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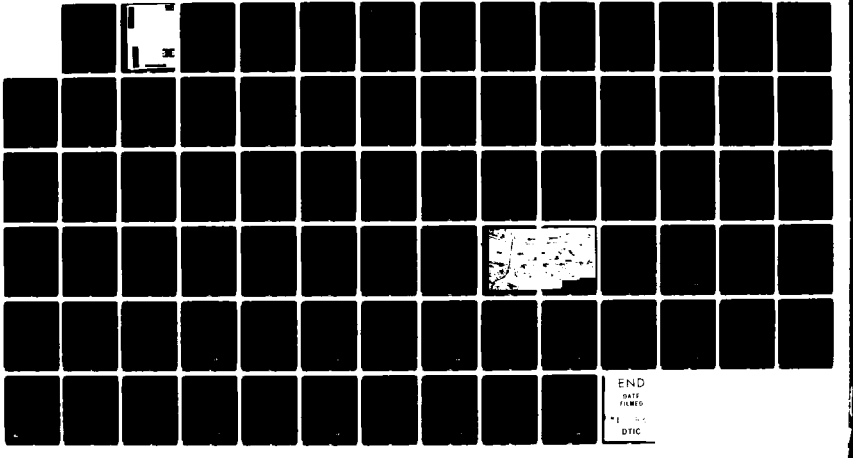

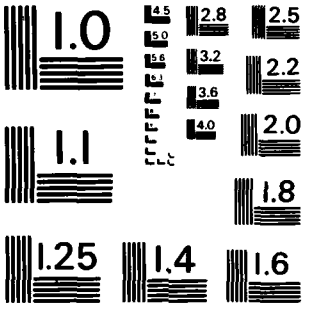

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LOCKS (WATERWAYS)
INLAND WATERWAYS
MISSISSIPPI RIVER

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

It is recommended that both the landward lock, the riverward lock and the dam at Lock & Dam no. 1, Minneapolis, Minnesota be completely rehabilitated. Based on studies completed to the date of this report, more detailed studies are required to firmly establish cost estimates, environmental effects, and the construction scheduling necessary to insure the work can be completed in the proposed two year construction period without delaying navigation.

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DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT. CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL. MINNESOTA 55101

IN REPLY REFER TO
NCSED-D

28 October 1976

SUBJECT: Rehabilitation of Lock and Dam No. 1, Mississippi River, Minneapolis, Minnesota: General Design Memorandum, Phase A Report - Study of Alternatives for Rehabilitation

Division Engineer, North Central

1. Study design memorandum is submitted in accordance with Engineer Regulation No. 1110-2-1150.

2. This design memorandum presents the Study of Alternatives for Rehabilitation of Lock and Dam No. 1. The St. Paul District has contracted with Harza Engineering Company from Chicago for the preparation of a two-phase design memorandum. Phase A consists of a formulation study to determine the extent of rehabilitation necessary, time needed for construction of rehabilitation, and the estimated cost. Rehabilitation is defined as any work necessary to extend the life of the structures for 40 years without increasing the depth, width or length of the locks.

3. A hydraulic model is currently being constructed at WES for the purpose of testing modifications to the filling and emptying system as recommended in this report. Testing began in October 1976. Preliminary results on which to base major engineering decisions will be available in April 1977.

4. A contract was negotiated in June 1976 with Harza Engineering Company to prepare a Phase B Design Memorandum studying in detail the recommended plan for rehabilitation of both locks. Portions of the study not dependent on the model study results will be studied initially. Portions of the work dependent on model study results will be prepared in detail after model study results are available.

5. An environmental impact statement or assessment for the rehabilitation of Lock and Dam No. 1 will be prepared during the more detailed Phase B design studies. Normal maintenance procedures for locks are described in the final Environmental Impact Statement for the operation and maintenance of the Upper Mississippi River 9-foot navigation channel. The rehabilitation of Lock and Dam No. 1 is more extensive than normal maintenance procedures and, therefore, requires further study. The additional

NCSED-D 28 October 1976

SUBJECT: Rehabilitation of Lock and Dam No. 1, Mississippi River, Minneapolis, Minnesota: General Design Memorandum, Phase A Report - Study of Alternatives for Rehabilitation

information that would be obtained during Phase B would involve the study of alternatives and impacts, and analysis of existing conditions. These studies are required for the preparation of the environmental document.

6. Excerpts from the Phase A report will be incorporated into a brochure for distribution to all interested parties attending public coordination meetings to be held in the first quarter of fiscal year 1977. Minutes of the public meetings will be incorporated in the Phase B Design Memorandum.

Forrest T. Gay III

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

2 Incl
1. Vols I-IV (16 cys)
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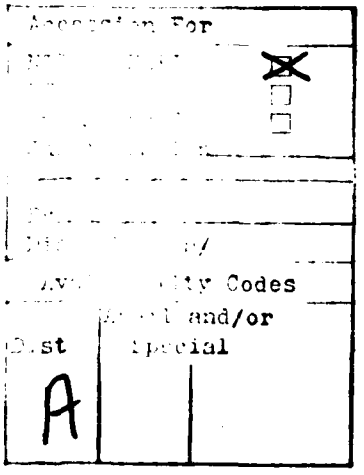

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1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

IN REPLY REFER TO

NCSED-D

21 June, 1976

SUBJECT: Rehabilitation of Lock and Dam No. 1, Mississippi River, Minneapolis, Minnesota: General Design Memorandum, Phase A Report - Study of Alternatives for Rehabilitation

Division Engineer, North Central

1. Study design memorandum is submitted in accordance with Engineer Regulation No. 1110-2-1150.

2. This design memorandum presents the Study of Alternatives for Rehabilitation of Lock and Dam No. 1. The St. Paul District has contracted with Harza Engineering Company from Chicago for the preparation of a 2-phase design memorandum. Phase A consists of a study to determine the extent of rehabilitation necessary, time needed for construction of rehabilitation, and the estimated cost. Rehabilitation is defined as any work necessary to extend the life of the structures for 40 years without increasing the depth, width or length of the locks.

3. A hydraulic model is currently being constructed at WES for the purpose of testing modifications to the filling and emptying system as recommended in this report. Testing will begin in October 1976. Preliminary results on which to base major engineering decisions will be available in April 1977.

4. A contract will be negotiated in June 1976 with Harza Engineering Company to prepare a Phase B Design Memorandum studying in detail the recommended plan for rehabilitation of both locks. Portions of the study not dependent on the model study results will be studied initially. Portions of the work dependent on model study results will be prepared in detail after model study results are available.

5. An environmental impact statement or assessment for the rehabilitation of Lock and Dam No. 1 will be prepared during the more detailed Phase B design studies. Normal maintenance procedures for Locks are described in the final Environmental Impact Statement for the Operation and Maintenance of the Upper Mississippi River 9-Foot Navigation Channel. The rehabilitation of Lock and Dam No. 1 is more extensive than normal maintenance procedures and, therefore, requires further study.

NCSED-D 21 June, 1976

SUBJECT: Rehabilitation of Lock and Dam No. 1, Mississippi River, Minneapolis, Minnesota: General Design Memorandum, Phase A Report - Study of Alternatives for Rehabilitation

The additional information that would be obtained during Phase B would involve the study of alternatives and impacts and analysis of existing conditions. These studies are required for the preparation of the environmental document.

6. Excerpts from the Phase A Report will be incorporated into a brochure for distribution to all interested parties attending public coordination meetings to be held in the fifth quarter of fiscal year 1976. Minutes of the public meetings will be be incorporated in the Phase B Design Memorandum.

1 Incl in 4 volumes (16 cys)

FORREST T. GAY, III
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DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

MISSISSIPPI RIVER

STUDY OF ALTERNATIVES FOR REHABILITATION OF LOCK AND DAM NO. 1

MINNEAPOLIS, MINNESOTA

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DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

MISSISSIPPI RIVER

STUDY OF ALTERNATIVES FOR REHABILITATION OF LOCK AND DAM NO. 1

MINNEAPOLIS, MINNESOTA

PERTINENT DATA

Authority

River and Harbor Act of 1884, as amended.

Location

Lock and Dam No. 1 is located in the St. Paul-Minneapolis reach of the Mississippi River at mile 847.6 (above the Ohio River).

Pool Elevations

Based on observation period 1951 through 1972.

	Maximum	Normal	Minimum
Upper pool (feet)	734.7	725.1	722.6
Lower pool (feet)	719	687.2	686.2

Lock Data

	Landward	Riverward
Width (feet)	56	56
Length (feet)	400	400
Upstream sill elevation (feet)	709.7	709.7
Downstream sill elevation (feet)	677.2	679.7

Lock Walls

	Land Wall	Intermediate Wall	River Wall New	River Wall Old
Length (feet)	531.5	531.5	598	475
Maximum width (feet)	30	35	32	28
Height (feet)	59.5	57	57	55.5
Number of monoliths	18	19	21	-
Top elevation (feet)	732.7	732.7	732.7	735.4

Guide Walls

	Upper	Lower
Concrete Gravity		
Length (feet)	210	64
Maximum width (feet)	14	18
Height (feet)	27	35.5
Number of Monoliths	7	2
Top elevation (feet)	732.7	709.7
Concrete Gravity on Timber Cribs		
Length (feet)	190	336
Maximum width (feet)	18	20
Height (feet)	26	34
Number of Monoliths	6	11
Top elevation (feet)	732.7	709.7

Filling and Emptying Conduits

Number	4
Invert elevation	
Entrance	708.7 feet
Exit	681.2 feet
Size	
Rectangular	8 x 10 feet
Circular, diameter	9.5 feet

Dam

Type	Concrete hollow Ambursen
Length	574 feet
Width	61 feet
Height	32.5 feet
Crest elevation	723.1 feet
Number of monoliths	36
Number of sluiceways	8
Invert elevation in sluiceways	
Entrance	697.1 feet
Exit	693.35 feet
Size of gate opening	6 x 6 feet
Top of flashboard elevation	725.1 feet

DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

SUBJECT: Study of Alternatives for Rehabilitation of Lock and Dam No. 1 on Mississippi River at Minneapolis, Minnesota

TO: Division Engineer
North Central Division
Chicago, Illinois 60605

AUTHORIZATION

1. Authority to prepare a report of general design memorandum scope was granted by office, Chief of Engineers, in 2nd Indorsement, ENGCW-OM, 5 December 1963, subject: Replacement Program, Mississippi River Lock and Dam No. 1. The design memorandum was submitted to the Division Engineer on 11 May 1966 and returned to the District on 10 April 1967 for resubmission as a survey report.

2. By letter, NCSED-B, 14 September 1967, above subject, to North Central Division, St. Paul District submitted a plan of study for evaluating benefits attributable to a new lock at Lock and Dam No. 1 and sizing of a new lock at various alternative sites. The design memorandum had recommended a new lock of 75 feet x 480 feet. By 2nd Indorsement ENGCW-OC, 26 January 1968, to referenced letter of 14 September 1967, Office, Chief of Engineers, advised that a proper economic analysis could best be accomplished by a complete traffic and transportation analysis of principal commodity movements to and from terminals above Lock and Dam No. 1. This same indorsement noted that sizing of a replacement lock could also be accomplished via a systems analysis.

3. At a 3 to 5 June 1968 meeting in the St. Paul District among OCE, BERH, NCD, and District representatives, agreement was reached that, in addition to consideration of a replacement lock alternative, the scope of the study would be broadened to include consideration of rehabilitating the existing lock structure.

4. From an interim report of traffic analysis, findings concluded that the 56-foot x 400-foot lock size is adequate, and the need for rehabilitating or replacing the existing lock must be based on engineering criteria. With incremental annual navigation benefits of $1,197,972 for

pool No. 1 and related incremental costs of lock replacement plans ranging from $1,919,000 to $2,661,000, a new lock is not justified at the present time.

5. Preparation of a Design Memorandum for the Rehabilitation of Lock and Dam No. 1 was authorized by OCE in 2nd Indorsement, DAEN-CWP-C/DAEN-CWO-M(19 July 72), subject: Lock and Dam No. 1 Replacement Study.

EXTENT OF INVESTIGATION

6. Phase A of the Design Memorandum for Rehabilitation of Lock and Dam No. 1 was divided into three major sections:

a. Phase A Study and Report

b. Site Topography

c. Foundation Exploration and Laboratory Testing

7. Four alternative plans of rehabilitation were investigated:

a. Plan 1: Rehabilitation of landward lock without interruption of navigation.

b. Plan 2: Rehabilitation of landward lock with temporary use of riverward lock for navigation.

c. Plan 3: Rehabilitation of landward lock with navigation closed during construction.

d. Plan 4: Rehabilitation of both locks without interruption of traffic.

8. Phase A Study and Report. During the Phase A investigations the following main work items were examined.

a. Stability of Walls and Dam. The stability of all lock and guide wall monoliths and dam was determined. Proposals for stabilization were made for the structures which do not satisfy present design criteria.

b. Inspection of Concrete and Metals. Concrete and metals in the lock and dam structures were inspected, existing conditions were determined, and proposals were made for necessary repairs and replacements.

c. Mechanical and Electrical Equipment. All hydraulic lines, electrical wiring, pumps and machinery are to be replaced for the landward lock. Recommendations were made for the repair of miter gates. The possibility of replacing the existing stoney gates valves with butterfly or tainter valves or any other equivalent valves were investigated. The technical feasibility of electrical controls for the miter gates, valves, control house equipment, tow haulage unit, air compressor, and bubbler systems, similar to those of St. Anthony Falls, were determined to the extent required for preparation of construction cost estimates.

d. Hydraulic Modifications. Several shortcomings, deficiencies, and operating conditions hazardous to navigation exist at the locks presently. These hydraulic problems and recommended solutions were presented in a special report prepared by Martin E. Nelson under Contract No. DACW 37-74-0038. The recommended modifications were studied and evaluated in this Phase A Report.

e. Central Control Station. Preliminary design and cost estimates were prepared for a new control station, that will be located at the center of the lock on the land wall, with the possible exception of Plan 4 where it could be located on the downstream end of the intermediate wall.

f. Aesthetic and Environmental Quality Design. Aesthetic aspects of the proposed and landscaping features were planned to harmonize and blend with the environment.

g. Construction Methods and Scheduling. Construction schedules, methods, access facilities, and temporary shelters were studied and evaluated for the four plans of rehabilitation.

h. Traffic and Navigation Benefit Analysis. During Phase A the Contracting officer conducted navigation traffic and benefit studies to determine the economic impact on navigation interests which would result from construction activities for each plan of rehabilitation.

9. Site Topography. A topographic survey, including channel and river soundings, was implemented within the designated boundaries and a topographic map was prepared of the project site. Horizontal control was re-established in the area.

10. Foundation Exploration and Laboratory Testing. A comprehensive boring and testing program was developed and implemented. The program was of sufficient scope and detail to permit a sound foundation analysis for each plan studied.

11. Design Memorandum No. 1. On 11 May 1966, Design Memorandum No. 1 was issued with a recommendation to replace the existing locks with a new lock at the present site. The new lock was determined to have a width of 75 feet, a length of 480 feet, and a navigable depth of 9 feet. Two alternative locations were investigated for the new lock. The design memorandum plan assumed that the lock will be constructed near the west bank of the Mississippi River. An alternative plan envisioned that the new lock could be constructed on the east bank, assuming that the present Ford Motor Company hydroelectric plant will be abandoned. The amount of Federal funds needed for construction of the new lock were estimated to be $23,400,000 for the new bank location and $21,100,000 for the east bank site, both figures based on January 1966 construction cost levels.

The above design memorandum report was returned on 10 April 1967 for resubmission as a survey-scope report to include a comprehensive economic analysis and consideration of alternative courses of action.

12. Plan Formulation. A plan formulation was prepared in 1970 comparing alternative solutions for Lock and Dam No. 1.

Continued maintenance and repair of the existing lock was not considered a practical alternative because of continually deteriorating conditions and the possibility that a catastrophic failure would halt all navigation to and from Minneapolis.

Construction of a new lock and dam complex would mean the abandonment of the existing dam and Ford hydroelectric plant. Since the construction costs of this alternative were estimated to be in excess of $200,000,000, it was considered to be economically infeasible and this alternative was eliminated from further analysis.

Five alternatives were investigated to replace the existing locks with a new lock structure. Lock sizes 56 feet by 400 feet, 75 feet by 480 feet, and 110 feet by 600 feet, all with 9-foot navigation depth, were considered at west and east bank locations. The initial costs of these schemes varied from $29,170,000 to $37,730,000 and the total annual charges were between $2,085,000 and $2,655,000, expressed at October 1970 price levels.

However, during comparison of the preceding alternatives of a new lock with plans of rehabilitation, it became obvious that only rehabilitation of the existing lock is economically feasible. An additional reason in favor of rehabilitation is that the future increase of recreational traffic indicates that consideration need be given for separate or

additional recreational facilities sometime during the period of 1990 to 2000. Three different schemes of rehabilitation were investigated and the initial costs of these varied from $7,980,000 to $15,430,000. Total annual charges of the same schemes of rehabilitation ranged from $654,000 to $1,159,000.

Based on the results mentioned above, it was decided that rehabilitation of both locks should be considered. Four alternative plans of rehabilitation were outlined as described in Paragraphs 29-32 of this report.

13. Periodic Inspection Report No. 1. In March 1971 Periodic Inspection Report No. 1 was issued describing the conditions of the structures as found during a visual survey performed by an inspection team in August 1967. The report described the deteriorating condition of concrete, loss of fill material in joints, displacement of lock walls, stability of several wall monoliths and the unsatisfactory condition of operating machinery. Its conclusion was that problems continue to arise from unexpected sources and remedial measures will be necessary to maintain the lock in operation.

GENERAL DESCRIPTION OF STRUCTURES

14. Lock and Dam No. 1 is located at Mississippi River mile 847.6 above the mouth of the Ohio River and between the cities of St. Paul and Minneapolis, Minnesota. The location of the locks and adjacent topography are shown on Plates 1 and 2. The original structure was completed and placed in operation in 1917 and included a 152-foot long hydroplant adjacent to the left bank, a 574-foot crest-length, Ambursen-type dam surmounted by 2-foot high automatic release flashboards and eight sluiceways (of which only three sluice gates are operated and maintained at the present time), and a 80 by 360-foot navigation lock. In 1929 the lock failed, cutting off all barge traffic to Minneapolis. To insure against a future interruption to barge traffic, it was decided to build twin locks each 56 by 400 feet at this site. The first lock (riverward lock) was completed in 1930 and the second lock was placed in operation in 1932. A more complete description of the locks and dam is given in the following paragraphs. Plan and sections of the lock structures are shown on Plates 3 through 7.

15. Dam. The dam is an Ambursen-type concrete structure and for the greater part is supported on an alluvial fill consisting primarily of sand, gravel, and limestone slabs. There is a portion of the dam and apron, however, that is supported on timber piling. Along the upstream face of the dam is a steel sheet pile cutoff wall. There is also a row of steel sheet piling along the toe of the apron as a preventative

measure against scour. The crest and the downstream face has been resurfaced (1949-53). A major portion of the apron has been replaced and a baffle wall was constructed on the apron to induce a hydraulic jump to overcome serious scour below the dam. This work was completed in 1953. In 1952 the dam was stabilized by placing sand fill in the interior to reduce the possibility of failure by sliding. Three of the eight sluice gates in the dam were rehabilitated and hydraulic machinery to operate them was installed in 1954. Under present pool conditions, the dam maintains a normal head of about 38 feet during the navigation season and about 36 feet during the winter season. In general, the dam is in good condition.

16. Riverward Lock. The present riverward lock was built in 1929 and 1930 to replace the original lock which failed on 19 August 1929. The plan was to provide a structure suitable for 9-foot draft navigation based on the design pool level for lock and dam No. 2 which was then under construction. However, due to probable seepage damages, interests in the South St. Paul stockyards area pool 2 obtained a court order limiting the elevation to which the pool could be raised to 685.7 msl (mean sea level). Later, in 1934, the court approved the raising of the pool to elevation 687.2, 1.9 feet less than its designed height. As a result, there is a depth of only 7.5 feet over the lower sill at flat pool or about 8 feet at normal tail water elevation, hence the lock has had little use except for an occassional locking of pleasure boats, empty barges, or shallow-draft towboats. The stability of the lock walls, the poor condition of the operating machinery and the lack of guide walls making approach difficult have also been factors in limiting use of the riverward lock. Actually in building this riverward lock, the landward wall thereof was constructed of adequate width with two emptying and filling tunnels to serve as the intermediate wall of the twin locks when the second lock was constructed.

17. Landward Lock. The present landward lock was built in 1931-32 as a safeguard to maintain river traffic to and from Minneapolis. Minneapolis, as a result of the failure of the original lock, was without barge line service for over a year, and it was determined that a recurrence should be avoided if at all possible. The downstream sill of this lock has a top elevation of 677.2 providing a depth of flat lower pool of 10.0 feet or about 10.8 feet at normal tailwater elevation; hence, this landward lock handles practically all traffic through this facility.

18. Hydroelectric Plant. The hydroelectric plant, located at the east end of the dam, and flashboards on the crest of the dam are maintained by the Ford Motor Company, under Federal Power Commission License No. 362. Ford Motor Company, the owner of the hydro plant, has been considering abandonment of the power plant. Recently, however, an application has been filed with the Federal Power Commission for relicensing the power plant for a period of 10 to 15 years.

GEOLOGY AND SOILS

19. Lock and Dam No. 1 is situated in a post-glacial valley of the Mississippi River at Minneapolis-St. Paul, Minnesota. Topography at the site is dominated by the broad, essentially flat, valley floor, bounded by steep bluffs. The lock and dam is located near the center of a broad structural basin. Aquifers in this basin provide artesian water to the Twin Cities metropolitan area.

20. Numerous borings drilled by the Corps of Engineers and forty-four core holes completed during the present study, provide the detailed stratigraphic framework of the site. Geologic formations cored and sampled include the Platteville Limestone, the St. Peter Sandstone, and a short interval of the Shakoppe Dolomite. The concrete of the lock structures, river alluvium and backfill material were also cored and sampled.

21. The lock and dam is founded partly on St. Peter sandstone and partly on river alluvium. The St. Peter sandstone has been arbitrarily divided into two zones. The upper zone is a fine grained, friable, poorly cemented sandstone and is the foundation material for the upper and lower guidewalls, the river wall, the river lock and the center wall. Core recovery in the upper zone was very poor, and satisfactory samples were recovered only with the Longyear HQ-3 triple tube wireline core barrel. The lower zone consists of alternating beds of very fine grained silty sandstone, and moderately to well cemented sandstone. Included in the lower zone is an approximate six-foot siltstone interbed which locally contains soft variably plastic silt-clay seams up to 0.3 feet thick. River alluvium is the foundation for the dam and for most of the river lock. The remaining portions of the river lock rest on St. Peter sandstone. The river wall is founded on friction piles driven into river alluvium. The alluvium consists of sand and gravel (SP-GP), with limestone slabs, and minor amounts of nonplastic fines.

RIVER CHARACTERISTICS

22. Lock and Dam No. 1 is located at mile 847.6 (above the Ohio River) on the Mississippi River, approximately 2 miles upstream of its confluence with Minnesota River. The drainage area at the project site is approximately 19,500 square miles. Long term average discharge is about 7,200 cfs. The highest discharge of record, 91,000 cfs, occurred on 17 April 1965. The minimum discharge, about 600 cfs, was recorded on 13 September 1934 (586 cfs near Anoka; upstream of the site).

23. Lower pool elevation at the site is controlled by Dam No. 2 near Hastings and it is also influenced by discharges from the Minnesota

River. During the period of 1951 through 1972, the average tailwater elevation was about 690 and the minimum elevation was as low as 686.2. The highest water level downstream of the dam was recorded at 719 on 17 April 1965.

24. Upper pool elevation at the site is controlled by the overflow dam and by discharges through the low level sluices and through the Ford Power plant. During the navigation season, when flashboards on top of the dam are at raised position, the headwater is kept normally at 725. The flashboards on the dam contain shear pins which fail due to ice pressure or high spring flows. During the winter months the water surface in the upper pool will thus be lowered to approximately elevation 723. The highest headwater elevation ever recorded was 734.5, occurring on 17 April 1965.

CLIMATOLOGY

25. The normal annual temperature at the site is 45°F. The lowest normal average monthly temperature of 13°F occurs during January, and the highest normal average monthly temperature of 73°F occurs during July. Extreme temperatures recorded are a low of -34°F in January 1936, and a high of 108°F in July 1936.

26. Total annual precipitation at the site has ranged from a minimum of 11.59 inches in 1910 to a maximum of 41.64 inches in 1968. The average annual precipitation is 24.78 inches. Normal monthly precipitation varies from 0.70 inch in January to 4.00 inches in June. The greatest precipitation in any one month was 12.68 inches in September 1942. About 73 percent of the annual precipitation falls during the months from April through September, which coincides with the growing season. Annual snowfall averages about 44 inches, or about 16 percent of the total annual precipitation. The maximum 24-hour precipitation recorded at Lock and Dam No. 1 was 7.80 inches on 26 July, 1892.

STREAMFLOW DATA

27. Elevation Duration Curves and Stage Hydrographs. Elevation duration curves were developed for the Mississippi River at Lock and Dam No. 1 for each month and for the ice-free period, April-December, based on gage height records for the period 1930-1972. The curves indicate the percent of time that a specified elevation is exceeded based on the period of record. The elevation-duration curves are shown on Plates 8 and 9. Stage hydrographs were developed for the upper and lower pools of Lock and Dam No. 1 for minimum, average, and maximum flow conditions based on the period 1951 -1972. The stage hydrographs are shown on Plates 12 through 15.

28. Floods of Record. Floods on the Mississippi River at Lock and Dam No. 1 generally occur from spring snowmelt following a heavy accumulation of snow or from late winter rainfall on frozen ground. The larger floods have generally been produced by melting snow or a combination of melting snow and spring rains. The maximum flood of record, which occurred on 17 April 1965, had an instantaneous peak discharge of 91,000 cfs. Other large recent floods have occurred on 13 April 1969 - 73,900 cfs; 14 April 1952 -73,900 cfs; 15 April 1951 -62,700 cfs; and 3 May 1975 - 57,500 cfs.

ALTERNATIVE PLANS OF REHABILITATION

In Phase A of preparing the Design Memorandum, four alternative plans of rehabilitation were investigated.

29. Plan 1: Rehabilitation of Landward Lock Without Interruption of Navigation. In this plan most of the repair work will be implemented in the five-month winter season of November through March. During the remaining months, i.e. during navigation season, only such work will be carried out that does not interfere with boat traffic.

30. Plan 2: Rehabilitation of Landward Lock With Temporary Use of Riverward Lock for Navigation. According to this plan necessary repairs will be made in the riverward lock so that it can be used for navigation when landward lock will be repaired for permanent use.

31. Plan 3: Rehabilitation of Landward Lock With Navigation Closed During Construction. All boat traffic is shut off during navigation season when landward lock is rehabilitated.

32. Plan 4: Rehabilitation of Both Locks Without Interruption of Navigation. Most of the repair work in both locks will be carried out during winter season. Work that does not interfere with navigation will be done during the remaining months.

STRUCTURAL INVESTIGATIONS

33. Stability of Walls and Dam. The stability of all lock and guide wall monoliths and the dam was calculated using the results of foundation exploration program and laboratory testing. A factor of safety of 1.5 was used as a criteria when determining allowable foundation pressures and stability of wall monoliths against overturning and sliding. Details of the structural investigations are presented in Appendix C.

34. Upper Guide Wall. The structural stability factors of the upper guide wall monoliths, which are founded on Unit A Sandstone of the St. Peter Formation are within acceptable limits. The upstream monoliths of the guide wall, which are on rock filled cribs, could be pressure grouted to avoid any excessive movements due to settlement in the cribs. Surface protection of the guide wall with wall armor is also considered and included in cost estimates.

The first two monoliths of the upper guide wall may be replaced by new structures containing relocated intake openings for the modified hydraulic filling system. These new monoliths will be designed to satisfy structural stability against overturning and sliding.

35. Land Wall. All monoliths of the land wall are founded on Unit A^1 Sandstone of the St. Peter Formation.

Monolith No. 1 and upper miter gate Monolith No. 2 are supported by a mass concrete sill and present no structural stability or strength problems.

Structural analyses of Monoliths 3 through 16 result in stability factors which do not satisfy the acceptable values. To meet the requirements, two alternative modifications were investigated:

a) Lowering of backfill.

b) Stabilizing walls using inclined rock anchors.

The first of the two methods, which also includes partial reconstruction of the upstream end of crib wall along the bluff, was found to be more economical. However, lowering the backfill may not be the most practical solution.

The possibility of placing mass concrete behind the wall to replace backfill, does not result in a practical solution structurally or costwise. The use of the basin floor slab as a strut to stabilize the wall monoliths would not meet structural requirements as far as factor of safety against overturning, location of resultant on the base of the wall, or maximum soil pressures are concerned.

Downstream gate Monolith No. 17 requires the same treatment as wall Monoliths 3 through 16 to meet acceptable factors of safety.

36. Lower Guide Wall. All monoliths of the lower guide wall, which are founded on Unit A sandstone of the St. Peter Formation, have the required factors of safety against overturning. Hydraulic emptying systems proposed for all four plans of rehabilitation include replacement of the first two or three monoliths of the lower guide wall. These new monoliths to be constructed will be designed to satisfy the required factors of structural stability. Surface protection of the lower guide wall will be provided by wall armor.

To prevent accumulation of debris behind the lower guide wall, a trashrack should be placed in the downstream opening between the wall and the adjacent bluff.

37. Intermediate Wall. Along its entire length, the intermediate wall is founded on Unit A sandstone of the St. Peter Formation.

Monoliths Nos. 1 and 2 and upper miter gate Monolith No. 3 which are contiguous to mass concrete sills, fulfill structural stability requirements. Monoliths Nos. 4 through 17 meet structural requirements for allowable foundation pressures and factors of safety against overturning and sliding, both at normal operating and construction conditions.

Monolith No. 18 at the downstream miter gate, however, does not fall into the same category. Although actual sliding would be resisted by the massive sill slab, maximum soil pressure and factor of safety against overturning are not within the recommended limits. To fulfill the requirements, interconnection with the adjoining monoliths by use of horizontal and vertical shear keys is recommended. Shear keys will be constructed by drilling 2-foot diameter holes centered along the joints between monoliths and filling these with reinforced concrete.

There will be an extension of the intermediate wall in downstream direction to construct discharge monoliths for the improved hydraulic emptying system. Since these structures will not be subject to unbalanced waterloads, there will be no stability problems with the intermediate wall extension.

To improve bearing capacity and strength of the foundation underlying the intermediate wall, a program of contact compaction and consolidation grouting from the filling and emptying conduits is proposed.

38. River Wall. Monoliths Nos. 1 and 2 of the river wall are exposed to differential hydrostatic loads during the construction period only.

Monoliths Nos. 3 and 4 and miter gate Monolith No. 5 are adjacent to the mass concrete sill. None of these monoliths present any structural stability problems.

Stability computations of Monoliths 5 through 16 show that pile loadings or foundation loadings converted to area loadings beneath these structures are within acceptable limits. However, the individual pile loadings alone are very high, probably beyond the capacity of these short piles,placed under difficult driving conditions.

River wall Monoliths Nos. 17, 18, 19 and downstream miter gate Monolith No. 20 do not satisfy structural stability requirements. Two methods of stabilization are proposed to meet the required criteria:

a. Interconnection of miter gate Monolith No. 20 and adjacent Monoliths Nos. 19 and 21 by horizontal and vertical shear keys.

b. Backfilling the riverward side of Monoliths Nos. 17 through 21 up to El. 710.

It is recommended that both methods be used as neither one by itself would be quite sufficient to achieve the required stability factors for this part of the river wall.

To improve bearing capacity and strength of foundation underlying the downstream monoliths of the river wall, a program of contact compaction and consolidation grouting from the emptying conduit is proposed.

39. Dam. The stability of the hollow Ambursen dam monoliths, founded on river alluvium, was checked at various operating conditions. It was found that the most critical state of stability occurs at highest headwater elevation when a hydraulic jump still forms on the apron immediately downstream of the dam. To improve the stability of the dam, it is proposed that the sand fill in the dam monoliths be raised to El. 701.25. The dam stability will be reviewed during Phase B based on recent information furnished by the St. Paul District in "Brochure of Miscellaneous Data, Ambursen Dam Lock & Dam No. 1, August 1975."

40. Downstream Lock Floor Drainage and Filter. To prevent possible piping of material in a downstream direction from beneath the floor of both locks and intermediate wall, it is proposed that a filter and drainage system and a downstream concrete sill be incorporated into the modified hydraulic emptying system.

FILLING, EMPTYING AND VENTING SYSTEMS

41. Existing Conditions. The present filling, emptying, and venting system has been deemed to be inadequate because of excessive turbulence in lock chambers and in the navigation channel immediately downstream of the locks. Entrapment of air in the filling and emptying conduits also causes undesirable effects during locking operations. The hydraulic problems and proposed improvements are discussed in Appendix D.

Water surface elevations within the lock chamber for filling and emptying operations were recorded beginning with the time of initial valve opening. From this recorded data, filling and emptying curves were plotted for Lock Surface Elevation vs Time and Discharge vs Time. These curves are included in Appendix D.

Colored movies were taken of turbulence within the lock chambers during filling operations and in the discharge area downstream of the locks during emptying operations for dual and single culvert operation.

A copy of these films has been furnished to the Waterway Experiment Station for reference during the model testing.

42. Suggested Improvements. To improve the hydraulic operation of the locks, it is recommended that the following main revisions or new structures be considered:

a. Construction of new intake manifolds
b. Lowering and replacement of intake valves
c. Lowering of culverts
d. Expansion of venting system
e. Lowering and staggering of culvert ports in lock chambers
f. Construction of new lateral discharge manifolds.

The cost of all hydraulic improvements at October 1975 price level is estimated to be approximately $2,800,000 for Plans 1 through 3 rehabilitation, and about $4,800,000 to $5,300,000 for Plan 4, depending on the type of discharge structures selected. The proposed modifications are shown on Plates 10 and 11.

43. Hydraulic Model Testing. The Waterways Experiment Station has begun model construction. Hydraulic model tests of the revised filling and venting system and of the discharge structures downstream are being intiated to determine the most effective and economical solutions to the hydraulic problems.

COFFERDAMS

44. To facilitate the construction of hydraulic intake and discharge structures and to place backfill behind the downstream river wall mono-

liths, it will be necessary to unwater the construction areas by means of cofferdams. Space limitations, need for rapid construction and danger of scour led to the selection of cellular steel sheet pile cofferdams.

Major portions of both cofferdams will be constructed during the navigation season leaving only the short closure sections to be placed at the beginning of the construction period. The downstream cofferdam will be constructed partially from land along the west shore of the center island, and partially from barges. The upstream cofferdam can be constructed completely from barges. Ramps from the upper and lower guide walls will provide vehicular access to working areas within the two cofferdams. Drainage ditches, settling basins and pumps will keep the working areas unwatered.

The construction of cofferdams is scheduled in such a manner that no interruption or major hindrance to navigation will occur. Some restrictions to river traffic, however, may have to be imposed during the navigation season.

Layouts and descriptions of the cofferdams are presented in Appendix E.

CONCRETE EVALUATION STUDY

45. Need for Concrete Evaluation. A concrete evaluation study was considered essential in determining the structural adequacy of the concrete and the requirements for reconditioning as part of the overall rehabilitation study. Factors supporting such a need were: the unknown degree of apparent surface deterioration; the general lack of information on the quality of concrete materials and concrete used in the original construction; and, the necessity for information on the existing properties and condition of the concrete. Finally, the conclusions made from a concrete evaluation study would provide the basis for cost analyses and recommendations on concrete work involved in rehabilitation.

46. Evaluations Performed. A comprehensive field and laboratory investigation was conducted to evaluate the condition of the concrete of Lock and Dam No. 1. This work was performed during the summer and fall of 1974. The investigation included a program of core drilling, petrographic examination and compressive strength tests of core specimens, and a superficial condition survey. Both the interior and exterior concrete conditions of the structures were studied. Following completion of the investigation programs, the results were summarized and the overall condition of the concrete evaluated. A cost estimate for rehabilitation was prepared considering several alternates based on the concrete evaluation. The alternates included rehabilitation of the locks in part or completely, and the various methods which could be economically employed.

47. Results of Concrete Evaluation. The completed studies show the concrete structure is internally sound and that no reconstruction is necessary. Superfically, the structure is deteriorating from the primary effects of freeze-thaw action and secondary effects of sulfate attack. Surface deterioration extends over the entire structure but it is most serious on the exposed tops and edges of walls, the exposed sloping face of the river wall, and the vertical faces of the land lock. Vertical cracking, which is not related to surface deterioration, is most common on the river wall in the riverward lock and appears to related to shrinkage, the method of stage construction used, and the inconsistent joint pattern with adjacent concrete. The structure appears well aligned. In general, vertical joints between monoliths appear tight but leakage through the vertical joints in the intermediate wall was observed during operation of the landward lock. The details of the concrete evaluation study are contained in Appendix F.

48. Recommendations for Rehabilitation. The recommendations for reconditioning of the lock walls as derived from the concrete evaluation study are as follows:

a. Epoxy grouting of cracks and leaking horizontal construction joints.

b. Removal of concrete on all exposed surfaces to a minimum depth of three inches, or to sound concrete in deteriorated areas. No removal on the river side of the river wall would be required.

c. Replacing vertical surfaces to original line and grade by application of shotcrete, reinforced with welded wire fabric anchored to sound concrete.

d. Replacing the top of walls, including edges, to original line and grade by replacement of conventional concrete.

e. Sealing of vertical joints in walls and slabs by application of sealing compound.

f. Placing protective wall armor on upper and lower guide walls and along the edges of lock walls.

49. Program for Phase B Studies. The Phase B program should provide for additional core drilling and petrographic examination of core specimens to define more accurately the depth of surface deterioration over the entire structure. Areas which need further investigation include the vertical faces of the upper and lower guide walls and riverward lock walls, and the tops of all walls.

MECHANICAL EQUIPMENT

The rehabilitation of the landward lock requires the replacement of repair of all mechanical equipment in order to provide extended life for future service. The details of the mechanical studies are contained in Appendix H.

50. Miter Gates and Bulkheads. The condition of the existing miter gates requires general repair of any structural damage, prestressing and straightening of the gate leaves, sandblasting, painting and replacing pintles and anchorage eye bar bushings. The miter gate operators will be replaced with direct acting hydraulic operators similar to those at the St. Anthony Falls Locks. Since the current use of poiree needle dams for unwatering of lock chambers is rather cumberson and provides only limited protection against higher water levels, it is suggested that roller bulkheads of the type used at the St. Anthony Falls Locks be used at the site. Seven new 2.2-foot high bulkhead sections will be provided, which in conjunction with the three-foot high sections, existing at the St. Anthony Falls Locks, will enable sealing off one lock chamber at each end. The bulkhead sections will be stored behind the land wall. A lowering of the backfill behind the wall, as recommended for the stabilization of the wall because of lowest cost, however, will reduce the area available for the storage and handling of the bulkhead sections.

51. Filling and Emptying System. Various types of filling valves were studied. Model studies should verify the exact gate and conduit arrangement. Bulkheads will be provided which will enable valve maintenance when placed in the slots upstream and downstream of the valves.

Plan No. 4 consists of rehabiliation of both the riverward and landward locks. The rehabilitation of the riverward lock will be done in similar manner, except that floating and traveling mooring bitts, tow haulage units and additional bulkheads will not be provided. Floating mooring bitts for recreational craft have been suggested for the river lock and should be investigated in Phase "B".

52. Mooring Provisions. Three floating mooring bitts will be provided in the land wall of the rehabilitated landward lock. In addition, a traveling mooring bitt will be installed on the upper guide wall, as well as one tow haulage unit on both the upper and lower guide walls. All necessary check posts, chocks and snubbing buttons will also be provided.

53. Protection Against Ice. In order to prevent damage from ice formation on the miter gates and filling and emptying valves, a compressed air deicing system will be installed. The same compressed air system will be used to operate pneumatic tools for lock maintenance. It is also recommended that lightweight aluminum skinplates be fastened on the upstream

face of the miter gates to prevent collection of ice during winter operation. The space between the gate skinplate, beams, and the proposed aluminum skinplate would be filled with closed-cell polyurethane foam.

54. Miscellaneous Provisions and Systems

The central control station will be equipped with sanitary facilities, and heating and ventilating systems.

A fire protection system using pumped water supplied to nozzles along the top of the lock walls will be installed.

Sewage system from the new control house will be connected to the city sewer line. The system will include a force main from the lock area to the city sewer at Nawadaha Boulevard and 47th Avenue South, together with grinder pump and two lift stations.

Pool elevation recorders will be installed at both the upstream and downstream ends of the guide wall. Pool elevations will be displayed remotely at the lock control house.

A fully revolving floor mounted one-ton capacity pillar jib crane with electric motor driven chain hoist will be provided on the land wall, immediately upstream of the miter gate. The function of this crane is to remove debris from the gate bays and load it into a dumpster where it will be hauled away by truck.

A miter gate bolt back system will be provided to lock the lower miter gates into their recess position for winter shutdown.

The boat davit platform on the lower guide wall will be replaced. Overhead protection against falling rock will be provided. New boat davits will be provided on the upper guide wall.

Concrete slabs around pipe trenches will be replaced after settling of intermediate and river walls following sealing of monolith joints below.

A system consisting of an anchored warning sign, floats and cable, extending from the upstream end of the river wall approximately 500 feet into the upper pool, is suggested to keep pleasure craft away from the dam.

55. Provisions for Alternative Plans of Rehabilitation. Plans Nos. 1 and 3 consist of rehabilitation of the landward lock as described above, without any work on the riverward lock.

Plan No. 2 consists of rehabilitation of the landward lock as described above, and of temporary reconditioning of the riverward lock machinery to enable the use of riverward lock during the rehabilitation of landward lock. The temporary reconditioning of the riverward lock machinery includes reconditioning of the miter gate operators and stoney gate valves and their operators. This will be accomplished by utilizing existing parts of machinery from both locks to provide one set of operable machinery for the riverward lock.

Plan No. 4 consists of rehabilitation of both the riverward and landward locks. The rehabilitation of the riverward lock will be done in similar manner, except that non-floating or traveling mooring bitts, tow haulage units and additional bulkheads will not be provided for the riverward lock. Floating mooring bitts for recreational craft have been suggested for the river lock and should be investigated in Phase "B".

ELECTRICAL EQUIPMENT

56. Power Supply. New electrical power, control, lighting, heating, grounding and miscellaneous systems will be furnished for the rehabilitation locks. Normal power supply will be obtained from the existing hydro station adjoining the dam, and the emergency supply from an existing diesel generator set.

57. Equipment and Systems. New electrical systems and equipment will be similar to those utilized in locks, pumping stations and industrial plants. Controls for the miter gates, and for the gates for filling and emptying the lock chambers, will be electric, fully automatic once initiated, and operable from new upstream and downstream control stands. Wiring will be conventional except for use of a bridge for cables crossing over the lock chambers. Impressed-current type cathodic protection will be included for the miter gates. Raceways only are to be provided for communication equipment which will be installed and furnished by others. The details of the electrical investigations are given in Appendix I.

CENTRAL CONTROL STATION AND ACCESS BRIDGE

58. Central Control Station. Preliminary design and cost estimates were prepared for a new central control station and control stands. The new control station should be located at the center of the lock on the land wall, with the possible exception of Plan No. 4 where a location on the lower end of the intermediate wall would be more suitable. The new central control station on the land wall also includes a separate visitors area, while an observation platform would be constructed on the land wall if the central control station will be located on the intermediate wall. The two alternative control stations are described in Appendix J.

59. Access Bridge. A reinforced concrete personnel access bridge will be constructed across both lock chambers above the downstream end of lock walls. Space will be provided beneath the bridge floor slabs for piping and electrical cables.

SOURCES OF MATERIALS

60. All construction materials will be purchased from local suppliers whenever possible. Sand and gravel for cofferdam construction could be delivered by barges from downstream sources. All equipment will be ordered from U. S. Manufacturers.

ENVIRONMENTAL EFFECTS

61. Environmental Requirements. Landscaping requirements, present water quality, and the environmental effects of placing and removing cellular steel sheet pile cofferdams have been considered as part of the rehabilitation program for Lock and Dam No. 1. The evaluation has been based on photographs and maps, supplemented with environmental data provided by the Corps of Engineers. Appendix G describes these requirements and conditions and the steps that may be taken to ensure enhancement and preservation of the project environment during and after the rehabilitation construction period.

c2. Project Use of the Island and River Bank. Placement of the cofferdam at the south end of the locks will be facilitated by using the island as an access and staging area. Steel sheet piles and equipment will be moved by barge from a landing constructed on the east bank of the river. An area at the south end of the island will be cleared for the unloading and storage of steel sheet piles and for movement of construction vehicles. A road will have to be cleared from this landing area to the north end of the island, wide enough to allow trucks to pass each other.

The low area between the island and the lock will be filled with [illegible], gravel, and sand to approximately El. 690, in order to provide a firm work area for cranes setting the cofferdam. This fill will be removed following project completion, restoring the channel to its original configuration.

No buildings or sanitary facilities will be constructed on the island, but portable, self-contained toilets may be required.

c3. Impacts of the Project. The primary causes of impacts to the aquatic environment are expected to be the filling and clearing of the channel between the island and the lock, and the placement and removal of the cofferdam.

Dewatering from the downstream cofferdam area is estimated not to exceed 1500 gpm and from the upstream cofferdam area 500 gpm.

The filling of the channel between the island and the lock may be expected to cause some increased turbidity downstream, depending on the type of fill selected, principally on the size of the smaller sand particles. Additional siltation may be expected in the event of increased flows overtopping the filled area.

Care must be taken in the selection of fill material to ensure that no chemical can be leached from the filled area that would degrade the water quality.

Placement and, especially, removal of the cofferdam will certainly disrupt bottom sediments, possibly reintroducing undesirable materials into the river. The biological effects of this reintroduction will be more serious if the work is concentrated into a short time span (as, for instance, when work is being performed on a 24-hour basis). The essential river variable affecting the severity of these impacts will be flow; higher flows will provide dilution and sediments will be distributed further downstream. Quantitative predictions of these impacts cannot be made until the analyses of bottom sediments have been completed.

c4. Impacts to Island and East Bank. Use of the island for storage and movement of steel sheet piles and equipment will result in an impact on the floodplain woodland on the island. The nature and extent of this impact can only be assessed following the further evaluation of the ecosystems affected and public use of the island and the east bank landing area to be accomplished in Phase B of the Project.

65. Landscaping. The aesthetics of the lock area will be somewhat altered by the removal of five mature elms. These will be replaced with other species of shade trees and shrubs. Once the replacement plantings have become established, the appearance of the lock area is expected to be as attractive as before.

66. Mitigation of Impacts. Most of the Project's environmental effects probably can be substantially mitigated by careful planning. Landscaping measures have been proposed to enhance the aesthetic qualities of the lock region. Retention of the existing elms, however, has been determined to be infeasible because of high cost. A program of data acquisition has been proposed for Phase B studies of the Project.

DESIGN AND CONSTRUCTION SCHEDULES - PLANS 1 THROUGH 4

67. Design. After selecting the plan of rehabilitation, various structural, hydraulic, mechanical and electrical improvements will be designed during Phase B of the rehabilitation work. Additional exploratory drilling, laboratory soil testing, field and laboratory examination of concrete surfaces, and environmental investigations will also be implemented during the period. Hydraulic model testing of filling and venting systems and the energy dissipation structure downstream of the river wall would be carried out during the Phase B work. Incorporation of Corps of Engineers' revisions and final printing of design drawings, memos and report will be carried out during Phase C of the rehabilitation investigation program. Contract documents, specifications, and construction drawings will be prepared during the following phases.

68. Construction. Assuming that it takes about 19 months to complete hydraulic model testing for two locks, about 6 months to prepare Phase B drawings and design memos, about 4 months for Phase C review, revisions and final printing of the report, and at least 18 months for ordering, manufacture and delivery of equipment, the construction can be started at the earliest in summer 1979. Accordingly the construction contract should be awarded in April 1979, so that the contractor can move in immediately after the spring flood period.

All alternative plans of rehabilitation include the same major construction elements, such as move in, erection of cofferdams, unwatering, construction of hydraulic modifications, stabilization of lock and dam monoliths, repair of concrete surfaces, construction of new control house, mechanical and electrical replacements, removal of cofferdams, and clean-up of project site. Actual construction time for each alternative plan of rehabilitation is estimated to be approximately 2 years. Detailed construction schedules are presented in Appendix A.

69. Plan No 1. According to this plan, only the landward lock will be rehabilitated, and without interruption of navigation. Move-in and cofferdam construction will be carried out from July through October, and most of the rehabilitation work is scheduled to be implemented during a 5-month winter season of November through March. To facilitate construction during the cold winter months, a protective shelter will be placed over the landward lock and adjacent walls. The remainder of the construction work, that can be done without cofferdam enclosure and winter shelter, will be carried out during the following 12-month period. A construction schedule of Plan No. 1 is shown on Plate 12.

The riverward lock, which will be abandoned according to this plan, will be closed with bulkheads above the upper miter gates. Filling and emptying valves, all machinery and valve houses will be removed. Lower miter gates will be tied back, walkway on top of the upper miter gates will be widened, and tops of the lock walls will be resurfaced. If necessary and feasible the riverward lock may be rehabilitated at a later date.

70. Plan No. 2. This plan assumes that minimum repairs will be made for the riverward lock so that it can be used during the rehabilitation of the landward lock. In this plan, move-in and construction of cofferdams will follow the same schedule as in Plan No. 1. During the following 5-month winter season of November through March, hydraulic intake and discharge structures within the cofferdam areas and miscellaneous necessary features will be constructed. No winter shelter will be used in this plan. A major part of the rehabilitation work will be carried out during the summer and fall when the riverward lock will be used for navigation. The construction will be completed within two years. A construction schedule is shown on Plate 13 for Plan No. 2.

The riverward lock, which will be abandoned after the reconstruction of the landward lock, will be kept in condition described for Plan No. 1 above.

71. Plan No. 3. According to this plan the landward lock will be rehabilitated with navigation shut down during the construction period. Subsequent to move-in, the Contractor should complete the cofferdam in December, immediately after the closure of navigation season. No winter shelter will be constructed. Practically all of the rehabilitation work will be done during the next spring, summer, and fall, and the project work will be completed within two years. A construction schedule for this plan is shown on Plate 14. The riverward lock, which will be abandoned according to this plan, will be kept in condition described for plan No. 1 above.

72. Plan No. 4. This plan includes rehabilitation of both locks without interruption of navigation. It is similar to and has the same timing as Plan No. 1. During the 5-month winter period, however, 2 locks must be rehabilitated instead of one. A construction schedule for Plan No. 4 is shown on Plate 15.

SITE TOPOGRAPHY

73. A topographic survey, including channel and river soundings was made within the designated boundaries and a topographic map was prepared of the project site. Horizontal control was reestablished in the area. Topography of the Project area is shown on Plate 2.

FOUNDATION EXPLORATION AND LABORATORY TESTING

74. A comprehensive boring and testing program was developed and implemented. The program was of sufficient scope and detail to permit a sound foundation analysis for each plan studied in Phase A. The boring, sampling, and testing program provided the soil and rock properties to evaluate alternate methods of increasing the overturning and sliding factors of safety and to develop construction procedures for each alternative plan of rehabilitation so that an accurate cost comparison could be made. Boring samples were subjected to field classification and laboratory testing, such as classification tests, sieve analysis, triaxial and/or direct shear strength tests and such other testing as required.

75. Previous Investigation The Corps of Engineers completed several exploratory drilling programs at Lock and Dam No. 1 prior to the current study. A total of 40 wash borings were completed from 1915 through 1950. In addition a total of 13 AX and NX core holes were drilled in 1959 and 1964.

76. Present Investigation. Forty-four bore holes were completed at Lock and Dam No. 1 during the summer of 1974. The holes were located to establish the detailed geologic framework of the Project site. Representative sampling of all materials at the site, including soil, backfill, concrete, and rock were also an integral part of the program. Particular emphasis was given to the concrete of the lock structures and the foundation materials beneath each structural element. Data from these borings have been correlated with data from the previous investigations.

All materials were logged in the field as drilling progressed and selected samples were sent to the laboratory for testing. Water levels were recorded during drilling and piezometers were installed in 15

borings. Upon completion of the exploration program, the piezometers were used for an exploratory seepage study beneath the lock structures. The details of the foundation exploration and laboratory testing are given in Appendices B-1 and B-2 respectively.

SEEPAGE, UPLIFT, AND PIPING

77. Previous Observations and Improvements. Since the construction of the locks, seepage, scour, and settlement of wall monoliths has been noted on several occasions and appropriate remedial measures have been carried out to rectify these unsatisfactory conditions.

78. Present Investigations. During the fall of 1974, water level measurements in bore holes, observations of dye movements, falling head permeability tests, and constant head permeability tests were performed to obtain field data for Phase A and subsequent studies. Results of these tests are described in Appendix B-3.

79. Proposal for Seepage and Piping Control. To control seepage and eliminate possible piping, the following remedial measures are recommended as outlined in further detail in Appendix B-3:

a. Cut-off wall with filter and drains downstream of the lock structure.

b. Compaction grouting under intermediate wall and under the downstream portion of river wall (the latter for Plans 2 and 4 only).

c. Backfill against riverward side of downstream end of river wall (Plans 2 and 4 only).

d. Selective removal of lock basin floor slabs in both locks to investigate the possibility of piping and existence of seepage channels.

TRAFFIC AND NAVIGATION BENEFIT ANALYSIS

During Phase A navigation traffic and benefit studies were made to determine the economic impact on navigation interests by interrupting the lockage service for the four alternative plans of rehabilitation.

Major shippers using Pool No. 1 were consulted and interviewed by a St. Paul District staff economist during the period 2-11 October 1974. Additional office information obtained during previous studies unrelated to Lock and Dam No. 1 was also utilized for evaluating user disbenefits. A total of five (5) corporations were contacted. The corporations included the present lease holder of the Mineapolis Municipal Terminal, which handles most of the general cargo in Pool No. 1, the principal Twin City handles generating utility, a Twin City metro sand and gravel operator, and the two largest grain movers in Pool No. 1, - one of which emphasizes movements for smaller grain movers and custom houses. Two letters were also received in confidence from Pool No. 1 users for consideration in the alternative selection and decision-making process.

The participants agreed unanimously that Lock and Dam No. 1 is in need of repair and should be rehabilitated to preclude the possibility of navigation being interrupted due to a breakdown of equipment or failure of a portion of the lock.

The consensus of users interviewed unanimously preferred only limited intrusion into the shipping season at the beginning and close of each season. These interruptions were anticipated to cause only minor annual financial losses. Substantial annual losses, however, would be sustained in case of intrusion or shut-down of longer duration. In additon, the secondary impact upon firms currently dependent upon river transportation could be even more severe. Some diverted traffic and future traffic growth would be permanently lost to more expensive modes presumed to be more reliable. In addition, some firms would delay and perhaps permanently discard plans for modernization and improvements due to developing alternate modes of transportation.

COORDINATION WITH OTHER AGENCIES AND INTERESTS

81. Three meetings were held, one with shippers and users on 2 May 1975, and two with environmental agencies on 5 June 1975 and 8 July 1975, to explain rehabilitation study plans and gather input from them as a result of these meetings. Questions raised and recommendations made at these meetings will be examined and evaluated during the preparation of the Phase B report. A list of attendees and meeting notes are incorporated in Appendix L.

In addition, an abridged Phase A report will be distributed to Federal, State and local agencies, environmental and citizen groups, shippers and users, marina owners, yacht clubs etc., for their review and comment during the NCD and OCE review period.

Public meetings will be held to explain the project and gather review comments. Input received from these meetings will be evaluated and considered in the Phase B report.

RECREATION

82. A preliminary recreation use study was conducted in the summer of 1975 to determine the number and type of recreation craft that used the lock on weekdays and holidays. Observers were stationed at upstream and downstream advantage points to observe approaching pleasure craft to see if they used the lock. The observers reported that boats would wait two or three hours to use the lock and would then decide not to wait longer for lockage due to a line up of barges ahead of them waiting for passage through the lock. Rehabilitation of the riverward lock with its reduced draft would ideally serve the recreation craft, keep them separated from the commercial traffic, and reduce the waiting period for lockage for both commercial and recreation craft.

Many crafts used the island downstream of the lock while waiting for passage through the lock. Development of the island for recreational purposes will be evaluated in the Design Memorandum.

COST ESTIMATES

83. Costs have been estimated on the basis of the most up-to-date information available at the time the estimate was prepared. Accordingly all estimates are based upon price levels prevailing in January 1975 and escalated to October 1975. None of the unit prices or lump sum amounts in the body of the estimate contain any provision for price escalation. Detailed costs estimates are presented in Appendix A.

ESTIMATE OF FIRST COSTS

84. Summaries of cost estimates for the four alternative plans of rehabilitation are given in Table 1. A contingency allowance of approximately 20 percent to account for errors and omissions, unforeseen difficulties in construction, and possible variations in unit prices was added to the subtotal of the individual construction items. to the estimated total direct costs of construction were added costs of engineering and design (7 percent of direct construction cost), supervision and inspection (5 percent of direct construction), and overhead (25 percent on supervision and inspection). The total construction costs, i.e. first costs, for the four alternative plans of rehabilitation are as follows:

Plan No. 1	$13,500,000
Plan No. 2	$13,200,000
Plan No. 3	$12,500,000
Plan No. 4	$20,300,000

The cost given for Plan No. 4 is the total first cost of Plan No. 4C which provides most favorable discharge arrangement downstream. Cor-

responding cost for Plan No. 4A (discharging across the river) is $19,400,000 and for Plan No. 4B (discharging into the channel between the center island and rockfill dike downstream of the river wall) is $19,500,000. The cost of rehabilitation of the riverward lock separately at a later date (at October 1975 price levels) is $9,300,000.

ESTIMATE OF ANNUAL COSTS

85. Effective annual costs for the four alternative plans of improvement are comprised of two distinct segments. First is the sum of those charges which result from the interest and amortization; and maintainance, operation, and major replacements required were the plans constructed. In addition, however, disbenefits, annual losses or additional costs which would result to the users in Pool No. 1 with the various plans must also be recognized as a cost. Estimates of the losses to these users over the period of lock rehabilitation are shown in Figure 1 below. Figure 2 summarizes the annual costs of each plan resulting from both lock rehabilation and disbenefits to users. The estimated annual costs are based on 6-1/8 percent interest rate and 50-year project economic life.

Figure 1 - Disbenefits, losses or additional costs[1] to users for alternative plans

Plan No. 1	0 - $11,000[2]
Plan No. 2	$4,910,000[3]
Plan No. 3	$7,880,000[3]
Plan No. 4	0 - $11,000[2]

1/ Shown at October 1975 levels and including labor.
2/ Annual cost for one shipping season (period of construction).
3/ Annual cost for each of two shipping seasons (period of construction).

Figure 2 - Estimated annual costs

	Plan No. 1	Plan No. 2	Plan No. 3	Plan No. 4
Investment				
Federal				
First costs	$13,500,000	$13,200,000	$13,500,000	$20,300,000
Interest during construction	0	810,000	760,000	0
Total Federal investment	$13,500,000	$14,010,000	$14,260,000	$20,300,000
Average annual costs				
Average annual charges				
Federal				
Interest and amortization[1]	871,000	904,300	855,900	1,310,400
Maintenance, operation, & major replacement	324,200	324,200	324,200	365,000
Average annualized disbenefits, losses or additional costs to users	300	580,100	931,000	300
Total average annual costs	$1,195,900	$1,808,600	$2,111,100	$1,675,700

1/ Based on 6-1/8 percent interest rate and 50-year project economic life.

BENEFITS

86. The primary benefit attributable to the rehabilitation of the locks at Lock and Dam No. 1 with any of the identified plans is the extension of the useful life of the Mississippi River 9-foot channel to Minneapolis, Minnesota. Traffic moving to and from Minneapolis through Lock and Dam No. 1 has averaged about 1,668,000 tons annually for the last 10 years. Traffic in 1974 totaled 2,766,000 tons. Tonnages in 1974 include a large temporary downward movement of western coal which will cease or become minor as soon as a downstream coal terminal can be developed. By 1980, annual sustainable traffic moving through Lock and Dam No. 1 is expected to approximate 2.4 million tons.

ECONOMIC JUSTIFICATION

87. Present and potential traffic appears to amply justify the lock rehabilitation. With the opening of the locks at St. Anthony Falls in 1963, upbound traffic is developing rapidly. Downboard traffic apparently will develop more slowly. Although mooring facilities are limited, it is anticipated that pleasure craft or small-boat traffic will double in the near future.

ALLOCATION OF COSTS

88. The operation and maintenance as well as replacement or rehabilitation of navigation facilities on the Mississippi River is a Government responsibility. As such the first costs and annual charges shown in Figure 2 and the preauthorization study cost would be completely Federal.

REAL ESTATE REQUIREMENTS

89. The Government now owns all lands required in the construction area. However, the use of additional lands owned by private interests and possibly by Minneapolis-St. Paul, and the State of Minnesota may be required for access and as work areas by the contractor. The lands and easements, if required, would be at Federal expense. Outline of the area needed for rehabilitation work is shown on Plate 1. Because of the lack of other adjacent open spaces, it is proposed that the Center Island be used as the contractor's staging and work area, when placing, maintaining and removing downstream cofferdam cells. In case such a use of the Center Island for construction purposes is not permissible or meets too much opposition, other solutions, which are obviously more inconvenient and costly to the contractor, should be investigated in Phase B.

SCHEDULES FOR DESIGN AND CONSTRUCTION

90. Design. It is proposed to prepare a general design memorandum to cover all major engineering phases. Currently it is proposed to accomplish this work prior to 30 December 1977.

To insure no delays are experienced due to availability of materials, all operating machinery, filling and emptying valves, and sheet piling for cofferdams will be procured a year ahead of the beginning of the construction contract and supplied to the contractor as government furnished items.

91. Construction. One of the major features of this project is to maintain navigation through the existing landward lock during the construction period. It is proposed to do the work by contract, and the scope of the work will require approximately two years. Cofferdams are proposed that will pass winter runoff without damage to the permanent work. A detailed description of the construction procedure is given in Appendix A. Assuming construction could be started on May 1979, the rehabilitated locks could be open to navigation at the beginning of the navigation season of 1981.

FUNDS REQUIRED

92. Funds will be required by fiscal years approximately as follows:

		TOTAL
FY 1976 (O&M)		$ 393,000.00
Preparation of Design Memorandum	$ 289,000.00	
Model Study	113,000.00	
FY 1976 (T) (O&M)		110,000.00
Preparation of Design Memorandum	80,000.00	
Model Study	30,000.00	
FY 1977 O&M		310,000.00
Preparation of Design Memorandum	240,000.00	
Model Study	70,000.00	
FY 1978 CG		400,000.00
Plans and Specifications	400,000.00	
FY 1979 CG		4,550,000.00
Prde [illegible] furnished items		
Mech.	1,150,000.00	
Cofferdam	1,100,000.00	
Plans and Specifications	300,000.00	
Construction Contract	2,000,000.00	
FY 1980		
Construction Contract	8,000,000.00	8,000,000.00
FY 1981		
Construction Contract	8,000,000.00	8,000,000.00
TOTAL		$21,763,000.000

OPERATION AND MAINTENANCE

93. The maintenance and operation will conform generally to that of other locks in the upper Mississippi River system. Operation and maintenance of the dam will follow the same procedure currently in effect. In general, all work on the dam will be performed by the Government except as stipulated in the Federal Power Commission license No. 362. Under this license the Ford Motor Company will maintain and operate the flashboards on the crest of the dam, the machinery and sluice gates for the discharge tunnels through the dam and all work pertaining to the powerhouse including but not limited to building, generating equipment and access road to the east side of the dam.

DISCUSSION

94. Lock and Dam No. 1 has been included in the Lock and Dam Replacement Program for a number of years. The early reports considered the replacement of the entire lock and dam structure. In the interim period several rehabilitation contracts have restored various component parts of this structure. The downstream face of the dam was resurfaced (1949-53). Serious scour below the dam has been brought under control by the construction of a baffle wall on the lower apron (1953) to induce a hydraulic jump on the apron. The dam has been stabilized by placing sand fill in the interior to reduce the possibility of failure by sliding (1952). Also, three of eight sluice gates were rehabilitated and hydraulic machinery to operate them was installed in 1954. The lower stoney gate emptying valves were repaired in the winter of 1974-75. Because of the above construction activities, only the replacement of the lock feature has been included in the Lock and Dam Replacement Program in reports dating back to October 1960. This report, however, has covered an inspection and investigation of all component parts of the entire lock and dam structures.

95. The powerhouse section of the dam has been maintained by the Ford Motor Company under Federal Power Commission License No. 362 and insofar as can be determined is in good condition. The dam also is in good condition. The locks, however, present a serious problem. Embedded metals are corroding, and need replacement; operating machinery is obsolete. The entire hydraulic machinery system including all piping is in poor condition. This condition dictates a redesign and replacement of all machinery. Lock lighting fixtures need replacement. The incoming power cable has been repaired and is now, for a limited period, in a serviceable condition.

96. In addition to the rehabilitation work cited in paragraph 93, maintenance problems have been of serious concern for a number of years. Monoliths have settled requiring foundation grouting. Leakage under walls and through monolith joints has required a revision of the tie to the steel-sheet piling and a complete replacement of joint seals along the floor and at monolith joints. Hydraulic machinery pipelines have

been replaced on two occasions. Miter gate anchor arms have failed and have been replaced three times. The venting arrangement to the lock filling and emptying system has required maintenance over the years and has been replaced in parts over the years. Pumps have been overhauled on numerous occasions. Rams have been removed, pistons have cracked and rings have been replaced. Past history indicates that problems continue to arise from unexpected sources and remedial measures continue to be necessary to maintain the lock in operation. Existing machinery recesses in the concrete structure are not adequate for the adaptation of a more modern design operating machinery. In brief, the scope of maintenance has reached a stage where major rehabilitation is mandatory in the near future.

97. The plan of improvement is based on the assumption that river traffic will be maintained during the construction period. From investigations and visual inspection, the hydraulic machinery in its persent condition has a life expectancy of 1 to 5 years. It is proposed to extend this life up to 40 years by replacing all lock machinery.

98. The dam appears to be in good condition, but the locks are substandard. Operating machinery has an expected life span of 1 to 5 years in its present condition, settlement and leakage under the lock have required extensive maintenance over the years. Anticipated traffic conditions coupled with present conditions of the existing lock justifies major rehabilitation work. The plan proposed is based on an overall evaluation of all factors and features of construction.

99. The final draft of the Phase A report was reviewed by all elements of the St. Paul District (FM & S, Hydraulic, Construction-operations Environmental Resource, Planning, Design and the Lockmaster of L & D No. 1) prior to final printing. In-house coordination meetings were held to insure all aspects of the study were adequately covered or would be covered in the preparation of the Design Memorandum (Phase B). District Reviewers were asked to submit the advantages and disadvantages of rehabitating both locks. Their responses were reviewed, consolidated to avoid duplications, and are listed below.

The most compelling reasons for rehabilitation of both locks are as follows:

a. The same cofferdam is required upstream and downstream whether or both locks are rehabilitated. Estimated cost - $3,100.00

b. The riverward lock with its 7' draft can be used for recreation craft and empty barges and tow boats.

c. There will be less waiting time for lockages.

d. The cost of rehabilitating the second lock at a later date would be higher than at the present time.

e. The river lock must be rehabilitated or made inoperative to eliminate maintenance costs. This cost of making the lock inoperative could be placed toward the rehabilitation of the lock.

f. Less damage to the environment results by doing both locks at the same time.

Disadvantages:

a. Cost - rehab - land lock only $13,500,000.
rehab - both locks, $19,500,000. (Plan 4B).

b. Additonal personnel may be required to operate both locks.

RECOMMENDATION

100. It is recommended that both the landward lock, the riverward lock and the dam at Lock & Dam No. 1 be completely rehabilitated as outlined in Plan 4B at an estimated cost of $19,500,000. It is recommended that a general design memorandum be prepared studying in detail rehabilitation Plan 4B, incorporating into the design the results of the model study being performed at the Waterway Experiment Station at Vicksburg. Based on the studies completed to date, a more detailed study is required to firmly established cost estimates, environmental effects, and the construction scheduling necessary to insure the work can be completed in the proposed two year construction period without delaying navigation.

REHABILITATION OF LOCK AND DAM NO. 1

SUMMARY OF COST ESTIMATES

ITEM	PLAN NO. 1	PLAN NO. 2	PLAN NO. 3	PLAN NO.
1. Temporary Construction				
Diversion and Care of Water				
Downstream Cofferdam and Pumping	$ 1,295,000	$ 1,439,000	$ 1,295,000	$ 1,476
Upstream Cofferdam and Pumping	491,000	491,000	491,000	491
Other Facilities	529,000	50,000	48,000	93
2. Intake Manifolds	536,000	507,000	497,000	817
3. Discharge Structures	1,023,000	970,000	938,000	1,323
4. Upper Guide Wall	43,000	43,000	43,000	43
5. Land Wall	725,000	717,000	714,000	739
6. Intermediate Wall	630,000	624,000	620,000	1,059
7. River Wall	8,000	168,000	8,000	63
8. Dam	10,000	10,000	10,000	10
9. Bridge and Elevator	157,000	153,000	153,000	169
10. Control House	279,000	270,000	270,000	146
11. Observation Platform	–	–	–	25
12. Repair of Concrete Surfaces	1,121,000	1,121,000	1,121,000	1,515
13. Mechanical Equipment	1,430,000	1,524,000	1,430,000	2,290
14. Electrical Equipment	555,000	586,000	555,000	1,100
15. Protection of Pleasure Craft	2,000	2,000	2,000	2
16. Miscellaneous Facilities and Improvements	92,000	92,000	92,000	118
Subtotal Direct Cost	8,926,000	8,767,000	8,287,000	12,894
Contingencies (20% +)	1,824,000	1,783,000	1,663,000	2,606
Total Direct Construction Cost	10,750,000	10,550,000	9,950,000	15,500
Engineering and Design (7% +)	780,000	730,000	730,000	1,086
Supervision and Inspection (5% ±)	550,000	520,000	520,000	770
Overhead on Engineering & Design (25% ±)	190,000	180,000	180,000	270
Overhead on Supervision and Inspection (24% ±)	130,000	120,000	120,000	180
Total First Cost (January 1975 price levels)	$12,400,000	$12,100,000	$11,500,000	$17,806
Total First Cost (October 1975 price Levels)	$13,500,000	$13,200,000	$12,500,000	$19,400

1 Discharge from the River Wall across the River.

2/ Discharge from the River Wall into a natural channel between the Center Island and Rockfill Dike.

3 Discharge from the River Wall through the laterals downstream of River Lock.

4 Cost of rehabilitation of River Lock at at January 1975 price levels subsequent of Land Lock, assuming that hydraulic d from the River Wall will be constructed.

NOTE. Plans Nos. 1, 2 and 3 include cost (see paragraph 69 for description o

TABLE I

REHABILITATION OF LOCK AND DAM NO. 1

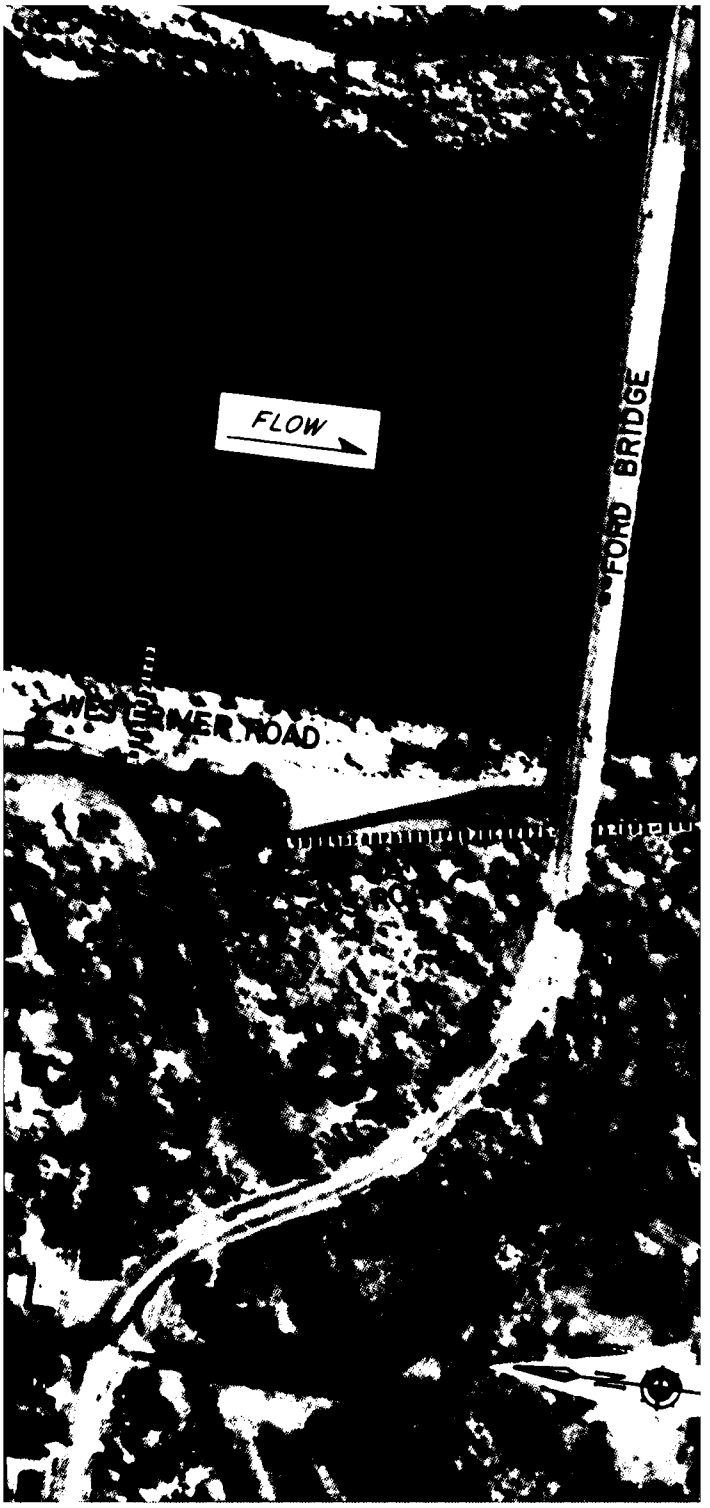
SUMMARY OF COST ESTIMATES

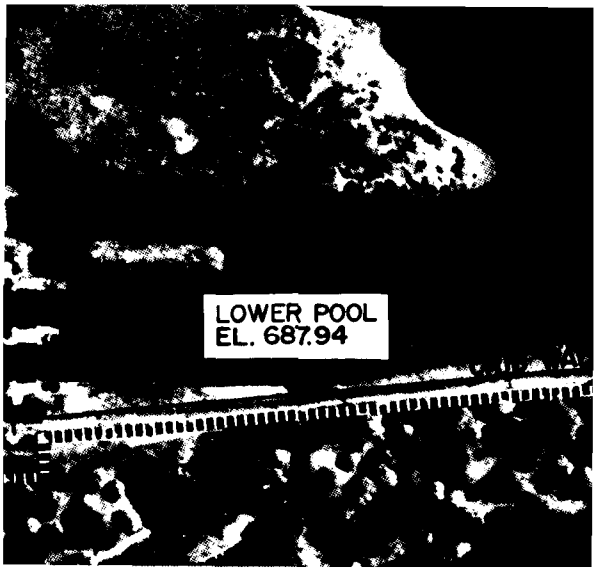
	PLAN NO. 1	PLAN NO. 2	PLAN NO. 3	PLAN NO. 4A[1]	PLAN NO. 4B[2]	PLAN NO. 4C[3]	RIVER LOCK[4]
mping	$ 1,295,000	$ 1,439,000	$ 1,295,000	$ 1,478,000	$ 1,478,000	$ 1,439,000	$ 1,394,000
ping	491,000	491,000	491,000	491,000	491,000	491,000	491,000
	529,000	50,000	48,000	934,000	934,000	934,000	529,000
	536,000	507,000	497,000	817,000	817,000	817,000	485,000
	1,023,000	970,000	938,000	1,323,000	1,399,000	1,880,000	335,000
	43,000	43,000	43,000	43,000	43,000	43,000	–
	725,000	717,000	714,000	739,000	739,000	739,000	–
	630,000	624,000	620,000	1,059,000	1,059,000	1,059,000	425,000
	8,000	168,000	8,000	630,000	630,000	630,000	620,000
	10,000	10,000	10,000	10,000	10,000	10,000	–
	157,000	153,000	153,000	169,000	169,000	169,000	–
	279,000	270,000	270,000	146,000	146,000	146,000	–
		-	–	24,000	24,000	24,000	–
	1,121,000	1,121,000	1,121,000	1,515,000	1,515,000	1,515,000	394,000
	1,430,000	1,524,000	1,430,000	2,296,000	2,296,000	2,296,000	943,000
	555,000	586,000	555,000	1,100,000	1,100,000	1,100,000	545,000
	2,000	2,000	2,000	2,000	2,000	2,000	–
provements	92,000	92,000	92,000	118,000	118,000	118,000	16,000
	8,926,000	8,767,000	8,287,000	12,894,000	12,970,000	13,412,000	6,177,000
	1,824,000	1,783,000	1,663,000	2,606,000	2,630,000	2,688,000	1,223,000
	10,750,000	10,550,000	9,950,000	15,500,000	15,600,000	16,100,000	7,400,000
	780,000	730,000	730,000	1,080,000	1,080,000	1,180,000	510,000
%±)	550,000	520,000	520,000	770,000	770,000	830,000	370,000
sign (25%±)	190,000	180,000	180,000	270,000	270,000	290,000	130,000
	130,000	120,000	120,000	180,000	180,000	200,000	90,000
ice levels)	$12,400,000	$12,100,000	$11,500,000	$17,800,000	$17,900,000	$18,600,000	$ 8,500,000
ice Levels)	$13,500,000	$13,200,000	$12,500,000	$19,400,000	$19,500,000	$20,300,000	$ 9,300,000

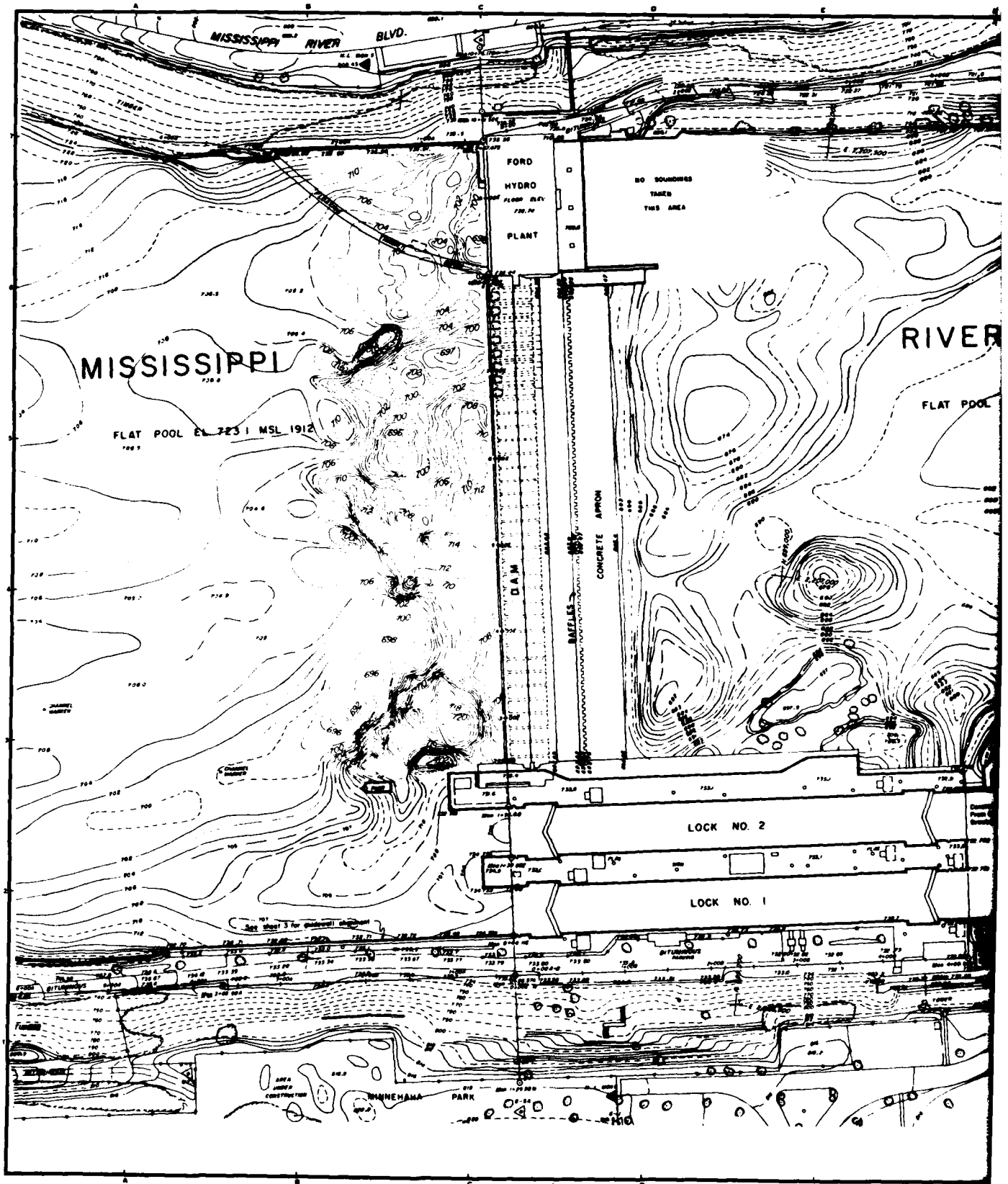
cross the River.
ato a natural channe
ckfill Dike.
hrough the laterals

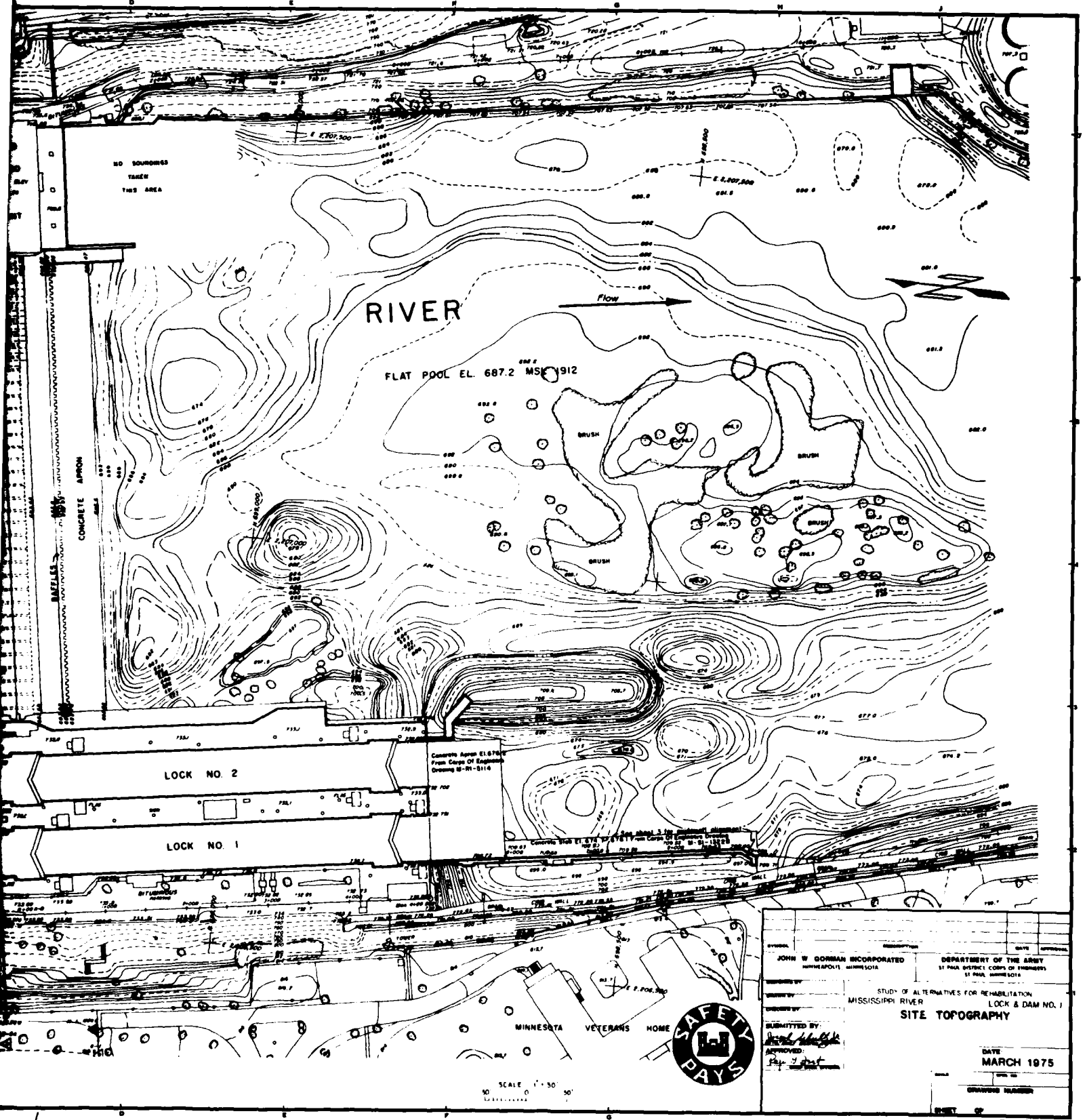
1/ Cost of rehabilitation of River Lock at a later date at January 1975 price levels subsequent to rehabilitation of Land Lock, assuming that hydraulic discharge structures from the River Wall will be constructed as in Plan No.4B.

NOTE: Plans Nos. 1, 2 and 3 include cost of abandoning the River Lock (see paragraph 69 for description of work).


FLOW
FORD BRIDGE
WEST RIVER ROAD


LOWER POOL
EL. 687.94


MISSISSIPPI RIVER BLVD.
FORD
HYDRO
PLANT
NO SOUNDINGS
TAKEN
THIS AREA
MISSISSIPPI
FLAT POOL EL. 723 I MSL 1912
RIVER
FLAT POOL
DAM
BAFFLES
CONCRETE APRON
LOCK NO. 2
LOCK NO. 1
MINNEHAHA
PARK



JOHN W. GORMAN INCORPORATED
MINNEAPOLIS, MINNESOTA

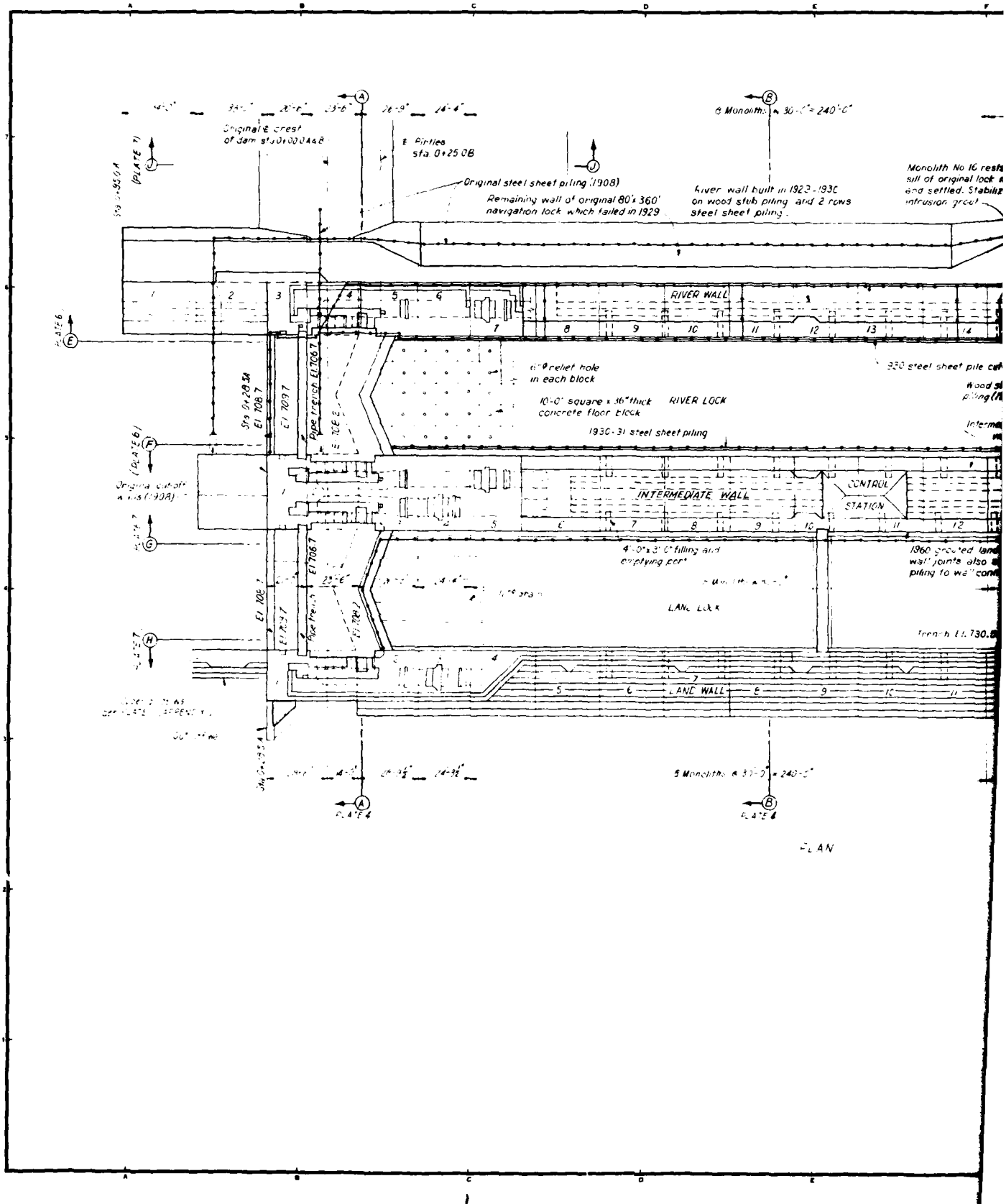
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

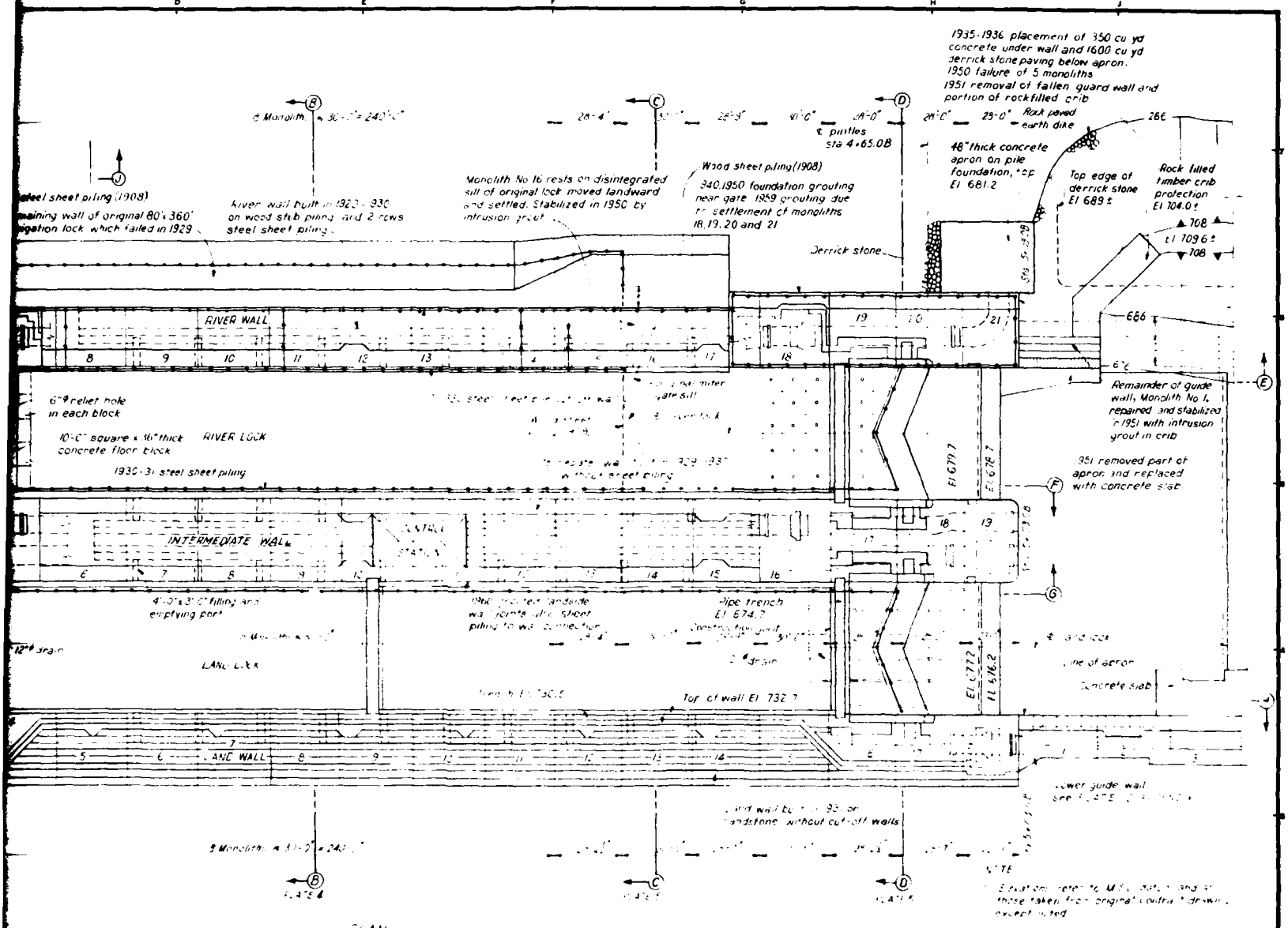
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO. 1

SITE TOPOGRAPHY

DATE
MARCH 1975

PLATE 2


Original ℄ crest of dam sta 0+00.04 &8
℄ Pintles sta 0+25.08
Original steel sheet piling (1908)
Remaining wall of original 80'x 360' navigation lock which failed in 1929
River wall built in 1923-1930 on wood stub piling and 2 rows steel sheet piling
6 Monoliths @ 30'-0" = 240'-0"
Monolith No 16 rests sill of original lock a and settled. Stabiliz intrusion grout
RIVER WALL
6"ø relief hole in each block
10'-0" square x 36" thick concrete floor block
RIVER LOCK
1930-31 steel sheet piling
330 steel sheet pile cut
Wood sh piling (N
Pipe trench EL 706.7
Sta 0+29.54
El 108.7
El 109.7
INTERMEDIATE WALL
CONTROL STATION
4'-0"x 3'-0" filling and emptying port
1960 grouted lam wall joints also g piling to wall conn
LAND LOCK
Trench EL 730.0
LAND WALL
5 Monoliths @ 30'-0" = 240'-0"
PLATE 6
PLAN



HARZA ENGINEERING COMPANY — DEPARTMENT OF THE ARMY

MISSISSIPPI RIVER — LOCK & DAM NO. 1

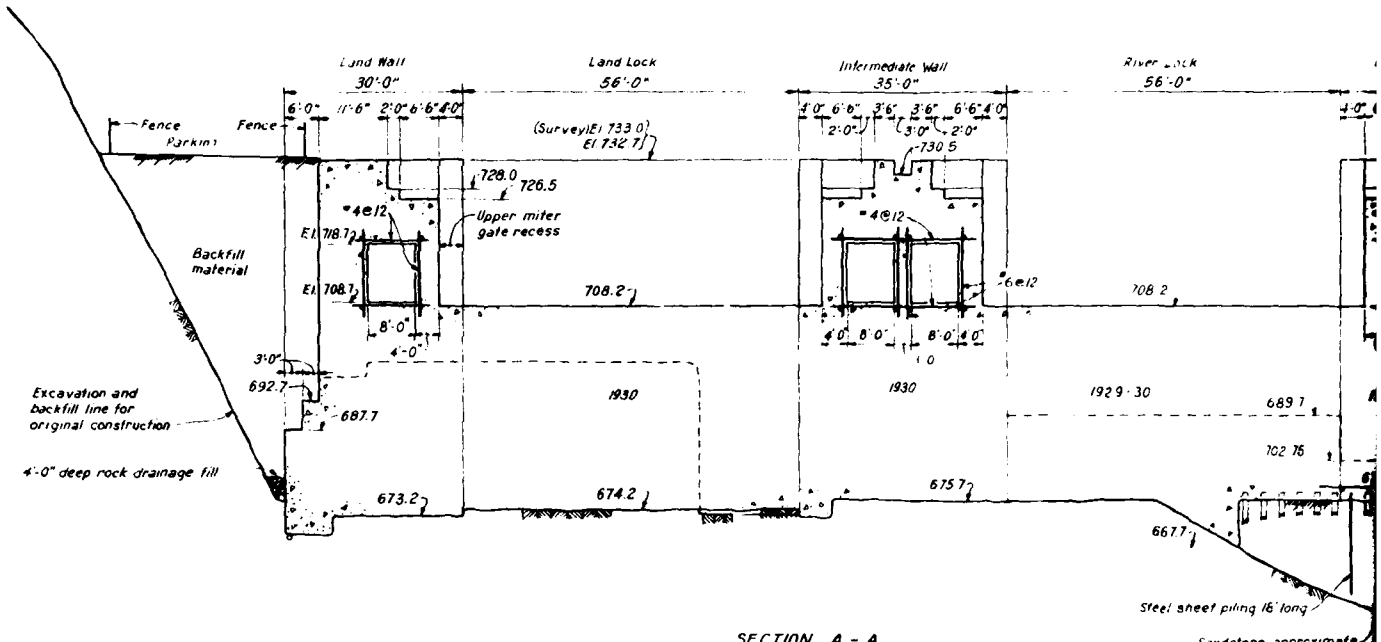
EXISTING LOCK STRUCTURES PLAN

DATE MARCH 1975

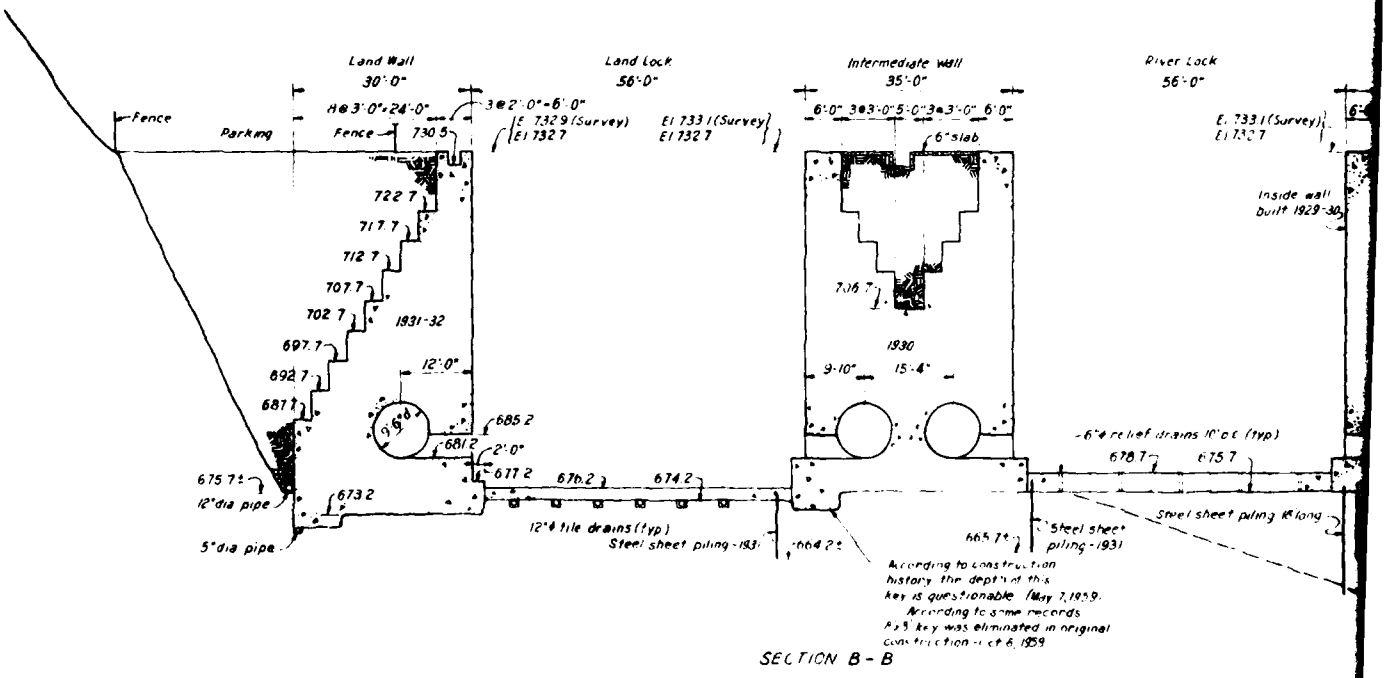
DRAWING NUMBER

SHEET OF

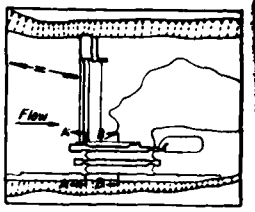
PLATE 3



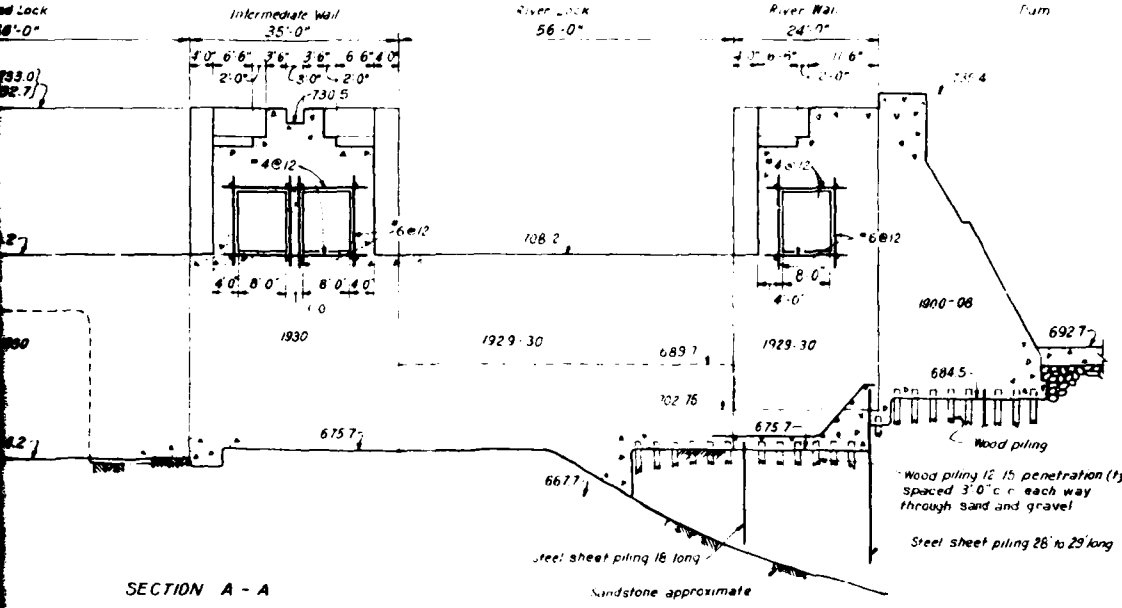
SECTION A - A



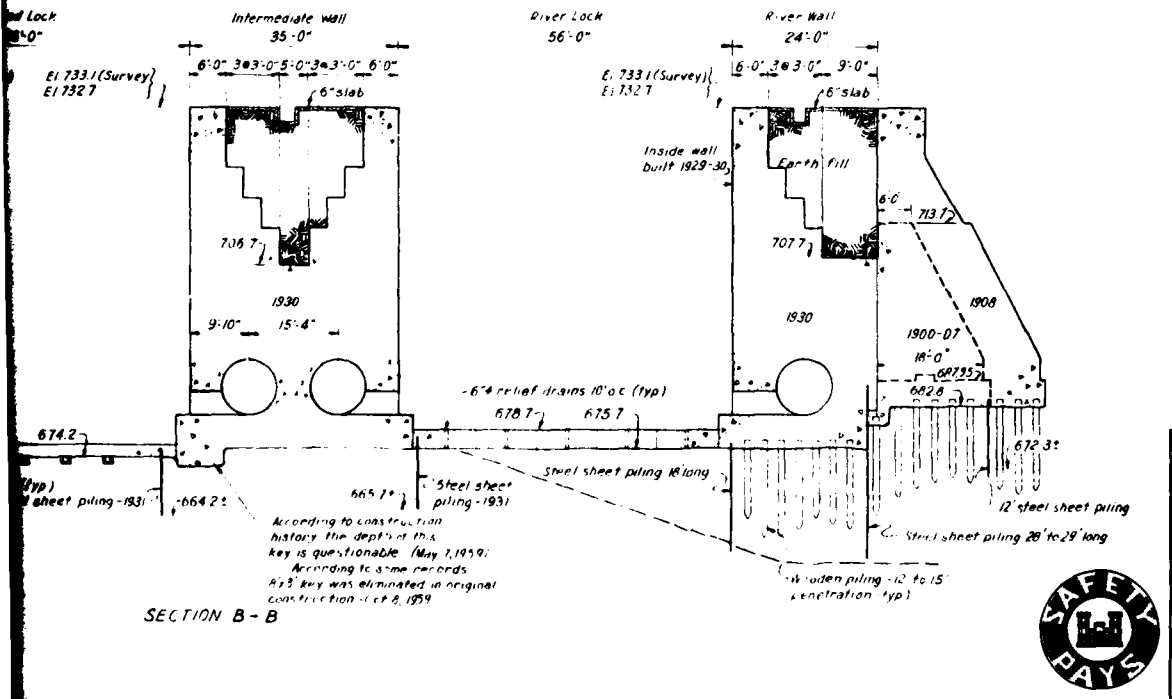
SECTION B - B



KEY PLAN



SECTION A - A



SECTION B - B

SAFETY PAYS

HARZA ENGINEERING COMPANY
CHICAGO ILLINOIS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY
DRAWN BY E J M
CHECKED BY R N M
SUBMITTED BY
APPROVED

STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1
EXISTING LOCK STRUCTURES
TRANSVERSE SECTIONS
SHEET 1

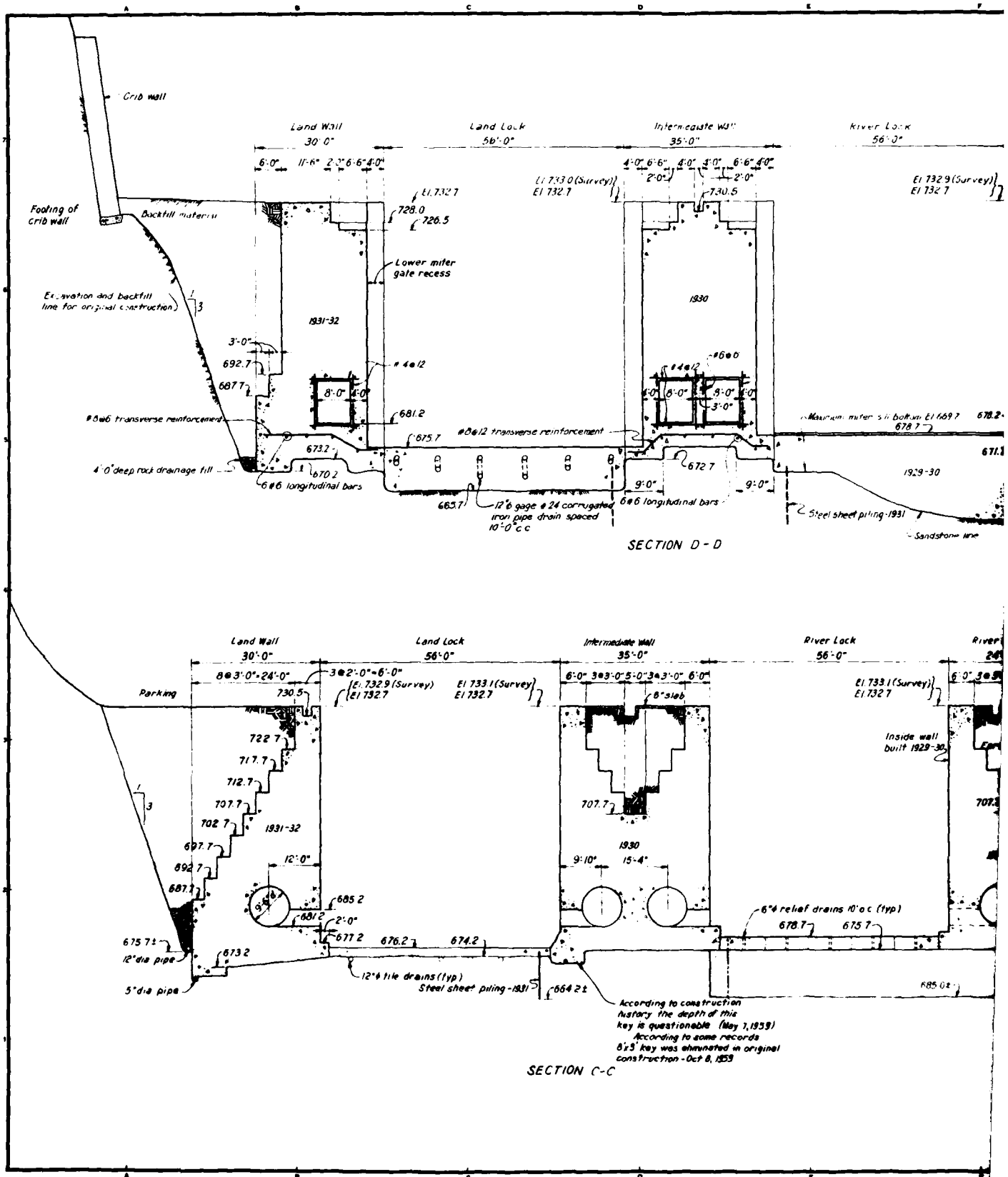
DATE
MARCH 1975

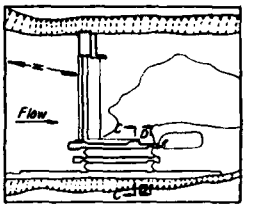
DRAWING NUMBER

SHEET OF

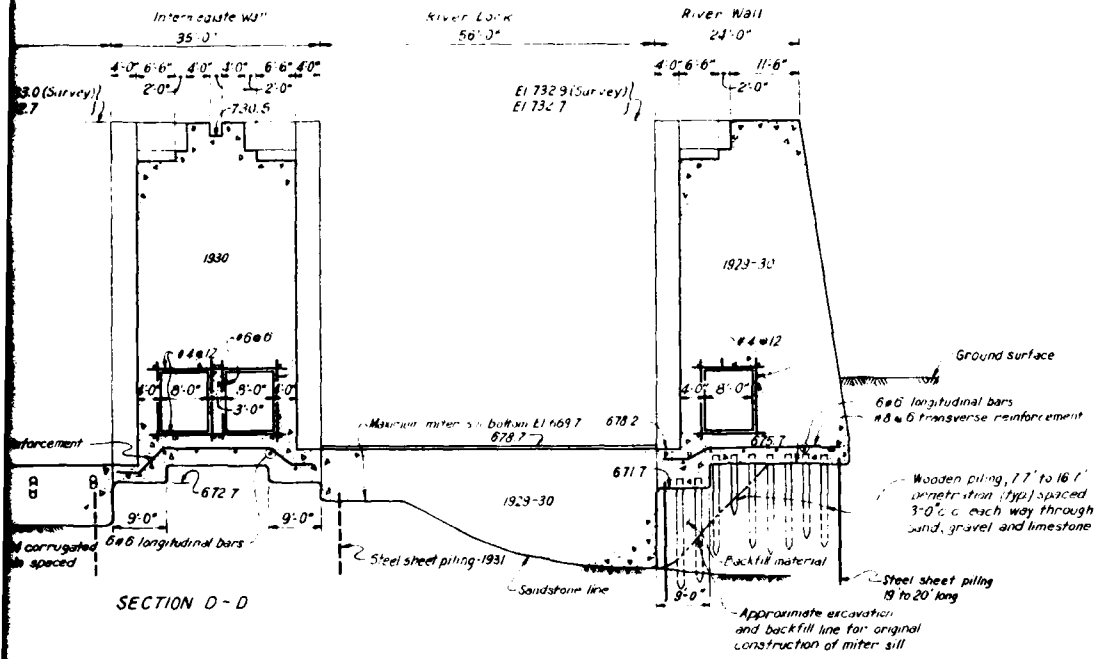
PLATE 4

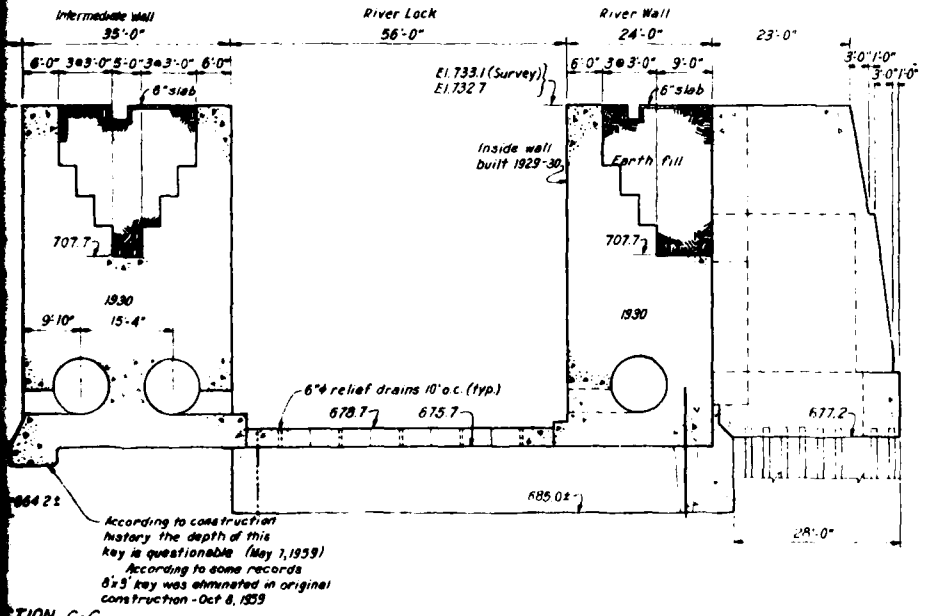
1 2


Crib wall
Land Wall
30'-0"
Land Lock
56'-0"
Intermediate Wall
35'-0"
River Lock
56'-0"
Footing of crib wall
Backfill material
Excavation and backfill line for original construction
Lower miter gate recess
1931-32
1930
1929-30
#8@6 transverse reinforcement
#8@12 transverse reinforcement
4'-0" deep rock drainage fill
6#6 longitudinal bars
12"ø gage #24 corrugated iron pipe drain spaced 10'-0" c c
Steel sheet piling-1931
Sandstone line
SECTION D-D
Land Wall
30'-0"
Land Lock
56'-0"
Intermediate Wall
35'-0"
River Lock
56'-0"
Parking
8"slab
Inside wall built 1929-30
12"dia pipe
5"dia pipe
12"ø tile drains (typ)
Steel sheet piling-1931
6"ø relief drains 10'o c (typ)
According to construction history the depth of this key is questionable (May 1, 1959)
According to some records 6'x9' key was eliminated in original construction - Oct 8, 1959
SECTION C-C



KEY PLAN





SCALE 1"=10'

DESIGNED BY:			
DRAWN BY: E J M			
CHECKED BY: R N M			
SUBMITTED BY:			
APPROVED:			

HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

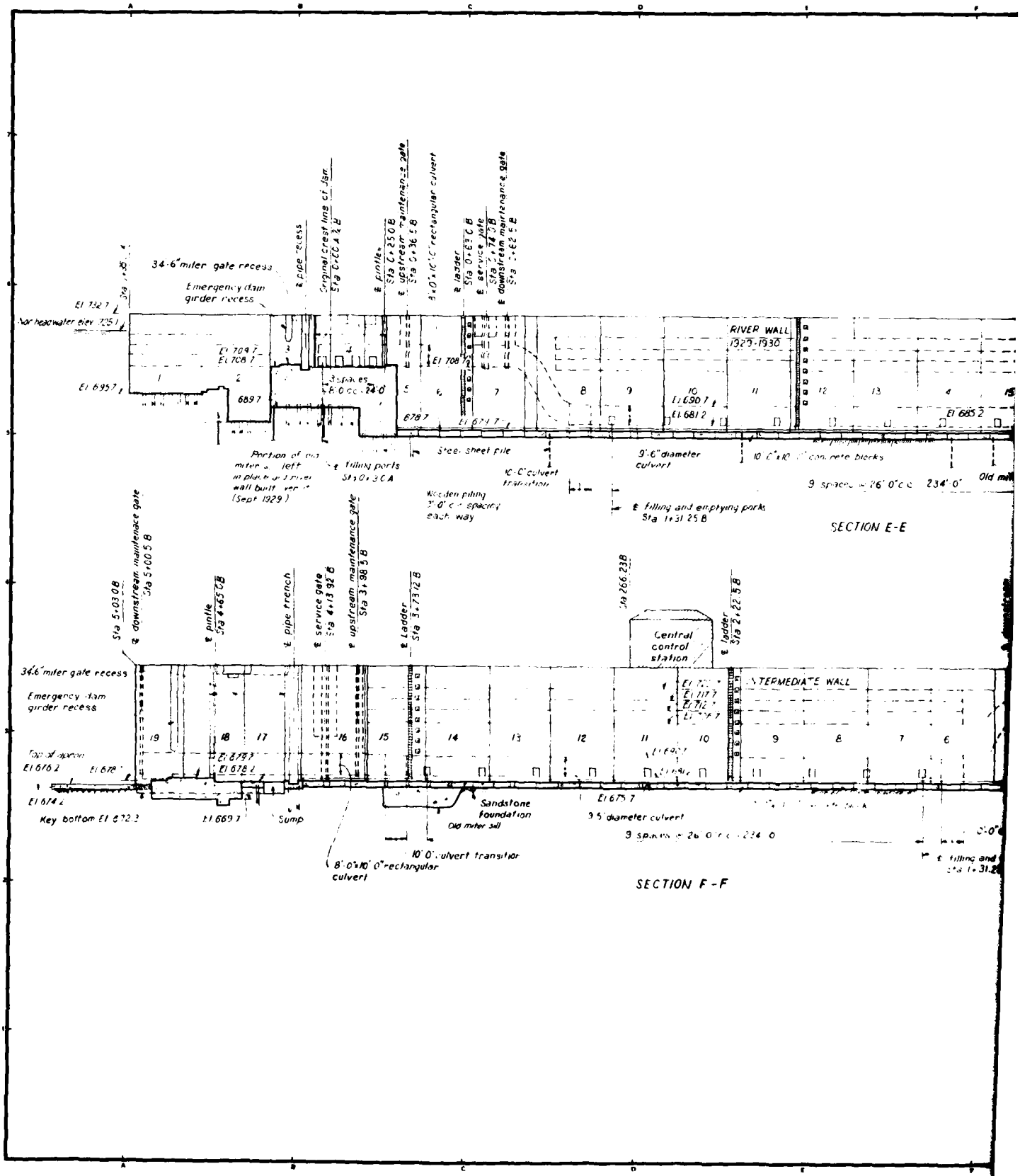
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1
EXISTING LOCK STRUCTURES
TRANSVERSE SECTIONS
SHEET 2

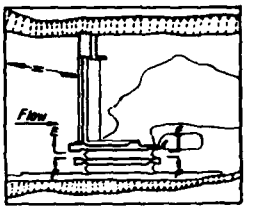
DATE: MARCH 1975

SCALE: | JOB NO.: | DRAWING NUMBER: | SHEET OF

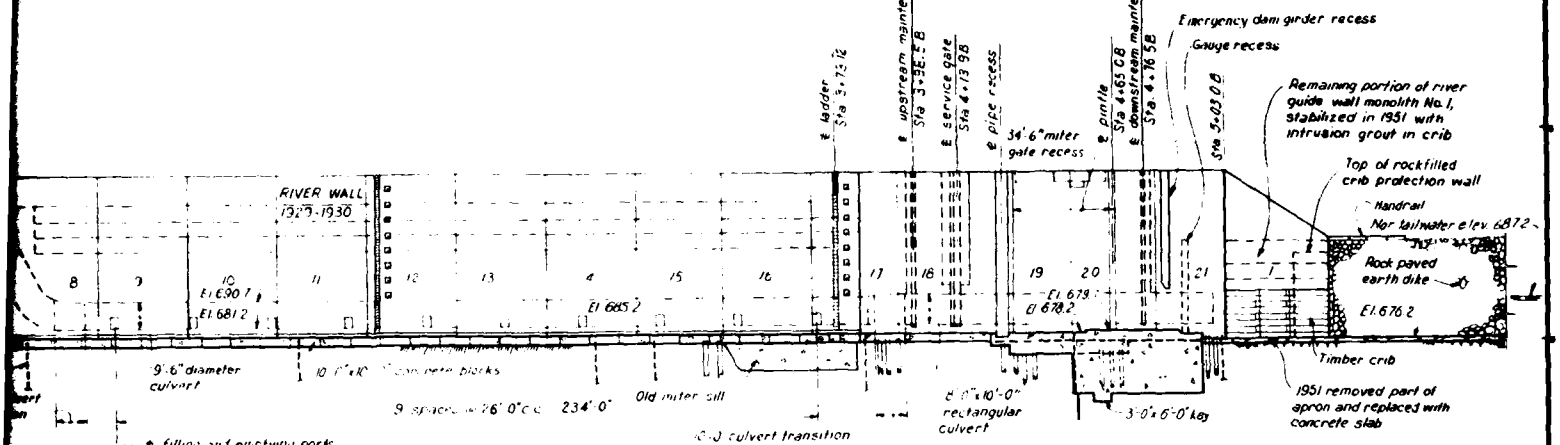
SAFETY PAYS

PLATE 5

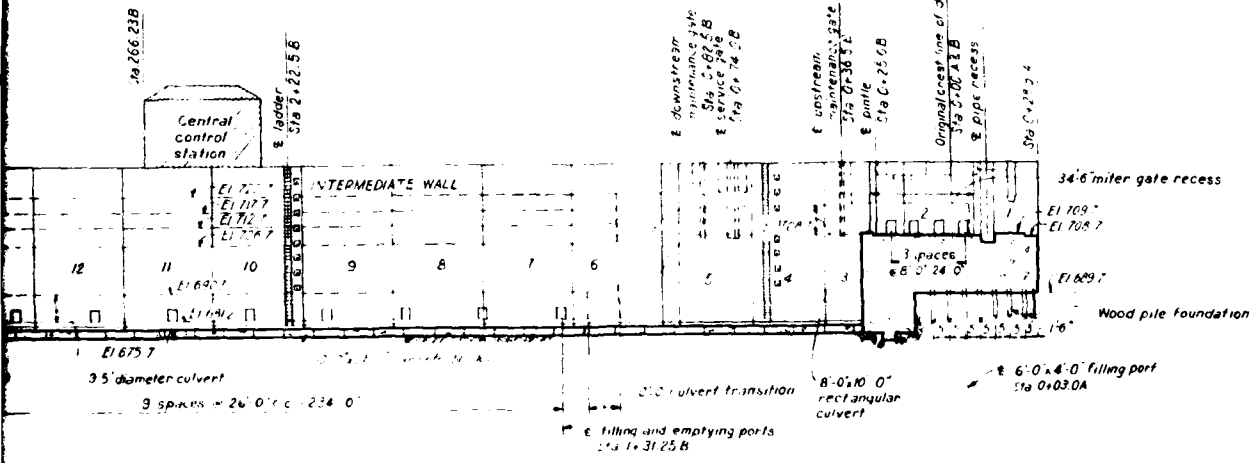

34'-6" miter gate recess
Emergency dam girder recess
℄ pipe recess
Original crest line of dam
℄ pintle Sta 0+25.0 B
℄ upstream maintenance gate Sta 0+36.5 B
8'-0" x 10'-0" rectangular culvert
℄ ladder Sta 0+83.0 B
℄ service gate Sta 0+74.3 B
℄ downstream maintenance gate Sta 1+02.5 B
El 732.7
Max headwater elev 725.1
El 709.7
El 708.7
El 695.7
3 spaces @ 8'-0" c.c. = 24'-0"
689.7
678.7
El 708.7
El 671.7
RIVER WALL 1929-1930
El 690.7
El 681.2
El 685.2
Portion of old miter sill left in place during river wall built (Sept 1929)
℄ filling ports Sta 0+93.0 A
Steel sheet pile
Wooden piling 3'-0" c.c. spacing each way
10'-0" culvert transition
9'-6" diameter culvert
10'-0" x 10'-0" concrete blocks
9 spaces @ 26'-0" c.c. = 234'-0"
Old miter
℄ filling and emptying ports Sta 1+31.25 B
SECTION E-E
Sta 5+03.0 B
℄ downstream maintenance gate Sta 5+00.5 B
℄ pintle Sta 4+65.0 B
℄ pipe trench
℄ service gate Sta 4+13.9 B
℄ upstream maintenance gate Sta 3+98.5 B
℄ ladder Sta 3+73.1 B
Sta 266.23 B
Central control station
℄ ladder Sta 2+22.5 B
34'-6" miter gate recess
Emergency dam girder recess
INTERMEDIATE WALL
El 679.7
El 676.2
El 678.7
El 674.2
Key bottom El 672.3
El 669.7
Sump
Sandstone foundation
Old miter sill
El 675.7
9'-5" diameter culvert
9 spaces @ 26'-0" c.c. = 234'-0"
10'-0" culvert transition
8'-0" x 10'-0" rectangular culvert
℄ filling and
Sta 1+31.2
SECTION F-F



KEY PLAN



SECTION E-E



SECTION F-F

SCALE 1" = 20'

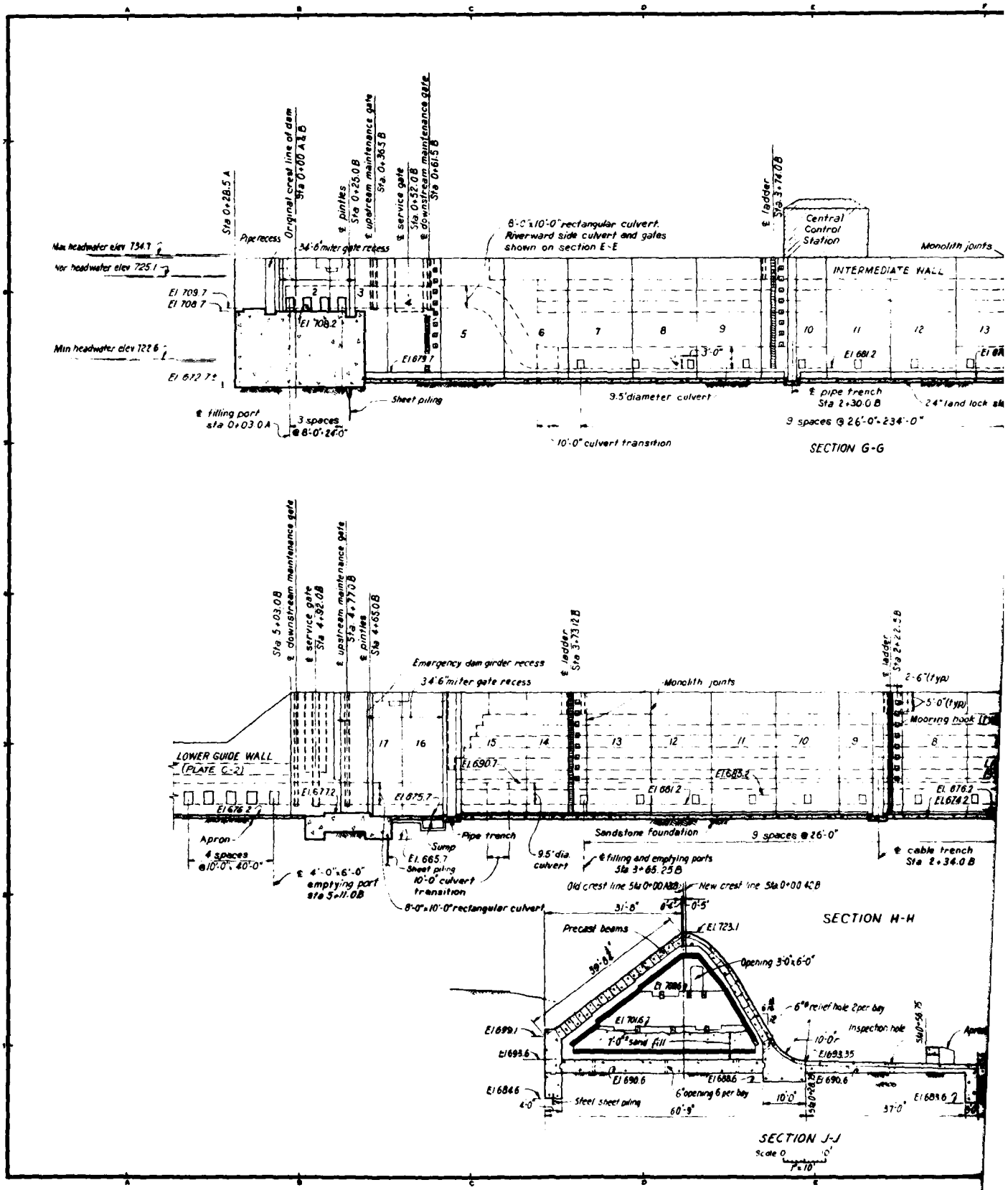
SYMBOL	DESCRIPTION	DATE	APPROVED
NARZA ENGINEERING COMPANY CHICAGO, ILLINOIS		DEPARTMENT OF THE ARMY ST PAUL DISTRICT CORPS OF ENGINEERS ST PAUL, MINNESOTA	
DESIGNED BY		STUDY OF ALTERNATIVES FOR REHABILITATION	
DRAWN BY E J M		MISSISSIPPI RIVER LOCK & DAM NO 1	
CHECKED BY R N M		EXISTING LOCK STRUCTURES	
SUBMITTED BY		LONGITUDINAL SECTIONS	
APPROVED		RIVERWARD LOCK	
		DATE MARCH 1975	
		DRAWING NUMBER	
		SHEET OF	

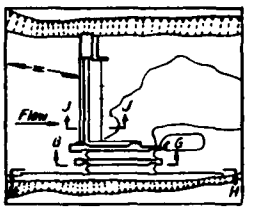
SAFETY PAYS

PLATE 6

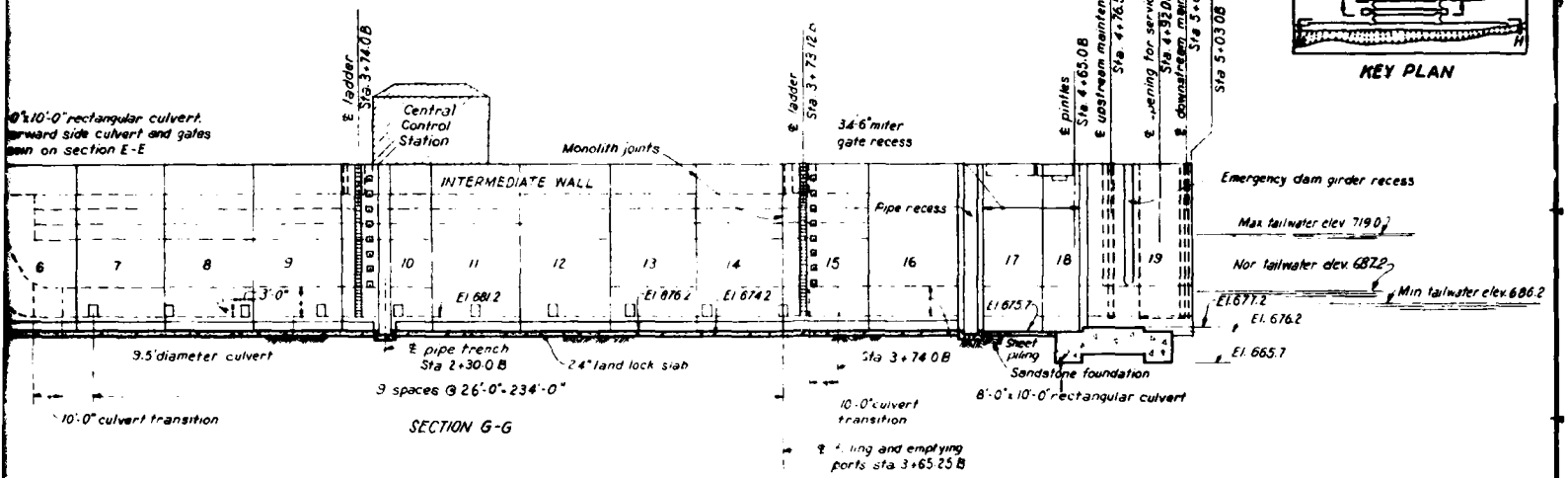
1

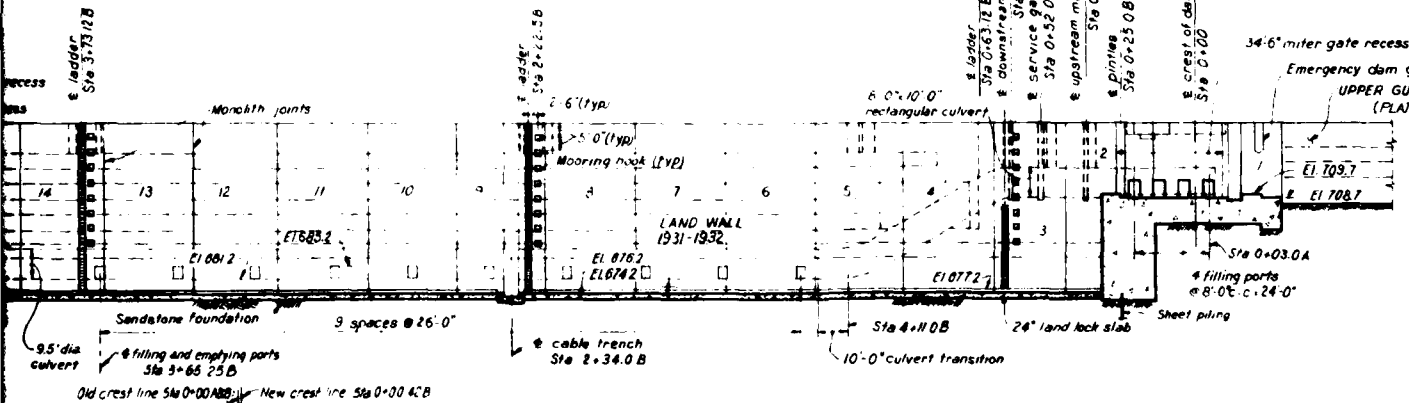
2

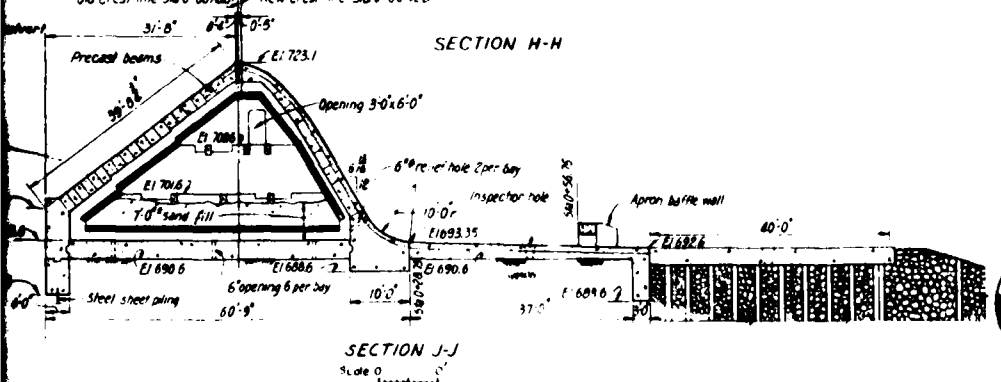

Sta 0+28.5 A
Original crest line of dam Sta 0+00 A&B
℄ pintles Sta 0+26.0 B
℄ upstream maintenance gate Sta 0+36.5 B
℄ service gate Sta 0+52.0 B
℄ downstream maintenance gate Sta 0+61.5 B
℄ ladder Sta 3+74.0 B
Central Control Station
Pipe recess
34'-6" miter gate recess
8'-0" x 10'-0" rectangular culvert. Riverward side culvert and gates shown on section E-E
Monolith joints
INTERMEDIATE WALL
Max headwater elev 734.1
Nor headwater elev 725.1
Min headwater elev 722.6
El 709.7
El 708.7
El 708.2
El 679.7
El 681.2
El 672.7
Sheet piling
9.5' diameter culvert
℄ pipe trench Sta 2+30.0 B
24" land lock
℄ filling port sta 0+03.0 A
3 spaces @ 8'-0" = 24'-0"
10'-0" culvert transition
9 spaces @ 26'-0" = 234'-0"
SECTION G-G
Sta 5+03.0 B
℄ downstream maintenance gate
℄ service gate Sta 4+82.0 B
℄ upstream maintenance gate Sta 4+77.0 B
℄ pintles Sta 4+65.0 B
Emergency dam girder recess
34'-6" miter gate recess
℄ ladder Sta 3+73.12 B
Monolith joints
℄ ladder Sta 2+22.2 B
2'-6" (typ)
5'-0" (typ)
Mooring hook
LOWER GUIDE WALL (PLATE C-2)
El 690.7
El 685.2
El 681.2
El 676.2
El 677.2
El 675.7
Apron 4 spaces @ 10'-0" = 40'-0"
℄ 4'-0" x 6'-0" emptying port sta 5+11.0 B
Sump
El. 665.7
Sheet piling
10'-0" culvert transition
Pipe trench
9.5' dia. culvert
Sandstone foundation
9 spaces @ 26'-0"
℄ filling and emptying ports Sta 3+65.25 B
℄ cable trench Sta 2+34.0 B
8'-0" x 10'-0" rectangular culvert
Old crest line Sta 0+00 A&B
New crest line Sta 0+00 A&B
SECTION H-H
Precast beams
Opening 3'-0" x 6'-0"
6" relief hole 2 per bay
Inspection hole
1'-0" sand fill
El 699.1
El 693.6
El 690.6
El 688.6
El 684.6
El 684.6
6" opening 6 per bay
Steel sheet piling
60'-9"
37'-0"
SECTION J-J
Scale 0 10'
1"=10'



KEY PLAN







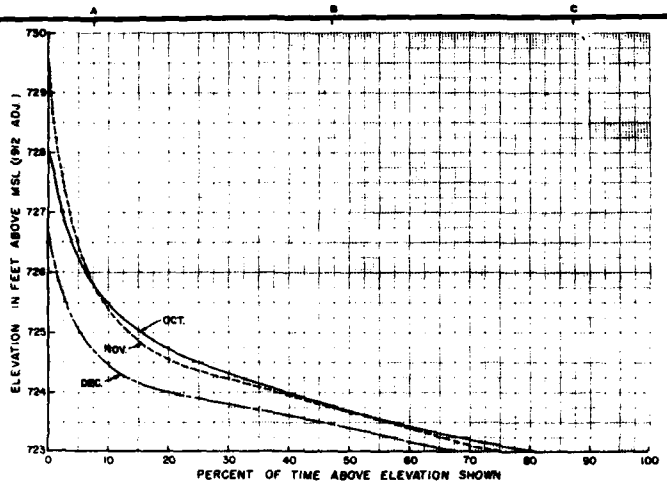
SCALE 1" = 20'
20 0 20'
Except as noted

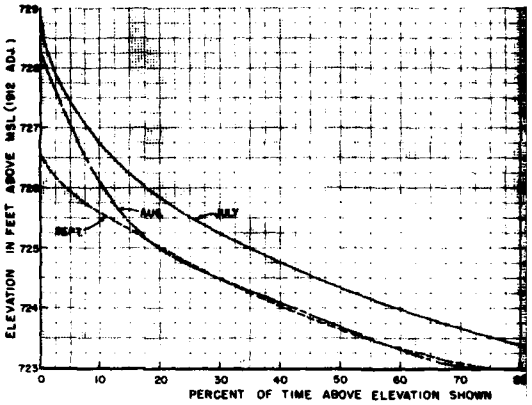
SAFETY PAYS

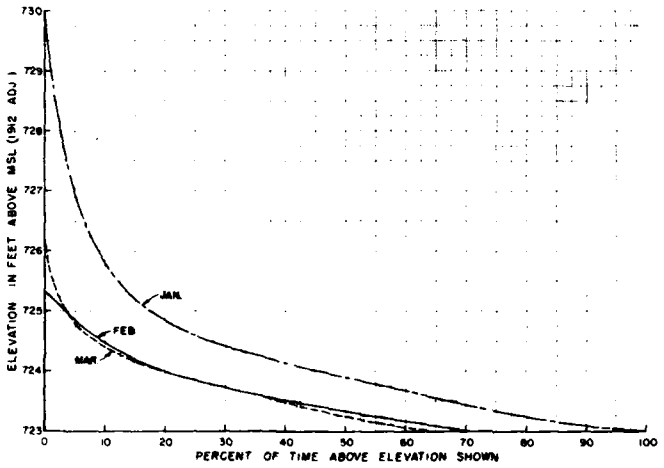
NO.	DESCRIPTION	DATE	APPROVED
	HARZA ENGINEERING COMPANY CHICAGO, ILLINOIS	DEPARTMENT OF THE ARMY ST PAUL DISTRICT CORPS OF ENGINEERS ST PAUL, MINNESOTA	
DESIGNED BY			
DRAWN BY	J B C		
CHECKED BY	R N M		
SUBMITTED BY			
APPROVED			

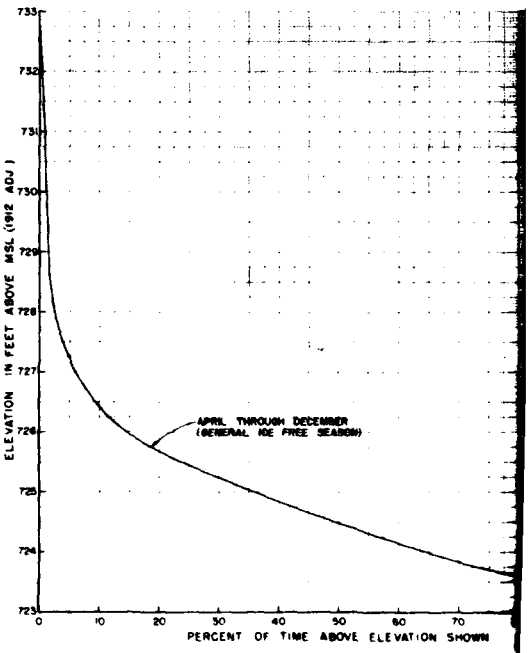
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1
EXISTING LOCK STRUCTURES
LONGITUDINAL SECTIONS
LANDWARD LOCK
DATE MARCH 1975
DRAWING NUMBER
SHEET OF

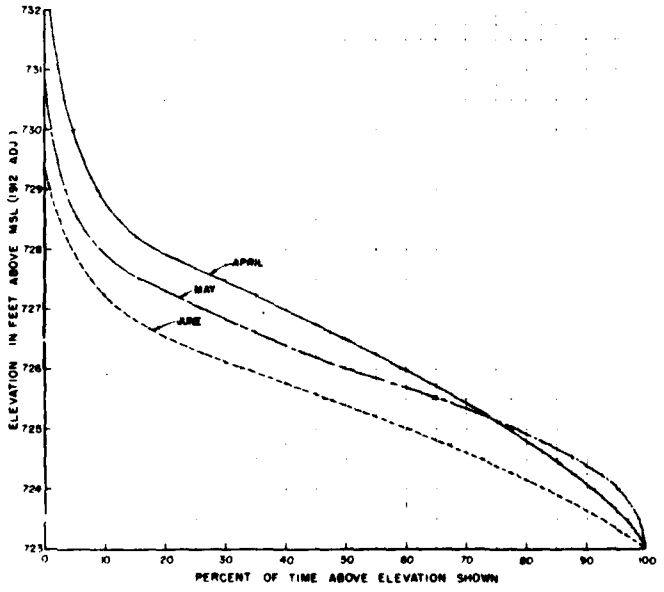
PLATE 7

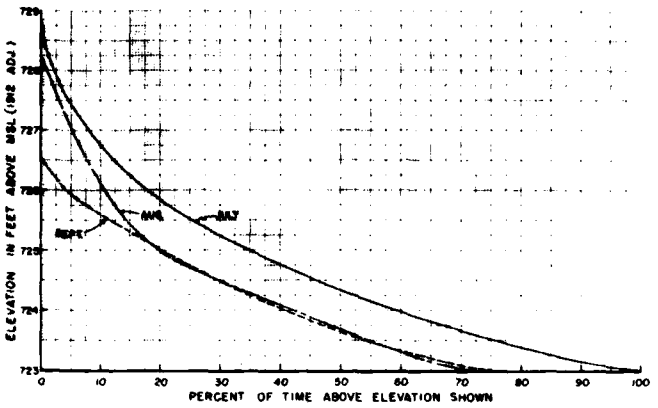

ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
PERCENT OF TIME ABOVE ELEVATION SHOWN
OCT.
NOV.
DEC.

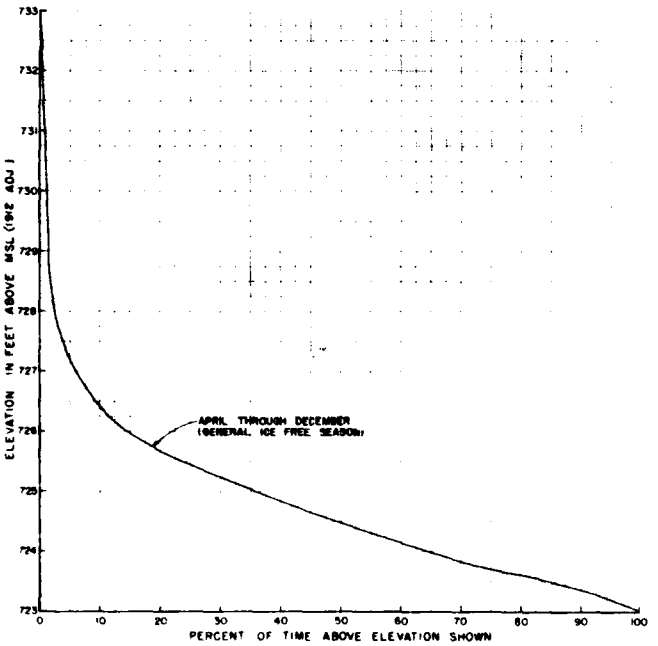

ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
PERCENT OF TIME ABOVE ELEVATION SHOWN
AUG.
JULY
SEPT.


ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
PERCENT OF TIME ABOVE ELEVATION SHOWN
JAN.
FEB
MAR


ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
PERCENT OF TIME ABOVE ELEVATION SHOWN
APRIL THROUGH DECEMBER
(GENERAL ICE FREE SEASON)


ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
PERCENT OF TIME ABOVE ELEVATION SHOWN
APRIL
MAY
JUNE





NOTES

1 ELEVATION DURATION CURVES ARE FOR THE LOCK AND DAM NO 1 HEADWATER FOR PERIOD JANUARY 1930 THROUGH DECEMBER 1972

2 HEADWATER STAGE HYDROGRAPHS ARE AVAILABLE FROM THE RESERVOIR REGULATING SECTION OF THE ST PAUL DISTRICT CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

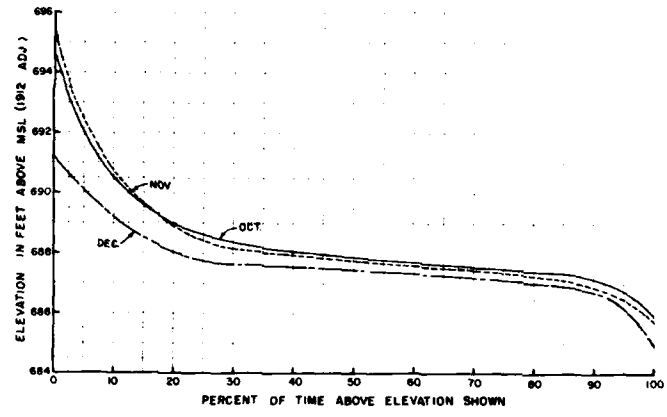
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER - LOCK & DAM NO 1

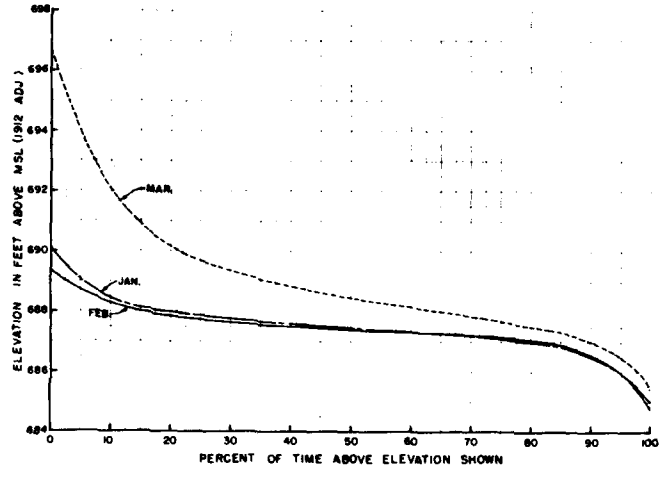
HEADWATER
ELEVATION DURATION CURVES

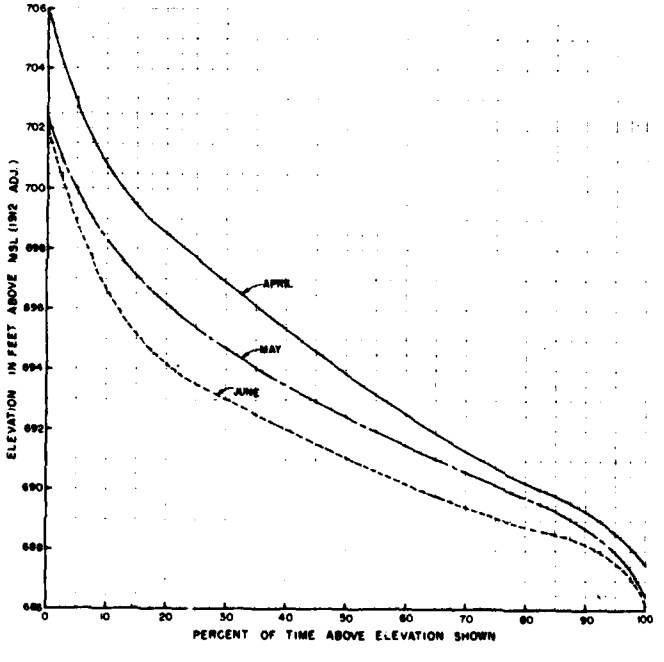
DRAWN BY: W J V
SUBMITTED BY:
APPROVED:
DATE:
SCALE: AS SHOWN

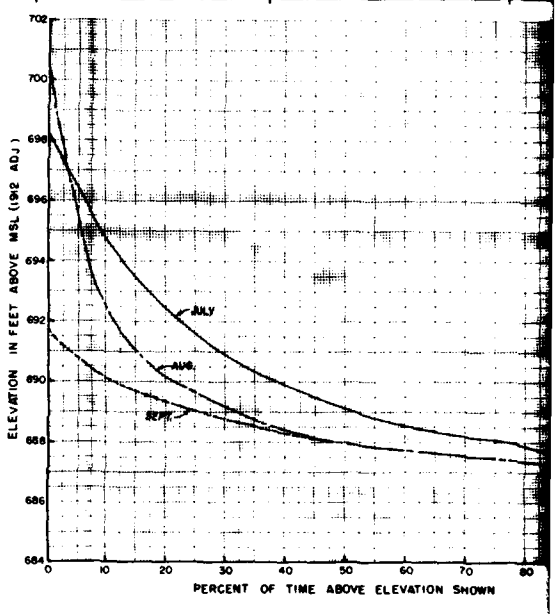
SAFETY PAYS

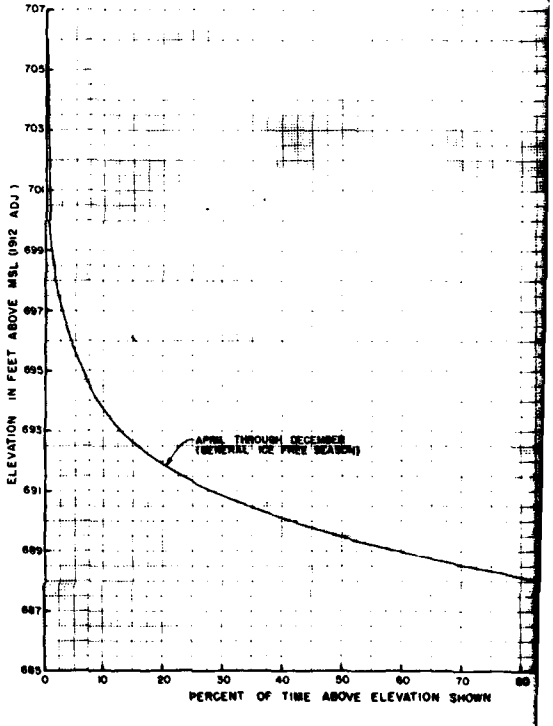
PLATE 8

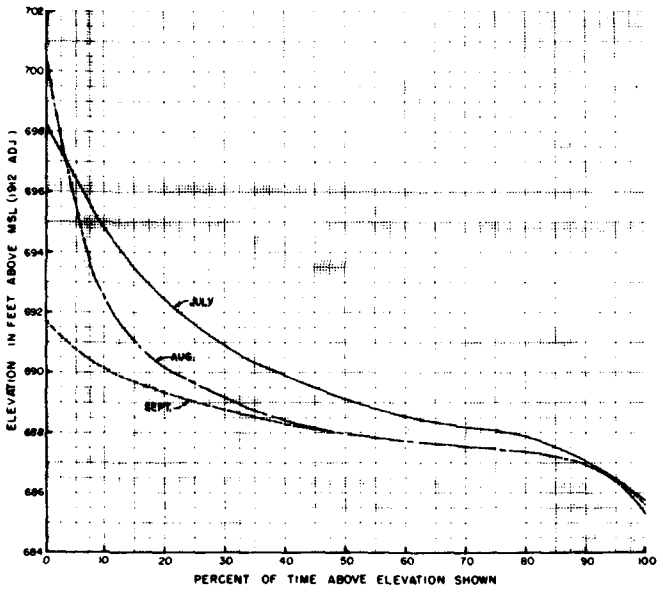

ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
NOV.
OCT.
DEC.
PERCENT OF TIME ABOVE ELEVATION SHOWN

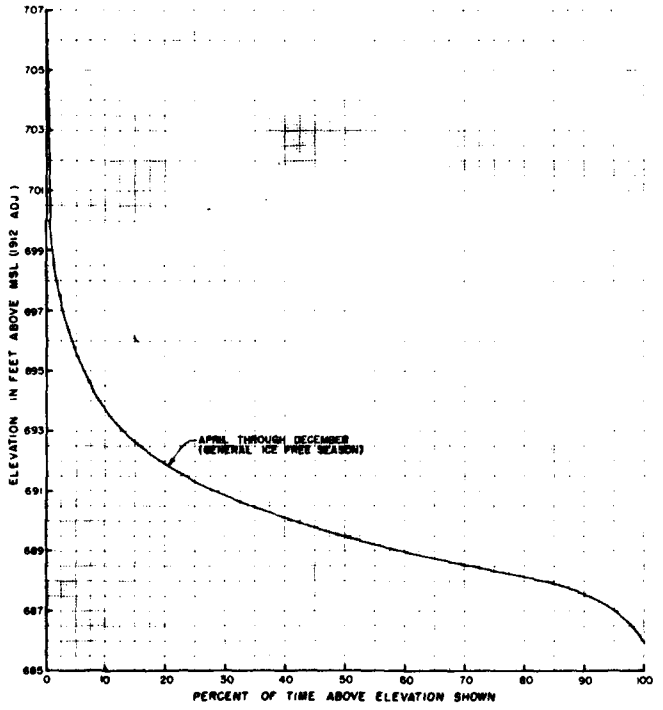

ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
MAR.
JAN.
FEB.
PERCENT OF TIME ABOVE ELEVATION SHOWN


ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
APRIL
MAY
JUNE
PERCENT OF TIME ABOVE ELEVATION SHOWN


ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
JULY
AUG.
SEPT.
PERCENT OF TIME ABOVE ELEVATION SHOWN


ELEVATION IN FEET ABOVE MSL (1912 ADJ.)
APRIL THROUGH DECEMBER
(GENERAL ICE FREE SEASON)
PERCENT OF TIME ABOVE ELEVATION SHOWN





NOTES

1 ELEVATION DURATION CURVES ARE FOR THE LUCK AND DAM NO 1 TAILWATER FOR PERIOD JANUARY 1930 THROUGH DECEMBER 1972

2 TAILWATER STAGE HYDROGRAPHS ARE AVAILABLE FROM THE RESERVOIR REGULATING SECTION OF THE ST PAUL DISTRICT, CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

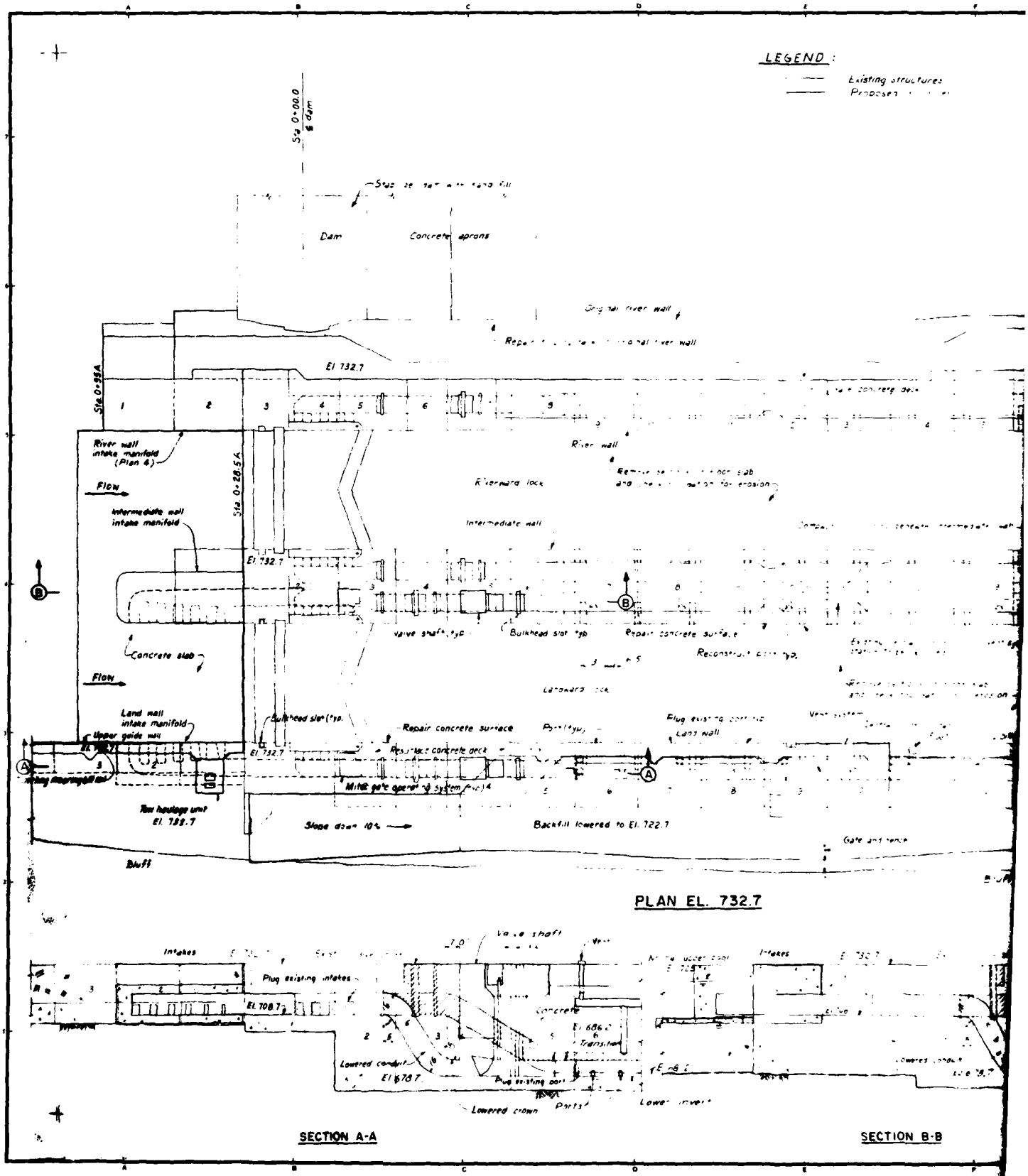
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER - LOCK & DAM NO 1

TAILWATER
ELEVATION DURATION CURVES

DESIGNED BY: W J V
SUBMITTED BY:
APPROVED
DATE
SCALE: AS SHOWN
SHEET OF

SAFETY PAYS

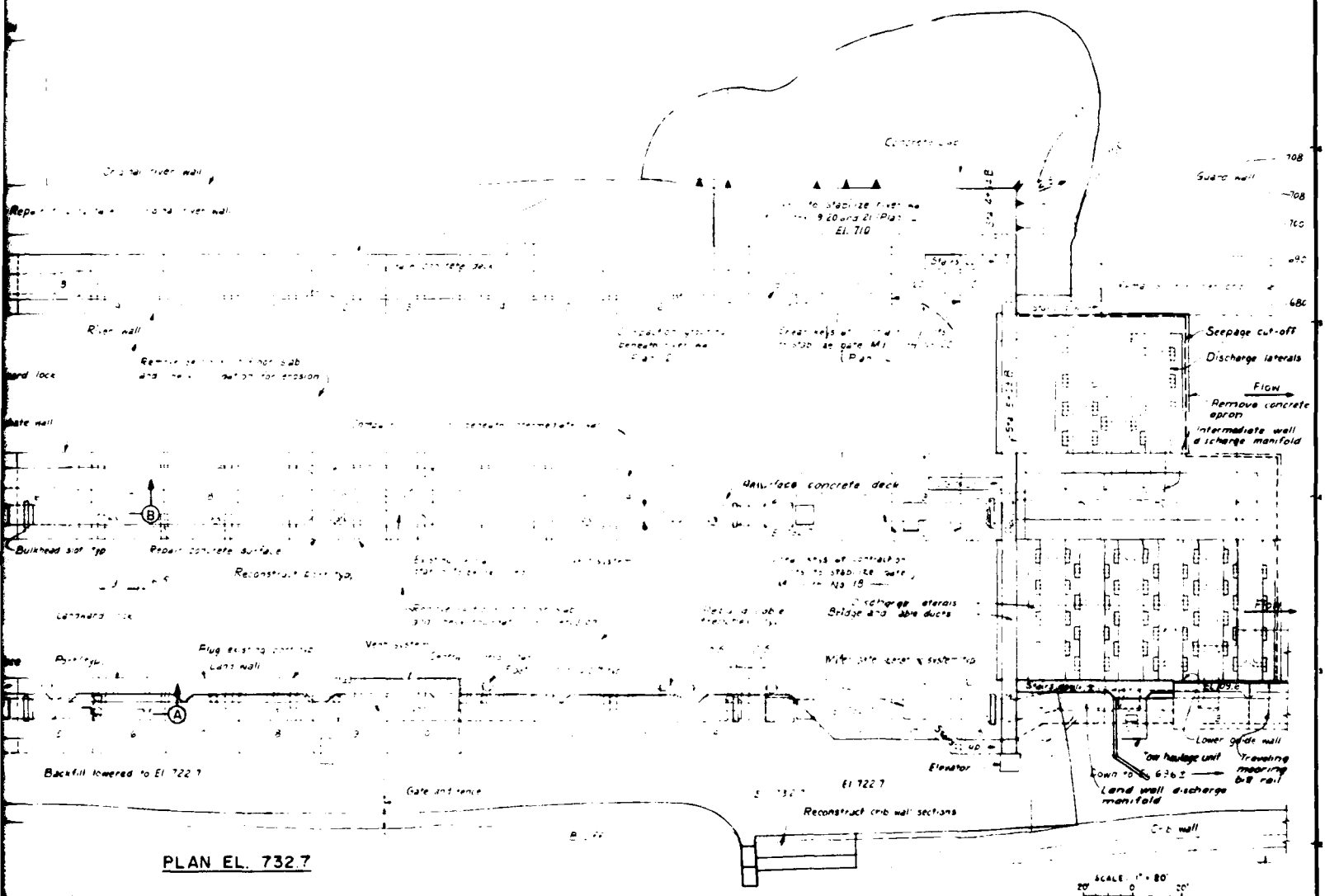
PLATE 9


LEGEND :
Existing structures
Sta 0+00.0 ℄ dam
Dam
Concrete aprons
Original river wall
El 732.7
Sta 0+39A
River wall intake manifold (Plan 6)
Flow
Sta 0+28.5A
Intermediate wall intake manifold
Riverward lock
Intermediate wall
Valve shaft, typ
Bulkhead slot typ
Repair concrete surface
Concrete slab
Flow
Landward lock
Land wall intake manifold
Upper guide wall
Bulkhead slot (typ.
Repair concrete deck
Plug existing conduits
Land wall
Miter gate operating system (typ.) 4
Tow haulage unit El. 732.7
Slope down 10%
Backfill lowered to El. 722.7
Gate and fence
Bluff
PLAN EL. 732.7
Intakes
Plug existing intakes
El. 708.7
Valve shaft
Concrete
El. 686.0
Transition
Lowered conduit
El 678.7
Plug existing conduits
Lowered crown
Lower invert
SECTION A-A
SECTION B-B

LEGEND :

Existing structures

Proposed



PLAN EL. 732.7

SECTION B-B

HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1

PROPOSED MODIFICATIONS
PLANS NO. 1, 2 AND 3

DESIGNED BY M T N & V T
DRAWN BY T E V
CHECKED BY V T
SUBMITTED BY
APPROVED

DATE JAN 1976

SCALE AS SHOWN

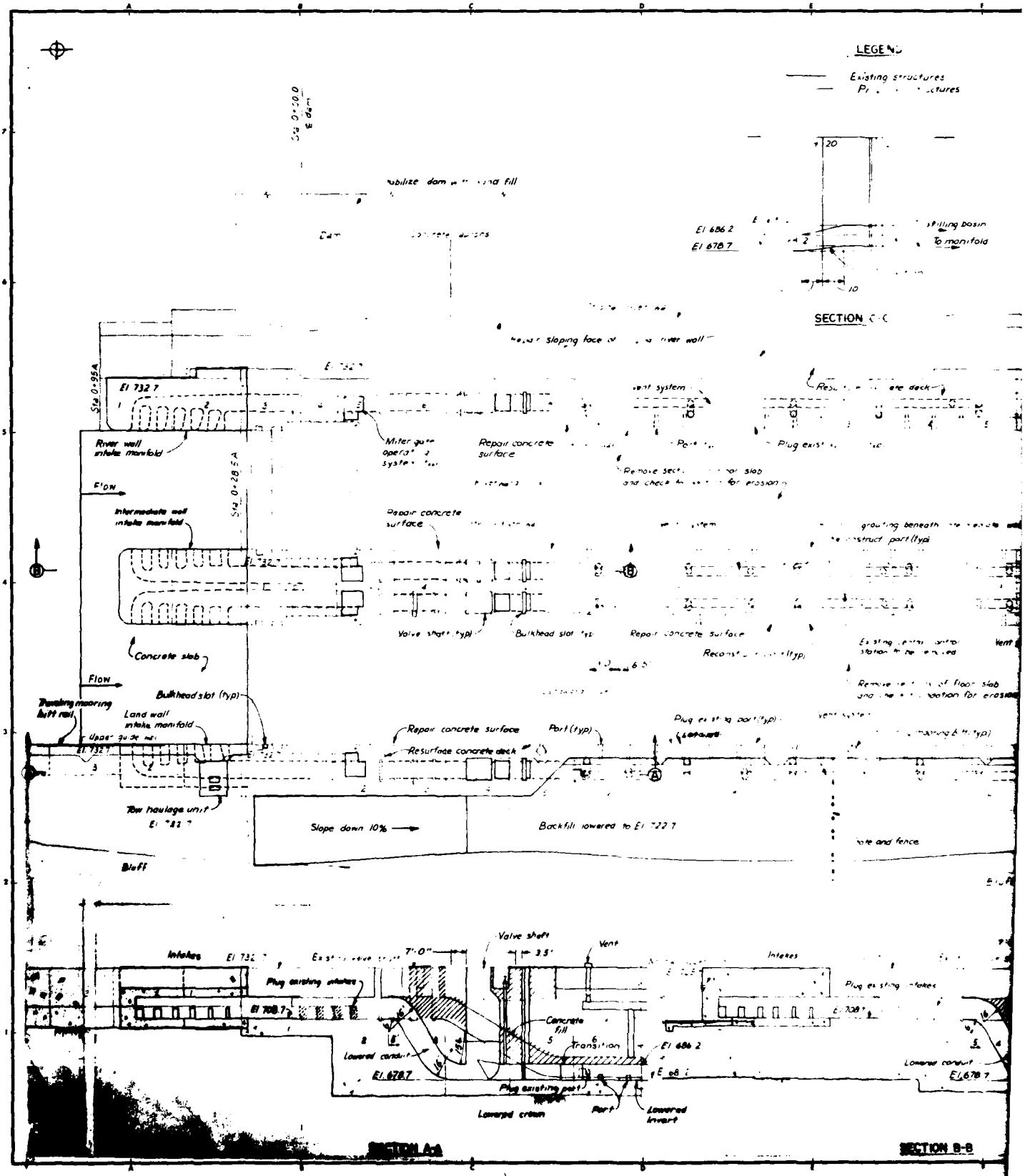
DRAWING NUMBER

SHEET OF

SAFETY PAYS

PLATE 10

1 2


LEGEND
Existing structures
SECTION C-C
El 686.2
El 678.7
Spilling basin
To manifold
El 732.7
River wall intake manifold
Flow
Intermediate wall intake manifold
Concrete slab
Bulkhead slot (typ)
Land wall intake manifold
Tow haulage unit
Slope down 10%
Backfill lowered to El 722.7
Bluff
Repair concrete surface
Resurface concrete deck
Port (typ)
Valve shaft
Vent
Intakes
Plug existing intakes
Concrete fill
Transition
Lowered conduit
Plug existing port
Lowered crown
Lowered invert
SECTION A-A
SECTION B-B

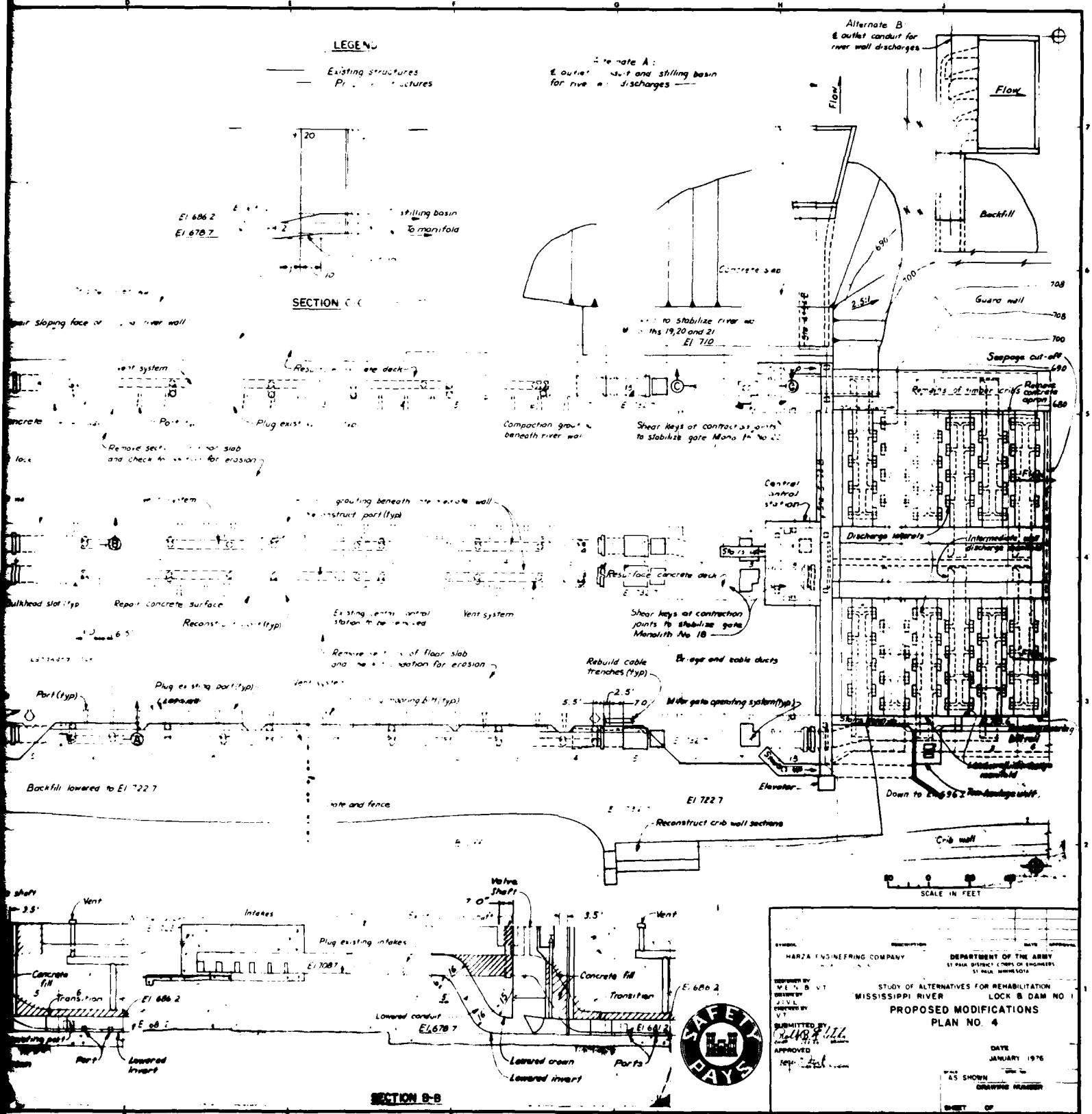
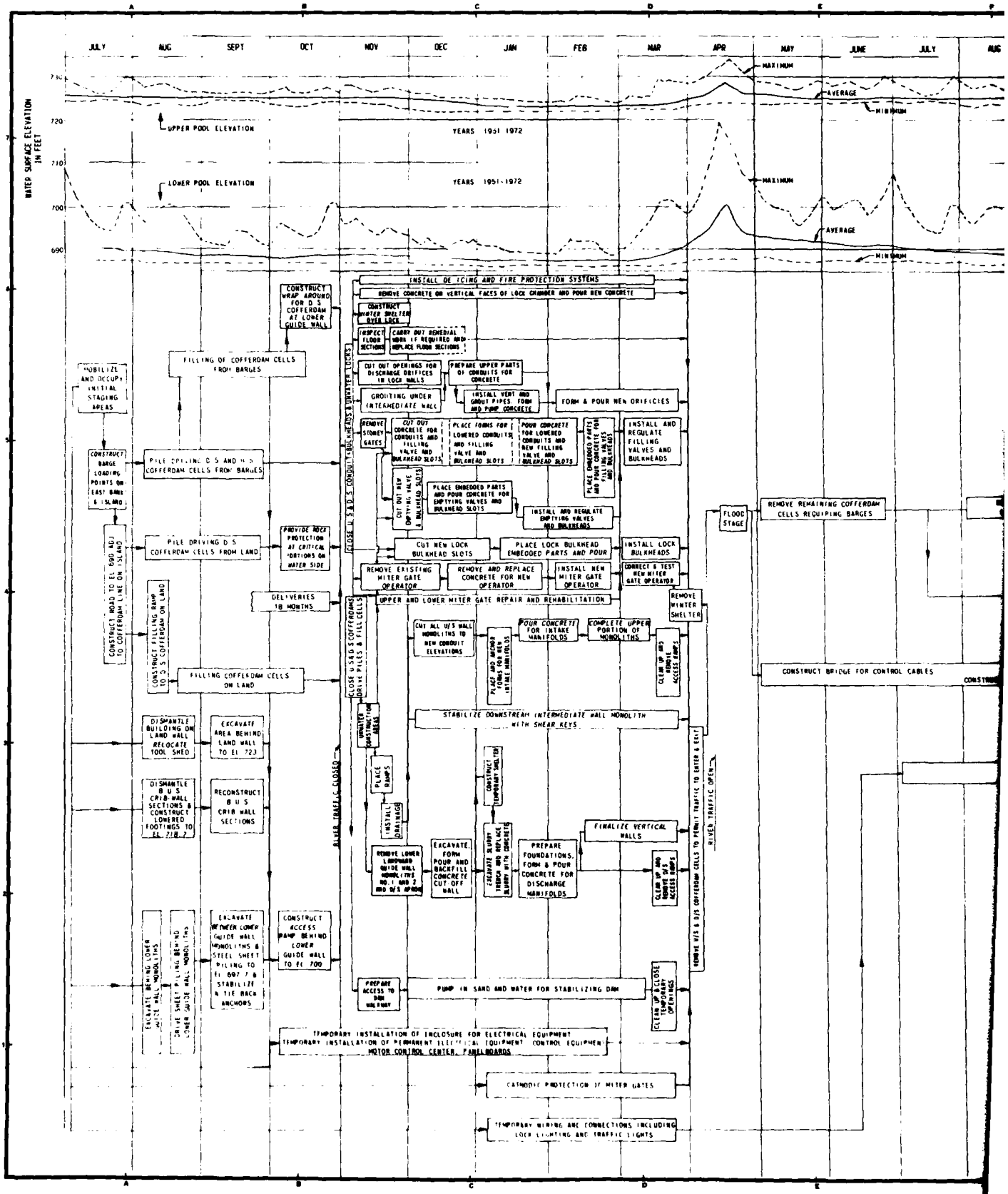
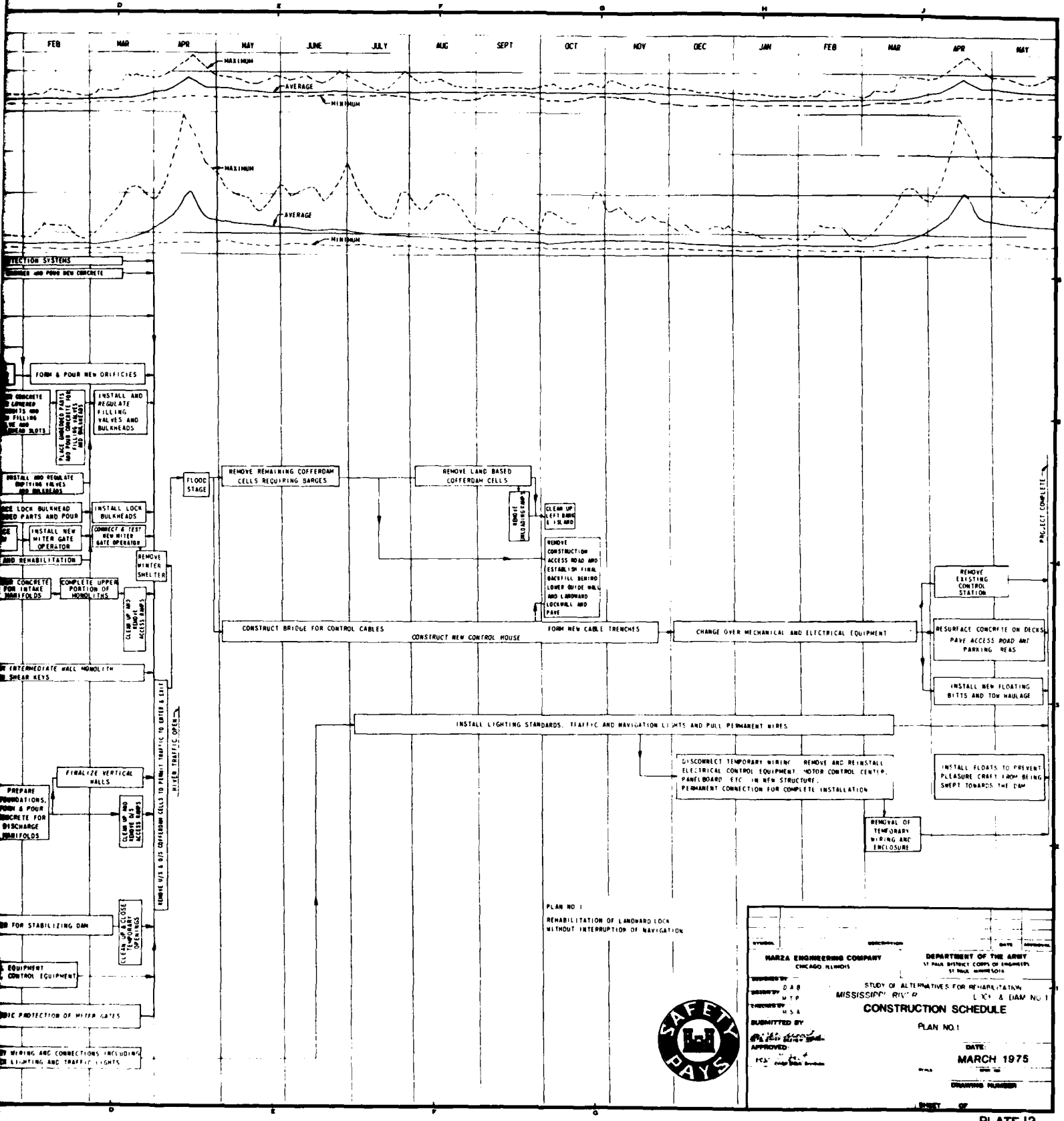

LEGEND
Existing structures
Alternate A:
Alternate B
E outlet conduit for river wall discharges
Flow
Backfill
Guard wall
Seepage cut-off
Remains of timber cribs
Remove concrete apron
Central control station
Discharge laterals
Intermediate pier discharge
Shear keys at contraction joints to stabilize gate Monolith No 18
Rebuild cable trenches (typ)
Bridge and cable ducts
Miter gate operating system (typ)
Elevator
Down to El 696.2
Backfill lowered to El 722.7
El 722.7
Reconstruct crib wall sections
Crib wall
SCALE IN FEET
SECTION C-C
El 686.2
El 678.7
stilling basin
To manifold
Concrete slab
El 710
Compaction grout beneath river wall
Plug existing ports
Remove section of floor slab and check for erosion
Repair concrete surface
Reconstruct floor (typ)
Existing central control station to be removed
Vent system
Remove section of floor slab and check foundation for erosion
Plug existing port (typ)
Port (typ)
Lowered invert
Valve shaft
Vent
Intakes
Plug existing intakes
El 708.7
Concrete fill
Transition
Lowered conduit
El 678.7
Lowered crown
Ports
SECTION B-B
SAFETY PAYS
HARZA ENGINEERING COMPANY
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1
PROPOSED MODIFICATIONS
PLAN NO. 4
DATE
JANUARY 1976
AS SHOWN
DRAWING NUMBER
SHEET OF

PLATE 11


JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
WATER SURFACE ELEVATION IN FEET
MAXIMUM
AVERAGE
MINIMUM
UPPER POOL ELEVATION
YEARS 1951 1972
LOWER POOL ELEVATION
YEARS 1951-1972
INSTALL DE ICING AND FIRE PROTECTION SYSTEMS
REMOVE CONCRETE ON VERTICAL FACES OF LOCK CHAMBER AND POUR NEW CONCRETE
CONSTRUCT WRAP AROUND FOR D S COFFERDAM AT LOWER GUIDE WALL
CONSTRUCT WATER SHELTER OVER LOCK
INSPECT FLOOR SECTIONS
CARRY OUT REMEDIAL WORK IF REQUIRED AND REPLACE FLOOR SECTIONS
MOBILIZE AND OCCUPY INITIAL STAGING AREAS
FILLING OF COFFERDAM CELLS FROM BARGES
CUT OUT OPENINGS FOR DISCHARGE ORIFICES IN LOCK WALLS
PREPARE UPPER PARTS OF CONDUITS FOR CONCRETE
GROUTING UNDER INTERMEDIATE WALL
INSTALL VENT AND GROUT PIPES, FORM AND PUMP CONCRETE
FORM & POUR NEW ORIFICES
CONSTRUCT BARGE LOADING POINTS ON EAST BANK & ISLAND
PILE DRIVING D S COFFERDAM CELLS FROM BARGES
REMOVE STONEY GATES
CUT OUT CONCRETE FOR CONDUITS AND FILLING VALVE AND BULKHEAD SLOTS
PLACE FORMS FOR LOWERED CONDUITS AND FILLING VALVE AND BULKHEAD SLOTS
POUR CONCRETE FOR LOWERED CONDUITS AND NEW FILLING VALVE AND BULKHEADS
PLACE EMBEDDED PARTS AND POUR CONCRETE FOR FILLING VALVES AND BULKHEADS
INSTALL AND REGULATE FILLING VALVES AND BULKHEADS
CLOSE U S & D S CONDUIT BULKHEADS & DEWATER LOCKS
CUT OUT NEW OPTIONAL VALVE & BULKHEAD SLOTS
PLACE EMBEDDED PARTS AND POUR CONCRETE FOR EMPTYING VALVES AND BULKHEADS
INSTALL AND REGULATE EMPTYING VALVES AND BULKHEADS
FLOOD STAGE
REMOVE REMAINING COFFERDAM CELLS REQUIRING BARGES
CONSTRUCT ROAD TO EL 690 ADJ TO COFFERDAM LINE ON ISLAND
PILE DRIVING D S COFFERDAM CELLS FROM LAND
PROVIDE ROCK PROTECTION AT CRITICAL LOCATIONS ON WATER SIDE
CUT NEW LOCK BULKHEAD SLOTS
PLACE LOCK BULKHEAD EMBEDDED PARTS AND POUR
INSTALL LOCK BULKHEADS
REMOVE EXISTING MITER GATE OPERATOR
REMOVE AND REPLACE CONCRETE FOR NEW OPERATOR
INSTALL NEW MITER GATE OPERATOR
CONNECT & TEST NEW MITER GATE OPERATOR
CONSTRUCT FILLING RAMP TO D S COFFERDAM ON LAND
DELIVERIES 18 MONTHS
UPPER AND LOWER MITER GATE REPAIR AND REHABILITATION
REMOVE WINTER SHELTER
CUT ALL U/S WALL MONOLITHS TO NEW CONDUIT ELEVATIONS
POUR CONCRETE FOR INTAKE MANIFOLDS
COMPLETE UPPER PORTION OF MONOLITHS
CLEAN UP AND REMOVE U/S ACCESS RAMPS
CONSTRUCT BRIDGE FOR CONTROL CABLES
CONSTRUCT
FILLING COFFERDAM CELLS ON LAND
CLOSE U S & D S COFFERDAMS DRIVE PILES & FILL CELLS
PLACE AND MONOLITH FORMS FOR INTAKE MANIFOLDS
STABILIZE DOWNSTREAM INTERMEDIATE WALL MONOLITH WITH SHEAR KEYS
DISMANTLE BUILDING ON LAND WALL RELOCATE TOOL SHED
EXCAVATE AREA BEHIND LAND WALL TO EL 723
UNWATER CONSTRUCTION AREAS
PLACE RAMPS
CONSTRUCT TEMPORARY SHELTER
INSTALL DRAINAGE
DISMANTLE B U S CRIB WALL SECTIONS & CONSTRUCT LOWERED FOOTINGS TO EL 718.7
RECONSTRUCT B U S CRIB WALL SECTIONS
RIVER TRAFFIC CLOSED
REMOVE LOWER LANDWARD GUIDE WALL MONOLITHS NO. 1 AND 2 AND U/S APRON
EXCAVATE FORM POUR AND BACKFILL CONCRETE CUT-OFF WALL
EXCAVATE SLURRY TRENCH AND BACKFILL WITH CONCRETE
PREPARE FOUNDATIONS, FORM & POUR CONCRETE FOR DISCHARGE MANIFOLDS
FINALIZE VERTICAL WALLS
CLEAN UP AND REMOVE U/S ACCESS RAMPS
REMOVE U/S & D/S COFFERDAM CELLS TO PERMIT TRAFFIC TO ENTER & EXIT
RIVER TRAFFIC OPEN
EXCAVATE BEHIND LOWER GUIDE WALL MONOLITHS
DRIVE SHEET PILING BEHIND LOWER GUIDE WALL MONOLITHS
EXCAVATE BETWEEN LOWER GUIDE WALL MONOLITHS & STEEL SHEET PILING TO EL 697.7 & STABILIZE N TIE BACK ANCHORS
CONSTRUCT ACCESS RAMP BEHIND LOWER GUIDE WALL TO EL 700
PREPARE ACCESS TO DAM WALKWAY
PUMP IN SAND AND WATER FOR STABILIZING DAM
CLEAN UP & CLOSE TEMPORARY OPENINGS
TEMPORARY INSTALLATION OF ENCLOSURE FOR ELECTRICAL EQUIPMENT
TEMPORARY INSTALLATION OF PERMANENT ELECTRICAL EQUIPMENT CONTROL EQUIPMENT MOTOR CONTROL CENTER, PANELBOARDS
CATHODIC PROTECTION OF MITER GATES
TEMPORARY WIRING AND CONNECTIONS INCLUDING LOCK LIGHTING AND TRAFFIC LIGHTS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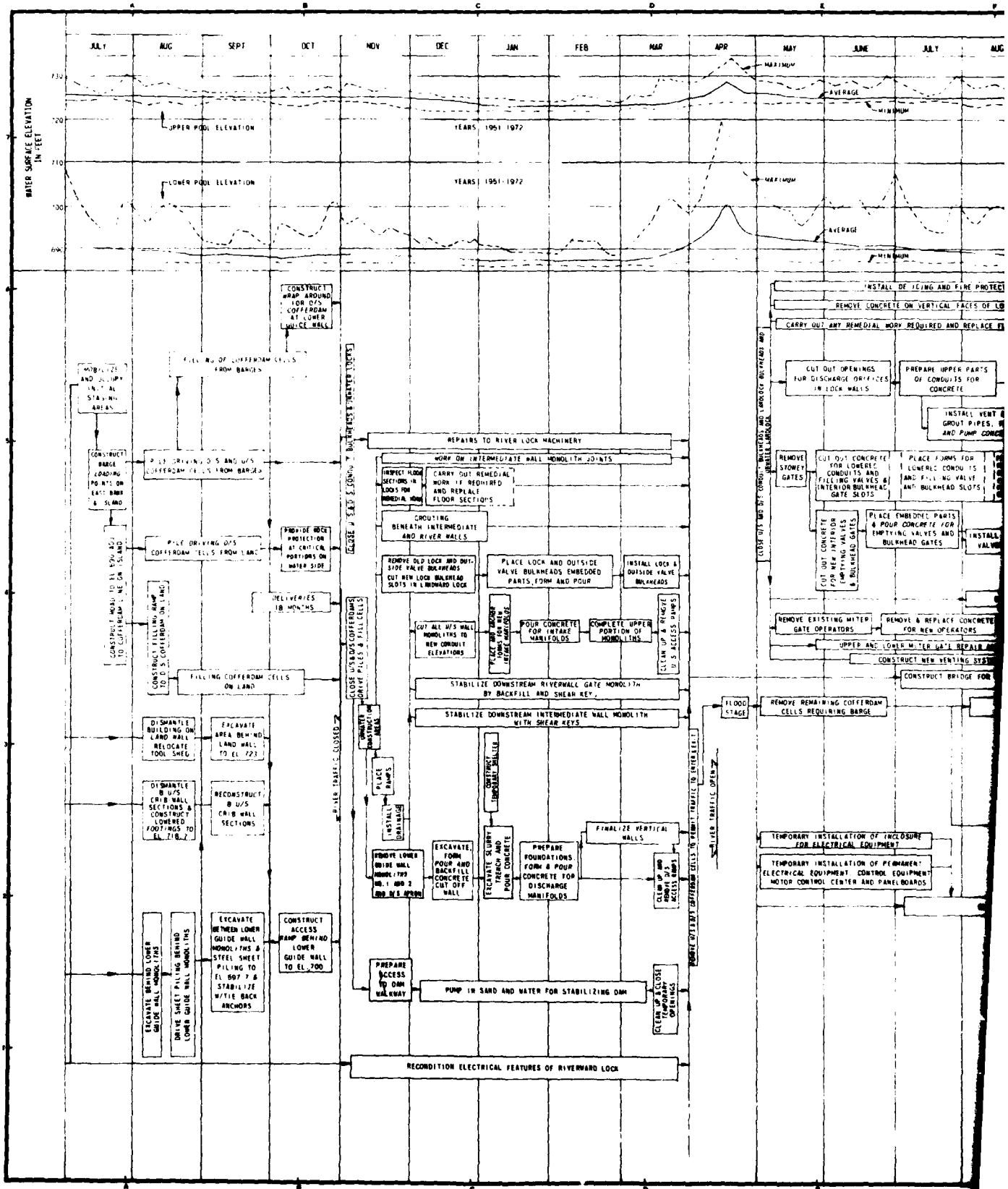
FORM & POUR NEW ORIFICIES
INSTALL AND REGULATE FILLING VALVES AND BULKHEADS
INSTALL LOCK BULKHEADS
INSTALL NEW MITER GATE OPERATOR
CONNECT & TEST NEW MITER GATE OPERATOR
REMOVE WINTER SHELTER
COMPLETE UPPER PORTION OF MONOLITHS
FINALIZE VERTICAL WALLS
FLOOD STAGE
REMOVE REMAINING COFFERDAM CELLS REQUIRING BARGES
REMOVE LAND BASED COFFERDAM CELLS
REMOVE UNLOADING RAMPS
CLEAR UP LEFT BANK & ISLAND
REMOVE CONSTRUCTION ACCESS ROAD AND ESTABLISH FINAL BACKFILL BEHIND LOWER GUIDE WALL AND LANDWARD LOCKWALL AND PAVE
CONSTRUCT BRIDGE FOR CONTROL CABLES
CONSTRUCT NEW CONTROL HOUSE
FORM NEW CABLE TRENCHES
CHANGE OVER MECHANICAL AND ELECTRICAL EQUIPMENT
REMOVE EXISTING CONTROL STATION
RESURFACE CONCRETE ON DECKS
PAVE ACCESS ROAD AND PARKING AREAS
INSTALL NEW FLOATING BITTS AND TOW HAULAGE
PROJECT COMPLETE
INSTALL LIGHTING STANDARDS, TRAFFIC AND NAVIGATION LIGHTS AND PULL PERMANENT WIRES
DISCONNECT TEMPORARY WIRING, REMOVE AND REINSTALL ELECTRICAL CONTROL EQUIPMENT, MOTOR CONTROL CENTER, PANELBOARD, ETC. IN NEW STRUCTURE, PERMANENT CONNECTION FOR COMPLETE INSTALLATION
REMOVAL OF TEMPORARY WIRING AND ENCLOSURE
INSTALL FLOATS TO PREVENT PLEASURE CRAFT FROM BEING SWEPT TOWARDS THE DAM
REMOVE U/S & D/S COFFERDAM CELLS TO PERMIT TRAFFIC TO ENTER & EXIT
MIXED TRAFFIC OPEN
CLEAN UP & CLOSE TEMPORARY OPENINGS
CLEAN UP AND REMOVE D/S ACCESS RAMPS
CLEAN UP AND REMOVE U/S ACCESS RAMPS
PREPARE FOUNDATIONS, FORM & POUR CONCRETE FOR DISCHARGE MANIFOLDS
PLAN NO 1
REHABILITATION OF LANDWARD LOCK WITHOUT INTERRUPTION OF NAVIGATION
HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA
DRAWN BY D A B
DESIGNED BY M T P
CHECKED BY M S A
SUBMITTED BY
APPROVED
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1
CONSTRUCTION SCHEDULE
PLAN NO 1
DATE
MARCH 1975
DRAWING NUMBER
SHEET OF
SAFETY PAYS

PLATE 12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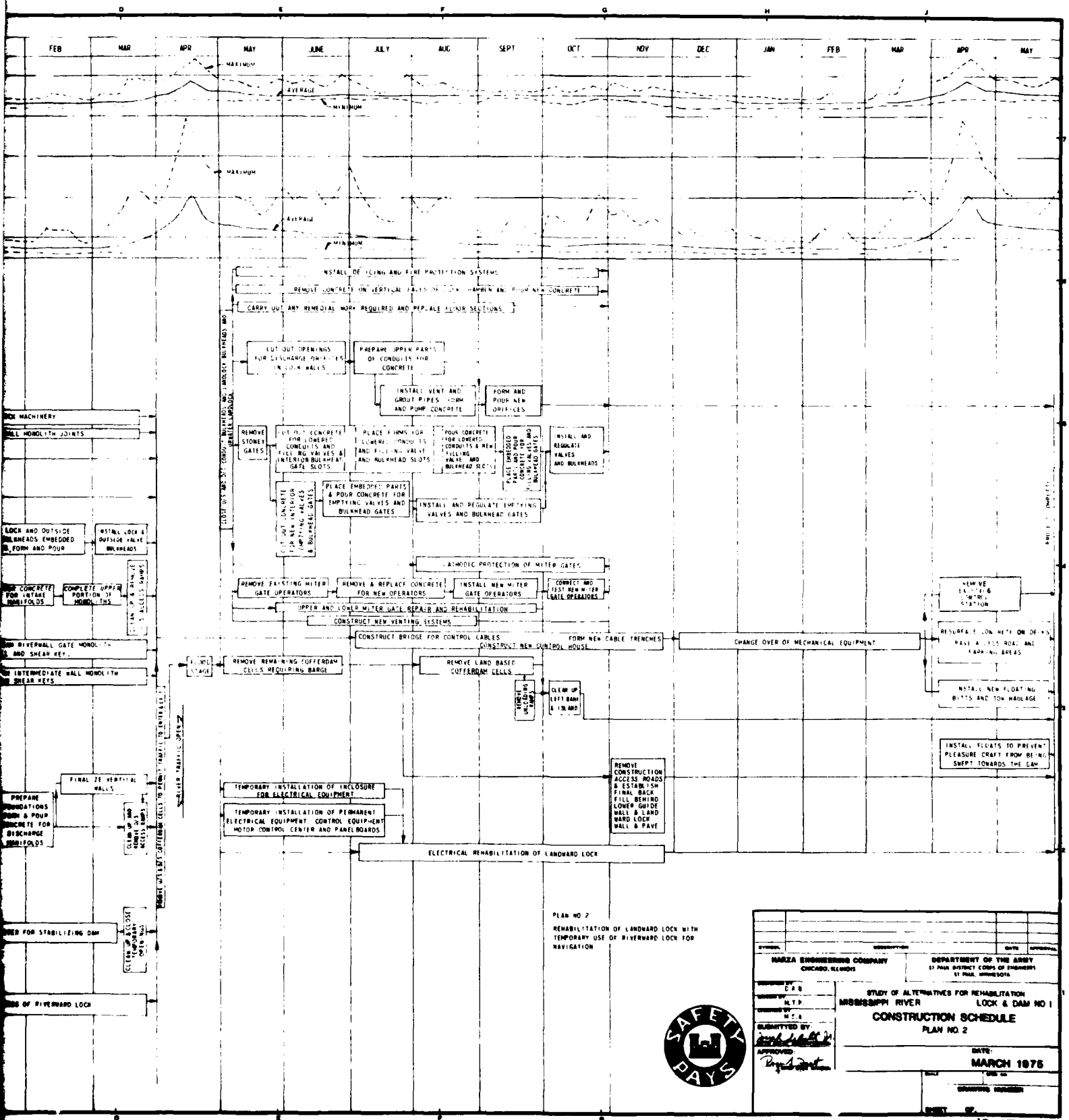
WATER SURFACE ELEVATION IN FEET
UPPER POOL ELEVATION
LOWER POOL ELEVATION
YEARS 1951-1972
MAXIMUM
AVERAGE
MINIMUM
CONSTRUCT WRAP AROUND U/S COFFERDAM AT LOWER GUIDE WALL
FILL ALL OF COFFERDAM CELLS FROM BARGES
MATERIALIZE AND EQUIP UNDERWATER STAGING AREAS
CONSTRUCT BARGE LOADING PORTS ON EAST BANK & ISLAND
PILE DRIVING D/S AND U/S COFFERDAM CELLS FROM BARGES
PILE DRIVING D/S COFFERDAM CELLS FROM LAND
PROVIDE ROCK PROTECTION AT CRITICAL PORTIONS ON WATER SIDE
CONSTRUCT ROAD TO EL 690 ALONG ISLAND TO COFFERDAM
CONSTRUCT FILLING RAMP TO D/S COFFERDAM ON LAND
DELIVERIES 18 MONTHS
FILLING COFFERDAM CELLS ON LAND
DISMANTLE BUILDING ON LAND WALL RELOCATE TOOL SHED
EXCAVATE AREA BEHIND LAND WALL TO EL 723
DISMANTLE 8 U/S CRIB WALL SECTIONS & CONSTRUCT COMBINED FOOTINGS TO EL 716.7
RECONSTRUCT 8 U/S CRIB WALL SECTIONS
EXCAVATE BEHIND LOWER GUIDE WALL MONOLITHS
DRIVE SHEET PILING BEHIND LOWER GUIDE WALL MONOLITHS
EXCAVATE BETWEEN LOWER GUIDE WALL MONOLITHS & STEEL SHEET PILING TO EL 697.7 & STABILIZE W/TIE BACK ANCHORS
CONSTRUCT ACCESS RAMP BEHIND LOWER GUIDE WALL TO EL 700
REPAIRS TO RIVER LOCK MACHINERY
WORK ON INTERMEDIATE WALL MONOLITH JOINTS
INSPECT FLOOR SECTIONS IN LOCKS FOR REMEDIAL WORK
CARRY OUT REMEDIAL WORK IF REQUIRED AND REPLACE FLOOR SECTIONS
GROUTING BENEATH INTERMEDIATE AND RIVER WALLS
REMOVE OLD LOCK AND OUTSIDE VALVE BULKHEADS CUT NEW LOCK BULKHEAD SLOTS IN LANDWARD LOCK
PLACE LOCK AND OUTSIDE VALVE BULKHEADS EMBEDDED PARTS, FORM AND POUR
INSTALL LOCK & OUTSIDE VALVE BULKHEADS
CUT ALL U/S WALL MONOLITHS TO NEW CONDUIT ELEVATIONS
POUR CONCRETE FOR INTAKE MANIFOLDS
COMPLETE UPPER PORTION OF MONOLITHS
CLEAN UP & REMOVE U/S ACCESS RAMPS
STABILIZE DOWNSTREAM RIVERWALL GATE MONOLITH BY BACKFILL AND SHEAR KEY
STABILIZE DOWNSTREAM INTERMEDIATE WALL MONOLITH WITH SHEAR KEYS
CONSTRUCT TEMPORARY WALLS
PLACE RAMPS
INSTALL DRAINAGE
REMOVE LOWER GUIDE WALL MONOLITHS NOS. 1 AND 2 AND U/S APRON
EXCAVATE, FORM POUR AND BACKFILL CONCRETE CUT OFF WALL
EXCAVATE SLURRY TRENCH AND POUR CONCRETE
PREPARE FOUNDATIONS FORM & POUR CONCRETE FOR DISCHARGE MANIFOLDS
FINALIZE VERTICAL WALLS
CLEAN UP AND REMOVE U/S ACCESS RAMPS
PREPARE ACCESS TO DAM WALKWAY
PUMP IN SAND AND WATER FOR STABILIZING DAM
CLEAN UP & CLOSE TEMPORARY OPENINGS
RECONDITION ELECTRICAL FEATURES OF RIVERWARD LOCK
CLOSE U/S AND D/S COFFERDAMS AND LANDWARD BULKHEADS AND REMOVE WATER FROM COFFERDAM CELLS TO PERMIT TRAFFIC TO INTERFERE
RIVER TRAFFIC CLOSED
RIVER TRAFFIC OPEN
FLOOD STAGE
INSTALL DE-ICING AND FIRE PROTECT
REMOVE CONCRETE ON VERTICAL FACES OF LO
CARRY OUT ANY REMEDIAL WORK REQUIRED AND REPLACE FL
CUT OUT OPENINGS FOR DISCHARGE ORIFICES IN LOCK WALLS
PREPARE UPPER PARTS OF CONDUITS FOR CONCRETE
INSTALL VENT & GROUT PIPES, & AND PUMP CONCR
REMOVE STOWEY GATES
CUT OUT CONCRETE FOR LOWER CONDUITS AND FILLING VALVES & INTERIOR BULKHEAD GATE SLOTS
PLACE FORMS FOR LOWER CONDUITS AND FILLING VALVE AND BULKHEAD SLOTS
CUT OUT CONCRETE FOR NEW INTERIOR EMPTYING VALVES & BULKHEAD GATES
PLACE EMBEDDED PARTS & POUR CONCRETE FOR EMPTYING VALVES AND BULKHEAD GATES
INSTALL VALVE
REMOVE EXISTING MITER GATE OPERATORS
REMOVE & REPLACE CONCRETE FOR NEW OPERATORS
UPPER AND LOWER MITER GATE REPAIR
CONSTRUCT NEW VENTING SYST
CONSTRUCT BRIDGE FOR
REMOVE REMAINING COFFERDAM CELLS REQUIRING BARGE
TEMPORARY INSTALLATION OF ENCLOSURE FOR ELECTRICAL EQUIPMENT
TEMPORARY INSTALLATION OF PERMANENT ELECTRICAL EQUIPMENT CONTROL EQUIPMENT MOTOR CONTROL CENTER AND PANELBOARDS



PLAN NO 2

REHABILITATION OF LANDWARD LOCK WITH TEMPORARY USE OF RIVERWARD LOCK FOR NAVIGATION

SYMBOL	DESCRIPTION	DATE	APPROVAL

HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D A B
DRAWN BY: M T P
CHECKED BY: M T R
SUBMITTED BY:
APPROVED:

STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1

CONSTRUCTION SCHEDULE
PLAN NO 2

DATE:
MARCH 1975

SCALE: 1 INCH =
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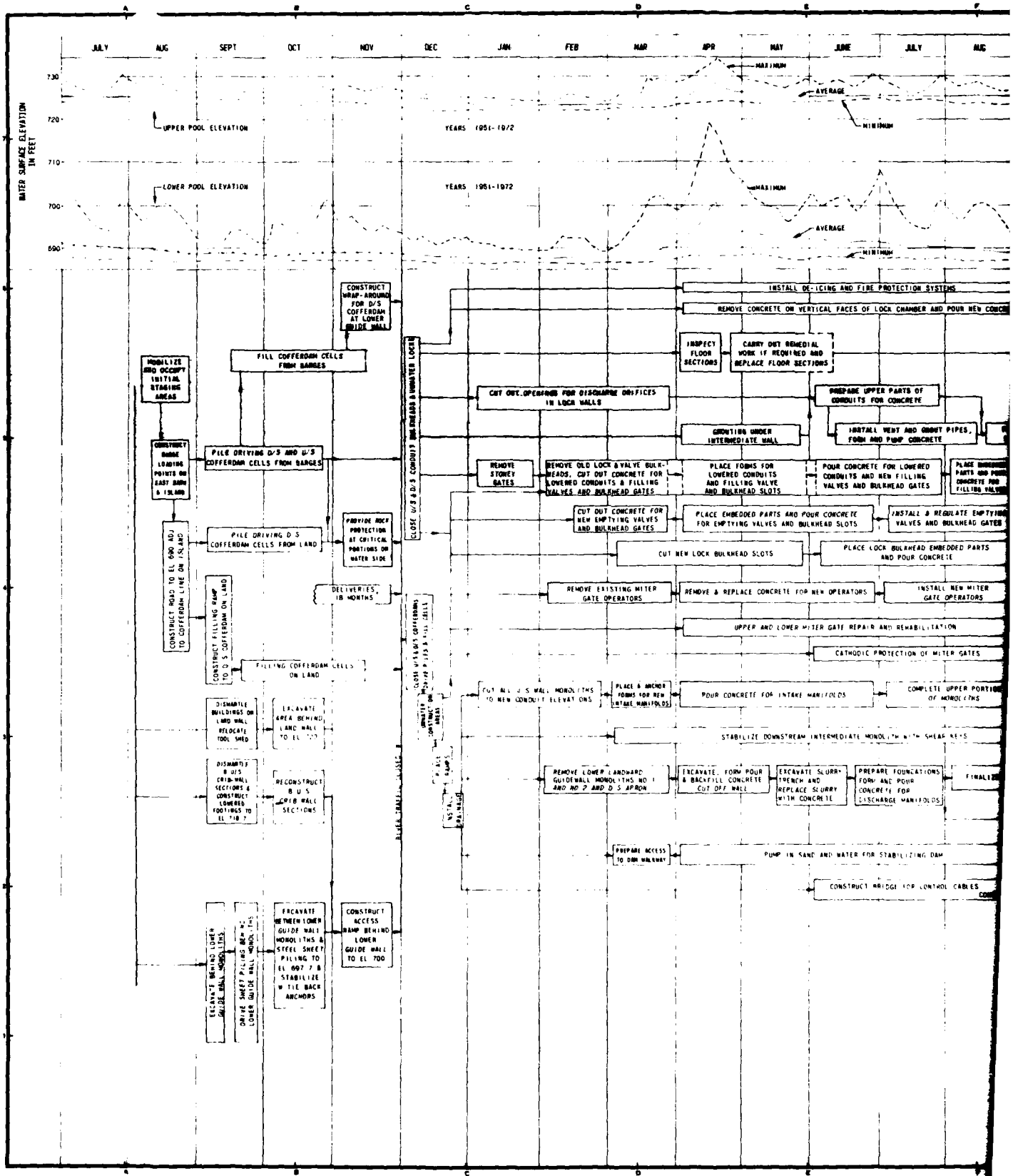
PLATE 13

1 2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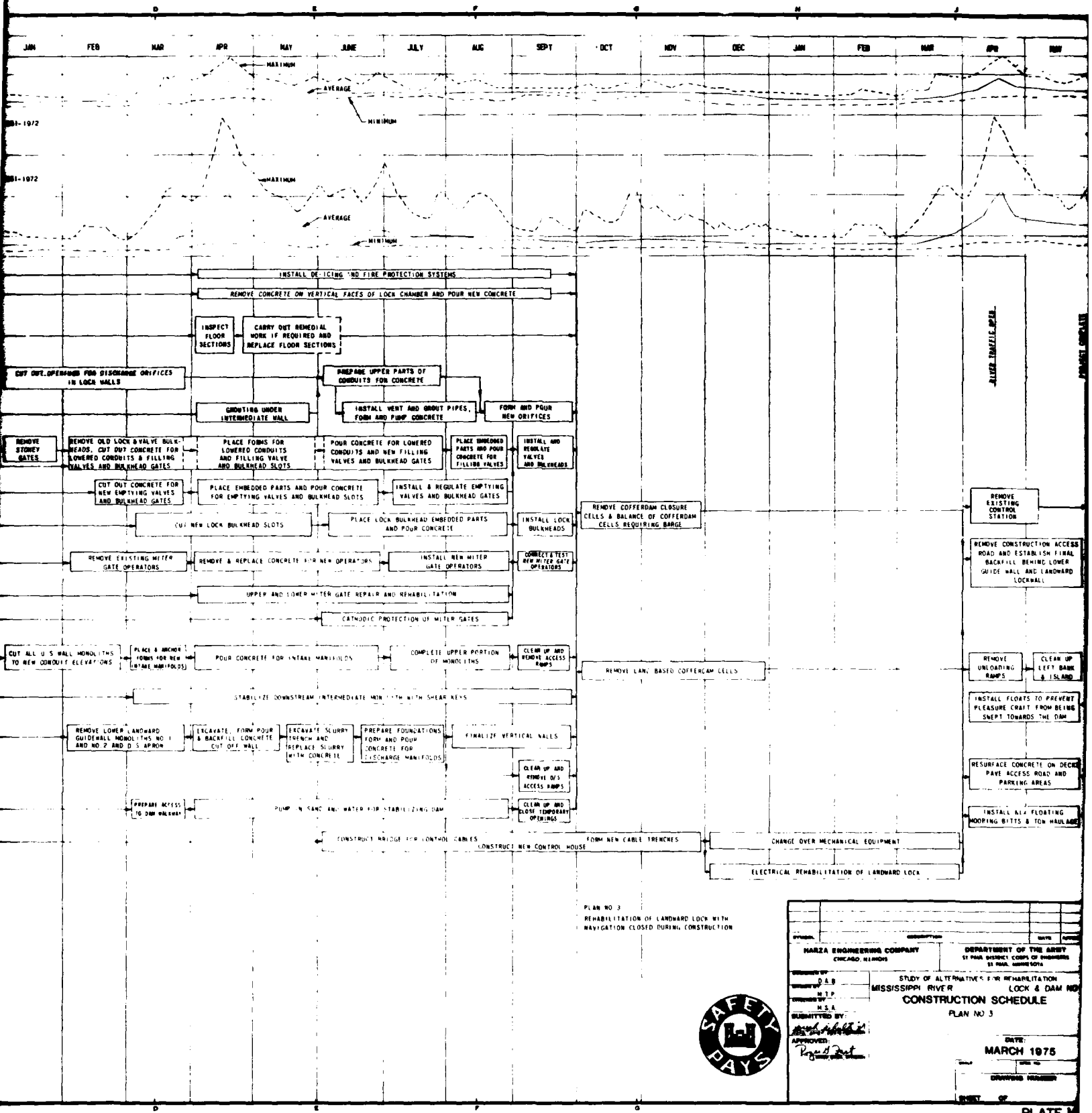
WATER SURFACE ELEVATION IN FEET
730
720
710
700
690
MAXIMUM
AVERAGE
MINIMUM
UPPER POOL ELEVATION
YEARS 1951-1972
LOWER POOL ELEVATION
YEARS 1951-1972
CONSTRUCT WRAP-AROUND FOR D/S COFFERDAM AT LOWER GUIDE WALL
INSTALL DE-ICING AND FIRE PROTECTION SYSTEMS
REMOVE CONCRETE ON VERTICAL FACES OF LOCK CHAMBER AND POUR NEW CONCRE
MOBILIZE AND OCCUPY INITIAL STAGING AREAS
FILL COFFERDAM CELLS FROM BARGES
INSPECT FLOOR SECTIONS
CARRY OUT REMEDIAL WORK IF REQUIRED AND REPLACE FLOOR SECTIONS
CUT OUT OPENINGS FOR DISCHARGE ORIFICES IN LOCK WALLS
PREPARE UPPER PARTS OF CONDUITS FOR CONCRETE
GROUTING UNDER INTERMEDIATE WALL
INSTALL VENT AND GROUT PIPES, FORM AND PUMP CONCRETE
CONSTRUCT BARGE LOADING POINTS ON EAST BANK & ISLAND
PILE DRIVING D/S AND U/S COFFERDAM CELLS FROM BARGES
REMOVE STONEY GATES
REMOVE OLD LOCK & VALVE BULKHEADS, CUT OUT CONCRETE FOR LOWERED CONDUITS & FILLING VALVES AND BULKHEAD GATES
PLACE FORMS FOR LOWERED CONDUITS AND FILLING VALVE AND BULKHEAD SLOTS
POUR CONCRETE FOR LOWERED CONDUITS AND NEW FILLING VALVES AND BULKHEAD GATES
CONSTRUCT ROAD TO EL 690 ADJ TO COFFERDAM LINE ON ISLAND
PILE DRIVING D/S COFFERDAM CELLS FROM LAND
PROVIDE ROCK PROTECTION AT CRITICAL PORTIONS ON WATER SIDE
CLOSE U/S & D/S CONDUITS AND BULKHEAD & MITER LOCKS
CUT OUT CONCRETE FOR NEW EMPTYING VALVES AND BULKHEAD GATES
PLACE EMBEDDED PARTS AND POUR CONCRETE FOR EMPTYING VALVES AND BULKHEAD SLOTS
INSTALL & REGULATE EMPTYING VALVES AND BULKHEAD GATES
CUT NEW LOCK BULKHEAD SLOTS
PLACE LOCK BULKHEAD EMBEDDED PARTS AND POUR CONCRETE
DELIVERIES, 18 MONTHS
CONSTRUCT FILLING RAMP TO D/S COFFERDAM ON LAND
REMOVE EXISTING MITER GATE OPERATORS
REMOVE & REPLACE CONCRETE FOR NEW OPERATORS
INSTALL NEW MITER GATE OPERATORS
UPPER AND LOWER MITER GATE REPAIR AND REHABILITATION
FILLING COFFERDAM CELLS ON LAND
CATHODIC PROTECTION OF MITER GATES
CUT ALL D/S WALL MONOLITHS TO NEW CONDUIT ELEVATIONS
PLACE & ANCHOR FORMS FOR NEW INTAKE MANIFOLDS
POUR CONCRETE FOR INTAKE MANIFOLDS
COMPLETE UPPER PORTION OF MONOLITHS
DISMANTLE BUILDINGS ON LAND WALL RELOCATE TOOL SHED
EXCAVATE AREA BEHIND LAND WALL TO EL ???
STABILIZE DOWNSTREAM INTERMEDIATE MONOLITH WITH SHEAR KEYS
DISMANTLE U/S CRIB-WALL SECTIONS & CONSTRUCT LOWERED FOOTINGS TO EL 710 ?
RECONSTRUCT U/S CRIB WALL SECTIONS
REMOVE LOWER LANDWARD GUIDEWALL MONOLITHS NO 1 AND NO 2 AND D/S APRON
EXCAVATE, FORM POUR & BACKFILL CONCRETE CUT OFF WALL
EXCAVATE SLURRY TRENCH AND REPLACE SLURRY WITH CONCRETE
PREPARE FOUNDATIONS FORM AND POUR CONCRETE FOR DISCHARGE MANIFOLDS
FINALIZE
PREPARE ACCESS TO DAM WALKWAY
PUMP IN SAND AND WATER FOR STABILIZING DAM
CONSTRUCT BRIDGE FOR CONTROL CABLES
EXCAVATE BEHIND LOWER GUIDE WALL MONOLITHS
DRIVE SHEET PILING BEHIND LOWER GUIDE WALL MONOLITHS
EXCAVATE BETWEEN LOWER GUIDE WALL MONOLITHS & STEEL SHEET PILING TO EL 697.7 & STABILIZE W TIE BACK ANCHORS
CONSTRUCT ACCESS RAMP BEHIND LOWER GUIDE WALL TO EL 700



PLAN NO 3
REHABILITATION OF LANDWARD LOCK WITH NAVIGATION CLOSED DURING CONSTRUCTION

HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY D.A.B.
DRAWN BY M.T.P.
CHECKED BY M.S.A.
SUBMITTED BY:
APPROVED:

STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO
CONSTRUCTION SCHEDULE
PLAN NO 3

DATE:
MARCH 1975

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SAFETY PAYS

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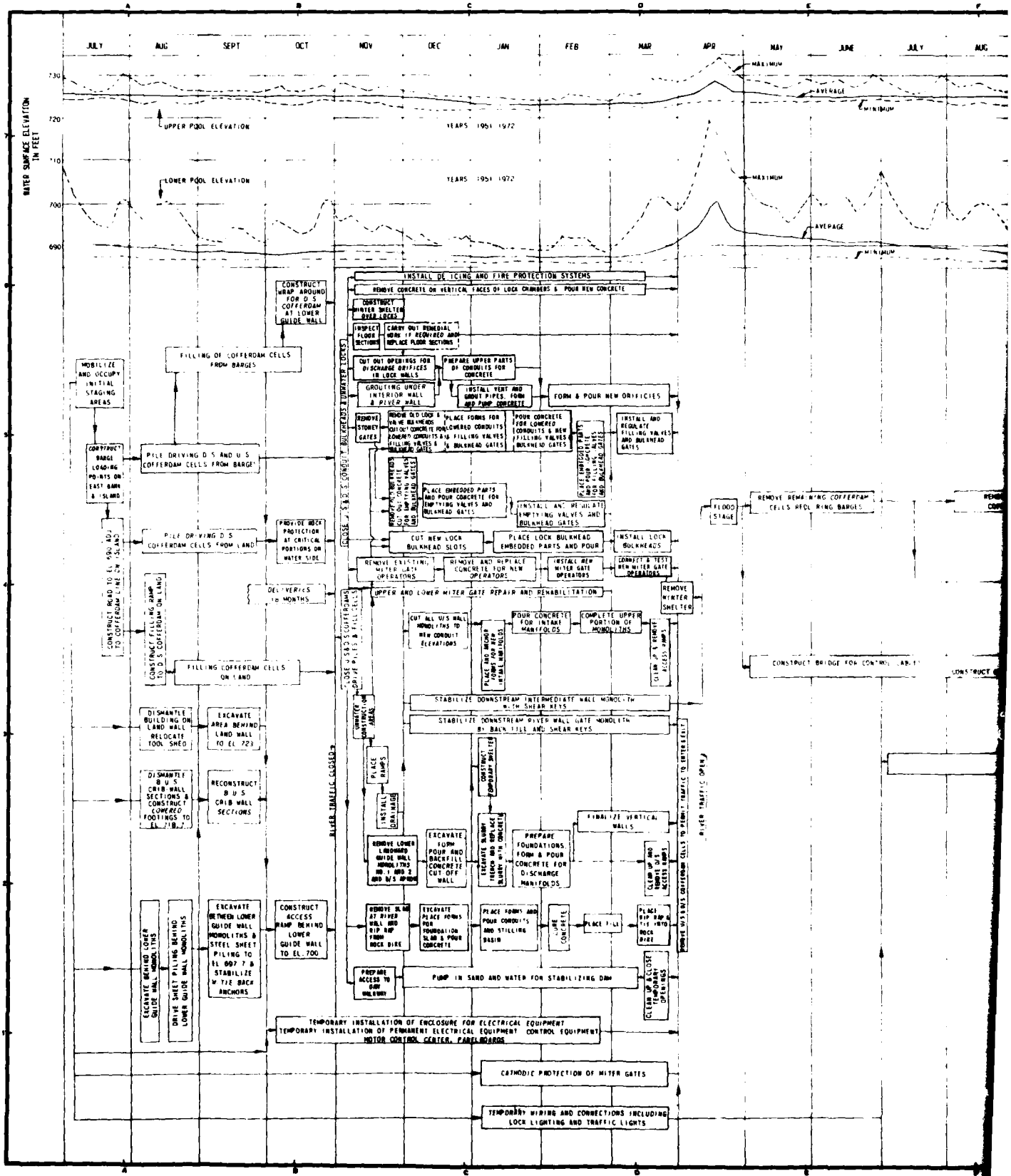
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WATER SURFACE ELEVATION IN FEET
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AVERAGE
MINIMUM
UPPER POOL ELEVATION
YEARS 1951-1972
LOWER POOL ELEVATION
YEARS 1951-1972
INSTALL DE-ICING AND FIRE PROTECTION SYSTEMS
REMOVE CONCRETE ON VERTICAL FACES OF LOCK CHAMBERS & POUR NEW CONCRETE
CONSTRUCT WINTER SHELTER OVER LOCKS
INSPECT FLOOR SECTIONS
CARRY OUT REMEDIAL WORK IF REQUIRED AND REPLACE FLOOR SECTIONS
CONSTRUCT WRAP AROUND FOR D S COFFERDAM AT LOWER GUIDE WALL
FILLING OF COFFERDAM CELLS FROM BARGES
MOBILIZE AND OCCUPY INITIAL STAGING AREAS
CUT OUT OPENINGS FOR DISCHARGE ORIFICES IN LOCK WALLS
PREPARE UPPER PARTS OF CONDUITS FOR CONCRETE
GROUTING UNDER INTERIOR WALL & RIVER WALL
INSTALL VENT AND GROUT PIPES, FORM AND PUMP CONCRETE
FORM & POUR NEW ORIFICIES
REMOVE STOREY GATES
REMOVE OLD LOCK & WALL BULKHEADS CUT OUT CONCRETE FOR LOWERED CONDUITS & FILLING VALVES & BULKHEAD GATES
PLACE FORMS FOR LOWERED CONDUITS & FILLING VALVES
POUR CONCRETE FOR LOWERED CONDUITS & NEW FILLING VALVES BULKHEAD GATES
INSTALL AND REGULATE FILLING VALVES AND BULKHEAD GATES
CONSTRUCT BARGE LOADING POINTS ON EAST BANK & ISLAND
PILE DRIVING D S AND U S COFFERDAM CELLS FROM BARGE
REMOVE CONCRETE AT BULKHEAD SLOTS
PLACE EMBEDDED PARTS AND POUR CONCRETE FOR EMPTYING VALVES AND BULKHEAD GATES
INSTALL AND REGULATE EMPTYING VALVES AND BULKHEAD GATES
CLOSE U/S & D/S CONDUIT & BULKHEADS & WATER LOCKS
FLOOD STAGE
REMOVE REMAINING COFFERDAM CELLS FROM BARGES
PILE DRIVING D S COFFERDAM CELLS FROM LAND
PROVIDE ROCK PROTECTION AT CRITICAL PORTIONS ON WATER SIDE
CUT NEW LOCK BULKHEAD SLOTS
PLACE LOCK BULKHEAD EMBEDDED PARTS AND POUR
INSTALL LOCK BULKHEADS
REMOVE EXISTING MITER GATE OPERATORS
REMOVE AND REPLACE CONCRETE FOR NEW OPERATORS
INSTALL NEW MITER GATE OPERATORS
CONNECT & TEST NEW MITER GATE OPERATORS
CONSTRUCT ROAD TO EL 690 ADJ TO COFFERDAM LINE ON ISLAND
DELIVERIES 10 MONTHS
UPPER AND LOWER MITER GATE REPAIR AND REHABILITATION
REMOVE WINTER SHELTER
CONSTRUCT FILLING RAMP TO D S COFFERDAM ON LAND
CUT ALL U/S WALL MONOLITHS TO NEW CONDUIT ELEVATIONS
POUR CONCRETE FOR INTAKE MANIFOLDS
COMPLETE UPPER PORTION OF MONOLITHS
PLACE AND ANCHOR FORMS FOR NEW BULKHEADS
CLEAN UP & REMOVE ACCESS RAMPS
FILLING COFFERDAM CELLS ON LAND
CONSTRUCT BRIDGE FOR CONTROL AREA
CLOSE U/S & D/S COFFERDAMS
DRIVE PILES & FILL CELLS
STABILIZE DOWNSTREAM INTERMEDIATE WALL MONOLITH WITH SHEAR KEYS
STABILIZE DOWNSTREAM RIVER WALL GATE MONOLITH BY BACK FILL AND SHEAR KEYS
DISMANTLE BUILDING ON LAND WALL RELOCATE TOOL SHED
EXCAVATE AREA BEHIND LAND WALL TO EL 723
UNWATER CONSTRUCTION AREAS
PLACE RAMPS
CONSTRUCT COFFERDAM SHELTER
DISMANTLE B U S CRIB WALL SECTIONS & CONSTRUCT COVERED FOOTINGS TO EL 710.7
RECONSTRUCT B U S CRIB WALL SECTIONS
INSTALL DRAINAGE
RIVER TRAFFIC CLOSED
REMOVE LOWER LANDWARD GUIDE WALL MONOLITHS NO 1 AND 2 AND U/S APRON
EXCAVATE FORM POUR AND BACKFILL CONCRETE CUT OFF WALL
EXCAVATE TRENCH AND REPLACE BLINDING WITH CONCRETE
PREPARE FOUNDATIONS FORM & POUR CONCRETE FOR DISCHARGE MANIFOLDS
FINALIZE VERTICAL WALLS
CLEAN UP AND REMOVE U/S ACCESS RAMPS
RIVER TRAFFIC OPEN
EXCAVATE BEHIND LOWER GUIDE WALL MONOLITHS
DRIVE SHEET PILING BEHIND LOWER GUIDE WALL MONOLITHS
EXCAVATE BETWEEN LOWER GUIDE WALL MONOLITHS & STEEL SHEET PILING TO EL 697.7 & STABILIZE W TYE BACK ANCHORS
CONSTRUCT ACCESS RAMP BEHIND LOWER GUIDE WALL TO EL 700
REMOVE SLAB AT RIVER WALL AND RIP RAP FROM ROCK DIKE
EXCAVATE PLACE FORMS FOR FOUNDATION SLAB & POUR CONCRETE
PLACE FORMS AND POUR CONDUITS AND STILLING BASIN
CURE CONCRETE
PLACE FILL
PLACE RIP RAP & TYE INTO ROCK DIKE
POWER HOUSE & COFFERDAM CELLS TO REMAIN TRAFFIC TO INTERSTATE
PREPARE ACCESS TO OLD RAILWAY
PUMP IN SAND AND WATER FOR STABILIZING DAM
CLEAN UP & CLOSE TEMPORARY OPENINGS
TEMPORARY INSTALLATION OF ENCLOSURE FOR ELECTRICAL EQUIPMENT
TEMPORARY INSTALLATION OF PERMANENT ELECTRICAL EQUIPMENT CONTROL EQUIPMENT
MOTOR CONTROL CENTER, PANELBOARDS
CATHODIC PROTECTION OF MITER GATES
TEMPORARY WIRING AND CONNECTIONS INCLUDING LOCK LIGHTING AND TRAFFIC LIGHTS

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1972
1972
FLOOD STAGE
FORM & POUR NEW ORIFICES
POUR CONCRETE FOR LOWERED CONDUITS & NEW FILLING VALVES BULKHEAD GATES
INSTALL AND REGULATE FILLING VALVES AND BULKHEAD GATES
INSTALL AND REGULATE EMPTYING VALVES AND BULKHEAD GATES
PLACE LOCK BULKHEAD EMBEDDED PARTS AND POUR
INSTALL LOCK BULKHEADS
INSTALL NEW MITER GATE OPERATORS
CONNECT & TEST NEW MITER GATE OPERATORS
REMOVE WINTER SHELTER
POUR CONCRETE FOR INTAKE MANIFOLDS
COMPLETE UPPER PORTION OF MONOLITHS
REMOVE REMAINING COFFERDAM CELLS REQUIRING BARGES
REMOVE LAND BASED COFFERDAM CELLS
REMOVE CONSTRUCTION ACCESS ROAD AND ESTABLISH FINAL BACKFILL BEHIND LOWER GUIDE WALL AND LANDWARD LOCKWALL AND PAVE
CONSTRUCT BRIDGE FOR CONTROL CABLES
CONSTRUCT NEW CONTROL HOUSE
FORM NEW CABLE TRENCHES
INSTALL NEW MECHANICAL AND ELECTRICAL EQUIPMENT
REMOVE EXISTING CONTROL STATION
PROJECT COMPLETE
RESURFACE CONCRETE ON DECKS PAVE ACCESS ROAD AND PARKING AREAS
INSTALL NEW FLOATING BITTS AND TOW HAULAGE
INSTALL LIGHTING STANDARDS, TRAFFIC AND NAVAGATION LIGHTS AND PULL PERMANENT WIRES
DISCONNECT TEMPORARY WIRING REMOVE AND REINSTALL ELECTRICAL CONTROL EQUIPMENT MOTOR CONTROL CENTER PANELBOARD ETC IN NEW STRUCTURE PERMANENT CONNECTION FOR COMPLETE INSTALLATION
REMOVAL OF TEMPORARY WIRING AND ENCLOSURE
PREPARE FOUNDATIONS FORM & POUR CONCRETE FOR DISCHARGE MANIFOLDS
STABILIZE VERTICAL WALLS
CLEAN UP AND REMOVE ACCESS RAMPS
PLACE RIP RAP
ARCH DIKE
CLEAN UP AND REMOVE TEMPORARY OPEN HOLE
ELECTRICAL EQUIPMENT
CONTROL EQUIPMENT
CATHODIC PROTECTION OF MITER GATES
POWER WIRING AND CONNECTIONS INCLUDING LOCK LIGHTING AND TRAFFIC LIGHTS
PLAN NO 4
REHABILITATION OF BOTH LOCKS WITHOUT INTERRUPTION OF NAVIGATION
HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA
DESIGNED BY: D & E
DRAWN BY: R T P
CHECKED BY: R E K
SUBMITTED BY:
APPROVED:
STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO 1
CONSTRUCTION SCHEDULE
PLAN NO. 4
DATE:
MARCH 1975
DRAWING NUMBER
SHEET OF
SAFETY PAYS

PLATE 15

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END

DATE
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