TABLE 2 SEEPAGE MEASUREMENTS ON THE IRON RIVER, NEAR IRON RIVER, MICHIGAN

Description of measuring point	Length of reach (miles)	Distance below upper measuring point (miles)	Oct. 17, 1945 Discharge sec.-ft.	Oct. 17, 1945 Gain	Oct. 17, 1945 Loss	Nov. 30, 1945 Discharge sec.-ft.	Nov. 30, 1945 Gain	Nov. 30, 1945 Loss	Mar. 2, 1946 Discharge sec.-ft.	Mar. 2, 1946 Gain	Mar. 2, 1946 Loss	Apr. 29, 1946 Discharge sec.-ft.	Apr. 29, 1946 Gain	Apr. 29, 1946 Loss	Sept. 19, 1946 Discharge sec.-ft.	Sept. 19, 1946 Gain	Sept. 19, 1946 Loss	Nov. 21, 1946 Discharge sec.-ft.	Nov. 21, 1946 Gain	Nov. 21, 1946 Loss	June 10, 1947 Discharge sec.-ft.	June 10, 1947 Gain	June 10, 1947 Loss
Iron River at bridge on County road 657 to Gibbs City		0.00	28.1			34.32			28.83			31.17			24.06			29.58			38.71		
Reach	0.57			1.1			0.87			0.68			0.81			0.25			0.52			1.15	
Iron River at Township Hall		.57	29.2			35.19			29.51			31.98			24.31			30.10			39.86		
Iron Lake Creek (inflow)			0			0			0			0			0			0			1.54		
Reach	1.42			2.6			2.26			3.00			1.95			2.51			3.68			2.01	
Iron River at C. & N.W. RR bridge in sec. 22		1.99	31.8			37.45			32.51			33.93			26.82			33.78			43.41		
Sunset Creek (inflow)			15.3			14.73			13.08			16.59			11.79			13.21			16.70		
Stanley Creek (inflow)			1.7			2.65			2.23			1.70			1.16			2.14			2.72		
Reach	2.55			4.5			7.28			1.02			4.32			1.96				.05		3.42	
Iron River at bridge on County road 653 to Mineral Hills		4.54	53.3			62.11			48.84			56.54			41.73			49.08			66.25		
Reach	.67				.3			2.63			0.17		1.01			1.15			1.14			4.04	
Iron River at bridge on 7th Street in Iron River		5.21	53.0			59.48			48.67			57.55			42.88			50.22			70.29		
James-Sherwood-Minckler Ditch (inflow)			.7			3.88			3.62			3.97			6.38			6.67			.74		
Spies-Virgil Ditch (inflow)			1.0			.92			1.33			.61			1.27			1.52			.73		
Reach	.66				.4		2.23			1.04			3.49			2.71			.82			4.94	
Iron River at bridge on East Genesee Street		5.87	54.3			66.51			52.58			58.64			47.82			59.23			66.82		
Iron River at township line below Hiawatha No. 2 mine		7.38													53.65			58.00			76.88		
Holmes Creek (inflow)															.47			.57			.92		
Caspian Shaft pumpage (inflow)															2.92			2.78			0		
Sewage - Brady Ave.															.01			.01			.01		
Reach	.85															1.04				3.28		2.77	
Iron River at bridge on East Caspian Ave.		8.23													58.09			58.08			80.58		
Baker Creek (inflow)															1.45			3.16			2.57		
Reach	.76															2.02			1.02			6.49	
Iron River at bridge on County road 424 to Gaastra		8.99													57.52			62.26			89.64		
Caspian sewer															.97			1.03			.99		
Buck mine pumpage and Gaastra sewer															.44			.38			.45		
Reach	1.99															1.66			5.59			3.79	
Iron River at footbridge near E¼ cor. sec. 13		10.98													60.59			69.26			94.87		
Reach	2.55															5.77			1.70			3.20	
Iron River, 500 feet above junction with Brule River		13.53													66.36			70.96			98.07		

TABLE 7. CHEMICAL ANALYSES OF GROUND WATER IN IRON RIVER DISTRICT, MICHIGAN

(Parts per million)

Well No.	Location	Date of collection	Elevation of sampling point above or below sea level U.S.G.S. datum	Formation	Specific conductance (K x10^5 at 25° C.)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Aluminum (Al)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Strontium (Sr)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Phosphate (PO_4)	Dissolved solids	Total hardness as $CaCO_3$	pH	Temp. °F.
SAMPLES COLLECTED AT LAND SURFACE																									
	T. 42 N., R. 34 W.																								
Buck mine #1	SE¼SE¼SW¼ sec. 6	2-7-47		Glacial drift	46.7	10.0	0.04	0.00	1.0	50	27	4.4	2.0		202	64	6.5	0.4	7.0		1	277	236	7.6	45
Village of Gaastra #1	SW¼SW¼NW¼ sec. 9	2-7-47		" "	41.3	10.0	.13	.25	.7	43	25	5.5	2.1		227	27	4.5	.2	4.5		1	236	210	8.1	45
	T. 42 N., R. 35 W.																								
Caspian shaft	SE¼NE¼ sec. 1	2-6-47		Bedrock and glacial drift	77.2	10.0	.10	.75	3.4						308	154	23.0		.8		0	308	154	7.1	45
Village of Caspian	NW¼SW¼NW¼ sec. 1	2-6-47		Glacial drift	30.7	13.0	.08	.00	.5	36	17	4.8	.9		171	20	3.0	.2	6.9		1	188	160	8.1	45
	T. 43 N., R. 34 W.																								
Bates mine #1	SW¼SW¼NW¼ sec. 19	2-6-47		" "	33.4	12.0	.09	.00	.5	32	18	6.1	1.7		171	20	4.2	.3	2.2		1	188	154	7.8	45
Bates Township #1	NE¼NE¼NE¼ sec. 28	2-6-47		" "	27.4	6.0	.10	.00	1.8						202	43	8.0		1.2		0	228	189	7.7	45
	T. 43 N., R. 35 W.																								
Homer Well #3	SW¼NE¼NE¼ sec. 22	2-5-47		" "	28.4	14.0	.09	.00	.2	33	14	5.2	1.2		159	17	2.2	.4	.8		0	166	140	7.7	45½
Cardiff shaft	SE¼NE¼NE¼ sec. 22	2-6-47		Infiltration gallery in bedrock	42.8	14.0	.13	.00	.3	42	22	15.0	1.8		188	65	3.5	.7	1.8		0	261	195	7.7	45
Homer Well #5	NE¼SW¼NE¼ sec. 22	2-6-47		Glacial drift	15.8	10.0	.10	.00	.5																
Homer Well #4	NW¼SE¼NE¼ sec. 22	2-6-47		" "	30.2	12.0	.20	.12	2.0						154	25	4.0		.5		2	168	144	8.0	45
Homer Well #8	NW¼SE¼NE¼ sec. 22	2-6-47		" "	24.0	11.0	.10	.25	.7						180	52	4.0		.5		2	224	196	7.7	45
Homer Well #2	SW¼SE¼NE¼ sec. 22	2-6-47		" "	29.2	10.0	.30	.25	1.9						159	29	4.0		.5		4	180	152	7.8	45
Homer Well #10	SW¼SE¼NE¼ sec. 22	2-6-47		" "	30.2	7.0	.30	.25	.3						168	67	8.0		.5		3	250	196	7.8	45
Sauerman Pit	SW¼SE¼NE¼ sec. 22	2-6-47		" "	61.6	14.0	.30	.00	1.6						195	74	10.0		.5		0	280	204	7.5	45
Homer Well #1	NW¼SW¼NW¼ sec. 23	2-6-47		" "	57.6	12.0	.45	.00	.4	66	30	6.7	3.0		228	143	12.0		11.0		0	442	196	7.3	47½
Homer Well #14	SW¼NE¼SW¼ sec. 23	2-5-47		" "	43.0	18.0	.08	.00	.6	48	24	5.0	3.0		220	112	5.8	.5	.8		1	363	288	7.4	45½
Homer Well #16	SE¼NE¼SW¼ sec. 23	2-5-47		" "	32.4	8.0	.10	.00	.5						189	69	2.8	.3	2.2		0	261	218	7.6	45
Homer Well #15	SW¼NW¼SE¼ sec. 23	2-5-47		" "	51.3	11.0	.20	.00	.4						193	59	6.0		1.2		3	250	196	7.8	45½
Homer Well #17	SW¼SW¼SE¼ sec. 23	2-5-47		" "	50.6	11.0	.09	.00	.7	56	28	8.5	3.0		206	128	6.0		2.0		2	368	272	7.7	45½
Village of Stambaugh #1	NW¼NE¼SE¼ sec. 25	2-6-47		" "	31.1	7.0	.10	.00	.5						230	73	6.8	.4	2.5		1	305	254	7.6	45½
City of Iron River #2	NW¼SE¼NE¼ sec. 26	2-6-47		" "	45.6	11.0	.13	.00	.9	50	26	6.8	2.2		211	40	6.0		2.0		0	232	189	7.8	47
Iron River Township #1	SW¼SW¼SE¼ sec. 27	2-6-47		" "	28.7	13.0	.10	.00	2.6						216	64	3.0	.3	.8		0	273	232	7.7	45
															177	9.7	4.0		3.0		0	166	144	7.8	46
SAMPLES COLLECTED BELOW LAND SURFACE																									
Homer, Minckler, Wauseca, mines																									
Drip from wall crosscut to north on 3rd level	1680S, 2760E of NW cor. sec. 23, T. 43 N. R. 35 W.	3-20-47	+1,303	Hanging wall	78.2	6.0	3.00	.00	1.9	90	47	10.0	4.8	1.7	207	259	3.5	.2	1.8	0.0	0	565	418	6.9	45½
Drip from blast hole in wall, air raise cross-cut 6th level	2550S, 2380E of NW cor. sec. 23, T. 43 N. R. 35 W.	3-20-47	+ 940	Oxidized formation	43.5	6.8	.21	.00	.9	47	23	7.7	5.4	1.0	191	70	2.2	.6	1.8	.5	0	261	212	7.1	
Flow from end of brest in large water vug on 9th level	1800E, 2720S of NW cor. sec. 23, T. 43 N. R. 35 W.	3-21-47	+ 454	Bottom of ore	58.2	9.2	.07	.12	1.2	76	23	11.0	4.8	1.1	188	142	8.0	.2	.5	.5	0	398	284	5.9	47
Flow from long drill hole 877 to south	2750S, 2910E of NW cor. sec. 23, T. 43 N. R. 35 W.	3-20-47	+ 660	Footwall	111.0	6.5	3.40	.28	5.3	175	21	56.0	12.0	.5	88	535	21.0	.6	1.0	.9	0	930	523	6.2	50½
Hiawatha mine																									
Drip from wall 10' SW of air raise south of shaft on 7th level	522N, 1883W of SE cor. sec. 35, T. 43 N. R. 35 W.	3-12-47	+ 777	Hanging wall	69.0	4.8	1.80	.00	2.1	114	28	11.0	3.6	1.4	301	171	2.0	.2	.5	.46	0	506	400	7.5	51
Drip from wall at junction main drift with north cross cut on 3rd level	3300W, 800N of SE cor. sec. 35, T. 43 N. R. 35 W.	3-12-47	+1,221	Oxidized formation	26.8	7.1	.07	.00	.6	34	14	2.0	1.6	.2	154	19	1.2	.2	.8	.00	0	157	142	7.9	44
Flow from drill hole HL 45 on 18th level in H8 stope area	472N, 1450W of SE cor. sec. 35, T. 43 N. R. 35 W.	3-12-47	- 566	Bottom of ore	223.0	10.0	3.40	.00	5.3	249	64	76.0	11.0	3.8	161	148	550.0	.2	1.8	.46	0	1,200	884	7.2	62½
*Flow from drill hole 301 on 3rd level north of shaft	1050N, 1970W of SE cor. sec. 35, T. 43 N. R. 35 W.	3-12-47	+1,196	*Footwall	52.4	4.0	.72	.00	.22	60	28	7.6	2.6	.7	177	128	4.0	.2	.5	.00	0	337	264	7.5	46½
Baltic, Fogarty, Zimmerman mines																									
Drip from wall in long drift to east from Baltic 10th level -- Zimmerman	1030S, 2620E of NW cor. sec. 7, T. 42 N. R. 34 W.	3-24-47	+ 611	Hanging wall	45.8	5.2	.08	.02	1.10	38	34	7.8	3.4	.6	231	59	2.8	.2	1.5	.50	0	268	235	7.8	53
Drip from wall on 10th level south of shaft-- Baltic	860E, 350S of NW cor. sec. 7, T. 42 N. R. 34 W.	3-24-47	+ 608	Oxidized formation	42.4	5.2	.09	.00	.90	21	22	5.8	4.2	.4	121	54	1.8	.6	1.5	.90	0	178	143	7.3	55
Drip from wall in drift east of shaft 11th level - Fogarty	350E, 240N of NW cor. sec. 7, T. 42 N., R. 34 W.	3-24-47	+ 462	Bottom of ore	54.2	8.4	.43	.00	1.30	32	31	24.0	5.9	1.1	90	125	43.0	.6	1.8	1.40	0	338	208	7.2	53
Drip from wall in storage drift west of shaft 11th level -- Fogarty	170N, 550W of NW cor. sec. 7, T. 42 N., R. 34 W.	3-24-47	+ 465	Footwall	473.0	1.0	.10	.20	6.30	228	146	454.0	14.0	3.8	57	38	1,480.0	.6	.2	.90	0	2,400	1,170	7.0	53

*Additional information obtained since the time of sampling, indicates this drill hole penetrates the hanging wall sequence.

Direction	Location
(1) S. 3° W.	NW¼SE¼ sec. 21, T. 42 N., R. 35 W., about 1,000 feet NE of farm house. (See note at end of table.)
S. 1° W.	
(2) S. 4° W.	300 feet east of (1).
S. 5° W.	
S. 7° W.	
(3) S. 5° W.	600 feet ENE of (2).
S. 6° W.	
S. 13° W.	
(4) S. 7° W.	About 100 feet west of farm house referred to in (1).
S. 8° W.	
S. 11° W.	
(5) S. 8° W.	SW¼ sec. 36, T. 43 N., R. 35 W., about 400 feet south of Stambaugh High School. (See note.)
(6) S. 14° W.	About 100 feet SW of new school addition; and north of (5).
(7) S. 34° W.	NW¼NE¼ sec. 13, T. 42 N., R. 35 W.
(8) S. 0° W.	NE¼SW¼ sec. 8, T. 44 N., R. 35 W., on summit of high outcrop ½ mile west of Gibbs City; striae and chattermarks convex to north.
(9) S. 43° W.	SW¼ sec. 13, T. 45 N., R. 37 W., outcrop on east edge of Forest Highway
S. 48° W.	
S. 51° W.	
(10) S. 81° W.	Center of sec. 19, T. 43 N., R. 31 W., in cut of road to Michigamme Falls, 1.9 miles north of State Highway 69.
S. 83° W.	
(11) (a) S. 86° W.	SW¼ sec. 19, T. 43 N., R. 31 W., 1.25 miles north of State Highway 69 on same road as (10). (See note.)
S. 84° W.	
S. 81° W.	
S. 79° W.	
(b) S. 41° W.	Earlier striae on same outcrops as (a).
S. 48° W.	
(12) S. 83° W.	SW¼ sec. 18, T. 43 N., R. 31 W., NW of Mansfield
S. 81° W.	
(13) S. 20° E.	Center of sec. 2, T. 46 N., R. 37 W., on east side of road.
S. 35° E.	
(14) S. 52° E.	NW¼ sec. 2, T. 46 N., R. 37 W., on prominent moutonnee on hill south of creek and old slate quarry.
(15) S. 30° E.	South of center of sec. 9, T. 46 N., R. 37 W., deep grooves in outcrop on NW side of road.
S. 35° E.	

(1) These grooves on ,"roche moutonnee" outcrops of greenstone breccia are accompanied by faint tail-like ridges of the greenstone trending south from light-colored inclusions in the breccia. The inclusions obviously offered greater resistance to glacial abrasion and buttressed the tails of greenstone in their lee.

(5) A few crescentic chatter marks on this outcrop at the south end of the athletic field are convex to the north, affirming southerly ice movement.

(11) The striae listed in (b), showing a much more southerly direction of ice movement than those in (a), are found only in small remnant patches en the west slopes of outcrops where they were not eradicated by the later abrasional work which product the striae listed in (a).

Table 1. Direction and location of observed glacial striae.

Date	Flow at upper weir, gpm	Pumpage inflow within reach, gpm	Outflow at lower end, gpm	Gain (+) or loss (-), gpm
11-30-45	128	3,220	3,300	-48
3-2-46	345	3,055	3,260	-135
4-29-46	2,390	3,120	4,880	-630
9-18-46	381	3,227	3,649	+41
9-20-46	685	3,213	3,807	-92
9-29-46	628	3,196	3,850	+26
9-30-46	528	3,210	3,769	+31
10-1-46	489	3,178	3,679	+12
10-2-46	465	3,223	3,666	-22
10-4-46	433	3,326	3,773	+14
10-5-46	422	3,162	3,704	-120
10-6-46	404	3,183	3,645	+58
10-11-46	459	3,307	3,668	-97
10-12-46	402	3,277	3,655	-24
10-13-46	386	3,326	3,521	-191
10-14-46	390	3,330	3,542	-178
10-18-46	413	3,348	3,602	-59
10-19-46	395	3,254	3,628	-31
10-20-46	383	3,189	3,519	-53
10-21-46	390	3,256	3,560	-94
10-22-46	391	3,238	3,518	-111
10-23-46	388	3,253	3,441	-200
11-21-46	406	3,020	3,780	-254
6-10-47	3,360	3,198	5,880	-678

Table 3. Gains and Losses in Sunset Creek.

Date	Flow at upper weir, gpm	Pumpage inflow within reach, gpm	Outflow at lower end, gpm	Loss, gpm
4-15-46	191	1,605	1,710	86
4-16-46	173	1,600	1,685	88
4-17-46	185	1,600	1,680	95
4-18-46	162	1,600	1,690	72
4-19-46	207	1,605	1,700	112

Table 4. Gains and Losses in James-Sherwood-Minckler ditch.

Time since flow started (hours)	Vessel No. 1	Vessel No. 2	Vessel No. 3
Clear water	252	47.5	169
2	166.2	33.3	97.2
5	52.2	31.8	54.8
24	27.7	21.5	27.8
30	23.5	18.2	22.3
48	18.8	14.6	18.8

98	10.4	8.9	11.3
124	9.3	6.8	9.8
148	7.9	6.4	8.0
196	6.8	5.5	6.7
267	5.2	4.9	5.1
316	4.5	4.4	4.3
364	3.7	3.6	3.6
460	3.2	2.9	3.1
628	3.1	2.9	3.0

Table 5. Percolation Rates in Gallons per Day per Square Foot at 60° F. in Permeameter Experiment.

	Above ledge			Below ledge		
Year	Public Supplies	Mineral Hills	Else-where	Mineral Hills	Else-where	Total
1936	513	6,324	No data	3,270	1,632	11,739
1937	531	5,623	No data	1,399	1,572	9,125
1938	491	6,075	1,429	1,336	1,857	11,188
1939	465	6,275	1,943	1,489	1,785	11,957
1940	507	6,029	1,057	1,936	1,842	11,371
1941	575	5,964	2,067	1,987	1,870	12,463
1942	742	7,092	1,963	2,271	1,917	13,985
1943	658	8,300	2,042	2,487	1,812	15,299
1944	631	7,902	397	2,387	1,340	12,657
1945	694	7,259	1,306	2,504	1,377	13,140
1946	690	7,904	2,010	2,671	1,239	14,514
1947	831	6,030	3,429	2,151	2,196	14,637

Table 6. Estimated average pumpage from Iron River district, in gallons a minute.

$\pi(Y_o \pm Y)M$	X/M										
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0	-∞	-1.3103	-.7199	-.3851	-.1605	0	.1169	.2008	.2574	.2903	.3010
1.	-.2651	-.2277	-.1342	-.0200	.0914	.1884	.2677	.3286	.3714	.3969	.4054
2.	.4413	.4489	.4703	.5016	.5382	.5754	.6097	.6385	.6600	.6733	.6778
3.	.9575	.9598	.9666	.9768	.9894	1.0029	1.0161	1.0275	1.0365	1.0421	1.0441
4.	1.4201	1.4209	1.4232	1.4268	1.4314	1.4363	4.4412	1.4455	1.4490	1.4512	1.4519
5.	1.8646	1.8649	1.8657	1.8670	1.8687	1.8705	1.8723	1.8739	1.8752	1.8760	1.8763
6.	2.3026	2.3027	2.3030	2.3035	2.3041	2.3048	2.3054	2.3060	2.3065	2.3068	2.3069
7.	2.7382	2.7383	2.7384	2.7386	2.7388	2.7390	2.7393	2.7395	2.7397	2.7398	2.7398
8.	3.1730	3.1730	3.1731	3.1732	3.1732	3.1733	3.1734	3.1735	3.1736	3.1736	3.1736
9.	3.6075	3.6075	3.6075	3.6075	3.6075	3.6076	3.6076	3.6077	3.6077	3.6077	3.6077

For all values of X/M

	$\pi(Y_o \pm Y)M$		$\pi(Y_o \pm Y)M$		$\pi(Y_o \pm Y)M$
10.	4.042	20.	8.385	30.	12.728
11.	4.476	21.	8.819	31.	13.162
12.	4.910	22.	9.253	32.	13.596
13.	5.345	23.	9.688	33.	14.030

14.	5.779	24.	10.122	34.	14.465
15.	6.213	25.	10.566	35.	14.899
16.	6.648	26.	10.990	36.	15.333
17.	7.082	27.	11.425	37.	15.768
18.	7.516	28.	11.859	38.	16.202
19.	7.950	29.	12.293	39.	16.636

Table 8. Values of function log10 [$\cos\pi(Y_o \pm Y) / M - \cos\pi X/M$].

Depth	At footwall	At middle of aquifer	At hanging wall
0	0	0	0
100	-90	-90	-90
200	-179	-179	-179
300	-270	-269	-268
400	-365	-358	-353
500	---	-433	-417
600	-455	-448	-442

Table 9. Hydraulic potentials, in feet of water, in a vertical aquifer 157 feet wide with a long drift 15.7 feet wide at the footwall, 500 feet below ledge; negligible head of water above outcrop.

	Negligible head of water above ledge			200 feet of water above ledge		
Depth	Footwall	Middle	Hanging wall	Footwall	Middle	Hanging wall
0	0	0	0	200	200	200
100	10	10	10	174	174	174
200	21	21	21	149	149	149
300	30	31	32	122	123	125
400	35	42	47	89	98	106
450	26	50	61	57	89	105
500	--	67	83	--	95	116
550	81	105	116	96	123	130

Table 10. Pressures, in feet of water, in vertical aquifer 157 feet wide, with drift 15.7 feet wide along the footwall, 500 feet below ledge.

	Depth of water above ledge (feet)		
	0	100	200
Single drift 200 feet below ledge:	122 P	183 P	244 P
Drifts at 200 feet and 100 feet below ledge:			
200 feet	112 P	140 P	167 P
100 feet	26 P	107 P	189 P
Drifts at 200 feet and 300 feet below ledge:			
200 feet	31 P	104 P	145 P

300 feet	114 P	100 P	125 P

Table 11. Relative discharge per unit length in long drifts 15.7 feet wide, at footwall, at different levels in vertical aquifer 157 feet wide.

		Length of opening (feet)				
Depth below ledge (feet)	Drill hole 2 ½" diameter	200	400	600	1,000	2,000
100	83	437				
200	152	600	874			
300	216	755	1,040	1,310		
500	341	1,050	1,360	1,640	2,180	
1,000	635	1,700	2,100	2,420	3,000	4,370
1,400	855	2,190	2,640	3,000	3,630	5,000

Table 12. Approximate ratio of total flow to transmissibility in vertical aquifer with a long opening at various depths below ledge.

Sunset Creek Well Field					
Date of test	Pumped well	Observation well	Coef-ficient of trans-missibility (gpd/ft.)	Coef-ficient of storage	Duration of test (days)
11-22-45	Homer Well 1	Homer Well 6	17,100	0.045	11
	"	Test " 23	10,600	.081	11
	"	Cardiff " 8	21,300	.021	11
	"	Test " 17	17,900	.0123	11
1-15-46	Homer Well 2	Cardiff " 8	42,800	.011	18
	"	Homer Well 9	50,200	.047	18
9-18-45	Homer Well 4	Cardiff " 8	24,200	.147	18
7-26-46	"	"	24,400	.0007	¼
South Homer-Minckler Well Field					
10-19-45	Homer Well 15	Test Well 33	93,200	.113	6
	"	Homer Well 17	155,000	.060	6
11-3-45	Homer Well 17	Test Well DD 2	215,000	.207	100
	"	" DD 3	207,000	.216	100
	"	" DD 4	235,000	.158	100
	"	" DD 5	210,000	.189	100
	"	" DD 6	186,000	.211	100
	"	" DD 7	195,000	.192	100
	"	" 32	274,000	.385	100
Iron River City Well					
1-15-46	Iron River	Iron River	75,000	.130	1

	Well	Test Well			

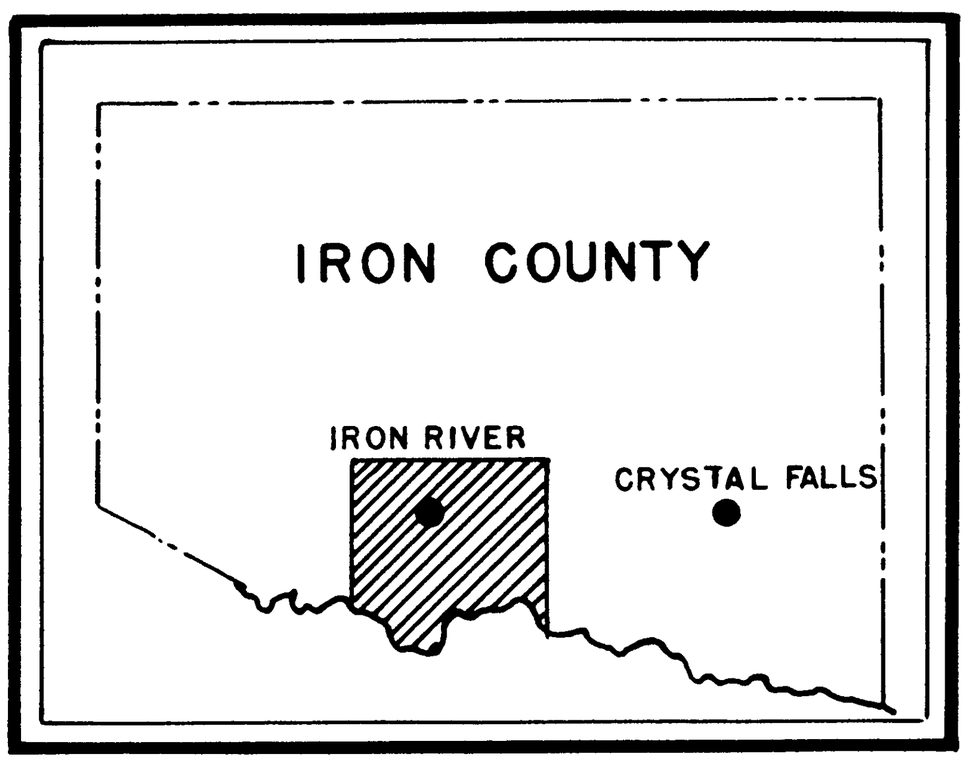
Table 13. Coefficients of transmissibility and storage of the glacial overburden as computed from pumping tests in Mineral Hills Area.

Time in days of continu-ous pumping.	2½ inches	4 inches	6 inches	12 inches	24 inches	60 inches	10 feet	50 feet	100 feet	200 feet
1	0.81	0.86	0.91	1.00	1.12	1.32	1.53	2.43	3.25	4.92
10	.83	.88	.92	1.00	1.10	1.26	1.42	2.00	2.44	3.13
100	.85	.89	.93	1.00	1.08	1.21	1.34	1.78	2.04	2.44
1,000	.86	.90	.94	1.00	1.07	1.19	1.30	1.63	1.84	2.11
10,000	.88	.91	.94	1.00	1.07	1.17	1.25	1.54	1.69	1.89

Table 14. Ratio of yield of wells of various diameters to that of a well 12 inches in diameter.

Time in days of continu-ous pumping.	2½ inches	4 inches	6 inches	12 inches	24 inches	60 inches	10 feet	50 feet	100 feet	200 feet
1	1.24	1.16	1.10	1.00	0.90	0.76	0.65	0.41	0.31	0.20
10	1.20	1.14	1.09	1.00	.91	.79	.70	.50	.41	.32
100	1.17	1.12	1.08	1.00	.93	.82	.74	.56	.49	.41
1,000	1.16	1.11	1.07	1.00	.93	.84	.77	.61	.54	.48
10,000	1.14	1.10	1.06	1.00	.94	.86	.80	.65	.59	.53

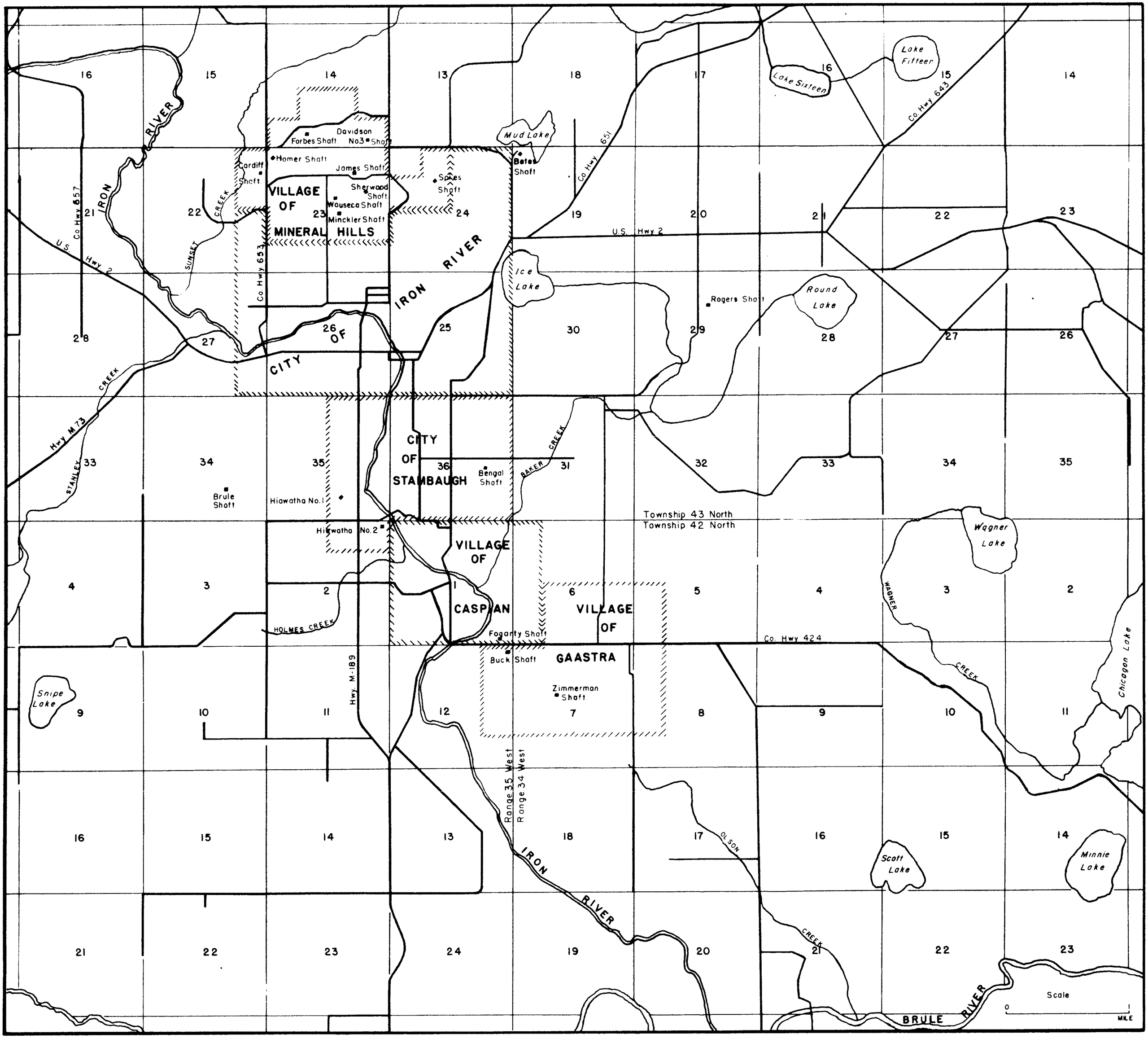
Table 15. Ratio of drawdown in wells of various diameters to that in a well 12 inches in diameter.



Iron River district.

FIGURE 1

INDEX MAP OF MICHIGAN SHOWING LOCATION OF IRON RIVER DISTRICT IN IRON COUNTY.


IRON RIVER
Co. Hwy 657
U.S. Hwy 2
SUNSET CREEK
Co. Hwy 653
Forbes Shaft
Davidson No3 Shaft
Homer Shaft
Cardiff Shaft
James Shaft
Sherwood Shaft
Wauseca Shaft
Minckler Shaft
Spies Shaft
VILLAGE OF MINERAL HILLS
Mud Lake
Bates Shaft
Co. Hwy 651
Lake Sixteen
Lake Fifteen
Co. Hwy 643
U.S. Hwy 2
Ice Lake
Rogers Shaft
Round Lake
CITY OF IRON RIVER
CREEK
Hwy M 73
STANLEY
CITY OF STAMBAUGH
Bengal Shaft
BAKER CREEK
Brule Shaft
Hiawatha No. 1
Hiawatha No. 2
Township 43 North
Township 42 North
Wagner Lake
VILLAGE OF CASPIAN
VILLAGE OF GAASTRA
HOLMES CREEK
Fogarty Shaft
Buck Shaft
Zimmerman Shaft
Co. Hwy 424
WAGNER CREEK
Chicagon Lake
Snipe Lake
Hwy. M-189
Range 35 West
Range 34 West
OLSON CREEK
IRON RIVER
Scott Lake
Minnie Lake
BRULE RIVER
Scale
0
1
MILE

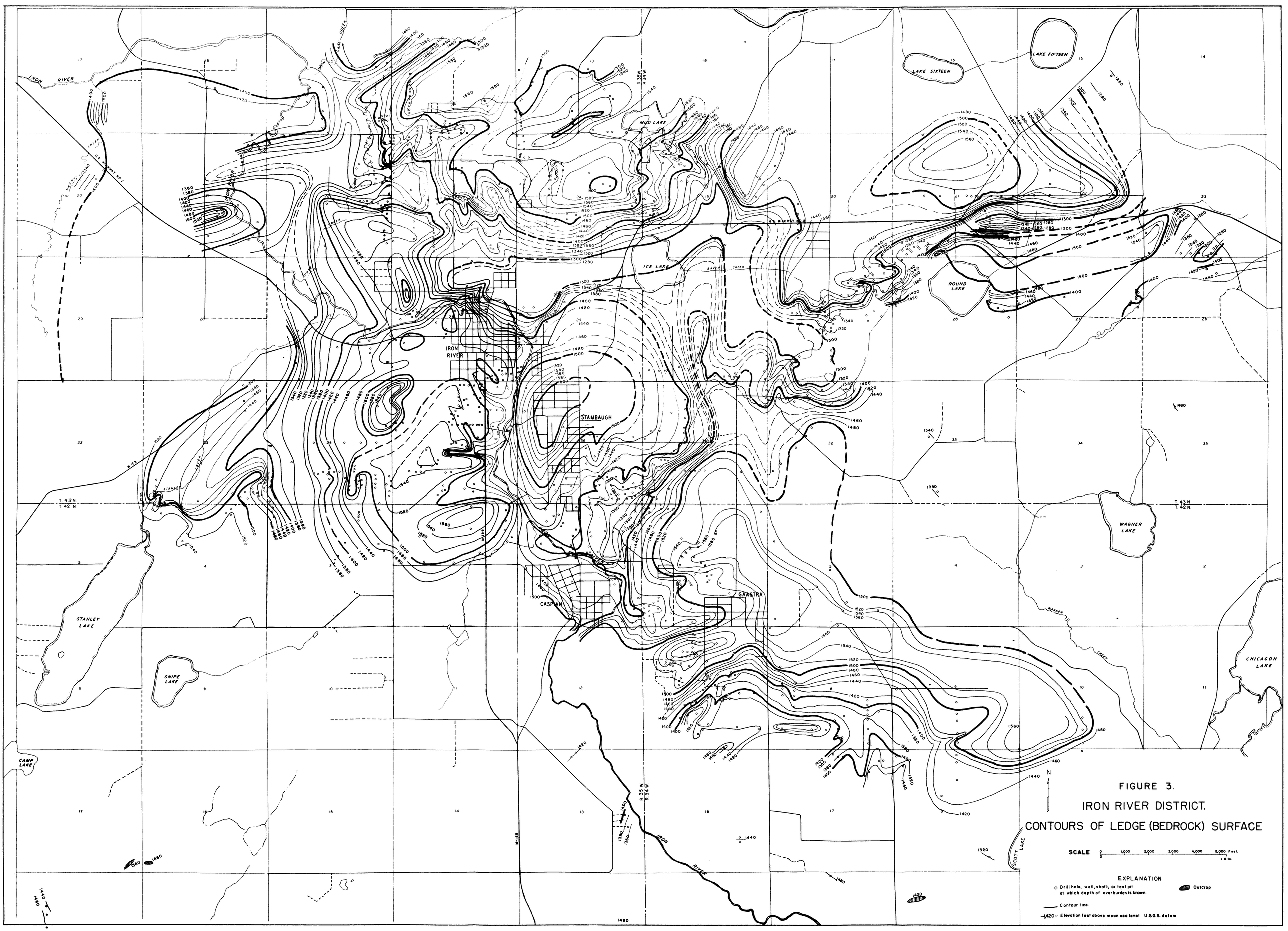


FIGURE 3.

IRON RIVER DISTRICT.

CONTOURS OF LEDGE (BEDROCK) SURFACE

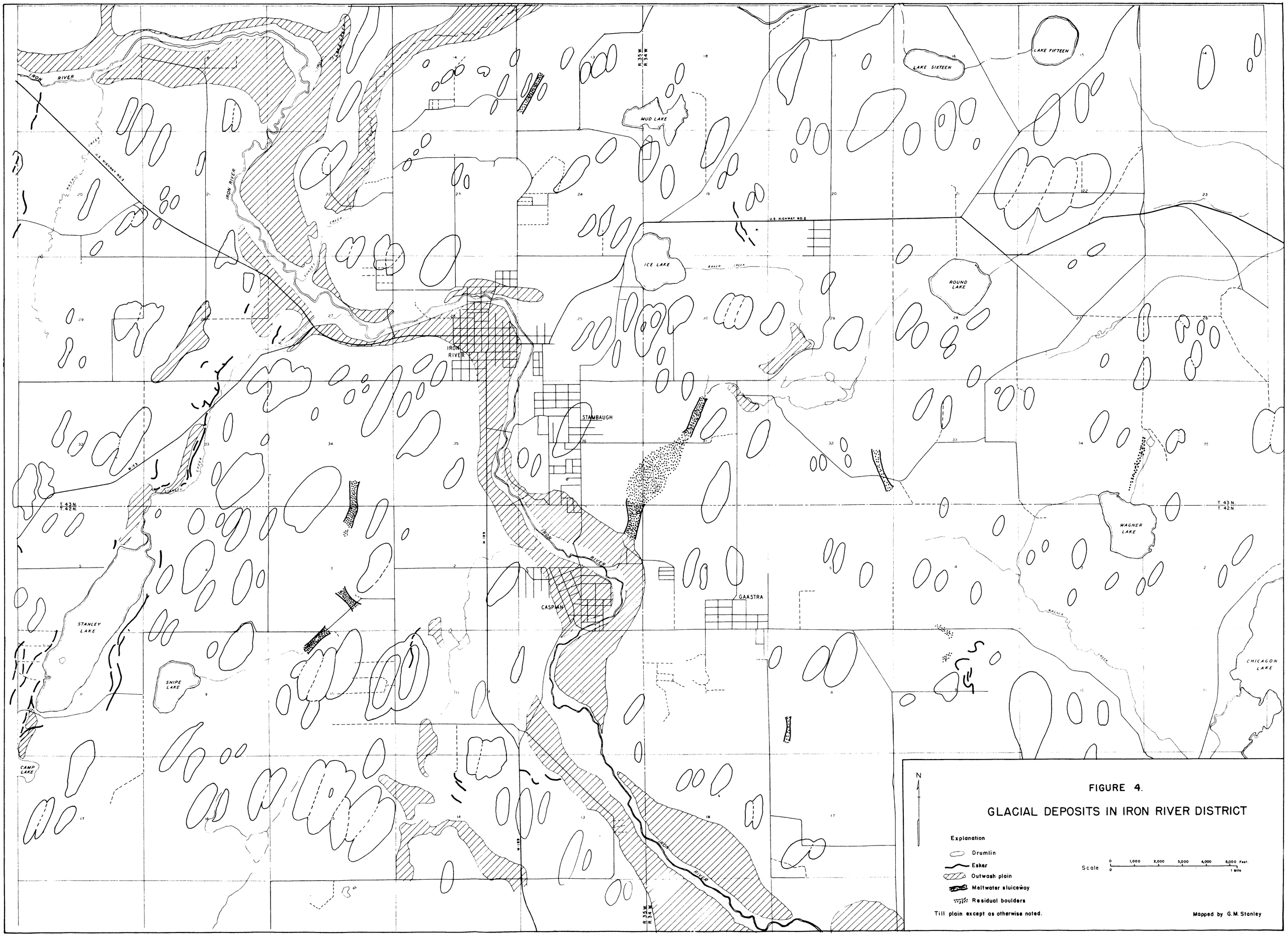


FIGURE 4.

GLACIAL DEPOSITS IN IRON RIVER DISTRICT

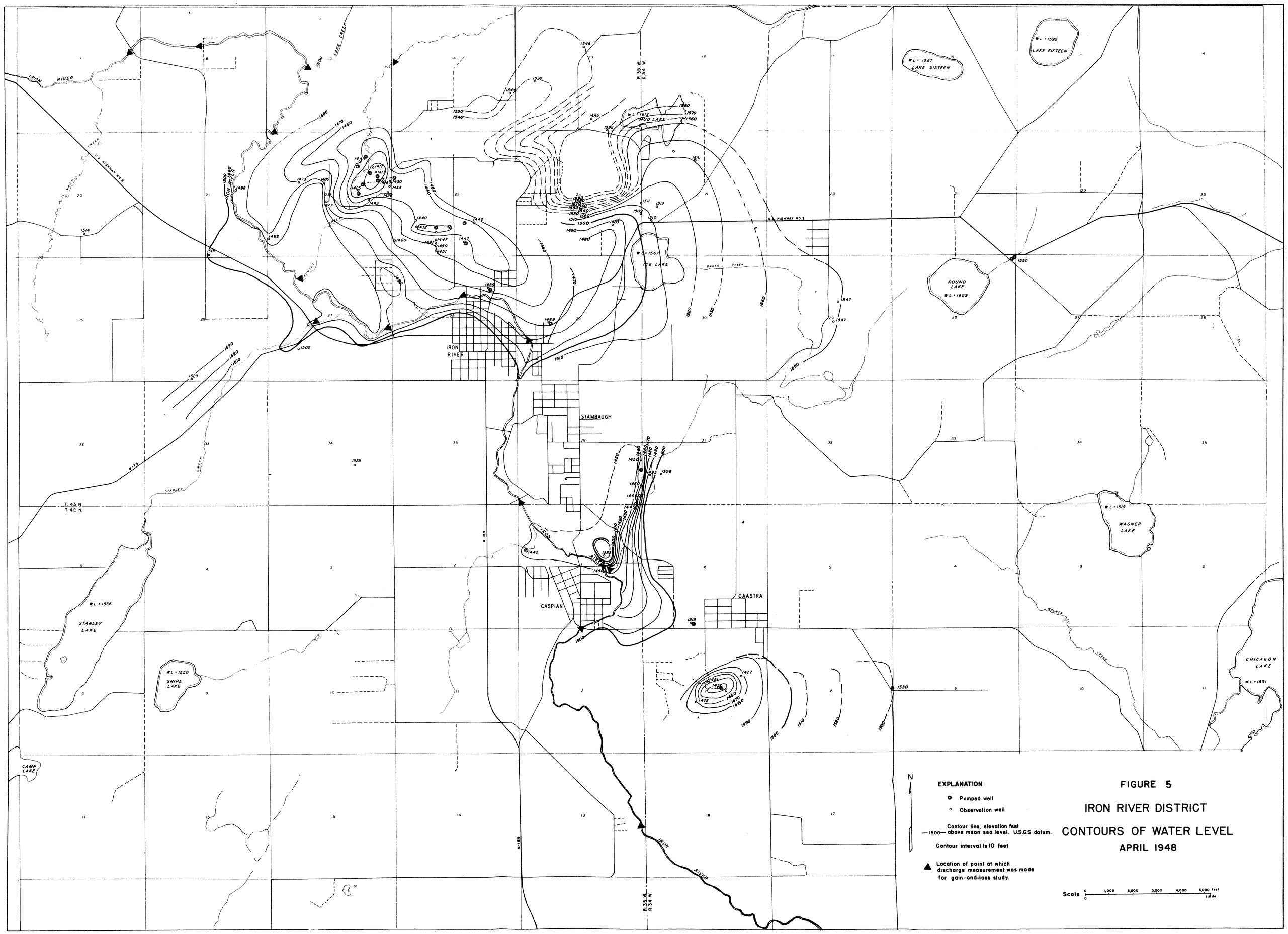


FIGURE 5

IRON RIVER DISTRICT

CONTOURS OF WATER LEVEL

APRIL 1948

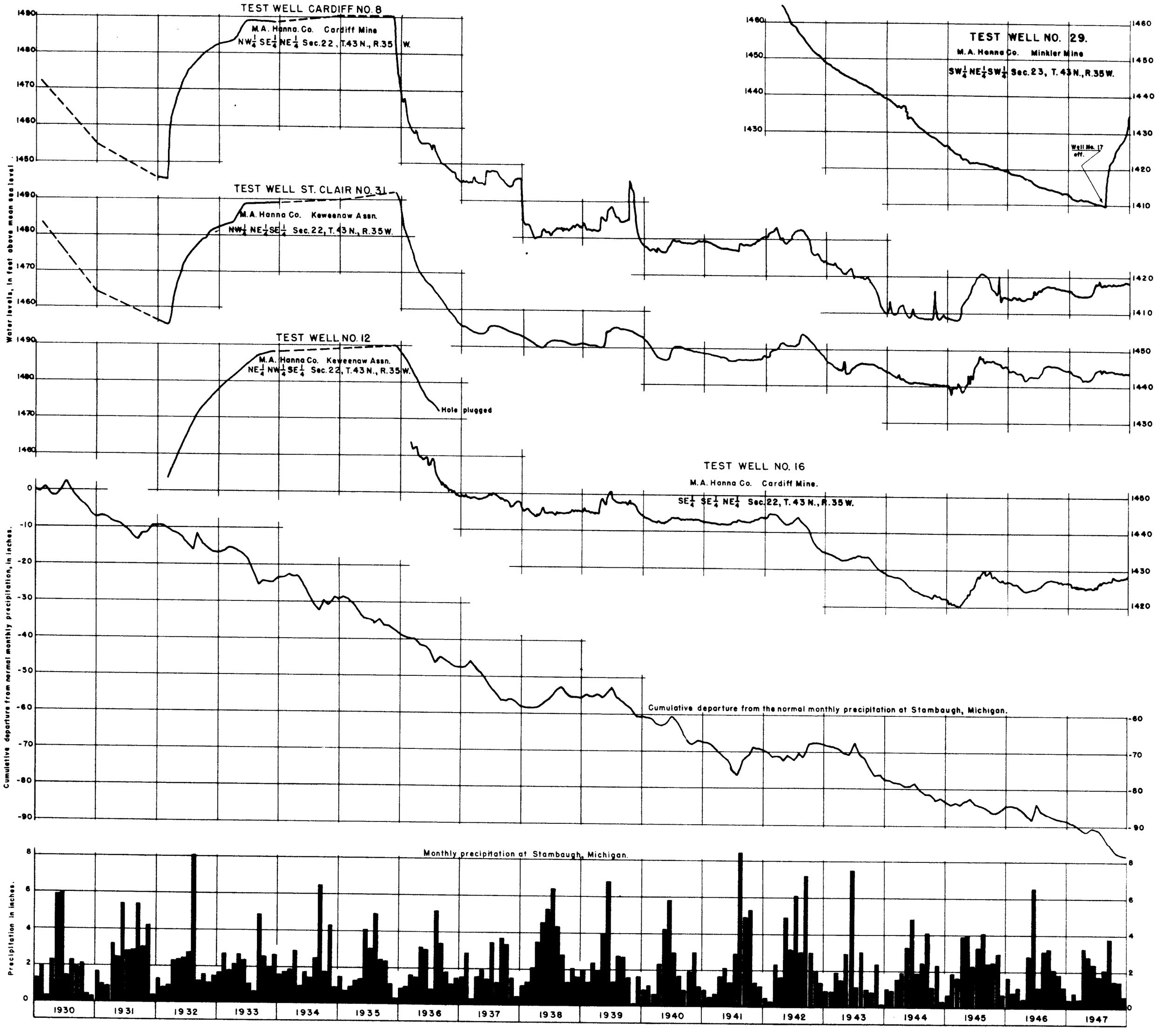


FIGURE 6. GRAPHS SHOWING FLUCTUATIONS OF WATER LEVELS AND PRECIPITATION, IRON RIVER DISTRICT.

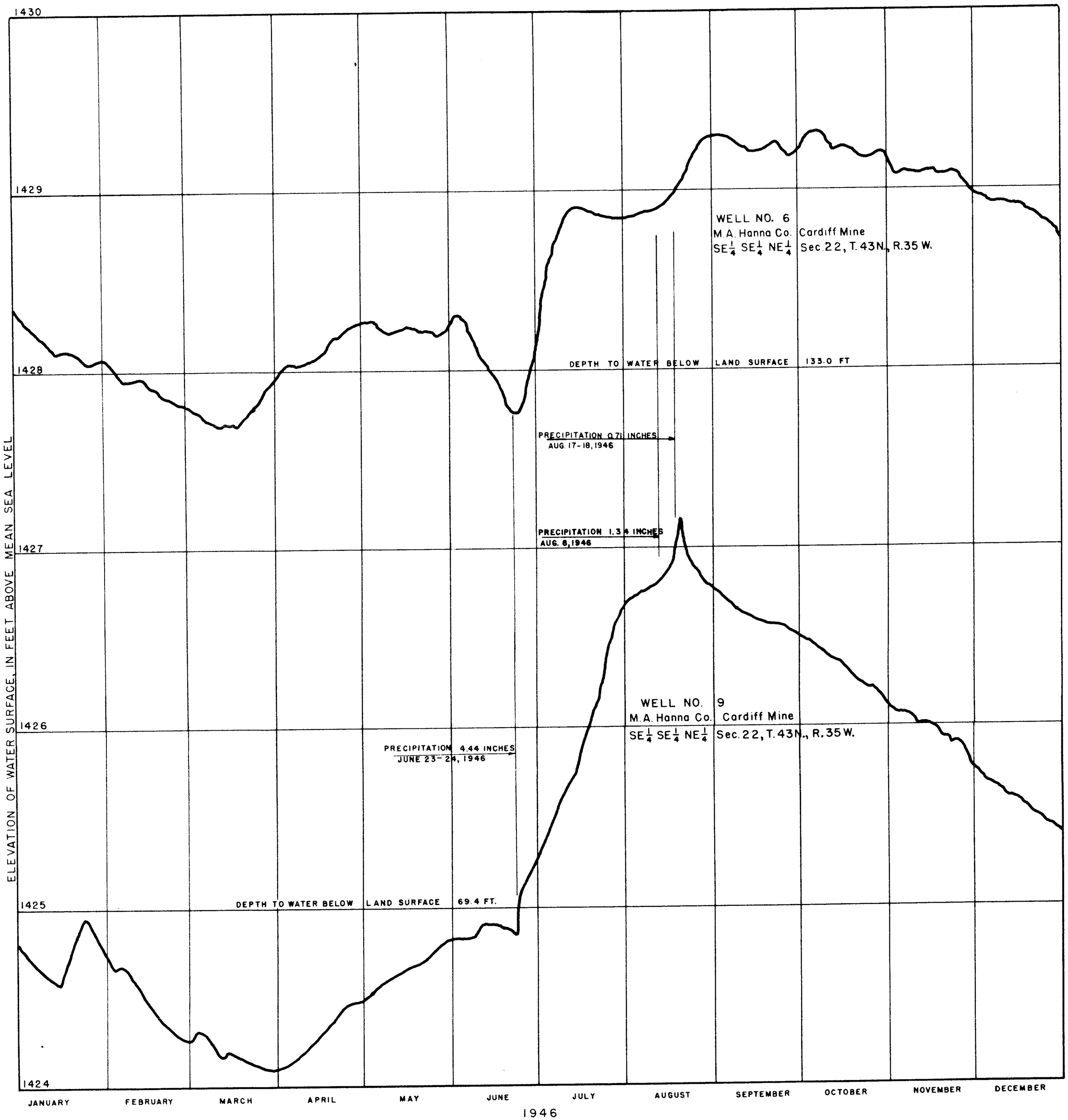


FIGURE 7. Hydrographs of wells showing rise resulting from a rainstorm and accompanying stream runoff.

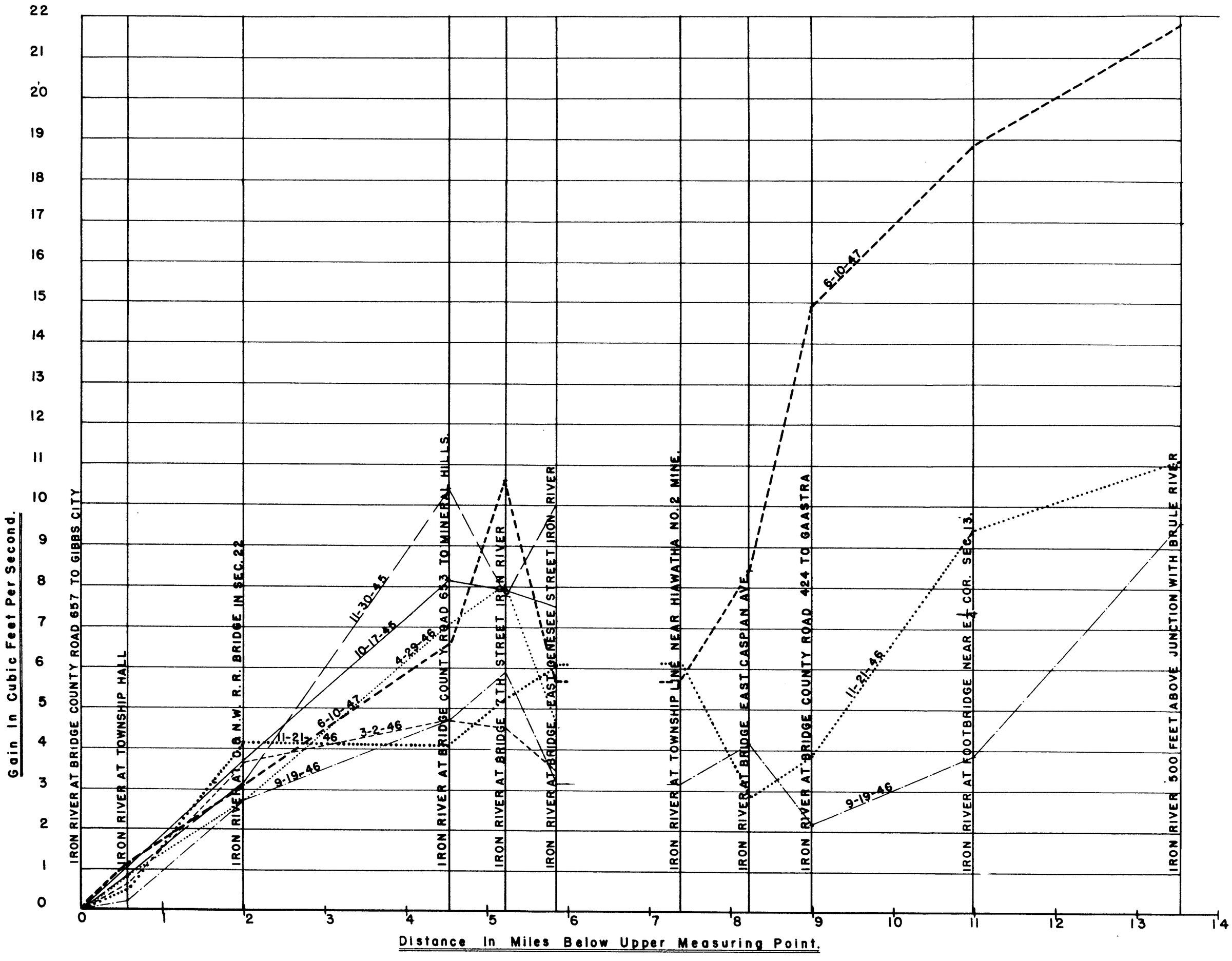
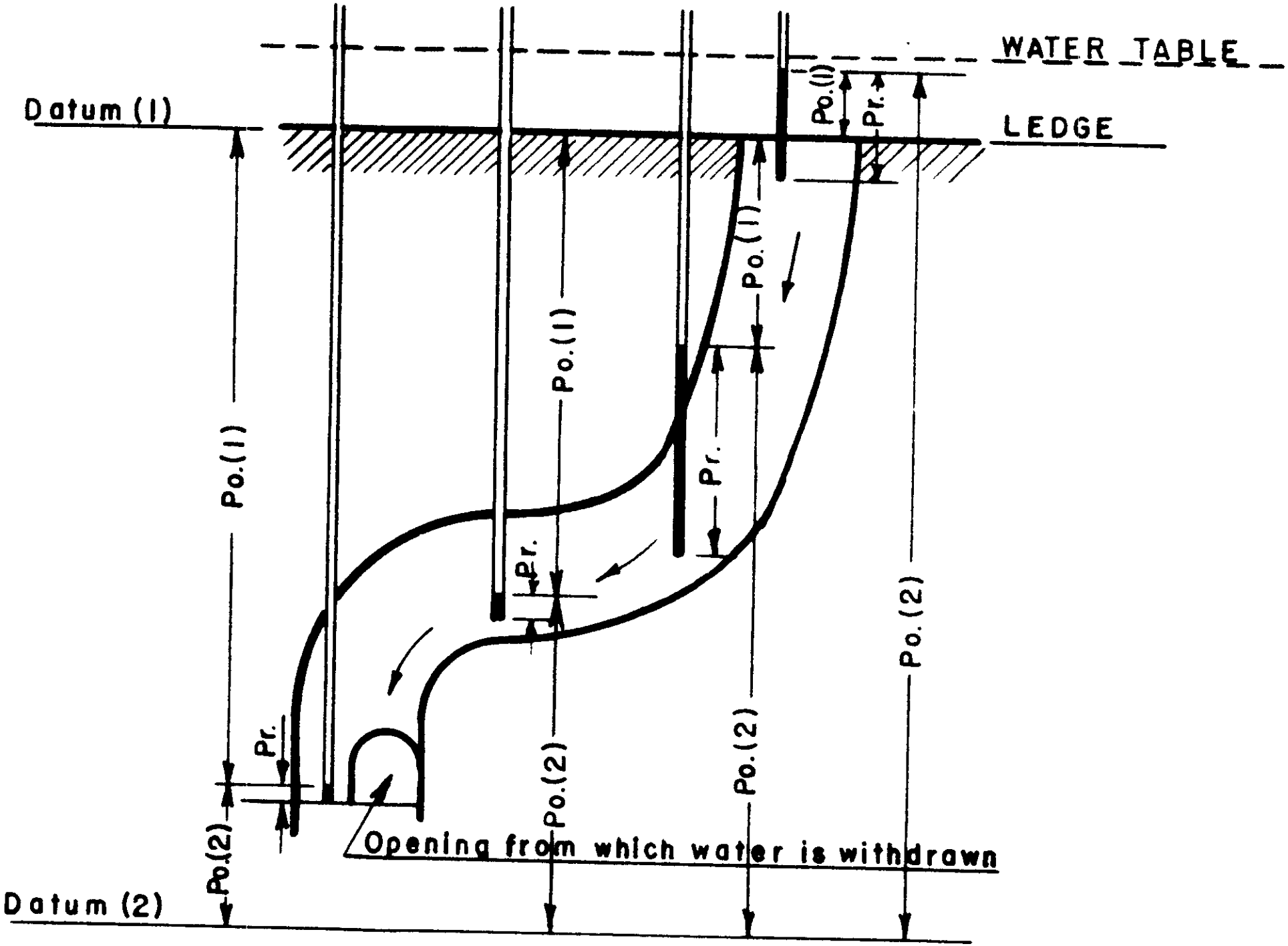
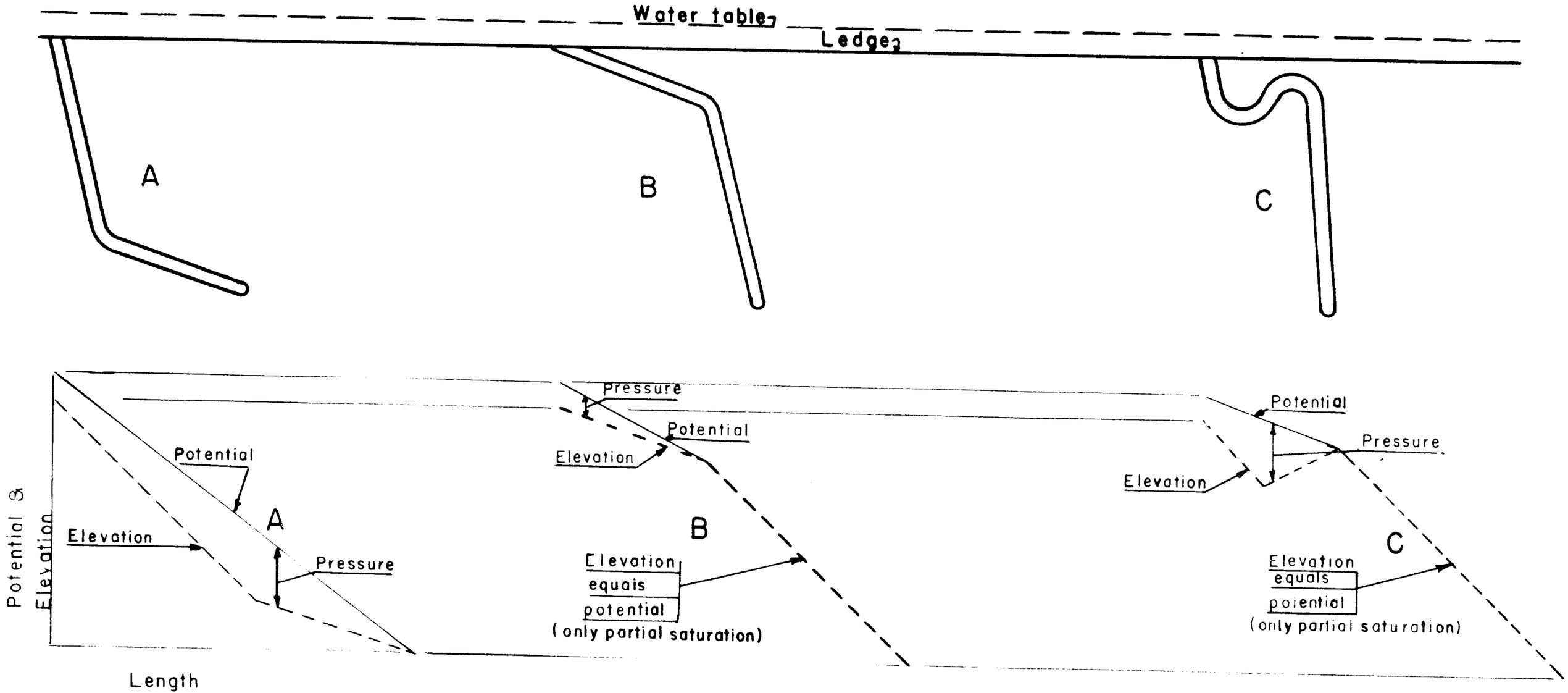
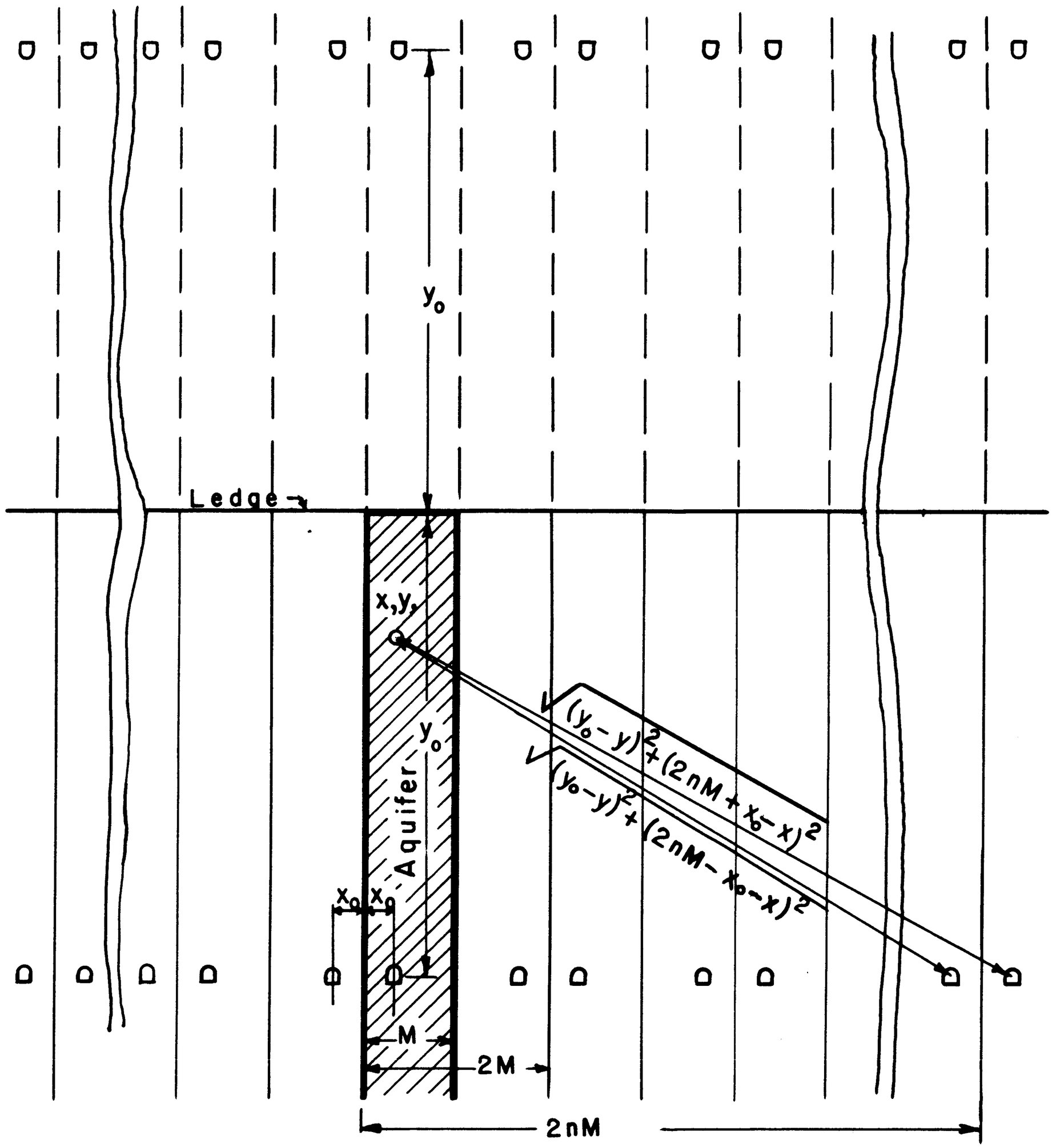


FIGURE 8. CUMULATIVE GAINS AND LOSSES, IRON RIVER NEAR IRON RIVER, MICHIGAN.


WATER TABLE
Datum (1)
LEDGE
Po.(1)
Pr.
Po.(1)
Pr.
Po.(1)
Po.(1)
Pr.
Pr.
Po.(2)
Po.(2)
Po.(2)
Po.(2)
Pr.
Opening from which water is withdrawn
Datum (2)

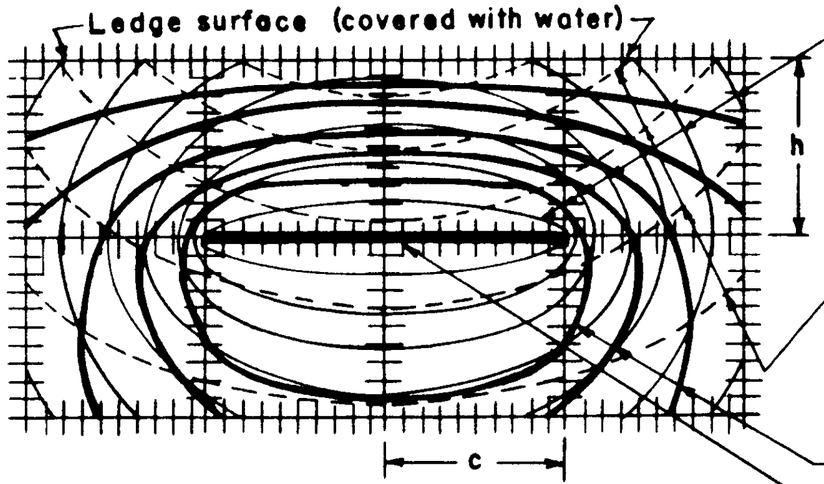

Water table
Ledge
A
B
C
Potential & Elevation
Length
Potential
Elevation
Pressure
Elevation equals potential
(only partial saturation)



for $X_o = 0$;

$$v = v_e + (2.3\,F/2\pi P)\left\{\log_{10}\left[\cosh \pi\,(y_o - y)/M - \cos \pi x/M\right] - \log_{10}\left[\cosh \pi\,(y_o + y)/M - \cos \pi x/M\right]\right\}$$

FIGURE 10. Image system for a long drift in a vertical aquifer sub-outcropping under saturated overburden.



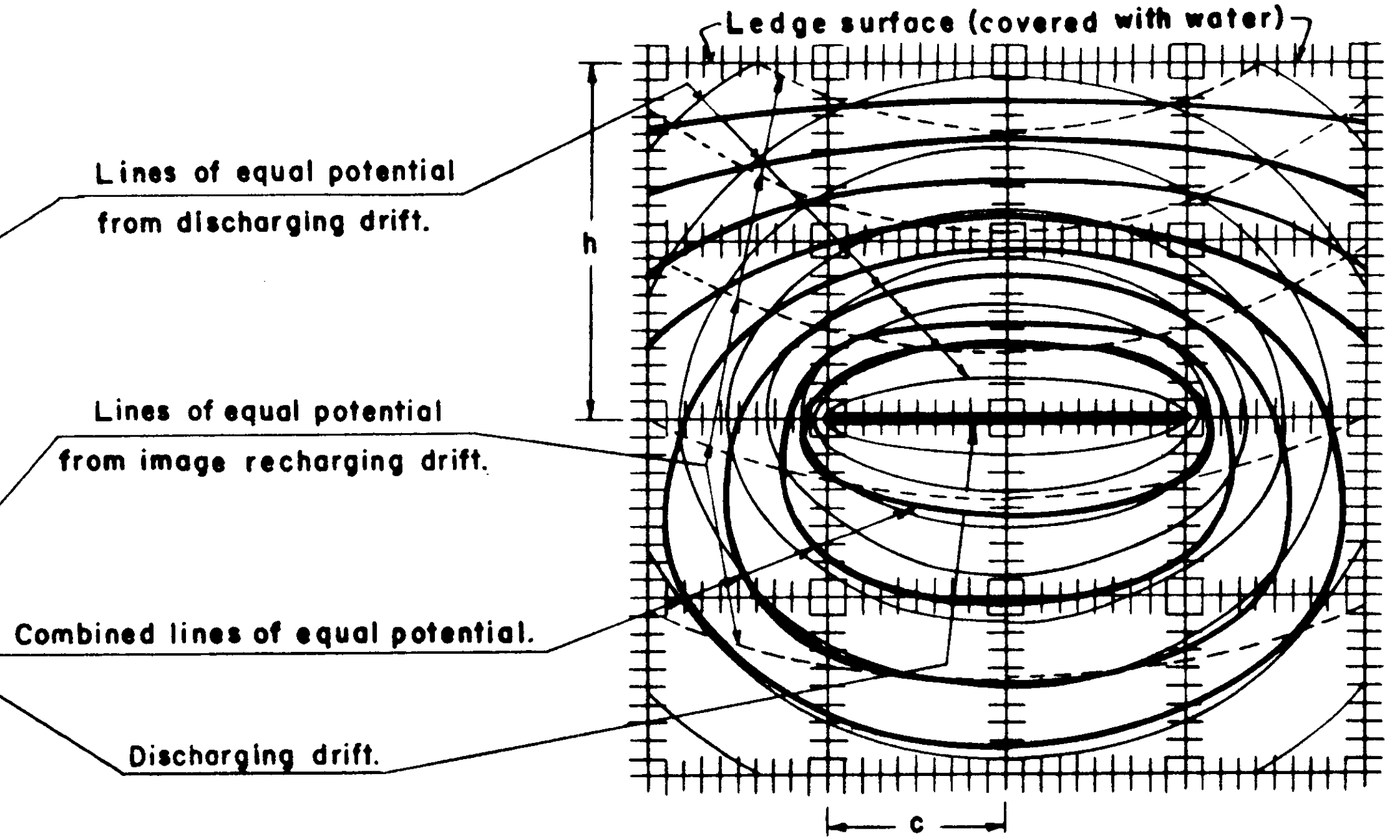
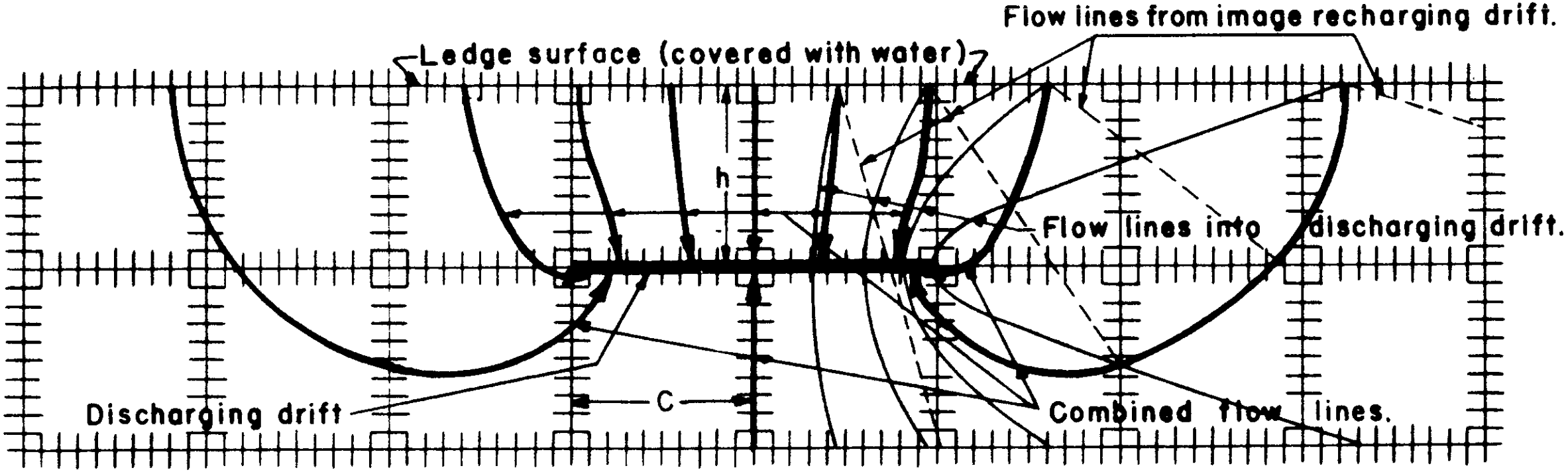


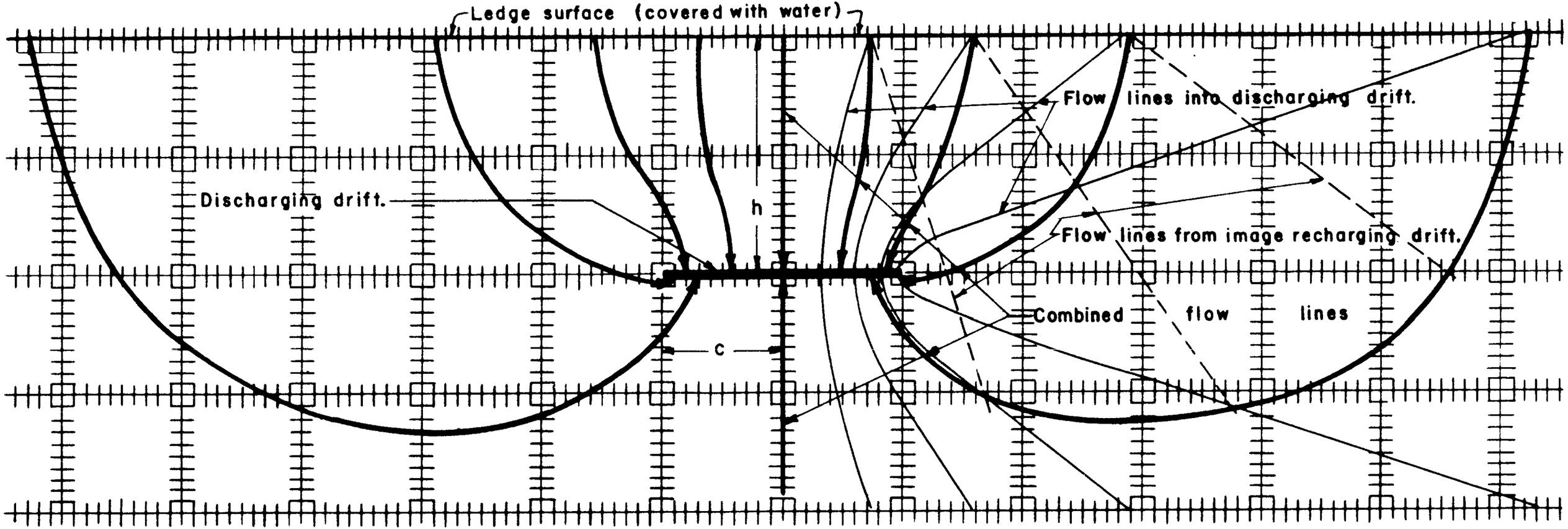
FIGURE 11. LINES OF EQUAL POTENTIAL AROUND A DRIFT.

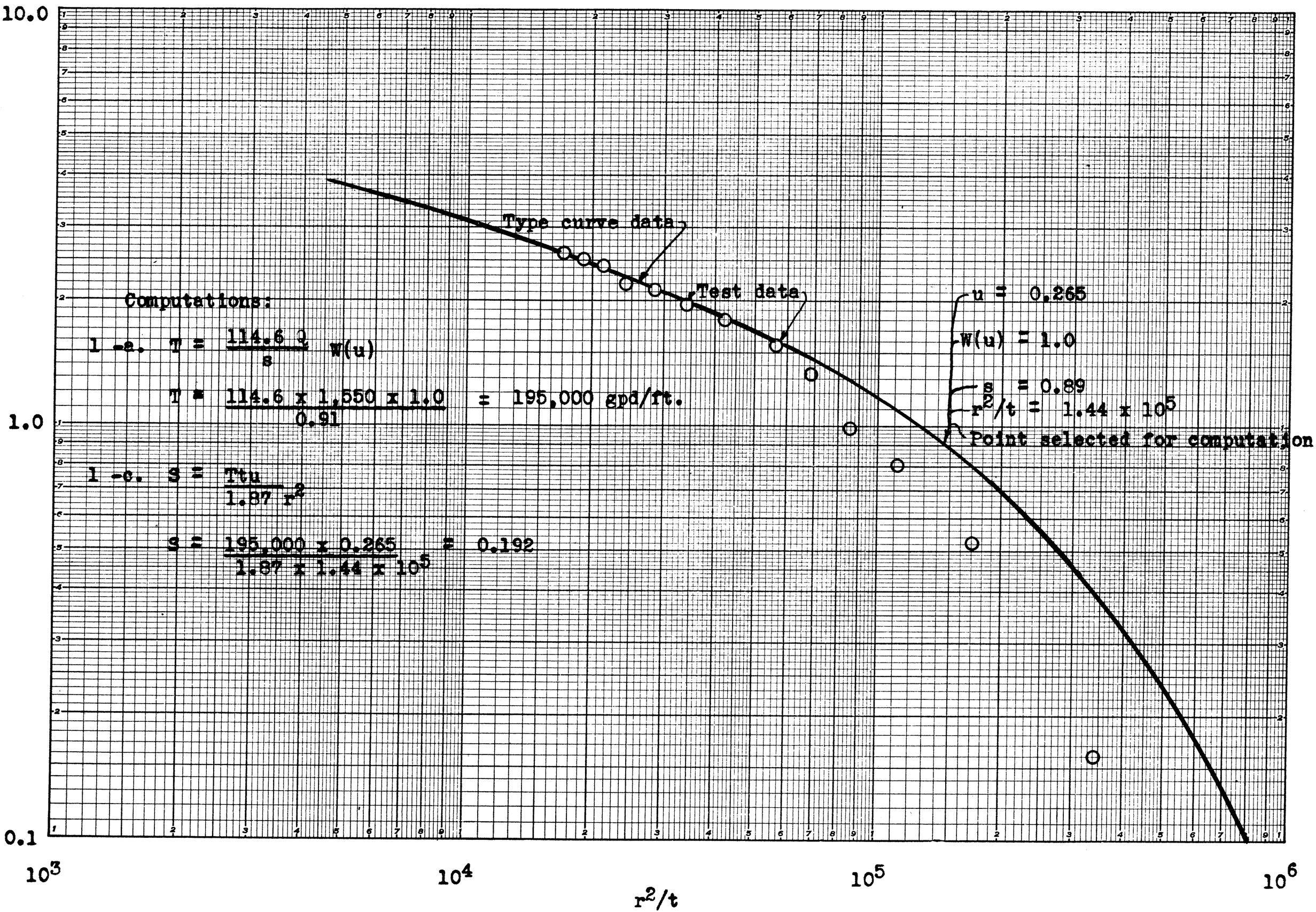
(Longitudinal section) h/c = 1

FIGURE 12. LINES OF EQUAL POTENTIAL AROUND A DRIFT

(Longitudinal section) h/c = 2


Flow lines from image recharging drift.
Ledge surface (covered with water)
h
Flow lines into discharging drift.
Discharging drift
C
Combined flow lines.


Ledge surface (covered with water)
Flow lines into discharging drift.
Discharging drift.
h
Flow lines from image recharging drift.
Combined flow lines
c


10.0
1.0
0.1
s = drawdown, in feet.
10^3
10^4
10^5
10^6
r^2/t
Type curve data
Test data
u = 0.265
W(u) = 1.0
s = 0.89
r^2/t = 1.44 x 10^5
Point selected for computation
Computations:
1 -a. $T = \frac{114.6\ Q}{s}\ W(u)$
$T = \frac{114.6 \times 1,550 \times 1.0}{0.91} = 195,000$ gpd/ft.
1 -c. $S = \frac{Ttu}{1.87\ r^2}$
$S = \frac{195,000 \times 0.265}{1.87 \times 1.44 \times 10^5} = 0.192$

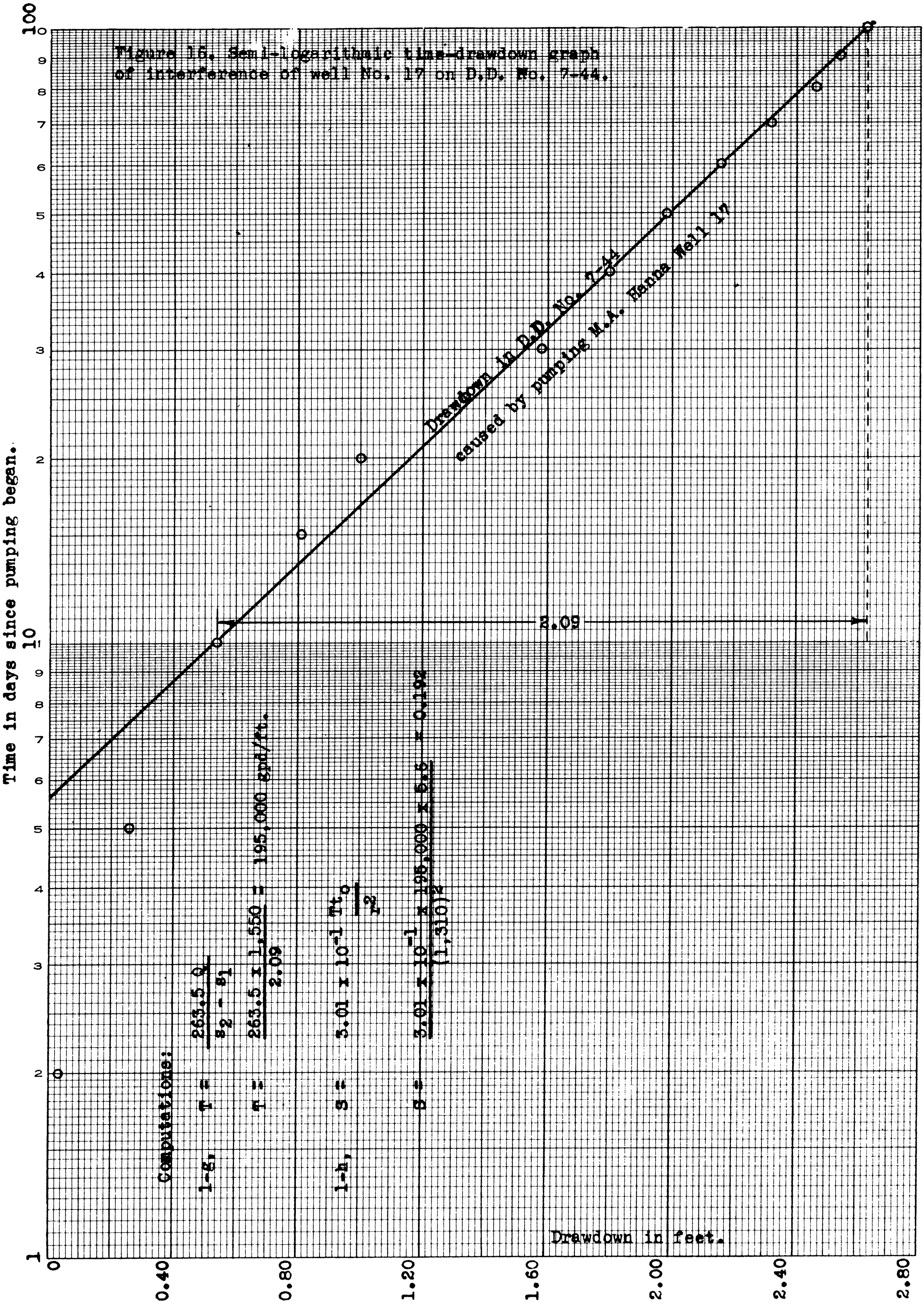


Figure 16. Semi-logarithmic time-drawdown graph of interference of well No. 17 on D.D. No. 7-44.

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December 28, 1949

Mr. Olaf P. Senkins, State Mineralogist
Div. of Mines, Dept. of Natural Resources
San Francisco 11, California

Fellow State Geologist:

The attached Technical Report #2 is the publication I referred to and promised you at the San Francisco 1949 meeting of the A.A.S.G. With the possible exception of a recent report by the United States Bureau of Mines, which pertains chiefly to water-handling methods, I believe this is the first report of its kind in which is discussed the geology and hydralics of ground water movements through both man-made and natural underground workings. The conclusions are necessarily broad and generalized. Many factors are as yet unknown. However, the study is being continued in the Marquette Range, and it is anticipated that future reports will be of even greater value to geologists and engineers working with problems of mine drainage.

Sincerely

G. E. Eddy

GEOLOGICAL SURVEY DIVISION
G. E. Eddy
State Geologist

GEE:nvd