PART III

AQUIFER CHARACTERISTICS

COT 102B100

8108120351

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TABLES

FIGURES

INTRODUCTION

The aquifer characteristics are a crucial factor in determining direction and rate of flow of fluids in the vicinity of the Cotter Canon City mill site. Wahler Associates has reviewed previous investigations at the site, completed additional investigations, and will make recommendations and draw conclusions in Part V of this report. This portion of the report will summarize what is presently known about the aquifer characteristics.

This part of the report will be directed toward the characteristics of the "shallow path", which has been the recent emphasis of investigations conducted · Wahler Associates. To date there are no completed investigations on the "deep path". Dr. Runnells at the Univers..ty of Colorado has conducted some laboratory permeabilities as part of an ongoing study. He has found that core samples from Poison Canyon and Raton Formations have a hydraulic conductivity 10^{-6} to 10^{-7} cm/sec. No reliable information exists on water levels or aquifer parameters (transmissivity and storage coefficient) in the bedrock aquifers, and it is therefore difficult to draw any conclusions.

PREVIOUSLY COLLECTED DATA

Previous investigations will be briefly described in this section. There were no investigations of the hydrogeology in the area until 1977. Since that time, not enough consistent data has been collected to allow an adequate interpretation of the aquifer characteristics for the shallow path.

The Hershey (1977) and Nalco Environmental Sciences, Appendix G, (1977), reports presented a baseline description of the hydrogeology at the mill site (Section 16) and in the Lincoln Park Area south of the Arkansas River.

Those reports however did not evaluate the hydrogeology between the mill site and Lincoln Park. They concluded that a shallow aquifer at the mill site may not be continuous.

Harding - Lawson Associates (1978) completed a geophysical survey of potential leakage through the SCS Dam and a survey of the shallow material in the SE¼ of Section 9. They postulated some leakage beneath the dam. They also detected anomalies in the SE¼ of Section 9. It was postulated that the anomalies were caused by either tailings pond "brine" or geologic conditions. They suggested shallow drillings in order to ascertain the cause of the anomalies. No drill holes were ever completed.

Wahler (1978b) completed a study on seepage from the tailings ponds investigating both the hydrogeology and water quality. The report contained several recommendations and listed the following conclusions:

1. Most of the raffinates are contained on the Cotter property but some seepage of the raffinates into the Soil Conservation Service reservoir and into the ground waters of a limited area in Lincoln Park was detected.

2. Laboratory tests of the ground waters in the affected area of Lincoln Park indicate that the principal water-quality concern is with dissolved metals and not necessarily radioactive elements.

3. The raffinates enter the ground-water body as seepage from unlined ponds at the mill and travel northerly to the affected area at a shallow depth through a complex permeable zone that consists of alluvium, terrace deposits and the upper part of the jointed bedrock.

Logan (1979a) evaluated chemical parameters which would be indicative of raffinate. He concluded that the most useful parameter would be molybdenum followed by natural uranium, selenium or electrical conductivity. That report did not discuss the hydrogeology and was not intended to.

Logan (1979b) recommended additional monitoring locations and procedures. The report was not intended to reach any conclusions.

WAHLER'S ONGOING PROGRAM

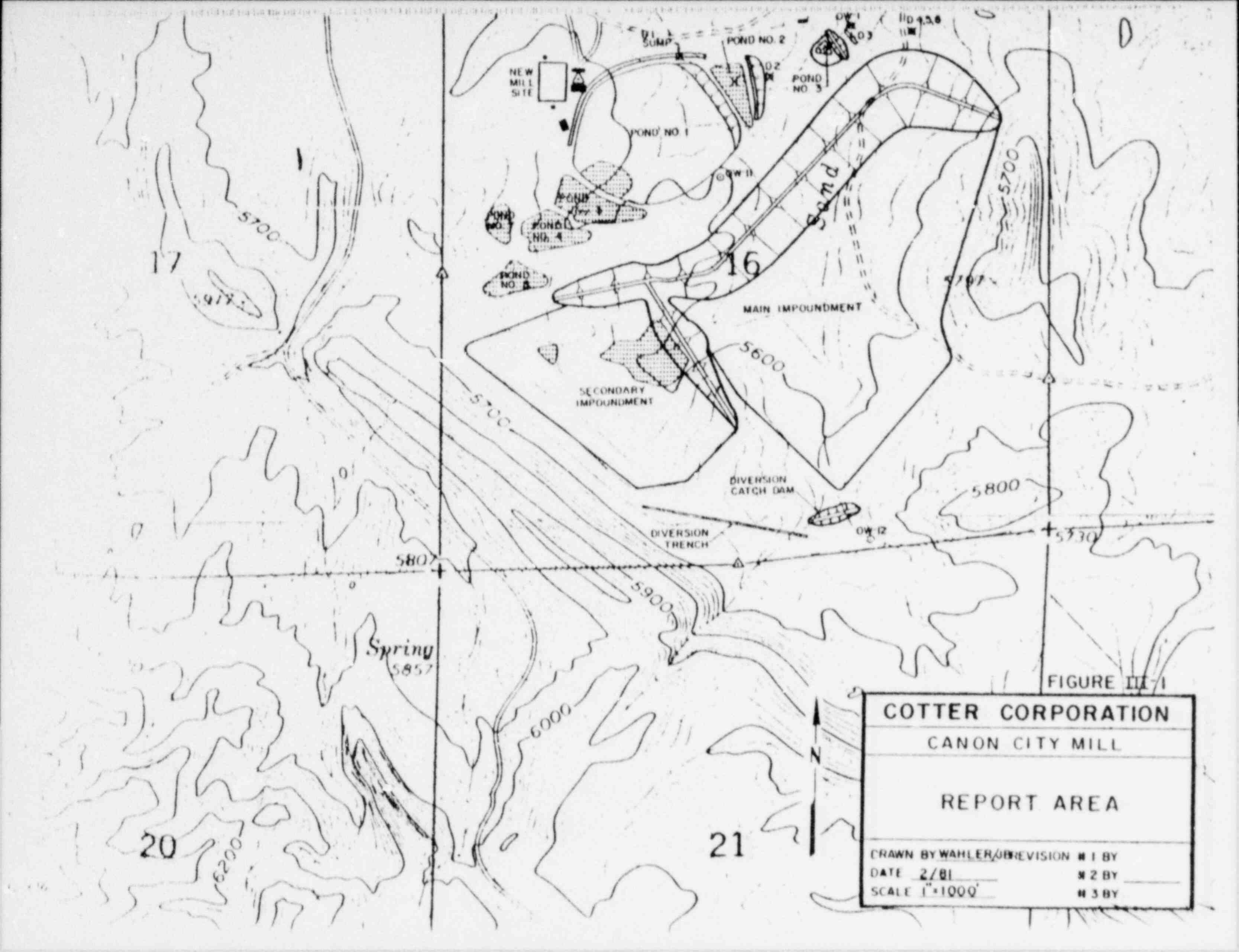
Wahler Associates' objective, as it relates to the direction and rate of fluid movement, has been to first evaluate the "shallow path" in order to reasonably predict the direction and rate of movement. Wahler has completed wells (see Part I, Geology of this report) in Sections 8 and 9 with the intent of describing movement of fluids in that area. None of the previous investigations have evaluated that area. Once a reasonable accounting can be made of fluid movement in the shallow system, then a determination of direction and rates of movement is possible.

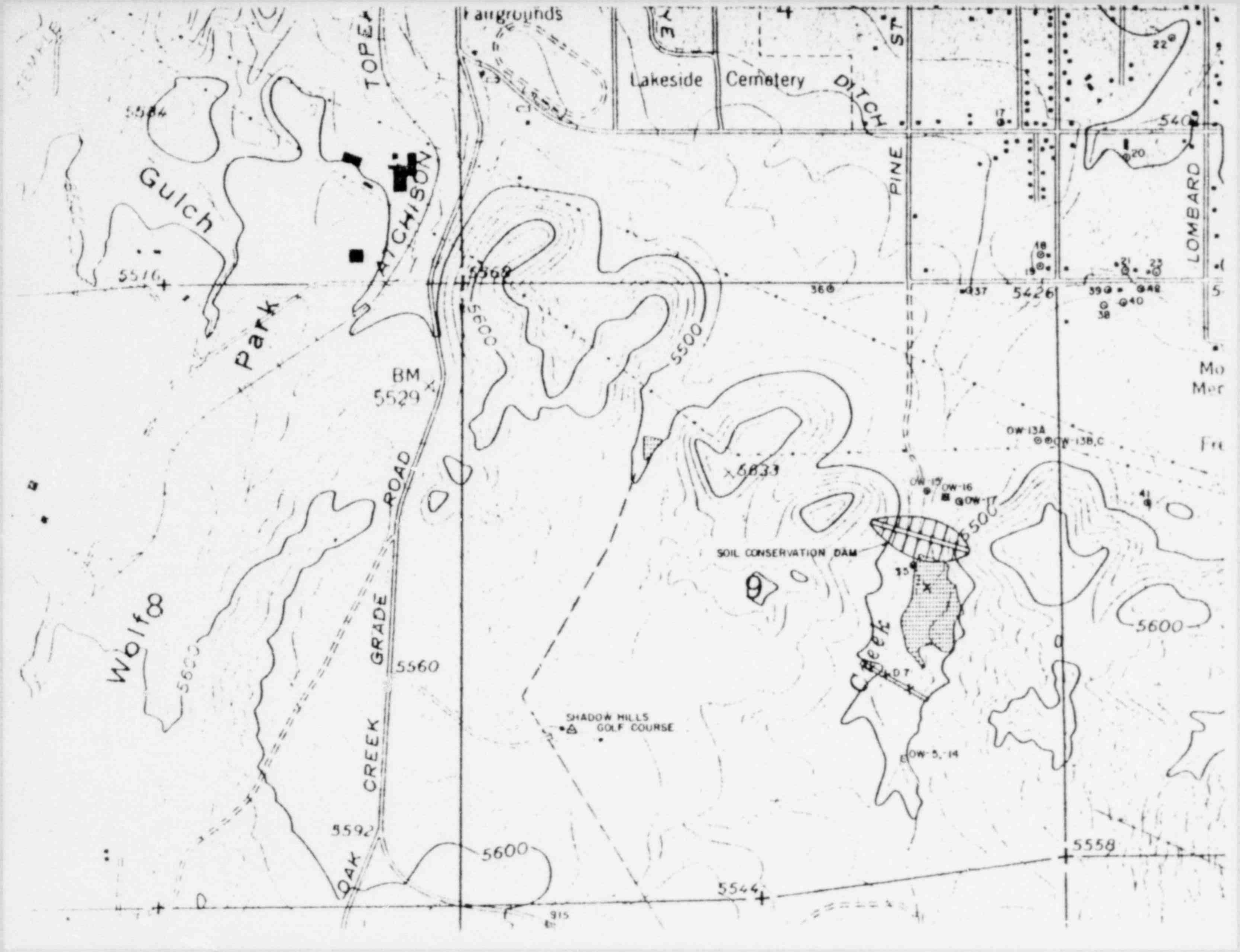
SHALLOW AQUIFER

The mill site lies in the Sand Creek Drainage (Figure III-1) and is underlain by a shallow hydrologic unit composed of alluvial material and the upper most portion of the Poison Canyon Formation. The shallow hydrologic unit has no formal name and is hereafter referred to as the shallow aquifer.

The area of interest for this report includes the SE¼ of Section 8, the S½ of Section 9, the NE¼ of Section 17 and most of Section 16. Part of the Sand Creek drainage lies within the report area. The remainder of the report a[illegible] is drained by an unamed ephemeral drainage in the northwest portion of the report area (see Figure III-1).

As described in Part I, Geology, the report area lies on either side


NEW MILL SITE
SUMP
POND NO. 2
POND NO. 3
POND NO. 1
OW 11
POND NO. 7
POND NO. 4
POND NO. 5
Sand
17
16
5700
5600
5800
5900
6000
6200
MAIN IMPOUNDMENT
SECONDARY IMPOUNDMENT
DIVERSION CATCH DAM
OW 12
DIVERSION TRENCH
5807
5730
Spring
5857
20
21
N
FIGURE III-1
COTTER CORPORATION
CANON CITY MILL
REPORT AREA
DRAWN BY WAHLER/JB REVISION #1 BY
DATE 2/81 #2 BY
SCALE 1"=1000' #3 BY


Fairgrounds
Lakeside
Cemetery
DITCH
ST
PINE
LOMBARD
TOPEKA
ATCHISON
Gulch
Park
BM
5529
ROAD
GRADE
CREEK
OAK
Wolf
Creek
SOIL CONSERVATION DAM
SHADOW HILLS
GOLF COURSE
5600
5500
5560
5592
5544
5558
5426
5516
5584
5568
OW-13A
OW-13B,C
OW-16
OW-17
OW-5, 14
9
8

of the axis of the Chandler syncline. From the standpoint of the shallow aquifer, the limbs of the syncline form a boundary on the western, southern, and northern edges of the shallow aquifer. The eastern edge of the shallow aquifer is formed from topographically higher bedrock (Poison Canyon).

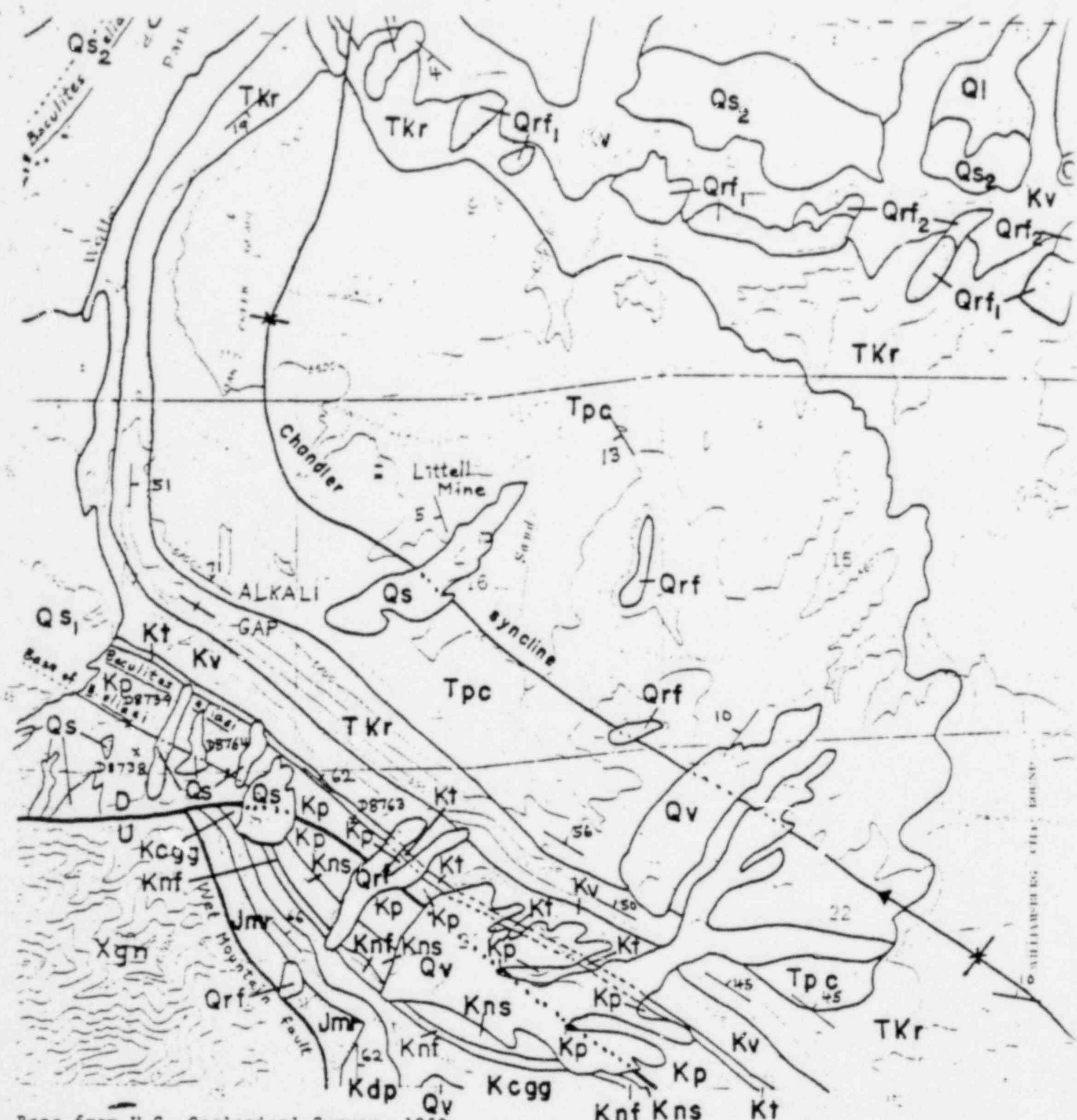
The surfic al geologic map (Figure III-2) indicates that the report area is underlain b, a small quantity of alluvial material. Based on numerous drill holes installed under the direction of Hershey-Wooderson, John Logan and Wahler Associates and numerous visits to the site by Wahler personnel, Wahler is in disagreement with the amount of alluvial material shown on Scott's (1977) map. Wahler has made no attempt to redefine the extent of alluvial material or to determine the source of such material. The requirement of this report is to define the physical characteristics of the shallow aquifer. Therefore, the shallow aquifer is viewed as a hydrologic unit and not as a time or rock stratigraphic unit.

The hydrologic unit consists of varying thicknesses of alluvial or colluvial material and varying thicknesses of weathered Poison Canyon, and varying thicknesses of unweathered uppermost Poison Canyon. During the drilling program for wells COT 1 - 6, the objective was to locate the uppermost saturated zone within 100 feet of the surface. The description of that drilling program is contained in Part I, Geology.

The assumption is made that the hydrologic unit is continuous. That assumption appears valid as illustrated by the potieniometric maps described in a later section of this report.

RECHARGE - DISCHARGE AREAS

The natural recharge for the shallow aquifer is through the near vertical southern limb of the Chandler syncline. The recharge area extends



Base from U.S. Geological Survey, 1959

N

COTTER CORPORATION	
CANON CITY MILL	
SURFICIAL GEOLOGIC MAP	
DRAWN BY JB	REVISION # 1 BY
DATE 2/81	# 2 BY
SCALE 1:24000	# 3 BY

FIGURE III - 2

from Alkali Gap on the west to the NE¼ of Section 21, which lies south of the present diversion reservoir. The natural flow paths would be in a northeasterly direction with flow paths roughly parallel to the surface. For a shallow system such as this, the water table should approximate the land surface topography. Previous investigations (Hershey-Wooderson, 1977 and Logan, 1978) have concluded that and the information collected for this report bears out that conclusion.

The natural discharge area for the shallow aquifer should be along the northern limb of the syncline south of the east-west trending ridge in Section 9. There is no natural discharge to the surface in the form of springs or seeps. The one exception might be the SCS spring, which occurs in the Raton Formation, on the west side of Sand Creek south of the SCS dam. However, not enough data has been collected on the spring to determine its source of recharge water.

The natural discharge from this shallow aquifer, therefore, must have been in the subsurface through the gaps in the ridge at Sand Creek and at the unamed ephemeral channel to the west. That path seems quite likely because the indurated sediments of the Raton Formation which form the ridge are less permeable than those of the shallow aquifer.

Superimposed upon the natural system are the facilities at the mill site which have been there for two decades. The various unlined ponds have served as artificial recharge areas and reconstruction of the natural flow system is nearly impossible. However, the objective is to determine the rate and direction of movement from the mill. The objective should be obtainable even with the uncertainty introduced by the unknown quantity of artificial recharge.

Darcy's Law, the underlying theory for flow in porous media.

$$\text{Darcy's Law} = Q = T\ I\ L$$

when coupled with a potentiometric map would allow a flow net analysis of the site. If accurate determinations or best estimates of each variable in Darcy's Law are made, then rates of movement for the shallow path can be predicted. Two of the variables, gradient (I) and length of flow path (L), are relatively easy to determine for the shallow aquifer. The other two variables are not as easy to determine or even estimate. Transmissivity (T) has been determined at well COT #1 as described in the next section of this report. A single transmissivity value is inadequate for this shallow aquifer. The remaining variable, Q, quantity of water flowing through any particular portion of the aquifer, has not been determined. Q would have two components. One component would be the natural recharge which can be determined once the flow of water in Sand Creek through Alkali Gap has been determined. The second Q component would be the quantity of water discharged to the various ponds which subsequently seeps to the shallow aquifer. The Q variable is the most difficult to determine and, in fact, even an estimate may be impossible. The reason for the difficulty lies in the steady state (constant flow) assumption necessary to use Darcy's Law in a flow net analysis. The artificial recharge to the shallow aquifer from the ponds has not been steady with time.

A non-steady state approach, which would be more sophisticated, would better model the shallow system. A non-steady state approach is not possible because of lack of data on discharge rates to the ponds with time.

AQUIFER - PUMP TEST

In order to assess the water-transmitting capabilities of shallow horizons in the vicinity of the Cotter tailings ponds, a single-well pump test was carried out at well number 1. The duration of the pumping period was 3½ hours, and recovery data was recorded for an additional 75 minutes after pumping stopped. Tables III-1 and III-2 show the reduced data for each test. This data is plotted in Figures III-3 and III-4. Original data from the field is given in Appendix A. Although minor fluctuations in the pumping rate appear to have occurred, it is reasonable to assume a steady-discharge of 33.6 gallons per minute throughout the pump test.

It is essential that the semi-log plot of Figure III-3 be analyzed with an understanding of the hydrogeology in the immediate vicinity of the pumped well, because field investigations show that geologic conditions are overall highly variable in the surficial deposits and underlying Poison Canyon Formation. Based upon the record of drilling of the pumped well, the static groundwater level in the well is derived from confining pressure on a lower water-bearing layer. Figure III-5 depicts the initial conditions for the pump test of this confined aquifer.

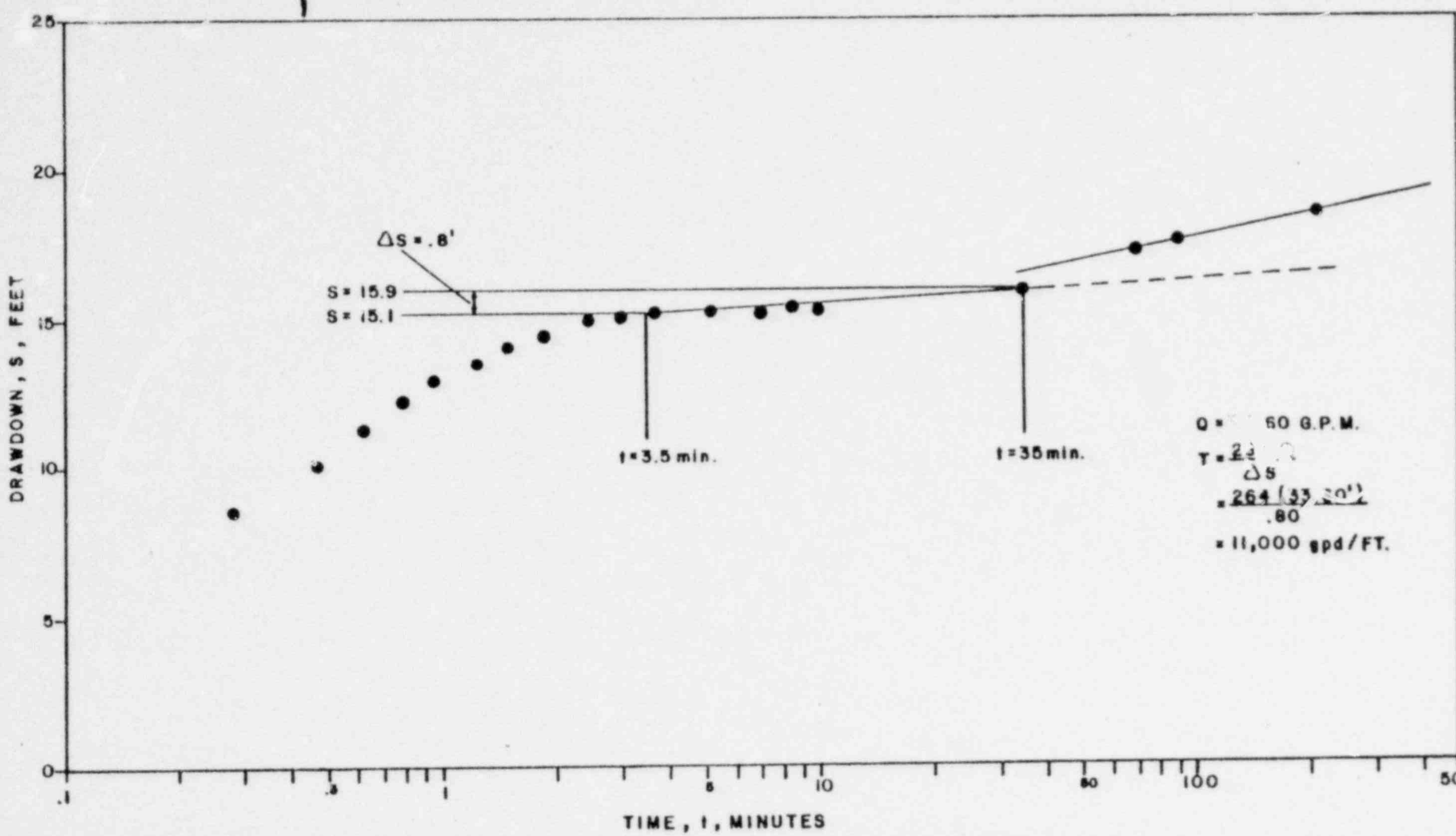
The Jacob straight line fitted through the points spanning the time period between 3.5 and 35 minutes in Figure III-3 is considered to be a valid approximation of the well function for transient flow in confined aquifers. The transmissivity shown on Figure III-3 was evaluated based upon this technique; details of the Jacob method are given in Appendix A. In addition, a second transmissivity was determined from the recovery data of Figure III-4. This value was also found by the Jacob method. The final value of T is taken to be 11,000 gal/day-ft.

TABLE III - [illegible]EDUCED DATA - AQUIFER PUMP TEST, SINGLE WELL, COT # (333), January 21, 1981, Canon City Mill Site

Elapsed time t (min)	drawdown S (ft)
0	0
.28	8.5
.47	10
.62	11.2
.79	12.2
.95	12.9
1.22	13.5
1.5	14
1.88	14.5
2.45	14.9
3.0	15
3.67	15.2
5.18	15.2
7	15.2
8.5	15.3
10	15.2
13	15.3
17	15.3
35	15.9
68	17.2
90	17.5
210	18.4

TABLE III - 2 REDUCED DATA - AQUIFER RECOVERY TEST, SINGLE WELL, COT # (333), January 21, 1981, Canon City Mill Site

Time Since Pumping Stopped	Total Time Since Pumping Started	Ratio	Residual Drawdown
t' (min)	t (min)	t/t'	S' (ft)
1	211	211	1.53
10	220	22	1.19
20	230	11.5	1.11
30	240	8	1.03
40	250	6.25	0.98
57	267	4.68	0.90
75	285	3.8	0.82

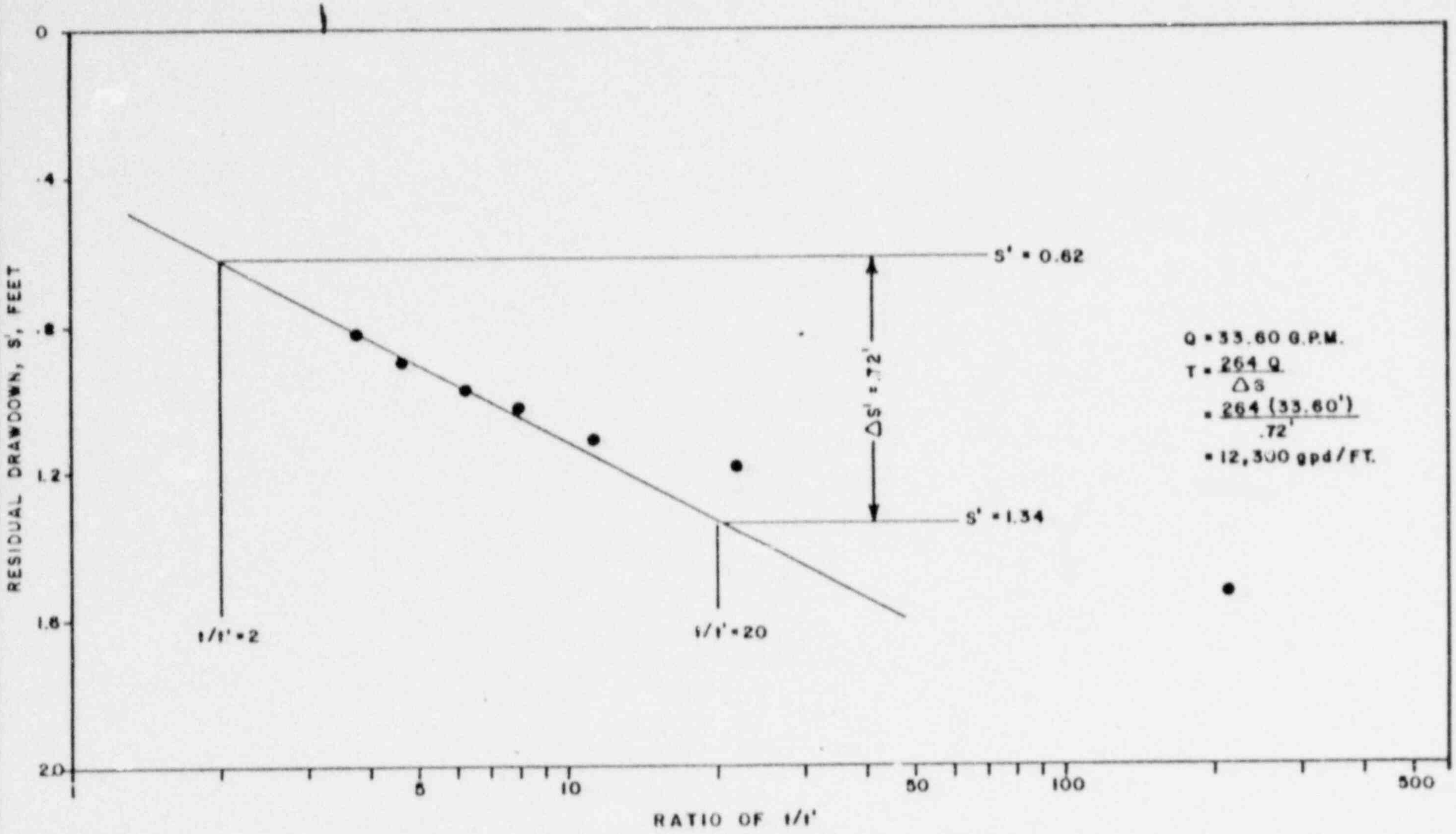


Wahler Associates

AQUIFER PUMP TEST, SINGLE WELL, COTTER #1 (333), 1-21-81
COTTER CANON CITY MILL SITE

FIGURE: III - 3

PROJECT # COT.102B100



Wahler Associates

AQUIFER RECOVERY TEST, SINGLE WELL, COTTER #1(333), 1-21-81
COTTER CANON CITY MILL SITE

FIGURE: III - 4

PROJECT # COT.102B100

The third rising limb of the curve of Figure III-3 is of particular interest, for part of it represents drawdown as a function of time after the aquifer ceased to be confined. Under unconfined conditions, the source of water to a well comes from lowering the water table. (dashed lines of Figure III-5). This in turn reduces the transmissivity, which further accelerates the rate of drawdown. When the drawdown is high as compared to the initial thickness of an unconfined aquifer, many of the assumptions of classical well-flow theory break down (Bear 1979, pp 331-339). That is a possible reason for the departures on the third limb.

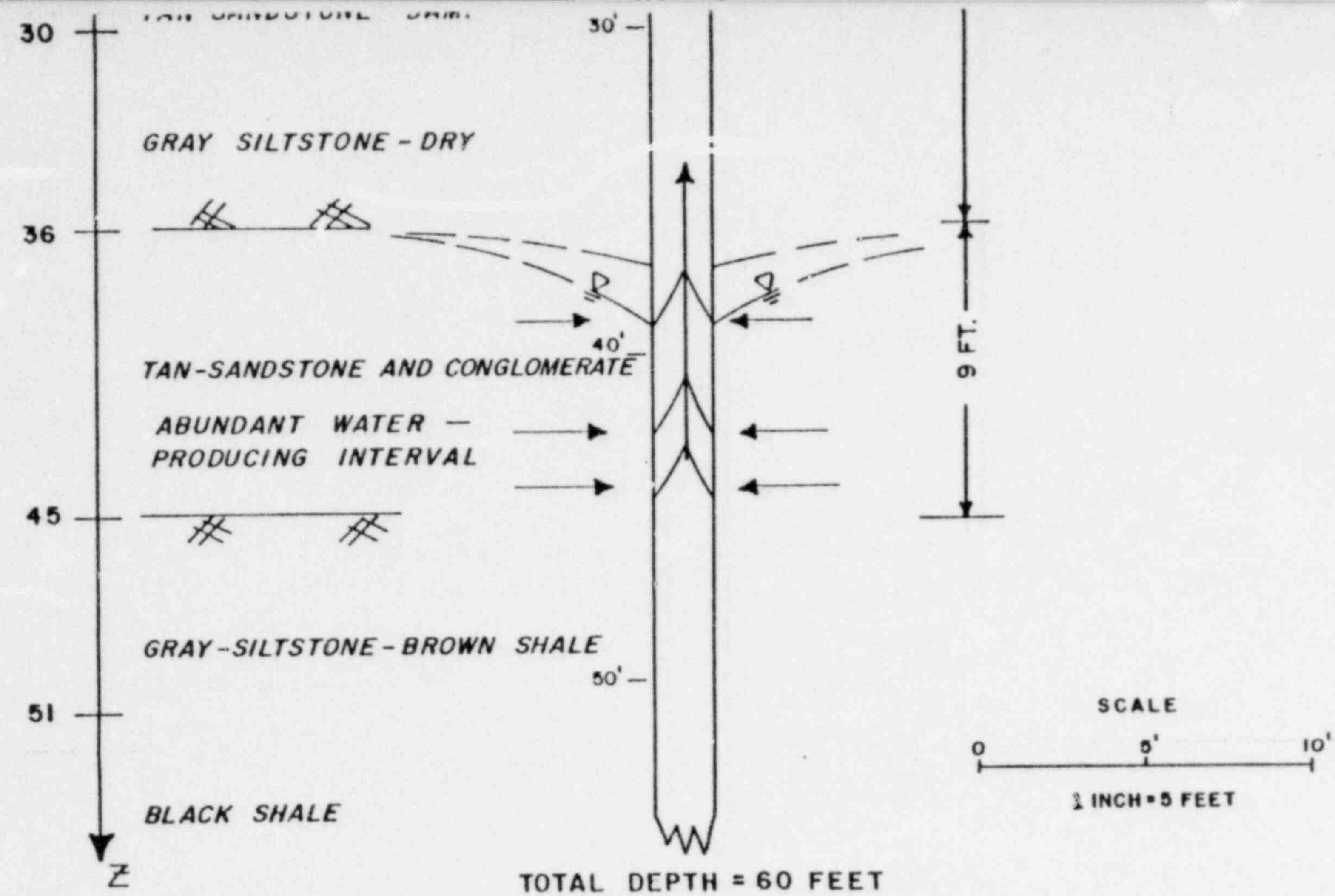
A barrier boundary located some distance from the pumped well can also be quite a valid explanation for the departure. If a barrier did exist, it would be quite difficult to assess the relative contributions of the large drawdown and the barrier. A pump test of longer duration is therefore recommended for the same well in addition to the installation of closer observation wells. Pump tests on other wells in the area are also recommended in order to test geologic uniformity.

The validity of the computed value for transmissivity remains to be determined. Assuming a 9 foot producing interval for the pumped well, the hydraulic conductivity is:

$$K = \frac{11{,}000 \text{ gal/day-ft}}{9 \text{ ft}} = \frac{1200 \text{ gpd}}{\text{ft}^2},$$

since T = Kb, where K is hydraulic conductivity and b is aquifer thickness.

Davis and DeWiest (1964, pg 164) state that this value lies within a range of K value characteristic of clean sands. Bouwer (1978, pg 38) also classifies this conductivity value as being typical of unconsolidated sands,

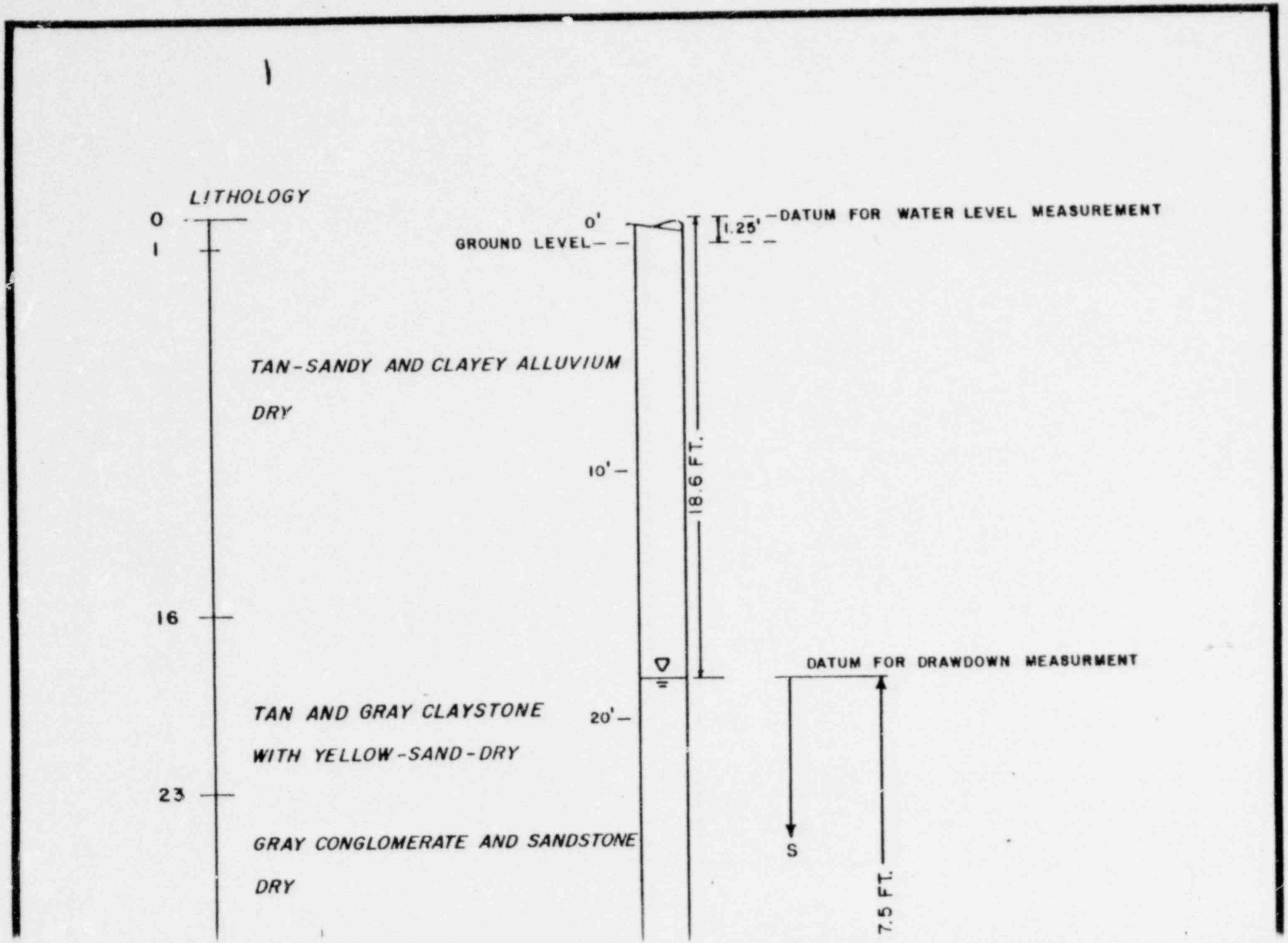


Wahler Associates

LITHOLOGY AND INITIAL GROUNDWATER CONDITIONS AT THE PUMPED WELL, AND A SCHEMATIC OF SOME FLOW PROCESSES.

FIGURE: III - 5

PROJECT: COT.102 B100



LITHOLOGY
0
1
16
23
TAN-SANDY AND CLAYEY ALLUVIUM
DRY
TAN AND GRAY CLAYSTONE
WITH YELLOW-SAND-DRY
GRAY CONGLOMERATE AND SANDSTONE
DRY
0'
GROUND LEVEL
10'
20'
1.25'
DATUM FOR WATER LEVEL MEASUREMENT
18.6 FT.
DATUM FOR DRAWDOWN MEASURMENT
S
7.5 FT.

gravels, and sand-gravel mixtures. In a future report entitled Part IV. Analytical Chemistry and Dispersion Analysis", a sequence of calculations shall be presented which show that a reasonable maximum specific discharge, q, that could occur along a possible shallow flow path from the Cotter ponds to the Lincoln Park Area is on the order of .5 ft/day. If Darcy's law is applied to such a flow situation, an average maximum hydraulic gradient may be computed between the ponds and Lincoln Park, which would then represent that gradient required (but not necessarily known at present) in order to have fluid flow to Lincoln Park at this given specific discharge and known value of K. Letting I = hydraulic gradient, then the maximum required value of i is computed as: $I = \frac{q}{K} = \frac{.5 \text{ ft/day}}{(1200 \text{ gal/day-ft}^2)(\frac{1 \text{ gal}}{7.5 \text{ ft}^3})}$

$$I = .003 ,$$

which is indeed a reasonable value. Based upon this result, monitor wells are necessary along a line to Lincoln Park in order to support or refute much of the above calculated data.

AQUIFER PARAMETERS AND THEIR VARIABILITY

There are two aquifer parameters which are characteristically reported in describing an aquifer -- transmissivity and coefficient of storage. Those parameters are determined through the conduction of an aquifer-pump test as described in the previous section. For this report there was not sufficient time to determine the coefficient of storage. The coefficient of storage requires a nearby observation well. For future aquifer-pump tests, installation of observation wells will be necessary. In determining direction and rate of movement, the coefficient of storage is not necessary.

A transmissivity of 11,000 gallons/day foot (gpd/ft) was calculated for COT #1, as described in the previous section. As pointed out, that value for transmissivity is reasonable for the type of material.

Caution should be exercised in extending the same transmissivity value to all portions of the shallow aquifer. As pointed out in the section describing the shallow aquifer, the system is a hydrologic unit consisting of alluvial, colluvial, and weathered Poison Canon rock types. It is safe to assume that the aquifer parameter transmissivity changes with material type. That implies anisotropic (physical parameters change in space) conditions. Even with anisotropic conditions, an economy of scale will allow analyses to be performed using different transmissivity values. It will be possible to better predict direction and rate of movement after more aquifer-pump tests have been performed. Determination of the spacial distribution of transmissivity will indicate the range of transmissivity and, therefore, a better prediction of direction and rate of fluid movement.

It should be noted that the Harding-Lawson Associates (1978) geophysical survey describes an anomaly near the location of COT #1 where the aquifer-pump test was performed. The report noted that the location may be one of increased porosity or hydraulic conductivity. Thus the transmissivity determined at COT #1 may, in fact, be toward the high end of the range for the shallow aquifer.

If indeed COT #1 is in a buried channel that has high hydraulic conductivity, then the rising limb of Figure III-3 is most likely a barrier boundary. The boundary, of course, would be the bank of the buried channel. An additional pump test in COT #1 with the use of an additional observation well, would be most useful.

POTENIOMETRIC MAP AND WATER LEVEL FLUCTUATIONS

A water table or poteniometric map can be utilized to construct a flow net analysis, as described in a previous section. Hershey-Wooderson

(1977) constructed such a map for the mill site. As part of Wahler's ongoing program, a poteniometric map (Figure III-6) was constructed using wells COT #1 - 2, and 4 - 6 and the water elevations for December, 1980. Appendix B contains the depth to water information (wells COT #1 - 6) for November and December, 1980 and January, 1981. Figure III-7 and III-8 illustrates water table elevation changes with time.

It should be noted on the water level fluctuation figures that the first readings were taken shortly after drilling and are probably not representative of natural conditions. It can be seen that very little change occurred between December, 1980 and January, 1981. A complete year's worth of data will enable an analysis of fluctuations and an interpretation of seasonal trends.

The poteniometric map was constructed using the water table elevations and the assumption that water levels generally mirror the surface topography in a simple system such as this. Additional points would be necessary to connect the contour lines between wells #1, 2, and 4; and wells #5 and 6.

WATER QUALITY

At the time of this report only one suite of water analyses has been completed (December, 1980 period). Table III-3 contains those analyses. Note that COT #1 has higher concentrations of all parameters in comparison to COT # 2 - 7. The analyses of other major cations and antons will be beneficial when completed.

INTERCEPTOR WELLS

Potential locations for interceptor wells are discussed in Part V of this report (Conclusions and Recommendations.

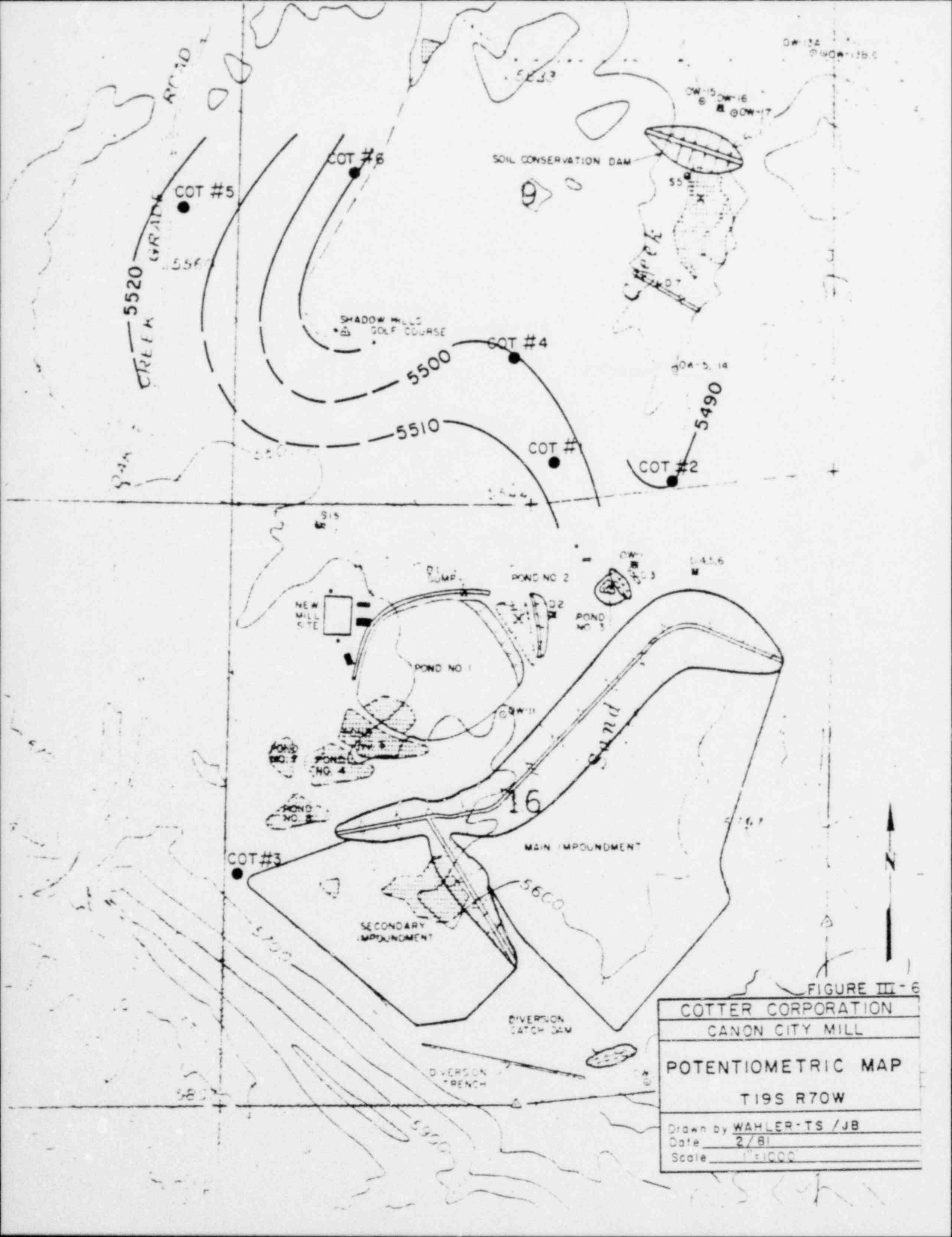


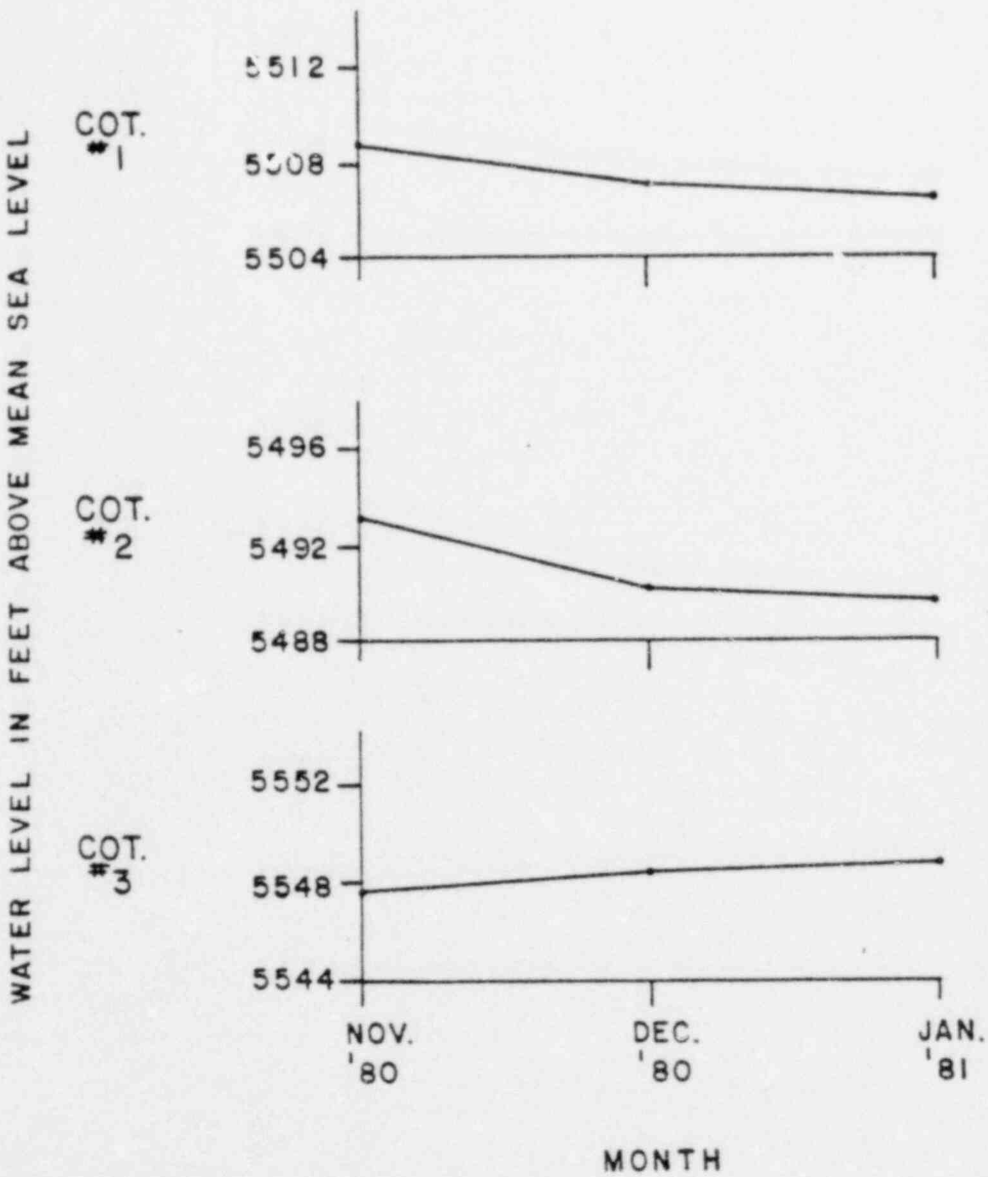
FIGURE III-6

COTTER CORPORATION
CANON CITY MILL

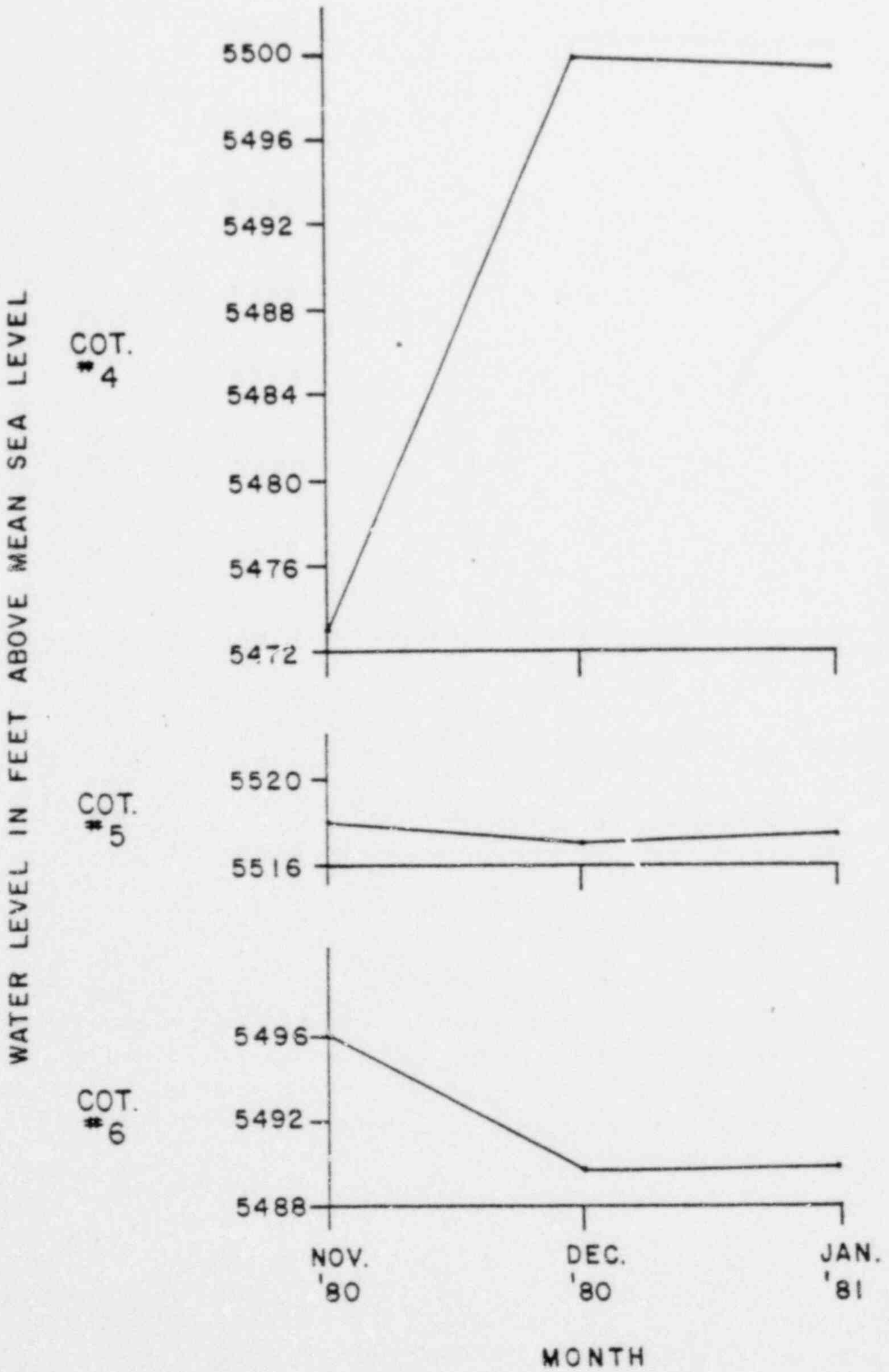
POTENTIOMETRIC MAP

T19S R70W

Drawn by WAHLER-TS /JB
Date 2/81
Scale 1"=1000'



Wahler Associates	WATER TABLE ELEVATIONS FOR WELLS: COTTER #1, #2 & #3	FIGURE: III-7
		PROJECT # COT. 102 B 100



Wahler Associates	WATER TABLE ELEVATIONS FOR WELLS: COTTER #1, #2 & #3	FIGURE: III-8 PROJECT # COT. 102 B 100

TABLE III-3 WATER QUALITY ANALYSES WELLS COT #1 - 6

Station No.	Date	Water Depth Below MP	Temp. C	Ph	Cond.	U	Mo.	V	Se	Cl	So4	Co3	TDS	230Th	210Pb	210Po	226
						mg/1								pCi/1			
133 COT #1	12/20	18.1	15.2	8.15	6,300	7.0	18.3	*.5	0.031	325	3,529	545	6,358	**	**	3.3±0.8	0.7±
134 COT #2	12/21	11.05	14.1	8.23	990	.09	*.2	*.5	0.001	26	297	289	661			1.1±0.9	0.0±
135 COT #3	12/26	120.55	14.2	7.91	1,900	.07	*.2	*.5	0.001	36	937	167	1,484			1.1±1.1	0.2±
136 COT #4	12/26	38.25	14.2	9.33	2,000	.07	*.2	*.5	0.012	79	745	56	1,279			1.0±0.5	0.0±
137 COT #5	12/26	37.2	14.4	8.13	3,000	.07	*.2	*.5	0.005	146	2,010	189	3,301			0.6±1.1	1.0±
138 COT #6	12/26	32.4	13.9	7.60	2,500	.07	*.2	*.5	0.008	74	1,350	334	2,347			0.9±0.5	0.3±

* Less than

** Analyses not yet received

REFERENCES

This list of references contains only those reports which di:ectly relate to the aquifer characteris ics.

Harding-Lawson Associates, 1978, Geophysical Investigation, Tailings Pond and Dam Seepage Study, Cotter Corporation, Canon City, Colorado: consultant's report to W. A. Wahler & Associates.

Hershey, L. A., 1977, Geohydrology of the Cotter Mill Environment: consultant's report to Nalco Environmental Sciences.

Logan, J., 1979(a), Recognition of Raffinates in the Groundwater of Lincoln Park: report to W. A. Wahler and Associates.

Logan, J., 1979(b), Ground-Water and Surface-Water Monitoring South of Canon City, Colorado: report to W. A. Wahler and Associates.

Nalco Environmental Sciences, 1977, Environmental Report for the Cotter Uranium Mill, Canon City, Colorado: consultant's report to the Cotter Corporation.

Runnells, D. In progress, Contamination of Ground and Surface Water by Uranium Mining and Milling: U. S. Bureau of Mines Project #J0295033.

Scott, G. R., 1977, Reconnaissance Geologic Map of the Canon City Quandrangle, Fremont County, Colorado: U. S. Geological Survey, Miscellaneous Field Map MR-892.

Wahler, W. A., & Associates, 1978(a), Cotter Corporation Uranium-Vanadium Tailings Impoundment, Canon City, Colorado: consultant's report to Mountain States Mineral Enterprises, Inc.

Wahler, W. A. and & Associates, 1978(b), Investigations Related to Seepage From the Existing Cotter Tailings Impoundments: report to Cotter Corporation.

APPENDIX A.

ORIGINAL FIELD DATA AND ANALYTICAL DETERMINATION OF AQUIFER TRANSMISSIVITY

The method of analysis used for this pump test is the Jacob's Modified Non-Equilibrium Formula. This method is a modification of the Non-Equilibrium Well Equation developed by Theis. The derivation of the Theis Formula is based on the following assumptions:

1) The aquifer is isotropic, homogeneous, fully saturated and confined.

2) The aquifer has infinite areal extent.

3) The well is fully penetrats the entire thickness of the aquifer.

4) The well has an infinitesimal (reasonably small) diameter.

5) Water removed from storage responds simultaneously with the change of pressure head.

The Theis Formula is: $S = \frac{114.6Q}{T} W(u)$,

where
- S = drawdown in feet
- Q = pumping rate, in gallons per minute
- T = transmissivity, in gallons per day per foot
- W(u) = the well function of u

period the value of "u" is probably larger than 0.02, so the modified formula is not applicable within that period of time. The transmissivity is calculated from the pumping rate and from the slope of the time-drawndown graph by using the following relationship:

$$T = \frac{264Q}{\Delta S}$$

where:

T = transmissivity in gallons per day per foot

Q = pumping rate in gallons per minute

ΔS = slope of the time-drawdown graph expressed as the change in drawdown between any two values of time on the log scale whose ratio is 10.

After pumping has been stopped, the water level in the well will begin to rise to its original position, this being the recovery of the well. The rise of the water level is measured as residual drawdown. The recovery method of analysis has the same restriction as Jacob's method and the same formula is applied. Transmissivity calculations and values are shown in Figures III-3 and III-4.

Wahler Associates
Geotechnical Engineering

PUMP TEST RECORD OF OBSERVATION / PUMPING WELL COT # 1 / 333

SHEET 1 OF 2

COTTER MILL SITE CANON CITY COLORADO	[illegible]	PROJECT NO. COT 102B 100
COT # 1 333	COT # 2	9:45	3:30
8"	DEPTH 60'	DEPTH	DISTANCE OBS. TO PUMPING	TOP OF CASING	1' 3"
55 BELOW CASING	—	RECORDER T. SCHULTZ	CONTRACTOR ALPINE DRILLING
5 HP GOULDS 230 SINGLE PHASE	FOREMAN TOM SCHULTZ	DAVE KNIGHT
ELECTRICAL EQUIPMENT 30 KV GENERATOR	INSPECTOR JOEL SIEGEL	ALPINE DRILLING

TIME & DAY	TOTAL ELAPSED TIME T MIN	TOTAL ELAPSED TIME T DAY	T/R² DAY/FEET²	ELAPSED TIME MIN	WATER LEVEL BELOW METERING POINT FEET	DRAWDOWN FEET	ORIFICE PIEZOMETER READING INCH	DISCHARGE (ORIFICE) GPM	DISCHARGE (BY) GPM	REMARKS
[illegible]	0	[illegible]			18.6			1		30 - [illegible]
[illegible] :5	[illegible]				22.3					25 - 2' 7"
	[illegible]				[illegible]					25 + 2' 1"
	[illegible]				28.5					25 + 3' 7"
	[illegible]				29.8					30 - 2½"
	[illegible]				30.8					30 + 10"
	7				31.5					30 + 1' 5½"
	[illegible]				32.1					30 + 2' 1½"
	[illegible]				32.6			55	50	[illegible] 30 + 7½
	[illegible]				33.1					30 + 3' 1" (2' 7½)
	[illegible]				33.5					30 + 3' 5½"
	[illegible]				33.6					35 - 1' 4½"
*	[illegible]				33.8			[illegible]	[illegible]	[illegible]
	[illegible]				33.8					35 - 1' 2"
	[illegible]				33.8			[illegible]	[illegible]	[illegible]
	[illegible] 30				33.9			[illegible]	[illegible]	[illegible] - 1 F T 3
	[illegible]				33.8			331	[illegible]	35 - 1' 2"
	[illegible]				33.9			432	33.61	35 - 1' 1½"
	[illegible]				33.9			566	[illegible].5	35 - 1' 1"
	[illegible]				—			800	33.4	
	[illegible]				—			[illegible]2	33.55	
	[illegible]				34.5			—		35 - 6½"
	[illegible]				—			[illegible]	[illegible]	
	[illegible]				35.8			—		35 + 9"
	[illegible]				—			[illegible]	33.[illegible]	
	[illegible]				36.1			—		35 + 1' 1"
	[illegible]				—			[illegible]	[illegible]	
	149				—			5010	33.7	

(Written vertically in DAY column: WATER SAMPLES COLLECTED BY [illegible])

* 35 - 1 FT 3 INCH

Wahler Associates
Geotechnical Engineering

PUMP TEST RECORD OF OBSERVATION / PUMPING WELL 333 SHEET 2 OF 2

TIME & DAY	TOTAL ELAPSED TIME T MIN	TOTAL ELAPSED TIME T DAY	T/R² DAY/FEET²	ELAPSED TIME MIN	WATER LEVEL BELOW METERING POINT FEET	DRAWDOWN FEET	ORIFICE PIEZOMETER READING INCH	DISCHARGE (ORIFICE) GPM	DISCHARGE (BY) GPM	REMARKS
	[illegible]:30 +				37.0			7:70		35+2' ½"
		(Recovery)								[illegible]
		(New [illegible] ([illegible]))						[illegible]		(7130 [illegible])
	5:00									30 - 1' 3½"
	[illegible]									35 - 1' 11"
	2.5									20 + 1½"
	1:00									20' - 1½"
	10:00									20' - 2½"
[illegible]	20:00									20' - 3½"
	30:00									20' - 4½"
	40:00									20' - 5"
	57:00									20' - 6" -
[illegible]	[illegible]									20' - 7"

[illegible] = 4:47:12
[illegible] [illegible]
[illegible] [illegible]

APPENDIX B

WATER TABLE ELEVATIONS FOR WELLS COT 1- 6

Well	Cement Base Elevation (feet)	Height of Measuring Point Above Cement (feet)	Nov.80*		Dec.80**		Jan. 81**	
			Static Depth (feet)	Elevation (feet)	Static Depth (feet)	Elevation (feet)	Static Depth (feet)	Elevation (feet)
1	5524.34	0.66	16.5	5508.5	18.1	5506.9	18.6	5506.4
2	5499.14	1.96	7.8	5493.3	11.05	5490.1	11.25	5489.9
3	5668.79	0.25	121.1	5547.9	120.55	5548.5	120.35	5548.7
4	5537.59	0.56	65.3	5472.9	38.25	5499.9	38.75	5499.4
5	5553.66	0.54	36.2	5518.0	37.2	5517.0	36.7	5517.5
6	5518.01	4.08	26.1	5496.0	32.4	5489.7	32.15	5489.9

* Wahler Associates

** Cotter Corporation