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"WATER-SUPPLY INVESTIGATION AT THOREAU, MCKINLEY COUNTY, NEW MEXICO" By: L. C. Halpenny & H. A. Whitcomb.

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United States

Department of the Interior

Geological Survey

Water-supply investigation at Thoreau, McKinley County, New Mexico

By

L. C. Halpenny and H. A. Whitcomb

Albuquerque, New Mexico
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INTRODUCTION

The Indian school at Thoreau, McKinley County, New Mexico, has been closed for several years. When the school was in operation, water was supplied from a well which produced from sandstone in the Chinle formation. The pump was removed and the well was capped at the time that the school was closed. In 1948 the Navajo Service desired to reopen the school. The Geological Survey had been studying ground-water problems on the Navajo Indian Reservation since January 1948, and the Navajo Service requested that the program include Indian schools, such as the one at Thoreau, that are not on the Reservation, but are, nevertheless, the responsibility of that office. Accordingly, the Geological Survey made a brief reconnaissance to determine the adequacy of the existing water supply at Thoreau and to make recommendations for further development if necessary.

It was reported that about 20,000 gallons of water per day would be needed for operation of the school on a boarding basis. A continuous discharge of 14 gallons per minute would be needed to furnish this amount of water. Pumping 16 hours per day, about 21 gallons per minute would be required.

Location

Thoreau is located in south-central McKinley County, New Mexico, about 4 miles east of the Continental Divide and 35 miles east of Gallup. U. S. Highway 66 and the Santa Fe Railroad pass through the settlement. State Highway 56, a graded road, links Thoreau with Crown Point, 37 miles to the north. The school is situated in the NE¼NW¼ sec. 32, T. 14 N., R. 13 W., on 40 acres of land allotted to the Navajo Service by the Federal Government.

Topography and drainage

Thoreau lies on the north flank of the Zuni uplift. Topographically, the region may be described generally as characteristic of a dissected dome. A series of cuesta ridges of sandstone parallel the axis of the dome, with steep escarpment slopes facing southward in the direction of its center. Broad, flat valleys cut in beds of shale lie between the cuesta ridges and facilitate travel from east and west across the uplifted area.

Drainage is predominantly to the east, away from the Continental Divide which attains an altitude of 7,246 feet 4 miles west of Thoreau. The altitude at Thoreau is about 7,150 feet. The land surface slopes so gently to the east that stream gradients are too low to accomplish much down cutting.

Field work

A pumping test was made by L. C. Halpenny, engineer, H. A. Whitcomb, geologist, and A. D. Pulido and G. A. Lerua, student engineers, during the period August 17-20, 1948. Records of shallow wells and water samples were collected by H. A. Whitcomb and R. J. Drake in early December 1948.

Acknowledgments

J. D. Hem, District Chemist, Quality of Water Branch, prepared the quality-of-water section for this report. C. V. Theis, District Geologist for ground-water investigations in New Mexico, gave helpful suggestions during the course of the investigation and reviewed the report. H. E. Skibitzke, engineer, reviewed the computations for the pumping test. C. B. Read, Geologist, Fuels Section, Geologic Division, discussed the stratigraphy of the region with the authors and reviewed the geologic section of the report.

GEOLOGY

The broad, flat valley in which the town of Thoreau is situated is underlain by Triassic and Permian strata. The lowest stratigraphic unit which could be considered as a possible aquifer at Thoreau is the Glorieta sandstone member of the Middle Permian San Andres formation. The rocks below this member are known to yield water of poor quality in the region, and therefore they will not be discussed in this report. The geologic section was examined in the vicinity of Prewitt, 10 miles east of Thoreau, where better exposures occur. The thicknesses in that vicinity are considered to be applicable to the strata in the Thoreau area.

Stratigraphy

The Glorieta sandstone member of the Middle Permian San Andres formation is not exposed in the area studied. The log of well 9 (table 2) indicates that the member is about 188 feet thick in the vicinity of Prewitt. Exposures in other parts of the region show that the Glorieta sandstone member is gray, fine-grained, hard, massive, and cross bedded.

The San Andres limestone member of the San Andres formation is the youngest of the Permian strata exposed in the area. About 150 feet of this gray, coarse-grained, massive, sandy limestone, containing abundant Middle Permian fossils, crops out in the wall of Bluewater Canyon about 6 miles southwest of Thoreau. The contact with the underlying Glorieta sandstone member was not observed in the area examined.

Immediately overlying the San Andres formation is about 30 feet of red, medium-grained, rather soft, shaly to thin-bedded sandstone which contains scattered small quartzite pebbles. According to Read,[1/] this sandstone may be the equivalent of the Shinarump conglomerate, of Upper (?) Triassic age.

Overlying the Shinarump (?) conglomerate is an estimated thickness of 260 feet of soft red, gray, and purplish shale, containing beds of generally coarse and commonly cross bedded gray sandstone. These deposits were designated by Darton[2/] as the Moenkopi formation. Recent studies by C. B. Read, in a paper by Theis[3/], produced paleobotanical evidence that these beds are of a later Triassic age than Moenkopi, and suggest that they are more properly correlated with the Chinle formation than with the much older Moenkopi formation. These beds are designated in this report

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1/ Read, C. B., Oral communication, December 10, 1948.

2/ Darton, N. H., "Red Beds" and associated formations in New Mexico: U. S. Geol. Survey Bull. 794, p. 143, 1928.

3/ Theis, C. V., Ground-water conditions near Wingate Ordnance Depot: U. S. Geol. Survey (Report to Army Engineers), pp. 10-11, 1941.

as the "lower shale member of the Chinle formation".

About 100 feet of gray to buff, coarse-grained, rather hard, massive sandstone containing conglomeratic lenses in its lower part, overlies the lower shale member of the Chinle formation. This sandstone is exposed at the top of the steep south-facing escarpment slope south of Thoreau. This sandstone was correlated with the Shinarump conglomerate by Darton.4/ In this report it is designated as the "middle sandstone member of the Chinle formation".

Conformably overlying the middle sandstone member of the Chinle formation is about 1,100 feet of soft gray, maroon, and purple shales and interbedded thin red to brown sandstones. This sequence is designated in this report as the "upper shale member of the Chinle formation". Erosion of these beds has produced the wide valley lying between the sandstone-capped cuesta to the south and the red sandstones of Jurassic age which form the high cliffs of Dutton Plateau to the north.

Structure

The Zuni uplift consists of an elongated dome, the axis of which strikes roughly northwest. The strata on the northeastern flank dip uniformly to the north and northeast at angles ranging from 2° to 3°. Dips are much steeper on the southwestern flank. The northeastern limb of the upwarp has been dissected by erosion to form a series of northwest-trending cuestas. The areas between successive cuestas are occupied by broad valleys cut into soft Triassic, Jurassic, and Cretaceous shales lying between more resistant sandstones and limestones.

The only fault observed in the area is evident in the southern wall of Dutton Plateau, about 5 miles northeast of Thoreau. Darton's5/ geologic map of the Zuni Mountain region shows this fault as probably extending from the south rim of the plateau southward about 25 miles to the core of the Zuni uplift. The east side is upthrown.

4/ Darton, N. H., op. cit., p. 143.
5/ Darton, N. H., op. cit., pl. 33.

GROUND-WATER RESOURCES

It is not believed advisable to consider the strata below the San Andres formation as a source of ground water for the Thoreau school, as the quality of water yielded by these strata is known to be poor. The discussion of ground-water resources is confined, therefore, to the water-bearing character of the rocks described in the geologic section of this report.

Occurrence of ground water

The Glorieta sandstone member of the San Andres formation yields water to three railroad wells at Chavez (pl. 1). Two of the wells flow, and in the third well the water level is reported to be about 10 feet below the land surface. The altitude at Thoreau is about 100 feet higher than at the wells, and therefore a well at Thoreau that taps the member could not be expected to flow. The top of the member is estimated to be about 850 feet below the land surface at Thoreau.

The San Andres limestone member of the San Andres formation is not known to be water bearing in the area. However, it is possible that some of the water produced from the wells at Chavez is obtained from the San Andres limestone member.

It is reported that the Shinarump (?) conglomerate does not yield water to the railroad wells at Chavez. The top of the formation is estimated to be about 650 feet below the land surface at the school, but an examination of the outcrops indicated that the formation may not transmit water readily.

The lower shale member of the Chinle formation is not water bearing in the area. The middle sandstone member is believed to be the principal aquifer in the school well (see log, well 19, table 2). The log shows that 20 feet of water-bearing sand was encountered at 343 feet. The sandstone beds of the upper shale member yield small amounts of water to domestic wells in the area. Wells 21 and 22 (table 1) are reported to produce water from a depth of about 200 feet.

Pumping test

In order to determine if the school well at Thoreau would supply the required 21 gallons per minute, a pumping test was made in August 1948. During the test, water samples were collected for analysis. Prior to the test the well had been capped for at least 6 years. The well was pumped by air lift during the test, and the average discharge was 13.8 gallons per minute for 5 hours and 52 minutes. The well is lined with 10-inch casing, perforated from about 340 to 365 feet. Although there were four wells within a radius of a mile from the school well, they did not produce water from the middle sandstone member of the Chinle formation.

The transmissibility of the aquifer was calculated by the Theis[6/] method, according to the following equation:

$$T = 264\, q\, \frac{\log t/t'}{s}$$

in which T = coefficient of transmissibility, expressed in field terms as the number of gallons of water per day that percolates under prevailing conditions through each mile of water-bearing bed under investigation (measured at right angles to the direction of flow) for each foot per mile of hydraulic gradient

q = discharge of the pumped well, in gallons per minute

t = time since pumping began, in hours

t'= time since pumping stopped, in hours

s = residual drawdown, in feet

6/ Theis, C. V., The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage: Am. Geophys. Union Trans., 1935, p. 520.

The coefficient of transmissibility was calculated to be 57.9 gallons per day per foot. The transmissibility is low, indicating that the aquifer could be overdeveloped easily. The specific capacity of the well was obtained by dividing the average discharge by the total drawdown, and found to be 0.185 gallons per minute per foot of drawdown. This means that, with a discharge of 21 gallons per minute, the drawdown would be about 115 feet. With this drawdown, the pumping level would be about 240 feet below the land surface.

The data collected during the pumping test indicated that, although the well would produce the desired 21 gallons per minute, the quality of the water was not satisfactory for domestic use. Accordingly, a further short field study was made to determine whether or not the shallower aquifers would produce sufficient water of suitable quality to supplement the existing supply. Records of the wells and springs visited are given in table 1.

QUALITY OF WATER

Analyses of water samples from nine wells in the vicinity of Thoreau are shown in table 3.

The Santa Fe Railroad wells at Chavez are reported to produce water from the San Andres formation. As shown by the analysis for well 17, water from this aquifer is hard. If no other water of better quality were available, water from the San Andres formation in the vicinity of Chavez probably would be satisfactory for most domestic purposes.

Water encountered in the Chinle formation varies in quality both with depth in formation and from place to place in the Thoreau area. Water from the upper part of the formation contains a moderate concentration of dissolved solids at Thoreau and would be satisfactory for domestic use, as shown by the analyses for wells 21 and 22. These wells are located less than a mile from the school.

Apparently water from the middle sandstone member of the Chinle formation is rather highly mineralized at Thoreau, as shown by the analyses for the school well (No. 19), which is reported to develop water from this part of the formation. The well was sampled three times during the pumping test on August 18 and 19. Although the samples show some variation in chemical character as pumping proceeded, it appears unlikely that continued pumping would materially improve the quality of the water. The analyses show that the water from this well is comparatively soft, but the water contains excessive concentrations of sodium, chloride, and sulfate, and therefore is considered unsatisfactory for domestic use. Water of lower dissolved solids content from the middle sandstone member of the Chinle formation contains mostly sodium and bicarbonate, as shown by the analyses for wells 9 and 20, although the proportion of sulfate to total dissolved solids is nearly as great as in the more highly mineralized water.

POSSIBILITIES FOR OBTAINING ADDITIONAL WATER

The records of wells 21 and 22 show that wells near the school produce at least 4 gallons per minute from a depth of about 200 to 250 feet. Table 3 indicates that the water from wells 21 and 22 is of better quality than the water from well 19.

Two methods by which additional water of better quality could be obtained at the Thoreau school are: (1) Perforate the casing of well 19 from 200 to 250 feet, allowing water from the shallower aquifers to enter the well; (2) drill a well near the school to a depth of about 250 feet, and mix the water produced from the new well with water produced from well 19. The water from well 19 should be diluted with at least twice as much water from the shallower aquifers.

The investigation showed that the Glorieta sandstone member of the San Andres formation may be water bearing at the Thoreau school. The water-bearing character of the sandstone and the quality of water that might be yielded could be determined by drilling a test well. The top of the sandstone is estimated to be about 850 feet below the land surface at Thoreau.

CONCLUSIONS AND RECOMMENDATIONS

1. A minimum of 21 gallons per minute of potable water will be needed at the Thoreau Indian school as soon as the school is opened.

2. The existing well at the school will produce 21 gallons per minute, but the water is of poor quality.

3. Additional water could be obtained by: (1) Perforating the casing in the school well between 200 and 250 feet, allowing water of better quality to enter the well; (2) drilling a new well near the school to a depth of about 250 feet.

4. If no more than 21 gallons per minute is available for the school, the pumping plant would have to be operated 16 hours per day. If both the alternatives outlined in paragraph 3 of this section are followed, the pumping plant could be operated a shorter period each day and a standby supply would be available in the event of temporary failure of one of the wells.

5. If the school is expanded at a later date and more water is needed, the Glorieta sandstone member of the San Andres formation may yield sufficient water of suitable quality to supply the increased requirements, although the water may be hard.

Table 1.-Records of we[illegible] and springs in Thoreau area, [illegible]inley County, New Mexico
(All wells are drilled)
(Numbers correspond to numbers on plate 1 and in tables 2 and 3.)

Office Number	Location and State file number	Owner	Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Diameter of well (in.)
	T. 13N., R. 12 W.						
d/ 9	NE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 11	Navajo Service	C.C.C.	1934?	-	1,987	7
	T. 13 N., R. 13 W.						
d/ 15	NE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 1	A.T.& S.F. Railroad	Lyman & Clampitt	1902	-	707	10
16	do.	do.	Gus Mulholland	1911	-	725	10
d/ 17	do.	do.	Clampitt & Moss	1918	-	930	12$\frac{1}{2}$
	T. 14 N., R. 13 W.						
d/ 19	NE$\frac{1}{4}$NW$\frac{1}{4}$ sec. 33	Navajo Service	C.C.C.	1934?	7,163	505	10
d/ 20	NW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 28	do.	Kiersey and Co.	1932	-	730	10$\frac{1}{2}$
d/ 21	SW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 33	J. J. Radosevich	Oscar Carter	-	7,155	235	6
d/ 22	do.	Oscar Carter	do.	-	7,160	227	5$\frac{1}{2}$
	T. 14 N., R. 12 W.						
d/ 23	NE$\frac{1}{4}$NW$\frac{1}{4}$ sec. 20	Navajo Service	Thos. Sartin	1941	-	430	8
d/ 24	SW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 17	do.	-	-	-	-	-

Records obtai[illegible]d by H. A. Whitcomb, L. C. Halp[illegible]y, and R. J. Drake

Office number	Water level: Depth below measuring point (feet) a/	Water level: Date of measurement, 1948	Pump and power b/	Use of water c/	Temp. °F	Remarks
9	80.65	June 25	C,G	D	56	Baca school. Plugged back to 475 feet to cut off "bad" water. Reported discharge, 4½ gallons per minute from Chinle formation. See log.
15	Flows	-	A,D	RR	62	At Chavez. Measured flow, 3 gallons per minute, June 25, 1948. Reported discharge by air lift, 100 gallons per minute. Reported to produce water from Glorieta sandstone member of San Andres formation. See log.
16	10	e/	A,D	RR	-	At Chavez. Reported to have flowed 13 gallons per minute in 1911. See log.
17	Flows	-	A,D	RR	65	Measured discharge, 20 gallons per minute, June 25, 1948. Reported to have flowed 5 gallons per minute in 1918. See log.
19	121.98	July 30	None	N	56	Thoreau school. Had been sealed for several years prior to measurement. Test pumped by air lift, Aug. 17-19, 1948. Produces water from Chinle formation. See log.
20	280	e/	C,W	S	-	Reported drawdown, 160 feet after pumping 18 gallons per minute for 1/2 hour. Produces water from Chinle formation. See log.
21	60	e/	C,W	D	-	Reported discharge, 8 gallons per minute. Produces water from Chinle formation.
22	60	e/	C,W	D	-	Reported discharge, 4 gallons per minute. Produces water from Chinle formation.
23	95	e/	C,W	D,S	-	At San Antonio sheep station. Produces water from Chinle formation. See log.
24	-	-	-	S	45	Spring.

a/ Measuring point was top of casing.
b/ C, cylinder; A, airlift; G, gasoline; D, diesel; W, windmill.
c/ D, domestic; RR, railroad; S, stock; N, none.
d/ See table 3 for analysis of water sample.
e/ Water level reported.

Table 2. - Logs of wells in Thoreau area, McKinley County, New Mexico.

Formations identified by H. A. Whitcomb and L. C. Halpenny

	Thickness (feet)	Depth (feet)
Driller's log of well 9.		
Navajo Service, owner.		
Baca Indian school.		
Surface sand	5	5
Chinle formation		
Hard sand	4	9
Purple shale	7	16
Dark-gray sand	5	21
Dark-blue shale	6	27
Gray shale	11	38
Red shale	6	44
Purple shale	8	52
Gray lime	36	88
Purple shale	22	110
Gray lime	4	114
Green shale	4	118
Dark-gray water sand (5 gpm)	6	124
Sandy gray shale	23	147
Gray sand	27	174
Sandy gray shale	12	186
Gray sand	28	214
Gray shale	15	229
Red shale	14	243
Gray shale	26	269
Purple shale	30	299
Red shale	16	315
Brown shale	9	324
Gray shale	30	354
Lime shell	4	358
Red shale and hard conglomerate	22	380
Sandy lime	6	386
Gray sand	16	402
Sand, little water	3	405
Red shale	35	440
Red shale with lime shell	32	472
Gray shale	40	512
Hard gray sand	14	526
Gray lime shell	26	552
Gray lime	19	571
Sand, little water	6	577
Sandy brown shale	4	581
Red shale	23	604
Shinarump conglomerate (?)		
Gray sand	13	617
Driller's log of well 9, cont.		
San Andres formation		
San Andres limestone member		
Gray lime	46	663
Glorieta sandstone member		
White water sand	8	671
Hard white sand	5	676
Hard gray sand	8	684
White sand	112	796
Gray shale	3	799
White sand	52	851
Yeso formation (?)		
Gray shale	3	854
Red sand	12	866
Red sand with shale streaks	17	883
Sandy red shale	17	900
Red sand	14	914
Red shale	12	926
Red water sand (37 gpm)	7	933
Red shale	6	939
Sticky red clay	6	945
Red shale	17	962
Sandy red shale	49	1,011
Lime shell	5	1,016
Gray sand	6	1,022
Dark-gray lime	12	1,034
Blue shale	2	1,036
Gray sand	4	1,040
Sandy gray shale	11	1,051
Gray sand	3	1,054
Sandy red shale	4	1,058
Red sandstone	14	1,072
Dark-gray lime	2	1,074
Sandy red shale	5	1,079
Dark-gray lime	5	1,084
Sandy red shale	38	1,122
Dark-gray lime	2	1,124
Sandy red shale	66	1,190
Red shale	6	1,196
Sandy red shale	254	1,450
Red water sand	18	1,468
Red sand	48	1,516
Abo formation (?)		
Sandy red shale	24	1,540

Table 2. - Logs of wells in Thoreau area, McKinley County, New Mexico - Cont.

	Thickness (feet)	Depth (feet)
Driller's log of well 9, cont.		
Abo formation (?), cont.		
Red shale	22	1,562
Sandy red shale	70	1,632
Red sandstone	38	1,670
Sandy red shale	14	1,684
Red shale	16	1,700
Sandy red shale	10	1,710
Hard sand, iron pyrite	6	1,716
Sandy red shale	12	1,728
Hard shell	5	1,733
Red shale	83	1,816
Hard shell	4	1,820
Red shale	87	1,907
[illegible] water sand (33 gpm)	17	1,924
Red shale	8	1,932
Sandy red shale	5	1,937
Red sand	7	1,944
Red shale	43	1,987
TOTAL DEPTH		1,987
Driller's log of well 15.		
A.T. & S.F. Railroad, owner.		
Chinle formation		
Red clay	45	45
Gray sandstone	150	195
Red clay	335	530
Blue clay	40	570
Shinarump conglomerate (?)		
Gray sandstone	25	595
Black sand	5	600
San Andres formation		
Gray sandstone	107	707
TOTAL DEPTH		707
Driller's log of well 16.		
A.T. & S.F. Railroad, owner.		
Shale, fire clay, and sandstone	615	615
Limestone	45	660
Gray sandstone	22	682
White sandstone	43	725
TOTAL DEPTH		725
Driller's log of well 17.		
A.T. & S.F. Railroad, owner.		
Chinle formation		
Sand, rock, and shale	55	55
White sand rock	45	100
Sand rock and shale	52	152
Hard white sand rock	33	185
Sand rock and shale	198	383
Driller's log of well 17, cont.		
Chinle formation, cont.		
Very hard sandstone	7	390
Red shale	130	520
Gray shale	45	565
Shinarump conglomerate (?)		
Hard gray sandstone	10	575
Sand rock with slate streaks	25	600
San Andres formation		
Gray sandstone	25	625
White sandstone on lime rock	25	650
Brown sandstone	30	680
Gray sandstone	10	690
White sandstone	145	835
White and yellow sandstone	50	885
Reddish-brown sandstone	45	930
TOTAL DEPTH		930
Driller's log of well 19.		
Navajo Service, owner.		
Thoreau Indian school		
Chinle formation		
Blow sand	123	123
Quicksand, some water	7	130
Dark-red shale	18	148
Light-red shale	55	203
Light-gray shale	34	237
Water sand	5	242
Purple shale	46	288
Hard sand	12	300
Light-gray shale	43	343
Sand, 22 gallons of water per minute	20	363
Brown shale	18	381
Sandy gray shale	26	407
Dark-gray shale	68	475
Hard sand	4	479
Gray shale	26	505
TOTAL DEPTH		505

Table 2. - Logs of wells in Thoreau area, McKinley County, New Mexico - Cont.

	Thickness (feet)	Depth (feet)
Driller's log of well 22.		
Navajo Service, owner.		
<u>Chinle formation</u>		
Red shale	88	88
Dark, sandy shale	357	445
Dark-red shale	110	555
Water sand	14	569
Red shale	46	615
Water sand	17	632
Fine-grained sand	19	651
Water sand	45	696
Dark, sticky shale	18	714
[illegible]k, sandy shale	16	730
TOTAL DEPTH		730
Driller's log of well 23.		
Navajo Service, owner.		
Blow sand	49	49
Red shale	201	250
Lime (?) slate	50	300
Yellow shale	130	430
TOTAL DEPTH		430

Table 3. - Analyses of water from wells and springs in Thoreau area, McKinley County, New Mexico.
Analyzed in Southwestern Laboratory of Geological Survey, Albuquerque, New Mexico.
(Numbers correspond to numbers given in table 1 and plate 1.)
(Parts per million except specific conductance.)

No.	Date of collection 1948	Specific conductance, (micromhos @ 25°C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$
9	June 23	727	45	17	104	332	102	15	3.5	0.5	462	182
15	June 25	762	-	-	-	271	-	5	-	-	-	
17	do.	889	125	37	23	256	285	5	0.2	0.6	615	464
a/ 19	Aug. 18	3,590	26	10	760	272	515	705	1.0	4.5	2,160	106
b/ 19	do.	3,700	-	-	-	259	-	725	-	-	-	-
c/ 19	Aug. 19	3,630	18	3.8	867	260	534	705	1.0	2.4	2,260	60
20	Dec. 3	576	1.2	.5	141	276	54	19	.4	.9	353	5.0
21	Dec. 6	679	52	11	85	289	64	34	.2	9.3	398	174
22	do.	1,090	26	7.0	217	334	184	50	.5	10	672	94
23	Nov. 15	4,380	7.0	11	911	502	523	765	2.6	2.5	2,470	62
24	do.	881	2.0	3.3	219	436	77	33	1.2	8.6	559	18

a/ Collected at 11:38 a.m.
b/ Collected at 1:13 p.m.
c/ Collected at 1:00 p.m.