INVESTIGATION OF CHECK DRAINS DISCHARGING INTO THE DELTA-MENDOTA CANAL

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SUMMARY

The staff of the Agricultural Unit of the Central Valley Regional Water Quality Control Board investigated the check drains of the Delta Mendota Canal as potential sources of selenium to this canal and the Mendota Pool. On 22 and 29 July 1986, Board staff surveyed the drains between canal mile posts 70.00 and 115.57 (O'Neill Forebay and the Mendota Pool). Of the 93 drains identified by the U.S. Bureau of Reclamation, 20 were discharging to the Delta Mendota Canal, an additional five showed recent signs of having discharged, and 11 either could not be found or were abandoned. The water being discharged was for the most part agricultural tail water, however, in some instances subsurface drainage was mixed with the tail water. A drainage area study was made for each check drain. Using field observation and information from Regional Board files, the drainage area of each active check drain was determined. In general, the drainage area of each check drain is the contiguous land extending upslope to the next major hydrologic barrier (major canals or highways) and ranges in size from 10 to over 1000 acres. In some instances these drainage areas include subsurface drainage sumps. Nineteen check drains are suspected of receiving subsurface drainage.

INTRODUCTION

The Delta-Mendota Canal (DMC) transports water south along the west side of the San Joaquin Valley to the Mendota Pool near Mendota, California. The water is mainly used by agriculture, but some is used to maintain wetlands habitat and some even finds its way into municipal supplies. Monitoring of the DMC has shown elevated selenium levels (1-10 ug/L)* in its lower reach; similarly monitoring of the Mendota Pool has shown elevated selenium levels (1-4 ug/L)**. In consideration of the uses of the water from the DMC and Mendota Pool, these levels of selenium are cause for concern.

The Delta-Mendota Canal

The DMC is a major water transport feature of the federal Central Valley Project (CVP). It conveys water from the Sacramento-San Joaquin Delta south to the Mendota Pool, a distance of 117 miles by canal. Approximately 70 miles south of the Delta, the DMC is joined to the San Luis Reservoir(an off-stream storage reservoir used by the CVP and State Water Project) by O'Neill Forebay. The reach of the DMC between the Delta and O'Neill Forebay is located at the eastern toe of the coastal mountains. However, the lower reach cuts southeast across farmland to connect with the Mendota Pool.

The portion of the DMC of interest is the southern reach between O'Neill Forebay and the Mendota Pool. This reach has a significant amount of irrigated agriculture upslope of it. It crosses through or downslope of areas with high selenium subsurface drainage water. Additionally, water quality testing of the DMC done by the United States Bureau of Reclamation (USBR) indicates elevated selenium values in this reach.

* USBR Monitoring; submitted via letter dated 24 April 1987.
**Personal Communication: Robert Capehart, Manager, San Luis Canal Company.

There are four physical features of the DMC of interest here. The upslope berm of the canal was constructed with check drains. These drains allow high flows (any flow with an elevation higher than the water level in the canal) to enter the canal. They were included to prevent over topping of the upslope berms by flood flows. A second feature of interest are the pressure relief valves located in the bottom of the concrete lined sections to prevent hydraulic uplift from buckling the bottom or caving in the sides of the canal. A third feature are the sub-surface drains installed along the upslope side of the canal along its southern end (from canal milepost 100 to canal milepost 110) to lower ground water elevations. These drains are pumped into the DMC. Lastly, the southern end of the canal is earth lined. The concrete lined portion ends at canal milepost 97, and the canal is earth lined from there to the Mendota Pool.

The importance of these features is as follows:

1. Check Drains. The check drains are potentially a major source of inflow to the DMC even during the nonrainy period and a potential source of selenium.

2. Pressure Relief Valves. The pressure relief valves could only be sources of inflow when the canal water elevation is low; for instance when the DMC is shut down and dewatered.

3. Subsurface Drains. Monitoring confirms these drains contribute selenium to the DMC.

4. Earth Lined Section. As with the pressure relief valves, the earth lined section could only have ground water inflow when the canal water level is low.

The likely sources of selenium to the DMC are the discharges of the USBR's subsurface drains and the check drains. The USBR monitors the discharges of their subsurface drains and reports the information to the Regional Board. The purpose of this study is to investigate the check drains as a source of selenium to the DMC.

DRAIN SURVEY

On 22 and 29 July 1986, the DMC was inspected between milepost 70.00 and milepost 115.57 by Regional Board staff. The USBR document 'Milepost at Structure Sites, Delta-Mendota Canal' (December 1985) was used to locate and identify check drains. Some recently constructed road drains not listed were found.

In total, 93 check drains plus one pumped discharge were identified or searched for along the 45 mile stretch of the DMC between O'Neill Forebay and the Mendota Pool. Of the 93 check drains, 20 were flowing, five showed evidence of recent use, and 11 either could not be located or had been abandoned. In general all operational drains could receive storm flows. During the survey all the flowing drains were receiving agricultural runoff. All the drains showing evidence of having recently flowed were adjacent to freshly irrigated agricultural crops. An additional 25 drains showed strong possibilities of receiving agricultural flows by virtue of being connected to field drainage systems and being located at the low point of field(s) in production.

To determine the type of drainage flowing into the DMC, the specific conductance (EC) of the discharge was measured in the field. EC values above 500 umhos/cm were assumed to be indicative of the presence of subsurface drainage. Of the 20 flowing drains, 12 had EC values greater than 500 umhos/cm. Eight of the 12 drains with EC values greater than 500 umhos/cm were sampled for analysis for minerals, selected trace elements and selenium. At one of the sampled drain sites (MP 83.02) there was the distinct odor of a synthetic organic chemical in the discharge.

Table 1 summarizes the information available on the check drains and the field observations made by Regional Board staff. Tables 2A, 2B, and 2C present the results of laboratory analyses of the samples taken from the eight flowing drains.

The selenium analyses (Table 2C) were done by the USBR/USGS laboratory in Sacramento. The analyses for trace elements (Table 2B) and minerals (Table 2A) were done by ANLAB of Sacramento.

Selenium levels above the detection limit were found in five of the eight samples. The highest selenium concentrations were from sites MP 88.60 (23 ug/L) and MP 89.67 (22 ug/L); both are known to have tile drains in their drainage areas.

DRAINAGE AREAS

The approximate drainage area for each check drain was determined using field inspection, topographical maps, and information available in Regional Board files. During September 1986, Regional Board staff surveyed the area immediately upslope of the DMC between O'Neill Forebay and the Mendota Pool to determine surface runoff patterns, identify and confirm the location of subsurface drain sumps and to determine the location and direction of flow of agricultural surface drains. The information from the field inspection was combined with information supplied by the drainage and irrigation districts on the location of surface drains and subsurface drainage facilities, and U.S. Geological Survey 7.5 minute topographical maps to produce maps of the estimated drainage area for each check drain.

Figures 1A through 1L present the estimated drainage areas for the check drains. Subsurface drainage sumps are also indicated on these figures. However, we feel the location of subsurface drainage sumps is incomplete. There are likely to be additional sumps in interior areas not easily accessed from public roads. This not withstanding, we were able to identify 19 check drains as possibly receiving subsurface drainage. This was done on the basis of either location of a known sump in the drainage area or the finding of EC values above

500 umhos/cm in check drain discharges. Table 3 lists check drains suspected of receiving tile drainage.

It should be noted that the drainage areas tributary to each check drain are quite changeable. The flow pattern and points of discharge of the agricultural surface drains are easily altered. Some are probably changed each year to accommodate different crops and changes in land ownership.

CONCLUSIONS AND RECOMMENDATIONS

1. The check drains are a source of selenium and other trace elements to the DMC.
2. In general, each discharge is small, contributing only a fraction of 1 ug/L to the overall selenium concentration in the DMC and Mendota Pool. However, the cumulative effect of each check drain discharge, plus USBR drains, on top of the base load, especially when the flow in the DMC is low, could be significant.
3. Elevated levels of selenium in the DMC are a management problem and should be able to be controlled to protect beneficial uses. The key to controlling selenium levels in the DMC is the coordination of flow and discharges. When the flow is very low, discharges need to be curtailed or diverted elsewhere.
4. A distinct organic smell was noted at one discharging check drain. Because of the close proximity of irrigated fields to the DMC there is a high potential for the check drains discharges to contain agricultural chemicals. An investigation directed at this possibility should be done.

TABLE 1

DELTA-MENDOTA CANAL CHECK DRAINS

MP	TYPE	FLOWING	SAMPLED	EC	FIELD AG	FIELD STORM	NOT FOUND OR ABANDONED
70.64	24" Concrete Pipe w/Flap Gate					X	
70.69	30" Concrete Pipe w/Flap Gate					X	
71.35	24" Concrete Pipe					X	
71.79	18" Concrete Pipe					X	
72.25	24" Concrete Pipe					X	
72.25	6" Steel Pipe				X		
72.61	24" Concrete Pipe w/Flap Gate				X		
72.91	18" Concrete Pipe w/Flap Gate					X	
73.12	18" Concrete Pipe w/Flap Gate					X	
73.47	18" Concrete Pipe				X	X	
73.96	12" CMP					X	
74.35	30" Concrete Pipe w/Flap Gate					X	
74.62	30" Concrete Pipe				X		
*	CMP Road Drain					X	
74.80	18" Concrete Pipe					X	
*	CMP Road Drain					X	
*	CMP Road Drain					X	
*	CMP Road Drain					X	
75.16	10" CMP					X	

* = New drains
x = Positive response

TABLE 1
(Continued)

DELTA-MENDOTA CANAL CHECK DRAINS

MP	TYPE	FLOWING	SAMPLED	FIELD EC	SOURCE AG	SOURCE STORM	NOT FOUND OR ABANDONED
75.18	24" Concrete Pipe					X	
75.25	10" CMP					X	
75.38	12" CMP						X
75.73	24" Concrete Pipe w/Flap Gate				X	X	
76.04	18" Concrete Pipe				X		
76.45	24" Concrete Pipe w/Flap Gate				X		
76.64	3-30' Concrete Pipe w/Flap Gate				X		
76.73	18" Concrete Pipe w/Flap Gate				X		
77.10	18" Concrete Pipe				X		
77.33	3' x 2'6" Concrete Box				X		
77.58	24" Concrete Pipe				X		
78.02	24" Concrete Pipe				X		
78.35	12" Steel Pipe						X
78.59	6' x 3'3" Concrete					X	
78.87	24" Concrete Pipe	X		300 umhos/cm	X		
79.12	14" Transite Pipe				X		

* = New drains
x = Positive response

TABLE 1
(Continued)

DELTA-MENDOTA CANAL CHECK DRAINS

MP	TYPE	FLOWING	SAMPLED	FIELD EC	SOURCE AG	SOURCE STORM	NOT FOUND OR ABANDONED
79.13	10" Steel Pipe				X		
79.37	18" Concrete Pipe				X		
79.50							X
*	Steel Pipe, Pumped				X		
80.33	30" Concrete Pipe w/Flap Gate	X	X	530 umhos/cm		X	
80.68	24" Concrete Pipe				X		
81.13	30" Concrete Pipe	X		380 umhos/cm		X	
81.53	5' x 2'6" Concrete Box				X		
81.70	12" CMP	X		520 umhos/cm		X	
81.78	30" Concrete Pipe				X		
82.17	30" Concrete Pipe w/Flap Gate					X	
82.59	24" Concrete Pipe				X		
82.81	18" Concrete Pipe	X	X	860 umhos/cm	X		
83.02	30" Concrete Pipe	X	X	1600 umhos/cm	X		
83.18	5' x 2'6" Concrete Box				X	X	
83.45	30" Concrete Pipe	X		450 umhos/cm	X		
83.80	18" Concrete Pipe	X			X		

* = New drains
x = Positive response

TABLE 1
(Continued)

DELTA-MENDOTA CANAL CHECK DRAINS

MP	TYPE	FLOWING	SAMPLED	FIELD EC	SOURCE AG	SOURCE STORM	NOT FOUND OR ABANDONED
83.90	18" Concrete Pipe					X	
84.31	5' x 2'6" Concrete Box					X	
84.58	18" Concrete Pipe				X		
84.82	18" Concrete Pipe w/Flap Gate				X		
85.16	5' x 2'6" Concrete Box				X		
85.69	30" Concrete Pipe				X		
86.07	30" Concrete Pipe				X		
86.51	2'6" x 2'6" Concrete Box	X		270 umhos/cm	X		
86.72	18" Concrete Pipe	X		310 umhos/cm	X		
86.96	30" Concrete Pipe	X		300 umhos/cm	X		
87.47	18" Steel Pipe						
87.66	5' x 2'6" Concrete Box					X	
88.12	24" CMP	X		430 umhos/cm	X		
88.13	10" CMP					X	
88.60	5' x 2'6" Concrete	X	X	1700 umhos/cm	X		
89.35	5' x 2'6" Concrete				X		

* = New drains
x = Positive response

TABLE 1
(Continued)

DELTA-MENDOTA CANAL CHECK DRAINS

MP	TYPE	FLOWING	SAMPLED	FIELD EC	SOURCE AG	SOURCE STORM	NOT FOUND OR ABANDONED
89.67	5' x 2'6" Concrete Box	X	X	2100 umhos/cm	X		
90.16	24" Concrete Pipe				X		
90.52	24" Concrete Pipe						X
96.50	3' x 2'6" Concrete Box					X	
97.26	5' x 2'6" Concrete Box						X
100.52	2' x 2'6" Concrete Box						X
101.84	20 x 2'6" Concrete Box				X		X
102.13	2'6" x 2'6" Concrete Box	X		650 umhos/cm	X		
102.44	2'6" x 2'6" Concrete Box						X
102.86	2'6" x 2'6" Concrete Box	X	X	1200 umhos/cm	X	X	
103.21	2'6" x 2'6" Concrete Box	X	X	900 umhos/cm	X	X	
104.19	2'6" x 2'6" Concrete Box	X		760 umhos/cm	X	X	
104.37	2'6" x 2'6" Concrete Box	X		800 umhos/cm	X		

* = New drains
x = Positive response

TABLE 1
(Continued)

DELTA-MENDOTA CANAL CHECK DRAINS

MP	TYPE	FLOWING	SAMPLED	FIELD EC	SOURCE AG	SOURCE STORM	NOT FOUND OR ABANDONED
104.87	2'6" x 2'6" Concrete Box				X		
105.37	2'6" x 2'6" Concrete Box					X	
105.60	2'6" x 2'6" Concrete Box					X	
106.12	2'6" x 2'6" Concrete Box						X
106.77	2'6" x 2'6" Concrete Box					X	
107.24	2'6" x 2'6" Concrete Box				X	X	
107.78	2'6" x 2'6" Concrete Box				X	X	
108.36	2'6" x 2'6" Concrete Box	X	X	960 umhos/cm	X		
109.12	2'6" x 2'6" Concrete Box						X
109.50	2'6" x 2'6" Concrete Box				X		
110.27	18" Concrete Pipe				X		
110.83	2'6" x 2'6" Concrete Box						X
115.37							X

* = New drains
x = Positive response

TABLE 2A

MINERALS IN CHECK DRAIN DISCHARGES TO THE DMC

Check Drain	Date Sampled	Sulfate (mg/l)	Chloride (mg/l)	Total Alkalinity (mg/l as $CaCO_3$)	Specific Conductance (umhos/cm)
MP80.33	7/22/86	52	56	70	300
MP82.81	7/22/87	120	110	90	460
MP83.02	7/22/87	250	220	110	910
MP88.60	7/29/87	470	160	88	1600
MP89.67	7/29/87	580	240	140	2100
MP102.86	7/29/87	230	84	230	1100
MP103.21	7/29/87	140	65	190	810
MP108.36	7/29/87	150	76	180	880

TABLE 2B

TRACE ELEMENTS* IN CHECK DRAIN DISCHARGES TO THE DMC

Check Drain	Date Sampled	Boron (mg/l)	Copper (ug/l)	Chromium (ug/l)	Nickel (ug/l)	Zinc (ug/l)
MP80.33	7/22/86	0.4	5	3	6	2
MP82.81	7/22/87	0.5	4	3	<5	<1
MP83.02	7/22/87	1.0	5	2	9	3
MP88.60	7/29/87	1.1	29	29	75	200
MP89.67	7/29/87	1.5	14	13	20	4
MP102.86	7/29/87	1.3	4	3	<5	5
MP103.21	7/29/87	0.8	4	4	5	5
MP108.36	7/29/87	0.9	5	3	5	4

*Samples were also analyzed for lead, mercury and molybdenum. No levels above their detection limits (Pb <5 ug/l, Hg <0.5 ug/l, and Mo <5 ug/l) were reported.

TABLE 2C

SELENIUM IN CHECK DRAIN DISCHARGES TO THE DMC

Check Drain	Date Sampled SE	Concentration
MP80.33	7/22/86	<1 ug/l
MP82.81	7/22/86	3
MP83.02	7/22/86	8
MP88.60	7/29/86	23
MP89.67	7/29/86	22
MP102.86	7/29/86	<1
MP103.21	7/29/86	<1
MP108.36	7/29/86	3

TABLE 3

CHECK DRAINS SUSPECTED OF RECEIVING SUBSURFACE DRAINAGE

Check Drain	Indication
MP80.33	High EC
MP81.70	High EC
MP82.81	High EC
MP83.02	High EC
MP86.96	Sump
MP88.12	Sump
MP88.60	High EC, Sump
MP89.67	High EC, Sump
MP96.50	Sump
MP100.91	Sump
MP102.13	High EC
MP102.86	High EC, Sump
MP103.21	High EC
MP104.19	High EC, Sump
MP104.37	High EC, Sump
MP105.60	Sump
MP107.24	Sump
MP108.36	High EC
MP109.50	Sump

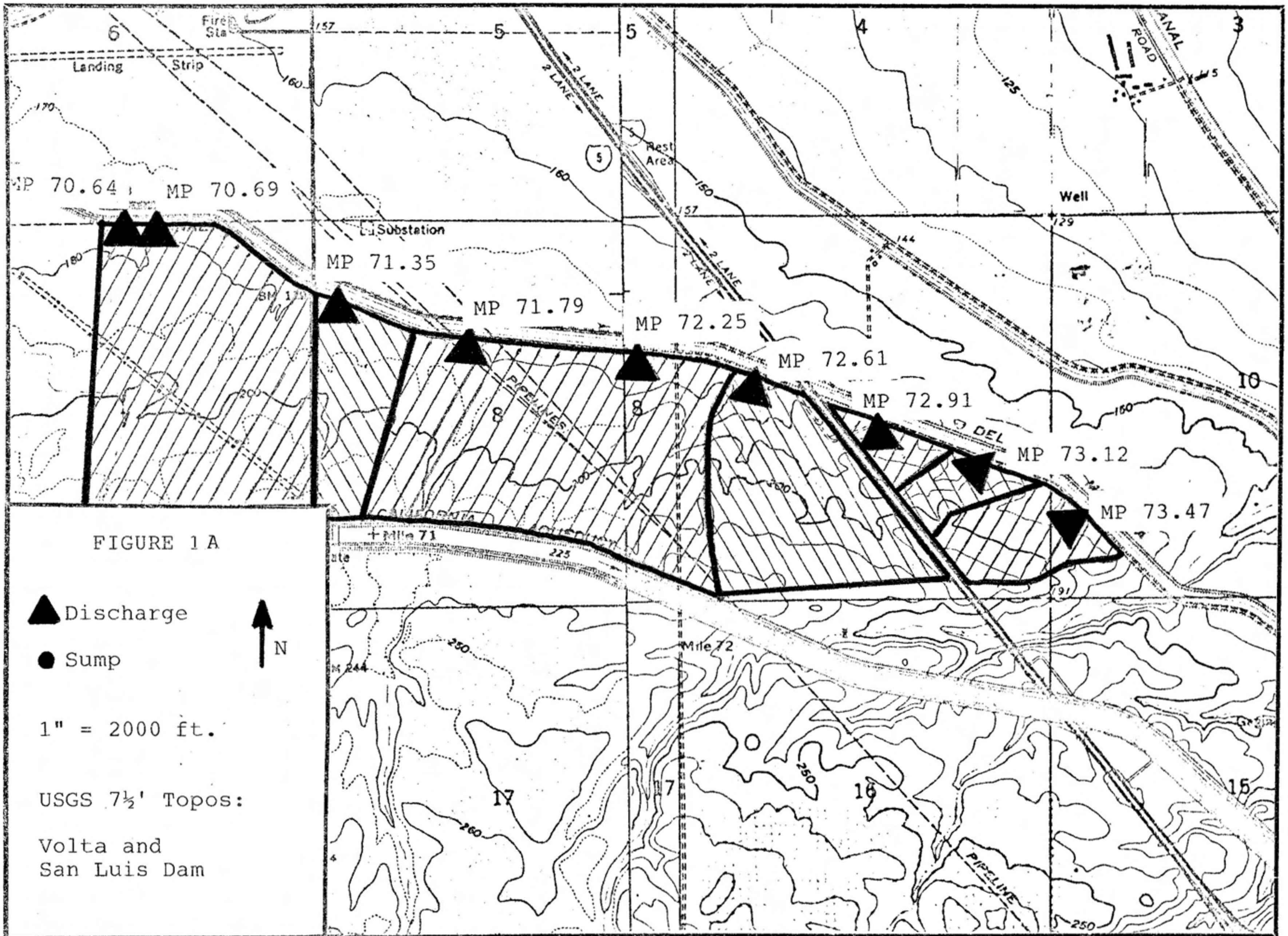

MP 70.64
MP 70.69
MP 71.35
MP 71.79
MP 72.25
MP 72.61
MP 72.91
MP 73.12
MP 73.47
Landing Strip
Fire Sta
Substation
Rest Area
2 LANE
PIPELINES
PIPELINE
Well
Mile 71
Mile 72
ROAD
Discharge
Sump
N
1" = 2000 ft.
USGS 7½' Topos:
Volta and
San Luis Dam

FIGURE 1 A

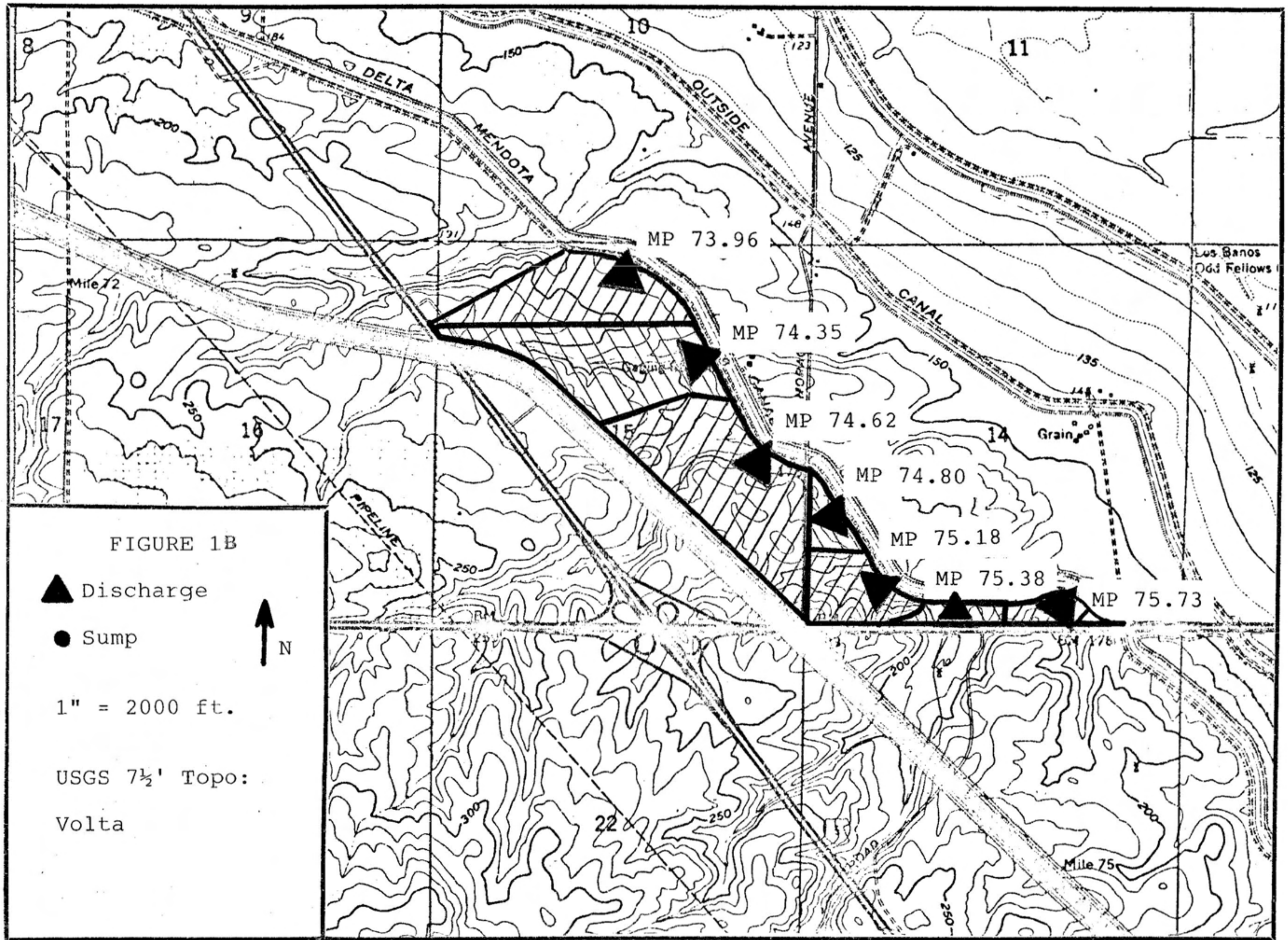


FIGURE 1B

▲ Discharge

● Sump

1" = 2000 ft.

USGS 7½' Topo: Volta

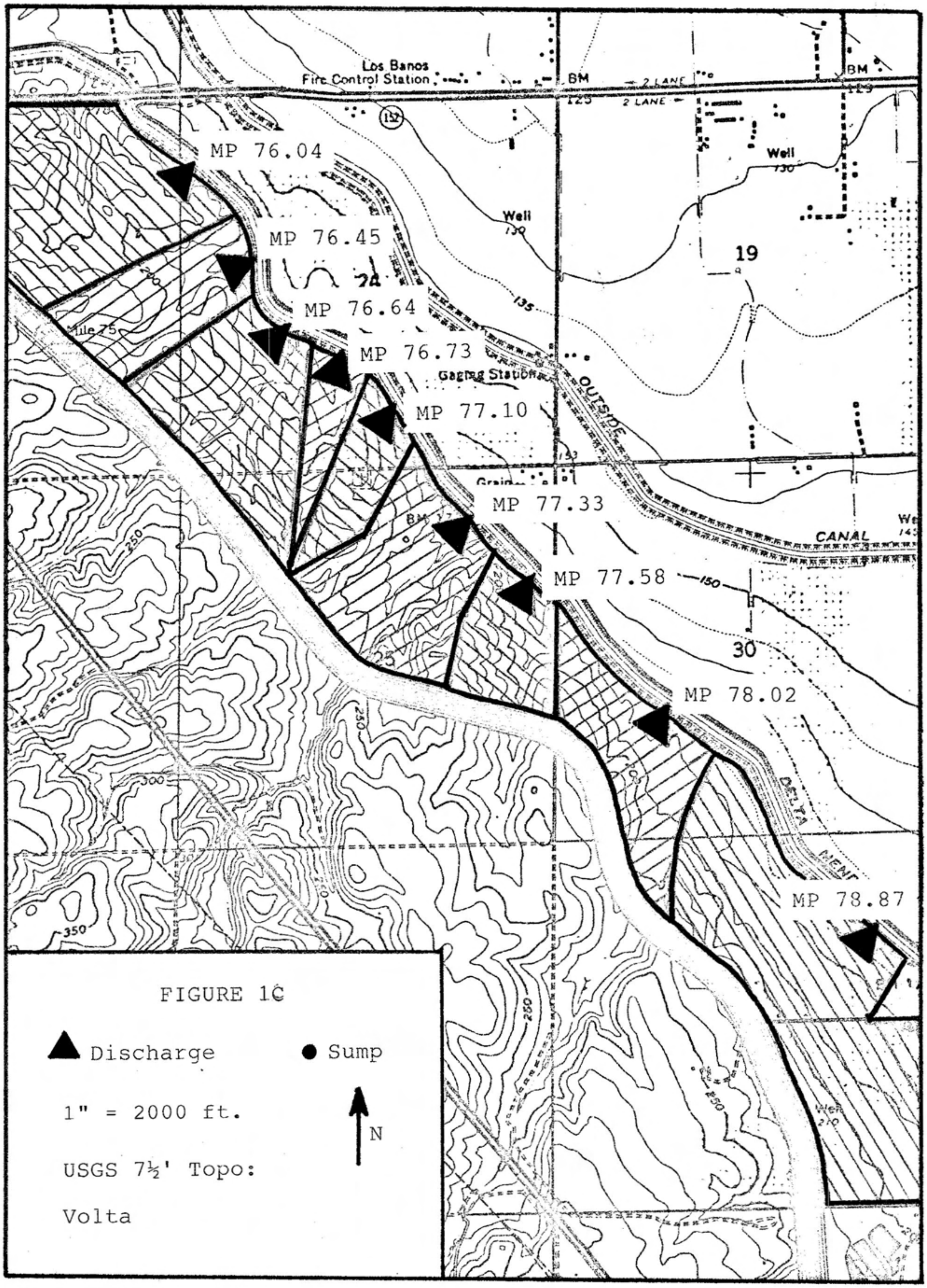
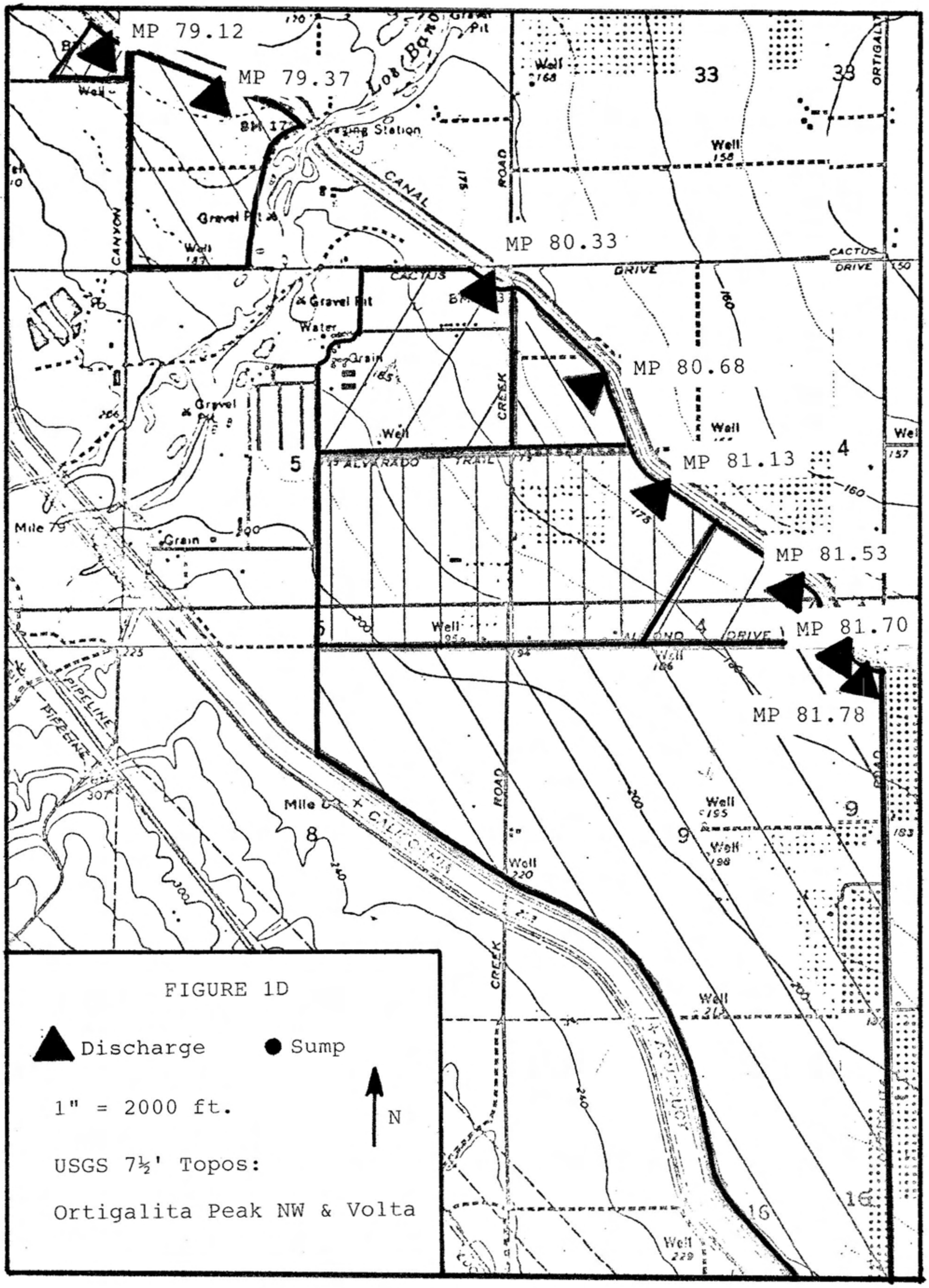

Los Banos
Fire Control Station
BM
125
2 LANE
BM
129
152
Well
130
Well
130
19
24
135
Mile 75
Gaging Station
OUTSIDE
153
CANAL
150
30
DELTA
250
300
350
MP 76.04
MP 76.45
MP 76.64
MP 76.73
MP 77.10
MP 77.33
MP 77.58
MP 78.02
MP 78.87
Discharge
Sump
1" = 2000 ft.
USGS 7½' Topo:
Volta
N

FIGURE 1C


MP 79.12
MP 79.37
MP 80.33
MP 80.68
MP 81.13
MP 81.53
MP 81.70
MP 81.78
FIGURE 1D
Discharge
Sump
1" = 2000 ft.
N
USGS 7½' Topos:
Ortigalita Peak NW & Volta

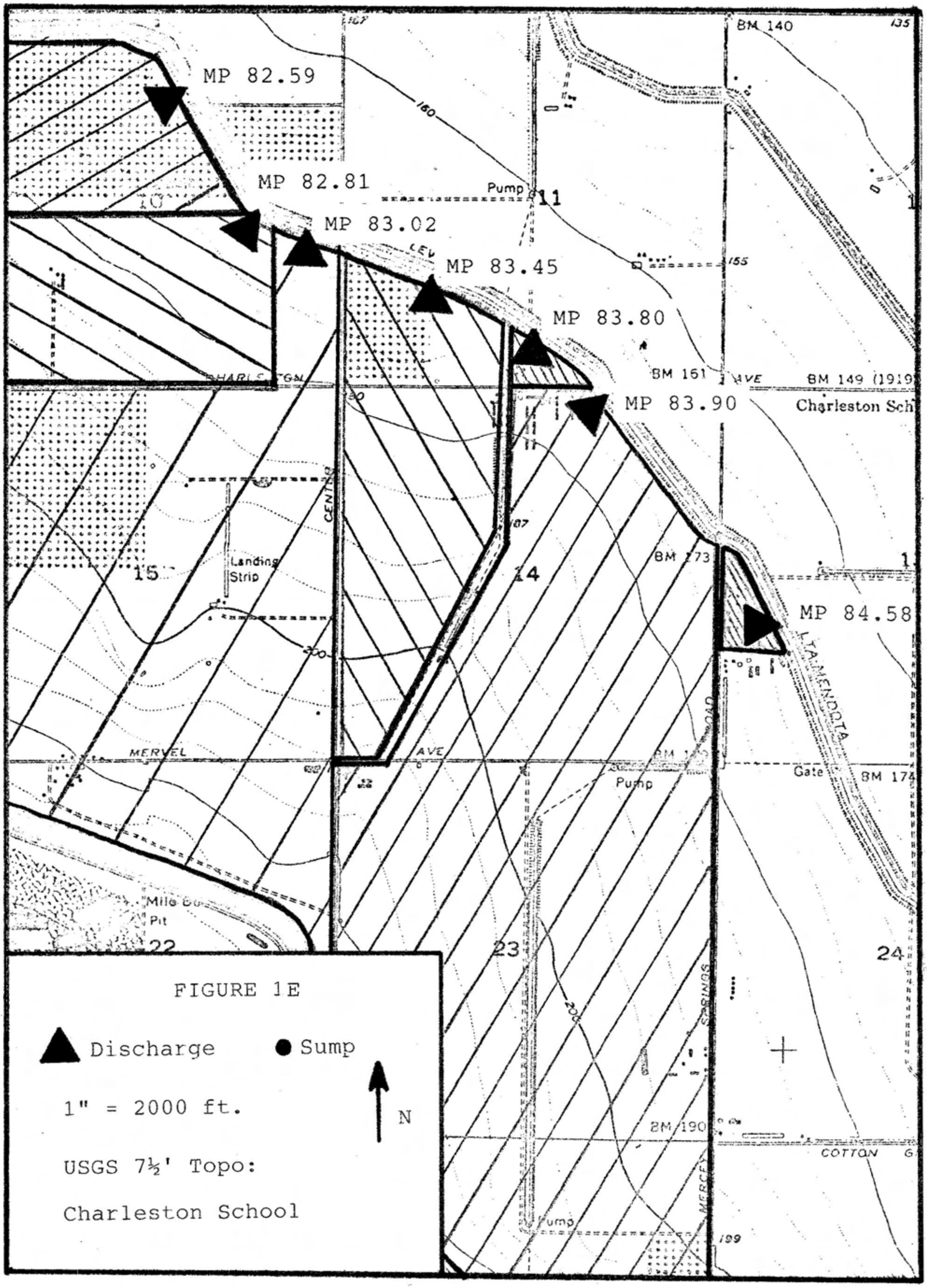


FIGURE 1E

▲ Discharge ● Sump

1" = 2000 ft.

N

USGS 7½' Topo:

Charleston School

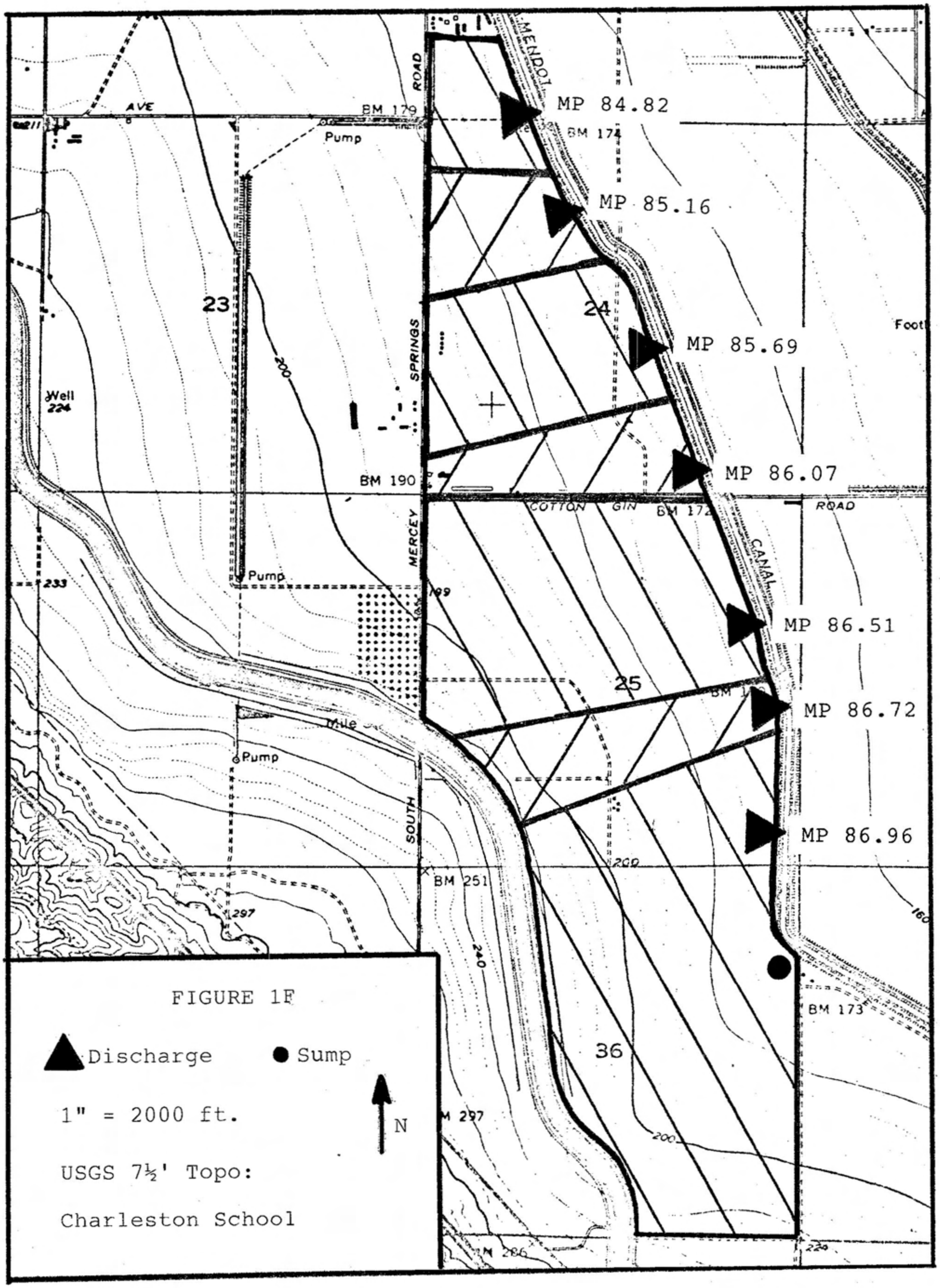

MP 84.82
MP 85.16
MP 85.69
MP 86.07
MP 86.51
MP 86.72
MP 86.96
MENDOTA
CANAL
COTTON GIN ROAD
MERCEY SPRINGS ROAD
SOUTH
AVE
BM 179
BM 174
BM 190
BM 172
BM 251
BM 173
BM 297
Pump
Pump
Pump
Well 224
23
24
25
36
200
240
233
297
199
Discharge
Sump
1" = 2000 ft.
N
USGS 7½' Topo:
Charleston School

FIGURE 1F

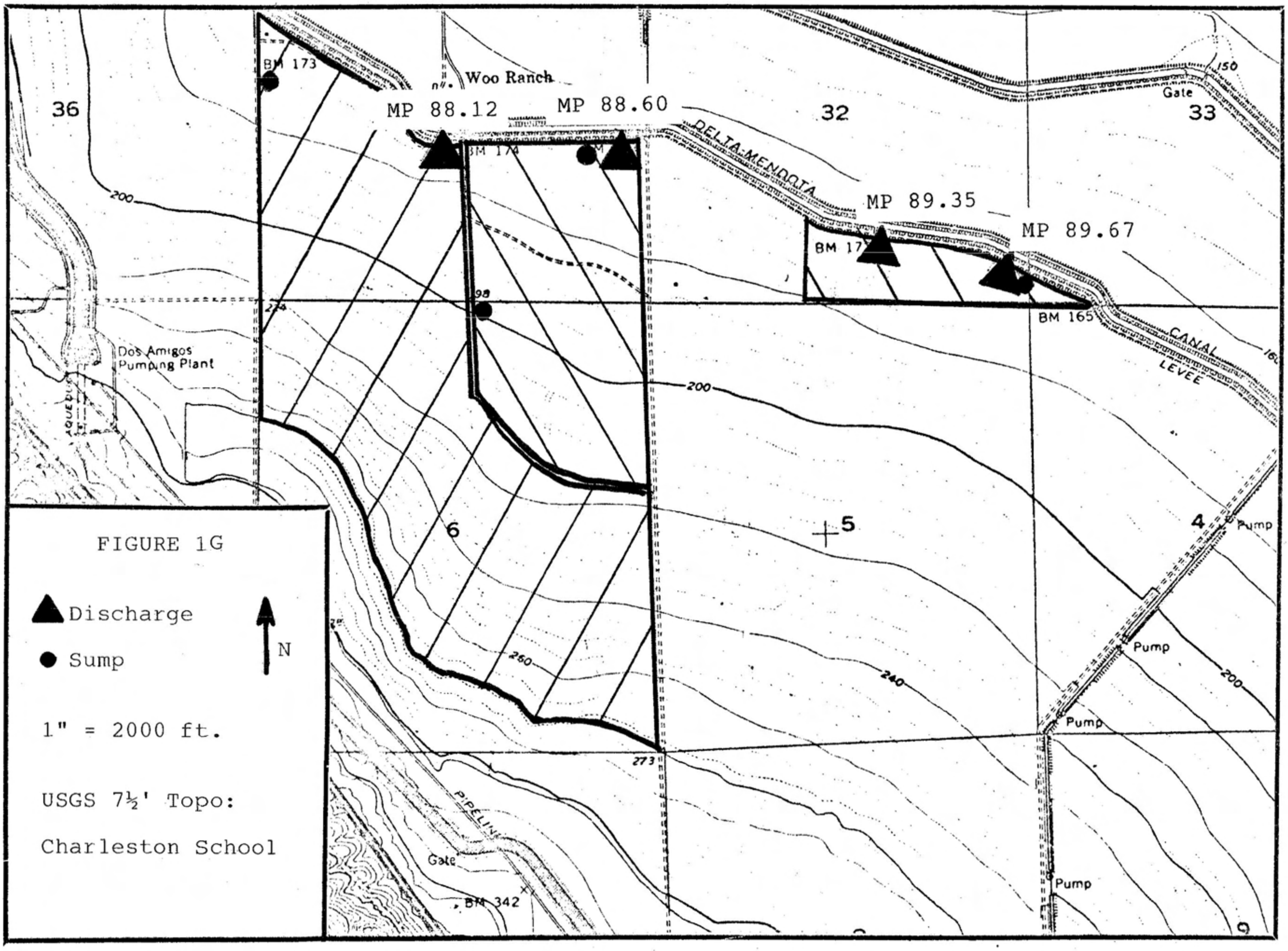


FIGURE 1G

1" = 2000 ft.

USGS 7½' Topo: Charleston School

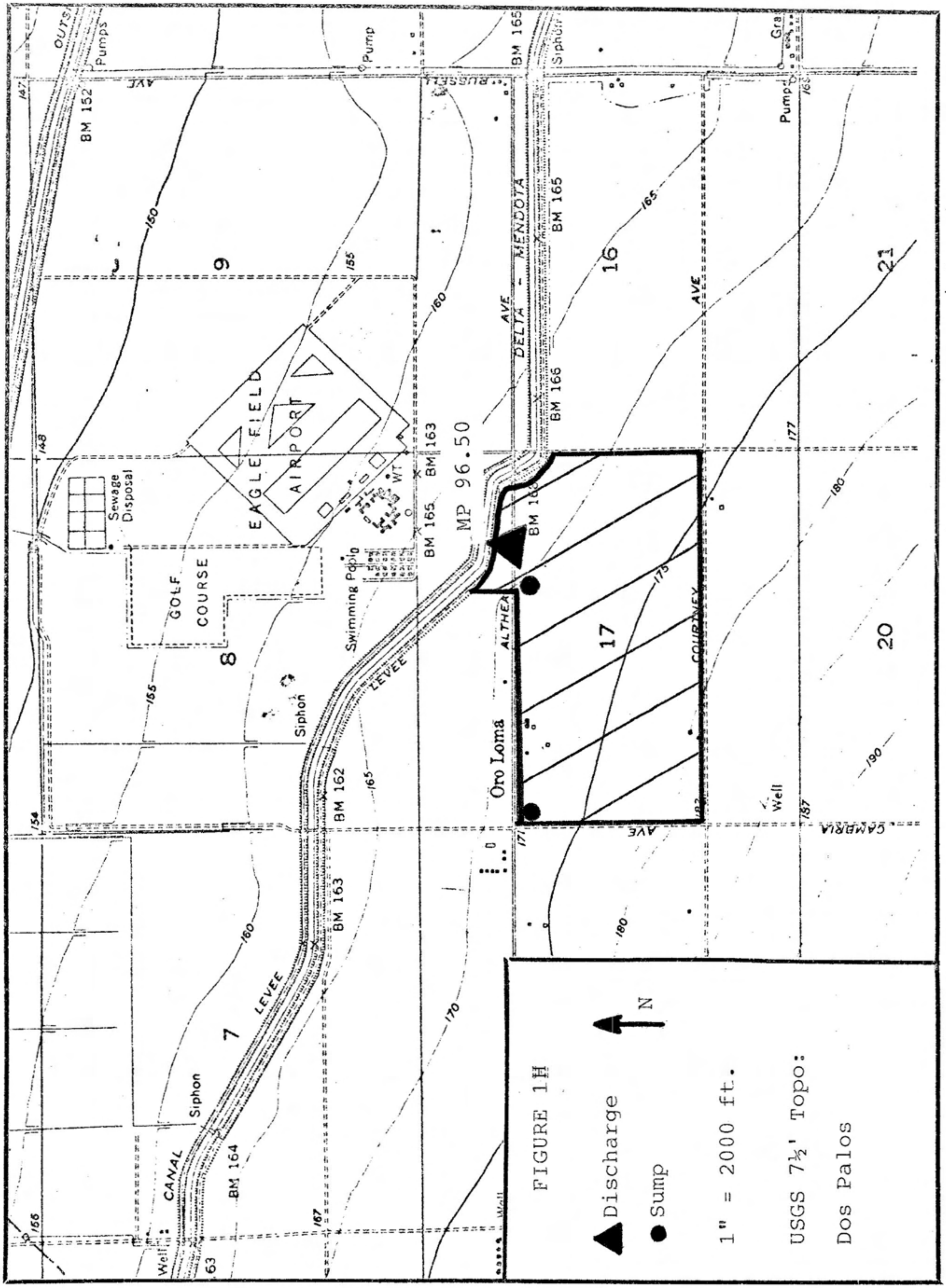


FIGURE 1H
Discharge
Sump
1" = 2000 ft.
USGS 7½' Topo:
Dos Palos
N
MP 96.50
EAGLE FIELD
AIRPORT
GOLF COURSE
Sewage Disposal
Swimming Pool
Siphon
LEVEE
CANAL
DELTA - MENDOTA
AVE
RUSSELL
ALTHEA
COURTNEY
CAMBRIA
Oro Loma
Pump
Pumps
Well
BM 152
BM 162
BM 163
BM 164
BM 165
BM 166
7
8
9
16
17
20
21

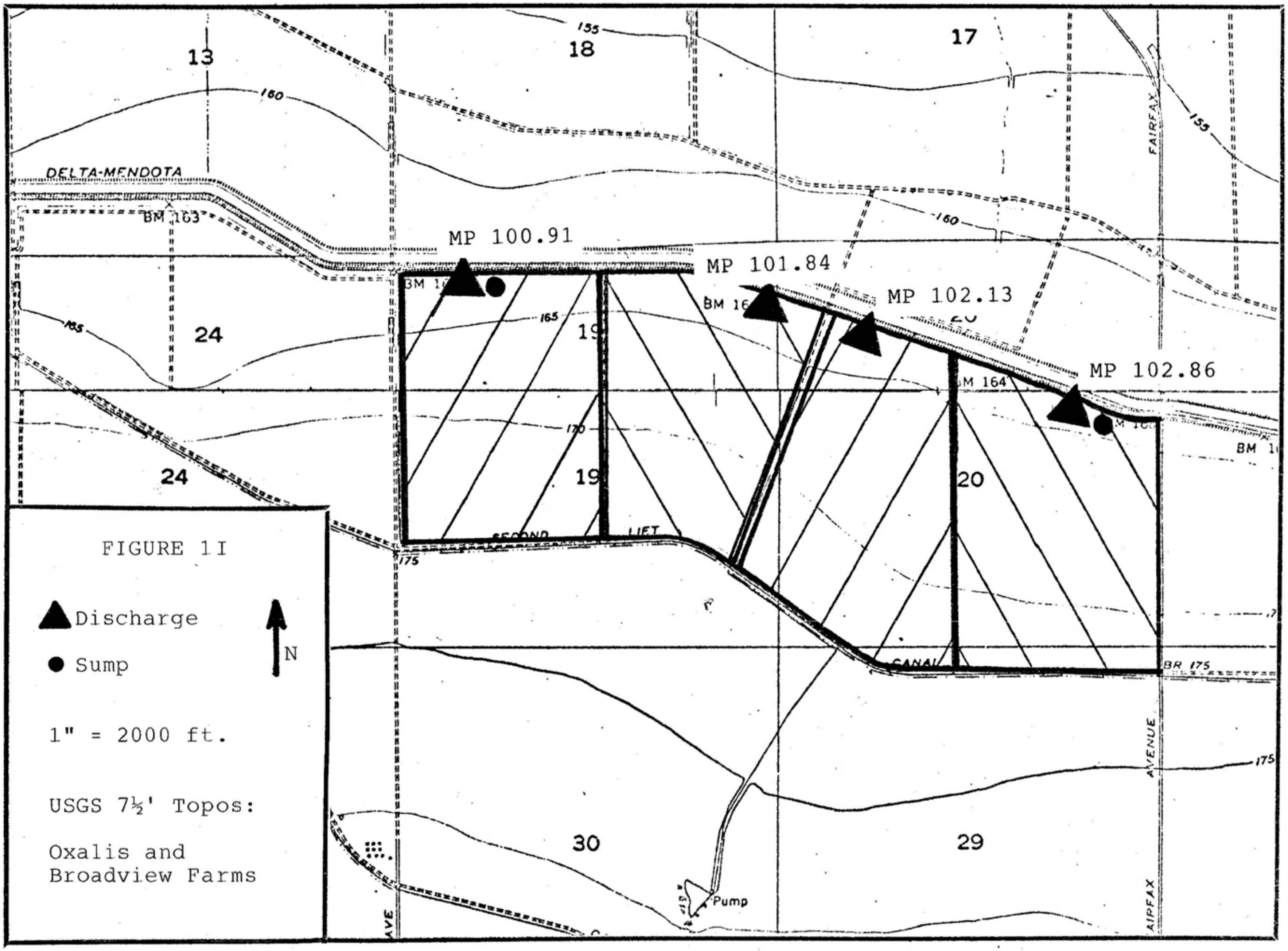


FIGURE 1I

Discharge

Sump

1" = 2000 ft.

USGS 7½' Topos:

Oxalis and
Broadview Farms

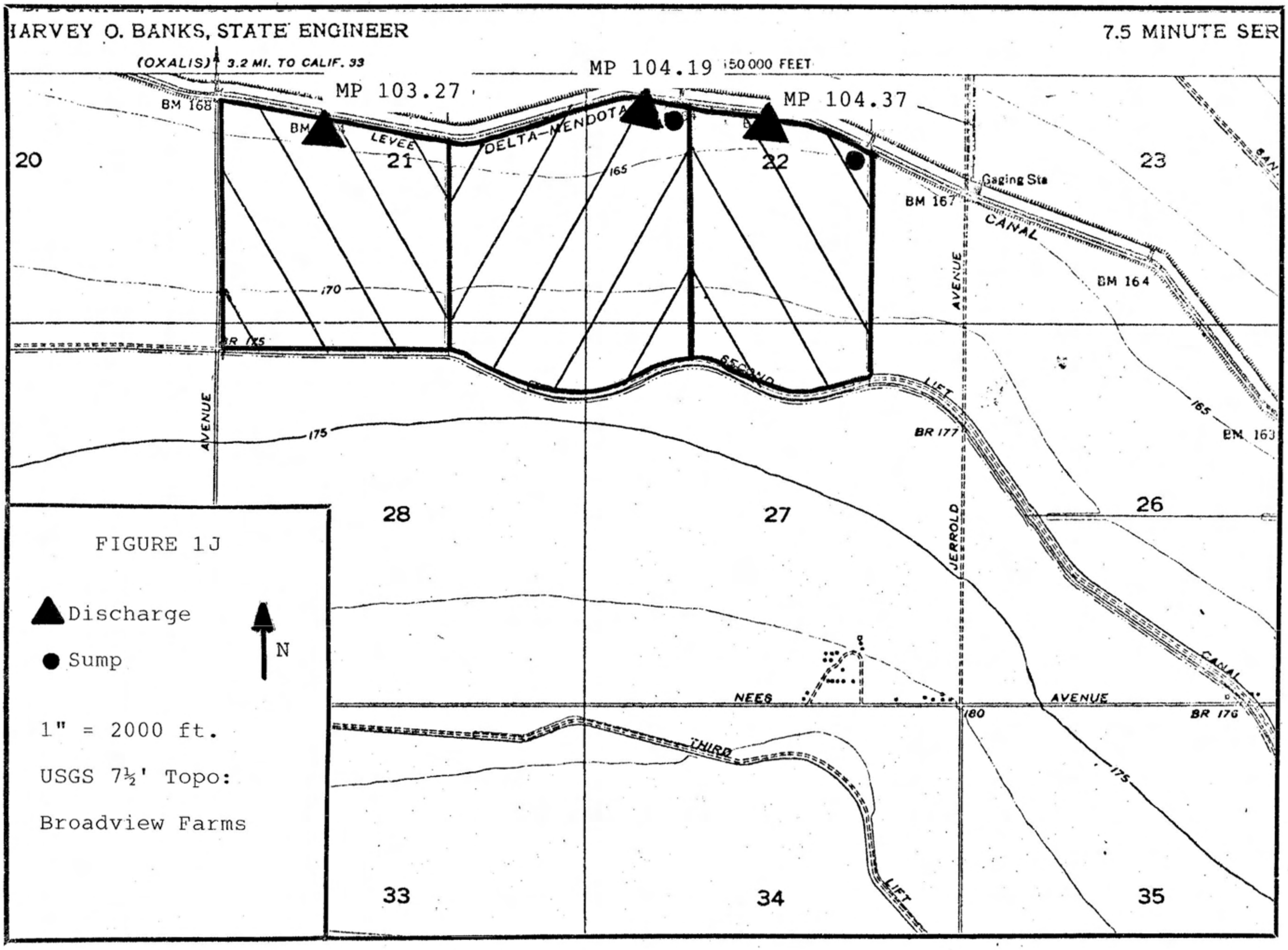


FIGURE 1J

1" = 2000 ft.

USGS 7½' Topo:

Broadview Farms

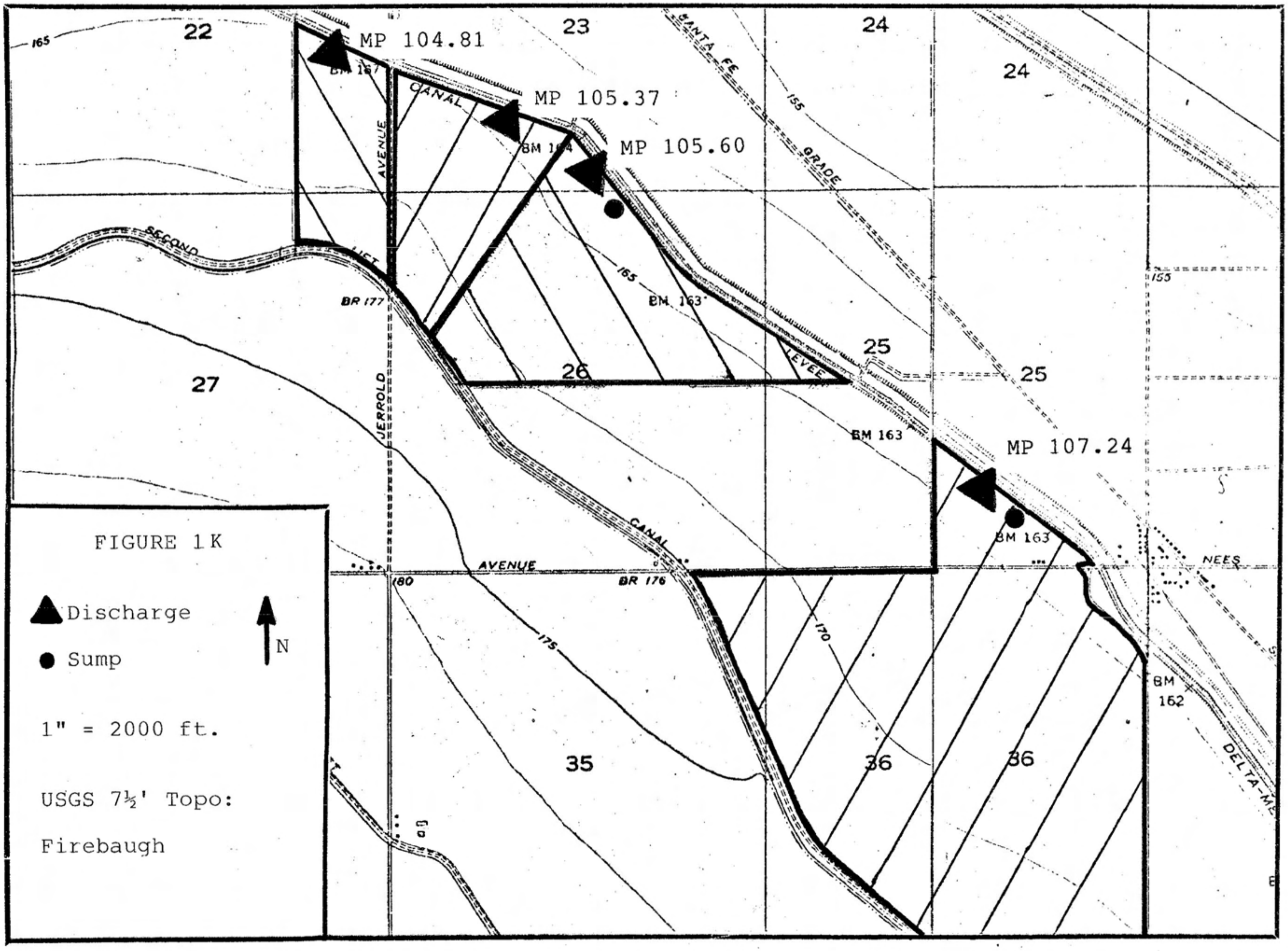

MP 104.81
MP 105.37
MP 105.60
MP 107.24
22
23
24
24
25
25
26
27
35
36
36
CANAL
AVENUE
JERROLD
SECOND
SANTA FE
GRADE
LEVEE
NEES
DELTA-ME
BM 163
BM 163
BM 163
BM 162
BR 177
BR 176
155
165
170
175
180
Discharge
Sump
N
1" = 2000 ft.
USGS 7½' Topo:
Firebaugh

FIGURE 1K

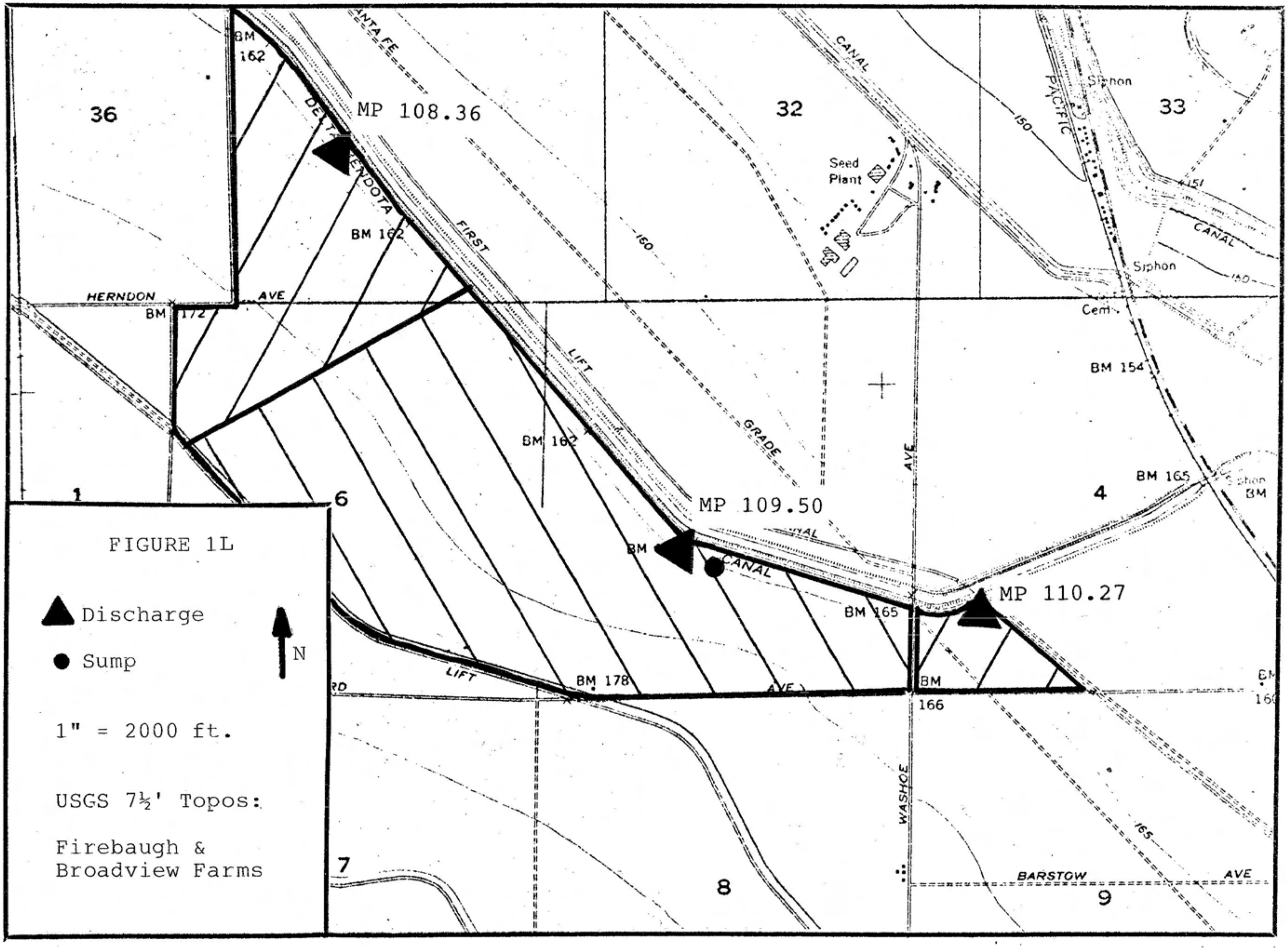

MP 108.36
MP 109.50
MP 110.27
36
32
33
1
6
4
7
8
9
HERNDON
AVE
BM 172
BM 162
BM 162
BM 162
BM 154
BM 165
BM 165
BM 178
BM
166
SANTA FE
DELTA MENDOTA
FIRST
LIFT
CANAL
GRADE
Seed
Plant
PACIFIC
Siphon
Siphon
CANAL
Cem
150
160
165
AVE
WASHOE
BARSTOW
AVE
Discharge
Sump
N
1" = 2000 ft.
USGS 7½' Topos:
Firebaugh &
Broadview Farms

FIGURE 1L