Dodson-Lindblom Associates, Inc.

A DLZ Company

ENGINEERS • ENVIRONMENTAL SCIENTISTS • SURVEYORS

July 9, 1996

Mr. J. Bruce Pickens, P.E.
Chief Engineer
Division of Engineering
Ohio Department of Natural Resources
1889 Fountain Square, Bldg. F-3
Columbus, Ohio 43224

Re: Buckeye Lake State Park
Dam Embankment and North Shore
Launch Ramp/Picnic Point Improvements
Fairfield and Licking Counties, Ohio
Review of Gardner Spillway Adequacy Report

Dear Mr. Pickens:

Per your request, a review has been made of the Buckeye Lake Spillway Adequacy Report prepared by W.S. Gardner and Associates for the Save The Lake Committee. In general, the Probable Maximum Precipitation (PMP) and the Probable Maximum Flood (PMF) pool elevation, for existing spillway conditions with no overtopping of the dam, shown in the Gardner report do not differ significantly from those developed by Dodson-Lindblom Associates, Inc. (DLA) in 1987. However, in reviewing the Gardner report in some detail, several inconsistencies were noted regarding the presented modeling. These inconsistencies include:

1) It appears the rainfall has been distributed over a 12-hour time frame, not a 6-hour period as mentioned in the report. The inflow hydrograph and its resultant peak will be different if the rainfall is based on a 12-hour period rather than a 6-hour period. The Gardner report also states the rainfall distribution corresponds to a type II distribution, which is not apparent based on the model.

2) The Gardner report states that a maximum PMF pool elevation of 894.1 will be obtained if 4 additional gates, similar to the Amil gate at the principal spillway, were to be constructed at Sellers Point. Based on the HEC-1 model presented in the Gardner report, all 5 gates would be completely opened at the onset of the storm and would result in an outflow of approximately 23,000 cfs. Is it the intention to release this large flow into the downstream area, which would result in flooding, every time it rains?

6121 Huntley Road • Columbus, Ohio 43229-1003 • (614) 848-4141 • FAX (614) 848-6712
With Offices in Cleveland - Cuyahoga Falls - Hamilton, Ohio • Lansing, Michigan • Indianapolis - South Bend, Indiana

3) With 23,000 cfs being released from the lake at a time of minimum inflow to the lake, the result would have to be a significant decrease in the pool level. However, the HEC-1 model presented in the Gardner report does not allow for a decrease in the pool level below elevation 892 (the surface area/elevation data begins at elevation 892). DLA modified the Gardner model to include data below elevation 892. The results indicate the pool level would drop to an elevation below 889 before inflow to the lake exceeded that which was being released and the pool begin to rise. Results also indicate the pool would drop from 891.75 (normal pool) to below 889 in less than 6 hours. This rapid drawdown could have serious impact on the stability of the dam.

4) The Gardner HEC-1 models show an area of 340 square feet for the Amil gates. The actual area for the existing Amil gate, when it is completely open, is approximately 50 square feet below the gate and 90 square feet if the openings around the sides of the gate are included. The Gardner model indicates a peak outflow from the gate of 4500 - 5500 cfs. The peak flow for the existing gate is closer to 600 - 800 cfs. A copy of the Amil gate brochure is attached.

5) Exhibit 22 of the Gardner report indicates the length of the existing ogee weir is to be reduced to 300 feet to accommodate the additional Amil gates. No such reduction has been included in the model which uses a length of 472 feet. A higher estimated PMF pool elevation could be expected if the model were to use only 300 feet as shown on the exhibit.

6) The Gardner report indicates that the drainage area used, 26.1 sq.mi., is approximately a 44 percent reduction over the 44.1 sq.mi. (not 46.7) used in the 1987 DLA report. In the 1987 DLA report, 27.4 sq.mi. was determined to drain directly into the lake while another 16.7 sq.mi. of drainage was intercepted by the Kirkersville Feeder Canal. The canal was determined to have a capacity of approximately 2000 cfs. The HEC-1 model used in the 1987 DLA report diverted any flow greater than 2000 cfs from entering the computation for the Buckeye Lake routings. This diversion essentially reduced the drainage area from 44.1 to 27.4 square miles. The 1987 DLA report took into account that some flow would enter the lake from the 16.7 sq. mi. but limited it to the capacity of the canal. The Gardner report fails to acknowledge DLA's recognition of this situation.

In drafting its response to the Save the Lake Committee we suggest that ODNR present not only the "technical" deficiencies of the Gardner report, but also include a discussion in "layman's terms" for the Committee. This layman's discussion should note that both the Gardner and DLA reports show that the PMP is in excess of 22 inches of rainfall in 6 hours. Both reports note that under current conditions, Buckeye Lake cannot pass the design storm without overtopping the embankment. The differences between the two reports lies in how the prevention of overtopping is handled. DLA and ODNR proposes to prevent overtopping of the embankment by raising the height of the embankment to a uniform elevation of 896.5 Normal summer pool elevations will remain essentially constant (except during periods of significant drought) through the automatic (unmanned) operation of the regulatory Amil gate and the Sellers Point spillway. The Gardner report proposes to prevent overtopping of the embankment by increasing the outflow from the lake. Based on the model presented in the Gardner report it appears that these large discharges could be expected even for lower intensity storms. The Gardner - Save the Lake approach, however, fails to recognize the resulting flooding in downstream areas with the increased discharge from the lake; the possible failure of the embankment and other shoreline areas from the rapid drawdown; the lower summer pool level that would result if the storm failed to produce enough runoff to offset the large discharge that was released at the beginning of a storm; or the manpower requirements to operate the proposed radial gates at Seller's Point. The result of the Gardner - Save the Lake approach would have a far greater impact on shoreline and downstream residents, recreational boaters, anglers, and other users of Buckeye Lake State Park than ODNR's currently proposed alternative.

If you should have any questions or comments, please feel free to contact me at your earliest convenience.

Sincerely,

DODSON-LINDBLOM ASSOCIATES, INC.

A. James Siebert, III

A. James Siebert, III

AJS/ja

C: Michele Willis, Chief, Division of Water
Gary Harsanye, Division of Engineering
George Mills, Division of Water

B:\94210023.QQ

HEC-1 INPUT

```
                                              HEC 1 INPUT
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10        PAGE
  1            ID          PMF OVER LAKE . 472 FT WEIR, FIVE AMIL GATES   **GARDNER REPORT**
  2            IT      30  1AUG96    1200      80
  3            IO       1
  4            JD               0
  5            PH      10               0    0.87    1.87    3.45   15.56   18.72      20
  6            JR    PREC       1    0.75     0.5       0       0       0
  7            KK  WALNUT
  8            KO       1       2       0       0      22
  9            BA     9.7
 10            BF      10       0     1.3
 11            PB      23
 12            IN      15  1AUG96
               * HOURLY PRECIPITATION
 13            PC       0  0.2175   0.435  0.6525  0.6343  0.7497   0.935  1.0957  1.2687  1.4417
 14            PC  1.7877  2.1913  2.9987   4.205    6.84 10.4377 11.5333  10.726    7.64   5.405
 15            PC  3.5177  2.7175   2.265  1.8125    1.36    1.02    0.68    0.34       0
 16            LS    0.42      82      10
 17            UD     2.5
 18            KK   HONEY
 19            KO       1       2       0       0      22
 20            BA     9.5
 21            BF      10       0     1.3
 22            PB      22
 23            IN      15  1AUG96
               * HOURLY PRECIPITATION
 24            PC       0  0.2175   0.435  0.6525  0.6343  0.7497   0.935  1.0957  1.2687  1.4417
 25            PC  1.7877  2.1913  2.9987   4.205    6.84 10.4377 11.5333  10.726    7.64   5.405
 26            PC  3.5177  2.7175   2.265  1.8125    1.36    1.02    0.68    0.34       0
 27            LS   0.469      81      16
 28            UD     5.4
 29            KK  HARBOR
 30            KO       1       2       0       0      22
 31            BA     6.9
 32            BF      10       0     1.3
 33            PB      23
 34            IN      15  1AUG96
               * HOURLY PRECIPITATION
 35            PC       0  0.2175   0.435  0.6525  0.6343  0.7497   0.935  1.0957  1.2687  1.4417
 36            PC  1.7877  2.1913  2.9987   4.205    6.84 10.4377 11.5333  10.726    7.64   5.405
 37            PC  3.5177  2.7175   2.265  1.8125    1.36    1.02    0.68    0.34       0
 38            LS    0.42      82      23
 39            UD     2.4
 40            KK   DAM40   CNAME  40TO20
 41            KO       0       0       0       1      22
 42            HC       3
 43            KK   DAM40
               * RESERVOIR STORAGE
 44            KO       0       0       0       1      22
 45            RS       1    ELEV  891.75       0
 46            SA    2758    2800    2925    3093    3260    3427    3762    4096
 47            SE     892  892.25     893 893.875  894.75 895.625   896.5 897.375  898.25 899.125
 48            SS   892.2     472     3.3     1.5
 49            SL     886    1700     0.7     0.5
 50            ST   896.5   21700     2.3     1.5
 51            ZZ
```

SSP

Orifice Flow – Gates.

Top of Dam

Cross sectional area.

472' Long weir, Exhibit ZZ says 300 ft.

PROBS of Analysis.

1. Assumes reservoir does not go below 892.0
2. No Backwater at any time in channel
3.) Cross-sectional area + : discharge, changes w/ lake level. Flow depends on both head + available cross-sectional area. Must use stage-storage-discharge curve instead of orifice flows. for AMIL gate.

RAINFALL USED IN MODEL

HYDROGRAPH AT STATION WALNUT

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1	AUG	1200	1	.00	.00	.00	10.
1	AUG	1230	2	.09	.08	.01	10.
1	AUG	1300	3	.10	.09	.01	13.
1	AUG	1330	4	.11	.10	.01	22.
1	AUG	1400	5	.12	.11	.01	36.
1	AUG	1430	6	.14	.11	.02	55.
1	AUG	1500	7	.15	.11	.04	80.
1	AUG	1530	8	.49	.29	.21	140.
1	AUG	1600	9	.57	.23	.34	281.
1	AUG	1630	10	.68	.20	.48	573.
1	AUG	1700	11	8.80	.69	8.11	2192.
1	AUG	1730	12	.89	.02	.87	5235.
1	AUG	1800	13	.59	.01	.57	9889.
1	AUG	1830	14	1.56	.03	1.53	14829.
1	AUG	1900	15	.93	.01	.91	17956.
1	AUG	1930	16	5.12	.06	5.06	19973.
1	AUG	2000	17	.75	.01	.74	21134.
1	AUG	2030	18	.62	.00	.61	22198.
1	AUG	2100	19	.53	.00	.52	22251.
1	AUG	2130	20	.17	.00	.16	21443.
1	AUG	2200	21	.14	.00	.14	19798.
1	AUG	2230	22	.13	.00	.13	17333.
1	AUG	2300	23	.12	.00	.11	14485.
1	AUG	2330	24	.11	.00	.10	11430.
2	AUG	0000	25	.10	.00	.10	8979.
2	AUG	0030	26	.00	.00	.00	7059.
2	AUG	0100	27	.00	.00	.00	5583.
2	AUG	0130	28	.00	.00	.00	4371.
2	AUG	0200	29	.00	.00	.00	3398.
2	AUG	0230	30	.00	.00	.00	2607.
2	AUG	0300	31	.00	.00	.00	1966.
2	AUG	0330	32	.00	.00	.00	1470.
2	AUG	0400	33	.00	.00	.00	1099.
2	AUG	0430	34	.00	.00	.00	817.
2	AUG	0500	35	.00	.00	.00	602.
2	AUG	0530	36	.00	.00	.00	438.
2	AUG	0600	37	.00	.00	.00	310.
2	AUG	0630	38	.00	.00	.00	224.
2	AUG	0700	39	.00	.00	.00	163.
2	AUG	0730	40	.00	.00	.00	114.

12 HRS

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS
2	AUG	0800	41	.00	.00	.00
2	AUG	0830	42	.00	.00	.00
2	AUG	0900	43	.00	.00	.00
2	AUG	0930	44	.00	.00	.00
2	AUG	1000	45	.00	.00	.00
2	AUG	1030	46	.00	.00	.00
2	AUG	1100	47	.00	.00	.00
2	AUG	1130	48	.00	.00	.00
2	AUG	1200	49	.00	.00	.00
2	AUG	1230	50	.00	.00	.00
2	AUG	1300	51	.00	.00	.00
2	AUG	1330	52	.00	.00	.00
2	AUG	1400	53	.00	.00	.00
2	AUG	1430	54	.00	.00	.00
2	AUG	1500	55	.00	.00	.00
2	AUG	1530	56	.00	.00	.00
2	AUG	1600	57	.00	.00	.00
2	AUG	1630	58	.00	.00	.00
2	AUG	1700	59	.00	.00	.00
2	AUG	1730	60	.00	.00	.00
2	AUG	1800	61	.00	.00	.00
2	AUG	1830	62	.00	.00	.00
2	AUG	1900	63	.00	.00	.00
2	AUG	1930	64	.00	.00	.00
2	AUG	2000	65	.00	.00	.00
2	AUG	2030	66	.00	.00	.00
2	AUG	2100	67	.00	.00	.00
2	AUG	2130	68	.00	.00	.00
2	AUG	2200	69	.00	.00	.00
2	AUG	2230	70	.00	.00	.00
2	AUG	2300	71	.00	.00	.00
2	AUG	2330	72	.00	.00	.00
3	AUG	0000	73	.00	.00	.00
3	AUG	0030	74	.00	.00	.00
3	AUG	0100	75	.00	.00	.00
3	AUG	0130	76	.00	.00	.00
3	AUG	0200	77	.00	.00	.00
3	AUG	0230	78	.00	.00	.00
3	AUG	0300	79	.00	.00	.00
3	AUG	0330	80	.00	.00	.00

TAL RAINFALL = 23.00, TOTAL LOSS = 2.18, TOTAL EXCESS = 20.82

FLOW	TIME		MAXIMUM AVERAGE FLOW			
S)	(HR)		6-HR	24-HR	72-HR	39.50-HR
51.	9.00	(CFS)	17689.	5432.	3301.	3301.
		(INCHES)	16.955	20.827	20.828	20.828
		(AC-FT)	8771.	10775.	10775.	10775.

CUMULATIVE AREA = 9.70 SQ MI

LAKE INFLOW HYDROGRAPH

```
[redacted]*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
          **************
          *            *
.0 KK     *    DAM40   *        CNAME   40T020
          *            *
          **************
.1 KO         OUTPUT CONTROL VARIABLES
                   IPRNT          1  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE
                   IPNCH          1  PUNCH COMPUTED HYDROGRAPH
                    IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                   ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                   ISAV2         80  LAST ORDINATE PUNCHED OR SAVED
                  TIMINT       .500  TIME INTERVAL IN HOURS
.2 HC         HYDROGRAPH COMBINATION
                   ICOMP          3  NUMBER OF HYDROGRAPHS TO COMBINE
                                                          ***
*****************************************************************************************
                                        HYDROGRAPH AT STATION     DAM40
                                            SUM OF  3 HYDROGRAPHS
                                           PLAN 1,    RATIO =  1.00
*****************************************************************************************
```

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HR
1 AUG 1200	1	30.	1 AUG 2200	21	45967.	2 AUG 0800	41	2370.	2 AUG 18
1 AUG 1230	2	30.	1 AUG 2230	22	42563.	2 AUG 0830	42	2006.	2 AUG 18
1 AUG 1300	3	40.	1 AUG 2300	23	38164.	2 AUG 0900	43	1723.	2 AUG 19
1 AUG 1330	4	66.	1 AUG 2330	24	33118.	2 AUG 0930	44	1477.	2 AUG 19
1 AUG 1400	5	108.	2 AUG 0000	25	28939.	2 AUG 1000	45	1277.	2 AUG 20
1 AUG 1430	6	163.	2 AUG 0030	26	25334.	2 AUG 1030	46	1102.	2 AUG 20
1 AUG 1500	7	233.	2 AUG 0100	27	22166.	2 AUG 1100	47	952.	2 AUG 21
1 AUG 1530	8	372.	2 AUG 0130	28	19162.	2 AUG 1130	48	823.	2 AUG 21
1 AUG 1600	9	672.	2 AUG 0200	29	16504.	2 AUG 1200	49	708.	2 AUG 22
1 AUG 1630	10	1266.	2 AUG 0230	30	14195.	2 AUG 1230	50	615.	2 AUG 22
1 AUG 1700	11	4414.	2 AUG 0300	31	12138.	2 AUG 1300	51	530.	2 AUG 23
1 AUG 1730	12	10329.	2 AUG 0330	32	10313.	2 AUG 1330	52	461.	2 AUG 23
1 AUG 1800	13	19305.	2 AUG 0400	33	8694.	2 AUG 1400	53	398.	3 AUG 00
1 AUG 1830	14	28659.	2 AUG 0430	34	7342.	2 AUG 1430	54	346.	3 AUG 00
1 AUG 1900	15	34898.	2 AUG 0500	35	6207.	2 AUG 1500	55	300.	3 AUG 01
1 AUG 1930	16	39580.	2 AUG 0530	36	5257.	2 AUG 1530	56	261.	3 AUG 01
1 AUG 2000	17	43096.	2 AUG 0600	37	4444.	2 AUG 1600	57	229.	3 AUG 02
1 AUG 2030	18	46402.	2 AUG 0630	38	3803.	2 AUG 1630	58	198.	3 AUG 02
1 AUG 2100	19	47804.	2 AUG 0700	39	3259.	2 AUG 1700	59	173.	3 AUG 0
1 AUG 2130	20	47725.	2 AUG 0730	40	2779.	2 AUG 1730	60	149.	3 AUG 0

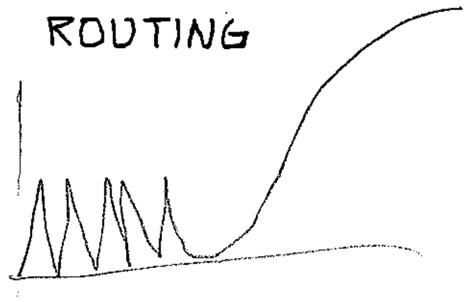
EAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	39.50-HR
47804.	9.00	(CFS)	39604.	14373.	8763.	8763.
		(INCHES)	14.108	20.481	20.550	20.550
		(AC-FT)	19639.	28509.	28606.	28606.

CUMULATIVE AREA = 26.10 SQ MI

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** **
```

47800 cfs peak PMF inflow based on precipitation over 12 hr time frame.

RESERVOIR ROUTING



HYDROGRAPH AT STATION DAM40
PLAN 1, RATIO = 1.00

A	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTF
1	AUG	1200	1	22885.	.0	891.8	2	AUG	0130	28	29834.	5260.7	893.8	2	AUG	1500	55	-
1	AUG	1230	2	0.	.0	892.0	2	AUG	0200	29	29112.	4779.9	893.6	2	AUG	1530	56	233
1	AUG	1300	3	23377.	.0	892.0	2	AUG	0230	30	28300.	4228.1	893.5	2	AUG	1600	57	
1	AUG	1330	4	0.	.0	892.0	2	AUG	0300	31	27432.	3620.7	893.3	2	AUG	1630	58	233
1	AUG	1400	5	23377.	.0	892.0	2	AUG	0330	32	26537.	2969.6	893.0	2	AUG	1700	59	
1	AUG	1430	6	0.	.0	892.0	2	AUG	0400	33	25642.	2284.3	892.8	2	AUG	1730	60	233
1	AUG	1500	7	23377.	.0	892.0	2	AUG	0430	34	24784.	1574.0	892.6	2	AUG	1800	61	
1	AUG	1530	8	0.	.0	892.0	2	AUG	0500	35	24014.	845.9	892.3	2	AUG	1830	62	233
1	AUG	1600	9	23377.	.0	892.0	2	AUG	0530	36	23450.	102.3	892.0	2	AUG	1900	63	
1	AUG	1630	10	0.	.0	892.0	2	AUG	0600	37	0.	.0	892.0	2	AUG	1930	64	233
1	AUG	1700	11	23377.	.0	892.0	2	AUG	0630	38	23377.	.0	892.0	2	AUG	2000	65	
1	AUG	1730	12	0.	.0	892.0	2	AUG	0700	39	0.	.0	892.0	2	AUG	2030	66	233
1	AUG	1800	13	23466.	125.2	892.0	2	AUG	0730	40	23377.	.0	892.0	2	AUG	2100	67	
1	AUG	1830	14	23480.	145.8	892.1	2	AUG	0800	41	0.	.0	892.0	2	AUG	2130	68	233
1	AUG	1900	15	23711.	478.5	892.2	2	AUG	0830	42	23377.	.0	892.0	2	AUG	2200	69	
1	AUG	1930	16	24186.	1021.1	892.4	2	AUG	0900	43	0.	.0	892.0	2	AUG	2230	70	233
1	AUG	2000	17	24940.	1708.0	892.6	2	AUG	0930	44	23377.	.0	892.0	2	AUG	2300	71	
1	AUG	2030	18	25918.	2500.2	892.9	2	AUG	1000	45	0.	.0	892.0	2	AUG	2330	72	233
1	AUG	2100	19	27049.	3345.7	893.2	2	AUG	1030	46	23377.	.0	892.0	3	AUG	0000	73	
1	AUG	2130	20	28218.	4171.1	893.4	2	AUG	1100	47	0.	.0	892.0	3	AUG	0030	74	233
1	AUG	2200	21	29309.	4911.8	893.7	2	AUG	1130	48	23377.	.0	892.0	3	AUG	0100	75	
1	AUG	2230	22	30206.	5505.1	893.9	2	AUG	1200	49	0.	.0	892.0	3	AUG	0130	76	23
1	AUG	2300	23	30825.	5907.2	894.0	2	AUG	1230	50	23377.	.0	892.0	3	AUG	0200	77	
1	AUG	2330	24	31121.	6097.3	894.1	2	AUG	1300	51	0.	.0	892.0	3	AUG	0230	78	23
2	AUG	0000	25	31115.	6093.7	894.1	2	AUG	1330	52	23377.	.0	892.0	3	AUG	0300	79	
2	AUG	0030	26	30872.	5937.1	894.0	2	AUG	1400	53	0.	.0	892.0	3	AUG	0330	80	23
2	AUG	0100	27	30431.	5651.9	893.9	2	AUG	1430	54	23377.	.0	892.0					

AK OUTFLOW IS 31121. AT TIME 11.50 HOURS

EAK FLOW (CFS)	TIME (HR)		6-HR	24-HR	72-HR	39.50-HR
			MAXIMUM AVERAGE FLOW			
31121.	11.50	(CFS)	29715.	19225.	16265.	16265.
		(INCHES)	10.585	27.394	38.143	38.143
		(AC-FT)	14735.	38132.	53095.	53095.

AK STORAGE (AC-FT)	TIME (HR)	6-HR	24-HR	72-HR	39.50-HR
		MAXIMUM AVERAGE STORAGE			
6097.	11.50	5169.	1651.	1003.	1003.

EAK STAGE (FEET)	TIME (HR)	6-HR	24-HR	72-HR	39.50-HR
		MAXIMUM AVERAGE STAGE			
894.08	11.50	893.77	892.57	892.35	892.35

CUMULATIVE AREA = 26.10 SQ MI

Initial outflow ≈ 23,000 cfs is greater than inflow (see previous page). Lake should be dropping below elevation 892.0 but input data does not go below 892.0.

SUMMARY OF OUTPUT

SUMMARY OF DAM OVERTOP[illegible]

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF [illegible]
ELEVATION	891.75	892.20	896.50
STORAGE	0.	555.	14322.
OUTFLOW	22885.	23764.	44814.

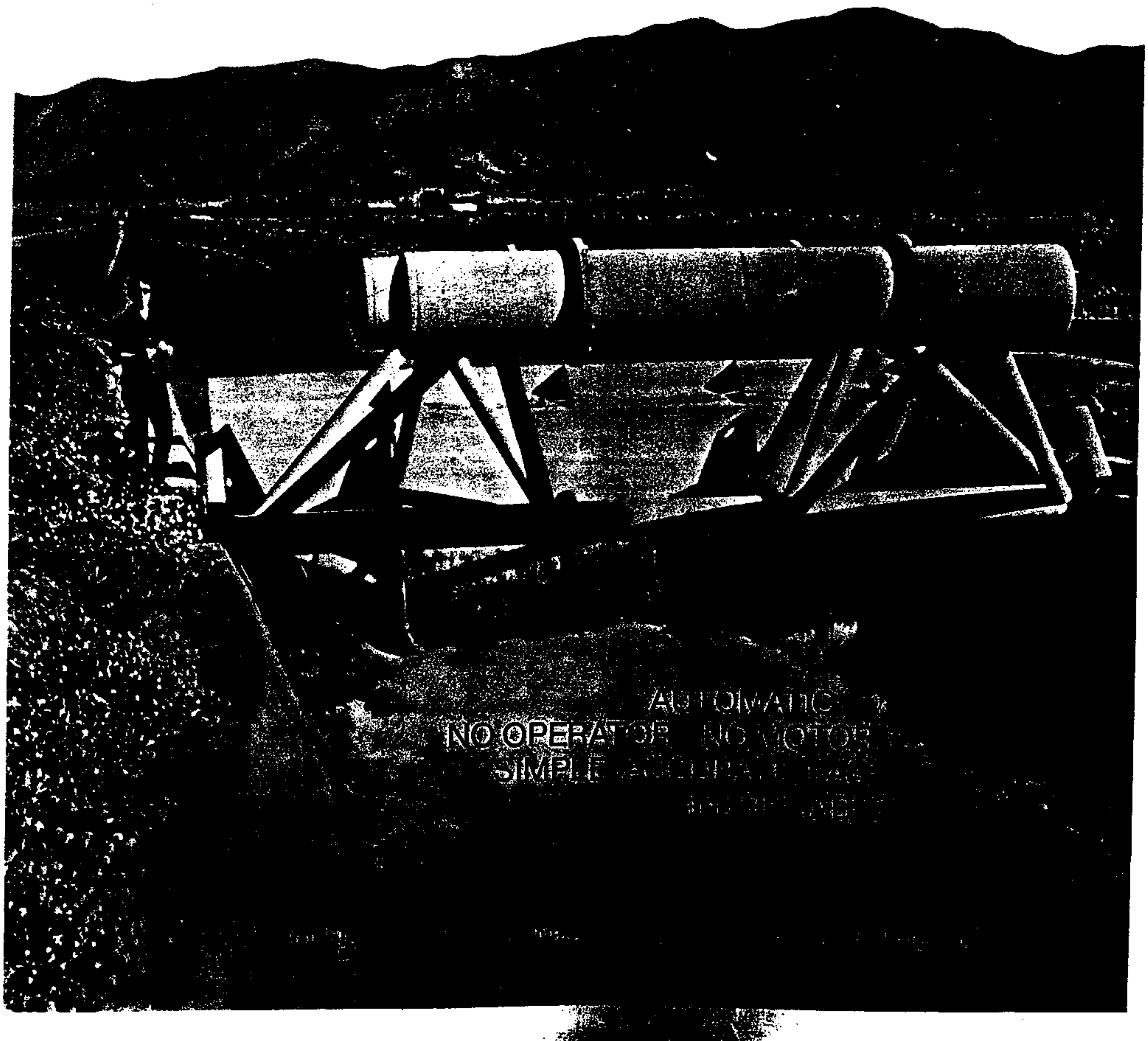
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	894.08	.00	6097.	31121.	.00	11.50	.00
.75	892.85	.00	2413.	25805.	.00	11.50	.00
.50	892.03	.00	78.	23433.	.00	7.00	.00

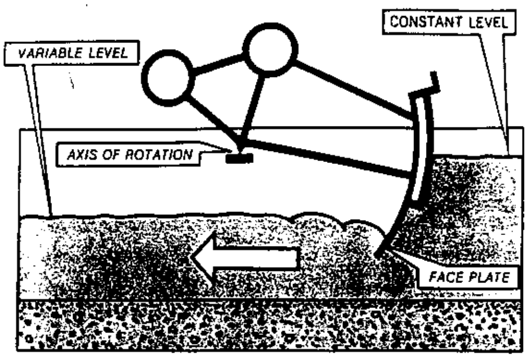
** NORMAL END OF HEC-1 ***

MAXIMUM PMF POOL 894.1

The
AMIL
Constant Upstream Level Gate

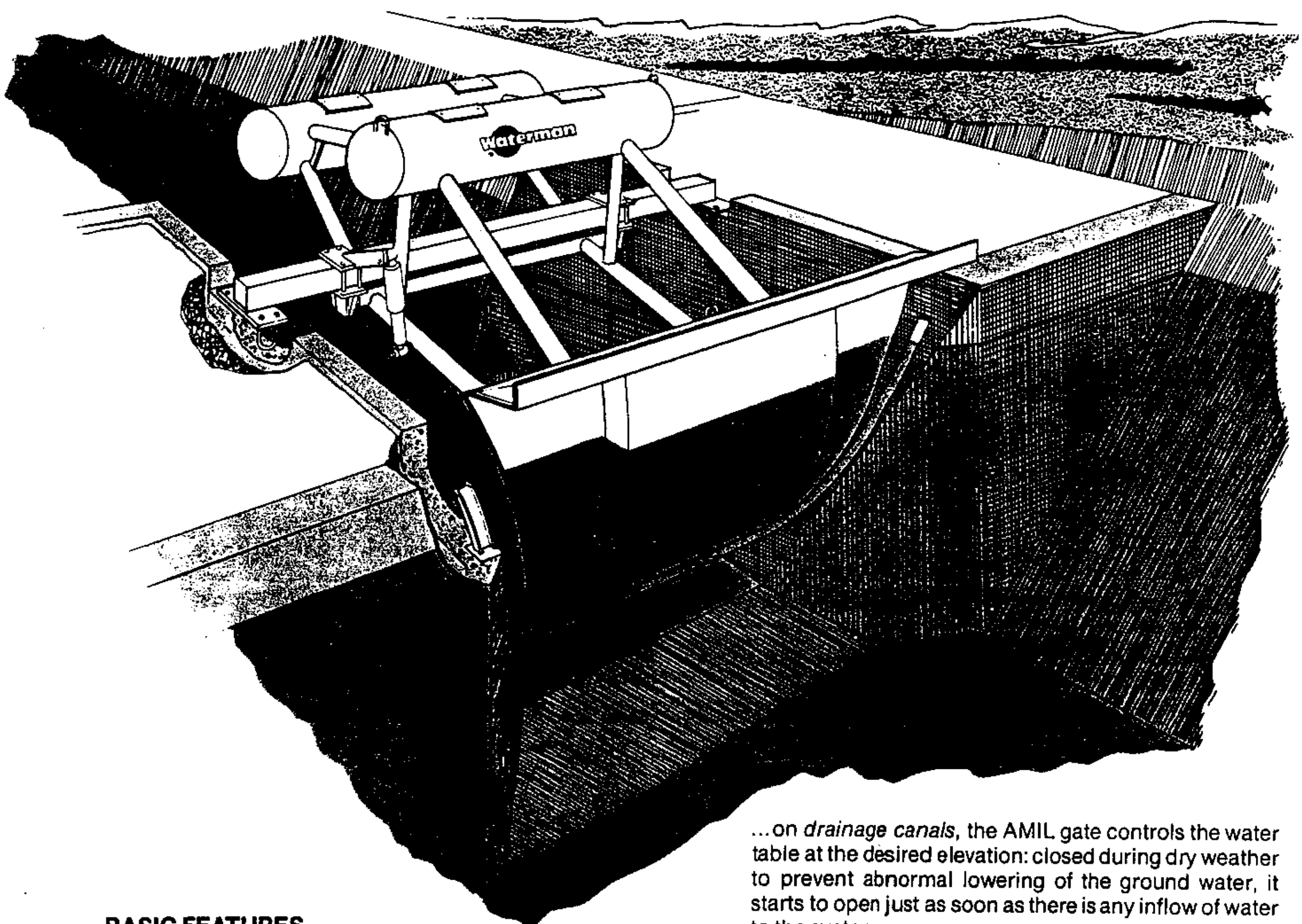
75 YEARS
Waterman INDUSTRIES, INC.
1912 • 1987





The **AMIL** gate automatically maintains a *constant* water level on the *upstream* side of the gate section. It operates...

- WITHOUT ANY OUTSIDE POWER OR MOTOR
- FREE OF ANY MANUAL INTERVENTION
- IRRESPECTIVE OF THE VOLUME OF INCOMING FLOW
- INDEPENDENTLY OF THE DOWNSTREAM LEVEL



BASIC FEATURES

The AMIL gate is *directly* actuated by the water level it controls. Bothersome hoists, cables, floats, floatwells, and other structural complications have been completely eliminated. Instead, the upstream side of the radial face plate is simply provided with a specially designed buoyant compartment.

The supporting frame rotates about a horizontal shaft and includes ballast containers for easy and accurate balancing of the gate.

Frictionless, non-stick operation is guaranteed by the tapered shape of the leaf and matching sluice.

...on *drainage canals*, the AMIL gate controls the water table at the desired elevation: closed during dry weather to prevent abnormal lowering of the ground water, it starts to open just as soon as there is any inflow of water to the system

...on *recreation lakes*, the AMIL gate maintains a pleasantly constant water level in all seasons

...on *flood control* or *water supply reservoirs*, the AMIL gate permits a large increase in storage volume without sacrificing spillway capacity or reliability

...on *irrigation canals*, the AMIL gate maintains a high and constant head on turnouts, irrespective of flow in the canal or through the turnouts. Used in series along the distribution network, at different check structures, AMIL gates insure an automatic, safe, reliable, and flexible irrigation program, at *sharply reduced labor costs*.

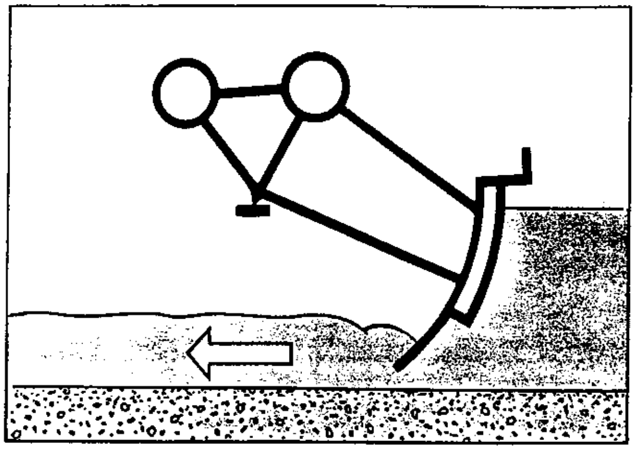
OPERATING PRINCIPLE

The AMIL gate maintains the *upstream water level* at the elevation of the gate trunnion axis.

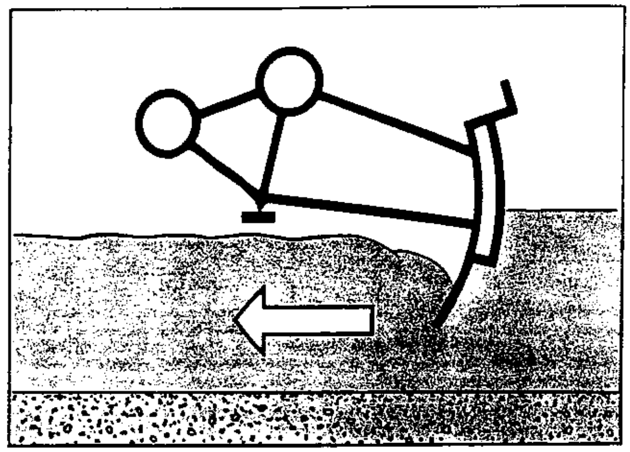
The torques generated by the hydraulic thrust on the face plate and the weight of the gate are equal and opposite for all angular positions of the AMIL gate *only* when the upstream water level is at the elevation of the gate trunnion axis.

As long as this condition is fulfilled, the gate will remain motionless, in complete equilibrium.

Whenever the flow varies and the upstream water level has a tendency to rise or fall, the gate adjusts its opening immediately, automatically passing the exact discharge required to keep the upstream water level constant.



SMALL FLOW
The gate is almost completely closed



LARGE FLOW
The gate has opened to handle larger discharge

But: upstream level remains constant

AMIL GATES DESIGNED FOR MAXIMUM PROFITS

Savings on Operational Cost:

Once installed, an AMIL gate requires no further adjustment; there is no need for any manual intervention. Ever! No need for expensive power supplies.

Savings on Canal and Structure Investment:

A smaller freeboard is permissible, without the risk of overtopping; hence:

- for new canals, design capacities can be met by smaller cross-sections, therefore lower construction cost
- for old canals, capacities through existing cross-sections can be increased
- for both old and new canals, higher heads are made available at turnouts.

Savings on Emergency Canal Repairs:

Damage due to overtopping of banks is eliminated, because check structures equipped with AMIL gates are always ready to operate instantly as needed, are not subject to human or power failure.

Other unscheduled expenses are avoided because banks are no longer subject to dangerous underpressures caused by water level fluctuations.

Also, wet lining is no longer periodically exposed to the sun.

Savings on Maintenance:

The AMIL gate has only one sturdy moving part of strong, heavy-gauge steel plate; frame and bearings remain above water. It has been designed for easy access to all surfaces requiring paint.

Bottom flow past the gate reduces sediment deposits; side flow prevents the accumulation of trash at the check structure.

Saving of Water in Distribution Networks:

Canal operation becomes much simpler because manual intervention is unnecessary at AMIL check structures. Thus a more accurate and far more flexible distribution system is available, reducing costly water waste.

QUIET
FAST
AUTOMATIC
ACCURATE
EFFICIENT
RELIABLE
EXPENSE-FREE Operation

a system that knows how to adjust instantly to changing flows at any time.

In addition, AMIL gates have been designed to complement the esthetic appearance of water management projects. They give a feeling of balance and their pleasant silhouette blends well with canal landscaping.

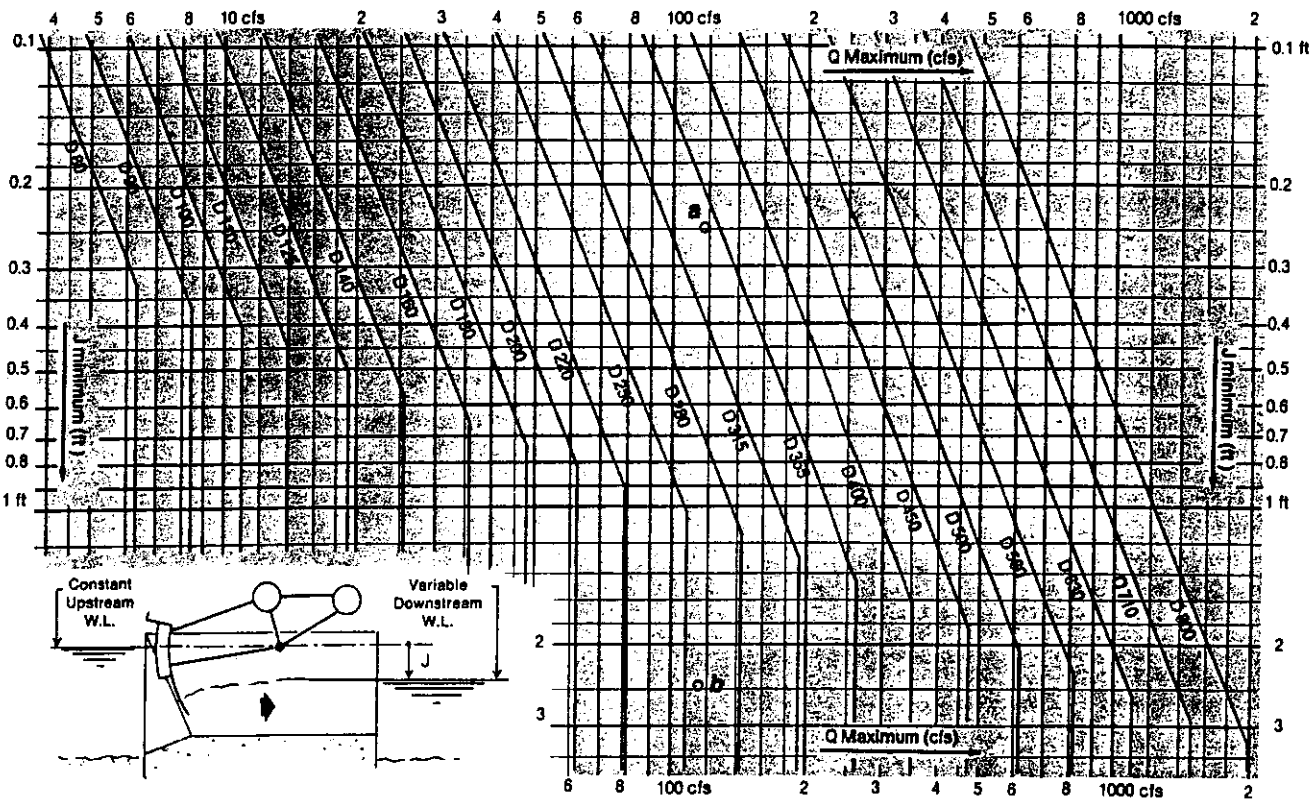
AMIL gates are manufactured in 21 standard sizes, designated AMIL D80, AMIL D90...up to AMIL D800.

SELECTING YOUR AMIL GATE

Plot on the chart below the point corresponding to:

1. *Maximum discharge Q_M* to be handled at the gate
2. *Minimum head differential J_m* available at maximum discharge for the equipped structure

Find the proper gate size on the first black line to the right of this point.



GATE SIZE SELECTION CHART

Hydraulic Data based on *TRANOR Standard Structure* (see next page)

Example 1:

The water level must be kept constant at elevation 54.00 ft. in a canal, at a location where the maximum discharge is 115 cfs. Maximum tailwater elevation is 53.75 ft. Which gate is suitable?

The minimum head differential available for the equipped structure is $J_m = 54.00 - 53.75 = 0.25$ ft. Point ***a*** *on the chart corresponds to Q_M = 115 cfs and J_m = 0.25 ft. The suitable gate size is the AMIL D355.*

Note that for a head differential of 0.25 ft., the AMIL D355 capacity is 124 cfs.

Example 2:

The free surface elevation of a lake has to be maintained constant. The maximum discharge at the outlet is equal to 115 cfs and the drop is 2.50 ft. Which gate is suitable?

Point ***b*** *on the chart corresponds to the above data and the suitable gate size is now the AMIL D280.*

Note that the AMIL D280 has a maximum capacity of 142 cfs.

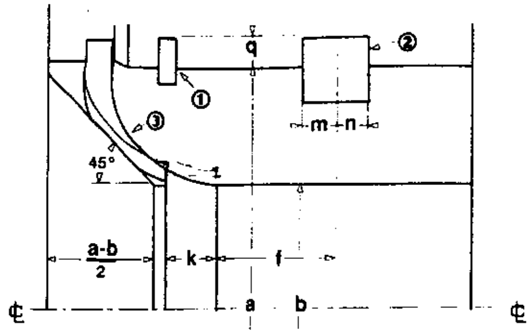
Two or more AMIL gates can be installed side by side (in parallel) to increase capacity, to reduce head differential or to better match structure and site.

HOW TO DESIGN THE STRUCTURE

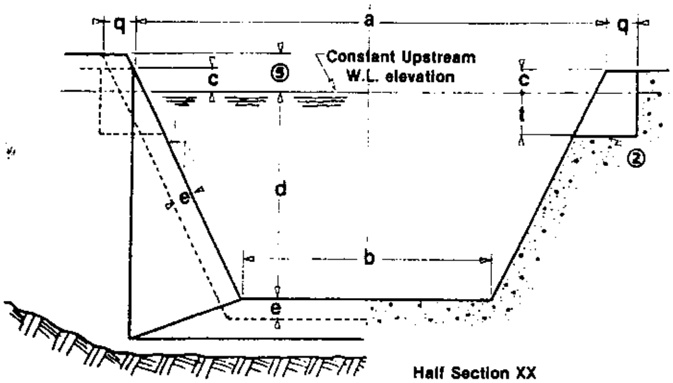
The TRANOR Standard Layout is recommended for the installation of AMIL gates. It leads to excellent hydraulic performance at minimum construction cost.

Other structure designs may be used (for instance, to suit local site requirements) leading, perhaps, to slightly different hydraulic characteristics. In this case a layout should be submitted to WATERMAN INDUSTRIES, INC., for further advice.

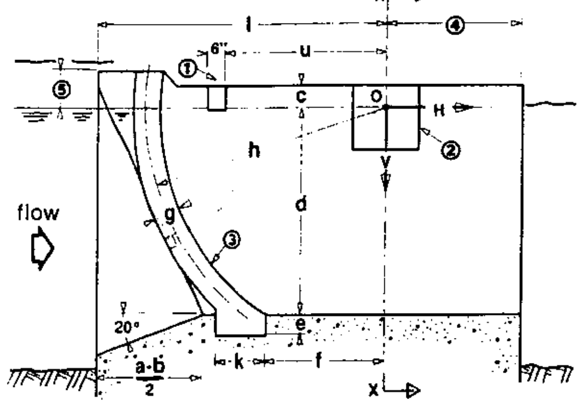
All dimensions are related to the gate trunnion axis O. Remember that the elevation of this axis is also the nominal value of the constant upstream W.L. to be constrolled by the gate. Note that this W.L. can be adjusted, within limits, after gate installation (to correct a small error in gate setting, or to control a different W.L., etc.)



½ Plan View



Half Section XX



Blockout areas ①, ② and ③ are provided in first stage concrete for grouting in gate components. Grout to be smoothed out flush with wall surface.

H and V are horizontal and vertical components of gate thrust on each (one) bank.

① On left bank only, for AMIL D500 and larger.
④ Determined by structure stability and concrete strength requirements.
⑤ Freeboard according to local conditions.

Larger structure drawing, with additional details, available upon request.

AMIL D	a ft. - in.	b ft. - in.	c in.	d ft. - in.	e in.	f ft. - in.	g in.	h ft. - in.	k in.	l ft. - in.	m in.	n in.	q min. in.	t in.	u ft. - in.	H lbs.	V lbs.
80	2 - 9½	1 - 5¾	1½	1 - 2¼	3	1 - 5½	4	2 - ¾	4½	2 - 6	6	6	6	6	[illegible]	40	100
90	3 - 1½	1 - 7¾	2	1 - 3¾	3	1 - 4½	4	2 - ¾	4½	2 - 6	6	6	6	6	[illegible]	56	110
100	3 - 5¼	1 - 10	2	1 - 5¾	3	1 - 2½	4	2 - ¾	5	2 - 6	6	6	6	6	[illegible]	80	130
110	3 - 10½	2 - ¾	2¼	1 - 7¾	3	1 - 0	4	2 - ¾	6	2 - 6	6	6	6	6	[illegible]	112	150
125	4 - 4	2 - 4	2¾	1 - 10	4	2 - 1	4	2 - 11½	5	3 - 7	7	7	8	8	[illegible]	[illegible]	[illegible]
140	4 - 11	2 - 7½	3¼	2 - ¾	4	1 - 10½	4	2 - 11½	6	3 - 7	7	7	8	8	[illegible]	224	310
160	5 - 7	2 - 11½	3½	2 - 4	4	1 - 6	4	2 - 11½	7	3 - 7	7	7	8	8	[illegible]	[illegible]	[illegible]
180	6 - 2¾	3 - 3¼	4	2 - 7½	4	2 - 10	6	4 - 1¼	8	5 - 0	9	9	8	8	[illegible]	450	525
200	6 - 11½	3 - 8	4	2 - 11½	4	2 - 6	6	4 - 1¼	9	5 - 0	9	9	8	8	[illegible]	630	750
220	7 - 9	4 - 1¼	4½	3 - 3½	4	2 - 0	6	4 - 1¼	10	5 - 0	9	9	8	8	[illegible]	900	[illegible]
250	8 - 8¼	4 - 7	5¼	3 - 8	[illegible]	[illegible]	6	5 - 3	12	6 - 4	10	10	10	8	[illegible]	1,250	1,400
280	9 - 10	5 - 3	5¾	4 - 1¼	6	2 - 10	6	5 - 3	13	6 - 4	10	10	10	8	[illegible]	1,800	[illegible]
315	11	5 - 10¾	7¾	4 - 7	6	4 - 2	8	6 - 6¾	13	7 - 11	10	10	12	10	[illegible]	2,600	2,500
355	12 - 3¾	6 - 6¾	7¾	[illegible]	6	3 - 4	8	6 - 6¾	16	7 - 11	10	10	12	10	[illegible]	[illegible]	[illegible]
400	13 - 11¼	7 - 4¼	8	5 - 11	6	5 - 3	8	8 - 2½	13	9 - 10	12	12	14	10	[illegible]	5,000	5,000
450	15 - 7	8 - 2½	9½	6 - 6¾	6	[illegible]	8	8 - 2½	15	[illegible]	12	12	14	10	[illegible]	7,100	6,000
500	17 - 4¾	9 - 2¼	10¼	7 - 4¼	6	6 - 8	10	10 - 4	15	12 - 5	22	12	8	24	7.0	10,000	9,100
560	19 - 8¼	10 - 4	11¾	8 - 2½	6	5 - 7	10	10 - 4	17	12 - 5	22	12	8	24	7.0	14,000	12,000
630	21 - 11¾	11 - 7¾	13¾	9 - 2¼	6	8 - 10	10	13 - 1½	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.0	20,000	18,000
710	24 - 7¼	13 - 1½	15¾	10 - 4	6	7 - 5	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.0	28,000	22,000
800	27 - 10¾	14 - 9¼	17¾	11 - 7¾	6	8 - 4	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	10.0	40,000	36,000

a = 27'10¾" = 27.9'
b = 14'9¼" = 14.8'
d = 11'7¾" = 11.6'
Area = 247.7 ft²

AMIL GATE

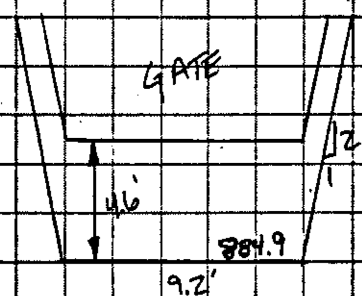
@ NORMAL POOL - 891.75 Q = 0 cfs*

@ SELLERS PNT CREST - 892.2 Q = 615 cfs*

@ 896.25 Q = 820 cfs*

DLA VALUES ARE LOWER TAKING INTO ACCOUNT HEADLOSS ACROSS WEIR U/S OF EXISTING AMIL.

CROSS-SECTIONAL AREA (COMPLETELY OPEN)



AREA BELOW GATE

9.2'(4.6') + 2(½)(4.6')(2(4.6)) = 53 ft²

AREA BELOW 896.5

9.2'(96.5-84.9) + 2(½)²(96.5-84.9)² − [9.2'(96.5-89.5) + 2(½)²(96.5-89.5)²] gate

= 85 ft²

GARDNER Q = 0.7 (340) (2g (pool elev. - 886))^0.5

@ NORMAL POOL - 891.75 Q = 4580 cfs

@ SELLERS PNT CREST - 892.2 Q = 4760 cfs

CROSS-SECTIONAL AREA 340 ft²

TO: Dodson-Stilson, Inc

ATTN: Mike Griffith

FAX#:

FROM: CAROL HALE

SUBJECT: Budget Prices

PAGE 1 OF 1

Waterman
INDUSTRIES SALES, INC.
P.O. Box 30635
Memphis, Tennessee 38130
(901) 365-8652 • FAX (901) 365-7192

DATE: 6-28-96

Your Fax request for Budget Prices on two (2) gates

First Gate: Radial Gate 34' wide x 10' High - No Price Ava.
This gate is too large for Waterman to Build

Second Gate: D800 Amil Gate $140,000.00 each.

Please feel free to call if you need further assistance.

Thank you
Carol