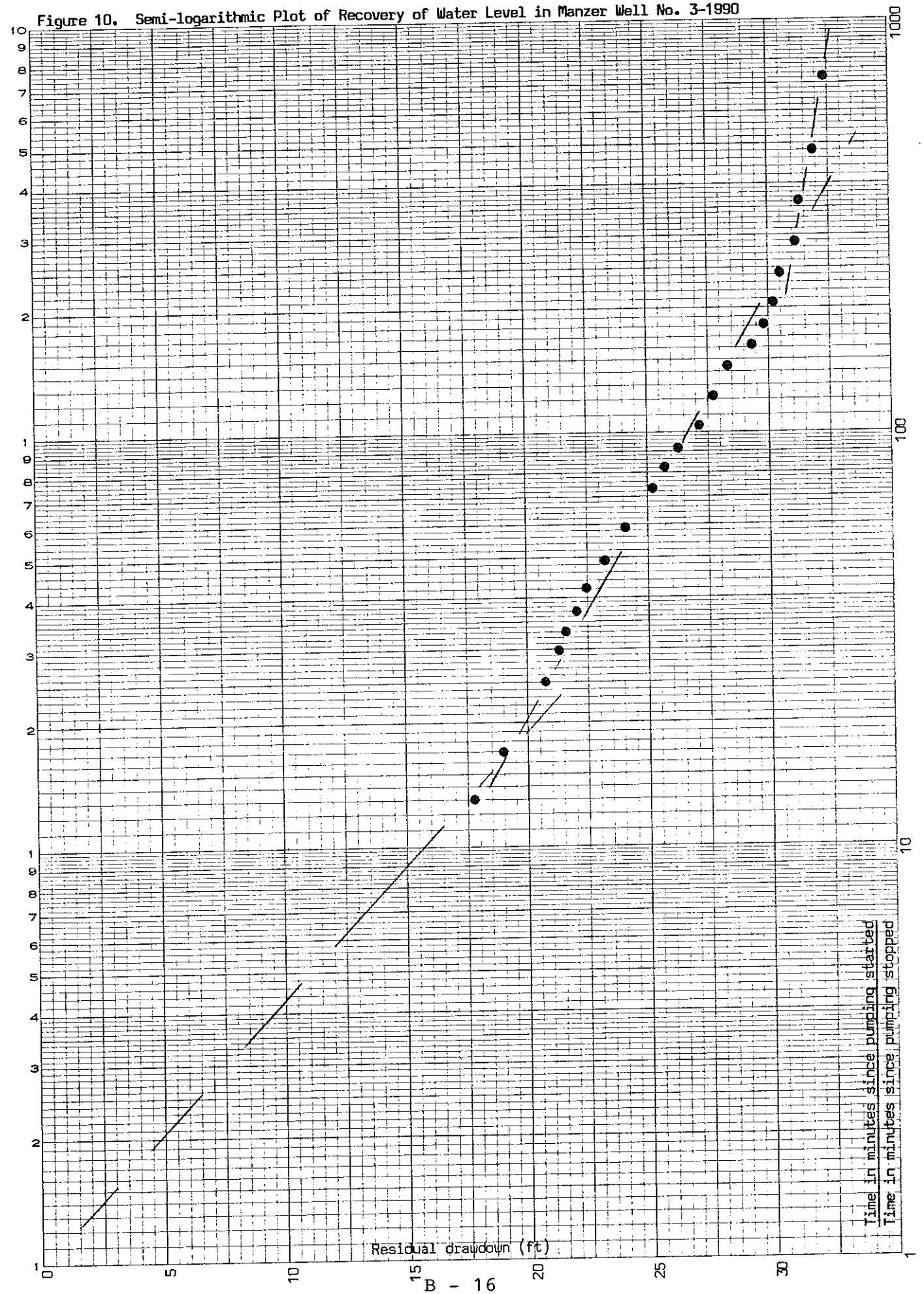
SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH

Figure 10. Semi-logarithmic Plot of Recovery of Water Level in Manzer Well No. 3-1990



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SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

APPENDIX C

GROUNDWATER QUALITY

JB Laboratories Ltd.
water/wastewaters

827 FORT STREET,
VICTORIA, B.C. V8W 1H6
TEL: (604) 385-6112
FAX: (604) 383-8099

DATE: October 5, 1990

JB 1439P930
JOB NO.: 11976
LR NO.:

Oct 3/90
SAMPLING DATE:

Client
SAMPLING AGENT:

The sample(s) submitted by the agent have been tested as requested and we report as follows:

Client: Manzer, Mr. M.
8611 Gaglardi Street
RR #2
Mission, B.C.
V2V 4H9

Sample: Sample # 1: Drilled Well - 8541 Gaglardi St., Missio Oct 3/90
Well No. 1-1974

			Sample 1
Tot Dissolved Solids	mg/L		125
Conductivity	umhos/cm		158
pH			7.7
Alkalinity	mg/L $CaCO_3$		74.8
Total Hardness	mg/L $CaCO_3$		33
Calcium	mg/L		12.0
Magnesium	mg/L		0.8
Iron	mg/L	<	0.1
Manganese	mg/L	<	0.02
Sodium	mg/L		21.0
Chloride	mg/L		5
Sulphate	mg/L		7
Fluoride	mg/L		0.10
Nitrite	mg/L N		0.012
Nitrate	mg/L N		0.68
Total Coliform	CFU/100ml	<	1

Note: Parameters analyzed are within the B.C. Water Quality Standards

John E. Evanoff, M.Sc. **Barbara M. Klassen,** B.Sc., C.Tech.

Analysis performed according to "A Laboratory Manual for the Chemical Analysis of Water, Wastewaters and Biological Tissues", Chemistry Laboratory, Water Resource Service and/or "Standard Methods/

Norwest Labs

203 - 20771 Langley By-Pass
Langley, B.C. V3A 5E8
Phone (604) 530-4344
Fax (604) 534-9996

Date: November 30, 1990

Work Order No.: 1395

Source of Sample:

Domestic Well Water from Monty Manzer
#1 Well - Gaglardi Road, Mission

CERTIFICATION OF POTABILITY

Norwest Soil Research Inc. certifies that the above mentioned water sample number 90-7133 supplied by A & H Construction meets the chemical and bacteriological requirements specified by the 1989 Guidelines for Canadian Drinking Water Quality for the constituents tested.

Sincerely,

Dr. Thomas F. Guthrie, P.Ag.
Laboratory Manager

TELEPHONE (604) 530-434
FACSIMILE (604) 534-99

NORWEST LABS

"Keeping B.C. Growing"

WATER ANALYSIS REPORT

W.O. NUMBER : 1395
LAB. NUMBER : 907133

SAMPLE RECEIVED : 11-27-1990
ANALYSIS COMPLETED : 11-30-1990
SAMPLE RETAINED FOR 30 DAYS

SAMPLE SUBMITTED BY :

A & H CONSTRUCTION
BOX 38
ABBOTSFORD, B.C. V2S 4N7

SAMPLE IDENTIFICATION : MONTY MANZER, #1 WELL GAGLARDI ROAD, MISSION

ANALYTICAL RESULTS			GUIDELINES FOR DRINKING WATER
pH	9.02		pH values between 6.5 & 8.5 considered acceptable
Electrical Conductivity	0.17	ms/cm	Values above 1.0 ms/cm indicate increasing salt content
Total Dissolved Solids	167	mg/l	Objective level 500 mg/l; higher values indicate high salts
Total Suspended Solids	6	mg/l	Values above 250 mg/l indicate increasing levels of sediment
Ammonium-N	0.0	mg/l	Acceptable values below 0.5 mg/l; objective level below 0.01 mg/l
Potassium	31.0	mg/l	No acceptable level set; values normally in the 0.5 to 10 mg/l range
Calcium	9.0	mg/l	Below 200 mg/l acceptable; objective level below 75 mg/l
Magnesium	2.2	mg/l	Below 150 mg/l acceptable; objective level below 50 mg/l
Sodium	58.0	mg/l	Below 300 mg/l acceptable; over 20 mg/l high for low sodium diets
Iron	0.40	mg/l	Above 0.3 mg/l may cause staining & deposits; objective limit 0.05 mg/
Copper	0.00	mg/l	Below 1.0 mg/l acceptable; objective limit below 0.01 mg/l
Zinc	0.04	mg/l	Below 5.0 mg/l acceptable; objective limit below 1.0 mg/l
Manganese	0.00	mg/l	Below 0.05 mg/l acceptable; objective limit below 0.01 mg/l
Phosphate-P	0.0	mg/l	No acceptable limit set; below 0.2 mg/l desirable
Sulphate-S	3.9	mg/l	Below 500 mg/l acceptable; objective limit below 250 mg/l
Nitrate-N	0.0	mg/l	Below 10 mg/l acceptable: high values may indicate contamination
Chloride	7.8	mg/l	Below 250 mg/l acceptable
Fluoride	0.73	mg/l	Values up to 1.2 mg/l desirable; under 1.5 mg/l acceptable
Boron	0.20	mg/l	Below 5.0 mg/l acceptable
Carbonate	5	mg/l	Presence indicates alkaline water
Bicarbonate	62	mg/l	Presence indicates mildly alkaline water
Hardness (CaCO3 equiv)	32	mg/l	Soft waters are less than 75 mg/l; hard waters above 150 mg/l
Total coliforms		2/100ml	Above 2/100 ml unacceptable
Fecal coliforms		0/100ml	Greater than 0/100ml unacceptable

Results quoted as zero indicate concentrations below the following detection limits:
Less than 0.01 mg/l Fe, Cu, Zn, Mn, B
Less than 0.05 mg/l Na, Ca, Mg, K, PO4-P, NH4-N, NO3-N
Less than 0.10 mg/l Cl, Fl, SO4-S; Less than 1 mg/l TDS, TSS, carbonate & bicarbonate

Norwest Labs

203 - 20771 Langley By-Pass
Langley, B.C. V3A 5E8
Phone (604) 530-4344
Fax (604) 534-9996

Date: November 30, 1990

Work Order No.: 1395

Source of Sample:

Domestic Well Water from Monty Manzer
#2 Well - Gaglardi Road, Mission

CERTIFICATION OF POTABILITY

Norwest Soil Research Inc. certifies that the above mentioned water sample number 90-7134 supplied by A & H Construction meets the chemical and bacteriological requirements specified by the 1989 Guidelines for Canadian Drinking Water Quality for the constituents tested.

Sincerely,

Dr. Thomas F. Guthrie, P.Ag.
Laboratory Manager

Note: all reports are the confidential property of our clients. Publication of statements, conclusions or extracts from or regarding our reports is not permitted without our written approval. Any liability attached thereto is limited to the fee charged.

TELEPHONE (604) 530-4344
FACSIMILE (604) 534-9998

NORWEST LABS

"Keeping B.C Growing"

WATER ANALYSIS REPORT

W.O. NUMBER : 1395
LAB. NUMBER : 907134

SAMPLE RECEIVED : 11-27-1990
ANALYSIS COMPLETED : 11-30-1990
SAMPLE RETAINED FOR 30 DAYS

SAMPLE SUBMITTED BY :

A & H CONSTRUCTION
BOX 38
ABBOTSFORD, B.C. V2S 4N7

SAMPLE IDENTIFICATION : MONTY MANZER #2 WELL, GAGLARDI ROAD, MISSION

ANALYTICAL RESULTS			GUIDELINES FOR DRINKING WATER
pH	9.03		pH values between 6.5 & 8.5 considered acceptable
Electrical Conductivity	0.15	ms/cm	Values above 1.0 ms/cm indicate increasing salt content
Total Dissolved Solids	143	mg/l	Objective level 500 mg/l; higher values indicate high salts
Total Suspended Solids	8	mg/l	Values above 250 mg/l indicate increasing levels of sediment
Ammonium-N	0.0	mg/l	Acceptable values below 0.5 mg/l; objective level below 0.01 mg/l
Potassium	2.1	mg/l	No acceptable level set; values normally in the 0.5 to 10 mg/l range
Calcium	5.0	mg/l	Below 200 mg/l acceptable; objective level below 75 mg/l
Magnesium	0.9	mg/l	Below 150 mg/l acceptable; objective level below 50 mg/l
Sodium	55.0	mg/l	Below 300 mg/l acceptable; over 20 mg/l high for low sodium diets
Iron	0.50	mg/l	Above 0.3 mg/l may cause staining & deposits; objective limit 0.05 mg/l
Copper	0.00	mg/l	Below 1.0 mg/l acceptable; objective limit below 0.01 mg/l
Zinc	0.02	mg/l	Below 5.0 mg/l acceptable; objective limit below 1.0 mg/l
Manganese	0.00	mg/l	Below 0.05 mg/l acceptable; objective limit below 0.01 mg/l
Phosphate-P	0.0	mg/l	No acceptable limit set; below 0.2 mg/l desirable
Sulphate-S	4.3	mg/l	Below 500 mg/l acceptable; objective limit below 250 mg/l
Nitrate-N	0.0	mg/l	Below 10 mg/l acceptable; high values may indicate contamination
Chloride	4.7	mg/l	Below 250 mg/l acceptable
Fluoride	0.74	mg/l	Values up to 1.2 mg/l desirable; under 1.5 mg/l acceptable
Boron	0.10	mg/l	Below 5.0 mg/l acceptable
Carbonate	5	mg/l	Presence indicates alkaline water
Bicarbonate	56	mg/l	Presence indicates mildly alkaline water
Hardness (CaCO3 equiv)	16	mg/l	Soft waters are less than 75 mg/l; hard waters above 150 mg/l
Total coliforms	1/100ml		Above 2/100 ml unacceptable
Fecal coliforms	0/100ml		Greater than 0/100ml unacceptable

Results quoted as zero indicate concentrations below the following detection limits:
Less than 0.01 mg/l Fe, Cu, Zn, Mn, B
Less than 0.05 mg/l Na, Ca, Mg, K, PO4-P, NH4-N, NO3-N
Less than 0.10 mg/l Cl, Fl, SO4-S; Less than 1 mg/l TDS, TSS, carbonate & bicarbonate

Norwest Labs

203 - 20771 Langley By-Pass
Langley, B.C. V3A 5E8
Phone (604) 530-4344
Fax (604) 534-9996

Date: November 30, 1990

Work Order No.: 1395

Source of Sample:

Domestic Well Water from Monty Manzer
#3 Well - Gaglardi Road, Mission

CERTIFICATION OF POTABILITY

Norwest Soil Research Inc. certifies that the above mentioned water sample number 90-7135 supplied by A & H Construction meets the chemical and bacteriological requirements specified by the 1989 Guidelines for Canadian Drinking Water Quality for the constituents tested.

Sincerely,

Dr. Thomas F. Guthrie, P.Ag.
Laboratory Manager