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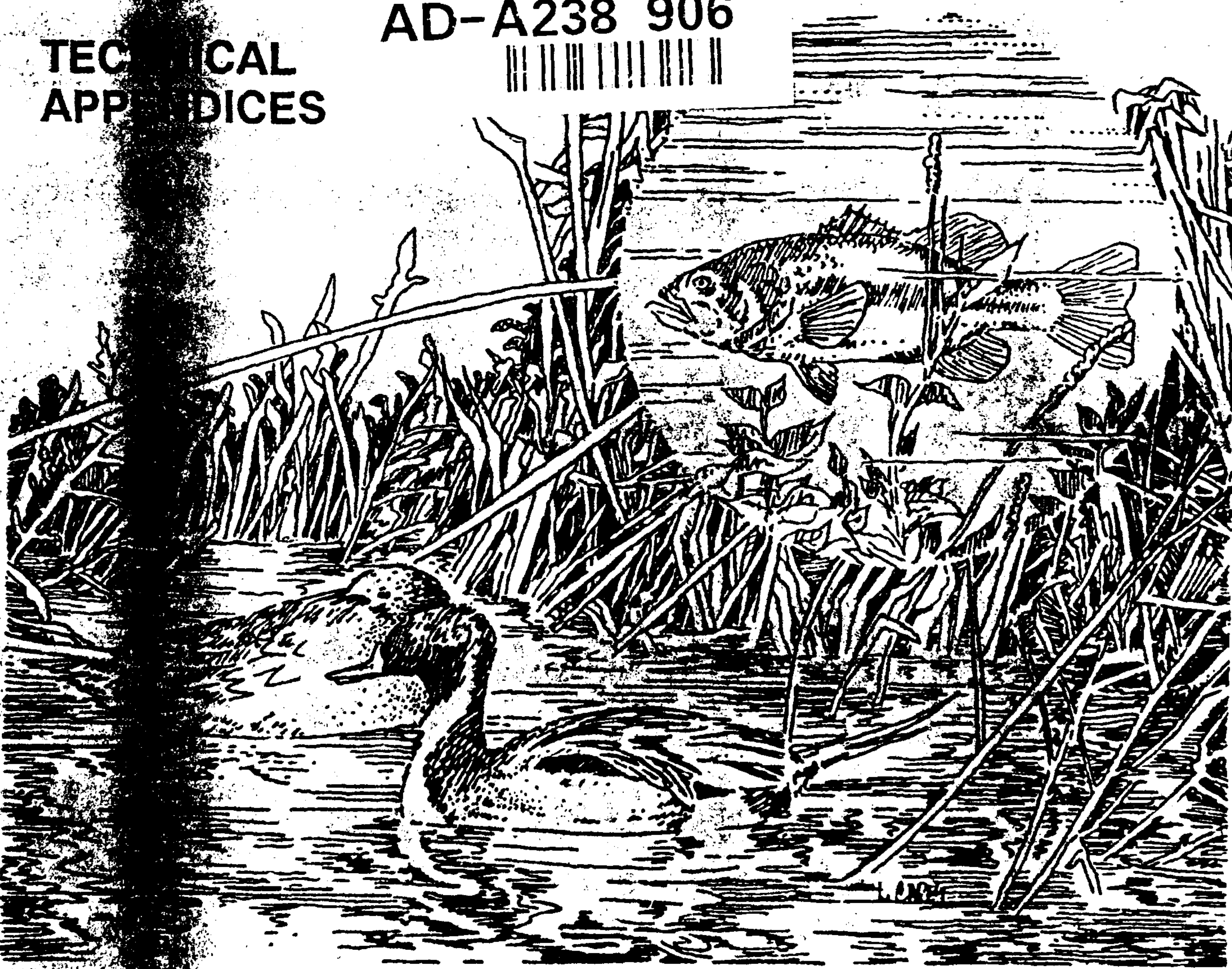
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT (R-7F)
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LAKE CHAUTAUQUA

REHABILITATION AND ENHANCEMENT

AD-A238 906

TECHNICAL APPENDICES



MAY 1991

US Army Corps
of Engineers
Rock Island District

91-05671

LA GRANGE POOL
ILLINOIS WATERWAY
MASON COUNTY, ILLINOIS

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DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING—P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF:

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-7F)

LAKE CHAUTAUQUA REHABILITATION AND ENHANCEMENT
LA GRANGE POOL, ILLINOIS WATERWAY, RIVER MILES 124-128
MASON COUNTY, ILLINOIS

TECHNICAL APPENDICES

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MAY 1991

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TECHNICAL APPENDICES

F - HYDROLOGY AND HYDRAULICS

G - WATER QUALITY

H - GEOTECHNICAL CONSIDERATIONS

I - NOT USED

J - NOT USED

K - HABITAT EVALUATION AND QUANTIFICATION

L - MECHANICAL AND ELECTRICAL CONSIDERATIONS

HYDROLOGY AND HYDRAULICS

APPENDIX F

UPPER MISSISSIPPI RIVER SYSTEM
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APPENDIX F
HYDROLOGY AND HYDRAULICS

→ Climate and hydrology

F-1. GENERAL.

Lake Chautauqua, located about 45 miles southwest of Peoria, Illinois, lies within the Illinois River floodplain and is part of the Chautauqua National Wildlife Refuge.

flow and flood

This appendix serves several purposes. General climatic and hydrologic conditions of the Lake Chautauqua area are described, and the design of the proposed water control structures for the upper and lower unit of the lake are discussed. The appendix also summarizes the study of the effect of dredging approximately 1 mile of Liverpool ditch and provides details of the pump sizing and selections. And, finally, the effect of the proposed levee on the Illinois River water surface profile is examined.

F-2. CLIMATE.

The climate in central Illinois is characterized by extreme temperatures and moderate precipitation. The National Weather Service operates a weather station in Havana, Illinois, located at approximate river mile (RM) 120.0 on the Illinois River, which has over 66 years of record. Temperatures range from a maximum average monthly of 100 degrees Fahrenheit in the summer to a minimum average monthly of 3 degrees Fahrenheit in the winter.

Most of the precipitation occurs in summer and fall months, with June normally the wettest month, having a monthly average of 4.05 inches. Winters are normally the driest parts of the year. The average annual precipitation is 34.0 inches, and the average annual snowfall is 21.3 inches. Table F-1 lists the appropriate monthly precipitation amounts. at the Havana gage for the 66 years of record during the periods 1901 to 1966.

TABLE F-1

Normal and Extremes of Monthly Precipitation

Month	Total Precipitation: Normal Inches	Record Max. Inches	Record Max. Yr.	Record Min. Inches	Record Min. Yr.	Snowfall: Normal Inches	Record Max. Inches	Record Max. Yr.
January	1.83	9.74	16	.02	19	5.58	22.9	18
February	1.49	4.35	08	.05	47	4.70	14.2	08
March	2.78	7.30	01	.26	10	4.43	23.5	60
April	3.62	7.68	57	.89	01	0.68	11.5	20
May	3.76	9.82	35	.39	34	0.00		
June	4.05	9.68	47	.40	33	0.00		
July	3.50	10.95	37	.25	16	0.00		
August	3.12	7.16	65	.52	35	0.00		
September	3.61	13.14	11	.07	40	0.00		
October	2.42	12.22	41	.12	64	0.13	3.50	25
November	2.14	6.78	42	.04	14	1.07	9.70	26
December	1.68	5.82	49	.26	19	4.71	15.2	42

F-3. HYDROLOGY.

The Rock Island District, Corps of Engineers, developed Illinois River water surface profiles using Dr. Robert Barkau's Unsteady Flow Model. Plate F-1 presents computed profiles for various exceedence frequency events in the project reach. The Illinois River discharge frequency relationships and corresponding water surface profiles were developed based on recorded gage data at Kingston Mines, Illinois (RM 145.0), Havana, Illinois (RM 120.0) and Copperas Creek, Illinois (RM 136.8). Also, daily stage hydrographs for the period of record 1960 to 1990 were used to compute monthly and year-round elevation duration relationships for the project site as presented on plates F-2 through F-5. The 50-percent duration elevation can be interpreted as the average elevation. The months of August, September, and October have the lowest normal elevations of 431.7, 431.3, and 431.0 feet National Geodetical Vertical Datum of 1929 (NGVD), respectively. The year-round normal elevation is about 434.1 feet NGVD. Table F-2 shows the river elevations during selected flood events at locations of the proposed structures around the lake. Plate F-6 shows the location of the existing and proposed structures.

TABLE F-2

Illinois River Elevations for Select Events
(in feet, NGVD)

River Mile	Description	2-year flood	5-year flood	10-year flood	50-year flood	100-year flood
129.4	Radial gates	443.13	446.76	449.04	452.51	453.70
128.4	Cross dike and pump	442.97	446.64	448.93	452.42	453.61
124.0	Proposed stoplog structure	442.58	446.35	448.68	452.21	453.40

For the purpose of determining pump operating conditions, a frequency relationship was computed for the lowest elevation for the months of June and July. The lowest monthly elevation recordings at Liverpool, Illinois (RM 128) were used for the period from 1940 to 1981. The computed average of data from Havana, Illinois, and Copperas Creek, Illinois, was used for the period from 1982 to 1990. The results are shown on plates F-7 and F-8.

F-4. WATER CONTROL OF UPPER LAKE CHAUTAUQUA.

The proposed project includes repairing an existing perimeter levee around the upper portion of Lake Chautauqua and an existing cross dike. The levee, including the cross dike, will be reconstructed to elevation 449.0 feet NGVD (a 10-year event). The levee will have 4 on 1 side slopes. Four on 1 and 6 on 1 side slopes will be provided on the cross dike upstream and downstream slopes, respectively. The function of levee will be to impede flood waters and the associated sediment load. The anticipated operating elevation of the upper lake will vary between 434.0 and 436.0 feet NGVD.

Currently there are 4 radial gates in the upper unit. Each gate has a span width of 12.0 feet. The bottom elevation of the existing gate openings is 433.5 feet NGVD, and the top elevation of gate openings is 445.5 feet NGVD. The proposed modification to the gate openings will be to raise the sill to 437.5 feet, thereby raising the elevation of the top of the gate to 449.5 feet NGVD. This will maintain 12.0-foot by 12.0-foot openings when filling the upper lake. Within the raise+d sill itself, there will be 8 4-foot by 3-foot openings, each opening having a bottom elevation of 433.5 feet NGVD and a top elevation of 436.5 feet NGVD. These openings will help to maintain the drainage capacity for the upper lake. It is also proposed that a 60-inch circular culvert and a 5-foot by 5-foot box culvert be installed. The sizes of these conduits were based on expected filling and drainage time of the upper unit. To ensure proper filling and draining time, a 41,000 gpm pumping station is proposed to be installed. The selection and sizing of the pump is described further in this appendix.

a. **Inflow Through the Radial Gates.** To minimize levee damage during overtopping events, flow must enter the upper portion of the lake such that by the time the river elevation reaches the levee height, the elevation of the upper lake would be within 1.0 foot of the river elevation. This head differential is consistent in minimizing erosion damage to the levee. The basis for inflow routing is as follows:

- The levee height around the radial gates is 449.0 feet NGVD (10-year flooding event).

- The Illinois River rises 1.0 foot per day. From analyzing existing historic hydrographs of typical floods at this river reach, it was determined that the rate of rise for the river varies between 0.5 and 1.0 foot per day. To be conservative, 1.0 foot per day was chosen.

- The initial upper lake elevation is 435.0 feet NGVD.

- It is known 3 days in advance that a 10-year flooding event will occur (this is possible because of river gages upstream of the lake and past records of river stages during flooding events).

- There are 4 - 12-foot by 12-foot radial gate openings, a 60-inch circular culvert, and a 5-foot by 5-foot box culvert to allow inflow into the upper portion of the lake. The box culvert and the circular culvert are proposed structures.

Inflow rating curves were determined for each of the structures for varying lake levels. In general, the U.S. Bureau of Public roads method was used for culvert ratings. The Corps of Engineers HEC-2 computer program also was used to check the rating for the 12-foot by 12-foot structure. After checking the individual rating curves, they were combined for use in the routing computations.

A trial and error routine was developed using the river stage (assumed constant for the interval), the beginning lake level, and the known beginning inflow for the incremental period. An inflow volume was assumed. The resulting total storage and lake level at the end of the period was computed using the elevation storage relationship for the lake shown on plate F-9. The average inflow for the period was computed and converted to a volume. If the computed volume did not match the assumed inflow volume, a new assumption was tried until a match resulted and computation could proceed to the next time interval.

The routing was computed using half-day increments. The computed results are shown in table F-3. A graphical result can be seen on plate F-10.

TABLE F-3

Inflow Scenario of Upper Lake During Overtopping Event with Initial Upper Lake Elevation of 435.0 Feet NGVD

Day	Illinois River Elevation (feet)	Upper Lake Initial Elevation (feet)	Head Differential (feet)	Flowrate (cfs)	Cumulative Storage (acre-feet)	Upper Lake Final Elevation (feet)
0.0	446.0	435.0	11.0	3,600	6,600	438.1
0.5	446.5	438.1	8.4	3,600	10,200	441.0
1.0	447.0	441.0	6.0	3,475	13,650	443.8
1.5	447.5	443.8	3.7	2,800	16,450	446.4
2.0	448.0	446.4	1.6	1,825	18,250	447.7
2.5	448.5	447.7	0.8	800	19,050	448.4
3.0	449.0	448.4	0.6	600	19,800	449.0

Under the assumed conditions, the water surface elevation of the upper lake will be less than 1 foot below the Illinois River water surface elevation when the levee is overtopped. Based on these conditions, the gate openings, the box culvert, and the circular culvert adequately meet the requirement of filling the upper lake before overtopping occurs. An initial upper lake level of 434.0 feet NGVD also was investigated. This resulted in only slight differences, and the proposed inlet capacity was again satisfactory.

b. **Draining the Upper Unit of Lake Chautauqua.** To minimize pumping cost to drain water from the upper lake, the ideal condition is for the upper lake water surface elevation to recede at approximately the same rate as the Illinois River water surface elevation. The goal is to lower the upper lake water surface elevation to within 0.5 foot of the river water surface elevation within about 2 weeks after the river elevation stops receding. The basis for the drainage conditions is as follows:

- The Illinois river water surface elevation will recede at the rate of 0.5 foot per day. It will stop receding at the elevation of 431.0 feet NGVD.

- The initial water surface elevation of the lake is 437.5 feet NGVD (elevation of the raised sill at the radial gate).

- There are eight 4-foot by 3-foot openings at the radial gates to drain water from elevations 436.5 feet NGVD to 433.5 feet NGVD. This is the proposed modification of the radial gates.

- There is a 60-inch circular culvert where the inlet invert is at 429.0 feet NGVD. This culvert can serve a dual purpose of improving inflow capacity as well as drainage capacity. The 5-foot by 5-foot culvert was not considered.

The same rating procedure as described earlier was used to develop discharge elevation relationships. An approximate routing procedure was used assuming that beginning of period relationships are constant throughout the period. A comparison study indicated good agreement with the trial and error approach previously described. The computed results are shown in table F-4 and on plate F-11.

TABLE F-4

Elevation of Upper Lake When Draining

Day	Illinois River Elevation (feet)	Upper Lake Initial Elevation (feet)	Head Differential (feet)	Flowrate (cfs)	Cumulative Storage (acre-feet)	Upper Lake Final Elevation (feet)
0.0	437.0	437.5	0.5	422	5,400	437.0
1.0	436.5	437.0	0.5	422	4,800	436.5
2.0	436.0	436.5	0.5	390	4,200	436.0
3.0	435.5	436.0	0.5	318	3,600	435.5
4.0	435.0	435.5	0.5	248	3,120	435.1
5.0	434.5	435.1	0.4	198	2,653	434.7
6.0	434.0	434.7	0.7	143	2,361	434.5
7.0	433.5	434.5	1.0	125	2,118	434.2
8.0	433.0	434.2	1.2	127	1,866	434.0
9.0	432.5	434.0	1.5	132	1,591	433.7
10.0	432.0	433.7	1.7	125	1,346	433.5
11.0	431.5	433.5	2.0	114	1,127	433.2
12.0	431.0	433.2	2.2	106	910	432.9
13.0	431.0	432.9	1.9	103	775	432.7
14.0	431.0	432.7	1.7	97	586	432.4
15.0	431.0	432.4	1.4	89	408	432.1
16.0	431.0	432.1	1.1	80	251	431.8
17.0	431.0	431.8	0.8	69	116	431.5

Approximately 18 days are needed for the upper lake water surface elevation to recede from 437.5 feet NGVD to 431.5 NGVD. The river takes 12 days for the water surface elevation to recede from 437.5 feet NGVD to 431.0 feet NGVD. Therefore, the openings and culvert allow the upper lake water surface elevation to be within half a foot of the river water surface elevation approximately 1 week after the river stops receding.

F-5. WATER CONTROL OF LOWER LAKE CHAUTAUQUA.

The lower lake will be operated as a moist soil management unit (MSMU) during the summer/fall months of each year. Beginning in early June, water levels will be drawn down to allow moist soil plants to begin growing by late July/early August. Water levels will be lowered by the proposed stoplog structure and the pump station (described later).

Although the existing levee system is less than a 2-year event, hydraulic routings were performed based on proposed present improvements consistent with the management plan of the lower lake. There is an existing stoplog structure with an 18-foot opening. The present project proposes increasing the opening to 20 feet for gravity draining purposes. Under future lower lake improvements, the lower levee would be raised to the 2-year event with a second 20-foot stoplog structure and new spillway. These structure would replace the presently obsolete stoplog structure and existing west and south spillways. Routings using the proposed present stoplog structure and the future structures were performed.

a. **Inflow Through the Stoplog and Spillway.** For inflow purposes, the situation is similar to those of the upper unit. Flow must go into the MSMU such that by the time the river elevation reaches the levee height, the minimum elevation of the MSMU would be within 1 foot of the river elevation. The design basis for inflow routing is as follows:

- The levee height around the stoplog structures is 445.0 feet NGVD. (2-year event plus 2.0 feet).
- The Illinois River rises 1.0 foot per day.
- The initial MSMU and river elevation is 434.0 feet NGVD.
- There are two stoplog structures, each 20.0 feet in length.
- Spillway length is 700.0 feet effective at an elevation of 443.0 feet NGVD.
- Weir coefficient of stoplog and spillway is 2.8.
- The other existing spillways at 437.5 feet were not controllable and thus not evaluated in this study.

The routing was performed using the approximate technique as previously discussed. Discharges were computed in half day increments using the weir flow equation. The computed discharge was assumed to be the average flow into the MSMU. From the discharge, the volume of the MSMU was determined and the elevation of the MSMU found using plate F-12. Table F-5 shows the computed results; graphical results are shown on plate F-13.

TABLE F-5

Inflow Conditions of MSMU During 2-Year Flood

Days	River Elevation (feet)	Initial MSMU Elevation (feet)	Head Differential (feet)	Flowrate (cfs)	MSMU Storage (ac-ft)	Final MSMU Elevation (feet)
0.0	434.0	434.0	0.0	0	3,600	434.0
0.5	434.5	434.0	0.5	39	3,639	434.0
1.0	435.0	434.0	1.0	108	3,746	434.1
1.5	435.5	434.1	1.4	188	3,932	434.2
2.0	436.0	434.2	1.8	270	4,200	434.4
2.5	436.5	434.4	2.1	348	4,545	434.5
3.0	437.0	434.5	2.5	436	4,977	434.8
3.5	437.5	434.8	2.7	507	5,480	435.0
4.0	438.0	435.0	3.0	569	6,044	435.4
4.5	438.5	435.4	3.1	624	6,663	435.7
5.0	439.0	435.7	3.3	671	7,328	436.1
5.5	439.5	436.1	3.4	711	8,033	436.5
6.0	440.0	436.5	3.5	745	8,772	436.9
6.5	440.5	436.9	3.6	773	9,539	437.3
7.0	441.0	437.3	3.7	797	10,330	437.7
7.5	441.5	437.7	3.8	817	11,140	438.2
8.0	442.0	438.2	3.8	833	11,967	438.7
8.5	442.5	438.7	3.8	847	12,806	439.1
9.0	443.0	439.1	3.9	858	13,657	439.6
9.5	443.5	439.6	3.9	1,560	15,204	440.5
10.0	444.0	440.5	3.5	2,710	17,892	441.9
10.5	444.5	441.9	2.6	4,060	21,918	444.2
11.0	445.0	444.2	0.8	1,548	23,453	445.0

Based on the computed results, the given stoplog structures and spillway conditions adequately meet the needs to fill the MSMU to within 1 foot of the river elevation when the river elevation rises to 445.0 feet NGVD.

b. **Draining the Moist Soil Management Unit.** Drainage of the MSMU is done through the stoplog structures. The goal is to drain the MSMU within approximately 2 weeks after the Illinois River water surface elevation stops receding. The design basis for draining the lower lake is as follows:

- There are two stoplogs used. The existing stoplog structure has an invert elevation of 433.0 feet NGVD and a length of 18.0 feet. The proposed stoplog has an invert elevation of 429.0 feet NGVD and a length of 20.0 feet.

- The Illinois River water surface elevation recedes 0.5 foot per day to a minimum elevation of 431.0 feet NGVD.

- The weir coefficient of both stoplog structures is 2.8.

The discharges were computed in 1-day increments using the weir flow equation. Based on the discharge, the volume remaining in the MSMU was determined, and the elevation in the MSMU was found using plate F-12. Table F-6 shows the computed results; graphical results are shown on plate F-14.

TABLE F-6

Drainage Results of MSMU

Days	River Elevation (feet)	Initial MSMU Elevation (feet)	Head Differential (feet)	Flowrate (cfs)	MSMU Storage (ac-ft)	Final MSMU Elevation (feet)
0.0	437.5	437.5	0.0	0.0	9,900	437.5
1.0	437.0	437.5	0.5	37.6	9,825	437.5
2.0	436.5	437.5	1.0	99.9	9,627	437.4
3.0	436.0	437.4	1.4	166.6	9,297	437.2
4.0	435.5	437.2	1.7	228.6	8,843	436.9
5.0	435.0	436.9	1.9	281.5	8,285	436.6
6.0	434.5	436.6	2.1	324.5	7,642	436.3
7.0	434.0	436.3	2.3	358.0	6,932	435.9
8.0	433.5	435.9	2.4	383.5	6,171	435.4
9.0	433.0	435.4	2.4	402.6	5,372	435.0
10.0	432.5	435.0	2.5	360.2	4,658	434.6
11.0	432.0	434.6	2.6	333.9	3,995	434.2
12.0	431.5	434.2	2.7	310.9	3,379	433.8
13.0	431.0	433.8	2.8	304.6	2,775	433.5
14.0	431.0	433.5	2.5	239.6	2,299	433.2
15.0	431.0	433.2	2.2	192.0	1,918	433.0
16.0	431.0	433.0	2.0	156.8	1,607	432.8
17.0	431.0	432.8	1.8	131.1	1,347	432.6
18.0	431.0	432.6	1.6	108.6	1,132	432.4
19.0	431.0	432.4	1.4	89.3	955	432.2
20.0	431.0	432.2	1.2	73.2	810	432.1
21.0	431.0	432.1	1.1	59.9	691	431.9
22.0	431.0	431.9	0.9	49.2	593	431.8
23.0	431.0	431.8	0.8	40.6	513	431.7
24.0	431.0	431.7	0.7	33.6	446	431.6
25.0	431.0	431.6	0.6	28.0	391	431.6
26.0	431.0	431.6	0.6	23.5	344	431.5
27.0	431.0	431.5	0.5	19.9	305	431.5
28.0	431.0	431.5	0.5	16.9	271	431.4
29.0	431.0	431.4	0.4	14.5	242	431.3

It takes approximately 28 days for the MSMU to drain from a water surface elevation of 437.5 feet NGVD to 431.5 feet NGVD. It takes the Illinois

River 13 days for the water surface elevation to recede from 437.5 feet NGVD to 431.5 feet NGVD. Based on these conditions, the stoplog structures adequately meet the requirements to drain the MSMU.

F-6. LIVERPOOL DITCH EXCAVATION.

a. **Site Description.** Part of this project involves increasing the depth and cross-sectional area of Liverpool Ditch. This ditch flows along the Lake Chautauqua refuge.

Between Illinois River miles 124.0 and 128.7, water flows around an island in two channels. Most of the discharge flows in the navigation channel (north side of the island) past the city of Liverpool. A smaller portion of the total discharge flows south of the island in Liverpool Ditch. This ditch, 4 miles long, has a top width of about 110.0 feet. See plate F-15 for site map.

b. **Discussion of Problem and Method of Study** The proposed work includes dredging Liverpool Ditch. This analysis estimates the influence that increasing the cross-sectional area would have on the flow distribution, the water velocity, and the sedimentation rate.

Discharge and velocity estimates were computed using the Corps of Engineers HEC-2 backwater computer program. The method for determining the flow split around the island involved making two HEC-2 decks; one deck modeled the navigation (north) channel and another modeled Liverpool Ditch. A total discharge rating curve was obtained for RM 128.7 by summing both channel discharges for the same water surface elevation at RM 128.7. Estimates of sedimentation were based upon velocity information, past history, and experience.

Several cases were studied. The first case evaluated the existing without-project condition. The second case modeled increasing the cross-sectional area. The third case modeled installing a control structure at the entrance to Liverpool Ditch in addition to increasing the cross section.

c. **Description for Enlarged Cross Section and Control Structure.** Part of the proposed project included enlarging and deepening Liverpool Ditch. The enlarged channel would be dredged to elevation 419.4 at the downstream point where it enters the Illinois River. It would be trapezoidal with a bottom width of up to 50.0 feet, a side slope of 3 to 1 (horizontal versus vertical), and a depth of about 10.0 feet. The channel bottom slope would be 0.00003 foot per foot. The actual slope can vary quite a bit without influencing the design. A typical cross section is shown on plate F-16.

The control structure would be built between Liverpool Ditch and the Illinois River (RM 128.0). It would be 15.0 feet wide and have a minimum elevation of 426.3 feet NGVD. The depth was chosen to be 3.0 feet below the normal water elevation. The sides would slope upward with a side slope of 2 to 1.

d. **Range of Discharges Examined.** Flow duration curves exist for stations on the Illinois River that are upstream and downstream of the project site. Data from Meredosia (RM 71.3; drainage area 26,028 square miles) and Kingston Mines (RM 144.4; drainage area 15,819 square miles) are shown on plates F-17 and F-18. The LaGrange dam is taken out of operation when the discharge is between 23,000 and 24,000 cfs. Since the study is concerned with the influence of the project during conditions occurring most of the time, discharges from 0 to 24,000 cfs were examined.

e. **HEC-2 Models.** Four data decks were assembled. One deck modeled the Illinois River, another deck modeled Liverpool Ditch as it exists now, a third deck modeled Liverpool Ditch with the enlarged cross section, and the last deck modeled Liverpool Ditch with the enlarged cross section and with the upstream control structure.

Illinois River cross sections were taken from dredge sounding surveys. Cross sections for the Illinois River data deck started at RM 101 and continued upstream with a cross section every 3.0 miles to RM 123.0. Above this point, cross sections were a half mile apart. The deck stopped (Illinois River mile 128.7) where water would enter Liverpool Ditch.

The water surface level of the LaGrange pool is 429.0 feet NGVD. A water level of 429.2 feet NGVD obtained from sounding sheets was used as the starting water surface level in the model. RM 101 was selected after examining several profile plots. Downstream of RM 101 the channel water level was controlled by the pool level.

Plate F-15 shows the locations of the cross sections for both decks above RM 123. Expansion and contraction values of 0.1 and 0.3 were used in the data decks. A Manning's roughness coefficient (n-value) of 0.03 was used for all overbanks. An n-value of 0.02 was used for the main Illinois River channel while 0.025 was used for Liverpool Ditch. A computer run was made for the main channel using a 50 percent probability flood discharge of 48,000 cfs to see how the computed water level would compare to published profiles. The Illinois River water level computed by the HEC-2 model used in this study was 0.58 feet higher at RM 128.7 than published profiles obtained by unsteady state computer modeling. These results confirmed the selection of Illinois River n-values.

f. **HEC-2 Assumptions.** Sensitivity runs were made to determine the influence of starting water surface and the n-value selection.

When the river channel slope is slight, the assumed starting water surface elevation is critical. For this reason, the model started far downstream of the project. To determine the sensitivity of the model to starting water surface elevation, two additional runs were made with starting levels of 428.2 feet NGVD and 430.2 feet NGVD for a discharge of 12,000 cfs. These starting elevations resulted in computed levels through the project area that were 0.3 foot lower and 0.4 foot higher, respectively, than values used in this study. However, this difference was not significant enough to change the ratio of flows going down either channel.

Another series of sensitivity runs were made to determine the influence of Illinois River channel n-values. Runs using n-values of 0.015 and 0.025 were compared to the 0.02 value used in this study. A discharge of 10,000 cfs resulted in levels that were about 0.8 foot higher and lower through the project site. This change would produce flows in Liverpool ditch of 720 cfs or 1,280 cfs compared to the 950 cfs used in this study. Liverpool ditch velocities fluctuated less than 0.1 foot per second.

In the overall scheme of things, these variations are rather insignificant. The general flow ratios, velocities, and patterns hold true for a range of starting water surface elevations and n-values. This sensitivity analysis lends credibility to the study conclusions.

g. **HEC-2 Results and Conclusions.** Values showing the flow split for the existing ditch, the enlarged ditch, and the enlarged ditch with control structure appear in table F-7. A plot of the same data for the existing and with-project condition appears on plates F-19 and F-20. Presently, less than 2 percent of the total Illinois River discharge flows down Liverpool Ditch. With the enlarged ditch, this percentage will range from 8 to 10 percent. With the enlarged ditch and control structure, the percentage will range from 4 to 8 percent of the total Illinois River discharge.

TABLE F-7

Discharge in Liverpool Ditch for Various Cases
as a Function of Discharge in Navigation Channel

Illinois River	----------Liverpool Ditch----------		
Navigation Channel (cfs)	Existing Case (cfs)	Enlarged W/Struct. (cfs)	Enlarged Only (cfs)
5,000	0	230	500
10,000	9	950	950
15,000	95	1,025	1,500
20,000	278	1,650	2,200
24,000	480	2,200	2,800

The enlarged channel will lower water levels in the Illinois River navigation channel (RM 124-128.7) from one-quarter to one-half foot for discharges below that of the 2-year recurrence interval.

The enlarged channel will increase velocities in some sections of Liverpool Ditch. Average velocities of water with the enlarged channel will range from 0.5 to 1.7 feet per second. Average velocities for the existing case will range from 0.05 to 1.4 feet per second. Water velocities for all cases decrease when Liverpool Ditch enters Liverpool Lake. Calculated velocities are also lower for Liverpool Ditch than for the navigation channel (0.8 to 2.2 feet per second). Liverpool Ditch will probably start filling with sediment immediately.

The structure at the upstream portion of Liverpool Ditch reduces the discharges in the ditch by 300 to 600 cfs. It also has the potential to reduce the amount of bedload (sand) entering the ditch. However, since existing sediment in the ditch appears to be silt and not sand, this benefit may not be significant.

F-7. QUIVER CREEK TRIBUTARY DATA.

The drainage area of Quiver Creek is estimated to be 197 square miles. The average basin slope of the area is approximately 4.1 feet per mile. Using the Illinois Regional Regression Equation, the discharge frequency given in table F-8 was determined.

TABLE F-8

Summary of Discharge for Quiver Creek
(Discharge is in cfs)

Flooding Source	Drainage Area (square miles)	2-Yr	5-Yr	10-Yr	50-Yr	100-Yr
Quiver Creek	197	3,238	5,533	7,163	10,907	12,501

F-8. PUMP STATION.

To ensure that the upper and lower units have the proper amount of water or are drained of water, a pump station must be selected that will drain, as well as fill, both units in a reasonable amount of time. A 41,000 gpm pump station was selected.

a. **Draining the MSMU and the Upper Unit.** The MSMU has the largest water storage of the two units. Table F-9 gives some pumping requirements for various elevations of the MSMU based on drawdown to elevation 431.0 feet NGVD in 30 days.

TABLE F-9

Lake Chautauqua Pump Station Sizing of MSMU

Elevation Pump is Turned on (feet)	Volume of Water to Pump (Acre-feet)	Number of Days to Pump	Pump Size Required (gal/min)
433.0	2,000	30	15,000
433.5	2,800	30	21,000
434.0	3,700	30	28,000
435.0	5,400	30	41,000
436.0	7,300	30	55,000
437.0	9,200	30	69,000
438.0	11,100	30	84,000
439.0	13,000	30	98,000

To allow 2 full months of growing season for the MSMU, the latest time the pump can be activated is on July 1st. A pump size of 41,000 gpm was chosen. To be conservative, an elevation of 435.0 feet NGVD was chosen as the design elevation for the month of June as there is about a 75 percent probability (based on plate F-7) that the river would be that low or lower some time during the month.

With a 41,000 gpm pump station and a 30-day time period, water can be drained from the upper unit starting at an elevation of about 437.0 feet NGVD. There is an 80 percent probability that the upper unit will be at this elevation or lower during the month of June. The month of July experiences generally lower water surface elevations compared to June.

b. **Filling the MSMU and Upper Unit.** When the pump is used to fill both units, it will operate at an approximate 50 to 60 percent capacity because it is running under reversed condition. The pump will be used to fill the upper and lower units should there be drought conditions. The optimal water surface elevation required is 435.0 feet NGVD for the upper unit and 433.0 feet for the MSMU. Given a 41,000 gpm pumping station at about 50 percent capacity (21,000 gpm) and the worst condition where both upper and lower units are dried, the approximate time required to operate the pump to fill the units is 32 days for the upper unit and 21 days for the lower unit.

F-9. WAVE EROSION.

The purpose of studying wave erosion is to provide a slope condition of the upper lake that will reduce the wave impact to shoreline erosion. The reference to compute wave conditions are found in U.S. Army Coastal

Engineering Shore Protection Manual. Table 8-3 of the main document describes the design wave conditions.

In summary, it was concluded that slopes of 1V on 4H or flatter would be stable since the material used to create the shoreline slope will be cohesive clay, which is considered erosion resistant. The embankment cover will eventually be dominated by naturally colonized woody growth.

F-10. PROJECT EFFECT ON THE ILLINOIS RIVER PROFILE.

Based on Dr. Robert Barkqau's unsteady flow model the effect of the proposed levee on the Illinois River's water surface profiles were evaluated to the nearest tenth of a foot. The water surface elevation of the 10-year flood increased by no more than one-tenth of a foot, and there was no effect on the water surface elevation for the 100-year flood event. Tables F-10 and F-11 show the computed results of the water surface profile, with and without the levee. It should be noted that the computer model includes both conveyance and storage effects.

TABLE F-10

Effect of Levee on 10-Year Flood at Lake Chautauqua

River Miles	Before Levee Elevation (feet)	After Levee Elevation (feet)	Difference in Elevation (feet)
140.7	450.2	450.3	0.1
140.2	450.0	450.1	0.1
139.7	449.9	450.0	0.1
139.2	449.9	450.0	0.1
138.7	449.8	449.9	0.1
138.2	449.7	449.8	0.1
137.7	449.5	449.6	0.1
137.2	449.4	449.5	0.1
136.7	449.3	449.4	0.1
136.2	449.3	449.4	0.1
135.7	449.3	449.4	0.1
135.2	449.3	449.4	0.1
134.6	449.2	449.4	0.1
134.2	449.2	449.3	0.1
133.7	449.2	449.3	0.1
133.2	449.2	449.3	0.1
132.7	449.2	449.3	0.1
132.2	449.2	449.3	0.1
131.7	449.2	449.3	0.1

TABLE F-10 (Cont'd)

River Miles	Before Levee Elevation (feet)	After Levee Elevation (feet)	Difference in Elevation (feet)
131.4	449.1	449.2	0.1
130.9	449.1	449.2	0.1
130.4	449.1	449.2	0.1
129.9	449.1	449.2	0.1
129.4	449.1	449.1	0.1
129.4	449.0	449.1	0.1
129.4	449.0	449.1	0.1
128.9	449.0	449.0	0.0
128.4	448.9	448.9	0.0
127.9	448.9	448.9	0.0
127.3	448.8	448.8	0.0
126.9	448.8	448.8	0.0
126.4	448.8	448.8	0.0
125.9	448.8	448.8	0.0
125.4	448.8	448.7	0.0
124.9	448.7	448.7	0.0
124.4	448.7	448.7	0.0
123.9	448.7	448.7	0.0
123.4	448.6	448.6	0.0
122.9	448.5	448.5	0.0
122.4	448.5	448.5	0.0
121.9	448.4	448.4	0.0
121.4	448.4	448.4	0.0
120.9	448.4	448.4	0.0
120.8	448.4	448.4	0.0
120.4	448.3	448.3	0.0

TABLE F-11

Effect of Levee on 100-Year Flood at Lake Chautauqua

River Miles	Before Levee Elevation (feet)	After Levee Elevation (feet)	Difference in Elevation (feet)
140.7	454.9	454.9	0.0
140.2	454.8	454.8	0.0
139.7	454.6	454.6	0.0
139.2	454.6	454.6	0.0
138.7	454.5	454.5	0.0
138.2	454.4	454.4	0.0

TABLE F-11 (Cont'd)

River Miles	Before Levee Elevation (feet)	After Levee Elevation (feet)	Difference in Elevation (feet)
137.7	454.2	454.2	0.0
137.2	454.1	454.1	0.0
136.7	454.0	454.0	0.0
136.2	454.0	454.0	0.0
135.7	454.0	454.0	0.0
135.2	453.9	453.9	0.0
134.6	453.9	453.9	0.0
134.2	453.9	453.9	0.0
133.7	453.9	453.9	0.0
133.2	453.9	453.9	0.0
132.7	453.9	453.9	0.0
132.2	453.9	453.9	0.0
131.7	453.9	453.9	0.0
131.4	453.8	453.8	0.0
130.9	453.8	453.8	0.0
130.4	453.8	453.8	0.0
129.9	453.8	453.8	0.0
129.4	453.7	453.7	0.0
129.4	453.7	453.7	0.0
129.4	453.7	453.7	0.0
128.9	453.7	453.7	0.0
128.4	453.6	453.6	0.0
127.9	453.6	453.6	0.0
127.3	453.5	453.5	0.0
126.9	453.5	453.5	0.0
126.4	453.5	453.5	0.0
125.9	453.5	453.5	0.0
125.4	453.5	453.5	0.0
124.9	453.4	453.4	0.0
124.4	453.4	453.4	0.0
123.9	453.4	453.4	0.0
123.4	453.4	453.4	0.0
122.9	453.3	453.3	0.0
122.4	453.2	453.2	0.0
121.9	453.1	453.1	0.0
121.4	453.1	453.1	0.0
120.9	453.1	453.1	0.0
120.8	453.1	453.1	0.0
120.4	453.1	453.1	0.0

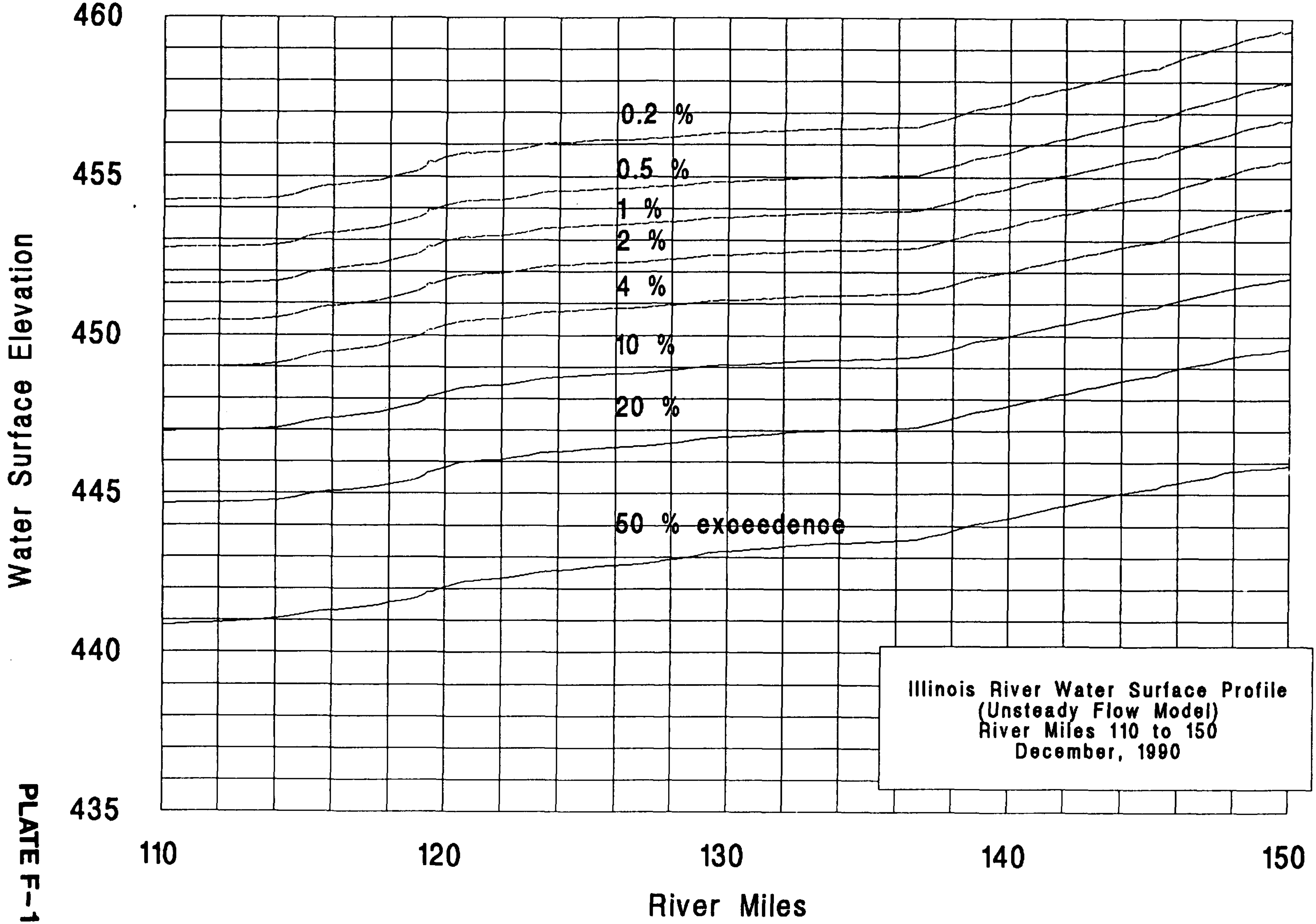
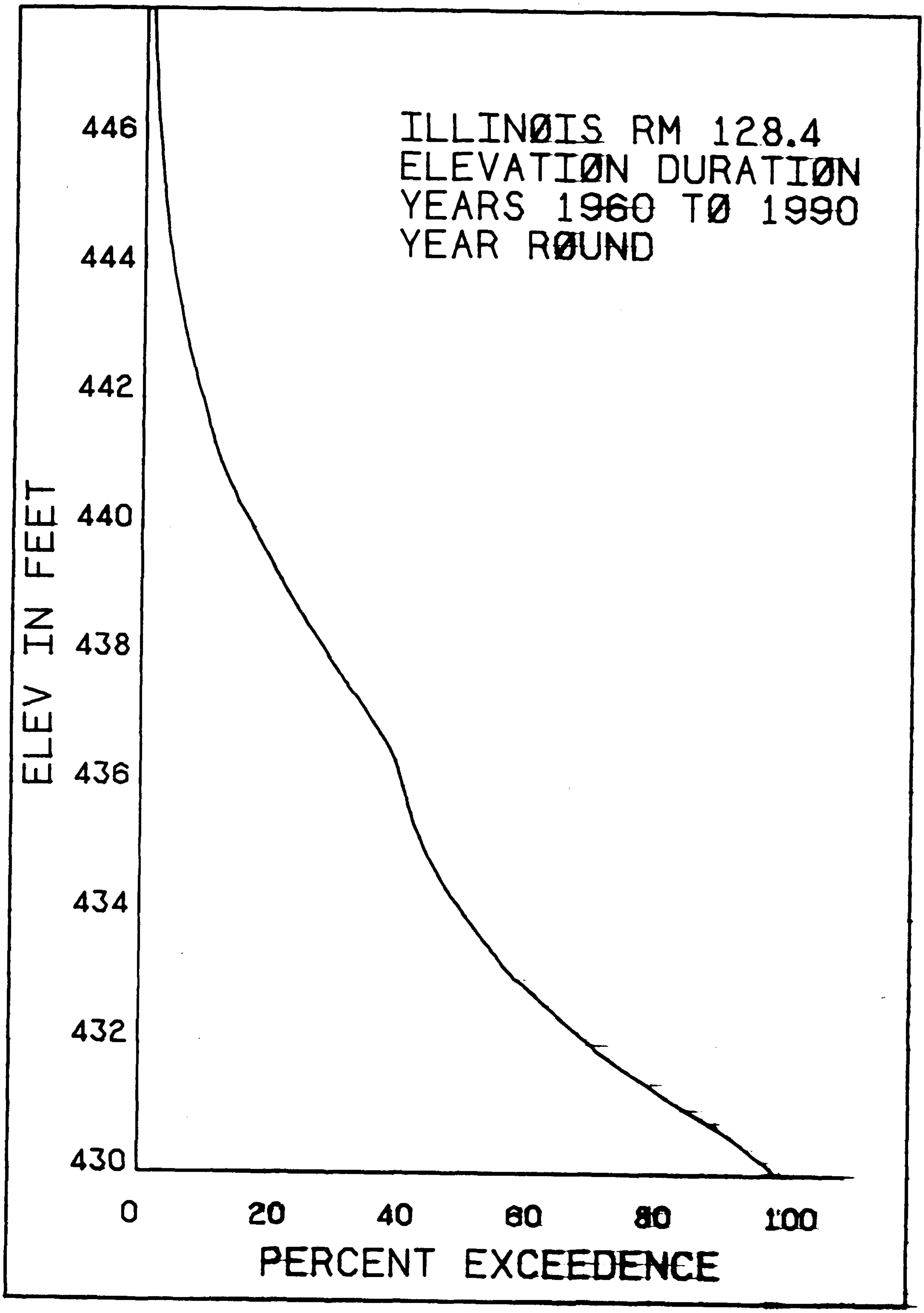
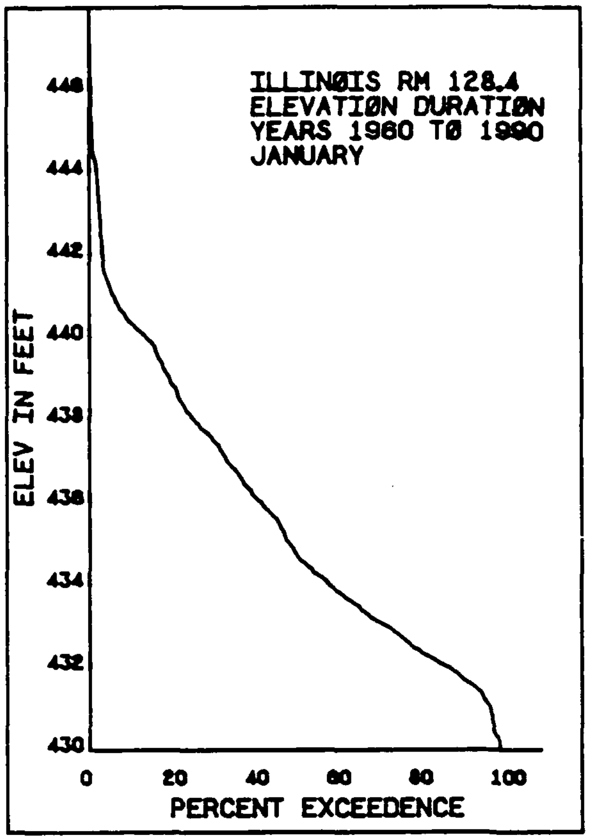

Illinois River Water Surface Profile
(Unsteady Flow Model)
River Miles 110 to 150
December, 1990
0.2 %
0.5 %
1 %
2 %
4 %
10 %
20 %
50 % exceedence
Water Surface Elevation
460
455
450
445
440
435
110
120
130
140
150
River Miles

PLATE F-1


ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
YEAR RØUND
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE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ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
JANUARY
ELEV IN FEET
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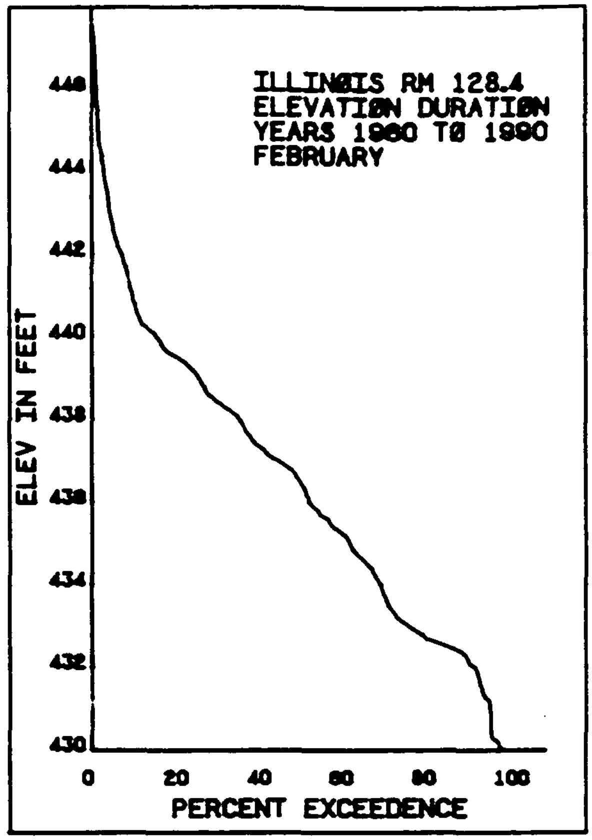
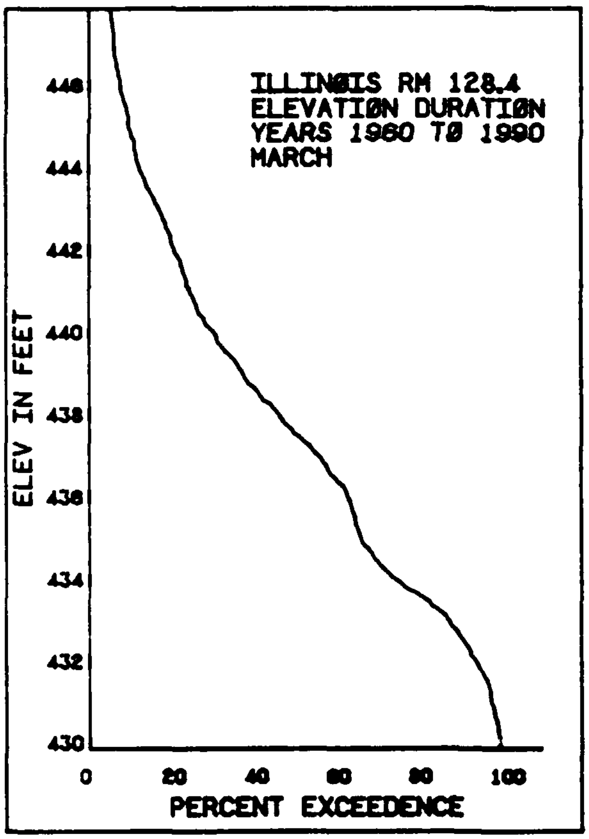
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
FEBRUARY
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
MARCH
ELEV IN FEET
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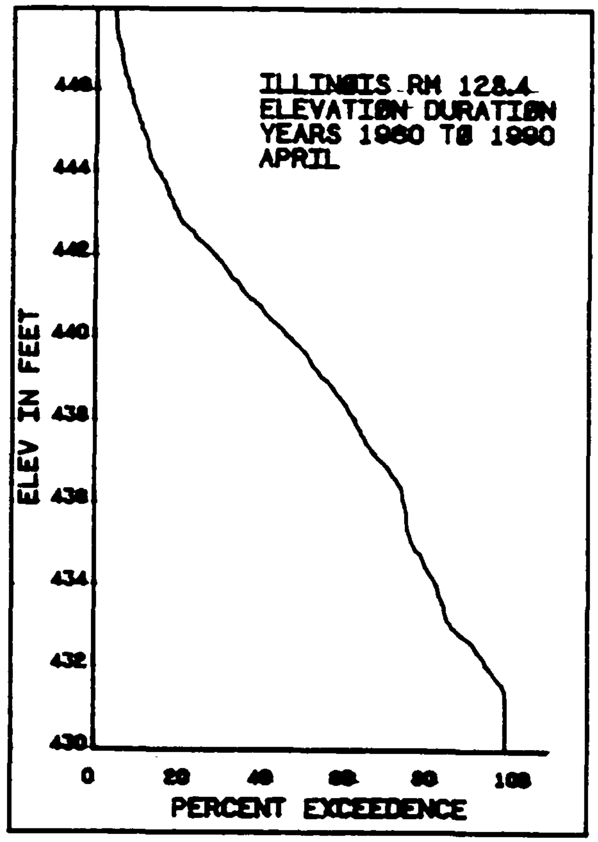
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE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ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
APRIL
ELEV IN FEET
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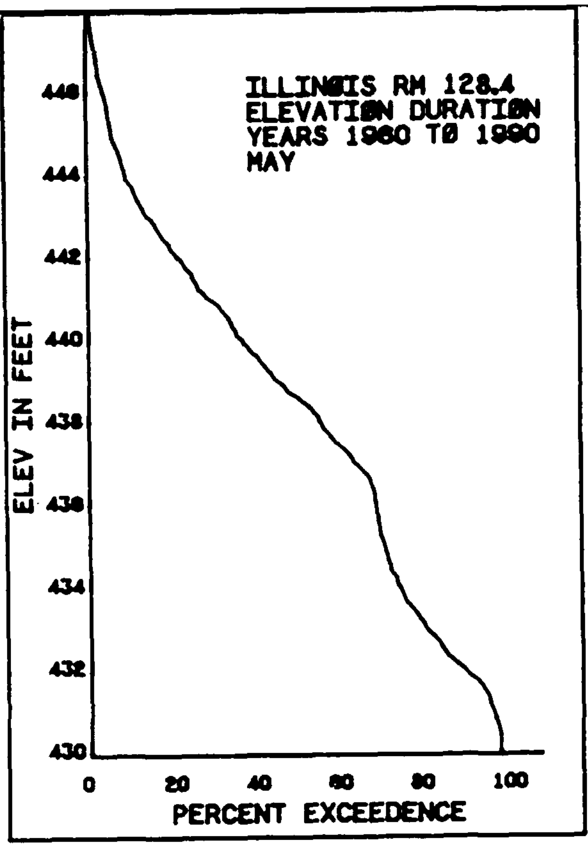
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINOIS RM 128.4
ELEVATION DURATION
YEARS 1960 TO 1990
MAY
ELEV IN FEET
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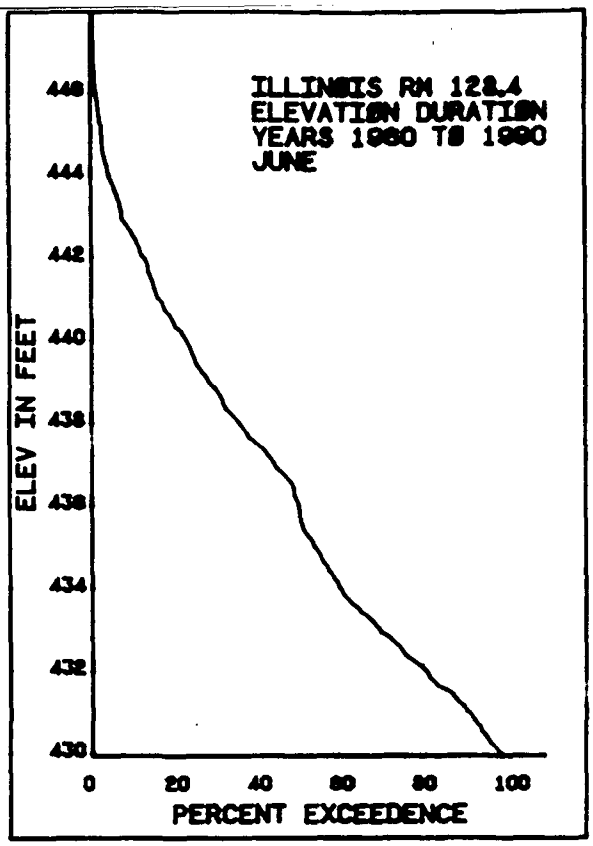
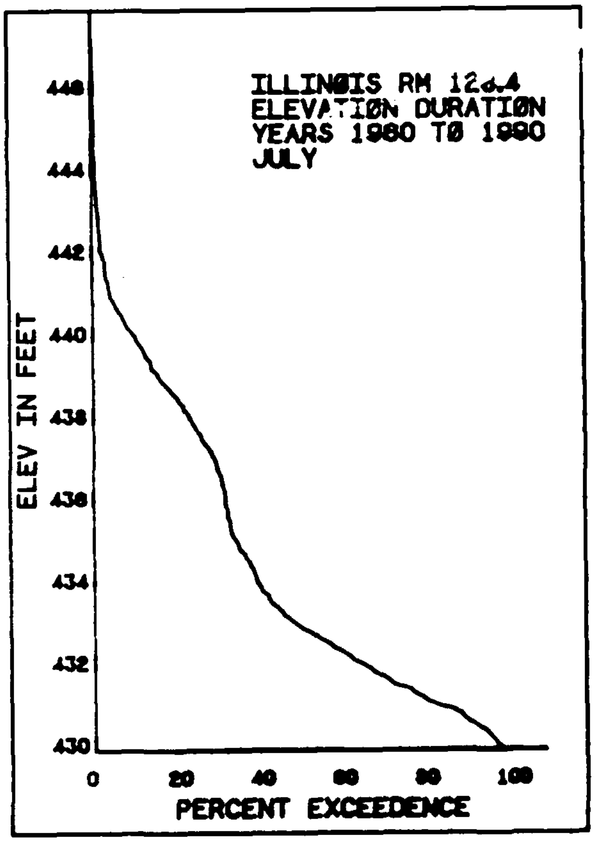
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINOIS RM 128.4
ELEVATION DURATION
YEARS 1960 TO 1990
JUNE
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINOIS RM 128.4
ELEVATION DURATION
YEARS 1960 TO 1990
JULY
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE

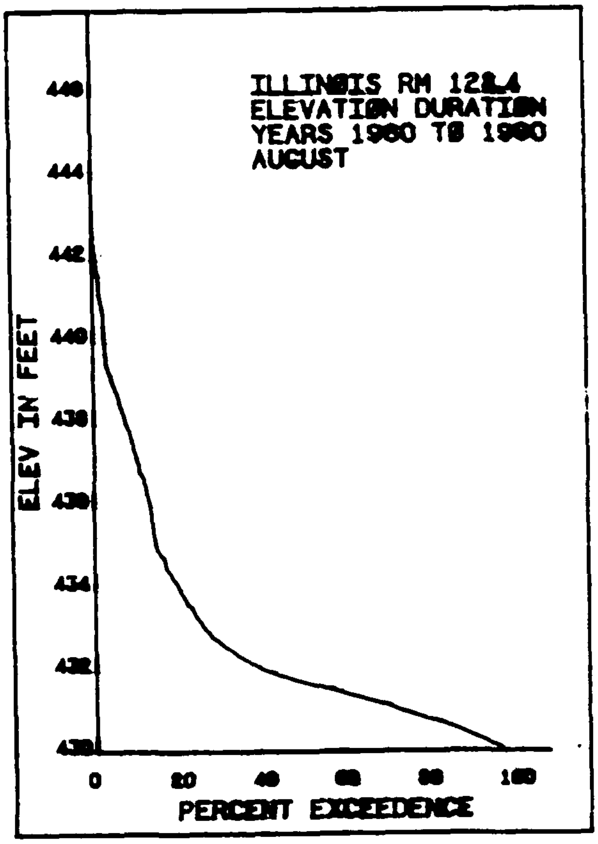
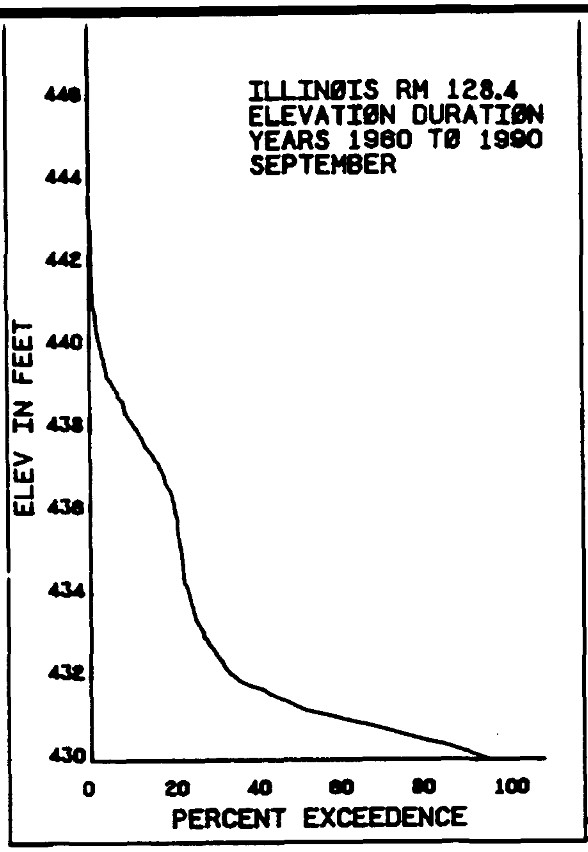
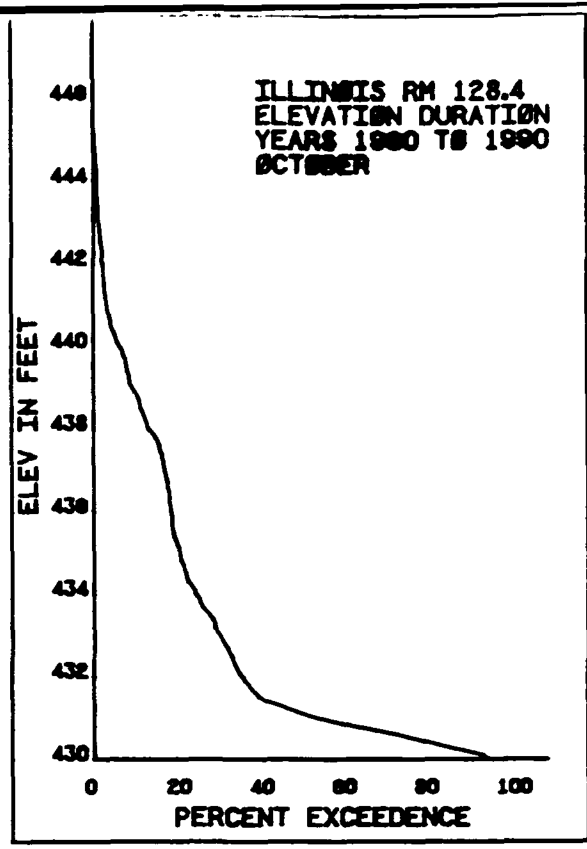
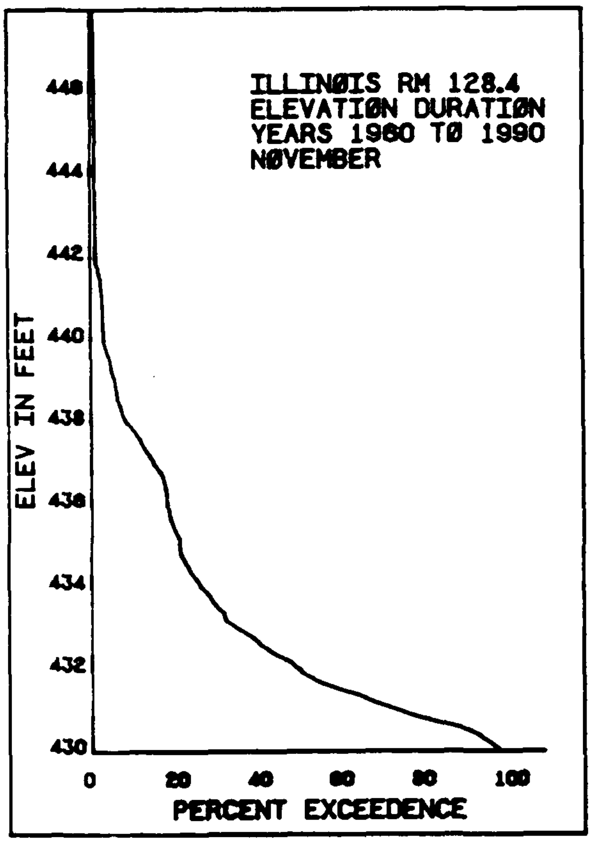

ILLINOIS RM 128.4
ELEVATION DURATION
YEARS 1960 TO 1990
AUGUST
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE

PLATE F-4


ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
SEPTEMBER
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
ØCTØBER
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE


ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
NØVEMBER
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE

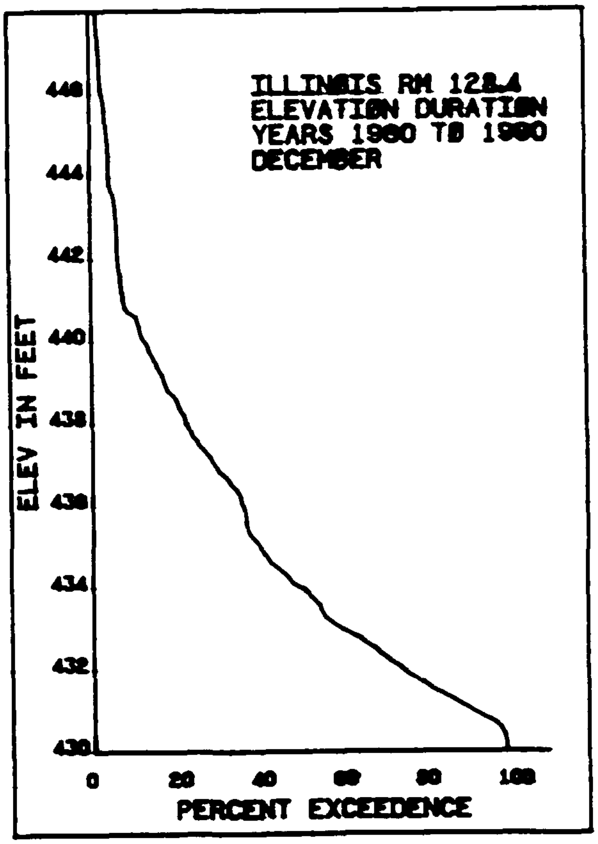

ILLINØIS RM 128.4
ELEVATIØN DURATIØN
YEARS 1960 TØ 1990
DECEMBER
ELEV IN FEET
446
444
442
440
438
436
434
432
430
0
20
40
60
80
100
PERCENT EXCEEDENCE

PLATE F-5

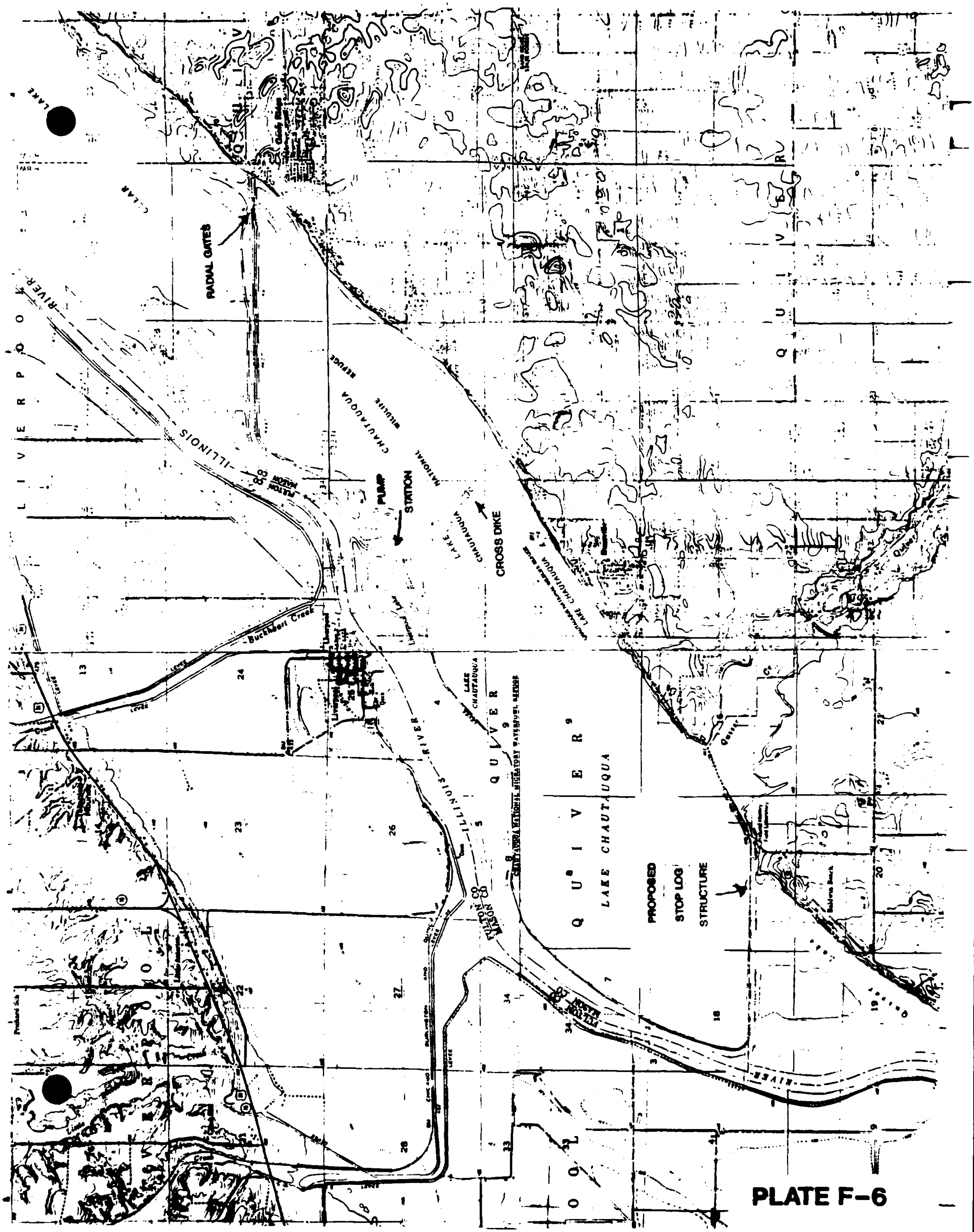
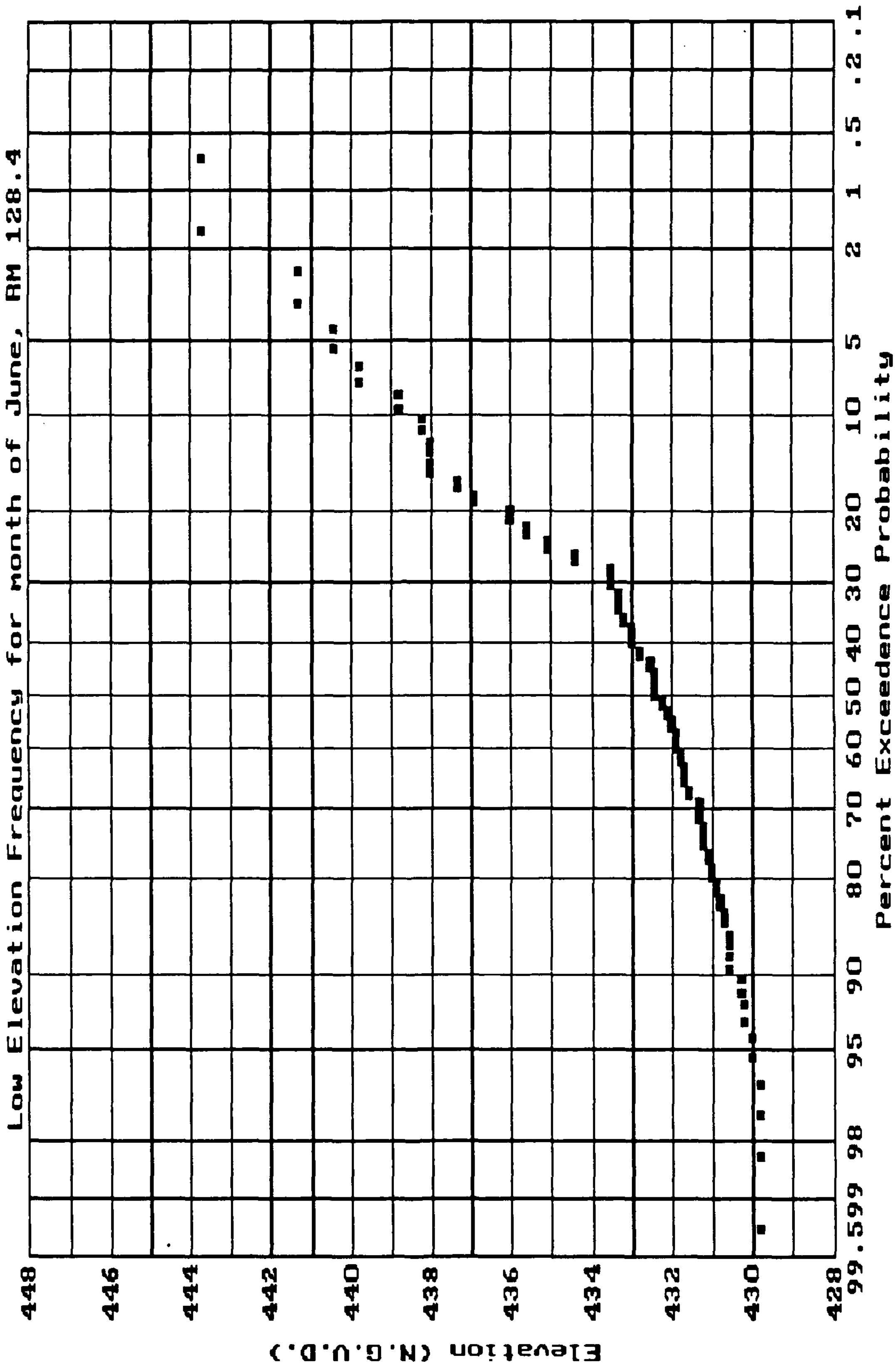

RADIAL GATES
PUMP STATION
CROSS DIKE
PROPOSED STOP LOG STRUCTURE
LAKE CHAUTAUQUA
CHAUTAUQUA NATIONAL WILDLIFE REFUGE
ILLINOIS RIVER
LIVERPOOL
QUIVER
FULTON CO
MASON CO
Buckheart Creek

PLATE F-6



Low Elevation Frequency for month of June, RM 128.4
Percent Exceedence Probability
.1 .2 .5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99.599.9
Elevation (N.G.V.D.)
448 446 444 442 440 438 436 434 432 430 428

PLATE F-7

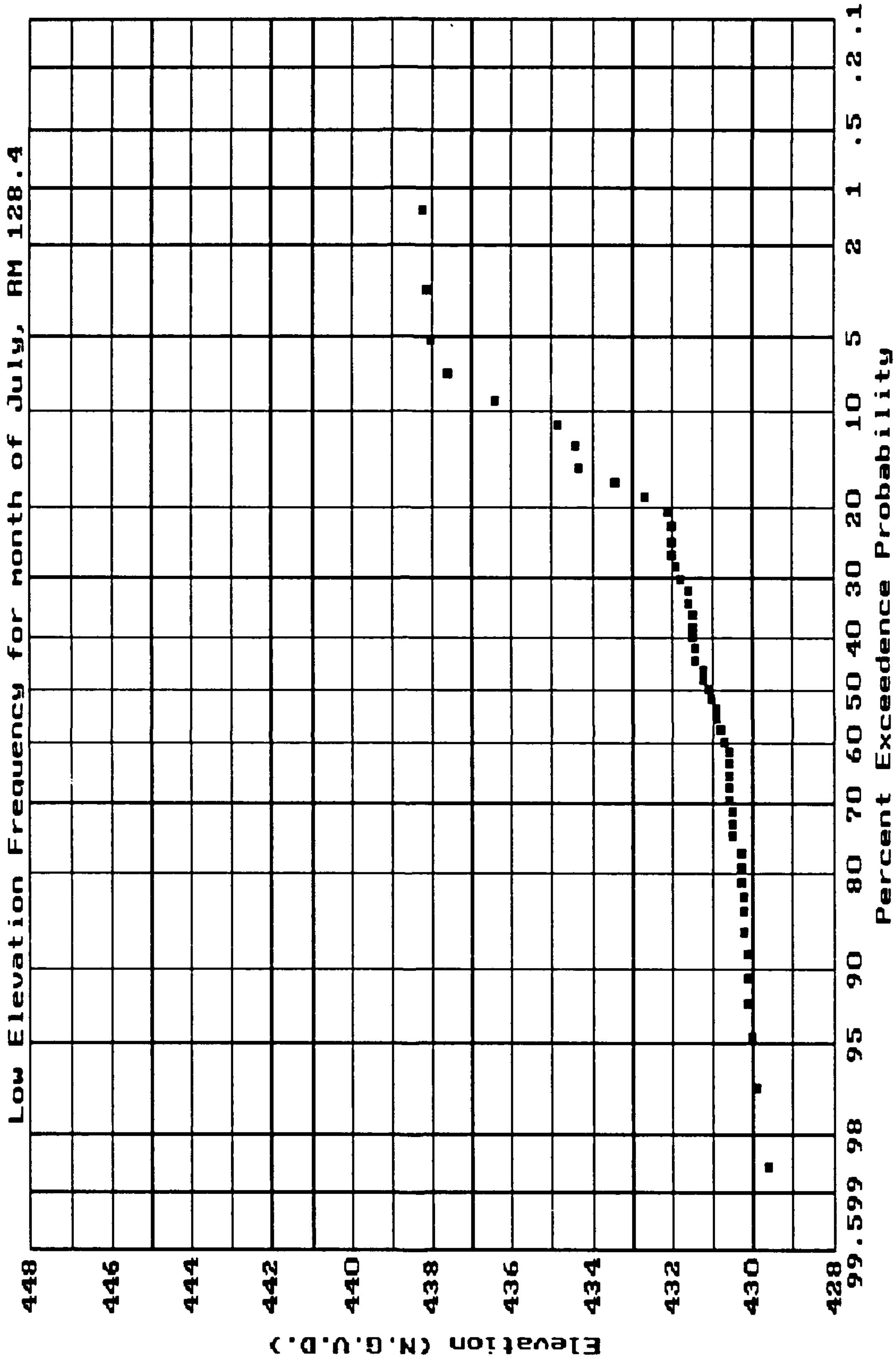

Low Elevation Frequency for month of July, RM 128.4
Percent Exceedence Probability
99.599 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
Elevation (N.G.V.D.)
428 430 432 434 436 438 440 442 444 446 448

PLATE F-8

UPPER LAKE	CHAUTAUQUA LAKE EMP
AREA/STORAGE VS. ELEVATION	

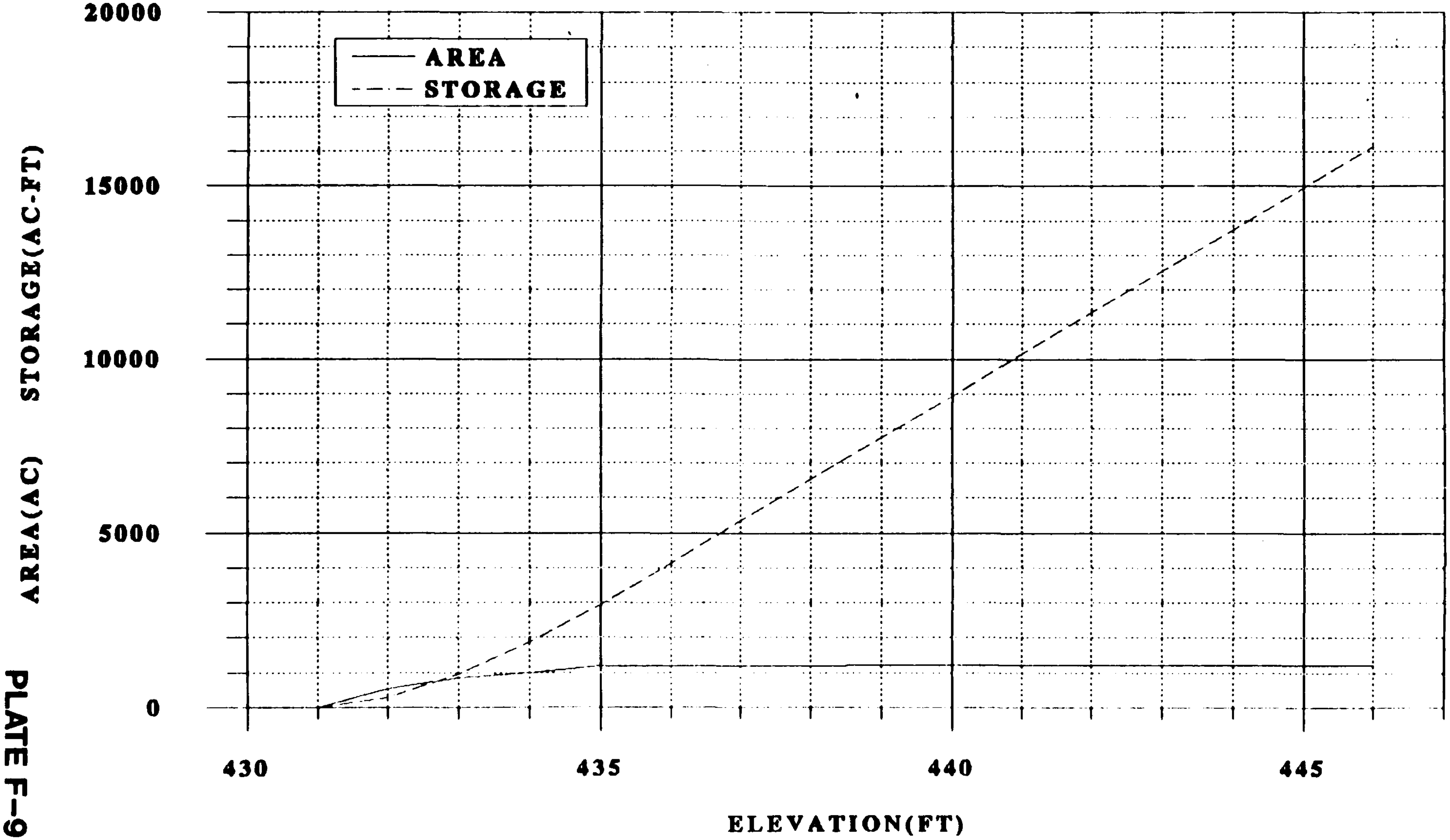


PLATE F-9

Inflow Scenario of the Upper Lake during a forecasted 10-year flood event

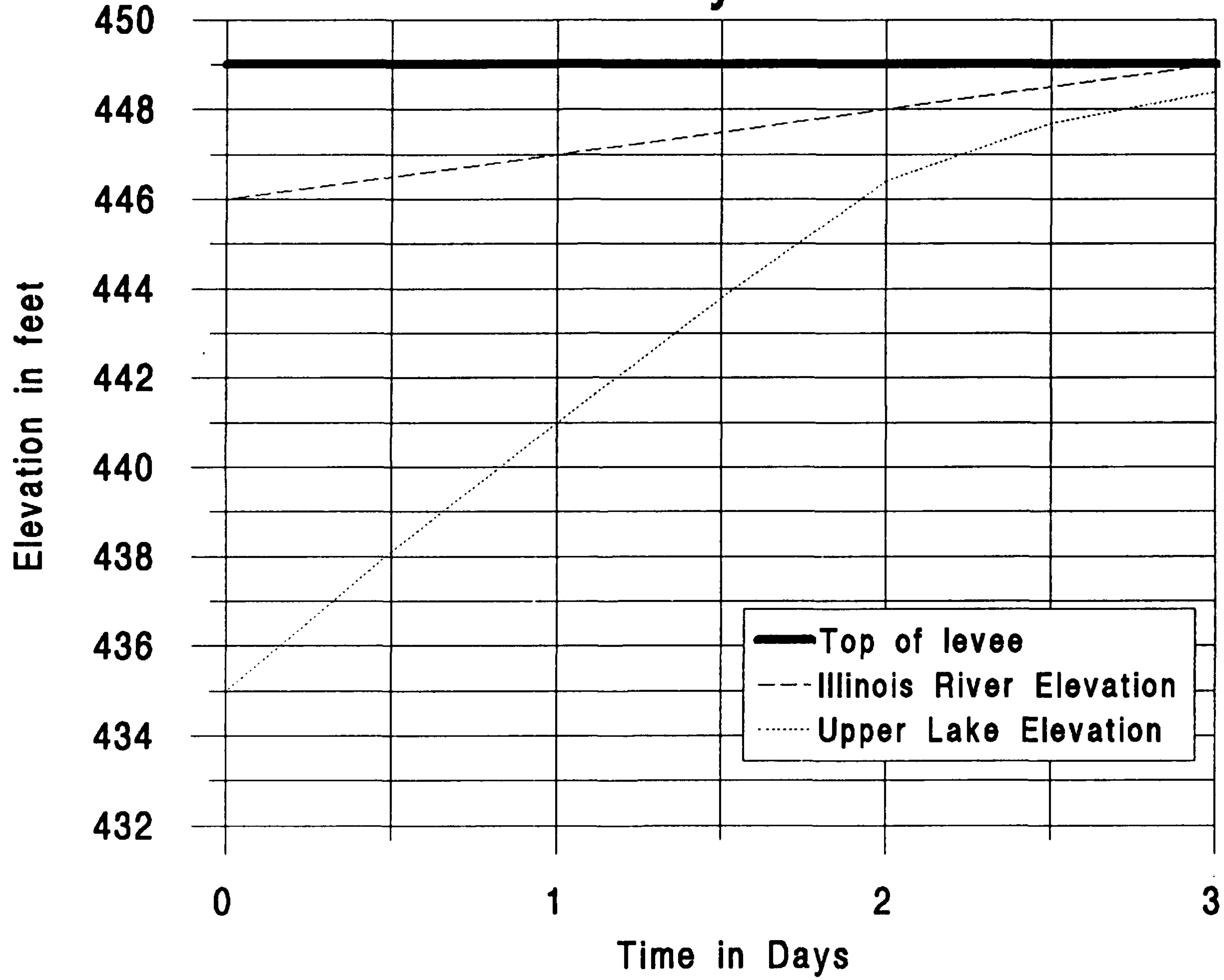


PLATE F-10

Drainage of Upper Lake Chautauqua

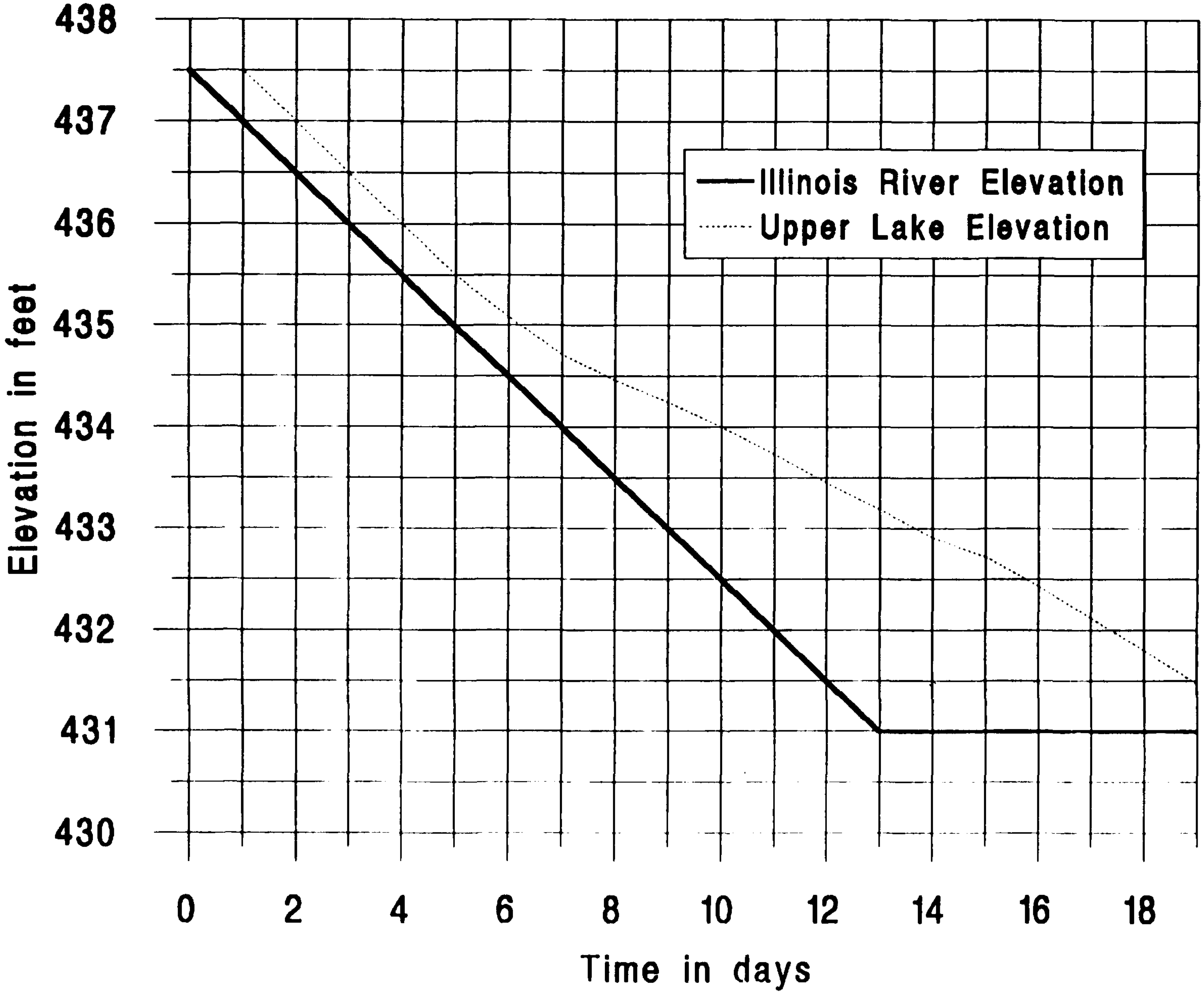
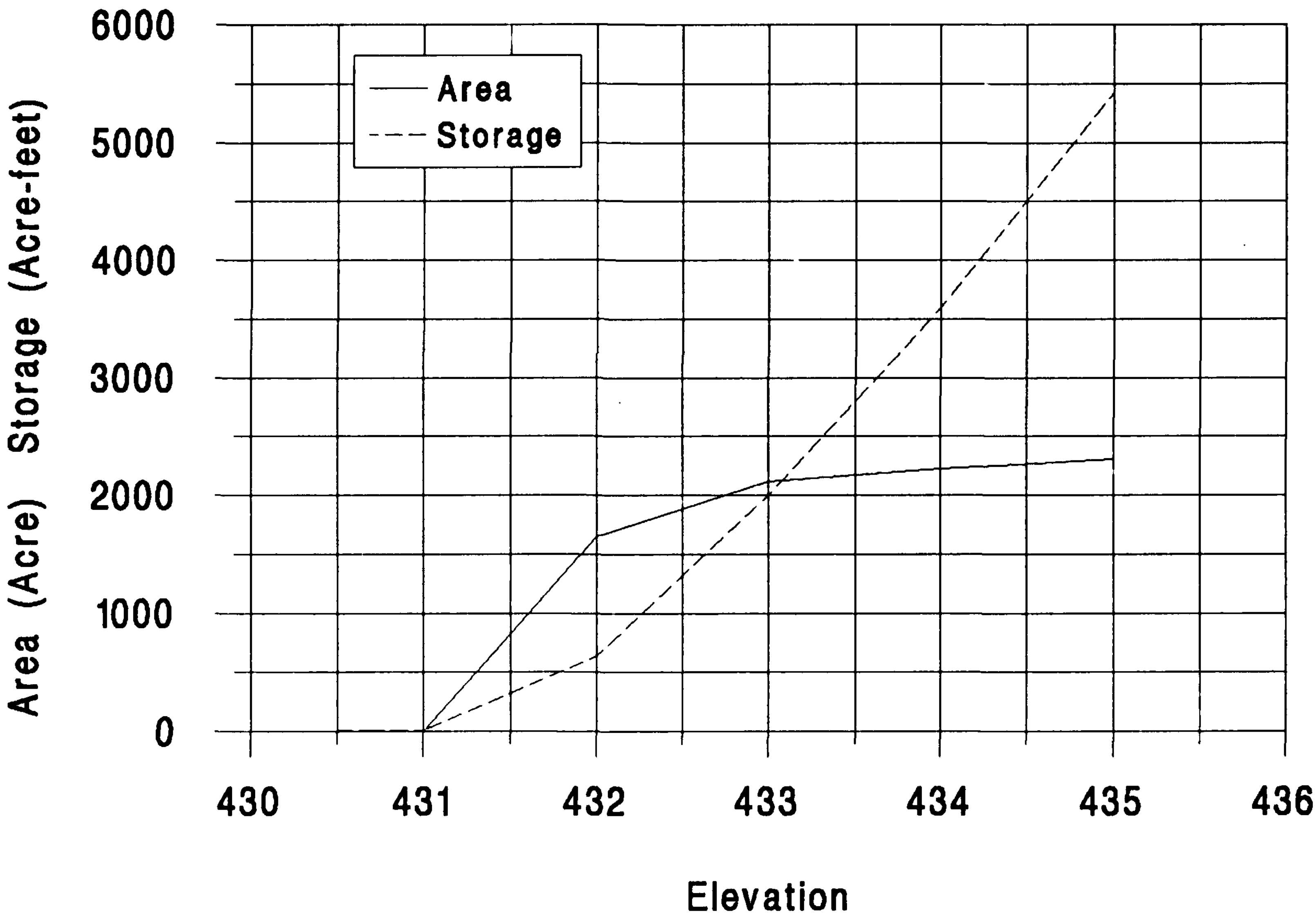
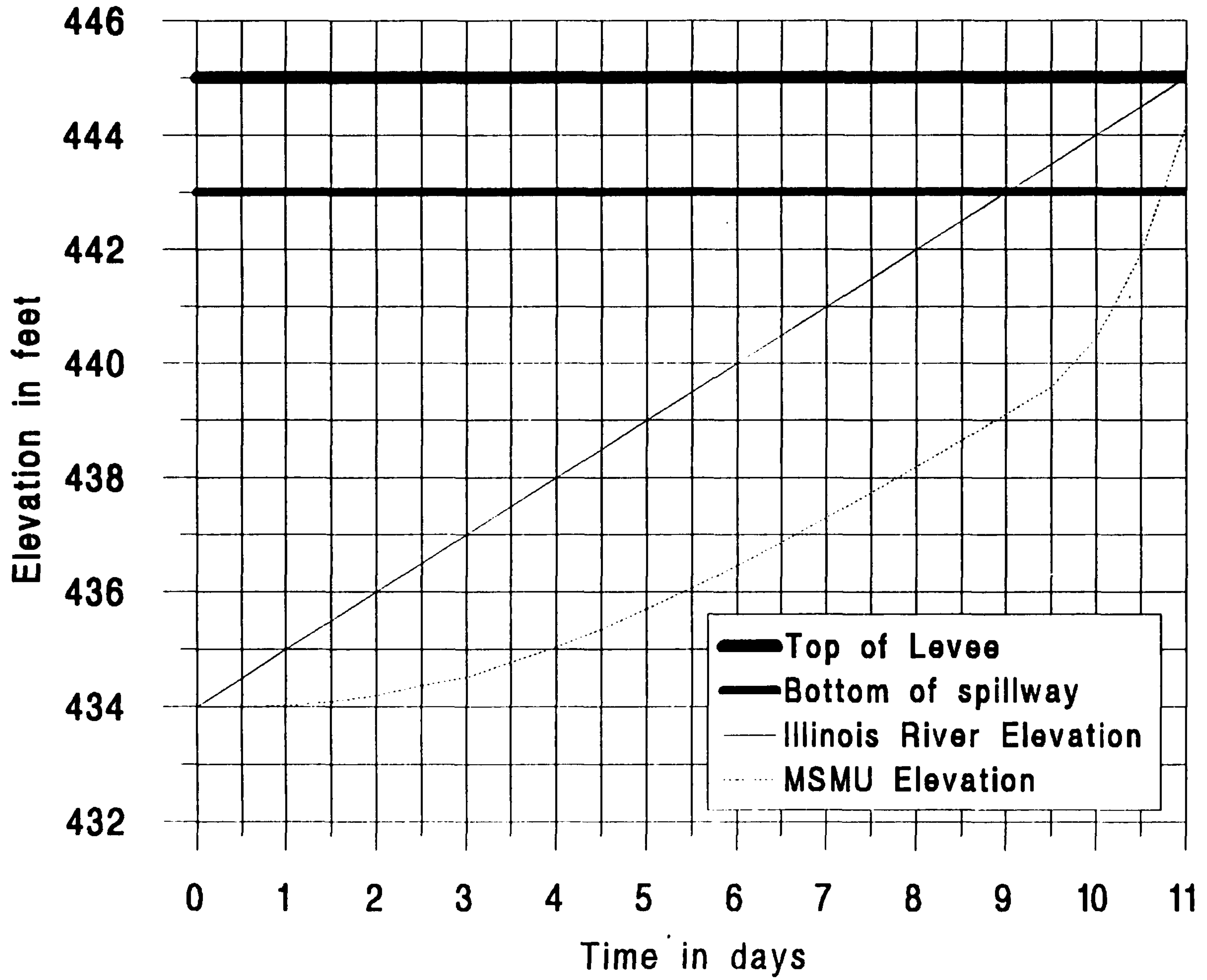


PLATE F-11

Moist Soil Management Area
Area/Storage vs. Elevation
Chautauqua Lake EMP



Inflow scenario of stoplog structures in southern unit with forecasted 2-year flood



Comparison of MSMU and Illinois River receding rate

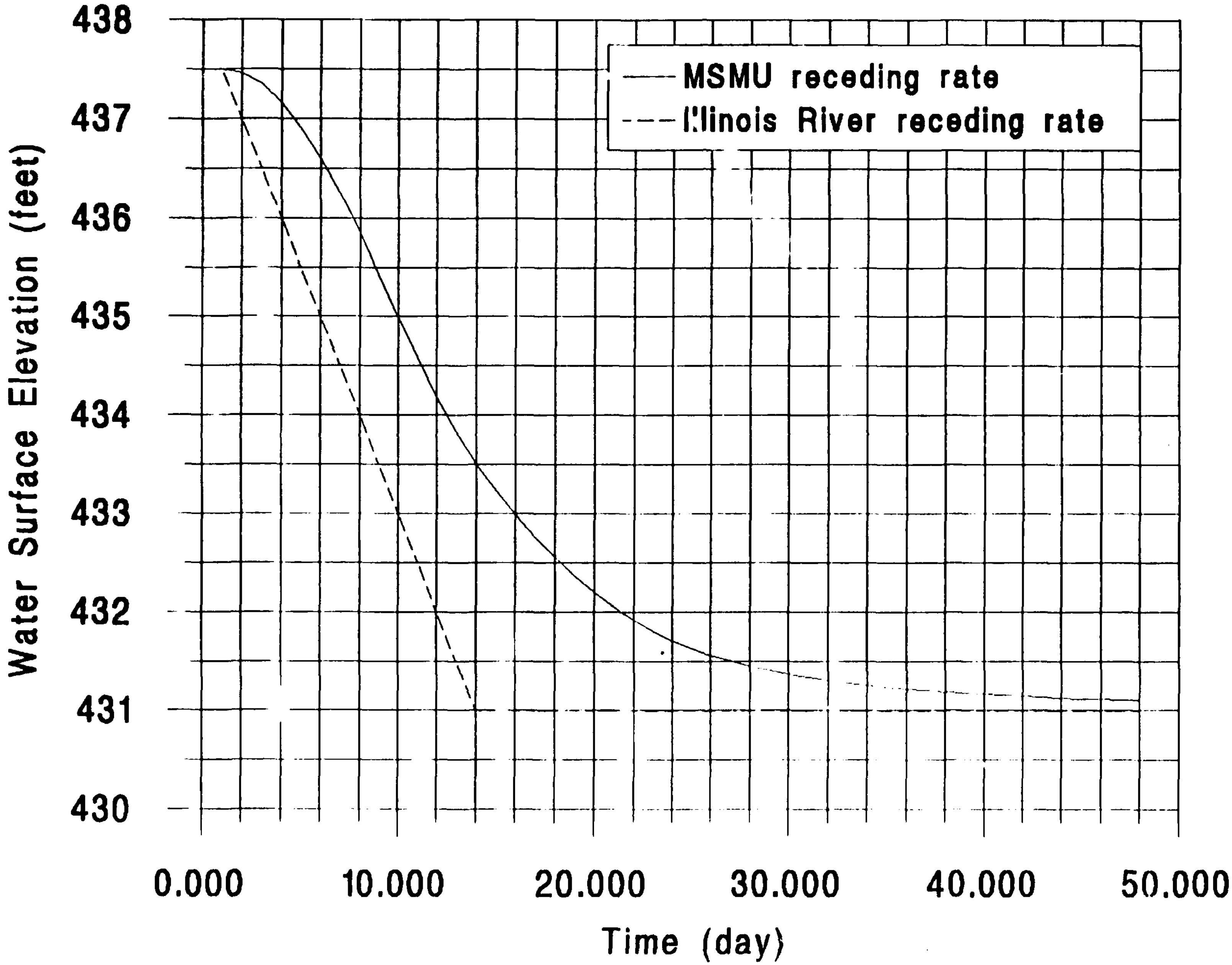


PLATE F-14

CHATAUQUA SI

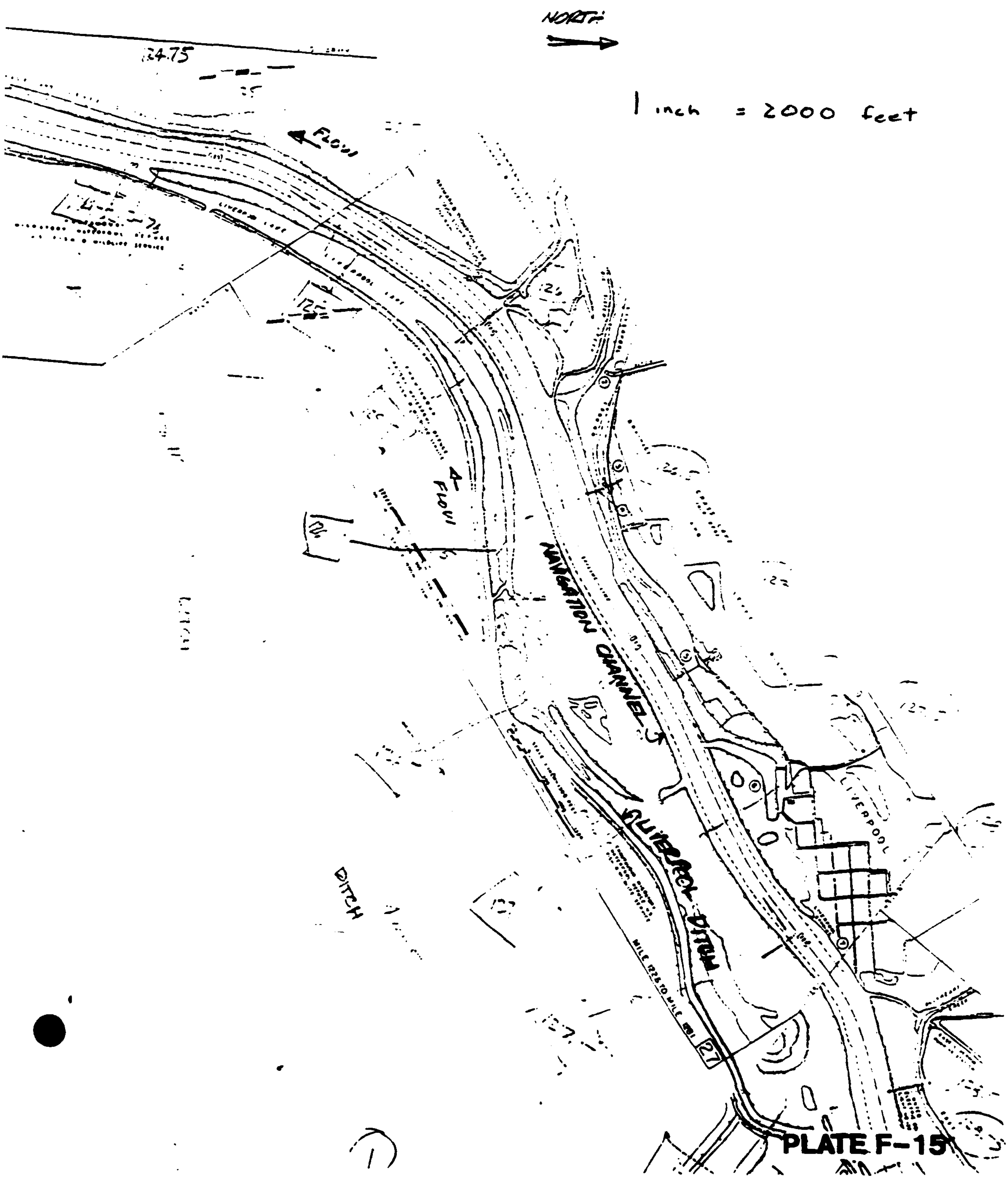
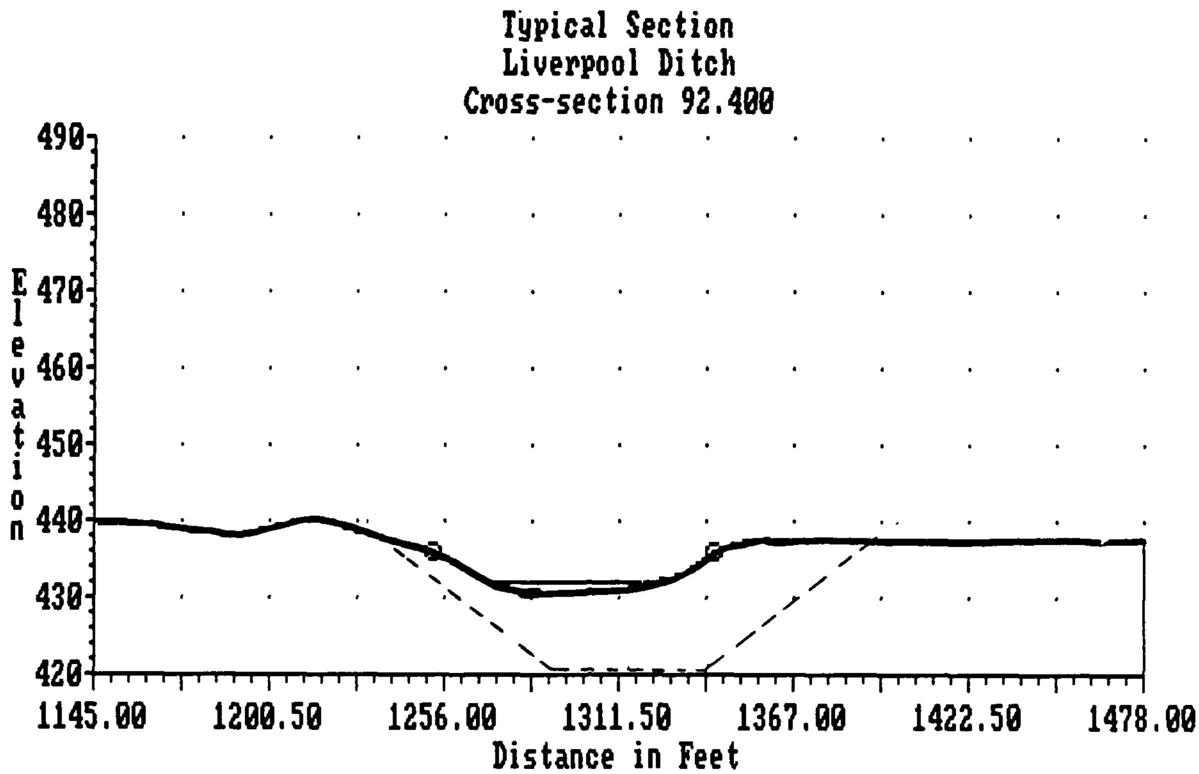
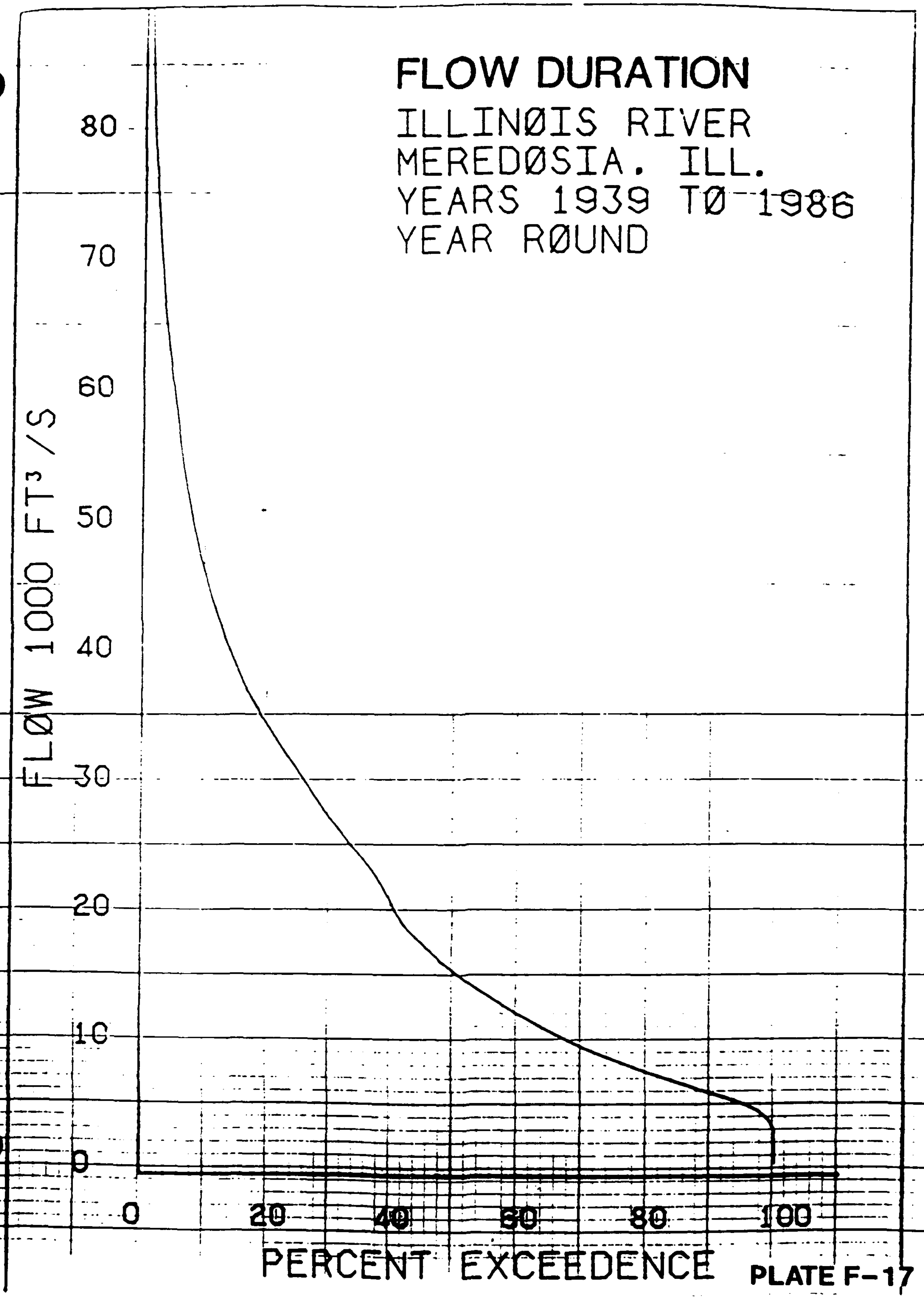


PLATE F-15



—— EXISTING CONDITION

- - - - Shape of channel after dredging.



FLOW DURATION
ILLINØIS RIVER
MEREDØSIA. ILL.
YEARS 1939 TØ 1986
YEAR RØUND
FLØW 1000 FT³/S
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
PERCENT EXCEEDENCE

PLATE F-17

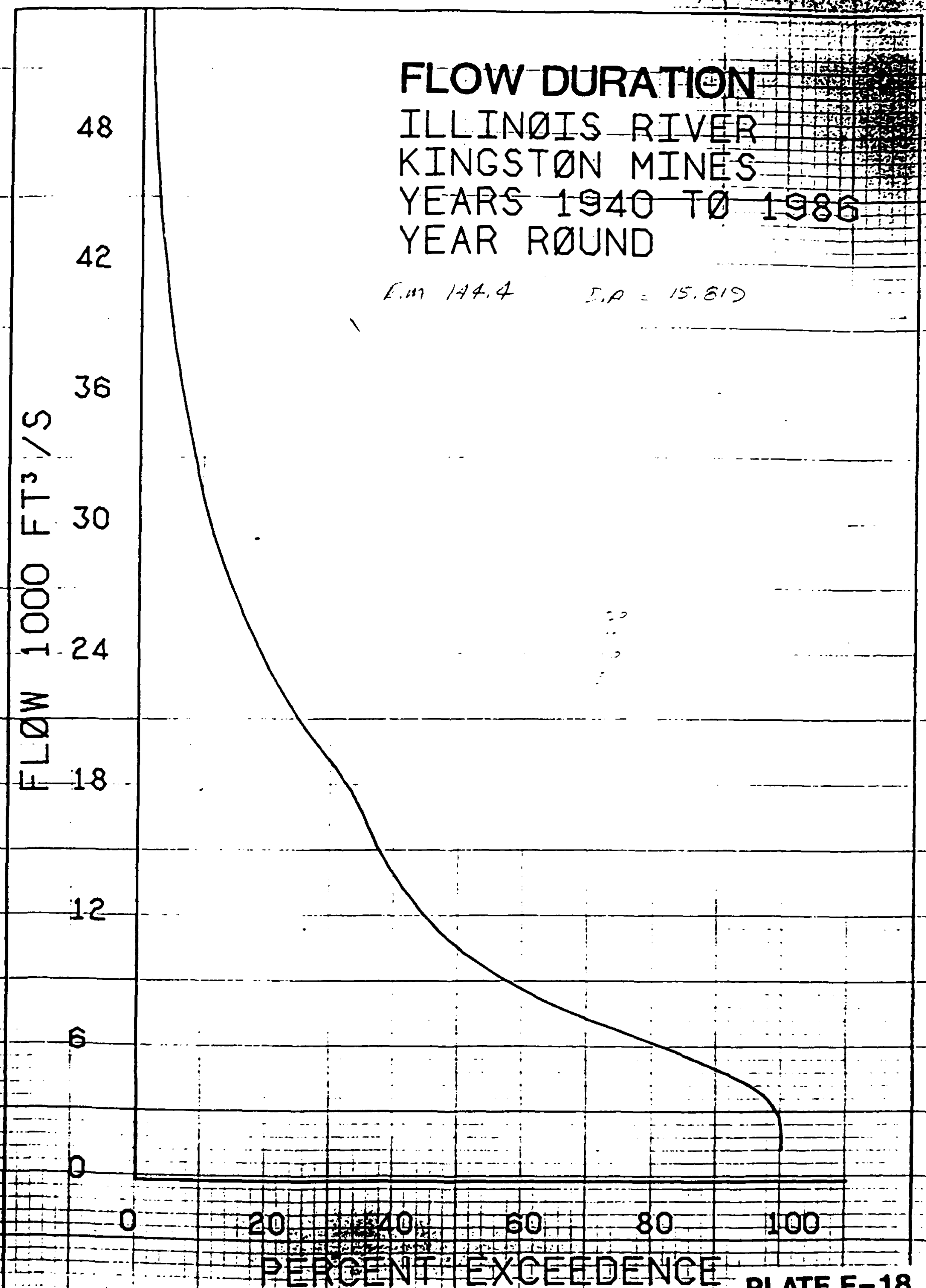
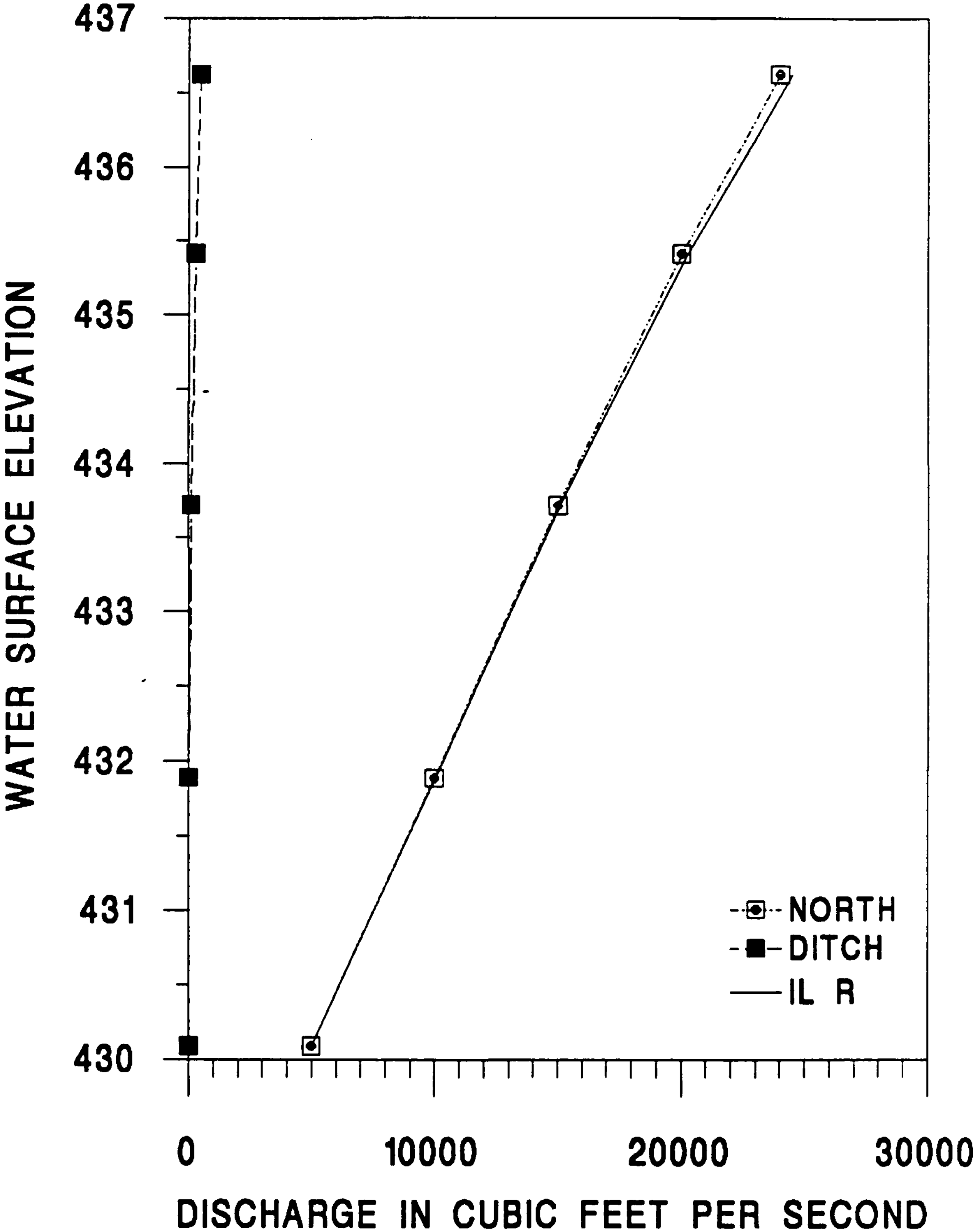

FLOW DURATION
ILLINØIS RIVER
KINGSTØN MINES
YEARS 1940 TØ 1986
YEAR RØUND
E.m 144.4 D.A = 15.819
48
42
36
30
24
18
12
6
0
FLØW 1000 FT³/S
0
20
40
60
80
100
PERCENT EXCEEDENCE

PLATE F-18

EXIST STAGE-DISCHARGE (IL R MILE 128.75)



W/P STAGE-DISCHARGE (IL R MILE 128.75)

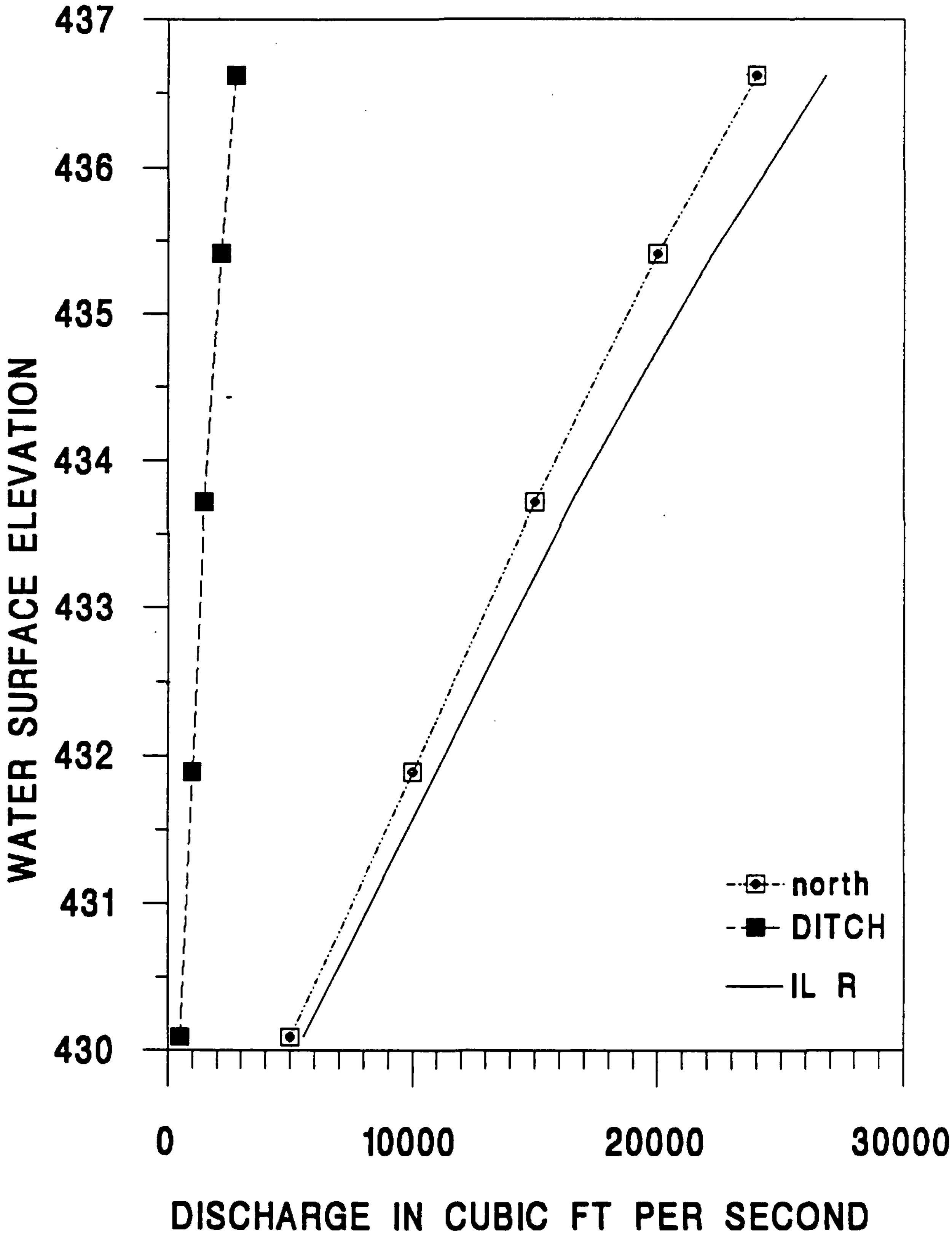


PLATE F-20

WATER QUALITY

APPENDIX

G

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-7F)

LAKE CHAUTAUQUA REHABILITATION AND ENHANCEMENT
LA GRANGE POOL, ILLINOIS WATERWAY, RIVER MILES 124-128
MASON COUNTY, ILLINOIS

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APPENDIX G
WATER QUALITY

G-1. INTRODUCTION

suspended sediments.

Water quality within Lake Chautauqua is primarily impacted by the deposition of sediment during periods when the Illinois River over tops the levees and the eventual resuspension of this sediment. The sedimentation process has occurred over several decades following the lakes impoundment. Because of the shallow nature of the water body, the unconsolidated, fine-grained sediments found throughout the majority of the lake form a 'false bottom.' This is unsuitable for the establishment of rooted aquatic vegetation. In addition, the resuspension of this material results in turbidity levels which are frequently high enough to severely limit light penetration thus contributing to the inhibition of aquatic plant growth within the lake.

These problems were recognized in Lake Chautauqua as early as the 1950's. Jackson and Starrett (1959) examined the causes and effects of sedimentation and resuspension of sediments in Lake Chautauqua between 1953 and 1957. During this period hundreds of turbidity and Secchi disk transparency readings were taken. Based on the results of these analyses as well as visual observations of meteorologic and hydrologic conditions, several generalizations were presented. It was felt that the highest turbidity values observed during the study period (up to 800 JTU) were the result of the resuspension of sediment. The major causes for this resuspension were wind-generated wave action and fish activity. Apparently, wind velocity had little effect on resuspension when vegetation or ice cover were present or when water depth exceeded about 5.8 feet. When water depths were less than 4.8 feet and vegetation and ice cover were absent, however, turbidity tended to be positively correlated with wind velocity. At times when wind had little or not effect on turbidity, fish activity and phytoplankton often prevented the lake from becoming clear. The removal of over 2 million pounds of fish from the lake over an 8-year period had no apparent effect on vegetative growth or turbidity.

This observation is contradictory to the findings of Cahoon (1953) who noted that the removal of 1.6 million pounds of carp from Lake Mattamuskeet, North Carolina, over a 5-year period resulted in a gradual increase in transparency from 6 inches to 3 to 4 feet. Jackson and Starrett felt that the lack of a positive response to the removal of fish was related to the reintroduction of fish from the river during flooding, and natural spawning within the lake. Jackson and Starrett also found that duck-food plants, which had formerly been abundant, were adversely affected by sedimentation and fluctuating water levels.

In order to predict the impact of proposed construction activities on water quality, water column and sediment samples were collected at several locations representative of the construction area. In addition, as one objective of the proposed project was to improve water quality, monitoring stations were established which will enable comparison of pre- and post-project water quality data.

G-2. METHODS

a. **Existing Conditions.** Water and sediment samples were collected by ED-HQ personnel on February 20, 1990, for the purpose of grain size, bulk sediment and elutriate analysis. Sediment samples were taken with a 36-inch, plastic-lined, core sampler at sites UCL-1, UCL-2, LCL-1, LCL-2, MD-1, LD-1 and LD-2. Duplicate grain size and bulk sediment samples were collected at site UCL-1. To obtain a representative sample at each station, at least three subsamples were collected: one near the bow of the boat, one amidships, and one near the stern. Each subsample was placed in a container and mixed to form a homogeneous composite sample. The composite was then placed into appropriate sample bottles and temporarily stored on ice.

Grain size analyses were performed by Corps Geotechnical Branch personnel according to U.S. Army Corps of Engineers (1986). Results are expressed as the percentage of material passing a number 230 sieve (<0.062 um).

Water samples were collected with a submersible pump. Water for the elutriate test was collected at each individual site near the surface. Water for ambient water column analyses was collected at sites MD-1 and UCL-1. Each sample was poured into an appropriate container, preserved as necessary, and placed on ice.

All samples requiring chemical analysis were shipped on ice to Applied Research and Development Laboratory, Inc., Mt. Vernon, Illinois, for analysis. Bulk sediment samples were analyzed according to U.S. Army Corps of Engineers (1981). The elutriate test was used to simulate river conditions that would occur during dredging. The test consisted of combining 50 ml of a wet, well-mixed sediment sample and 200 ml of process water collected from the lake. The mixture was shaked for 30 minutes, allowed to settle for 4 hours, and the supernatant was drawn off and analyzed. Ambient water and elutriate analyses were performed according to the American Public Health Association, et al. (1985), or the U.S. Environmental Protection Agency (1979).

b. **Baseline Monitoring.** On May 27, 1987, long-term monitoring was initiated at one location within lower Lake Chautauqua. Samples were collected approximately every 2 weeks at this location through September 1, 1987. No samples were collected during 1988, however, biweekly sampling was resumed in June 1989 and continued through October 1989. Water samples were collected just below the surface at sites UCL-1, UCL-2, and UCL-3 using a Kemmerer-type sampler. A total of 22 separate sampling trips were completed during this period.

Several parameters, including water temperature, Secchi disk depth, water depth, dissolved oxygen, pH, specific conductance, and total alkalinity, were determined in the field. Additional parameters were analyzed in the laboratory by the collection of representative water samples. These samples were placed in appropriate bottles, preserved as necessary, and placed on ice. All laboratory analyses were performed according to the American Public Health Association, et al. (1985) or the U.S. Environmental Protection Agency (1979).

Prior to contract award, all laboratory facilities were inspected by Government personnel to ensure that contractor staff and equipment were adequate to perform all work. Government personnel also accompanied the contractor in the field during the first collection trip to observe all field techniques and to clarify sampling locations. Quality control samples were provided to the contractor periodically throughout the testing period and results were compared to known values as a check on laboratory accuracy. A field duplicate was collected during each collection trip and results were compared as a check of field/laboratory precision.

G-3. RESULTS AND DISCUSSION

a. **Existing Conditions.** Results of all bulk sediment and elutriate analyses are shown in tables G-1 and G-2. From table G-1 it can be seen that all samples consisted of extremely fine-grained material, with all but one sample (LD-1) having greater than 95% of the material passing a number 230 sieve(<0.062 um). This is quite common of backwater areas along the Illinois River. The tremendous surface area associated with fine-grained material often results in various contaminants adhering to the surface of the sediment particles. This, in combination with naturally occurring concentrations, resulted in several parameters being found in concentrations considered to be notable. These include copper and zinc. While the concentrations of these materials were greater than usually seen in Illinois River sediments (Illinois EPA, 1988), it says nothing about their bioavailability. This question is addressed via the elutriate test. All concentrations of pesticides and PCB congegers in the sediment were below detection limits.

Table G-2 shows the results of the elutriate test. From the results, it can be seen that concentrations of most parameters were below Illinois

General Use water quality standards. Isolated exceptions to this were observed for copper from site LD-2 and iron, manganese, and ammonia nitrogen from several sites. While it is not unusual for Illinois River samples to display elutriate concentrations in excess of water quality standards for these parameters, the potential impacts to aquatic life must be considered in the selection of dredging and placement alternatives as well as the development of the construction schedule.

b. **Baseline Monitoring**. Table G-3 lists the results of baseline monitoring conducted between May 1987 and October 1989. With less than two field seasons of data available, definite trends have not been identified; however, several items are noteworthy. Secchi disk depths have been fairly constant, ranging from 0.2 foot to 1.10 feet, with most values falling between 0.5 and 1.0 foot. This is the same general range observed by Jackson and Starrett, 1959. With few exceptions, dissolved oxygen concentrations have consistently been above 4.0 mg/l. This appears to be related to the relatively high pH values and chlorophyll concentrations observed during the study period. Occasionally high ammonia nitrogen levels (<1.0 mg/l) also have been observed. Turbidity values have on occasion been quite high. This is not unexpected given the large, shallow nature of the lakes and the history of high turbidity values. No other water quality problems have been observed.

G-4. CONCLUSIONS

Given the fact that the upper lake will be dewatered prior to construction, it is obvious that no water quality problems will develop during construction. After construction, it is felt that water quality in the upper lake will be improved. This will result from the consolidation of the sediments during construction and the ability to regulate water levels after repair of the breach in the cross dike.

In the lower lake, temporary water quality degradation may result from the dredging and placement of material during construction of the channels. This will probably be in the form of elevated ammonia and turbidity values. As the lake is isolated from the river, it is likely that the impacts will be localized and short-term. As these conditions are presently observed with some frequency within the lower lake, it is not expected that the existing biota will be negatively impacted during the construction phase. Post-construction water quality should be similar to present conditions and may actually improve due to sediment consolidation.

Water quality in Liverpool Ditch probably will be negatively impacted during construction. Turbidity and ammonia concentrations again will be the parameters of concern. However, because existing water quality is poor due to sediment accumulation, any temporary water quality degradation will be more than compensated by improved post-construction conditions. Water will freely flow through the ditch, which will improve dissolved oxygen levels throughout the year. In addition, the increased current will be beneficial to the fisheries and will reduce sediment accumulation.

TABLE G-1. Bulk Sediment (mg/kg) and Grain Size (% Passing a #230 Sieve) Results, February 20, 1990.

	LOCATION							
PARAMETER	UCL-1	UCL-1(DUP)	UCL-2	LCL-1	LCL-2	MD-1	LD-1	LD-2
Arsenic	5.8	3.8	<2.3	6.3	4.1	4.8	3.8	4.6
Barium	170	180	170	130	200	140	120	130
Cadmium	<2.5	<2.4	<2.3	<1.6	<2.0	<2.3	<1.8	<1.5
Chromium	20	24	23	23	25	22	30	32
Copper	14	33	170	270	180	98	96	64
Lead	<2.5	<2.4	<2.3	<1.6	<2.0	<2.3	<1.8	<1.5
Mercury	<0.23	<0.20	<0.14	<0.12	<0.12	<0.13	<0.12	<0.087
Nickel	23	25	25	24	27	28	35	34
Selenium	<2.5	<2.4	<2.3	<1.6	<2.0	<2.3	<1.8	<1.5
Zinc	170	190	180	180	240	220	240	270
Iron	29,000	29,000	27,000	18,000	21,000	28,000	23,000	18,000
Manganese	600	630	440	590	760	900	630	720
Ammonia Nitrogen	130	95	70	54	120	180	140	118
Tot Volatile Solids	26,000	26,000	31,000	26,000	32,000	27,000	38,000	33,000
Tot Solids	320,000	330,000	380,000	580,000	430,000	410,000	490,000	610,000
Oil and Grease	3,600	3,400	2,600	5,600	3,500	3,000	4,300	5,000
Tot Organic Carbon	14,000	13,000	14,000	14,000	13,000	11,000	13,000	12,000
Aldrin	<0.18	<0.18	<0.16	<0.10	<0.14	<0.51	<0.43	<0.34
alpha-Chlordane	<0.64	<0.64	<0.55	<0.36	<0.49	<0.51	<0.43	<0.34
gamma-Chlordane	<0.64	<0.64	<0.55	<0.36	<0.49	<0.51	<0.43	<0.34
DDD	<0.50	<0.50	<0.43	<0.28	<0.38	<0.40	<0.34	<0.27
DDE	<0.18	<0.18	<0.16	<0.10	<0.14	<0.15	<0.12	<0.098
DDT	<0.55	<0.55	<0.47	<0.31	<0.42	<0.44	<0.37	<0.30
2,4 D	<2.40	<2.40	<2.10	<1.40	<1.90	<2.00	<1.60	<1.30
Dieldrin	<0.091	<0.091	<0.079	<0.052	<0.070	<0.073	<0.061	<0.049
Endrin	<0.27	<0.27	<0.24	<0.16	<0.21	<0.22	<0.18	<0.15
Heptachlor	<0.14	<0.14	<0.12	<0.07	<0.10	<0.11	<0.092	<0.074
Heptachlor Epoxide	<3.80	<3.80	<3.30	<2.20	<2.90	<3.00	<2.60	<2.00
Lindane	<0.18	<0.18	<0.16	<0.10	<0.14	<0.15	<0.12	<0.098
Methoxychlor	<8.00	<8.00	<6.90	<4.5	<6.10	<6.40	<5.40	<4.30
Silvex	<0.34	<0.34	<0.30	<0.20	<0.27	<0.28	<0.23	<0.19
Toxaphene	<11.0	<11.0	<9.5	<6.20	<8.40	<8.80	<7.30	<5.90
Arochlor-1016	<2.40	<2.40	<2.10	<1.40	<1.90	<2.00	<1.60	<1.30
Arochlor-1232	<2.40	<2.40	<2.10	<1.40	<1.90	<2.00	<1.60	<1.30
Arochlor-1242	<2.40	<2.40	<2.10	<1.40	<1.90	<2.00	<1.60	<1.30
Arochlor-1248	<2.40	<2.40	<2.10	<1.40	<1.90	<2.00	<1.60	<1.30
Arochlor-1254	<4.80	<4.80	<4.20	<2.80	<3.70	<4.00	<3.20	<2.60
Grain Size	97.7	96.3	98.5	98.8	99.4	99.5	85.7	95.2

* Il. EPA, 1988.

TABL 2. Elutriate and Ambient Water (S) Test Results (mg/l) from Nine Sites Sampled on February 20, 1990.

PARAMETER	UCL-1	UCL-1(DUP)	UCL-2	LCL-1	LCL-2	UCLS-1	MD-1	LD-1	LD-2	MDS-1	GENERAL USE STD
Arsenic	0.027	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1.0
Barium	1.0	0.43	0.084	0.051	0.14	0.050	0.11	0.11	0.093	<0.050	5.0
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Chromium	0.025	0.016	<0.010	0.012	<0.010	0.017	<0.010	<0.010	0.011	<0.010	-
Copper	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.26*	<0.025	0.02
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Mercury	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0005
Nickel	0.040	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	1.0
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1.0
Zinc	0.77	0.038	<0.020	<0.020	0.061	<0.020	<0.020	0.023	0.16	<0.020	1.0
Iron	-	8.0*	1.3*	0.83	8.5*	0.96	1.5*	3.3*	1.5*	0.66	1.0
Manganese	4.8*	1.2*	0.96	1.4*	1.3*	0.14	1.7*	0.90	1.7*	0.075	1.0
Ammonia Nitrogen	8.7*	7.0*	4.0*	2.5*	7.2*	0.74	16*	11*	8.5*	<0.01	15.0**
TOC	87	58	44	57	47	44	60	60	60	48	-
Tot Solids	2,000	1,800	1,700	910	1,800	320	1,700	1,400	900	430	-
Oil and Grease	-	21	6.4	20	10	4.4	6.4	6.8	1.6	4.7	-
Tot Sus Solids	-	1,500	1,300	450	1,300	43	1,200	870	470	41	-
Tot Vol Solids	210	170	180	190	260	150	280	210	140	110	-
Aldrin	0.0004	0.0004	0.0004	0.0004	.0004	.00004	.0004	.0004	.0004	.00004	-
alpha-Chlordane	0.0014	0.0014	0.0014	0.0014	.0014	.00014	.0014	.0014	.0014	.00014	-
gamma-Chlordane	0.0014	0.0014	0.0014	0.0014	.0014	.00014	.0014	.0014	.0014	.00014	-
DDD	0.0011	0.0011	0.0011	0.0011	.0011	.00011	.0011	.0011	.0011	.00011	-
DDE	0.0004	0.0004	0.0004	0.0004	.0004	.00004	.0004	.0004	.0004	.00004	-
DDT	0.0012	0.0012	0.0012	0.0012	.0012	.00012	.0012	.0012	.0012	.00002	-
Dieldrin	0.0002	0.0002	0.0002	0.0002	.0002	.00002	.0002	.0002	.0002	.00002	-
Endrin	0.0006	0.0006	0.0006	0.0006	.0006	-	.0006	.0006	.0006	.00006	-
Heptachlor	0.0003	0.0003	0.0003	0.0003	.0003	.00003	.0003	.0003	.0003	.00003	-
Heptachlor Epoxide	0.0083	0.008 3	0.0083	0.0083	.0083	.00083	.0083	.0083	.0083	.00083	-
Lindane	0.0004	0.0004	0.0004	0.0004	.0004	.00004	.0004	.0004	.0004	.00004	-
Methoxychlor	0.018	0.018	0.018	0.018	.018	.0018	.018	.018	.018	.0018	-
Toxaphene	0.024	0.024	0.024	0.024	.024	.0024	.024	.024	.024	.0024	-
Arochlor-1016	0.0050	0.0050	0.0050	0.0050	.0050	.0005	.0050	.0050	.0050	.0005	-
Arochlor-1221	0.0050	0.0050	0.0050	0.0050	.0050	.0005	.0050	.0050	.0050	.0005	-
Arochlor-1232	0.0050	0.0050	0.0050	0.0050	.0050	.0005	.0050	.0050	.0050	.0005	-
Arochlor-1242	0.0050	0.0050	0.0050	0.0050	.0050	.0005	.0050	.0050	.0050	.0005	-
Arochlor-1248	0.0050	0.0050	0.0050	0.0050	.0050	.0005	.0050	.0050	.0050	.0005	-
Arochlor-1254	0.010	0.010	0.010	0.010	.010	.0010	.010	.010	.010	.0010	-
Arochlor-1260	0.010	0.010	0.010	0.010	.010	.0010	.010	.010	.010	.0010	-

* Violation of the General Use water quality standard(Assume pH of 8.0 and water temperature of 20 deg C for un-ionized ammonia computation).
** Ammonia shall not exceed 15 mg/l, if >1.5 mg/l and <15 mg/l the un-ionized ammonia concentration shall not exceed 0.04 mg/l.

Table G-3. Results of Baseline Monitoring of Ambient Water Samples at Station LCL-1.

Parameter	Date (1987) 05/27	06/09	06/23	07/07	07/21	08/04	08/18	09/01
Air Temperature(deg C)	29	20	26	23	29	26	23	22
Water Temperature(deg C)	24	24	27	24	28	29	25	20
Wind Speed(mph)	15	15	5	5	5	2	5	2
Wind Direction	SE	NE	NE	SW	SW	NE	SW	SW
Cloud Cover(%)	0	-	-	-	0	-	-	0
Secchi Disk Depth(M)	.27	.14	.14	.11	.05	.11	.11	.12
Water Depth(ft)	5.5	5.5	2.9	1.6	1.25	1.3	1.3	1.7
Dissolved Oxygen(mg/l)	9.5	6.0	5.1	6.1	7.9	9.8	2.5	8.5
pH(units)	8.9	8.8	8.9	8.5	9.0	8.5	8.3	8.2
Specific Conductivity (umhos/cm @ 25 deg C)	480	470	480	460	510	440	510	470
Suspended Solids(mg/l)	36	70	110	190	350	140	100	96
Chlorophyll a(ug/l)	130	250	190	320	450	340	260	190
Chlorophyll b(ug/l)	5	<4	8	25	5	26	21	12
Chlorophyll c(ug/l)	23	52	30	33	48	48	41	15
Pheophytin a(ug/l)	22	59	51	62	73	98	79	110

Table G-4. Results of Baseline Monitoring of Ambient Water Samples at Station UCL-1.

PARAMETER	06/07	06/20	06/27	07/11	07/11X	07/18	08/02	08/08	08/23	08/28	09/18	10/03	10/09	10/24	10/31
	DATE (1989)														
Air Temperature(deg C)	23.	27.5		27.	27.	25.5	-	14.	24.5	26.5	25.5	9.	21.5	19.	5.5
Water Temperature(deg C)	25.	24.6	27.6	28.8	29.5	23.6	-	20.7	25.9	27.9	20.2	14.9	13.2	11.1	12.8
Cloud Cover(%)	0	0	100	75	75	95	-	-	30	70	-	<5	50	FOG	100
Wind Speed(mph)	5	<5	2	5	5	10/15	-	0	5	<3	5	10/15	<5	0	10/15
Secchi Depth(ft)	0.40	0.60	0.60	0.30	0.30	0.30	-	0.40	0.30	0.50	0.80	0.60	1.10	1.00	0.80
Water Depth(ft)	4.90	3.20	5.50	4.20	4.20	2.40	-	1.00	2.00	2.00	7.60	6.00	3.60	4.20	4.90
Dissolved Oxygen(mg/l)	10.60	5.30	5.15	5.95	7.20	4.41	-	4.93	9.83	8.57	6.54	8.77	12.67	12.50	8.83
ph(units)	9.56	8.50	8.04	8.54	8.96	8.88	-	8.63	8.49	8.65	7.94	8.96	9.02	8.94	8.15
Total Alkalinity(mg/l)	134	157	164	164	162	173	-	202	183	189		135	141	149	154
Specific Conductivity (umhos/cm @ 25 deg C)	367	463	483	517	517	503	-	537	481	483	494	455	457	453	477
Turbidity(ntu)	76	76	-	290	280	270	-	150	168	176	46	66	43	33	52
Nitrate Nitrogen(mg/l)	0.02	0.13	<0.05	<0.05	0.07	<0.05	-	<0.05	<0.05	<0.05	0.87	.05	<0.05	<0.05	<0.05
Ammonia Nitrogen(mg/l)	0.04	1.01	0.49	0.05	0.16	0.12	-	0.06	0.08	<0.04	0.18	<.04	<0.04	<0.04	<0.04
Total Phosphate(mg/l)	0.59	0.52	0.69	1.11	1.11	1.04	-	0.98	0.94	0.77	0.26	0.30	0.30	0.27	0.31
Suspended Solids(mg/l)	88	65	76	284	296	304	-	158	220	236	44	80	36	39	85
Chlorophyll a(ug/l)	52	16	15	26	27	<1	-	6	6	34	2	8	16	2.1	5
Chlorophyll b(ug/l)	-	-	-	-	-	5	-	5	6.7	19.5	2.1	5.7	9.1	3.1	9.4
Chlorophyll c(ug/l)	-	-	-	-	-	9	-	6	10.5	24.3	3.4	6.8	14.8	3.2	7.5
Pheophytin a(ug/l)	-	-	-	-	-	18	-	10	6.8	3.4	4.2	4.3	6.5	2.2	5.6
Arsenic(mg/l)		6.00		13.	11.		-	10			2.00			3.0	
Barium(mg/l)		50.00		87.	97.		-	<10			<1			<10	
Chromium(mg/l)		20.00		<30	<30		-	<30			<30			<30	
Lead(mg/l)		58.00		38	34		-	17.00			8.00			16.00	
Mercury(mg/l)		0.20		<0.2	<0.2		-	<0.2			0.2			<0.3	
Zinc(mg/l)		31.00		26	27		-	30.00			20.00			21.00	
Oil & Grease(mg/l)		5.00		<5	<5		-	<5			<5			<5	
Potassium(mg/l)		18.		34	39		-	28.5						26	
Sodium(mg/l)		134.		45	50		-	169						17.1	
Chloride(mg/l)							-	43.8						35.70	
Sulfate(mg/l)							-	50.6						51.80	
Calcium(mg/l)		342.		620	491		-	480.						367.0	
Magnesium(mg/l)		150.		189	208		-	187.						183	

Table G-5. Results of Baseline Monitoring of Ambient Water Samples at Station UCL-2.

PARAMETER	06/07	06/20	06/27	07/11	07/18	08/02	08/08	08/23	08/28	09/18	10/03	10/03X	10/09	10/24	10/31
Air Temperature(deg C)	23.0	27.5		27.0	25.5		16.5			25.5	9.0	9.0	21.5	19.0	5.50
Water Temperature(deg C)	25.40	25.10	27.50	30.50	24.00		0.00			20.70	15.00	15.10	13.20	11.90	12.30
Cloud Cover(%)	0	0	100	10	95		0			0	<5	<5	5	0	100
Wind Speed(mph)	5	<5	2	5	15	-	0	-	-	5	10/15	10/15	<5	<1	10/15
Secchi Depth(ft)	0.50	0.70	0.60	0.40	0.20					0.90	0.80	0.80	1.00	1.00	0.80
Water Depth(ft)	2.80	3.30	2.90	1.70	1.40					7.50	4.80	3.50	3.40	3.30	3.40
Dissolved Oxygen(mg/l)	12.60	4.90	3.20	8.90	5.30					11.20	8.72	9.01	12.08	11.94	9.39
ph(units)	9.55	8.60	8.09	4.06	8.70					8.69	8.86	8.77	8.80	8.86	8.44
Total Alkalinity(mg/l)	150	152	167	175	187						135	139	142	150	154
Specific Conductivity (umhos/cm @ 25 deg C)	375	435	479	508	501					490	562	532	449	434	485
Turbidity(ntu)	62	77	-	160	260					27	46	55	28	34	62
Nitrate Nitrogen(mg/l)	0.02	0.05	<0.05	<0.05	<0.05					0.90	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia Nitrogen(mg/l)	0.21	0.74	1.03	0.06	16.00					0.09	<0.04	<0.04	<0.04	<0.04	<0.04
Total Phosphate(mg/l)	0.57	0.70	0.90	1.19	1.15					0.27	0.26	0.30	0.28	0.31	0.36
Suspended Solids(mg/l)	78	58	85	172	308					31	48	61	40	36	67
Chlorophyll a(mg/l)	69	14	12	65	1					2.60	8.20	13.60	13.00	3.50	7.10
Chlorophyll b(mg/l)	-	-	-	-	10					2.7	5.5	8.3	11.8	3.3	13.6
Chlorophyll c(mg/l)	-	-	-	-	11					2.6	6.3	9.5	12.5	3.2	15.3
Pheophytin a(mg/l)	-	-	-	-	22					3.60	4.00	5.40	9.70	<1.00	8.50
Arsenic(mg/l)		8.00		10.00						2.00				3.00	
Barium(mg/l)		42.00		72.00						57.00				62.00	
Cadmium(mg/l)		1.00		<10						<1				<10	
Chromium(mg/l)		20.00		<30						<30				<30	
Lead(mg/l)		35.00		19.00						7.00				8.00	
Mercury(mg/l)		0.20		<0.2						<0.02				<0.02	
Zinc(mg/l)		19.00		38.00						15.00				17.00	
Oil & Grease(mg/l)		5.00		<5						<20				<5	
Potassium(mg/l)		16.7		30.										<5	
Sodium(mg/l)		100.		152										22.3	
Chloride(mg/l)														35.2	
Sulfate(mg/l)														52.0	
Calcium(mg/l)		292.		404.										334.	
Magnesium(mg/l)		135.		171.										171.	

Table G-6. Results of Baseline Monitoring of Ambient Water Samples at Station UCL-3.

PARAMETER	06/89	06/20	06/27	07/11	07/19	08/02	08/08	08/23	08/28	09/18	10/03	10/09	10/24	10/31
					DATE (1989)									
Air Temperature(deg C)	23.00	27.50					22.00	24.50	26.50	25.50	9.50	21.50	19.00	5.50
Water Temperature(deg C)	26.66	26.40	27.40	32.20			22.50	27.00	29.80	23.40	15.50	14.30	13.00	12.80
Cloud Cover(%)	0	0	50	10			0	40	60	0	<5	50	0	100
Wind Speed(mph)	5	<5	2	5	-	-	-	5	<3	5	10/15	<5	0	10/15
Secchi Depth(ft)	0.50	0.70	0 50	0.20			0.50	0.40	0.20	0.90	0.90	0.90	0.90	0.70
Water Depth(ft)	2.80	4.10	4.10	0.70			1.00	2.00	1.10	7.30	3.60	2.90	2.60	2.60
Dissolved Oxygen(mg/l)	9.50	5.50	5.50	12.09			1.75	11.56	13.72	16.78	9.39	15.44	15.35	8.78
pH(units)	9.07	8.95	8.64	9.12			8.78	9.19	9.11		8.71	9.01	9.02	8.27
Total Alkalinity(mg/l)	140	155	161	178			223	167	203		143	146	154	154
Specific Conductivity (umhos/cm @ 25 deg C)	406	412	446	491			478	376	411	480	471	446	454	475
Turbidity(ntu)	81	59	-	300			95	152	180	20	49	42	38	85
Nitrate Nitrogen(mg/l)	0.82	0.28	0.05	<0.05			<0.05	<0.05	<0.05	0.74	<0.05	0.15	0.17	<0.05
Ammonia Nitrogen(mg/l)	0.04	0.34	0.30	0.07			0.12	0.13	0.10	<0.04	<0.04	0.20	<0.04	<0.04
Total Phosphate(mg/l)	0.56	0.69	1.01	1.24			1.29	1.39	1.45	0.33	0.36	0.32	0.28	0.43
Suspended Solids(mg/l)	94	54	114	420			97	232	328	30	52	49	42	51
Chlorophyll a(mg/l)	31	41.	20.	40.			12.	25.1	42.3	5.2	17.4	26.9	3.5	6.2
Chlorophyll b(mg/l)	-	-	-	-			7	16.6	26.9	3.7	12.7	17.4	4.4	7.3
Chlorophyll c(mg/l)	-	-	-	-			7	17.	36.9	4.6	13.8	20.3	3.8	6.0
Pheophytin a(mg/l)	-	-	-	-			6.00	14.4	24.3	3.8	10.6	9.4	2.0	1.7
Arsenic(mg/l)		11.00		12.00			3.00			2.00			2.00	
Barium(mg/l)		55.00		90.00			80.00			56.00			66.00	
Cadmium(mg/l)		10.00		<10			<10			<1			<10	
Chromium(mg/l)		20.00		<30			<30			<30			<30	
Lead(mg/l)		11.00		20.00			16.00			15.00			11.00	
Mercury(mg/l)		0.20		<0.2			<0.2			<0.2			<0.2	
Zinc(mg/l)		16.00		49.00			44.00			47.00			<15	
Oil & Grease(mg/l)		5.00		<5			<5			<20			<5	
Potassium(mg/l)		19.9		33.			21.3						22.6	
Sodium(mg/l)		131.		146.			111.						168.	
Chloride(mg/l)							24.80						32.20	
Sulfate(mg/l)							34.20						46.80	
Calcium(mg/l)		355.		479.			515.						398.	
Magnesium(mg/l)		164.		188.			175.						188.	

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GEOTECHNICAL CONSIDERATIONS

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-7F)

LAKE CHAUTAUQUA REHABILITATION AND ENHANCEMENT
LA GRANGE POOL, ILLINOIS WATERWAY, RIVER MILES 124-128
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LA GRANGE POOL, ILLINOIS WATERWAY, RIVER MILES 124-128
MASON COUNTY, ILLINOIS

APPENDIX H
GEOTECHNICAL CONSIDERATIONS

H-1. LOCATION.

The Chautauqua National Wildlife Refuge, established in 1936 and administered by the U.S. Fish and Wildlife Service, Department of the Interior, is a wintering waterfowl refuge within the Mississippi Flyway, located from Canada to the Gulf of Mexico. The refuge is situated in Mason County in central Illinois and contains 4,200 acres of land and water within the Illinois River floodplains. Lake Chautauqua impounds about 3,800 acres of water, while another 400 acres of water and timbered bottom land are located outside of the impounded area. The remaining acreage is composed of upland and timber.

The refuge is bounded on the west by the Illinois River between river miles 124 and 128. Adjacent on the north and south ends are shallow floodplain lakes similar to Lake Chautauqua. On the east side is a sandy bluff, rising 70 feet above the lake with wave-cut and nearly vertical facies.

H-2. PHYSIOGRAPHY.

The project area is situated within the Central Lowland Province of the Galesburg Plain, a region of deeply dissected Illinoian glacial plains. The narrow, gentle, and wavelike appearance of the upland areas, interspersed by a maze of deep, sharp valleys, contrasts with the flat expanses of the Illinois Valley and its major tributary in this area, the Spoon Valley.

The most prominent topographic feature, the Illinois Valley, is 17 to 20 miles wide in the vicinity. This portion of the valley forms part of the Havana Lowland, a low, broad, and triangular alluvial plain that extends from Pekin to Beardstown, Illinois. The valley is bordered by steep, 80- to 150-foot-high bluffs on the northwest. East of the river, the valley bottom is covered by sand ridges and dunes 20 to 40 feet high.

H-3. PLEISTOCENE AND RECENT DEPOSITS.

The area was glaciated during the Pre-Illinoian and Illinoian stages of the Pleistocene which took place approximately 10,000 to 900,000 years ago. Glacial deposits of till, sand, and gravel outwash average about 50 feet, and locally, to as much as 150 feet over buried bedrock valleys.

The Pre-Illinoian glacier completely covered the area, and its deposits are widespread beneath younger drift and are rarely exposed. The Illinoian glacier deposited Illinoian drift during three separate advances which extensively underlie the uplands and are exposed in many places. Westerly winds, depositing loess during the Wisconsinan time and sand in recent times, formed surficial material in the bluffs throughout the area. Alluvial river and stream deposits of mostly clay and silt with some sand and fine gravels are the most recent deposits overlying glacial outwash. This material ranges from 15 to 20 feet in thickness.

H-4. BEDROCK.

The bedrock of the project area consists of layers of approximately 4,500-foot-thick Paleozoic sedimentary rocks that range in age from late Cambrian to middle Pennsylvanian. The Cambrian rocks rest on an ancient erosion surface of Pre-Cambrian granite. Thick deposits of sedimentary rocks in the basin, consisting of Pennsylvanian age sandstone, shale, limestone, and coal, were deposited in the ancient shallow seas and marshes that periodically covered Illinois, including the Lake Chautauqua area, during the Paleozoic Era. Bedrock in the project area ranges in depth from 50 to approximately 150 feet and is of the Spoon Formation.

H-5. SUBSURFACE EXPLORATIONS.

During May 1989, two onshore borings, LC-89-1 and LC-89-2, were taken. The borings were obtained with a CME-55(ATV) drill rig using 3-1/4-inch hollow stem augers and a 2-7/8-inch roller bit with mud rotary. Borings LC-89-1 and 2 had between 10 to 20 feet of fill overlying alluvial, medium to fat organic clays. The clay overlies glacial outwash sand and gravel with varying degrees of coarse material. Hole LC-89-2, being closer to the bluff, encountered shale bedrock at 48.0 feet. The deepest boring taken with the drill rig extended to a depth of 48.5 feet, approximate elevation 400.5 feet National Geodetic Vertical Datum (NGVD). During July 1989, seven offshore borings, LC-89-3, 4, 5, 6, 7, 8, and 9, were obtained by hand with a 4-inch Iwan auger. The predominate material encountered in the hand auger holes was medium to fat, organic clay. Two additional deep holes were drilled during January 1990. Boring LC-90-1 was taken on the west side for an inlet/outlet structure, and boring LC-90-2 was taken on the north side for a pump station. Boring LC-90-1 had 4 feet of fill (levee) overlying 27 feet of gray, lean clay. The clay overlies 10 feet of gray, sandy gravel. Gray, silty shale (bedrock) was encountered at 41.0 feet.

Boring LC-90-2 had 6 feet of fill (levee) overlying 28 feet of gray, medium to fat clay resting on gray fissile shale; no sand was encountered. Fourteen hand augers were performed during the months of December 1989 and February 1990 in Meyers and Liverpool ditches for excavation purposes. Typically, 8 to 15 feet of gray, medium to fat clay was encountered in both ditches with water depths averaging 3 to 5 feet. Three hand augers also were performed on top of the levee along the Liverpool ditch for stability of levee material.

Additional off-shore hand augers (LC-91-1, LC-91-2, and LC-91-4 through LC-91-6) were taken in January 1991 to verify the suitability of adjacent borrow for levee construction. The analysis revealed CL and CH medium to fat clay with sand. Water contents were in the range of 38.6 to 97.9 with the average of about 45 percent. This material will be suitable as borrow for levee construction.

The location of the borings and logs are shown on plates 9 through 12 of the main report.

H-6. GROUND WATER.

The sand and gravel in the Illinois Valley that underlies the clay provides a good supply of ground water. Water level observations were monitored during the boring operations and are noted on the boring logs. Based on interpretation of borings LC-89-1, LC-89-2, LC-90-1, and LC-90-2, the ground water levels encountered vary from hole to hole. The approximate elevations of the ground water levels range from elevation 434.2 (LC-89-1) to elevation 428.5 (LC-89-2). Allegedly, there are springs which supply water to Lake Chautauqua all year; however, this has not been confirmed.

H-7. CROSS DIKE RAISE.

The proposed cross dike raise, as shown on plates 17 and 18 of the main report, is 5 to 10 feet high, with the exception of stations 29+00 to 34+00 which will require 16 feet of fill. The cross dike is approximately 5,000 feet long. Its top elevation is constant at elevation 449.1 NGVD. The crown of the dike will be 15 feet wide, and the side slopes will be 1V on 6H downstream and 1V on 4H upstream. Construction of the cross dike will be accomplished using borrow from adjacent channel cuts and from the Liverpool ditch cleanout.

Before additional material can be placed, the levee must be prepared in the following manner. All vegetation and other deteriorated materials must be removed to a depth of 6 inches. All tap roots, lateral roots, and trees within the work area will be removed to a depth of 3 feet. A minimum 40-foot zone between the toe of the cross dike and the borrow excavation will remain undisturbed and in place.

H-8. EXISTING PERIMETER LEVEE EMBANKMENT.

The existing perimeter levee is 7 to 16 feet high and approximately 9 miles long with a top elevation of 432 to 451 NGVD. Portions of the existing levee have a very narrow top width.

The perimeter levee will be constructed to elevation 449.1 from station 0+00 to station 154+40. The crown of the levee will be 12 feet wide with slopes of 1V on 4H or flatter. This work done on the levee must include stripping all vegetation and other deteriorated materials to a depth of 6 inches. All tap roots, lateral roots, and trees within the work area will be removed to a depth of 3 feet. A minimum 12-foot buffer zone between the toe of the levee and the river must be maintained, as well as a 40-foot undisturbed zone between the toe of the levee and the borrow excavation.

H-9. FOUNDATIONS FOR STRUCTURES.

Three structures are proposed to be built as part of the project: a pump station, a gravity outlet, and stop log structure, all located in the existing perimeter levee. The pump station is located where the cross dike ties into the perimeter levee. The gravity outlet will be located approximately 100 feet upstream of the pump station. The stop log structure is located on the southern perimeter levee where Quiver Creek bends to the south. Site-specific borings have been taken to determine the engineering characteristics of the foundation materials. Detailed descriptions of the soils encountered are shown on the boring logs (see borings LC-90-1 and 2 on plate 11 of the main report). The borings do not show undesirable or soft materials. The unsuitable material which might not have been encountered by the subsurface boring exploration program will be replaced with appropriate fill. A dewatering system will be required to maintain the excavation area in dry condition. The levee will be constructed, and settlement plates will be used to ensure that all settlement is complete before construction of the structures commences.

H-10. SLOPE STABILITY.

A critical section was selected to conduct a slope stability investigation. It was determined that the cross dike was the most critical section for slope stability and it was analyzed for the end of construction condition.

The stability of the slope was analyzed by the Modified Swedish Method for a circular Arc Slope Stability Analysis in accordance with EM 1110-2-1902, "Engineering Design Stability of Earth and Rockfill Dams," dated April 1, 1970.

Conservative shear strengths (Q) were assumed for the most severe configuration of the embankment and foundation to estimate the stability of the embankment. These values are shown on plate H-1 and are based on tests and samples from other projects with generally similar soils and construction. Successive trials of various circular sliding surfaces were analyzed, and a determination of the critical failure arc having the lowest factor of safety was made. The summary of the slope stability analysis and the solution of the most critical arc appears on plate H-1. The computed minimum safety factor of 2.30 for the end of construction condition far exceeds the 1.3 minimum required by EM 1110-2-1913, "Design and Construction of Levees," dated March 31, 1978. Therefore, no slope stability problems are expected on the cross dike.

The slope stability analysis was checked using Utexas2. For the cross dike raise, the computed minimum is 2.25. This correlates favorably with the results obtained using Rock Island District's slope stability analysis and plot program.

H-11. UNDERSEEPAGE.

The occurrence of any underseepage related distress was investigated. This included a study of the thickness and permeability of the impervious top clay stratum and a study of the maximum hydraulic head expected. A review of the borings taken from the project site revealed the minimum thickness of the impervious clay layer to be 14 feet. An investigation of the operating procedures revealed the maximum hydraulic head to be 8 feet under flood conditions.

All of the levees at the project site have been in operation for many years with no apparent problems. By inspection, no seepage problems are expected.

H-12. SETTLEMENT.

Because the cross dike is being raised, a minimal amount of settlement is considered to be insignificant. To account for this settlement, a shrinkage allowance of 25 percent of the construction height will be provided for in the specifications. Settlement plates will be used at all structures to ensure that all settlement is completed before construction starts.

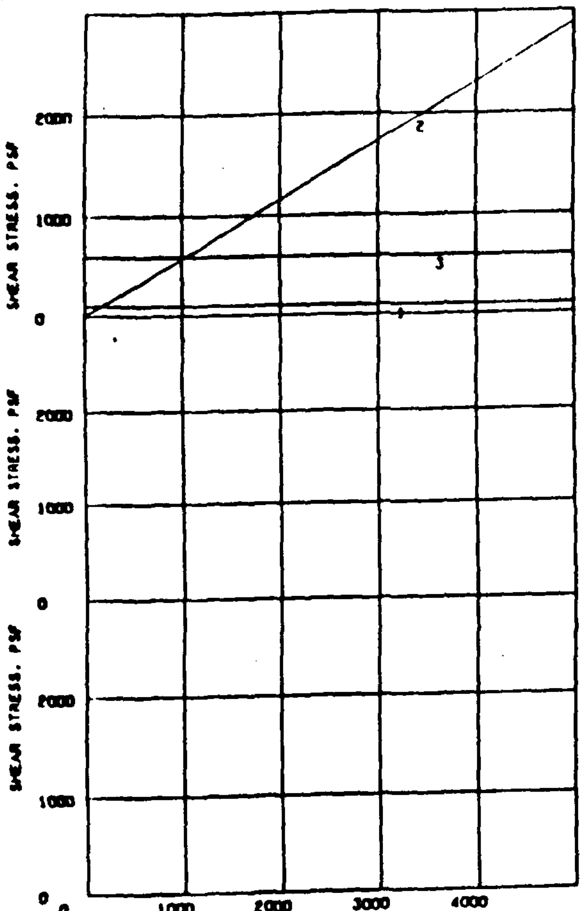
H-13. SLOPE PROTECTION.

The levee embankment will have 1V on 4-6H slopes. Therefore, it is anticipated that grass protection will be adequate against wave wash, as discussed in the main report.

H-14. BORROW MATERIAL.

Material for construction of the levees will be obtained from Liverpool Ditch cleanout and from adjacent channel cuts in the lake. Excavation adjacent to the cross dike will require a 40-foot minimum area beyond the toe of the embankment to remain undisturbed and in place.

Based on information obtained from borings, this material should be suitable for use in levee construction. Because of the relatively high water content (average 45 percent), the material should be placed in lifts not to exceed 3 feet and allowed to dry. Due to the relatively low heights and flat slopes of the embankments needed for this project, the uncompacted method of material placement is recommended. The fill for the structures will be placed in layers not exceeding 4 inches and will be compacted to not less than 95 percent of maximum laboratory density.

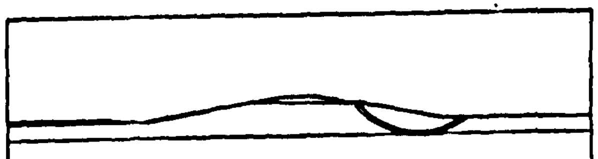


NORMAL STRESS, PSF
DESIGN ENVELOPES

MATERIAL		SOIL WT. LBS./CUFT		SHEAR STRENGTH							
				Q		R		S		(R+S)/2	
		MOIST	SAT.	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF
CLAY CAP 430.0 TO 440.0	1	110.00	110.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
SAND BASE 433.0 TO 443.8	2	110.00	115.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CLAY FOUNDATION BELOW 418.0	3	110.00	115.00	0.00	800.00	0.00	0.00	0.00	0.00	0.00	0.00

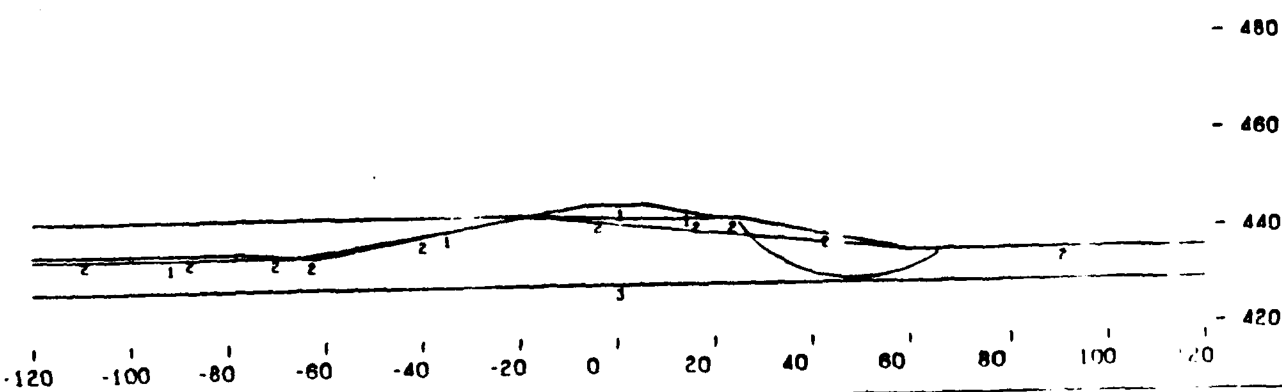
CIRCLE FAILURE SURFACE
RESULTS BY HARRIS-300
COMPUTER PROGRAM 741-H5-F424A
TANGENT TO ELEV 420.22
TRIAL ARCS

RADIUS OF CIRCLE	CENTER OF CIRCLE DISTANCE FROM ℄	CENTER OF CIRCLE ELEV	F.S. Q-SHEAR STRENGTH φ= 0.00	
30.00	48.00	480.00	2.30	
31.00	48.00	480.00	2.30	
31.00	50.00	480.00	2.32	
10.00	48.00	459.00	2.30	
12.00	48.00	481.00	2.30	
31.00	48.00	481.00	2.30	



RANGE OF TRIAL FAILURE SURFACES

NOTES
1- ANALYSES WERE RUN ACCORDING TO EM 1110-2-1902 DATED APRIL 1970
2- THE SIDE EARTH FORCE DIRECTION WAS TAKEN AS THE AVERAGE OF THE EMBANKMENT SLOPES IMMEDIATELY ADJACENT TO THE SLICE INTERFACE
3- PSI-SIESMIC COEFFICIENT USED IN ANALYSES



LAKE CHAUTAUQUA
CROSS DIKE RAISE
SLOPE STABILITY ANALYSIS
END OF CONSTRUCTION
JUNE 1980

PLATE H-1

NOT USED

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HABITAT EVALUATION AND QUANTIFICATION

APPENDIX K

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-7F)

LAKE CHAUTAUQUA REHABILITATION AND ENHANCEMENT
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APPENDIX K
HABITAT EVALUATION AND QUANTIFICATION

K-1. INTRODUCTION AND PURPOSE.

Based on fact sheets approved for each Habitat Rehabilitation and Enhancement Project (HREP) under the Environmental Management Program (EMP), the first step in project planning was to describe the project's goals and objectives. The next step was to develop an array of alternatives that could meet these goals and objectives. The Corps of Engineers (Corps) guidelines for this step in planning traditional projects has been well defined and includes several steps to assure that the desired results (i.e., flood control or navigation) are met.

The planning and construction of habitat enhancement projects as a sole project purpose is relatively new for the Corps, and, thus, in-depth guidance for this type of project has not been available. Because of this, early HREP project documents could not show if goals and objectives for a project were attainable and if the proposed solutions would result in any true habitat benefits.

These uncertainties eventually resulted in the development and selection of a technique to objectively quantify and compare potential alternatives on the basis of costs and benefits. This technique combines the Corps of Engineers guidance in EC 1105-2-185 (Fish and Wildlife Mitigation Incremental Analysis) and the Wildlife Habitat Appraisal Guide (WHAG). The development and implementation of WHAG has been extensively discussed in previous Habitat Definite Project Reports (DPR). Therefore, this appendix will focus primarily on the WHAG evaluation specific to the Lake Chautauqua HREP.

K-2. EVALUATION PROCEDURE.

The WHAG procedure was developed as a management tool to evaluate the benefits and impacts of potential uplands and wetlands habitat improvements in the State of Missouri. It is a modification of the U.S. Fish and Wildlife Service (USFWS) Habitat Evaluation Procedure (HEP) which quantifies a habitat's value based on its ability to meet life requirements of preselected species. Since WHAG was designed to be applicable state-wide, the evaluation species used in the method are rather cosmopolitan and representative of overall habitat quality.

Each HREP has different goals and objectives specific to its particular project site. Thus, some of the species in the WHAG species matrices are not especially significant to the particular project being evaluated. Due to the WHAG format, however, these species are evaluated along with those species (target species) of primary concern (i.e., fish and waterfowl) without any additional effort. These species have not been discussed separately unless they are significantly benefitted or impacted by the project. For example, there are 12 species in the wetland matrix but all 12 have not been discussed individually in this report (see figure K-3).

Another problem with the use of predetermined species matrices for all projects is that some species of critical project importance were absent from the matrices. For Lake Chautauqua, these species include fish and diving ducks. Using the USFWS-HEP blue books and other literature sources, preliminary working species models for largemouth bass, walleye, channel catfish, and diving ducks have been developed and incorporated into the habitat matrices of the WHAG software program. For example, the original wetland matrix of the WHAG was modified by deleting goose as a species and inserting diving ducks. The matrix was named "CNWRWET" to distinguish it from the original WHAG matrix (see figure K-1). Since WHAG included no fish species, a totally new set of characteristics had to be developed. A new matrix named "FISH" was created (see figure K-2). Although the validity of these species models has not been field tested as have the other matrix species, the necessity of quantifying benefits for fish and diving ducks requires their immediate use. The North Central Division, U.S. Army Corps of Engineers, is currently pursuing a separate work effort to develop more accurate models.

The WHAG analysis was performed by the USFWS ecological services field office (Rock Island) and the Rock Island District Environmental Analysis Branch. Biologists from Chautauqua Refuge and Illinois Department of Conservation (IDOC) also provided input to the analysis.

K-3. MODEL ASSUMPTIONS.

As with any model, the results of the model calculations are no better than the assumptions used when inputting model data. The following general assumptions apply to all the alternatives:

a. The Lake Chautauqua refuge and levees would be maintained by the USFWS for the foreseeable future regardless of any EMP involvement. In particular, the upper and lower lake levees would be maintained at their current level of protection.

SPECIES CHARACTERISTIC MATRIX VALUES MATRIX NAME CNWRWET TODAY'S DATE 04-05-1991

SPECIES

CHARACTERISTIC NO.	MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
1 PERCENT NONFOREST WETLANDS IN 2 MILE CIRCLE HAB TYPE N												
1. >75%			10	10	10	10				10		
2. 50-75%			8	8	8	8				8		
3. 25-50%			6	6	6	6				6		
4. 10-25%			4	4	4	4				4		
5. <10%			1	1	1	1				1		
2 PERCENT BOTTOMLAND HARDWOODS AND NONFOREST WETLANDS IN 2 MILE WIDE CIRCLE HAB TYPE NBC												
1. >75%	10						10	10	10			
2. 50-75%	8						8	8	8			
3. 25-50%	6						6	6	6			
4. 10-25%	4						4	4	4			
5. <10%	1						1	1	1			
3 FALL WINTER WATER CONDITIONS HAB TYPE NBC												
1. WAT ANNUAL PREDICT	10											
2. WAT MOST YRS PREDICT	7											
3. WAT 1 OUT 3 YRS PRED	4											
4. WAT UNPREDICT	1											
4 FALL-WINTER FLOOD CONDITIONS(FOOD PLANT AVAILABILITY) HAB TYPE NB												
1. FOOD UNAFFECTED	10											
2. REDUCED 1-25%	8											
3. REDUCED 25-50%	6											
4. REDUCED 50-75%	4											
5. REDUCED >75%	1											
5 WATER DEPTH 4-18 INCHES HAB TYPE NBC												
1. >90%	10											
2. 75-90%	8											
3. 50-75%	6											
4. 25-50%	4											
5. <25%	1											
6 WATER DEPTH <4 INCHES MAY-JUNE HAB TYPE N												
1. >90%				10						1		
2. 75-90%				8						2		
3. 25-75%				6						4		
4. 1-25%				4						7		
5. ZERO; ALL >4 IN DEEP				1						10		
7 WATER DEPTH 4-18 INCHES BY AUGUST HAB TYPE N												
1. >75%			1		10	1	10			10		
2. 50-75%			7		7	7	7			7		
3. 25-50%			10		4	10	4			4		
4. <25%			4		1	4	1			1		
8 PERMANENT WATER ENTIRE YEAR HAB TYPE N												
1. >90%					10							
2. 75-90%					8							
3. 50-75%					6							
4. 25-50%					4							
5. <25%					1							
9 PERCENT EMERGENT VEGETATION WITHIN 2 YDS OF WATER HAB TYPE N												
1. >75%			10							10		
2. 50-75%			7							7		
3. 25-50%			4							4		
4. <25%			1							1		

FIGURE K-1

CHARACTERISTIC NO. SPECIES	MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
			FILE NAME CNWRWET									
10 WOODY INVASION HAB TYPE N												
1. <10%			10		5	6	1					
2. 10-25%			8		4	8	6					
3. 25-50%			6		3	10	8					
4. 50-75%			4		2	4	10					
5. >75%			1		1	1	4					
11 EMERGENT VEGETATION COVERAGE HAB TYPE NB												
1. >90%			6	1			1					
2. 75-90%			10	2			2					
3. 50-75%			8	4			4					
4. 25-50%			4	6			10					
5. 10-25%			2	8			7					
6. <10%			1	10			1					
12 CATTAIL AND BULRUSH COVERAGE HAB TYPE N												
1. >75%					10	1				8		
2. 50-75%					8	2				10		
3. 25-50%					6	4				6		
4. 10-25%					4	7				4		
5. <10%					1	10				1		
13 WETLAND SIZE (ACRES) HAB TYPE NB												
1. >200 AC			10	10	10	10	10			10		
2. 100-200 AC			10	8	8	8	10			10		
3. 50-100 AC			8	6	6	6	10			8		
4. 25-50 AC			6	4	4	4	10			6		
5. 5-25 AC			4	1	2	2	5			4		
6. <5 AC			1	1	1	1	1			1		
14 WETLAND EDGE (BOTHRD-% ADJ WATER NONFORWET-% ADJ WOODY OR BOTHRD) HAB TYPE NB												
1. >75%							10					
2. 50-75%							8					
3. 25-50%							6					
4. 10-25%							4					
5. <10%							1					
15 WATER REGIME HAB TYPE N												
1. >75% WAT BY AUG 1			4	4	8	2	10			8		
2. 50-75% WAT BY AUG 1			6	6	6	6	6			6		
3. 25-50% WAT BY AUG 1			10	10	4	10	4			4		
4. <25% WAT BY AUG 1			8	8	2	8	2			2		
5. STABLE WATER			2	4	10	4	10			10		
6. NO WAT AFTER JUNE 1			1	1	1	1	1			1		
16 IMPORTANT FOOD PLANT COVERAGE HAB TYPE NB												
1. >75%	10											
2. 50-75%	8											
3. 25-50%	6											
4. 10-25%	4											
5. <10%	1											
17 PLANT DIVERSITY HAB TYPE NB												
1. >7	5											
2. 4-7	3											
3. <4	1											

FIGURE K-1 (Cont'd)

FILE NAME CNWRWET

CHARACTERISTIC NO.	SPECIES	MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
18	PERSISTENT EMERGENT AND WOODY VEGETATION COVERAGE HAB TYPE N												
	1. 5-15%	5											
	2. 15-25%	4											
	3. 25-50%	2											
	4. <5% OR >50%	1											
19	SUBSTRATE-SURFACE WATER INTERSPERSION HAB TYPE N												
	1. INTERSPERSED POOLS				10								
	2. ONE OR FEW POOLS				1								
20	PERCENT OPEN WATER HAB TYPE N												
	1. <10%	5				10					6		
	2. 10-25%	3				8					10		
	3. 25-50%	1				6					8		
	4. 50-90%	1				4					4		
	5. >90%	1				1					1		
21	WINTER WATER DEPTH (OCT.-MARCH) HAB TYPE N												
	1. 15-24 IN					10							
	2. 10-15 OR 24-30 IN					7							
	3. 6-10 OR 30-35 IN					4							
	4. <6 OR >36 IN					1							
22	SEDGE CANOPY COVERAGE HAB TYPE N												
	1. >90%						8						
	2. 75-90%						10						
	3. 50-75%						6						
	4. 25-50%						4						
	5. 1-25%						2						
	6. ZERO						1						
23	WETLAND SUBSTRATE HAB TYPE N												
	1. MUDDY				5								
	2. SANDY				3								
	3. GRAVEL				1								
24	PERCENT SOIL WATERLOGGED SUBSTRATE MAY-JUNE HAB TYPE N												
	1. >90% SUBSTRATE				10								
	2. 75-90% SUBSTRATE				8								
	3. 50-75% SUBSTRATE				6								
	4. 25-50% SUBSTRATE				4								
	5. <25% SUBSTRATE				1								
25	PERCENT EXPOSED SUBSTRATE AND 1-4 INCH SHALLOW WATER COVERED BY VEG HAB TYPE N												
	1. <10%				10								
	2. 10-25%				8								
	3. 25-50%				6								
	4. 50-75%				4								
	5. 75-90%				2								
	6. >90%				1								
26	PERCENT CHANNEL WITH AQUATIC VEGETATION (1/4 MI UP $ DOWN STREAM) HAB TYPE B												
	1. >10%								10	10			
	2. 5-10%								7	7			
	3. 1-5%								4	4			
	4. NONE; >1\4 MI TO WAT								1	1			
27	AVERAGE WATER FLUCTUATION IN CHANNEL - BANK FULL PER YEAR HAB TYPE B												
	1. BANK FULL <3 PER YR									10			
	2. BANK FULL 3-5 / YR									7			
	3. BANK FULL 5-7 / YR									4			
	4. BANK FULL >7 PER YR									1			

FIGURE K-1 (Cont'd)

CHARACTERISTIC NO. — SPECIES — FILE NAME CNWRWET

CHARACTERISTIC NO.	MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
28 CROPFIELD MANAGEMENT HAB TYPE C												
1. NO FALL TILLAGE	10											
2. WINTER WHEAT	2											
3. CHISEL PLOWING	8											
4. CHOPPED BALED GRAZED	6											
5. FALL DISC	4											
6. FALL PLOWED	1											
29 CROPPING PRACTICE HAB TYPE C												
1. >50% UNHARVESTED	10											
2. 25-50% UNHARVESTED	7											
3. 10-25% UNHARVESTED	4											
4. <10% UNHARVESTED	1											
30 WOODLAND TREE SPECIES HAB TYPE B												
1. >50% ELM COTT SYCAM	1							8	10			
2. 25-50% ELM COT SYCAM	4							10	8			
3. <25% ELM;<25% PIN O	6							1	6			
4. 25-50% PIN OAK	8							4	4			
5. >50% PIN OAK	10							6	1			
31 PERMANENT WATER WITHIN WOODLAND HAB TYPE B												
1. >25%	1						10	10				10
2. 10-25%	3						7	7				7
3. 5-10%	5						4	4				4
4. 1-5%	3						2	2				2
5. ZERO	2						1	1				1
32 FOREST OPENINGS HAB TYPE B												
1. 15-30% SCATTERED	1						10	10	5			
2. 15-30% ONE OR FEW	3						7	7	4			
3. 5-15%	5						4	4	3			
4. <5% OR >30%	1						1	1	1			
33 WOODLAND SIZE CLASS HAB TYPE B												
1. SAWTIMBER OPEN.CAN	10						4	10	4		10	10
2. SAWTIMBER CLOSED CAN	8						1	8	1		10	10
3. POLE W/25-50% SAWTIM	6						10	6	6		7	7
4. REGEN W/25-50% SAWTI	4						8	4	8		2	2
5. REGENERATION	1						8	1	10		1	1
6. POLE	1						6	2	6		4	4
34 PERCENT CANOPY FROM OLD GROWTH HAB TYPE B												
1. >25%								10	1			
2. 10-25%								8	4			
3. 5-10%								6	6			
4. 1-5%								4	8			
5. ZERO								1	10			
35. FOREST OVERSTORY CANOPY HEIGHT HAB TYPE B												
1. >80 FEET											10	10
2. 65-80 FEET											7	7
3. 40-65 FEET											4	4
4. <40 FEET											1	1
36 PERCENT FOREST SUBCANOPY CLOSURE HAB TYPE B												
1. >75%											10	1
2. 50-75%											7	4
3. 25-50%											4	10
4. <25%											1	7

FIGURE K-1 (Cont'd)

FILE NAME CNWRWET

CHARACTERISTIC NO. SPECIES	MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
37 WOODLAND (STAND) SIZE (% WITHIN 660 FT OPEN) HAB TYPE B												
1. <25%											10	10
2. 25-50%											7	7
3. 50-75%											4	4
4. >75%											1	1
38 PERCENT FOREST CANOPY ADJACENT (<250 FT) TO OR OVER PERMANENT WATER HAB TYPE B												
1. >25%												10
2. 10-25%												7
3. 5-10%												4
4. <5%												1
39 NUMBER OF SNAGES >9 INCHES DBH PER ACRE HAB TYPE B												
1. >4								5				10
2. 3-4								5				7
3. 1-2								3				4
4. <1								1				1
40 NUMBER OF CAVITY TREES PER ACRE HAB TYPE B												
1. >9								10				10
2. 3-9								7				7
3. 1-3								4				4
4. NONE								1				1
41 STEMS PER SQUARE YARD OF SHRUB AND TREE REPORDUCTION >3 FEET TALL HAB TYPE B												
1. >3								1	10		10	1
2. 1-3								3	7		7	4
3. .5-1								5	4		4	10
4. <.5								2	1		1	7
42 PERCENT WOODLAND WITHIN 660 FEET OF PERMANENT WATER HAB TYPE B												
1. >75%							10	10	10		10	10
2. 50-75%							7	7	7		7	7
3. 25-50%							4	4	4		4	4
4. <25%							1	1	1		1	1
43 DISTANCE TO NONFOREST WETLAND, OXBOW OR SLOUGH HAB TYPE BCG												
1. <250 FT WAT PREDICT	10						10	10	10			
2. 250-1/8 MI WAT PREDI	10						10	10	5			
3. 1/8-1 MI WAT PREDICT	10						1	1	1			
4. <250 FT WAT 1-3 YRS	5						5	5	3			
5. 250-1/8 MI WAT 1-3 Y	5						5	5	2			
6. 1/8-1 MI WAT 1-3 YR	5						1	1	1			
7. >1 MI;<1 MI WAT UNPR	1						1	1	1			
44 DISTANCE TO BOTTOMLAND HARDWOODS HAB TYPE NC												
1. <1/4 MI WAT PREDICT	10						5					
2. 1/4-1/2 MI WAT PREDI	10						3					
3. 1/2-1 MI WAT PREDICT	8						1					
4. <1/4 MI WAT 1-3 YRS	6						5					
5. 1/4-1/2 MI WAT 1-3 Y	6						3					
6. 1/2-1 MI WAT 1-3 YRS	4						1					
7. >1 MI;<1 MI WAT UNPR	1						1					
45 DISTANCE TO CROPLAND HAB TYPE NBG												
1. <1/4 MI UNHARV WAT	10											
2. 1/4-1/2 MI UNHAR WAT	8											
3. 1/2-1 MI UNHARV WAT	6											
4. <1/4 MI UNHAR WAT1-3	5											
5. 1/4-1/2MI UNH WAT1-3	4											
6. 1/2-1 MI UNHA WAT1-3	2											
7. > 1 MI; <1 MI PLOWED	1											

FIGURE K-1 (Cont'd)

CHARACTERISTIC NO.	SPECIES	FILE NAME CNWRWET MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
46 DISTANCE TO STREAM OR RIVER (PERMAENT FLOW OR POOLS) HAB TYPE NB													
1. <1/4 MI								10					
2. 1/4-1/2 MI								5					
3. >1/2 MI								1					
47 PERCENT AREA COVERED WITH SUBMERGED VEGETATION HAB TYPE N													
1. >70%			10										
2. 40-70%			6										
3. 10-40%			3										
4. <10%			1										
48 PERCENT COVER OF EMERGENT VEGETATION HAB TYPE N													
1. 25%			10										
2. 10-25% OR 25-50%			5										
3. <10% OR >50%			1										
49 PERCENT AREA COVERED WITH MOLLUSC BEDS HAB TYPE N													
1. >25%			5										
2. 10-25%			3										
3. <10%			1										
50 PERCENT AREA IN WATER DEPTH 1.5 TO 3 FT HAB TYPE N													
1. >70%			10										
2. 40-70%			5										
3. 10-40%			3										
4. <10%			1										
51 DISTURBANCE DURING MIGRATORY SEASON HAB TYPE N													
1. CLOSED		10	10										
2. NO WTRFL HUNTING		6	6										
3. ACCESS UNCONTRLD		1	1										
52 WATER LEVEL FLUCTUATION/MANAGEMENT HAB TYPE N													
1. CONTROL 2 OF 3 YR			10										
2. CONTROL 1 OF 2 YR			5										
3. UNCONTROLLED			1										

FIGURE K-1 (Cont'd)

FILE NAME CNWRWET

MAXIMUM POSSIBLE POINTS

	MALL	DIVE	BITT	YLEG	MUSK	RAIL	HERO	DUCK	BEAV	COOT	PARU	PROT
N	95	55	70	85	85	70	85			80		
B	105						100	110	95		60	100
C	70											
G												

FIGURE K-1 (Cont'd)

FILE NAME CNWRWET

LIMITING FACTOR CHARACTERISTICS

LINE NUMBER	SPECIES	SPECIES NUMBER	CHARACTERISTIC NUMBER	HABITAT	FACTOR TYPE
1	AMERCIAN COOT	10	7	N	LIMITING FACTOR
2	MUSKRAT	5	9	N	MULTIPLIER
3	LEAST BITTERN	3	12	N	LIMITING FACTOR
4	LESSER YELLOWLEGS	4	12	N	LIMITING FACTOR
5	KING RAIL	6	13	N	LIMITING FACTOR
6	AMERICAN COOT	10	13	N	LIMITING FACTOR
7	LEAST BITTERN	3	14	N	LIMITING FACTOR
8	LESSER YELLOWLEGS	4	14	N	LIMITING FACTOR
9	GREEN-BACKED HERRON	7	14	NB	LIMITING FACTOR
10	AMERICAN COOT	10	14	N	LIMITING FACTOR
11	LEAST BITTERN	3	16	N	LIMITING FACTOR
12	LESSER YELLOWLEGS	4	16	N	LIMITING FACTOR
13	MUSKRAT	5	16	N	LIMITING FACTOR
14	KING RAIL	6	16	N	LIMITING FACTOR
15	GREEN-BACKED HERON	7	16	N	LIMITING FACTOR
16	AMERCIAN COOT	10	16	N	LIMITING FACTOR
17	KING RAIL	6	23	N	LIMITING FACTOR
18	LESSER YELLOWLEGS	4	26	N	LIMITING FACTOR
19	WOOD DUCK	8	38	B	LIMITING FACTOR
20	NORTHERN PARULA	11	38	B	LIMITING FACTOR
21	PROTHONOTARY WARBLER	12	38	B	LIMITING FACTOR
22	PROTHONOTARY WARBLER	12	43	B	MULTIPLIER
23	WOOD DUCK	8	45	B	LIMITING FACTOR
24	GREEN-BACKED HERON	7	47	B	MULTIPLIER
25	WOOD DUCK	8	47	B	MULTIPLIER
26	BEAVER	9	47	B	MULTIPLIER

FIGURE K-1 (Cont'd)

SPECIES CHARACTERISTIC MATRIX VALUES FILE NAME FISH

CHARACTERISTIC NO.	SPECIES CCAT	WALL	LGMB
1 INSTREAM COVER (SNAGS AND ROOT WADS PER 500 FEET) HAB TYPE A			
1	10		10
2	8		8
3	6		6
4	4		4
5	1		1
2 STREAMBANK CONDITION (PERCENT CUTBACK PER 500 FEET) HAB TYPE A			
1	10		7
2	7		10
3	4		4
4	1		1
5	1		1
3 AQUATIC VEGETATION (% CHANL/500 FT.- EMRG OR SUBMRG) HAB TYPE A			
1	10	10	6
2	7	7	10
3	4	4	8
4	1	4	4
5	1	1	4
4 SUBSTRATE HAB TYPE A			
1	3	1	2
2	7	5	3
3	7	7	7
4	10	10	5
5	1	1	2
5 PERCENT AQUATIC/OPEN WATER >4 FT. HAB TYPE A			
1	10	10	10
2	8	8	10
3	6	6	10
4	6	6	4
5	4	4	8
6	1	1	1
6 AVERAGE VELOCITY F/S -(MAY-SEPT) HAB TYPE A			
1	6	6	10
2	7	8	8
3	10	10	2
4	1	1	1
7 PERCENT SHORELINE SHADED BY OVERSTORY HAB TYPE A			
1	10		5
2	8		5
3	6		10
4	4		5
5	1		1
8 LOWEST DAILY DISSOLVED OXYGEN HAB TYPE A			
1	1	1	1
2	5	5	5
3	10	10	10
9 WATER LEVEL STABILITY-MAY TO JUNE HAB TYPE A			
1			7
2			10
3			4
4			1

FIGURE K-2

CHARACTERISTIC NO.	SPECIES CCAT	WALL	LGMB
10 ACCESS TO WATER >6 FT - NOV-APR HAB TYPE A			
1	10	10	10
2	1	1	1
11 PERCENT OF AREA WITH RIP RAP >12 IN. HAB TYPE A			
1	1	1	1
2	10	10	10
3	5	5	5
4	3	3	3
12 AVERAGE DEPTH OF AQUATIC HABITAT IN PROJECT AREA HAB TYPE A			
1	1	1	1
2	3	2	5
3	8	5	10
4	10	10	10
13 AVERAGE VELOCITY DEC-FEB HAB TYPE A			
1	10		10
2	5		5
3	1		1

FILE NAME FISH

FILE NAME FISH

MAXIMUM POSSIBLE POINTS

	CCAT	WALL	LGMB
A	120	80	127

FILE NAME FISH

LIMITING FACTOR CHARACTERISTICS

LINE NUMBER	SPECIES	SPECIES NUMBER	CHARACTERISTIC NUMBER	HABITAT	FACTOR TYPE
1	CHANNEL CATFISH	1	8	A	LIMITING FACTOR
2	WALLEYE	2	8	A	LIMITING FACTOR
3	LARGEMOUTH BASS	3	8	A	LIMITING FACTOR

FILE NAME FISH

HABITAT CHARACTERISTIC/ ABREVIATION		HABITAT TYPES	NUMBER OF CATEGORIES
1	INSTREAM COVER (SNAGS AND ROOT WADS PER 500 FEET)		
	INSTREAM COVER	A	5
2	STREAMBANK CONDITION (PERCENT CUTBACK PER 500 FEET)		
	BANK CONDITION	A	5
3	AQUATIC VEGETATION (% CHANL/500 FT.- EMRG OR SUBMRG)		
	% VEGETATION	A	5
4	SUBSTRATE		
	SUBSTRATE	A	5
5	PERCENT AQUATIC/OPEN WATER >4 FT.		
	DEPTH >4	A	6
6	AVERAGE VELOCITY F/S -(MAY-SEPT)		
	AVG VELOC	A	4
7	PERCENT SHORELINE SHADED BY OVERSTORY		
	BANK COVER	A	5
8	LOWEST DAILY DISSOLVED OXYGEN		
	DISS OX (MG\L)	A	3
9	WATER LEVEL STABILITY-MAY TO JUNE		
	WATER LVL STB	A	4
10	ACCESS TO WATER >6 FT - NOV-APR		
	ACCESS WTR >6'	A	2
11	PERCENT OF AREA WITH RIP RAP >12 IN.		
	% RIP RAP	A	4
12	AVERAGE DEPTH OF AQUATIC HABITAT IN PROJECT AREA		
	AVRG DEPTH	A	4
13	AVERAGE VELOCITY DEC-FEB		
	AVG VEL.	A	3

FIGURE K-2 (Cont'd)

WILDLIFE HABITAT APPRAISAL GUIDE

FIELD SHEET LISTING - ALL HABITAT TYPES COMBINED

1 ___ INSTREAM COVER (1) >5 (2) 4-5 (3) 2-4 (4) <2 (5) ZERO
2 ___ STREAMBANK CONDITION (1) 25-50% (2) 10-25% (3) 50-75% (4) <10% (5) >75%
3 ___ AQUATIC VEGETATION (1) 10-25% (2) 25-50% (3) 50-75% (4) <10% (5)>75%
4 ___ SUBSTRATE (1)UNCONSOLIDATED SAND (2)BEDROCK (3) GRAVEL AND SAND <1 INCH (4) GRAVEL AND BOULDERS >1 INCH (5) SILT
5 ___ PERCENT AQUATIC/OPEN WATER > 4FT: (1)50-75% (2)75-90% (3)25-50% (4) >90% (5) 10-25% (6) <10%
6 ___ AVERAGE VELOCITY FT/SEC MAY-JUN (1) NO FLOW (2) <0.5 (3) 0.5-2.0 (4) >2.0
7 ___ PERCENT SHORELINE SHADED BY OVERSTORY TREES (1) >90% (2) 75-90% (3) 50-75% (4) 25-50% (5) <25%
8 ___ LOWEST DAILY DISSOLVED OXYGEN (1) <3 (2) 3-5 (3) >5
9 ___ WATER LEVEL STABILITY MAY-JUNE (1)RISING WATER LEVELS AND INUNDATED VEGETATION (2) STABLE WATER OR NO INUNDATED VEGETATION (3)DECLINE IN WATER LEVEL < 2 FT (4) DECLINE IN WATER LEVEL > 2 FT
10 ___ACCESS TO WATER >6 FT DEEP NOV-APR (1) YES (2) NO
11 ___PERCENT AREA WITH RIP RAP >12 IN.: (1) ABSENT (2)1-5% (3)5-20% (4)>20%
12 ___AVERAGE DEPTH OF AQUATIC HABITAT IN PROJECT AREA: (1)<1 FT. (2)1-3 FT (3)3-6 FT (4)>6 FT
13 ___AVERAGE VELOCITY DEC-FEB: (1)NO FLOW-OXYGEN NOT LIMITED (2)0-0.2 FT/SEC (3)>0.2 FT/SEC [PER SCHONHOFF/GALLEE]

MATRIX FISH 05-02-1991

FIGURE K-2 (Cont'd)

Wildlife Habitat Appraisal Guide Input and Output Data File for Upper Lake Existing Conditions Using "CNWRWET" Matrix

DATA FILE NAME cnwra00 MATRIX NAME CNWRWET
PROJECT NAME CHAUTAUQUA NWR- UPPER POOL

SAMPLE SITE NUMBER 1 HABITAT TYPE N

1 %NONFOR WETLND 2	19 SUBSTRATE-WATER 2	37 WOODLAND SIZE 0
2 %BHRDWDS&NFWET 2	20 % OPEN WATER 5	38 FOREST ADJ WATR 0
3 FALL-WINTR WATR 4	21 WINT WAT DEPTH 4	39 SNAGS/AC 0
4 FALL-WINTR FLD 5	22 SEDGE CAN COV 5	40 CAVITY TREE/AC 0
5 F-W WATER 18 5	23 WETLAND SUBSTRA 1	41 STEMS/SQ YD 0
6 WATER <4 IN 5	24 WATERLOG SUBSTR 1	42 WOOD W/IN 600 W 0
7 WAT 4-18 AUG 2	25 EXPOSED WET SUB 1	43 DIST NONFOR WET 0
8 PER WAT E YEAR 1	26 AQ VEG CHANNEL 0	44 DIST BOT HARDWS 7
9 %PER VEG 2YDS 4	27 WAT FLUCT CHANN 0	45 DIST CROPLAND 7
10 WOODY INVASION 1	28 CROPFIELD MGMT 0	46 DIST STREAM 1
11 EMER VEG COVER 6	29 CROPPING PRACT 0	47 % SUBMERG VEG 4
12 CAT BULR COVER 5	30 WOODL TREE SP 0	48 % EMERGENT VEG 2
13 WETLAND SIZE 1	31 PER WAT IN WOOD 0	49 % MOLLUSC BED 3
14 WETLAND EDGE 1	32 FOREST OPENINGS 0	50 %DEPTH 1.5-3 FT 4
15 WATER REGIME 1	33 WOOD SIZE CLASS 0	51 DISTURBANCE 1
16 FOOD PLNT COVER 5	34 OLD GROWTH 0	52 H2O LEVEL FLUX 3
17 PLANT DIVERSITY 3	35 OVERST CAN HT 0	53 0
18 PERST EM&WOODY 4	36 SUBCAN CLOSURE 0	54 0

SAMPLE SITE NUMBER 2 HABITAT TYPE B

1 %NONFOR WETLND 0	19 SUBSTRATE-WATER 0	37 WOODLAND SIZE 2
2 %BHRDWDS&NFWET 4	20 % OPEN WATER 0	38 FOREST ADJ WATR 2
3 FALL-WINTR WATR 4	21 WINT WAT DEPTH 0	39 SNAGS/AC 2
4 FALL-WINTR FLD 5	22 SEDGE CAN COV 0	40 CAVITY TREE/AC 3
5 F-W WATER 18 5	23 WETLAND SUBSTRA 0	41 STEMS/SQ YD 4
6 WATER <4 IN 0	24 WATERLOG SUBSTR 0	42 WOOD W/IN 600 W 3
7 WAT 4-18 AUG 0	25 EXPOSED WET SUB 0	43 DIST NONFOR WET 7
8 PER WAT E YEAR 0	26 AQ VEG CHANNEL 2	44 DIST BOT HARDWS 0
9 %PER VEG 2YDS 0	27 WAT FLUCT CHANN 4	45 DIST CROPLAND 7
10 WOODY INVASION 0	28 CROPFIELD MGMT 0	46 DIST STREAM 1
11 EMER VEG COVER 6	29 CROPPING PRACT 0	47 % SUBMERG VEG 0
12 CAT BULR COVER 0	30 WOODL TREE SP 1	48 % EMERGENT VEG 0
13 WETLAND SIZE 1	31 PER WAT IN WOOD 4	49 % MOLLUSC BED 0
14 WETLAND EDGE 1	32 FOREST OPENINGS 3	50 %DEPTH 1.5-3 FT 0
15 WATER REGIME 0	33 WOOD SIZE CLASS 2	51 DISTURBANCE 0
16 FOOD PLNT COVER 4	34 OLD GROWTH 1	52 H2O LEVEL FLUX 0
17 PLANT DIVERSITY 3	35 OVERST CAN HT 2	53 0
18 PERST EM&WOODY 0	36 SUBCAN CLOSURE 4	54 0

SAMPLE SITE NUMBER 3 HABITAT TYPE N

1 %NONFOR WETLND 3	19 SUBSTRATE-WATER 2	37 WOODLAND SIZE 0
2 %BHRDWDS&NFWET 4	20 % OPEN WATER 5	38 FOREST ADJ WATR 0
3 FALL-WINTR WATR 4	21 WINT WAT DEPTH 4	39 SNAGS/AC 0
4 FALL-WINTR FLD 5	22 SEDGE CAN COV 6	40 CAVITY TREE/AC 0
5 F-W WATER 18 5	23 WETLAND SUBSTRA 1	41 STEMS/SQ YD 0
6 WATER <4 IN 5	24 WATERLOG SUBSTR 1	42 WOOD W/IN 600 W 0
7 WAT 4-18 AUG 2	25 EXPOSED WET SUB 1	43 DIST NONFOR WET 0
8 PER WAT E YEAR 1	26 AQ VEG CHANNEL 0	44 DIST BOT HARDWS 7
9 %PER VEG 2YDS 4	27 WAT FLUCT CHANN 0	45 DIST CROPLAND 7
10 WOODY INVASION 1	28 CROPFIELD MGMT 0	46 DIST STREAM 1
11 EMER VEG COVER 6	29 CROPPING PRACT 0	47 % SUBMERG VEG 4

FIGURE K-3

16 FOOD PLNT COVER 5	34 OLD GROWTH 0	52 H2O LEVEL FLUX 3
17 PLANT DIVERSITY 3	35 OVERST CAN HT 0	53 0
18 PERST EM&WOODY 4	36 SUBCAN CLOSURE 0	54 0

SAMPLE SITE NUMBER 4 HABITAT TYPE B

1 %NONFOR WETLND 0	19 SUBSTRATE-WATER 0	37 WOODLAND SIZE 4
2 %BHRDWDS&NFWET 3	20 % OPEN WATER 0	38 FOREST ADJ WATR 1
3 FALL-WINTR WATR 4	21 WINT WAT DEPTH 0	39 SNAGS/AC 3
4 FALL-WINTR FLD 2	22 SEDGE CAN COV 0	40 CAVITY TREE/AC 3
5 F-W WATER 18 5	23 WETLAND SUBSTRA 0	41 STEMS/SQ YD 1
6 WATER <4 IN 0	24 WATERLOG SUBSTR 0	42 WOOD W/IN 600 W 1
7 WAT 4-18 AUG 0	25 EXPOSED WET SUB 0	43 DIST NONFOR WET 4
8 PER WAT E YEAR 0	26 AQ VEG CHANNEL 2	44 DIST BOT HARDWS 0
9 %PER VEG 2YDS 0	27 WAT FLUCT CHANN 4	45 DIST CROPLAND 7
10 WOODY INVASION 0	28 CROPFIELD MGMT 0	46 DIST STREAM 1
11 EMER VEG COVER 6	29 CROPPING PRACT 0	47 % SUBMERG VEG 0
12 CAT BULR COVER 0	30 WOODL TREE SP 1	48 % EMERGENT VEG 0
13 WETLAND SIZE 1	31 PER WAT IN WOOD 5	49 % MOLLUSC BED 0
14 WETLAND EDGE 1	32 FOREST OPENINGS 1	50 %DEPTH 1.5-3 FT 0
15 WATER REGIME 0	33 WOOD SIZE CLASS 3	51 DISTURBANCE 0
16 FOOD PLNT COVER 5	34 OLD GROWTH 2	52 H2O LEVEL FLUX 0
17 PLANT DIVERSITY 3	35 OVERST CAN HT 3	53 0
18 PERST EM&WOODY 0	36 SUBCAN CLOSURE 3	54 0

FIGURE K-3 (Cont'd)

MISSOURI DEPARTMENT OF CONSERVATION

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	DIVE	DIVING DUCKS	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERCIAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

PROJECT NAME CHAUTAUQUA NWR- UPPER POOL

MATRIX NAME CNWRWET A MATRIX THAT YOUR CREATED OR MODIFIED
DATA FILE NAME cnwra00

PLANNING CONDITION EXISTING

DATE FIELD WORK 3/2/1990
TODAYS DATE 04-09-1991

SAMPLE SITE HABITAT INDEXES

HAB	SITE	MALL	DIVE	BITT	YLEG	MUSK	RAIL
N	1	.28	.35	.59	.69	.15	.64
		HERO	DUCK	BEAV	COOT	PARU	PROT
		.68			.58		
HAB	SITE	MALL	DIVE	BITT	YLEG	MUSK	RAIL
B	2	.3					
		HERO	DUCK	BEAV	COOT	PARU	PROT
		.47	.54	.35		.5	.16
HAB	SITE	MALL	DIVE	BITT	YLEG	MUSK	RAIL
N	3	.24	.35	.56	.67	.14	.6
		HERO	DUCK	BEAV	COOT	PARU	PROT
		.64			.55		
HAB	SITE	MALL	DIVE	BITT	YLEG	MUSK	RAIL
B	4	.32					
		HERO	DUCK	BEAV	COOT	PARU	PROT
		.73	.63	.65		.6	.13

THIS DATA SET CONTAINS:
2 NONFOREST WETLAND SAMPLE SITES
2 BOTTOMLAND HARDWOODS-WETLAND SAMPLE SITES
0 CROPLAND-WETLAND SAMPLE SITES
0 GRASSLAND-WETLAND SAMPLE SITES

AVERAGE HABITAT INDEXES BY HABITAT TYPE

N	.26	.35	.57	.68	.15	.62	.66			.56		
B	.31						.6	.58	.5		.55	.14
C												

FIGURE K-3 (Cont'd)

b. Habitat evaluations were made based on average water level conditions expected to occur on the refuge over the next 50 years. We also assumed that the lower Lake Chautauqua levee would overtop annually and the upper lake levee would provide a 10-year level of protection.

c. We assumed that the current rate of sedimentation now occurring on the refuge would continue for the foreseeable future and that sediment related problems such as turbidity would not likely improve without intervention.

d. We assumed that without the project, Liverpool Channel would continue to maintain its present depth and configuration for the foreseeable future.

e. We assumed that without the project, Lake Chautauqua would eventually succeed toward an emergent wetland dominated by species such as *Saggitaria* sp., *Nelumbo* sp., and eventually to willow, silver maple, and cottonwood.

f. We assumed that areas cleared of bottomland hardwoods for construction purposes, would regenerate to a similar preconstruction species composition and that levees would be maintained as grassland.

In addition to the general assumptions described above, the following specific assumptions also were made with regard to each of the project alternatives.

a. Upper Lake - Water Control.

(1) We assumed that there is an adequate seed and plant bank available in the lake bottom (and through natural colonization) to establish submergent vegetation in the upper lake.

(2) We assumed that the lake would be dewatered once every 10 years to promote sediment consolidation.

(3) We assumed that the proposed management plan to gradually raise water levels after each drawdown would be implemented and then held stable until the next dewatering.

(4) It was assumed that continuing sedimentation would cause a gradual decline in mean water depth in the without-project condition. With the project, optimum levels/depths would be maintained except when levees were overtopped.

(5) It was predicted that the increased average water depth due to the project in the upper lake would not cause any significant impact to bottomland hardwoods in the Melz Slough area.

b. **Lower Lake - Water Control.**

(1) It was assumed that the water control structures and management plan for the upper lake is in place (i.e., the cross dike is repaired and the pump station is operable).

(2) It was assumed that sidecasting of material excavated from the drainage channel will cause negligible impacts and was, therefore, not accounted for in the WHAG.

(3) It was assumed that relocation of the lower lake water control structure to the southwest levee section would not result in any significant impacts to Quiver Lake.

(4) On the basis of historical accounts, it was determined that the lower lake has provided a marginal amount of moist soil plant production in past years.

(5) Based on the anticipated frequency of flooding, it was predicted that the moist soil plant production, and their availability to fall migrants, would only be successful 1 out of 2 years. This would be unlikely to improve until the perimeter levee is upgraded.

c. **Liverpool Side Channel Improvement.**

(1) It was assumed that the upper 2,200 feet of Liverpool Channel (from the cross dike upstream to its junction with the river) is part of the upper lake water control alternative and its costs and impacts are accounted for in that alternative's evaluation.

(2) It was assumed that the constructed channel would provide water depths greater than 4 feet up to year 30. After year 30, water depth is anticipated to gradually decrease until a 2-foot depth is reached at year 50.

(3) Based on fishery biologists opinions, it was assumed that construction of this alternative will benefit fish throughout the LaGrange navigation pool. The existing fish models, however, were unable to quantify pool-wide benefits.

(4) The entire 374 acres of Liverpool Island was included in the Liverpool side channel alternative evaluations.

(5) Liverpool Ditch was evaluated based on a present average water depth of 6 inches at flat pool elevations.

d. **Barrier Island Construction.**

(1) It was assumed that construction of three parallel barrier islands totaling 11,500 feet would provide a wind shadow effect on 300 acres of the upper lake.

(2) The barrier islands were evaluated without the upper lake water control alternative in place.

K-4. RESULTS AND DISCUSSION.

The WHAG analysis calculated Habitat Suitability Index (HSI) values for 12 species in the "nonforested" and "bottomland hardwoods" wetland habitats and for three fish species. The "cropland" and "grassland" habitats were not used in this analysis. An incremental analysis, using both HSI values and habitat acreage to calculate the Average Annual Habitat Units (AAHUs) was performed using only four wetland species in two habitats and three fish species. The other species, where only the HSI values were calculated, were used to evaluate impacts/benefits of the various alternatives on non-target species (i.e., muskrat, coot, lesser yellowlegs). Figures K-1 and K-2 represent the matrix models used in the WHAG incremental analysis evaluation. These models are modifications of the WHAG software package from Missouri. Figure K-3 illustrates 1 of 24 actual data output and input files from the WHAG program. It illustrates the HSI values of 12 species for existing habitat conditions in upper Lake Chautauqua for the wetland matrix. The other 23 files (not shown) contain the HSI values for other species, target years, and planning condition (alternative). The HSI species values of these 24 files were combined with the affected habitat acreages to generate the change in AAHUs over the 50-year project life. The net change in habitat value (for each target species only) is shown in figure K-4 for every analysis year and condition.

a. Alternative B1 (Upper Lake).

(1) Diving ducks were the primary target species in the upper lake. The existing HSI value for divers is 0.35 in year 0. Due primarily to sedimentation and irregular flooding, the HSI decreased to 0.27 in target year (TY) 50 without the project. With increased water level control and sediment consolidation, the HSI increased to 0.84 in TY 5 and gradually fell to 0.67 in TY 10 (with the project in place) and implementing the management plan. Following sediment consolidation in year 10, the HSI value again increased from 0.35 in year 11 to 0.84 in year 15. Five of these cycles were projected in the "with-project" condition. Over the 50-year project life on 1,000 acres, the AAHUs produced without the project was 310. With water control in place on the upper lake, the AAHUs produced was 731, or a 136 percent increase.

(2) Although dabbling ducks were not part of the specific objectives for the upper lake, any recommended plan must consider impacts to them. Mallards had an initial HSI value of 0.28 on the upper lake. Due to increased sedimentation and an anticipated marginal increase of moist soil vegetation, the HSI increased to 0.41 in TY 50 without the project. With the project in place and assuming a 0.53 HSI at the beginning of each 10-year cycle (based on 10-year dewatering interval), the HSI gradually

WHAG Analysis AAHU Spreadsheet Summary

CHAUTAUQUA NWR HREP- JUNE 1990

UPPER POOL

MALLARD

PLAN A - WITHOUT PROJECT

	TY 0		TY 1			TY 25			TY 50			
	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs
NONFOREST WETLAND	0.28	1000	0.28	1000	280	0.35	1000	7560	0.41	1000	9500	347
BOTTOMLAND HARDWOOD WETLAND	0.49	100	0.49	100	49	0.46	100	1140	0.43	100	1113	46
BOTTOMLAND HARDWOOD WETLAND- LEVEE	0.34	54	0.34	54	18	0.35	54	447	0.36	54	479	19

PLAN B - WATER LEVEL CONTROL

	TY 0		TY 1			TY 5			TY 10				
	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
NONFOREST WETLAND	0.28	1000	0.53	1000	405	0.61	1000	2280	0.53	1000	2850	554	60%
BOTTOMLAND HARDWOOD WETLAND	0.49	100	0.53	100	51	0.53	100	212	0.53	100	265	53	15%
BOTTOMLAND HARDWOOD WETLAND- LEVEE	0.34	33	0.34	33	11	0.34	33	45	0.34	33	56	11	-41%

PLAN C - BARRIER ISLANDS

	TY 0		TY 1			TY 10			TY 50				
	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
NONFOREST WETLAND	0.28	1000	0.28	1000	280	0.38	1000	2970	0.41	1000	15800	381	10%
BOTTOMLAND HARDWOOD WETLAND	0.49	100	0.44	100	47	0.44	100	396	0.38	100	1640	42	-10%
BOTTOMLAND HARDWOOD WETLAND- LEVEE	0.34	54	0.34	54	18	0.34	54	441	0.36	54	472	19	-1%

****

FIGURE K-4

CHAUTAUQUA NWR HREP- JUNE 1990
UPPER POOL

DIVING DUCKS

PLAN A - WITHOUT PROJECT

NONFOREST WETLAND

TY 0		TY 1			TY 25			TY 50				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.35	1000	0.35	1000	350	0.31	1000	7920	0.27	1000	7250	310	

PLAN B - WATER LEVEL CONTROL

NONFOREST WETLAND

TY 0		TY 1			TY 5			TY 10				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
0.35	1000	0.67	1000	510	0.84	1000	3020	0.67	1000	3775	731	135%

PLAN C - BARRIER ISLANDS

NONFOREST WETLAND

TY 0		TY 1			TY 10			TY 50				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
C.35	1000	0.35	1000	350	0.38	1000	3285	0.27	1000	13000	333	7%

****

CHAUTAUQUA NWR HREP- JUNE 1990
UPPER POOL
WOOD DUCK

PLAN A - WITHOUT PROJECT

TY 0		TY 1			TY 25			TY 50				
BOTTOMLAND HARDWOOD WETLAND												
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.54	100	0.54	100	54	0.54	100	1296	0.53	100	1338	54	
BOTTOMLAND HARDWOOD WETLAND- LEVEE												
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.65	54	0.65	54	35	0.63	54	829	0.62	54	844	34	

PLAN B - WATER LEVEL CONTROL

TY 0		TY 1			TY 5			TY 10				
BOTTOMLAND HARDWOOD WETLAND												
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
0.54	100	0.61	100	58	0.61	100	244	0.61	100	305	61	13%
BOTTOMLAND HARDWOOD WETLAND- LEVEE												
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.65	54	0.65	33	28	0.63	33	507	0.62	33	516	21	-38%

PLAN C - BARRIER ISLANDS

TY 0		TY 1			TY 10			TY 50				
BOTTOMLAND HARDWOOD WETLAND												
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
0.54	100	0.54	100	54	0.54	100	486	0.53	100	2140	54	0%
BOTTOMLAND HARDWOOD WETLAND- LEVEE												
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.65	54	0.65	54	35	0.63	54	829	0.62	54	844	34	0%

FIGURE K-4 (Cont'd)

****

CHAUTAUQUA NWR HREP- JUNE 1990
UPPER POOL
GREEN BACK HERON

PLAN A - WITHOUT PROJECT

	TY 0		TY 1			TY 25			TY 50			
	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs
NONFOREST WETLAND	0.68	1000	0.68	1000	680	0.71	1000	16680	0.74	1000	18125	710
BOTTOMLAND HARDWOOD WETLAND	0.68	100	0.68	100	68	0.71	100	1668	0.73	100	1800	71
BOTTOMLAND HARDWOOD WETLAND- LEVEE	0.75	54	0.75	54	41	0.71	54	946	0.67	54	932	38

PLAN B - WATER LEVEL CONTROL

	TY 0		TY 1			TY 5			TY 10				
	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
NONFOREST WETLAND	0.68	1000	0.68	1000	680	0.81	1000	2980	0.68	1000	3725	739	4%
BOTTOMLAND HARDWOOD WETLAND	0.68	100	0.74	100	71	0.74	100	296	0.74	100	370	74	4%
BOTTOMLAND HARDWOOD WETLAND- LEVEE	0.75	33	0.75	33	25	0.74	33	98	0.73	33	121	24	-36%

PLAN C - BARRIER ISLANDS

	TY 0		TY 1			TY 10			TY 50				
	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
NONFOREST WETLAND	0.68	1000	0.68	1000	680	0.85	1000	6885	0.74	1000	31800	787	11%
BOTTOMLAND HARDWOOD WETLAND	0.68	100	0.68	100	68	0.68	100	612	0.73	100	2820	70	-1%
BOTTOMLAND HARDWOOD WETLAND- LEVEE	0.75	54	0.73	54	40	0.73	54	946	0.67	54	945	39	1%

****

FIGURE K-4 (Cont'd)

FIGURE K-4 (Cont'd)

CHAUTAUQUA NWR HREP- JUNE 1990
LOWER LAKE
CHANNEL CATFISH

	TY 0 HSI	AREA	TY 1 HSI	AREA	ANNUAL HUs	TY 25 HSI	AREA	ANNUAL HUs	TY 50 HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
WITHOUT PROJECT	0.1	2250	0.1	2250	225	0.1	2250	5400	0.1	2250	5625	225	
WITH PROJECT	0.1	2250	0.1	2250	225	0.1	2250	5400	0.1	2250	5625	225	0%

****

WALLEYE

	TY 0 HSI	AREA	TY 1 HSI	AREA	ANNUAL HUs	TY 25 HSI	AREA	ANNUAL HUs	TY 50 HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
WITHOUT PROJECT	0.1	2250	0.1	2250	225	0.1	2250	5400	0.1	2250	5625	225	
WITH PROJECT	0.1	2250	0.1	2250	225	0.1	2250	5400	0.1	2250	5625	225	0%

****

LARGEMOUTH BASS

	TY 0 HSI	AREA	TY 1 HSI	AREA	ANNUAL HUs	TY 25 HSI	AREA	ANNUAL HUs	TY 50 HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
WITHOUT PROJECT	0.1	2250	0.1	2250	225	0.1	2250	5400	0.1	2250	5625	225	
WITH PROJECT	0.1	2250	0.1	2250	225	0.1	2250	900	0.1	2250	1125	225	0%

****

CHAUTAUQUA NWR HREP- JUNE 1990
LOWER POOL

MALLARD

	TY 0 HSI	AREA	TY 1 HSI	AREA	ANNUAL HUs	TY 25 HSI	AREA	ANNUAL HUs	TY 50 HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
PLAN A - WITHOUT PROJECT, NONFOREST WETLAND	0.24	2250	0.24	2250	540	0.3	2250	14580	0.37	2250	18844	679	
PLAN D - WATER LEVEL CONTROL, NONFOREST WETLAND	0.24	2250	0.67	2250	1024	0.67	2250	36180	0.67	2250	37688	1498	121%

****

CHAUTAUQUA NWR HREP- JUNE 1990
LOWER POOL
DIVING DUCKS

PLAN A - WITHOUT PROJECT

NONFOREST WETLAND

TY 0		TY 1			TY 25			TY 50				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.35	2250	0.35	2250	788	0.31	2250	17820	0.27	2250	16313	698	

PLAN D - WATER LEVEL CONTROL

NONFOREST WETLAND

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
0.35	2250	0.35	2250	788	0.35	2250	18900	0.35	2250	19688	788	13%

****

CHAUTAUQUA NWR HREP- JUNE 1990
LOWER POOL

GREEN BACK HERON

PLAN A - WITHOUT PROJECT

NONFOREST WETLAND

TY 0		TY 1			TY 25			TY 50				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.64	2250	0.64	2250	1440	0.67	2250	35370	0.69	2250	38250	1501	

PLAN D - WATER LEVEL CONTROL

NONFOREST WETLAND

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
0.64	2250	0.46	2250	1238	0.46	2250	24840	0.46	2250	25875	1039	-31%

****

CHAUTAUQUA NWR HREP- MARCH 1990
CATFISH

PLAN A- LIVERPOOL DITCH W/O PROJECT

TY 0		TY 1			TY 20			TY 50				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
0.1	6.6	0.1	6.6	1	0.1	6.6	13	0.10	6.6	20	1	

PLAN B- LIVERPOOL DITCH CLEANOUT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	6.6	0.52	11.6	3	0.61	11.6	157	0.10	11.6	103	5	514%

****

WALLEYE

PLAN A- LIVERPOOL DITCH W/O PROJECT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	6.6	0.1	6.6	1	0.1	6.6	13	0.10	6.6	20	1	

PLAN B- LIVERPOOL DITCH CLEANOUT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	6.6	0.61	11.6	3	0.54	11.6	160	0.10	11.6	93	5	500%

******

FIGURE K-4 (Cont'd)

LM BASS

PLAN A- LIVERPOOL DITCH W/O PROJECT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	6.6	0.1	6.6	1	0.1	6.6	13	0.10	6.6	20	1	

PLAN B- LIVERPOOL DITCH CLEANOUT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	6.6	0.49	11.6	3	0.72	11.6	168	0.10	11.6	119	6	5o9%

****

CHAUTAUQUA NWR HREP- JUNE 1990

LIVERPOOL DITCH

MALLARD

	TY 0		TY 1			TY 25			TY 50				
WITHOUT PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	CHANGE
	0.3	374	0.3	374	112	0.28	402	2699	0.25	402	2663	109	
WITH PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.3	374	0.32	359	114	0.33	387	2910	0.33	387	3193	124	14%

****

WOOD DUCK

	TY 0		TY 1			TY 25			TY 50				
WITHOUT PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.54	374	0.54	374	202	0.54	402	5028	0.53	402	5377	212	
WITH PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.54	374	0.51	359	192	0.63	387	5109	0.75	387	6676	240	13%

****

GREEN-BACKED HERON

	TY 0		TY 1			TY 25			TY 50				
WITHOUT PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.42	374	0.42	374	157	0.45	402	4052	0.48	402	4673	178	
WITH PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.42	374	0.75	359	214	0.77	387	6805	0.62	387	6724	275	55%

****

CHAUTAUQUA NWR HREP- JUNE 1990

UPPER LAKE

CHANNEL CATFISH

	TY 0		TY 1			TY 5			TY 10				
WITHOUT PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.1	1000	0.1	1000	100	0.1	1000	400	0.1	1000	500	100	
WITH PROJECT	HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
	0.1	1000	0.1	0	50	0.41	1000	613	0.1	1000	1275	194	48%

****

FIGURE K-4 (Cont'd)

WALLEYE

WITHOUT PROJECT

TY 0		TY 1			TY 5			TY 10				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	1100	0.1	1100	110	0.1	1100	440	0.1	1100	550	110	

WITH PROJECT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	1100	0.1	0	55	0.41	1100	675	0.1	1100	1403	213	48%

****

LARGEMOUTH BASS

WITHOUT PROJECT

TY 0		TY 1			TY 5			TY 10				
HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	1100	0.1	1100	110	0.1	1100	440	0.1	1100	550	110	

WITH PROJECT

HSI	AREA	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	HSI	AREA	ANNUAL HUs	AAHUs	
0.1	1100	0.1	0	55	0.57	1100	909	0.1	1100	1843	281	61%

****

FIGURE K-4 (Cont'd)

increased to 0.61 in year 5, 15, 25, 35, and 45. This resulted in an increased habitat value over 50 years from 412 AAHUs ("without project") to 618 AAHUs "with project." The primary benefit to dabbling ducks was predictable water levels which increased submergent vegetation.

(3) Implementation of water control caused a slight decrease in wood duck habitat, from 88 ("without project") to 82 ("with project") AAHUs. Refuge biologists believe wood duck habitat will actually improve because of additional aquatic vegetation. This is not reflected in the model, however, because only the project's effect on bottomland hardwoods is quantified. This was due to the unavoidable loss of bottomland forest on the levee from construction. The green-backed heron also showed a negligible 2 percent change.

(4) In addition to waterfowl, the upper lake also will provide a significant increase in aquatic benefits to fish. The HSI value of all three fish species (walleye, channel catfish, and largemouth bass) in the without condition was 0.1 from TY 0 through TY 50. With the project, HSI values gradually increased to 0.41, 0.41, and 0.57, respectively, by TY 5 and gradually declined to 0.1 by TY 10. The same 10-year cycle was repeated for the 50-year project life.

b. **Alternative B2 (Lower Lake).**

(1) Production of moist soil plants for dabbling ducks is the management objective in the lower lakes. The mallard duck was selected to represent all other dabblers except wood ducks. The existing HSI value for mallards on 2,250 acres of the lower lake is 0.24 without the project. That value increased to 0.37 in TY 50 ("without project"), primarily from an anticipated increase in emergent vegetation as the lake continues to fill with sediment. This resulted in an AAHU of 679. With the project in place, the HSI increased from 0.24 in TY 0 to 0.57 in TY 1 through TY 50 for an AAHU of 1498. This was a 121 percent increase.

(2) Diving ducks were relatively unaffected by the lower lake improvements, showing only a 13 percent increase from 698 to 788 AAHUs. The initial (TY 0) HSI of 0.35 declined to 0.27 in TY 50 due to increased emergent vegetation and shallow water depth. With the project, the HSI value remained at a constant 0.35 through TY 50.

\+ (3) The green-backed heron showed a 31 percent decline in AAHUs over a 50-year target life. Without the project, the HSI went from 0.64 to 0.69 over 50 years. This reflects the anticipated increase in woody and emergent vegetation around the lake and the lack of permanently flooded shallow marsh. With the project, the HSI decreased to 0.46 in TY 1 and remained there until TY 50.

(4) The lower lake water control improvement showed no change to fish species. In actuality, there may be an improvement via reduced fish kills. The new water control structure and drainage channels would allow fish egress from the lake as it is drawn down.

c. **Alternative C - Barrier Islands in Upper Lake.**

Values for mallards and diving ducks in the "without project" matched those in the upper lake (alternative B1). Fish were not evaluated after the preliminary WHAG evaluation showed only minimal benefits to waterfowl. Aside from the fact that the islands would provide a "wind shadow" on only 300 acres; the low HSI values are indirectly a result of the islands inability to ameliorate the major impacts of sedimentation (i.e., flocculent lake bottom).

d. **Alternative D - Liverpool Ditch.**

(1) The evaluation of the Liverpool Ditch excavation was based on 6.6 acres of available surface water. The TY 0 through TY 50 HSI value for all fish species was 0.1. The low HSI value was due primarily to the 6-inch average water depth at flat pool. At TY 1, HSI values increased to 0.52, 0.612, and 0.49, respectively, for catfish, walleye, and largemouth bass. These HSI values peaked in year 20 at 0.61, 0.54, and 0.72, respectively. From year TY 20 to TY 50, HSI values gradually decreased to 0.1 for all these species because of decreasing channel depth. The increase from 3 AAHUs (without project) to 16 (with project) is a deceptively low figure because the model does not account for benefits to fish from other pool locations that would use Liverpool Ditch in the winter. This "winter habitat" is a limiting factor that will increase the habitat value of "x" additional aquatic habitat acres in the pool. Until further studies are done that provide information on how far fish will travel to use this location, it is nearly impossible to come up with a reasonable acreage.

(2) Relatively insignificant benefits also were obtained for mallards (14 percent) and wood ducks (13 percent). The green-backed heron increased from 178 AAHUs to 275 AAHUs, or a 54 percent increase.

MECHANICAL AND ELECTRICAL CONSIDERATIONS

A P P E N D I X L

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-7F)

LAKE CHAUTAUQUA REHABILITATION AND ENHANCEMENT
LA GRANGE POOL, ILLINOIS WATERWAY, RIVER MILES 124-128
MASON COUNTY, ILLINOIS

APPENDIX L
MECHANICAL AND ELECTRICAL CONSIDERATIONS

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LAKE CHAUTAUQUA REHABILITATION AND ENHANCEMENT
LA GRANGE POOL, ILLINOIS WATERWAY, RIVER MILES 124-128
MASON COUNTY, ILLINOIS

APPENDIX L
MECHANICAL AND ELECTRICAL CONSIDERATIONS

L-1. PURPOSE AND SCOPE.

The purpose of this appendix is to present the preliminary design and selection of the pump for the pumping station for the Chautauqua Lake Refuge. Pump manufacturer's engineering information for standard catalog units was used to develop the design presented in the appendix. Pump sizing and layout are based on the efficient operation of the station and ease of normal maintenance.

Pump stations in this area will serve to control discharge and drainage of lands and waterways.

L-2. GENERAL.

A pump station containing one electric horizontal submersible propeller-type pump is proposed for the Chautauqua Lake Refuge. The pumping station will serve four functions: (1) discharging interior drainage from the upper lake; (2) discharging interior drainage from the lower lake; (3) discharging river water into the upper lake; and (4) discharging river water into the lower lake. The horizontal configuration was chosen for simplicity of design and less first cost. Electricity was chosen as the power source based on lower life cycle cost in comparison to a diesel generator operating a hydraulic pump. An electrical pump has a slightly higher initial investment ($200,000 versus $185,000); however, annual operation and maintenance costs are significantly less ($6,400 versus $10,600). In addition, the diesel unit will require an overhaul every 7 years. This results in a life cycle net present worth cost of $226,000 for the electrical unit versus $279,000 for the diesel unit. The pumping station will be located at the northern intersection of the control levee and the cross dike which separates the upper and lower lakes. The pumping station will be constructed integral with the levee section.

The pump unit is sized to complete the drawdown of the upper lake within approximately 30 days and the drawdown of the lower lake within 30 days. The pump will use automatic controls to draw down both lakes. Pumping from the river will be accomplished manually.

All necessary power and control equipment for the pump unit will be located outside of the pump station. Grating access hatches located on top of the station directly above the pump unit will be used for pump placement and removal. Hand cleanable trash racks will be provided at each conduit entrance for protection of the pump propeller against large debris. The pump discharge will have a 48-inch diameter flap gate to prevent backflow from the river. This gate will be propped open when pumping from the river. Dewatering of the sump for maintenance purposes will be accomplished after isolating the sump from the river and each lake by closing sluice gates at the sump entrances from the lower and upper lakes. The pump will be operated to its minimum water level. The remaining water will be removed with the use of a portable sump pump.

L-3. STATION FEATURES.

The pump station structure will consist of cast-in-place concrete sections. The station will be fed by approximately 50 feet of 5-foot by 5-foot reinforced concrete (R.C.) box culvert from the upper lake, and approximately 80 feet of 5-foot by 5-foot R.C. box culvert from the lower lake. The station discharge will be approximately 94 feet of 48-inch-diameter steel pipe. One 41,000 gpm electric horizontal submersible propeller-type pump with motor will be utilized. Access to the sump region will be by an embedded ladder through access hatches at the top of the pump station. System head computations and an example pump selection are shown on plates L-1 through L-8. The estimated annual energy costs are computed on plates L-9 and L-10. The life cycle cost analysis is shown on plates L-11 through L-14.

L-4. CONTROL SEQUENCE.

The pump unit will be completely manually operated, except for the automatic pump shutoff protection capability for low sump level conditions. Automatic pump shutoff will be accomplished with two redundant float switches located in a float control chamber. The float switch contacts will open (de-energizing the pump) at sump water level elevation 429.0 under normal conditions or elevation 426.5 when failure occurs at elevation 429.0. The selected setpoints maintain an adequate margin of protection for the pump and motor according to the minimum pump submergence requirement.

L-5. ELECTRICAL.

The pump station will be operated with one 125 hp electric motor pump. The pump will be controlled by an elevated pad-mounted motor control center (M.C.C.) on the site of the pump station. The pad elevation will be at elevation 455, approximately 6 feet above the top of the levee. Power will be provided by Menard Electric Cooperative which serves the local area. Power supply for the pump station will be tapped from 12.5 KV, 3-phase and cut down to 480 V, 3-phase, 60 Hz by a 150 KVA transformer. The utility company will own and maintain the primary transmission line through to the KW/Hr metering. Electrical analysis and short circuit analysis for the station are shown on plates L-15 through L-18.

Subject: CHAUTAUQUA PUMP STATION		Date: APRIL 91
Computed by: JWB	Checked by	Sheet 1 of

PUMP STATION SYSTEM LOSS CALCULATIONS

CONDITIONS

1. LOWEST DRAWDOWN OF UPPER AND LOWER LAKES EL. 429.0
2. FOR UPPER LAKE DEWATERING, USE 437.5 AS RIVER ELEVATION (RADIAL GATE SILL ELEV. AND 50 PERCENT JUNE ELEV. DURATION DURING A 10 YEAR FLOOD SEASON).
3. FOR LOWER LAKE DEWATERING, USE 435.0 RIVER ELEVATION. (APPROX. 10 PERCENT EXCEEDENCE PROBABILITY OF LOWEST MONTHLY JULY ELEVATIONS.
4. DIAMETER OF DISCHARGE = 48" STEEL
5. FLOW 41,000 GPM
7. INVERT @ SUMP - EL. 424.0
8. INVERT @ PUMP INLET - EL. 426.0
9. BOTTOM OF DISCHARGE TUBE @ PUMP EL. 427.0, @ DISCHARGE EL 427.5

SYSTEM LOSSES

1. TRASHRACK LOSSES
2. R.C. BOX CULVERT LOSS
3. DISCHARGE PIPE LOSSES WITH FLAP GATE
4. STATIC HEAD

1. TRASHRACK LOSS

VELOCITY TO TRASHRACK

$$V = 41{,}000\ GPM \times \frac{1\ min}{60\ s} \times \frac{1\ ft^3}{7.48\ GAL} \times \frac{1}{5\ ft} \times \frac{1}{5\ ft}$$

$$V = 3.65\ ft/s$$

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Subject CHAUTAUQUA PUMP STATION		Date APRIL 91
Computed by JWB	Checked by	Sheet 2 of

REF. "NEW CONCEPTS IN THE DESIGN OF PROPELLAR PUMPING STATIONS"
VINCENZO BIXIO CHAPTER 7

ASSUME RECTANGULAR BAR ASPECT RATIO = 5

a_0 = GAP OF BARS = 3"
S_1 = CENTER TO CENTER DIST. = 4"

$\frac{a_0}{S_1} = 0.75$ $K_1 = .24$ $\beta_1 = 2.34$ (FIG 7.3)

ASSUME ANGLE OF TRASHRACK = 60° = φ

$$h_{TR} = \Delta h = \frac{V^2}{2g} \beta_1 k_1 \sin \varphi$$

$$h_{TR} = \frac{(3.65)^2}{2(32.2)} (2.34)(.24) \sin 60$$

$$\boxed{h_{TR} = .10 \text{ ft}}$$ ✓

CHECK $Re = \frac{V_0 (a_0)}{\nu}$ V_0 = VELOCITY BETWEEN BARS

$$V_0 = \frac{41,000 \text{ gpm}}{60 (7.48)} \times \frac{1}{21.65 \text{ ft}^2} = 4.22 \text{ ft/s}$$

$$Re = \frac{(4.22)(3/12)}{1.06 \times 10^{-5}} = 9.95 \times 10^4 > 10^4$$ OK TO USE FIG 7.3

Subject		Date
CHAUTAUQUA PUMP STATION		APRIL 91
Computed by JWB	Checked by	Sheet 3 of

2. R.C. BOX CULVERT LOSS

USE EQUIVALENT DIAMETER $Dh = \frac{2h}{1+ar}$ ar = 1 FOR SQUARE DUCTS

$$Dh = \frac{2(5)}{2} = 5 \text{ ft}$$

Ref. "HANDBOOK OF HYDRAULICS" 6th ed BRATER & KING

$$V_{PIPE} = \frac{Q}{A} = \frac{(41{,}000\ GPM)\left(\frac{1}{7.48}\right)\left(\frac{1}{60}\right)}{\frac{\pi(5\text{ ft})^2}{4}}$$

$$V_{PIPE} = 4.65 \text{ ft/s}$$

$$V^2/2g = 0.336 \text{ ft}$$

$$V_{MAX} = \frac{0.59}{n} d^{2/3} s^{1/2} \quad (\text{EQ 6-26a}) \quad \text{WHERE } n = 0.016$$

$$S = \text{SLOPE} = 5/79 = .0633$$

$$V_{MAX} = \frac{0.59}{0.016} (5)^{2/3} (0.0633)^{1/2}$$

$$V_{MAX} = 27.13 \text{ ft/s}$$

$$h_{FRICTION} = \frac{2.87 n^2 \ell V^2}{d^{4/3}} \quad (\text{EQ 6-26c})$$

ℓ = PIPE LENGTH = 79 ft FROM LOWER LAKE

$$h_{FRICTION} = \frac{(2.87)(0.016)^2(79)(4.65 \text{ ft/s})^2}{(5)^{4/3}}$$

$$\boxed{h_{FRICTION} = .147 \text{ ft}}$$ ✓

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Subject		Date
CHAUTAUQUA PUMP STATION		APRIL 91
Computed by JWB	Checked by	Sheet 4 of

DISCHARGE AND ENTRANCE LOSSES

$$h_{DISCHARGE} = 0.01705\,(V_1 - V_2)^{1.919} \qquad V_2 = 0 \qquad (\text{Eq } 6\text{-}33)$$

$$h_D = .01705\,(4.65)^{1.919}$$

$$\boxed{h_D = .326 \text{ ft}} \checkmark$$

$$h_{ENTRANCE} = K_1 \frac{V^2}{2g} \qquad (\text{Eq } 6\text{-}31) \qquad \text{USE } K_1 = 0.5$$

$$h_{ENT} = 0.5\,\frac{(4.65)^2}{2(32.2)}$$

$$\boxed{h_{ENT} = .168 \text{ ft}} \checkmark$$

$$h_{BOX\ CULVERT} = h_{FRICTION} + h_{DISCHARGE} + h_{ENTRANCE}$$

$$= .147 + .326 + .168$$

$$\boxed{h_{B.C.} = .641 \text{ ft}} \checkmark$$

3. DISCHARGE PIPE LOSS WITH FLAP GATE

USE HAZEN-WILLIAMS FORMULA — HANDBOOK FOR CIVIL ENGINEERS 3rd ED MERRITT PG 21-24

$$h_f = \frac{4.727}{D^{4.87}}\, L \left(\frac{Q}{C_1}\right)^{1.85}$$

WHERE Q = FLOW ft^3/s

D = PIPE DIA. ft

C_1 = SURFACE ROUGHNESS COEFFICIENT

USE 115

Subject		Date
CHAUTAUQUA PUMP STATION		APRIL 91
Computed by JWB	Checked by	Sheet 5 of

$$h_f = \frac{4.727}{(4)^{4.87}}\, 94 \left(\frac{91.35}{115}\right)^{1.85}$$

$$\boxed{h_f = .339\ ft}$$ ✓

INCREASER LOSS   REF. EM 1110-2-3105
"MECH./ELEC. DESIGN OF PUMPING STATIONS"

$$h_I = K\left[\left(\frac{D_2}{D_1}\right)^2 - 1\right]^2 \frac{V_2^2}{2g}$$ $K = .26$ CHART E-4

$$V_2 = \frac{41{,}000}{(60)(7.48)} \times \frac{1}{\frac{\pi(4)^2}{4}} = 7.27\ ft/s$$

$$h_I = .26\left[\left(\frac{4}{3}\right)^2 - 1\right]^2 \frac{(7.27)^2}{2(32.2)}$$

$$\boxed{h_I = 0.166\ ft}$$ 0.129

[illegible] GATE LOSS   [illegible] HYDRAULIC [illegible]
[illegible] PG. [illegible]

$$h_L = K\frac{V^2}{2g}$$ $V = 7.27\ ft/s$

$K = .14$

$$h_L = 0.14\left(\frac{(7.27)^2}{2(32.2)}\right)$$ $$\boxed{h_L = 0.115\ ft}$$ ✓

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Subject: CHAUTAUQUA PUMP STATION		Date: APRIL 91
Computed by: JWB	Checked by	Sheet 6 of

$h_{DISCHARGE} = h_{FRICTION} + h_{INCREASER} + h_{FLAP\ GATE}$

$= .339 + 0.166 + 0.115$

$\boxed{h_{DISCHARGE} = .62\ ft}$ 0.583

4. STATIC HEAD 435.0 - 429.0 USE LOWER LAKE DEWATERING AS CRITICAL OPERATION.

$\boxed{h_{STATIC} = 6.\ ft}$ ✓

$TDH = h_{TRASHRACK} + h_{BOX\ CULVERT} + h_{DISCHARGE} + h_{STATIC}$

$= 0.10 + .641 + .62 + 6.0$

$\boxed{TDH = 7.36 ft}$ ✓

PUMP SELECTION

11 ; W SUBMERSIBLE HORIZONTAL PROPELLER PUMP
MODEL [illegible] 125 HP, 434 RPM, 36" PROPELLER DIA.
70% EFFICIENCY

$Req'd\ HP = \frac{GPM \times TDH}{3960 \times E_P} = \frac{41{,}000 \times 7.3}{3960 \times .70}$

$Req'd\ Hp = 108\ HP < 125$ OK ✓

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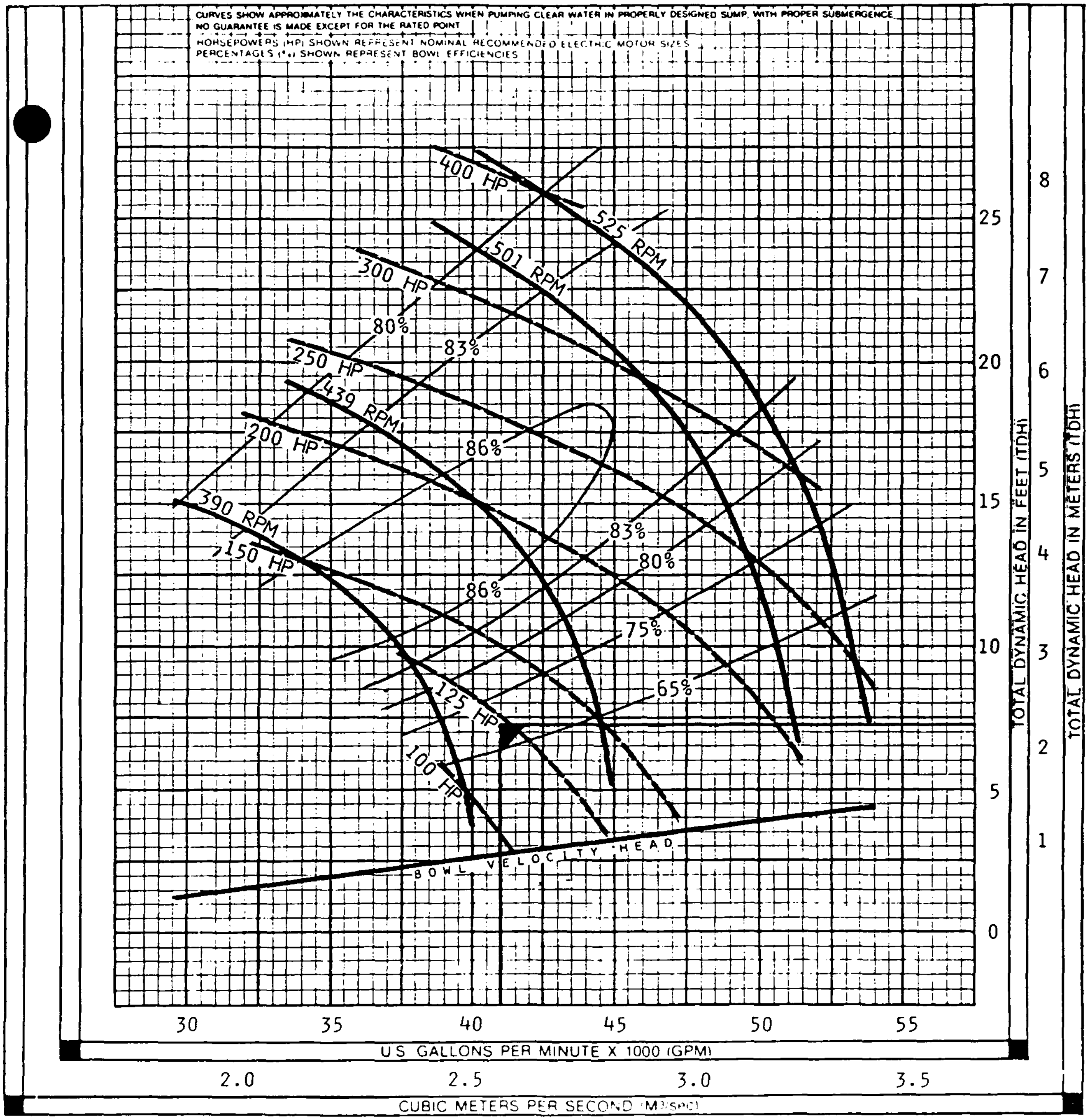
AXIAL FLOW 36"

C162



M&W PUMP-CORP.
DEERFIELD BEACH, FLORIDA 33441 U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE
VARIABLE SPEED

TYPE: AXIAL FLOW	PROPELLER DIA.: 36"
MODEL NO.: NC336P37	SPEED (RPM): AS NOTED
INTAKE DIA.: 54"	DISCHARGE COLUMN DIA.: 36"
CURVE NO.: VS36P37	Ns: 11,600 CODE: 50

SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY $\boxed{2.0}$ AND EFFICIENCY BY $\boxed{1.0}$

PERFORMANCE BASED ON PUMPING CLEAR COLD NON AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE

M&W PUMP CORPORATION
CERTIFIED BY
Available Upon Request

M&W PUMP CORPORATION
Deerfield Beach, Florida

All rights reserved. M&W PUMP CORPORATION 1985

PLATE L-7

Subject CHAUTAUQUA PUMP STATION		Date APR. 91
Computed by JWB	Checked by	Sheet 7 of

CHECK SPECIFIC SPEED

✓ Ns = 11,600 < ~19,000 OK REF. HYDRAULICS INSTITUTE STANDARDS

SUBMERGENCE REQUIREMENT

PER MANUFACTURER 65" FROM BOTTOM OF SUMP - DEPTH TO START PUMP

ACTUAL SUBMERGENCE = MIN. SUMP WATER ELEV. − ELEV. OF BOTTOM OF SUMP

prime req'd only req @ start

= 435.0 − 424.0 = 11.0 ft O.K.

MIN. LEVEL FOR PUMP SHUTOFF IS 32" FROM BOTTOM OF SUMP.

ACTUAL LEVEL 429.0 − 424.0 = 5.0 ft O.K.

Subject: CHAUTAUQUA PUMP STATION		Date: APRIL 1991
Computed by	Checked by	Sheet 8 of

YEARLY OPERATING BREAKDOWN

ELECTRIC

$$\frac{125\ HP}{1.341\ HP/KW} = 93.2\ KW = D$$

USE 30 DAYS PUMPING PER YEAR WHICH IS ONE BILLING PERIOD

KWH = 93.2 X 30 DAYS X 24 = 67,104 KWH/YR OR ONE BILLING PERIOD

COST

= (93.2 X 11.50) + (9300 X .068) + (9300 X .055) + (48,504 X .046) + 50.00

= \$4497.00 FOR ONE MONTH

YEARLY TOTAL = 4497 + (50 X 11) SERVICE CHARGE

YEARLY TOTAL = \$5047

DIESEL

10[illegible] ÷ .85 ([illegible]) ÷ .95 ([illegible]) ÷ .85 ([illegible])

= 157.3 HP

FUEL USAGE APPROXIMATELY 9 GPH

TOTAL NO. OF GALLONS = 9 X 30 X 24 = 6480 GALLONS/month

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Subject		Date
CHAUTAUQUA PUMP STATION		APRIL 83
Computed by JWB	Checked by	Sheet 9 of

ASSUMING $1.25/GAL DIESEL FUEL COST

YEARLY OPERATING COST = 6480 X 1.25

<u>YEARLY OPERATING COST = $ 8,100.00</u> ✓

SEE LIFE CYCLE COST ANALYSIS FOR COMPARISON BETWEEN THE TWO POWER SOURCES.

LIFE CYCLE COST ANALYSIS STUDY: XY

LCCID 1.035 DATE/TIME: 02-28-91 08:54:07

PROJECT NO., FY, & TITLE: LAKE CHAUTAUQUA FY 1991 PUMP STATION

INSTALLATION & LOCATION: EMP ILLINOIS

DESIGN FEATURE: ELECTRIC OR HYDRAULIC PUMP

ALT. ID. A; TITLE: ELECTRIC PUMP

NAME OF DESIGNER: JWB

BASIC INPUT DATA SUMMARY

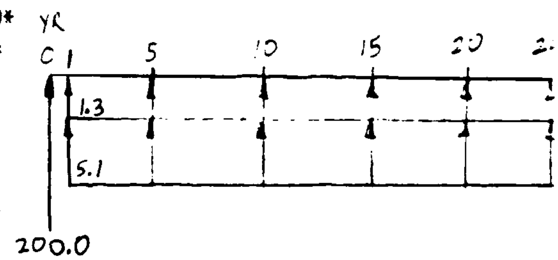
CRITERIA REFERENCE: OMB A-94 (OMB Circular A-94, 1972)

DISCOUNT RATE: 10%

KEY PROJECT-CALENDAR & ANALYSIS-TIMING-FRAMEWORK INFORMATION

KEY PROJECT CALENDAR INFORMATION (DATES PER ACTUAL PROJECTIONS)		ANALYSIS-TIMING-FRAMEWORK INFORMATION (DATES ASSUMED FOR ANALYSIS)	
DATE OF STUDY (DOS)	FEB 91	ANALYSIS BASE (ABD)	FEB 91
MIDPOINT CONSTRUCTION (MPC)	JUN 92	MIDPOINT CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY (BOD)	DEC 92	BENEFICIAL OCCUPANCY (BOD)	DEC 92
END OF FACILITY LIFE (FLED)	DEC 17	ANALYSIS END (AED)	DEC 17

TYPE OF COST/BENEFIT		COST	EQUIVALENT UNIFORM	TIME(S) COST INCURRED*	
COST CODE	COST / BENEFIT DESCRIPTION	IN ABD $ ($ X 10**3)	DIFFERENTIAL ESCALATION RATE (% PER YEAR)	ACTUAL PROJECTED PAYMENT DATES	PAYMENT DATES FOR ANALYSIS
II	INVESTMENT	200.0	.00	JUN 92	JUN 92
EN	ELECTRICITY	5.1	******	JUN93-JUN17	JUN93-JUN17
EN	ELECT DEMAND	.0	******	JUN93-JUN17	JUN93-JUN17
MR	O&M	1.3	.00	JUN93-JUN17	JUN93-JUN17



OTHER KEY INPUT DATA

LOCATION - ILLINOIS CENSUS REGION: 2

RATES FOR COMMERCIAL SECTOR.

ENERGY USAGE: 10**3 BTUS ELECTRIC DEMAND: 10**3 DOLLARS

ENERGY TYPE	$ / MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	22.09	229216.0	.0	DEC92-DEC17

PLATE L-11

LIFE CYCLE COST ANALYSIS STUDY: XX

LCCID 1.035 DATE/TIME: 02-28-91 08:54:07

PROJECT NO., FY, & TITLE: LAKE CHAUTAUQUA FY 1991 PUMP STATION

INSTALLATION & LOCATION: EMP ILLINOIS

DESIGN FEATURE: ELECTRIC OR HYDRAULIC PUMP

ALT. ID. A; TITLE: ELECTRIC PUMP

NAME OF DESIGNER: JWB

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		176.
ENERGY COSTS:		
ELECTRICITY	40.	
TOTAL ENERGY COSTS		40.
RECURRING M&R/CUSTODIAL COSTS		10.
MAJOR REPAIR/REPLACEMENT COSTS		0.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		226.

*NET PW EQUIVALENTS ON FEB91; IN 10**3 DOLLARS; IN CONSTANT FEB91 DOLLARS

PLATE L-12

LIFE CYCLE COST ANALYSIS

LCCID 1.035 DATE/TIME:
PROJECT NO., FY, & TITLE: LAKE CHAUTAUQUA FY 1991 PUMP
INSTALLATION & LOCATION: EMP ILLINOIS
DESIGN FEATURE: ELECTRIC OR HYDRAULIC PUMP
ALT. ID. B; TITLE: HYDRAULIC PUMP
NAME OF DESIGNER: JWB

BASIC INPUT DATA SUMMARY

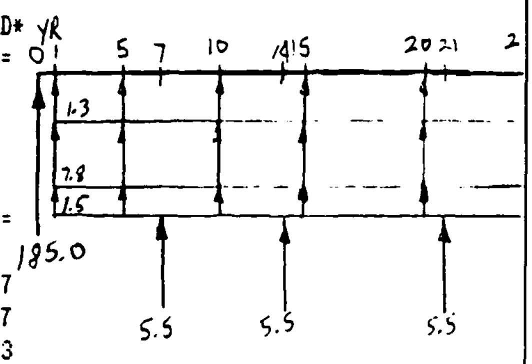
CRITERIA REFERENCE: OMB A-94 (OMB Circular A-94, 1972)

DISCOUNT RATE: 10%

KEY PROJECT-CALENDAR & ANALYSIS-TIMING-FRAMEWORK INFORMATION

KEY PROJECT CALENDAR INFORMATION (DATES PER ACTUAL PROJECTIONS)		ANALYSIS-TIMING-FRAMEWORK INFORMATI (DATES ASSUMED FOR ANALYSIS)	
DATE OF STUDY (DOS)	FEB 91	ANALYSIS BASE (ABD)	FEB 91
MIDPOINT CONSTRUCTION (MPC)	JUN 92	MIDPOINT CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY (BOD)	DEC 92	BENEFICIAL OCCUPANCY (BOD)	DEC 92
END OF FACILITY LIFE (FLED)	DEC 17	ANALYSIS END (AED)	DEC 17

TYPE OF COST/BENEFIT		COST	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE	TIME(S) COST INCURRED*	
COST CODE	COST / BENEFIT DESCRIPTION	IN ABD $ ($ X 10**3)	(% PER YEAR)	ACTUAL PROJECTED PAYMENT DATES	PAYMENT DATES FOR ANALYSIS
II	INVESTMENT	185.0	.00	JUN 92	JUN 92
EN	DISTILLATE OIL	7.8	******	JUN93-JUN17	JUN93-JUN17
MR	ANNUAL MAINTENANCE	1.3	.00	JUN93-JUN17	JUN93-JUN17
RR	OVERHAUL	5.5	******	DEC99-DEC13	DEC99-DEC13
OT	OPERATION	1.5	.00	JUN93-JUN17	JUN93-JUN17



OTHER KEY INPUT DATA

LOCATION - ILLINOIS CENSUS REGION: 2
RATES FOR COMMERCIAL SECTOR.

ENERGY USAGE: 10**3 BTUS ELECTRIC DEMAND: 10**3 DOLLARS

ENERGY TYPE	$ / MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	7.72	1014768.0		DEC92-DEC17

PLATE L-13

LIFE CYCLE COST ANALYSIS   STUDY: XX
LCCID 1.035   DATE/TIME: 02-28-91 08:54:07
PROJECT NO., FY, & TITLE: LAKE CHAUTAUQUA   FY 1991   PUMP STATION
INSTALLATION & LOCATION: EMP   ILLINOIS
DESIGN FEATURE: ELECTRIC OR HYDRAULIC PUMP
ALT. ID. B;   TITLE: HYDRAULIC PUMP
NAME OF DESIGNER: JWB

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		163.
ENERGY COSTS:		
DISTILLATE OIL	89.	
TOTAL ENERGY COSTS		89.
RECURRING M&R/CUSTODIAL COSTS		10.
MAJOR REPAIR/REPLACEMENT COSTS		4.
OTHER O&M COSTS & MONETARY BENEFITS		12.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		279.

*NET PW EQUIVALENTS ON FEB91; IN 10**3 DOLLARS; IN CONSTANT FEB91 DOLLARS

PLATE L-14

Subject CHAUTAUQUA PUMP STATION		Date
Computed by TU DOAN	Checked by	Sheet 3 of

LOAD STUDY.

Pump STATION HAS ONE M.C.C WATER PROOF TYPE. TO CONTROL ONE 125 Hp Submerge pump. And TWO sluice gates operate operators. Both operators will be operated by A GENERATOR set. Pump station has a power supply by 150 KVA 3 ϕ TR 12.5KV – 480 V. TRANSFORMER.

Ampacity require to run 125Hp Motor in Full load.

$$I_F = \frac{125 \times 746}{480 \times \sqrt{3} \times .80 \times .9} = 155.9 \text{ Amp}.$$

FROM NEC I_F = 156 Amp. pick 156 Amp.

Size of conductors.

$$I_c = 156 \times 1.25 = 195 \text{ Amp}.$$

FROM TABLE 310-16 - pick # 4/0 AWG COPPER 75°C Cable.

Check volt drop. Assume 100 ft FROM MCC TO Motor.

$$\% V_d = \frac{\sqrt{3} \times 156 \times 100 \times .063}{1000 \times 480} \times 100 = .34\% \text{ ok}.$$

Fuse protection (Dual Element Time delay Fuse).

$$F_A = 156 A \times 1.50 = 234 \text{ Amp}.$$ pick 225 Amp. DUAL Element Fuses.

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Subject		Date
Computed by	Checked by	Sheet 4 of

GENERAL LOAD. 2 - 20AMP Receptacle - Twist Lock Type.

$$I_F = \frac{1000 \times 2}{120} = 16.6 \text{ Amp}$$

use #12 AWG FOR Receptacle cable.

SHORT protect. $16.6 \times 1.25 = 20.8$ pick 20Amp.

~~constant~~ INVERSE Time Breaker.

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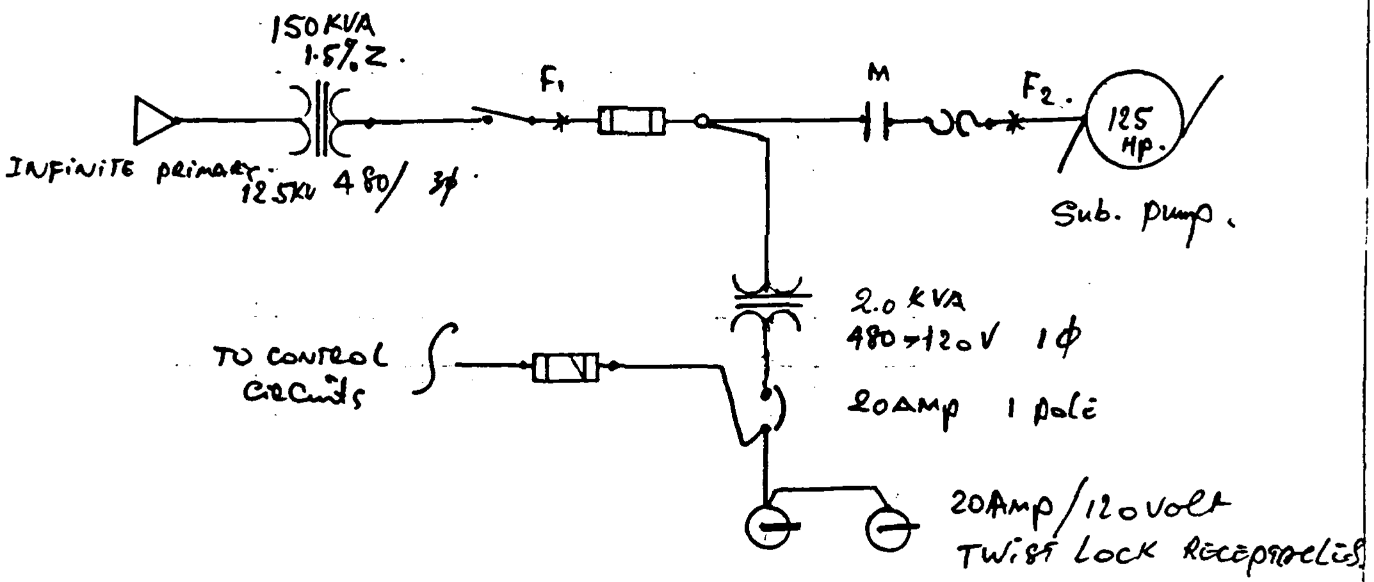
Subject		Date
CHAUTAUQUA PUMP STATION		
Computed by TUDOAN	Checked by fu	Sheet 5 of

FAULT STUDY.



FULL LOAD CURRENT IN SECONDARY.

$$I_F \quad \frac{150 \times 1000}{480 \times \sqrt{3}} = 180.6 \text{ AMP.}$$

1st MULTIPLIER FACTOR # = $100/1.5$ = 67.

FAULT current AT F_1 =

$$ISF_1 = 180.6 \times 67 = 12,060 \text{ AMP.}$$

MUTIPLIER FACTOR 2 :

$$\frac{\sqrt{3} \times 100 \times 12,060}{480 \times 13514} = 0.32.$$

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PLATE L-17

Subject		Date
Computed by	Checked by	Sheet 6 of

2nd multiplier factor $1/1+.32 = .76$.

Short ~~Cuto~~ circuit AT F2.

$I_{SF_2} = 12060\text{ A} \times .76 = 9165.6$ Amp.

ASYM. of MOTOR CONTRIBUTION

$$\frac{125\text{HP} \times 746}{480 \times .85 \, .90} \times 5 = 780 \text{ Amp}.$$

Ampacity AT FAULT F_2.

9165.6 + 780 Amp = 9,945 Amp IRMS.

AT FAULT F_1

12060 + 780 Amp = 12840 Amp IRMS.

- SO. All ELECTRICAL EQUIPMENTS SHALL BE Rate.

14.000 RMS Amp. Minimum.