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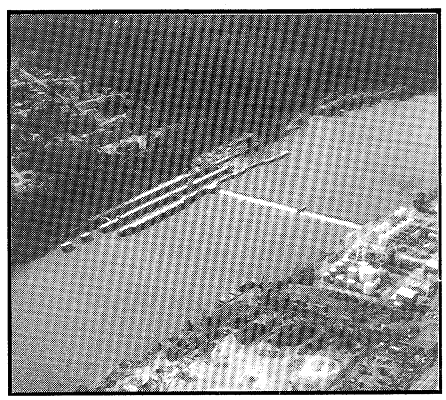
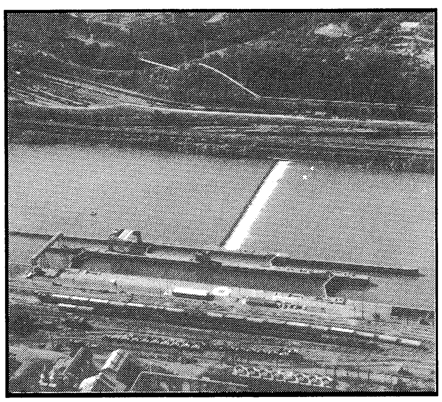
US Army Corps
of Engineers
Pittsburgh District

Lower Monongahela River Navigation System Feasibility Study

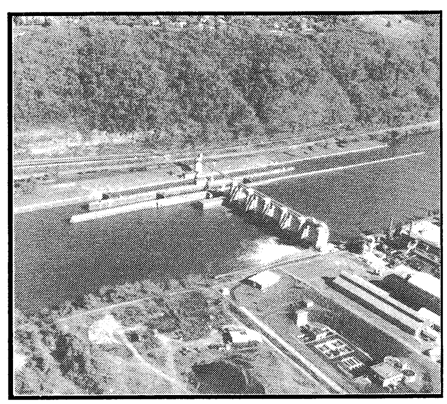
Interim Report



Locks and Dam 3



Locks and Dam 2



Locks and Dam 4

Volume 2 of 6

Engineering Technical and
Real Estate Appendices

FINAL
December 1991

LOWER MONONGAHELA RIVER NAVIGATION SYSTEM STUDY

FEASIBILITY REPORT

VOLUME 2

LIST OF APPENDICES

LOWER MONONGAHELA RIVER
NAVIGATION SYSTEM STUDY

APPENDIX

ENGINEERING
TECHNICAL

U.S. Army Engineering District, Pittsburgh
Corps of Engineers
Pittsburgh, Pennsylvania

MONONGAHELA RIVER NAVIGATION SYSTEM
PENNSYLVANIA
LOCKS AND DAMS 2, 3 AND 4

APPENDIX

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LOWER MONONGAHELA RIVER
NAVIGATION SYSTEM STUDY
FEASIBILITY REPORT
ENGINEERING TECHNICAL APPENDIX

1. General

A study was undertaken by the Pittsburgh District in order to evaluate the lower portion of the Monongahela River Navigation System consisting of Locks and Dam 2, 3 and 4. The projects range in age from 40 to 90 years and their structural condition and ability to serve navigation interests through the middle of the next century are questionable. The Feasibility Report describes the general problems caused by the age and small size of the locks at the projects and how these problems can best be remedied.

The results of this study indicate that Plan 1 is the most appropriate and cost effective plan and therefore designated as the National Economic Development (NED) plan. The selected plan is a "2 for 3" replacement alternative consisting of the replacement of the fixed-crest dam at Locks and Dam (L/D) 2 with a gated dam having 5 - 110' tainter gates, rehabilitation of Locks 2 in the year 2020 and the replacement of the floodway bulkhead structure for the small lock chamber; raising existing Pool 2 by 5 feet; adjustments or possible reconstruction of the Conrail Railroad Bridge at Monongahela River Mile 11.7; the construction of new twin 84' X 720' locks at L/D 4; the removal of L/D 3; lowering existing Pool 3 by 3.2 feet; associated miscellaneous relocations and channel dredging; and the establishment by the Coast Guard of a reduced vertical guide bridge clearance of 42.5 feet for the Monongahela River.

2. Hydrology

a. The Study and Report

(1) Scope of Study

Appendix 2 presents the basis for and the results of the hydrologic studies pertaining to the replacement of Locks and Dams No. 2, 3, and 4 on the Monongahela River in Pennsylvania. Plate 2-1 shows a basin map of the Monongahela River and the location of Locks and Dams No. 2, 3, and 4.

(2) Recommended Plan

The existing dam at Locks and Dam No. 2, river mile (r.m.) 11.2, would be replaced with a new gated dam at r.m. 11.3, 485 feet upstream of the present Dam No. 2. This change would enable the existing 110 ft land chamber to utilize the emergency bulkhead for the lock. The normal pool elevation would be raised from elevation 718.7 to elevation 723.7 feet. Within the existing Pool 3, the navigation channel would be excavated to 11 feet as opposed to the present nine feet. The existing lock chambers, one 110' x 720' and one 56' x 360', would undergo extensive rehabilitation. A hydraulically operated dam similar to that proposed for the Olmsted project on the Ohio River will be evaluated as an alternative to the tainter gates presently proposed. The existing Locks and Dam No. 3 would be removed and the existing locks at Dam No. 4 would be replaced with 2 - 84' x 720' lock chambers.

b. Basin Characteristics

(1) General Topography and River Curvature

The drainage areas at Locks and Dams Nos. 2, 3, and 4 are 7,431, 5,332, and 5,205 square miles, respectively. The tributary area between Locks and Dam No. 4 and Locks and Dam No. 2 is 2,226 square miles. Most of this tributary area between Dam 2 and Dam 4 is contained in the Youghiogheny River Basin with a drainage area of 1,764 square miles. The Monongahela River, from the headwaters at Fairmont, West Virginia, to the mouth at Pittsburgh, Pa., flows generally northward, following a sinuous course for its entire 128.7- mile length. Curves vary from 45 degrees to 135 degrees with radii of 0.5 to 1.5 miles. The maximum sight distance, therefore, may be limited to about one-half mile in certain reaches. The average gradient of the natural river from mile 11.2 to mile 41.5 is about 0.6 foot per mile.

(2) River Mile 11.2 to 41.5

The area tributary to the proposed sites is located in the unglaciated Allegheny Plateau. Westward of the river and over the smaller tributaries the relief is about 600 to 800 feet. Over the Youghiogheny River Basin the relief increases rapidly within a few miles of the mouth to the Appalachian Mountians which rise to elevations of more than 2000 feet along the eastern boundary of the basin.

The present stream banks have an average height of about 15 feet upstream from the present Dam 2 and about 20 to 25 feet downstream of the dam. At Dam 3, the average heights of the banks upstream of the dam is about 10 feet and about 15 feet downstream. At Dam 4, the banks are 15-feet high upstream and 25 feet downstream of the dam. The replacement of Dam 2 with a gated dam and raising the pool by five feet would reduce the bank heights upstream of Dam 2 by five feet to r.m. 23.8. Under the recommended plan, the height of banks would increase by three feet from r.m. 23.8 to r.m. 41.5.

The greatest tributary contribution to the mainstem flow within this reach of the Monongahela River comes from the Youghiogheny River, with a drainage area of 1,764 square miles. Four other lesser, though sizable, tributary streams also enter the river in this area. They are Turtle Creek, Peters Creek, Pigeon Creek, and Mingo Creek. These smaller streams are generally steep from the headwaters to the mouth. They are especially conducive to rapid runoff and early concentration of flood flows into the pools above the dams. Basic data for the tributaries are presented in TABLE 2-1.

TABLE 2-1
LOWER MONONGAHELA RIVER REPLACEMENT STUDY
LOCKS AND DAM NO.S 2, 3, AND 4
FEASIBILITY STUDY
MAJOR TRIBUTARIES - RIVER MILES 11.2-41.5

Stream	Bank	Location on Mononghela River Mile	Drainage Area Square Miles	Total Length Miles	Relief above Pool Feet
Turtle Creek	Right	11.5	148.0	19.5	530
Youghiogheny Riv	Right	15.5	1,764.0	132.0	2,080
Peters Creek	Left	19.7	51.5	16.5	370
Mingo Creek	Left	29.8	22.2	10.6	470
Pigeon Creek	Left	32.3	59.2	19.5	360
Other Areas			91.1		
Total			2136.0		
Monongahela River					
Locks and Dam No. 2	Right	11.2	7,341.		
Locks and Dam No. 3	Right	23.8	5,332.		
Locks and Dam No. 4	Right	41.5	5,205.		

c. <u>Upstream Reservoir and Flood Protection Projects</u>

No local flood protection projects exist on the Monongahela River within the study reach, r.m. 11.2 to 41.5. There is a local flood protection project on Turtle Creek that enters the Monongahela River on the right bank at r.m. 11.5. However, flood reduction and low-water augmentation on the Monongahela River upstream of the Youghiogheny River has been afforded by Tygart Dam since 1938 and more recently by the completion of Stonewall Jackson Dam. These control 1,286 square miles or about 24 percent of the drainage area upstream of the Youghiogheny River. Downstream of the Youghiogheny River the flood flows are further reduced by the Youghiogheny River Lake and Dam. The low-water regulated flows are augmented by the low water releases provided by this project. This system of flood-control projects controls about 23 percent of the drainage area at Locks and Dam No. 2. These projects have provided an average reduction of about 2.5 feet during high flows upstream of the Youghiogheny River and about 4.5 feet downstream at Dam No. 2. During low-flow periods, these projects assure no less than 420 cubic feet per second (cfs) in the Monongahela River upstream of the Youghiogheny River and 700 cfs from the Youghiogheny River to the mouth of the Monongahela River.

d. Climatology

(1) Climate

The climate in the vicinity of r.m. 11.2 to r.m. 41.5 is typical of this geographical area, being humid with fairly large seasonal temperature variation. This region of variable air mass activity, is subjected to polar and tropical, continental and maritime air- mass invasion. The weather is usually moderate, but may have frequent and rapid changes resulting from the passage of fronts associated with air-mass movement. The normal percent of sunshine during the year varies from about 35 percent in the winter months to about 65 percent during the summer months. Measurable precipitation occurs about 104 days each year while the average frost-free period is 136 days. The mean daily temperature falls below freezing about 35 days per year. The prevailing winds come from the southwest with some slight monthly variation.

(2) Temperature and Precipitation

Temperature and precipitation records applicable to this area are available for Locks and Dam No. 4, Charleroi, Pa., and Locks and Dam No. 2, Braddock, Pa. Records are also available at the National Weather Service (NWS) station at Pittsburgh, Pa., which is located near the mouth of the Monongahela River. Precipitation records have been maintained since 1948 at both Dam Nos. 2 and 4. Temperature records have been maintained by the NWS at the city station for the period 1926 to 1979 and at the airport since 1952. The normal monthly precipitation ranges from 2.37 inches in February to 3.88 inches in July at Charleroi. Severe local storms which sometimes result in rainfalls of 4 to 8 inches within a few hours, are not unusual during the summer months. Short-duration point-rainfall values as great as 12 inches have unofficially been recorded during several thunderstorms within 50 miles of the proposed projects. Snowfall averages about 28 inches per year along the lower Monongahela River and almost always occurs within the period of November to March. The maximum recorded snow for one storm in this area was 30 inches in November 1950. Snow cover along the Monongahela River is frequently lost during the course of the winter season. The average temperatures in this area vary from 32.1 degrees F in January to 74.9 degrees F in July at

Pittsburgh. The extremes of 103 degrees F and -20 degrees F were recorded at the NWS station in Pittsburgh. Various types of climatological data are available for the following stations in the vicinity of Dams 2 and 4: Allegheny County Airport, McKeesport, Bruceton, Sutersville, Donora, and Newell, Pa. TABLE 2-2 presents a summary of climatological data for Braddock, Pa. Charerloi, Pa. and the NWS station at Pittsburgh, Pa.

e. <u>Hydrology</u>

(1) <u>Stream Gaging Stations and Records</u>

(a) <u>Pittsburgh District</u>

Stage records are available in the Pittsburgh District for Locks and Dams 2, 3, and 4. The Locks and Dam 2 were orginally constructed in 1904-1906. The Locks and Dam 3 were built from 1905 to 1907 and Dam 4 was reconstructed from 1930 to 1932. The dam, which was reconstructed to provide a gated crest and to raise Pool 4 by six feet, was completed in June 1967. Prior to 1935, the upper and lower gages at all locks and dams were read once a day and more often during rises. From 1935 -1940, hourly readings were taken during high stages. Starting in 1940, readings have been taken at three hour intervals starting at 1 AM each day during normal stages and hourly during high stages. Each dam has a critical stage at which these hourly readings are recorded and this record continues until the river recedes below this stage.

(b) <u>Geological Survey</u>

In October 1933, the U. S. Geological Survey (USGS) installed a recording stream-gaging station at Dam 4 on the right bank upper guide wall. In 1967, the USGS relocated the recording gaging station to the end of the lower guide wall since the upper pool remains relatively constant with the gated dam.

In October 1976 the gaging station was relocated to a location just upstream from the upstream guide wall of Locks and Dam 3. A good stage-discharge relationship has been developed. This relationship, along with a lower pool rating, is shown on PLATE 2-2. The USGS established a gaging station in 1938, 1000 feet upstream of the dam at Locks and Dam No. 2 at Braddock. In 1951, the gage was moved to a site near the right bank on the river guide wall, 300 feet upstream from the dam. A fairly good stage-discharge relation has been developed for this gage during normal flows. However, during flood events, the streamward lock chamber is used as a floodway and the rating curve is not valid under this condition. Also, this gaging station may be affected by backwater caused by the Allegheny and Ohio Rivers. The stage discharge curves for normal conditions is shown as PLATE 2-3. TABLE 2-3 presents pertinent data for the stream-gaging stations from r.m. 11.2 to 41.5.

TABLE 2-2
CLIMATIC SUMMARY

Station	Years of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Normal Monthly and Annual Precipitations - Inches														
Braddock	41	2.58	2.37	3.31	3.47	3.60	3.98	3.99	3.81	2.90	2.41	2.90	2.59	37.91
Charleroi	41	2.78	2.41	3.48	3.56	3.69	3.61	3.88	3.55	2.95	2.42	2.95	2.69	37.97
Pittsburgh	54	2.68	2.37	3.40	3.26	3.51	3.64	3.67	3.25	2.83	2.48	2.42	2.56	36.07
Maximum Monthly and Annual Precipitation - Inches														
Braddock	41	5.77	5.72	5.81	5.98	7.30	10.62	9.09	7.88	6.32	8.18	11.11	5.10	53.01
Charleroi	41	5.69	5.39	6.85	6.02	7.00	10.90	7.50	8.01	6.30	6.70	11.02	5.10	50.60
Pittsburgh	54	7.75	5.97	6.38	6.26	6.55	7.73	7.90	8.17	8.84	7.79	7.40	5.09	47.45
Minimum Monthly and Annual Precipitation - Inches														
Braddock	41	0.53	0.32	1.00	0.59	1.48	0.91	1.38	0.07	0.22	0.21	0.49	0.28	26.93
Charleroi	41	0.78	0.40	1.02	1.17	1.70	0.42	0.58	0.07	0.28	0.61	0.56	0.27	28.93
Pittsburgh	54	0.73	0.37	0.94	0.44	0.66	0.78	1.33	0.29	0.29	0.57	0.16	0.26	22.60
Mean Monthly and Annual Snowfall - Inches														
Braddock	41	6.2	4.7	2.7	0.1							0.6	2.9	17.2
Charleroi	41	8.1	5.6	4.2	0.6	0.1					0.1	2.0	4.3	25.0
Pittsburgh	54	12.0	9.7	8.3	1.8						0.2	3.5	8.2	43.7
Normal Monthly and Annual Temperatures - Degrees F														
Pittsburgh	54	32.0	32.5	40.5	51.5	62.0	71.0	74.5	73.5	66.5	55.5	44.5	34.5	53.0
Maximum Monthly and Annual Temperatures - Degrees F														
Pittsburgh	54	51.0	49.0	63.0	70.0	81.0	86.0	89.0	88.0	82.0	75.0	59.0	50.0	65.0
Minimum Monthly and Annual Temperatures - Degrees F														
Pittsburgh	54	7.0	10.0	23.0	35.0	45.0	56.0	62.0	58.0	52.0	41.0	28.0	18.0	41.0

TABLE 2-3
STREAM GAGING STATIONS AND RECORDS

Stream	Station	Drainage Sq. Mi.	Period of Record	Minimum Discharge Period of Record cfs	Minimum Discharge Period of Record Date	Maximum Discharge Period of Record cfs	Maximum Discharge Period of Record Date
Monongalela River							
	L/D 2,* Braddock, Pa.	5,621	Oct 1938-Date	703	Sep 1946	201,800	Nov 1985
	L/D 3,** Elizabeth, Pa.	4,046	Oct 1933-Date			184,900	Nov 1985
	L/D 4,** Charleroi, Pa.	3,919	Oct 1933-Date			191,300	Nov 1985
Youghiogheny River							
	Sutters-ville, Pa.	1,281***	Oct 1938-Date	57	Sep 1922	108,000	Oct 1954
	Connels-ville, Pa.	892***	July 1908-Date	11	Sep 1908	103,000	Oct 1954
Turtle Creek	Wilmerding, Pa.	121	Apr 1940-Date			16,100	Jun 1972

* Reduced by Tygart, Stonewall Jackson, and Youghiogheny Dams since 1938 , 1990, and 1948, respectively
** Reduced by Tygart and Stonewall Jackson Dams since 1938 and 1990 respectively.
*** Reduced by Youghiogheny Dam since 1948.

(2) Historical and Recorded Flows

(a) Highest Known Historical Flood

The highest known flood prior to the installation of the gaging stations in the reach from Dam 4 to Dam 2 occurred in July 1888. The estimated peak discharge reached a flow of 156,000 cfs at Dam 4 and only had a slight increase at Dam 2 since this was an upper basin flood. This flood was caused by a severe convectional summer storm over the upper Monongahela River and the Cheat River Basins. The discharge reached a maximum immediately downstream of the Cheat River, where the high discharges from the upper Monongahela River combined with high flows from the Cheat River to produce the record flood downstream. It decreased only slightly as the flood wave moved downstream to the mouth.

(b) Highest Floods of Record

At Dam 2, the highest stage was recorded on the upper gage when the river rose to elevation 745.5 NGVD on 18 March 1936. This high stage occurred from the backwater from the Ohio and Allegheny Rivers and prior to the construction of any of the Pittsburgh Engineer District flood control dams. It would have been reduced to elevation 732.4 NGVD with the present reservoir system.

The highest flood of record, reduced by the present reservoir system, in the reach from r.m. 41.5 to r.m. 17.0, occurred on 5-6 November 1985. The remnants of Hurricane Juan passed over West Virginia during the first four days of November causing moderate to heavy rainfall. On November 4th, an intense slow-moving upper-level trough over the Ohio Valley set the stage for the heavy rainfall that fell in the upper Monongahela River Basin on the 4th and 5th of November. A high-pressure ridge located over the eastern seaboard and a low-level jet stream orginating in the Gulf of Mexico carried large amounts of moisture into the Upper Ohio Valley during the 4th and 5th of November. The peak discharge of 191,300 cfs at Dam 4 resulted in a crest elevation of 761.7 feet NGVD. The peak flow only increased slightly to 201,800 cfs at Dam 2 with a crest elevation of 738.4 feet NGVD. Numerous highwater marks were obtained shortly after the flood and a high water profile was drawn through these points. The highest flood recorded at Dam 2, reduced by the present reservoir system, occured in June 1972. This flood, the result of Tropical Storm Agness, produce a crest elevation at Dam 2 of 739.2 feet NGVD.

PLATE 2-4 presents profiles from r.m. 11.2 to r.m. 41.5 for the June 1972 and the November 1985 floods for present conditions. The June 1972 flood stages in the lower reach reflects the backwater effects from the Allegheny and Ohio Rivers in addition to the flood on the Monongahela River. The November 1985 flood was only on the Monongahela River.

(3) Flood Flows

(a) Monongahela River Flood Flows

The timing and magnitude of flood crests at all sites depend, of course, on the intensity, duration, and distribution of the rainfall, and during the winter and spring periods on the magnitude of any coincidental snowmelt. The flood crests on the lower Monongahela River are also affected by the backwater conditions from the Allegheny and Ohio Rivers. High flows from the Youghiogheny River can also cause backwater effects at Dam 3. Usually, these crests occur about 24 hours after the end of significant runoff-producing rainfall over the basin. Examination of flood flows since Tygart, Stonewall Jackson, and Youghiogheny Dams commenced operation reveals that flow from the Monongahela River mainstem, that is, water passing Dam No. 4 has contributed about 82 percent of the Dam No. 2 peak discharge. This is an average proportion; the actual ratio of individual peak discharge at Dam No. 4 to that of Dam No. 2 has varied from about 64 percent to 94 percent during the period of record. The Youghiogheny River normally contributes about 15 percent of the total flow at Dam No. 2 with the remaining flow coming from the tributaries. An exception to this was the October 1954 flood when much of the flow at Dam 2 came from the Youghiogheny River.

(b) Youghiogheny River Flood Flows

The Youghiogheny River, the largest of the tributaries, enters the Monongahela River on its right bank at McKeesport, Pennsylvania, 15.5 miles upstream of the mouth of the Monongahela River, 4.3 miles upstream of Dam No. 2, and 8.3 miles downstream of Dam No. 3. Although this is a tributary, it has mainstream runoff characteristics. The rate of runoff is infuenced and partially controlled by Youghiogheny River Dam. The Youghiogheny River Dam controls 25 percent of the Youghiogheny River drainage area.

(c) Tributary Flood Flows, River Mile 11.2 to 41.5

As previously noted, the local area immediately adjacent to the river reach from r.m. 11.2 to r.m. 41.5 is of fairly steep relief and thus conducive to rapid runoff. Records of streamflow stations indicate that tributaries to Dam No. 2 pool, such as Turtle Creek with a drainage area of 148 square miles, should crest about 6 hours after the end of significant rainfall. The highest flow on Turtle Creek during the 50 years of record, was 16,100 cfs on June 23, 1972. Since the uncontrolled drainage area between Locks and Dam 3 and Locks and Dam 2 is 1,575 square miles, and the combined uncontrolled drainage area from the Youghiogheny River and Turtle Creek is 1,477 square miles, it is clear that a localized flood over the lower Monongahela River Basin could cause a sudden rise on the lower Monongahela River within a period of a few hours. Since the drainage area between Locks and Dam 3 and Locks and Dam 4 is only 127 square miles, a local storm over these tributaries would cause only a rise to be observed at Locks and Dam 3 within a few hours after the rain.

The tributaries with small drainage areas should crest within two to three hours after the end of significant rainfall and would have little effect on the Monongahela River stages.

(4) Flood Frequency

The natural discharge frequency was developed from 66 years of record at Dam No. 2 and 54 years years at Dam No. 4. Floods occuring after construction of Tygart, Youghiogheny, and Stonewall Jackson Dams were adjusted to reflect the natural peak discharges which would have ocurred without the flood control dams. The method outlined in Statistical Methods in Hydrology, ER 1110 - 2 - 1450, dated January 1962, was used in making the computation. The natural frequency thus obtained was subsequently adjusted for the reduction by Tygart River, Stonewall Jackson, and Youghiogheny River Dams as applicable to produce a reduced-discharge frequency. TABLE 2-4 shows the reduced flood flow frequency at r.m. 11.2 and 41.5.

TABLE 2-4
MONONGAHELA RIVER NAVIGATION SYSTEM
REPLACEMENT OF LOCKS AND DAMS 2, 3, 4
FEASIBILITY STUDY
FLOW FREQUENCY REDUCED BY EXISTING RESERVOIRS

Recurrence Interval	River Mile 11.2	River Mile 41.5
0.50	79,500	63,000
1.00	102,500	82,500
2.0	124,000	100,000
5.0	150,500	121,000
10.0	168,500	138,500
20.0	186,000	154,800
50.0	211,500	177,000
100.0	231,500	194,000
200.0	250.500	211,400
500.0	275,500	234,000
1000.0	295,000	252,000

The existing 100-year profile from the mouth of the Monongahela River to upstream of Dam 4 is shown on PLATE 2-5. Also shown is the 100-year profile for the recommended plan. The reduced discharge at the mouth was 231,500 cfs while upstream of the Youghiogheny River the peak discharge was 194,000 cfs shown in the above TABLE 2-4.

(5) Minimum Low Flow

The most sustained and severe drought period on the Monongahela River occurred during the summer and autumn of 1930. Upstream of the Youghiogheny River, it was estimated that the Monongahela River monthly flows fell to below 200 cfs during this period. These drought flows were sustained for over two months.

Throughout the drought period, flows in the Monongahela River downstream of the Cheat River were augmented to some degree by periodic emergency releases of reserve storage in Lake Lynn Dam. This is normally conserved to maintain the the power head at the dam. The lowest five-day average flow at Locks and Dam 4 was about 30 cfs, from 26-30 November, when releases of water from Lake Lynn Dam were discontinued for five days in sucession. The minimum average daily inflow into Pool 4 was even lower, however, and dropped to approximately 10 cfs on several occasions in October when Lake Lynn outflow was curtailed for shorter periods and the natural flow was at its lowest. Low-flow augmentation by Tygart River Lake and Stonewall Jackson Lake would have improved conditions at Dams 4 and 3, as can be seen in TABLE 2-5.

TABLE 2-5
MONONGAHELA RIVER NAVIGATION STUDY
LOCKS AND DAMS 2, 3, 4
FEASIBILITY STUDY
ACTUAL AND AUGMENTED FLOWS AT LOCKS AND DAMS 4 AND 3
MONONGAHELA RIVER, DURING 1930 LOW WATER PERIOD

	Month of				
	July	Aug	Sep	Oct	Nov
Average discharge, cfs actual (augmented by Lake Lynn drawdown*)	420	190	370	320	250
Average natural discharge augmented by Tygart and Stonewall Jackson Lakes cfs	810	560	490	460	500

* Augmentation was made by special arrangement with West Penn Power Company

Flow values do not represent a recurrent condition. If the natural low flows were to occur today, augmentation by Tygart River Lake, Stonewall Jackson Lake, and Youghiogheny River Lake would improve conditions at Locks and Dam 2 as indicated by TABLE 2-6.

TABLE 2-6
MONONGAHELA RIVER NAVIGATION SYSTEM
LOCKS AND DAMS 2, 3, AND 4
FEASIBILITY STUDY
ACTUAL AND AUGMENTED FLOWS AT LOCKS AND DAM 2
MONONGAHELA RIVER, DURING 1930 LOW WATER PERIOD

	Month of				
	Jul	**Aug**	**Sep**	**Oct**	**Nov**
Average discharge, cfs actual (augmented by Lake Lynn drawdown*)	950	430	381	324	334
Average natural discharge augmented by Tygart Lake, Stonewall Jackson Lake, and Youghiogheny Lake, cfs	860	830	760	720	720

* Augmentation was made by special arrangement with West Penn Power Company

(6) Lockage Water Needs at River Mile 11.2 Locks and Dam 2

(a) General

The water requirements for lockages at r.m. 11.2 have been determined from recent records of tonnages at Locks 2. The estimated future requirements are based on traffic projections prepared by the Navigation Center located in the Huntington District. At this lock most of the lockages were accomplished as single lockages through the 110' x 720' lock chamber. The actual traffic volume is about 11 percent above the average during the low-flow months of summer and autumn.

(b) Estimated Water Needs For the Recommended Plan

During the low-flow periods, the lockage head would average 13.7 feet with the gated dam. Water use for a 110' x 720' lock for one lockage per day, therefore, would be equal to an average flow of about 12.7 cfs. It is assumed that through random distribution, one out of four lockages would be an upstream lockage following a downstream lockage. Since filling for upstream lockages would require no release of water, the average quantity required per lockage would be 75 percent of 12.7 or 9.5 cfs. An assumed average load would be 1000 tons per barge and 9 barges per tow. One half of all tows would return empty.

TABLE 2-7
MONONGAHELA RIVER NAVIGATION SYSTEM
REPLACEMENT LOCKS AND DAMS 2, 3, AND 4
LOCKAGE AND WATER REQUIREMENTS
RIVER MILE 11.3

(cfs) Year	No. of Lockages	Maximum Daily Lockages	Total Water Needs Recommended Plan
1990	4,313	13	187
2000	5,827	18	236
2010	6,649	20	256
2020	7,041	22	276
2030	8,180	25	305
2040	8,946	27	325
2050	9,841	30	353

(7) Lockage Water Needs at River Mile 41.5 With Twin 84' x 720' Locks

(a) General

The present water requirements for lockages at r.m. 41.5 have been determined from recent records of tonnage at the present Locks and Dam 4. Estimates of future requirements are based on the traffic projections. Most of these present lockages were accomplished as multiple lockages. The existing locks are one 56' x 720' and one 56' x 360' chambers. Revised lockage requirements have been developed for the two new proposed 84' x 720' locks. Again traffic volume is about 11 percent above the average during the low-water months of summer and autumn.

(b) Estimated Water Needs For The Recommended Plan

Under the recommended plan, Dam 3 is to be removed and the pool at Dam 2 is to be raised by five feet. The lockage head during the low flow would be 19.8 feet. Water use for the 84' x' 720' lock for one lockage per day, would be equal to an average flow of about 13.9 cfs. Again it was assumed that through the random distribution, one out of four lockages would be an upstream lockage folowing a downstream lockage. As before, the average flow required would be 75 percent of 13.9 or 10.4 cfs. The average tow was again assumed to be made up of 9 barges each carrying 1000 tons and one half of the tows would return empty.

Actual water needs at r.m. 41.5, Dam 4, would also include leakage as well as the water necessary to pass the projected river traffic. Leakage through the culvert valves, lock mitre gates, crest gates and possibly around or under the dam could eventually reach 50 cfs. TABLE 2-8 shows a summary of the number of lockages and the total water requirements for the replacement chambers.

TABLE 2-8
MONONGAHELA RIVER NAVIGATION STUDY
REPLACEMENT OF LOCKS AND DAMS 2, 3 AND 4
LOCKAGE AND WATER REQUIREMENT
RIVER MILE 41.5

(cfs) Year	Number of Lockages	Maximum Daily Lockages	Total Water Needs Recommended Plan
1990	4,754	15	228
2000	6,767	21	293
2010	7,874	24	326
2020	8,590	26	349
2030	10,190	31	404
2040	11,396	35	448
2050	12,807	44	542

(8) Intermittent Low Flow

(a) General

The continued variation in precipitation and runoff results in periods of low flows interspersed with periods of high flows. Even in years of normal average flow, these periods of low flow and shortness of intermittent higher-flow duration may impose severe limitations on water usage. Such conditions cannot always be detected by examining monthly averages or from ordinary duration studies. The regulation by Tygart and Stonewall Jackson Lakes will provide a fairly constant low flow in the Monongahela River upstream of the Youghiogheny; downstream the low flow is increased by the further augmentation by Youghiogheny River Lake. There will continue to be a strong element of variable runoff periodically orginating from the uncontrolled portions of the drainage basins.

Over the 50-year period from 1930 through 1979, there were some years with consistently above-normal precipitation and runoff while there are other years with consistently below-normal precipitation and runoff. During the drought year of 1988 the total precipitation was only 27.09 inches, while in 1990, over 52 inches were recorded.

(b) Flow Duration

General

Natural flow-duration curves were developed using a 50-year period, water years 1930-1979. The 50 year-record of daily flows was adjusted to reflect the present regulated conditions (i.e. as modified by Tygart, Stonewall Jackson, and Youghiogheny River Lakes). The regulated flows were obtained by adding the uncontrolled flows to the routed actual or routed simulated outflows. For Tygart River Lake, the actual outflows were used from January 1967, the effective date of the present operating schedule which altered the outflows significantly, to September 1979. The remaining record prior to January 1967 was simulated using the present operating schedule to reflect existing conditions. For Stonewall Jackson Lake, simulated records were used for the entire period of record. For Youghiogheny River Lake, the actual outflows were used from 1 January 1967, the effective date of the present operating schedule, which altered the outflow, to September 1979. The period of record prior to January 1967 was simulated using the present operating schedule to reflect current conditions. This flow duration curve for Dams 3, and 4 is shown on PLATE 2-6. The flow duration for Dam 2 is shown on PLATE 2-7.

To show the potential conditions in droughts, four of the driest years of recent record were analyzed. For the Locks and Dam 4, located upstream of the Youghiogheny Rive, the years of 1930, 1953, 1965, and 1988 were selected. Average daily flows, reflecting modification by Tygart and Stonewall Jackson Lakes were used as a basis for this analysis.

River Mile 41.5

Plate 2-8 presents flow duration curves for 1930, 1953, 1965, and 1988 at Locks and Dam 4. These curves show the longest duration within each year that the flows would have equalled or exceeded the curve values. Examination of the lowest points of these curves indicate that even in the driest years, flows could be sustained continuously above 420 cfs for 365 days, and above 1000 cfs for 275 days with the present reservoir system. During the 1930 drought the 1000 cfs could be maintained for only 200 days.

River Mile 11.2

PLATE 2-9 presents duration for 1930, 1953, 1965, and 1988 at r.m. 11.2, Locks and Dam 2. These curves show the longest duration of time within each year that a given flow would have equalled or exceeded the curve value. Examination of the lowest point of these curves shows that even in the driest year, flow could be sustained continunously above 700 cfs for 365 days, and above 1000 cfs for 330 days. In addition to these curves for assured flow in the individual dry years, Plate 2-9 shows the duration curve on the average number of days per year that a given discharge will be equalled or exceeded without regard to the distribution of the discharge value throughout the 50-year period.

(9) Stage Duration

The flow durations that were developed in Section 8 were converted to stage duration curves by means of rating curves developed for the existing dams. Upper and lower stage durations at Dam 4, Dam 3, and Dam 2 for the existing conditions are shown on PLATES 2-10 to 2-12.

PLATE 2-13 shows upper and lower stage duration for Locks and Dam 2 (r.m. 11.2) with the recommended plan. Plate 2-14 shows the upper and lower stage duration at Dam 4 (r.m. 41.5) for the recommended plan. The upper pool duration at Dam 2 will be different due to the gated dam and higher pool level while at Dam 4 the lower pool duration will change due to the reduced normal pool elevation. The upper stage duration will remain the same as at present.

(10) Stream Velocities and Rate of Flow in Pool

(a) Existing System

River Mile 11.2

The area capacity curve on PLATE 2-15 shows that between r.m. 11.2 and r.m. 23.8 there would be a total volume of 13,500 acre feet at normal pool, elevation 718.7. With the minimum augmented low flow to be supplied by Tygart, Stonewall Jackson, and Youghiogheny Lakes, and no precipitation, the displacement time for the total storage replacement, at normal pool, would be 16 days. Although this represents the time for inflow water to actually replace the storage in the pool, it does not indicate the time lag between an increase in inflow and the resultant increase in outflow. Under present conditions, translation times for flood waves between Locks and Dam 3 and Locks and Dam 2 averages about 2 hours.

River Mile 23.8

The area capacity curve on PLATE 2-16 shows that between Locks and Dam 3 and Locks and Dam 4 r. m. 41.5 there is a volume of 16,600 acre feet at elevation 726.9. With the minimum augmented low-flow to be supplied by Tygart and Stonewall Jackson Lakes, the displacement time for total storage replacement at normal pool elevation, would be 20 days. Although this does represent the time for inflow water to actually become outflow over the dam, it does not indicate the time between an increase in inflow and the resultant increase in outflow. Under present conditions, translation time for flood waves between the two dams is about 4 hours

(b) Recommended Plan

The area capacity curve on PLATE 2-17 shows the that between Dam 2, r.m. 11.2, and Dam 4, r.m. 41.5, the total volume at elevation 723.7 would be 31,500 acre feet. With the minimum augmented low flow supplied by Tygart, Stonewall Jackson, and Youghiogheny Lakes, displacement times for the total storage would be 38 days. Under this plan the translation time for flood waves between Dam 4 and Dam 2 is 6 hours.

(11) Standard Project Flood

The Standard Project Flood (SPF) is defined as one which would be exceeded in magnitude only on rare occasions. It establishes a standard for design that would provide a high degree of flood protection without regard to economic or other practical limitations. The standard project flood, however, is substantially less than the probable maximum flood.

The standard project flood for the lower Monongahela River would be caused by a storm with rainfall as set forth in Corps of Engineers' Engineer Manual (EM) 1110-2-1411, subject: Standard Project Flood Determination, dated March 1952. On this basis, the basin average rainfall would have a maximum intensity of 3.61 inches in six hours and 4.23 inches in 24 hours with a total of 6.34 inches in four days. The intensities and magnitude of the standard project flood indicates that this would probably be a summer-type storm. Infiltration rates computed for other storms in or near the Pittsburgh District for the season in which the standard project storm would probably occur have been assumed. Total storm losses were assumed to be 2.40 inches and the total storm runoff of 3.94 inches of which 1.56 inches would occur within an 18-hour period. Since this was considered a summer-type storm, occuring during a period when antecedent rainfall would be normal or below normal, it was assumed that the river would be at or near normal pool levels. The peak discharge reduced by Tygart and Stonewall Jackson Dams would be 253,250 cfs at existing Dams 4 and 3 and reach elevations 768.5 and 757.1 feet on the upper, gages respectively. The peak discharge reduced by Tygart, Stonewall Jackson, and Youghiogheny Dams at Dam 2 would be 291,200 cfs and reach elevation 747.2 feet. The profiles for the existing condition and recommended plan are shown on PLATE 2-18.

(12) Probable Maximum Flood

The probable maximum flood (PMF) on the lower Monongahela River has been developed from the probable maximum precipitation centered over the Monongahela River basin. The estimates of maximum rainfall used for the determination of the probable maximum flood were obtained by use of charts in Hydrometeorological Report (HMR) No. 51 (June 1978),"Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian," prepared by the Hydrometeorological Section of the U.S. National Weather Service. The probable maximum precipitation is defined in No. 51 as representing "the critical depth-duration-area rainfall relations for a particular area during various seasons of the year that would result if conditions during an actual storm in the region were increased to represent the most critical meteorolocical conditions that are considered probable of occurrence." The computed total precipitation over a three-day period over the lower Monongahela River is approximately 15.0 inches which is about one-third of the normal annual precipitation of this region. Rainfall of this magnitude has been recorded in this geographic region over much smaller areas, such as the July 1942 storm in northern Pennsylvania. However, the chances of such an occurrence over the entire Monongahela River basin are extremely remote. The computed modified peak, as reduced by Tygart Dam and Stonewall Jackson Dam at Dam 4, would be 609,100 cfs. At Dam 2, the peak flow as modified by Tygart Dam, Stonewall Jackson Dam, and Youghiogheny Dam would be 796,000 cfs. The PMF profile will be from 20 to 25 feet higher than the SPF profile shown on PLATE 2-18.

(13) Rates of Rise and Fall

(a) Rate of Rise

All major flood events from 1938 to date, were investigated to determine the shortest possible time interval during which the river might rise from various initial stages. The upper pool records at Dams 2, were searched to find the minimum times for changes in river levels of 2, 5, and 7 feet and relationships were developed These curves are shown on PLATE 2-19.

(b) Rate of Flood Fall

Similar analyses were performed to determine the shortest possible time interval which the river might fall 2, 5, and 7 feet from various stages. Curves for the upper pool for Dam 2 is shown on PLATES 2-20

(c) Lake Lynn Effects

Intermittent releases from the non-federal Lake Lynn hydropower dam on the Cheat River have caused waves on the Cheat and Monongahela River since the plant commenced operation in 1926. At Dam 4, lower-pool stage increases up to 1.5 feet due to the power releases and about 1 foot at Dam 2. Normally the rise at Dam 4 occurs over a two to five-hour period and the rate rarely exceeds one foot per hour. The leading edge of the wave is observed at Dam 4 about 3 hours, and at Dam 2 about 6 hours, after the initial release of water from Lake Lynn.

(14) Wind Waves

Actual record of wind velocities are not available for the immediate vicinity of Dams 2 to Dam 4. However, records at Pittsburgh, the nearest first-order National Weather Service station with wind velocity data, indicate that high winds have a predominantly western component. Pittsburgh is about 20 miles to the west of the study reach but these data are believed to be applicable to the study reach. They have been reviewed and expended graphically to show the maximum wind velocities for duration of one to 60 minutes for each month of the year and for the eight compass directions. The maximum velocity determined for one minute, in any direction, was in excess of 90 miles per hour; the maximum for one hour was 56 miles per hour. High-wind velocities may occur simultaneously with maximum river stages. During the passage of a cold front at the time of the flood crest on 5 March 1963, gusts from the southwest of about 63 miles per hour with an hourly average of 40 miles per hour were recorded at Greater Pittsburgh International Airport.

The Monongahela River flows in a northwesterly direction for a distance of of about 1.5 miles upstream of Dam 2 following a gradual bend in its course. The method outlined in Corps of

Engineers Engineer Technical Letter (ETL) 1110-2-305, dated 16 February 1984, "Determining Sheltered Water Wave Characteristics" was used to determine the effective wave fetch distances in the Dam 2 pool as well as to determine the resultant critical wind velocity and maximum wind height. The maximum one-minute southern component wind towards the dam, as determined from the study of records at Pitsburgh, is 65 miles per hour. The critical wind direction in this reach would be 6.7 minutes with a wind velocity of 58 miles per hour. The computed wave height under such conditions would be two feet.

(15) Fog

Morning fog is very common along the Monongahela River often persisting from dawn until late morning. Records from 1961 to 1964 and 1983 to 1986 at Dam 2 , mile 11.2, indicate that fog occurs about 84 days per year. About 50 percent of the time the fog is dense enough to interfere with navigation. TABLE 2-9 gives the distribution of fog during the year.

TABLE 2-9
LOWER MONONGAHELA RIVER NAVIGATION STUDY
LOCKS AND DAMS 2, 3 AND 4
FEASIBILITY STUDY
MORNING FOG CONDITIONS

Month	**Fog Days**	**Month**	**Fog Days**
January	1	July	12
February	2	August	14
March	2	September	15
April	4	October	11
May	8	November	2
June	12	December	1

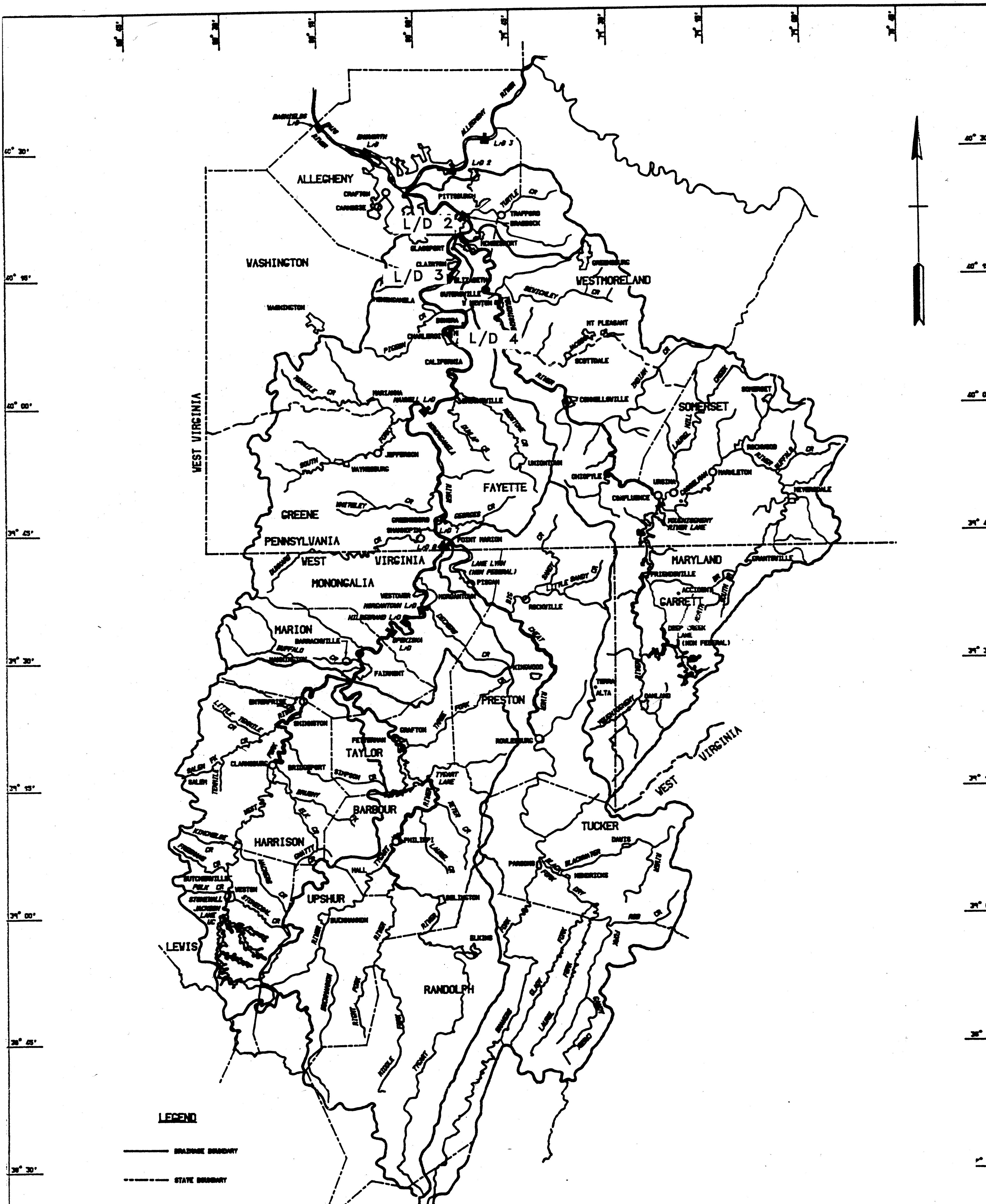
(16) Ice

Investigation of records of ice at Dam 2 to Dam 4 reveals that ice usually begins to form after about 4 days with night temperatures below 15 degrees F or one or two days when temperatures are below 10 degrees F. These are average values since this will also depend on the actual water temperature at the start of the cold weather. During prolonged periods of cold weather, ice may reach thicknesses of six inches or more in this reach of the river. There have been instances of major ice buildup behind the existing dams.

In recent years, varying thicknesses of ice have formed at some times during many winters behind these dams. In January and February 1963 one of the most severe cold spells of record caused ice to reach thicknesses of several inches during this period. The most prolonged period of ice occurred in January and February 1977 when ice was recorded for 16 days in sucession reaching a maximum thickness of 6 inches at Dam 4. In all these instances of heavy ice cover, three or four days of temperatures reaching around 50 degrees F and a rise of several feet at the head of the pool was sufficient to dislodge the ice and move it downstream.

The greatest interference by ice to navigation results when floating broken ice accumulates in the upper approaches. The ice collects near the locks when it is running and also when it follows in the wake of tows as they navigate an open track in an ice sheet. Artifical breaking of this ice in itself has negligible effects on local ice movement unless there has been a substantial deterioration. Ice buildup on the keel of a tow often causes inefficiency but generally does not cause great difficulty clearing the lock sills due to the depth of water over these sills.

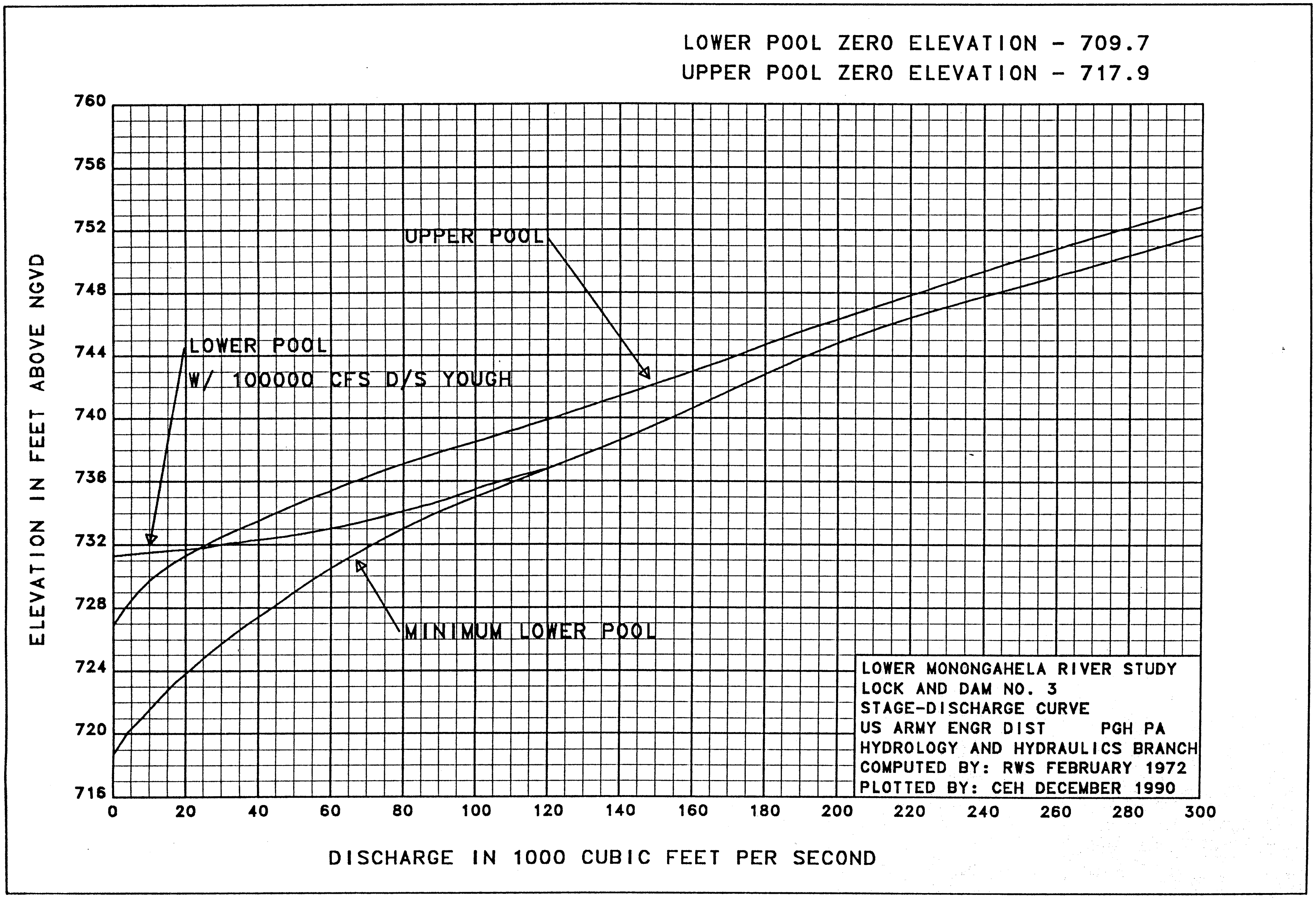
Recent and ongoing research and experience in ice engineering have added to the present knowledge of more efficient ice handling to benefit navigation. The recent River Ice Management (RIM) Research and Development Program findings will be utilized to the fullest to meet the need at these dams. As new information is made available, present methods will be improved to mimimize the navigation ice problems. Other benefits of this research program, which have and will be utilized, when applicable, are long-term and mid-winter forecasting techniques, travel-frequency procedures (convoying), possible vessel-based techniques (prows), unconventional energy applications to melt ice, optimum use of waste heat (power plant discharge), air screens, wall coatings, and ice control structures or methods. The District is presently working with the U.S. Army Engineer Cold Regions Research and Engineering Laboratory (CRREL) to adress these ice problems.



LOWER MONONGAHELA RIVER STUDY
LOCKS AND DAMS NO.S 2, 3, 4
BASIN MAP

US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH
PLOTTED BY: CEH SEP 1990

PLATE 2-1



LOWER POOL ZERO ELEVATION - 709.7
UPPER POOL ZERO ELEVATION - 717.9
UPPER POOL
LOWER POOL
W/ 100000 CFS D/S YOUGH
MINIMUM LOWER POOL
ELEVATION IN FEET ABOVE NGVD
760
756
752
748
744
740
736
732
728
724
720
716
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
DISCHARGE IN 1000 CUBIC FEET PER SECOND
LOWER MONONGAHELA RIVER STUDY
LOCK AND DAM NO. 3
STAGE-DISCHARGE CURVE
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: RWS FEBRUARY 1972
PLOTTED BY: CEH DECEMBER 1990

PLATE 2-2

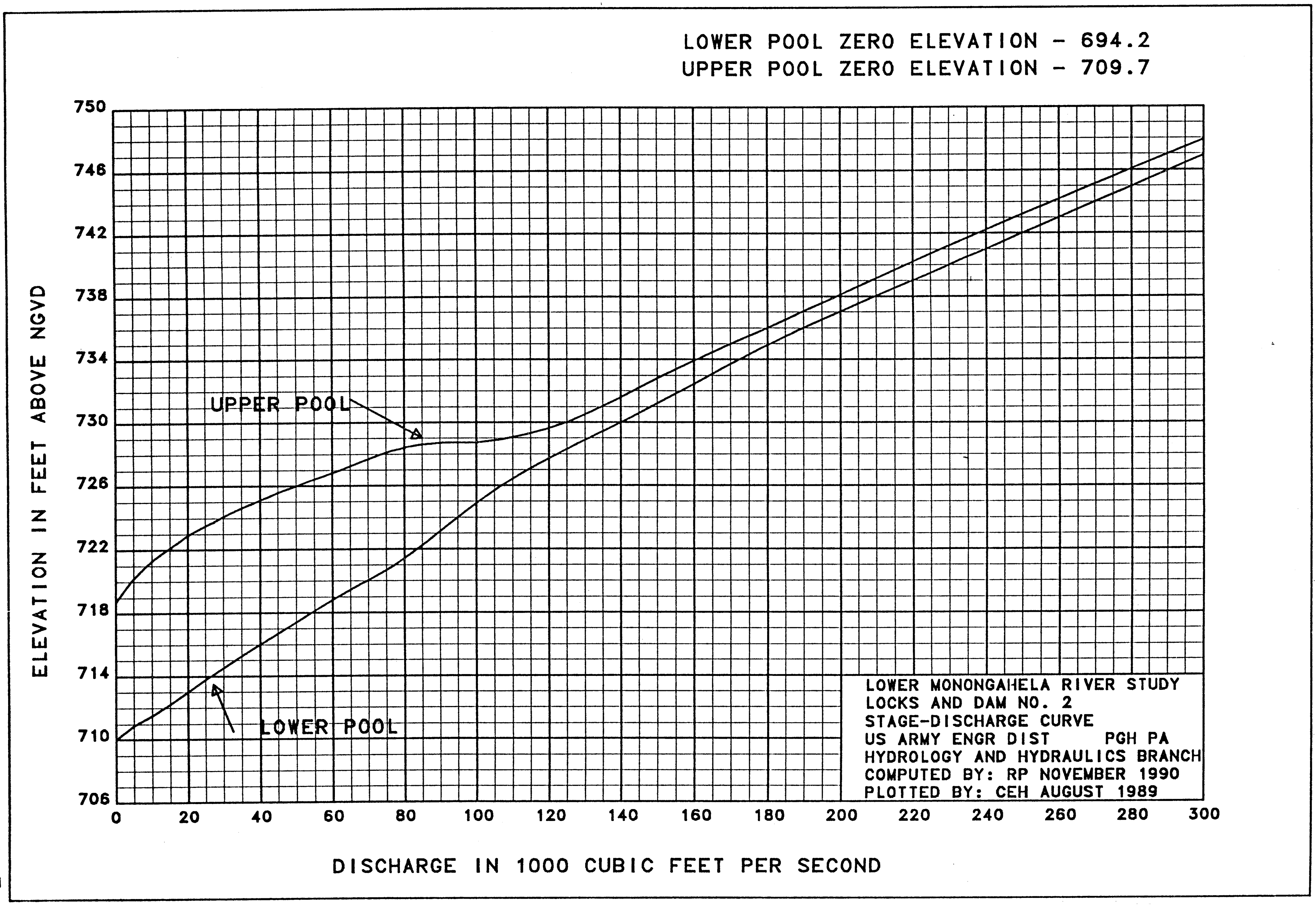

LOWER POOL ZERO ELEVATION - 694.2
UPPER POOL ZERO ELEVATION - 709.7
ELEVATION IN FEET ABOVE NGVD
750
746
742
738
734
730
726
722
718
714
710
706
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
DISCHARGE IN 1000 CUBIC FEET PER SECOND
UPPER POOL
LOWER POOL
LOWER MONONGAHELA RIVER STUDY
LOCKS AND DAM NO. 2
STAGE-DISCHARGE CURVE
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: RP NOVEMBER 1990
PLOTTED BY: CEH AUGUST 1989

PLATE 2-3

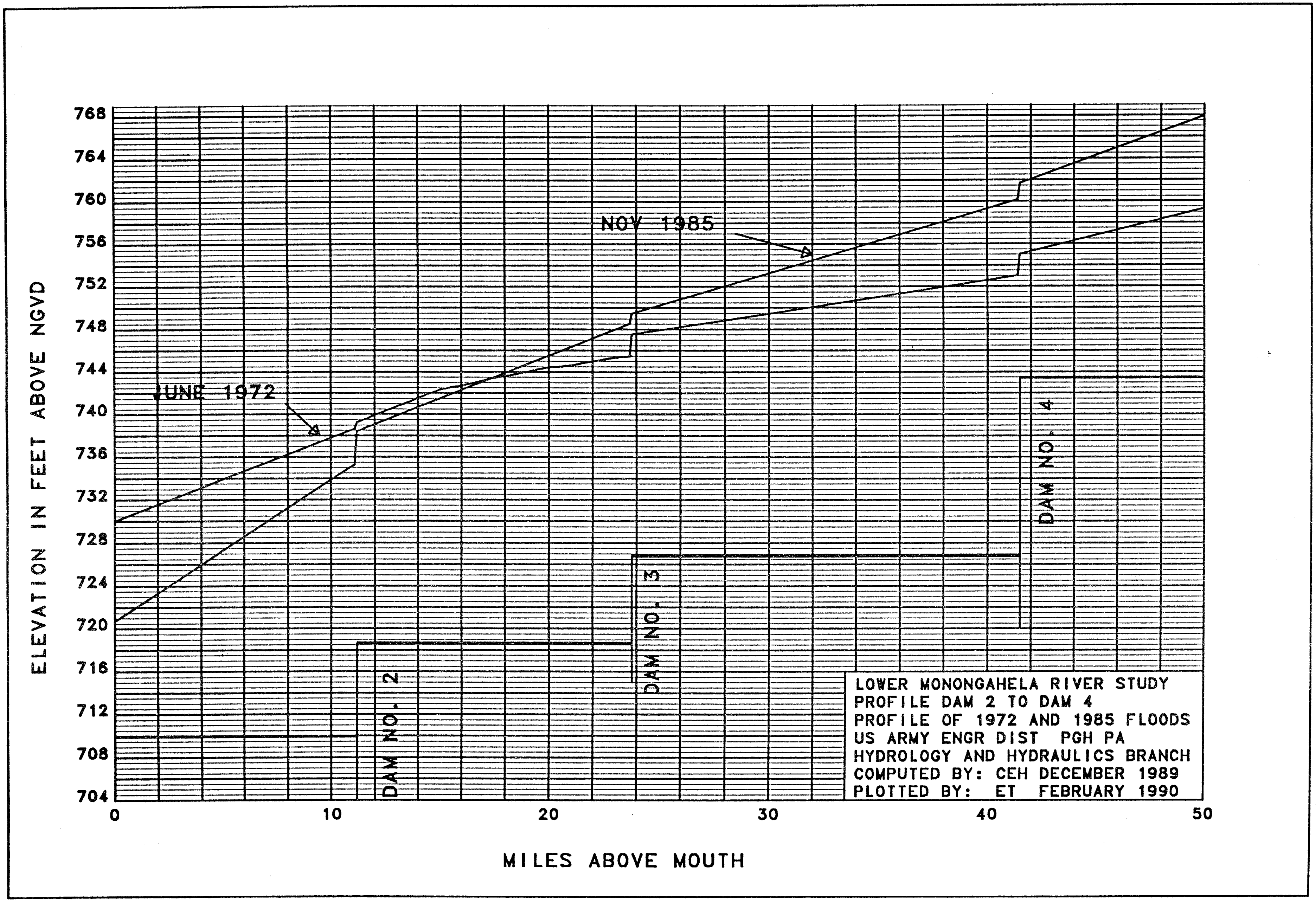

ELEVATION IN FEET ABOVE NGVD
768
764
760
756
752
748
744
740
736
732
728
724
720
716
712
708
704
0
10
20
30
40
50
MILES ABOVE MOUTH
NOV 1985
JUNE 1972
DAM NO. 2
DAM NO. 3
DAM NO. 4
LOWER MONONGAHELA RIVER STUDY
PROFILE DAM 2 TO DAM 4
PROFILE OF 1972 AND 1985 FLOODS
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET FEBRUARY 1990

PLATE 2-4

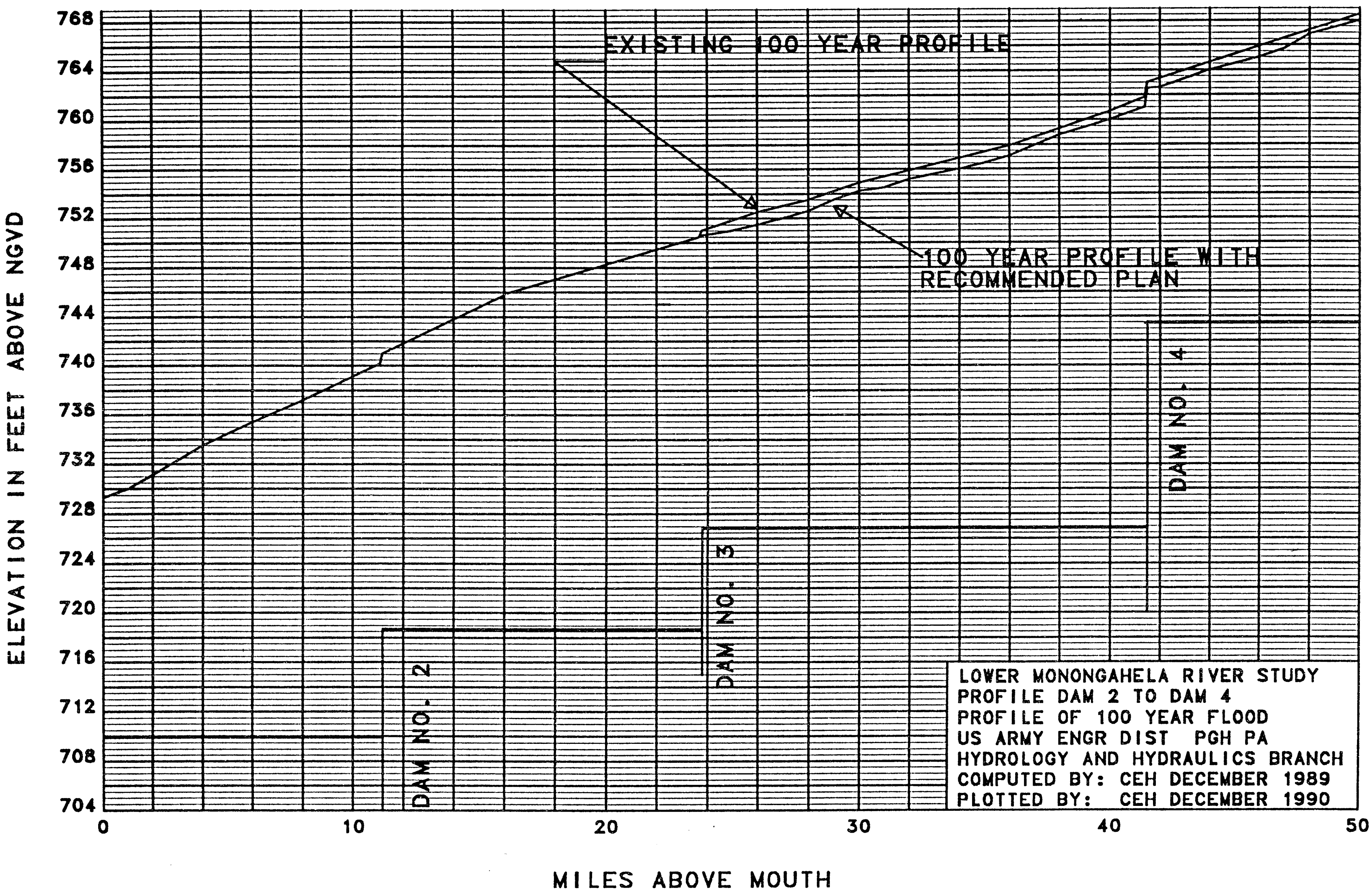

EXISTING 100 YEAR PROFILE
100 YEAR PROFILE WITH RECOMMENDED PLAN
DAM NO. 2
DAM NO. 3
DAM NO. 4
ELEVATION IN FEET ABOVE NGVD
768
764
760
756
752
748
744
740
736
732
728
724
720
716
712
708
704
0
10
20
30
40
50
MILES ABOVE MOUTH
LOWER MONONGAHELA RIVER STUDY
PROFILE DAM 2 TO DAM 4
PROFILE OF 100 YEAR FLOOD
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: CEH DECEMBER 1990

PLATE 2-5

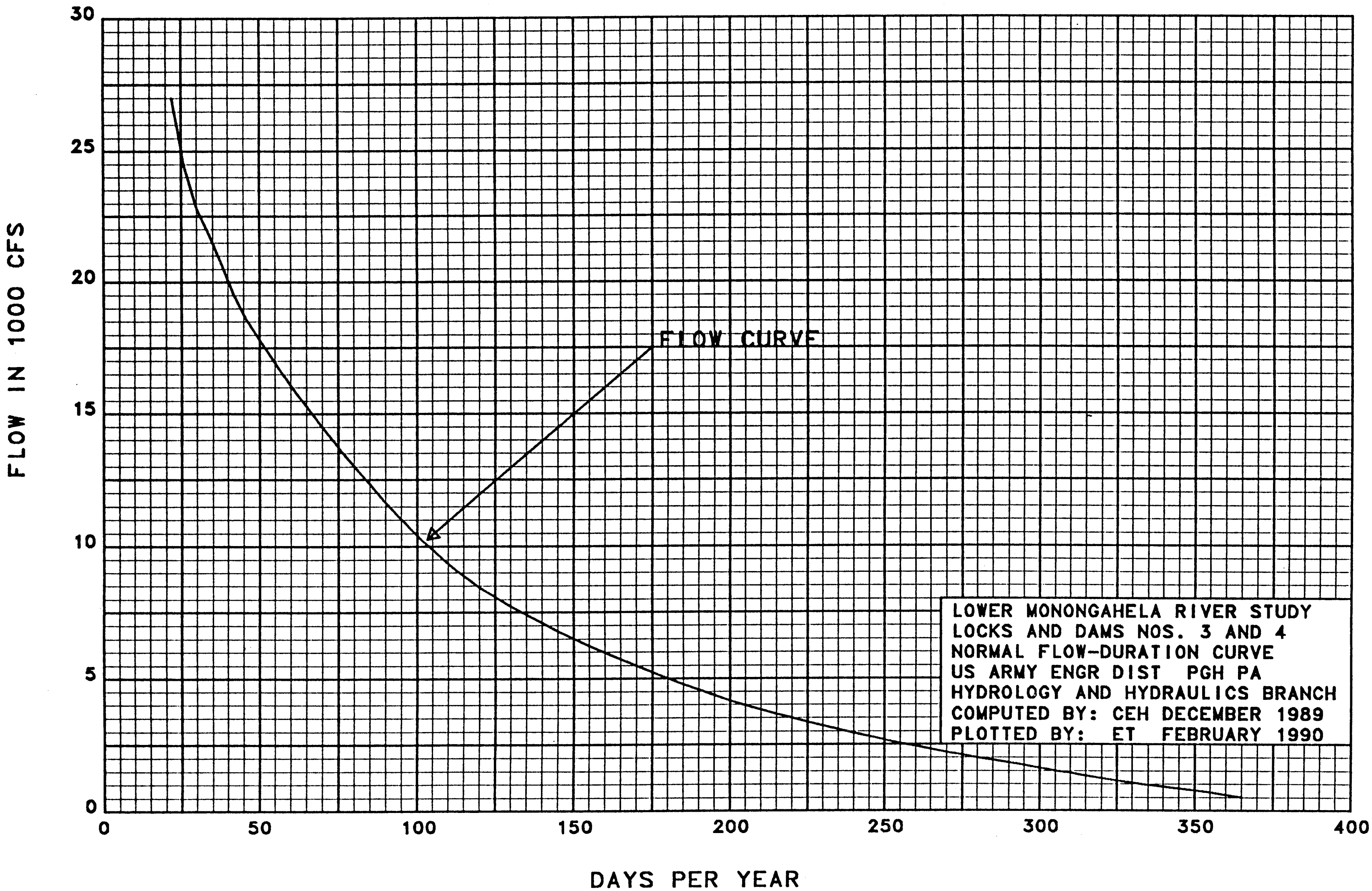
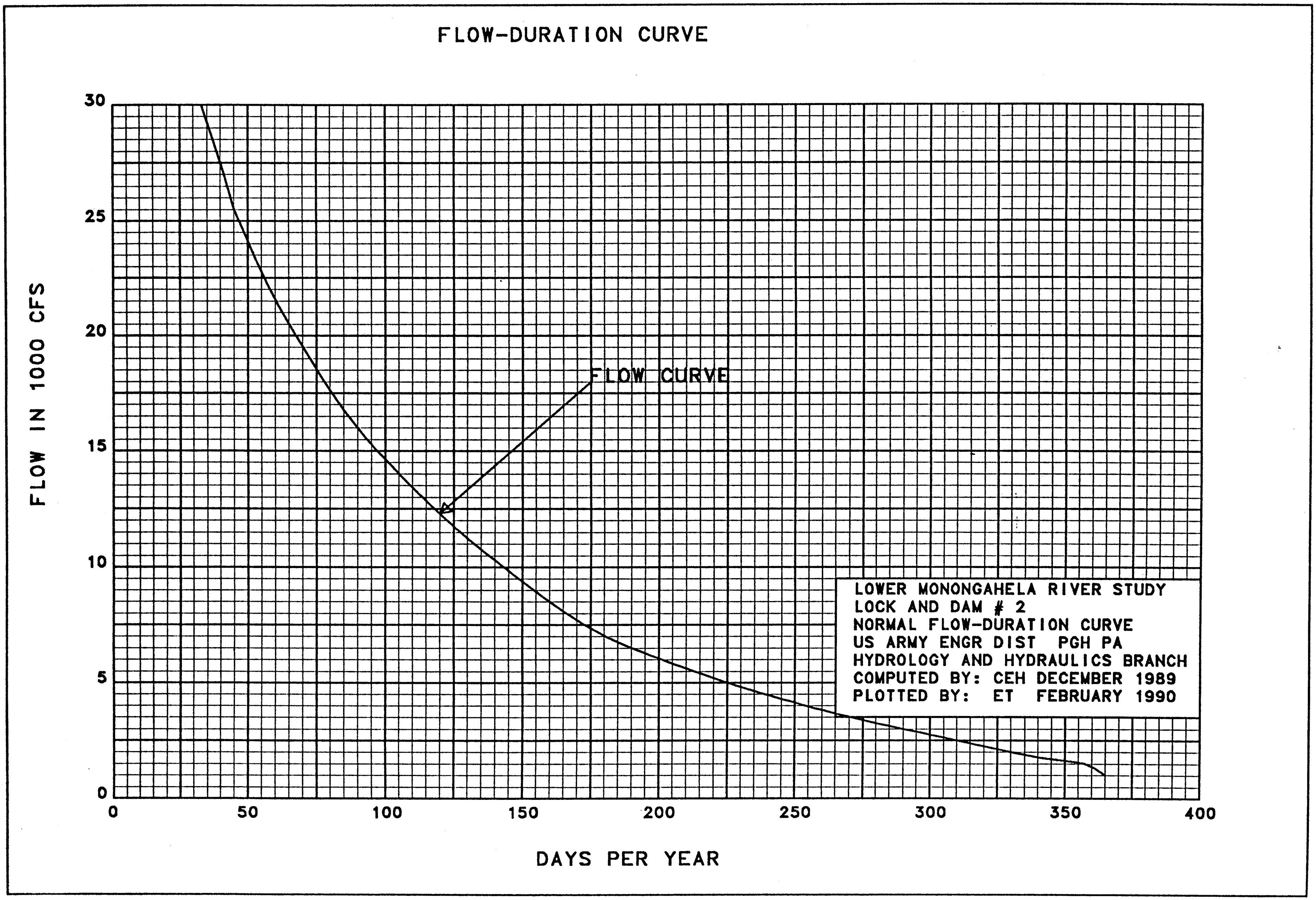

FLOW IN 1000 CFS
30
25
20
15
10
5
0
0
50
100
150
200
250
300
350
400
DAYS PER YEAR
FLOW CURVE
LOWER MONONGAHELA RIVER STUDY
LOCKS AND DAMS NOS. 3 AND 4
NORMAL FLOW-DURATION CURVE
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET FEBRUARY 1990

PLATE 2-6



FLOW-DURATION CURVE
FLOW IN 1000 CFS
0
5
10
15
20
25
30
0
50
100
150
200
250
300
350
400
DAYS PER YEAR
FLOW CURVE
LOWER MONONGAHELA RIVER STUDY
LOCK AND DAM # 2
NORMAL FLOW-DURATION CURVE
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET FEBRUARY 1990

PLATE 2-7

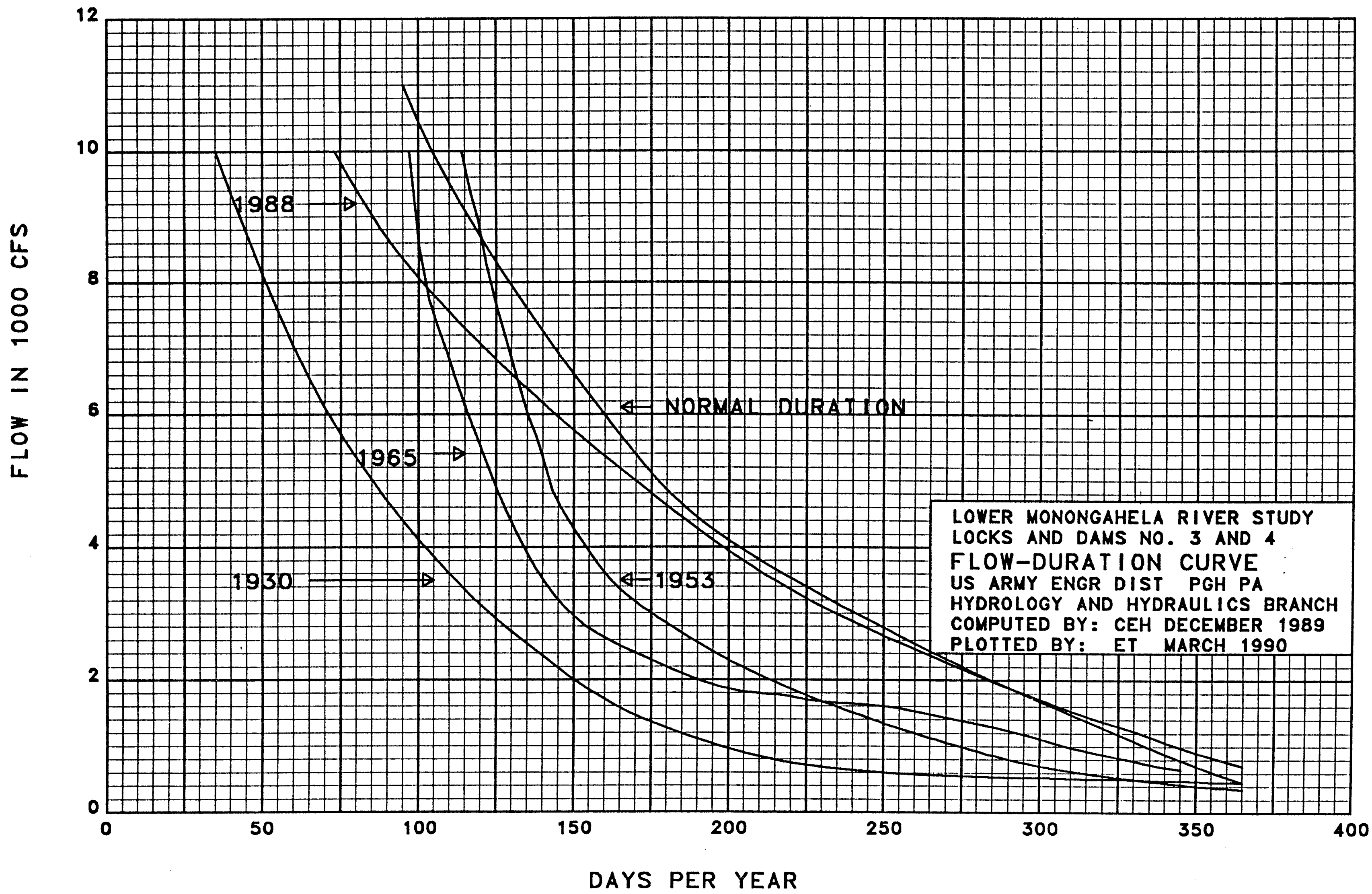

LOWER MONONGAHELA RIVER STUDY
LOCKS AND DAMS NO. 3 AND 4
FLOW-DURATION CURVE
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET MARCH 1990
FLOW IN 1000 CFS
DAYS PER YEAR
0
2
4
6
8
10
12
0
50
100
150
200
250
300
350
400
1988
1965
1930
1953
NORMAL DURATION

PLATE 2-8

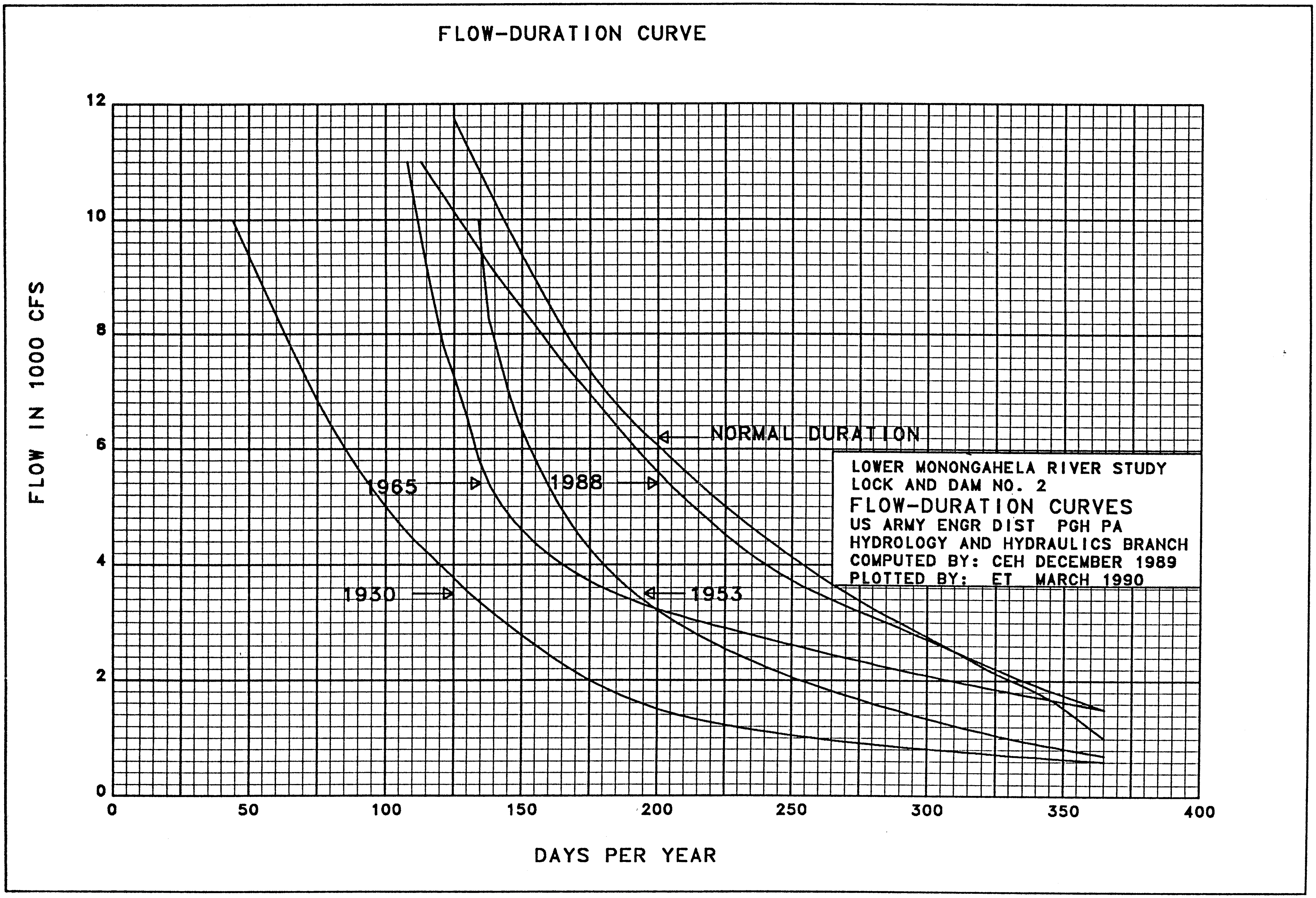

FLOW-DURATION CURVE
FLOW IN 1000 CFS
DAYS PER YEAR
0
2
4
6
8
10
12
0
50
100
150
200
250
300
350
400
NORMAL DURATION
1965
1988
1930
1953
LOWER MONONGAHELA RIVER STUDY
LOCK AND DAM NO. 2
FLOW-DURATION CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET MARCH 1990

PLATE 2-9

STAGE-DURATION CURVES

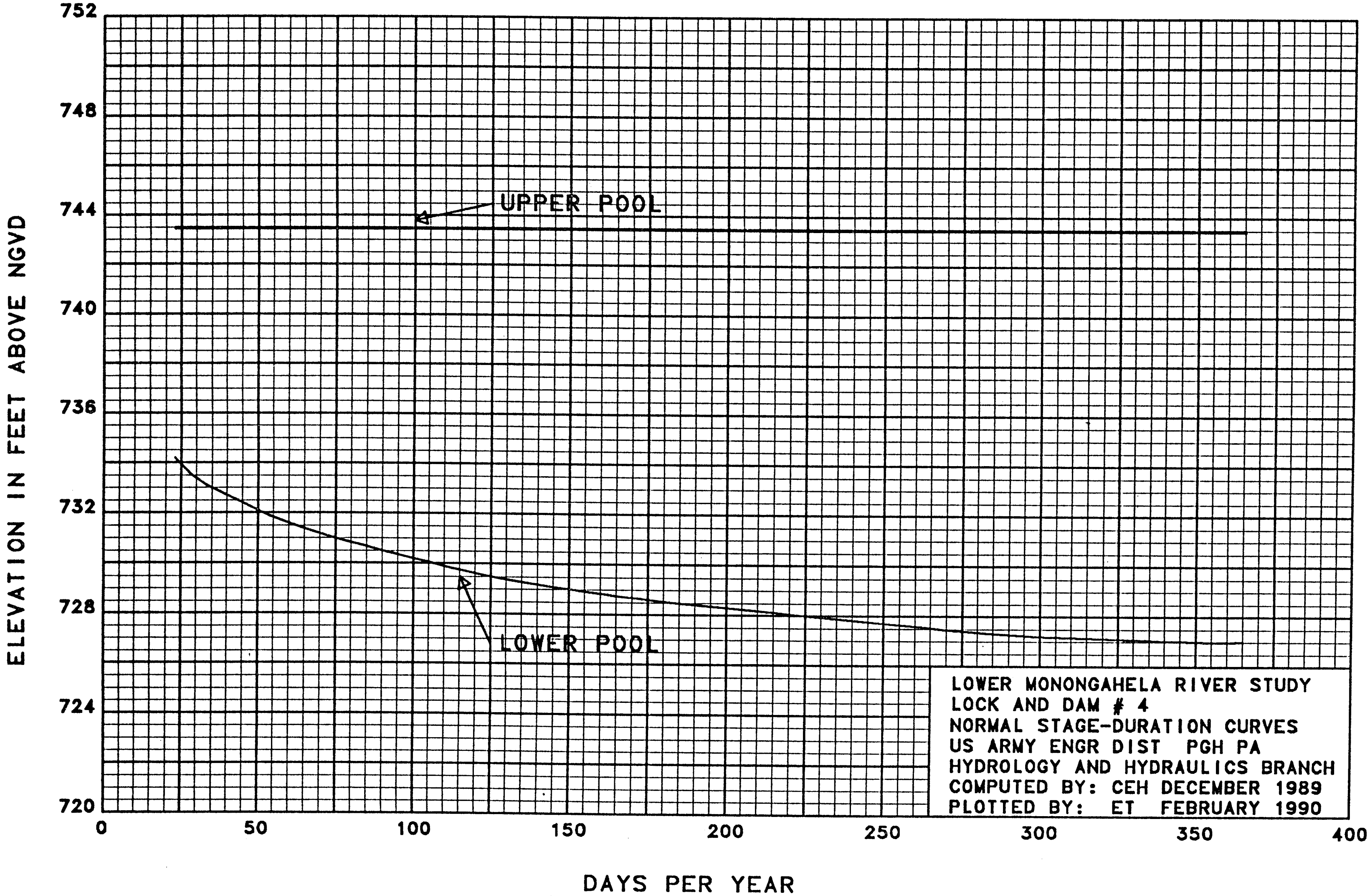


PLATE 2-10

STAGE-DURATION CURVES

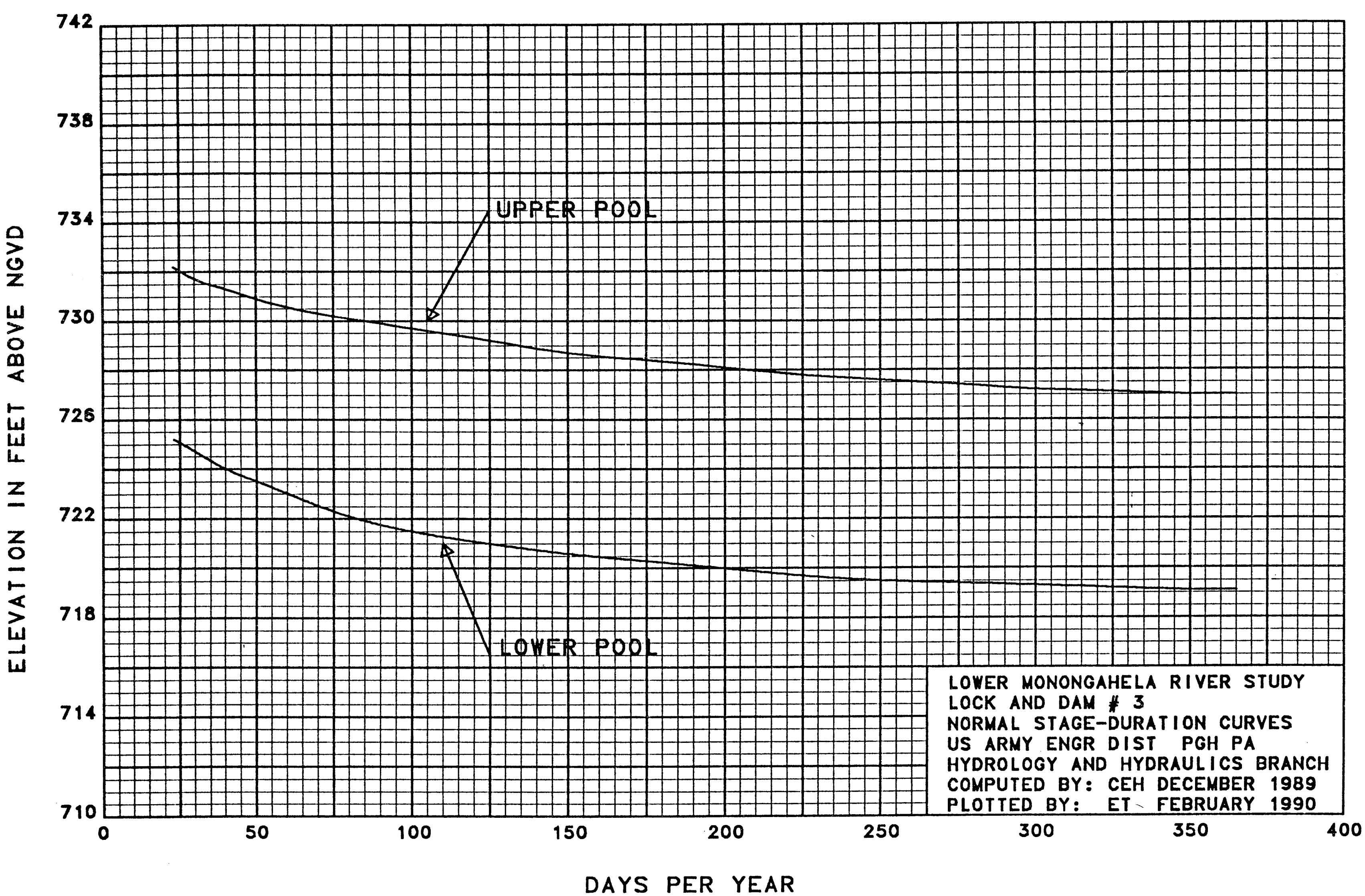
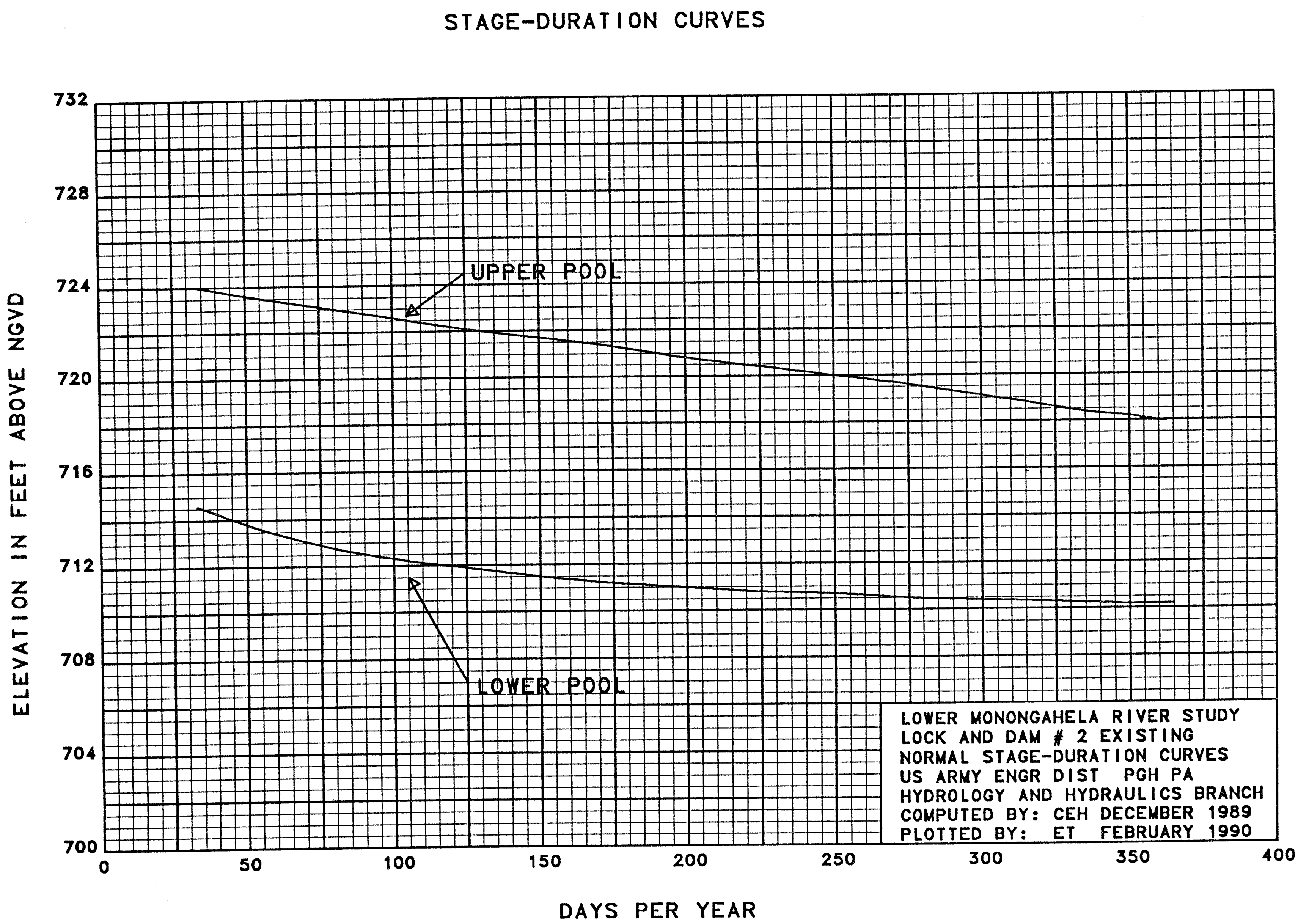


PLATE 2-11


STAGE-DURATION CURVES
732
728
724
720
716
712
708
704
700
ELEVATION IN FEET ABOVE NGVD
0
50
100
150
200
250
300
350
400
DAYS PER YEAR
UPPER POOL
LOWER POOL
LOWER MONONGAHELA RIVER STUDY
LOCK AND DAM # 2 EXISTING
NORMAL STAGE-DURATION CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET FEBRUARY 1990

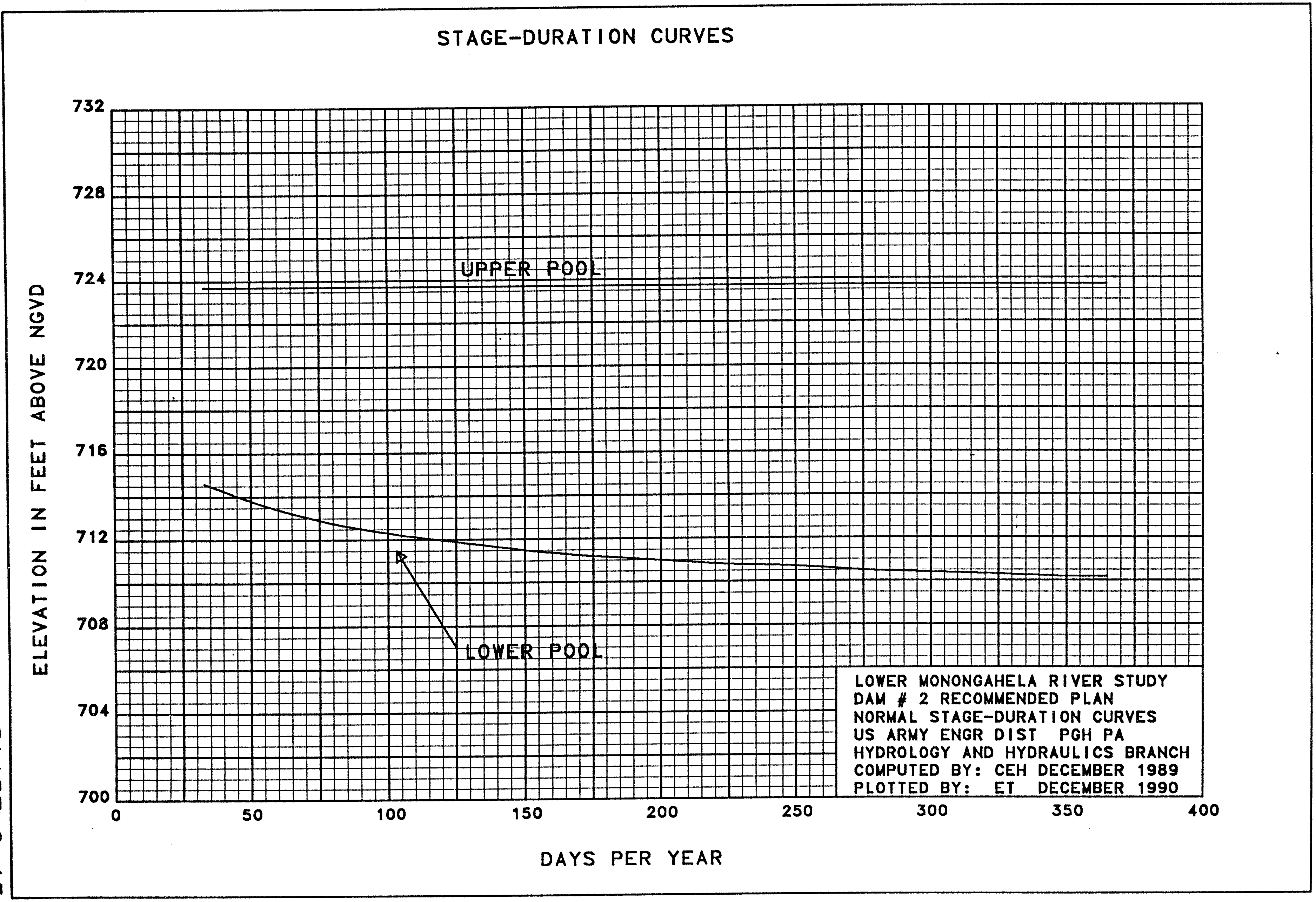

STAGE-DURATION CURVES
732
728
724
720
716
712
708
704
700
ELEVATION IN FEET ABOVE NGVD
UPPER POOL
LOWER POOL
0
50
100
150
200
250
300
350
400
DAYS PER YEAR
LOWER MONONGAHELA RIVER STUDY
DAM # 2 RECOMMENDED PLAN
NORMAL STAGE-DURATION CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET DECEMBER 1990

PLATE 2-13

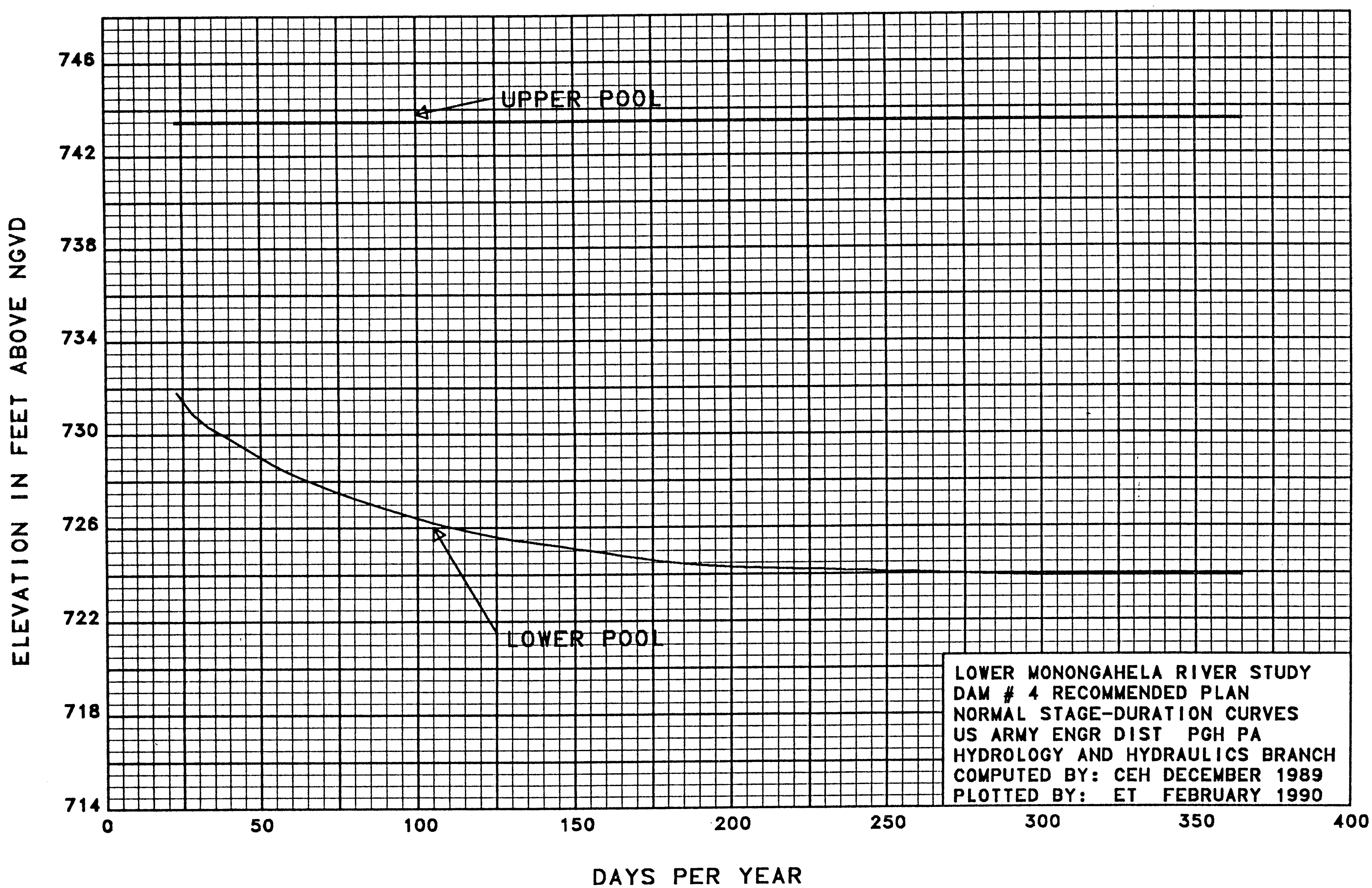

UPPER POOL
LOWER POOL
ELEVATION IN FEET ABOVE NGVD
746
742
738
734
730
726
722
718
714
0
50
100
150
200
250
300
350
400
DAYS PER YEAR
LOWER MONONGAHELA RIVER STUDY
DAM # 4 RECOMMENDED PLAN
NORMAL STAGE-DURATION CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: ET FEBRUARY 1990

PLATE 2-14

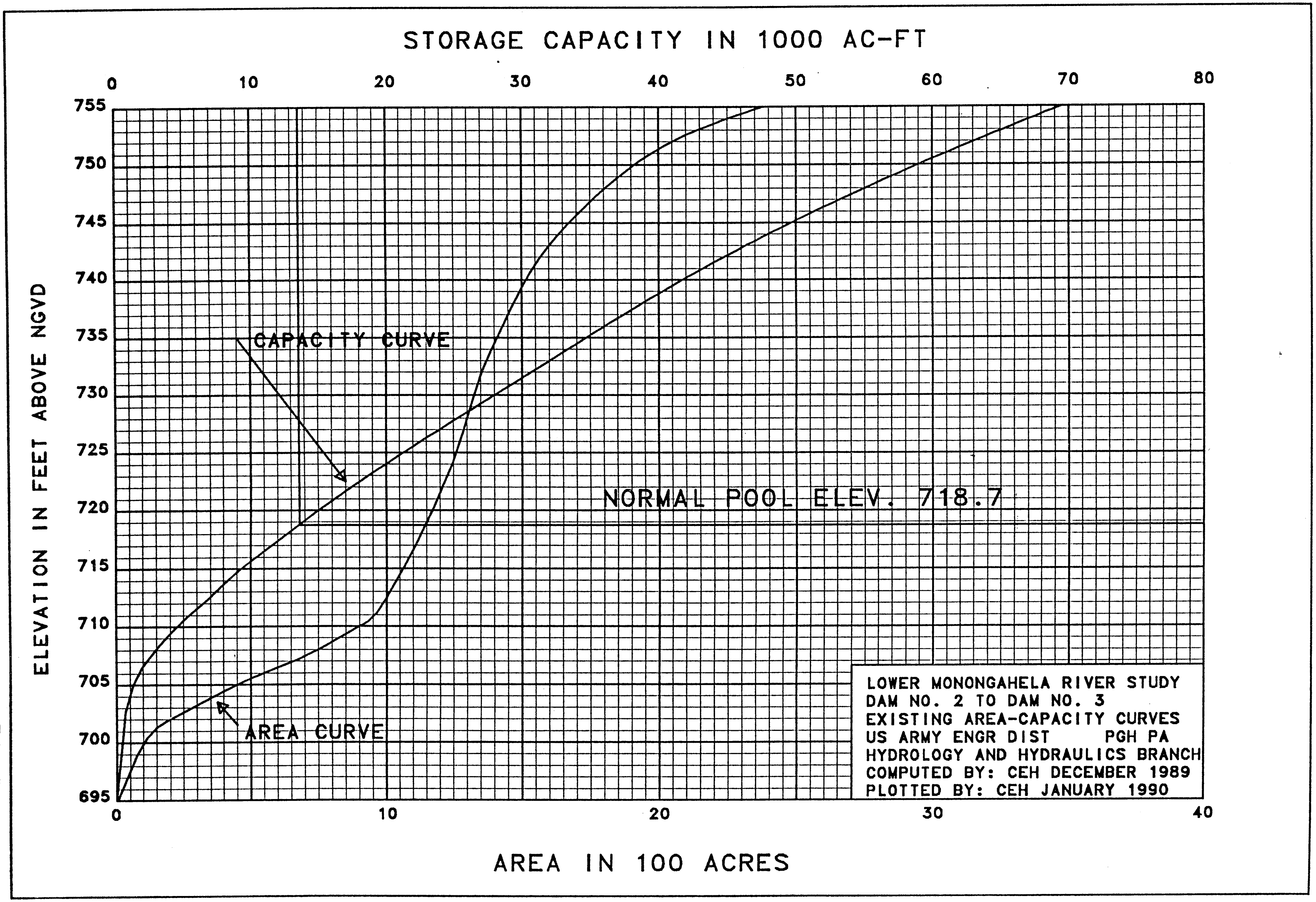

STORAGE CAPACITY IN 1000 AC-FT
0
10
20
30
40
50
60
70
80
755
750
745
740
735
730
725
720
715
710
705
700
695
ELEVATION IN FEET ABOVE NGVD
CAPACITY CURVE
NORMAL POOL ELEV. 718.7
AREA CURVE
LOWER MONONGAHELA RIVER STUDY
DAM NO. 2 TO DAM NO. 3
EXISTING AREA-CAPACITY CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: CEH JANUARY 1990
0
10
20
30
40
AREA IN 100 ACRES

PLATE 2-15

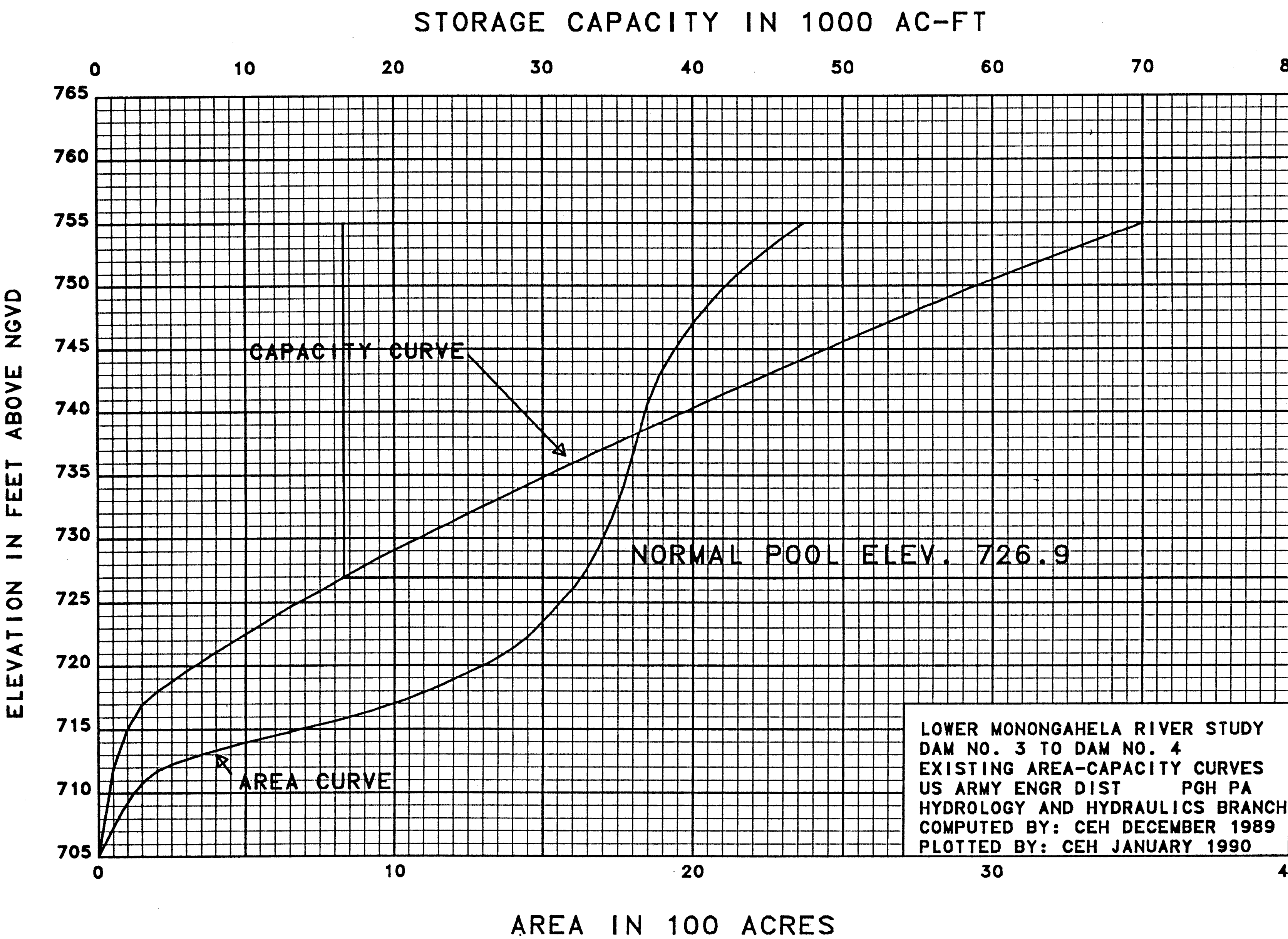
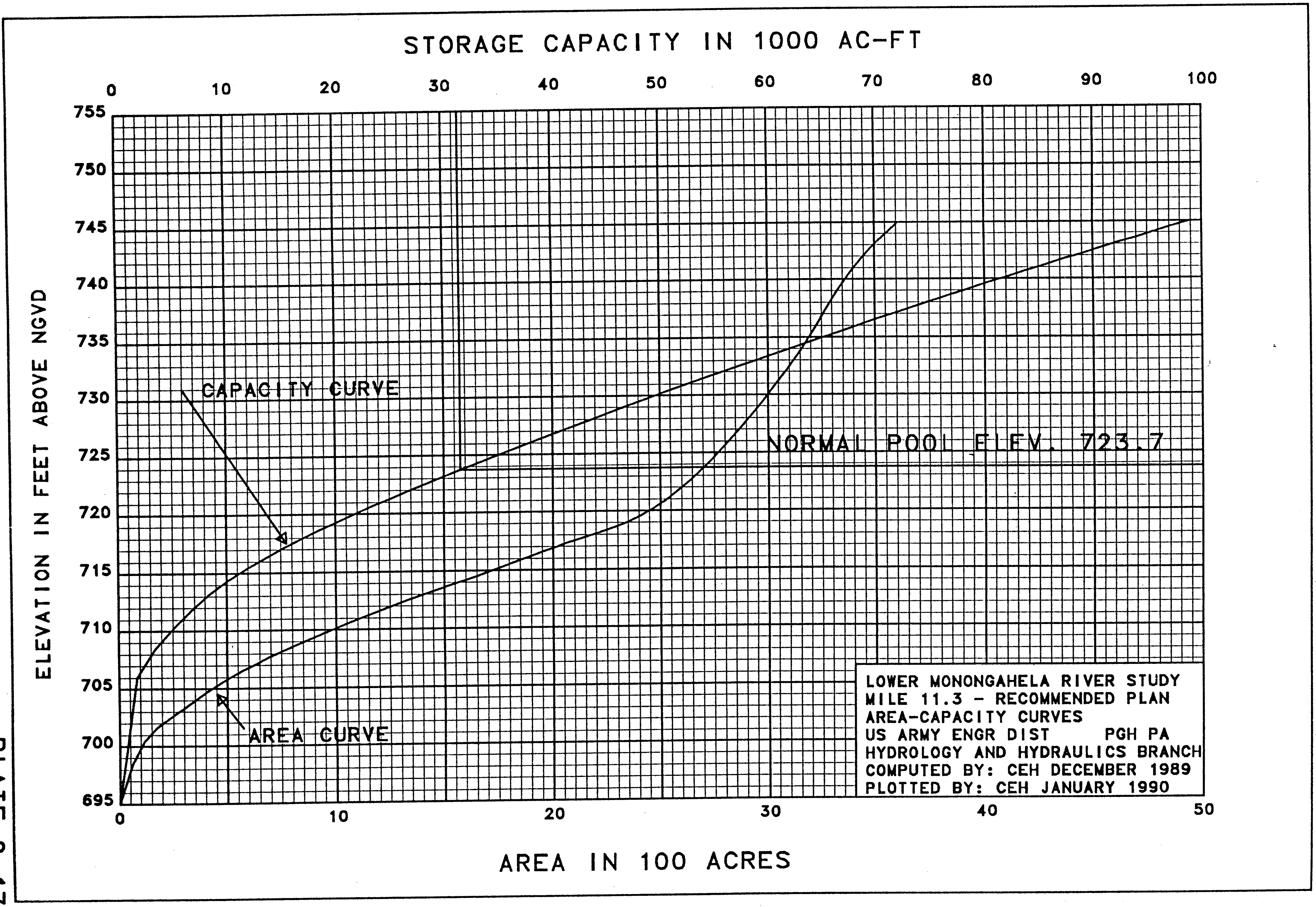

STORAGE CAPACITY IN 1000 AC-FT
0
10
20
30
40
50
60
70
80
765
760
755
750
745
740
735
730
725
720
715
710
705
ELEVATION IN FEET ABOVE NGVD
CAPACITY CURVE
NORMAL POOL ELEV. 726.9
AREA CURVE
LOWER MONONGAHELA RIVER STUDY
DAM NO. 3 TO DAM NO. 4
EXISTING AREA-CAPACITY CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: CEH JANUARY 1990
0
10
20
30
40
AREA IN 100 ACRES

PLATE 2-16



STORAGE CAPACITY IN 1000 AC-FT
0
10
20
30
40
50
60
70
80
90
100
755
750
745
740
735
730
725
720
715
710
705
700
695
ELEVATION IN FEET ABOVE NGVD
CAPACITY CURVE
NORMAL POOL ELEV. 723.7
AREA CURVE
0
10
20
30
40
50
AREA IN 100 ACRES
LOWER MONONGAHELA RIVER STUDY
MILE 11.3 - RECOMMENDED PLAN
AREA-CAPACITY CURVES
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: CEH JANUARY 1990

PLATE 2-17

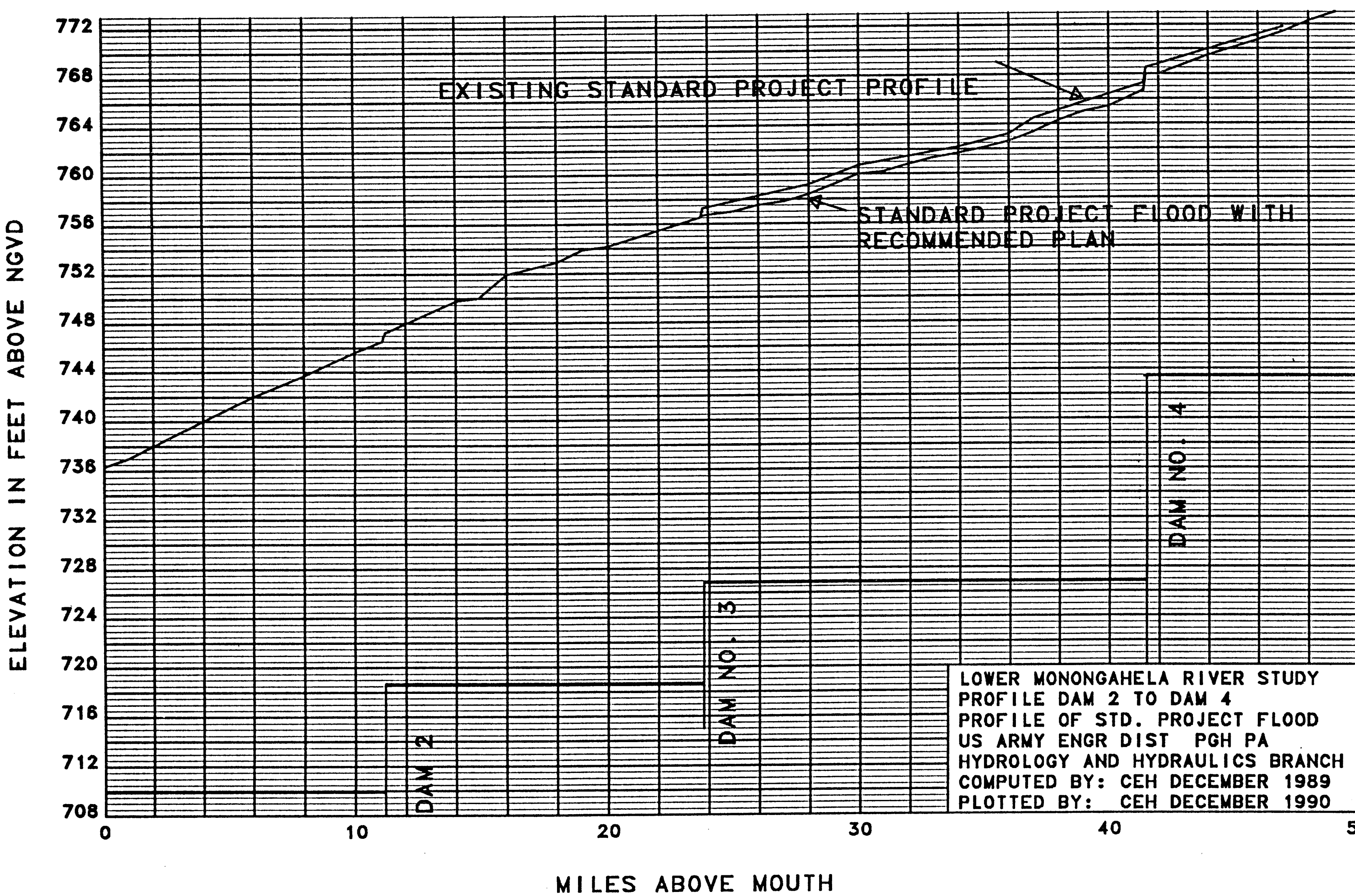

EXISTING STANDARD PROJECT PROFILE
STANDARD PROJECT FLOOD WITH RECOMMENDED PLAN
DAM 2
DAM NO. 3
DAM NO. 4
ELEVATION IN FEET ABOVE NGVD
MILES ABOVE MOUTH
772
768
764
760
756
752
748
744
740
736
732
728
724
720
716
712
708
0
10
20
30
40
50
LOWER MONONGAHELA RIVER STUDY
PROFILE DAM 2 TO DAM 4
PROFILE OF STD. PROJECT FLOOD
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1989
PLOTTED BY: CEH DECEMBER 1990

PLATE 2-18

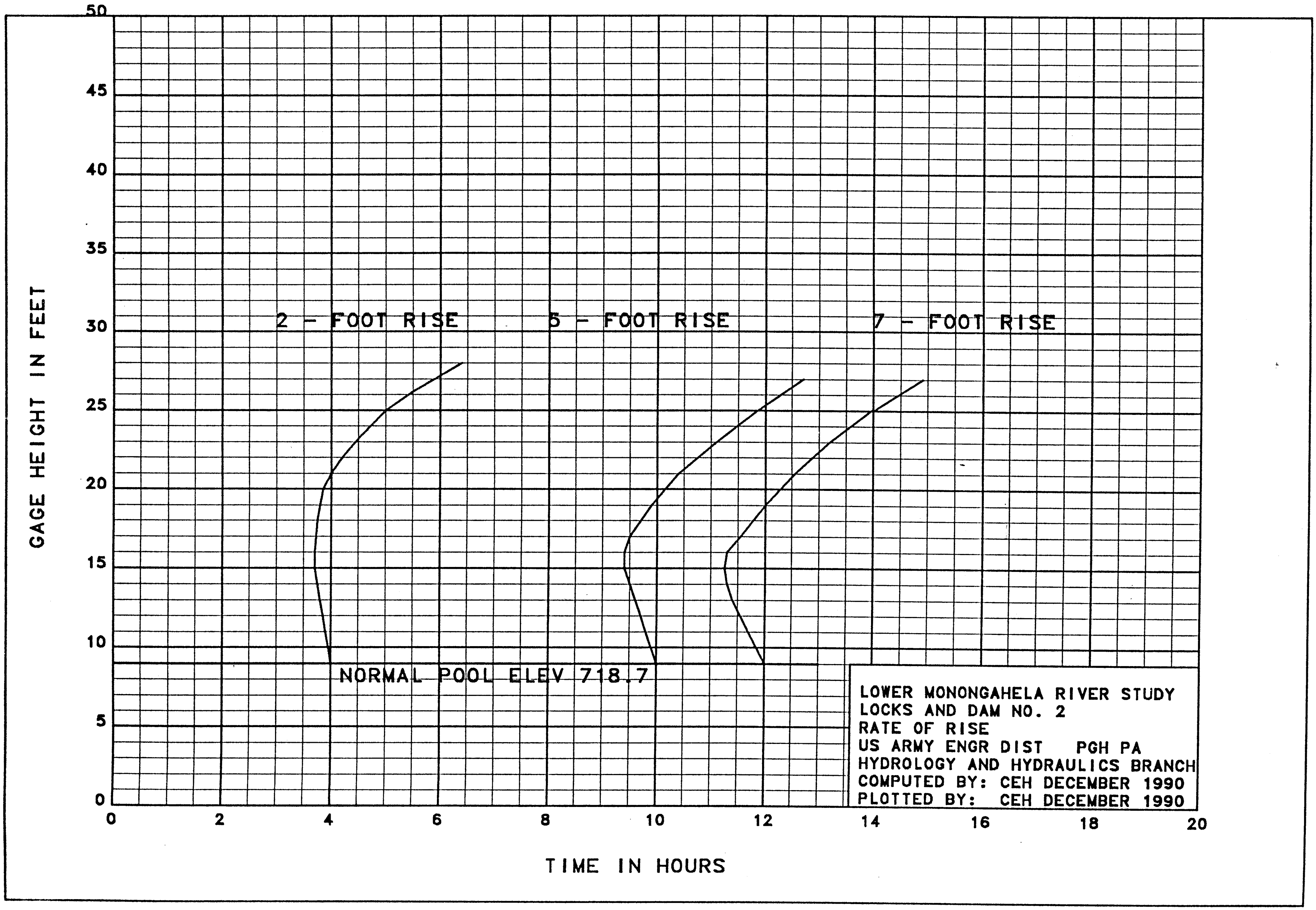

GAGE HEIGHT IN FEET
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
20
5
15
25
30
35
40
45
50
2 - FOOT RISE
5 - FOOT RISE
7 - FOOT RISE
NORMAL POOL ELEV 718.7
LOWER MONONGAHELA RIVER STUDY
LOCKS AND DAM NO. 2
RATE OF RISE
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1990
PLOTTED BY: CEH DECEMBER 1990

PLATE 2-19

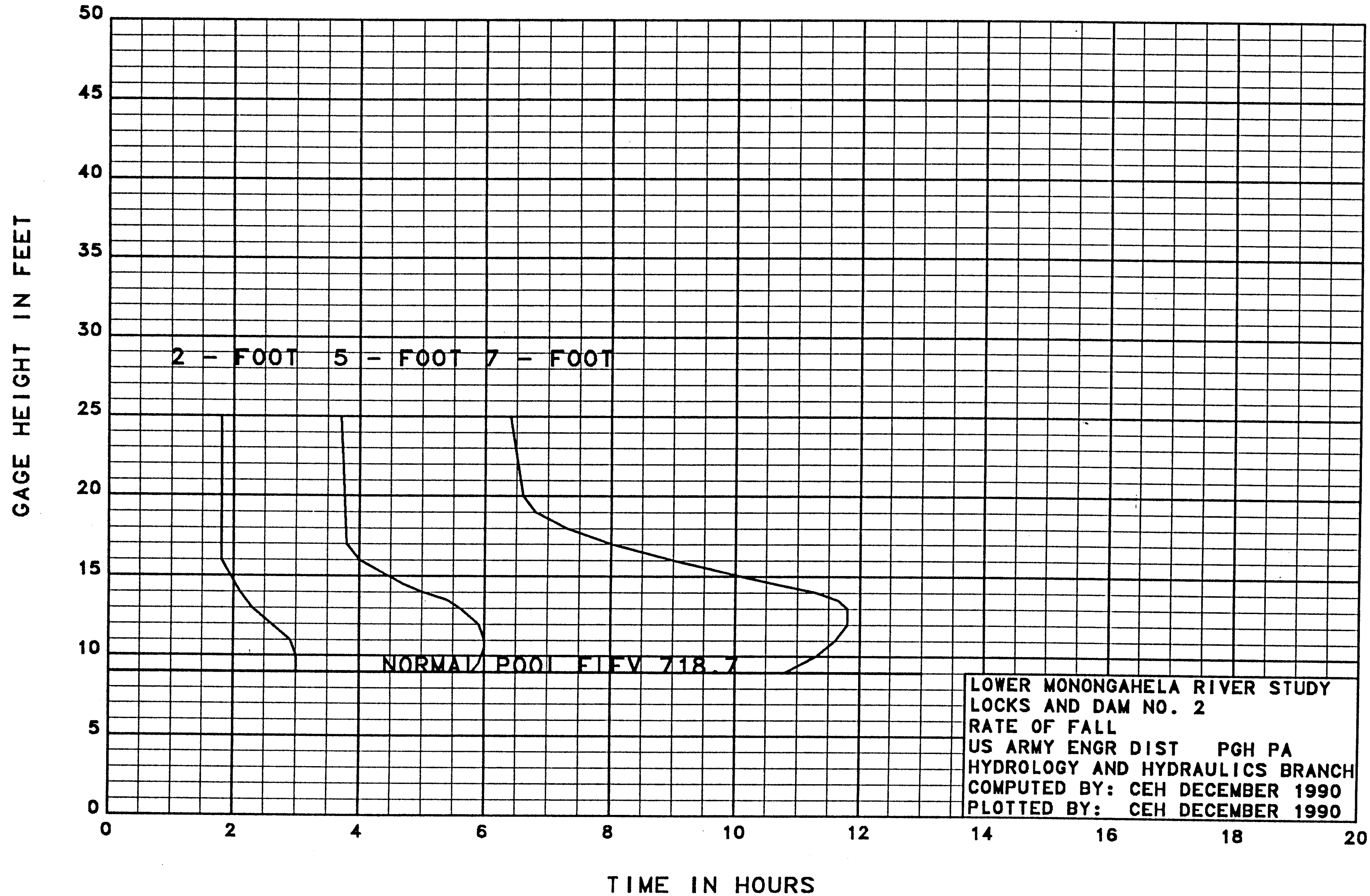

GAGE HEIGHT IN FEET
0
5
10
15
20
25
30
35
40
45
50
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
20
2 - FOOT
5 - FOOT
7 - FOOT
NORMAL POOL ELEV 718.7
LOWER MONONGAHELA RIVER STUDY
LOCKS AND DAM NO. 2
RATE OF FALL
US ARMY ENGR DIST PGH PA
HYDROLOGY AND HYDRAULICS BRANCH
COMPUTED BY: CEH DECEMBER 1990
PLOTTED BY: CEH DECEMBER 1990

PLATE 2-20

3. Hydraulics

a. Description of Recommended Plan

(1) Basis

The recommended plan is based on Plan 1. The existing Locks No. 2 and Dam No. 4 would be retained with present deficiencies corrected. Dam 2 would be replaced with a gated structure with the normal pool raised five feet to elevation 723.7. Removal of Locks and Dam 3 and excavation in Pool 3 would allow the new pool to extend to Locks and Dam 4, where two new 84 ft by 720 ft locks would be constructed.

(2) Departures from Original Plan 1

The recommended plan includes the following features which are significant departures from original screening Plan 1 described in the HYDRAULICS APPENDIX to the Main Report:

(a) Dam 2

The gates would be 110 ft wide instead of 84 ft. The new dam would be located 485 ft upstream of the existing dam (mile 11.3). These changes would enable the existing 110 ft land chamber to utilize the emergency bulkheading system for the new lock. The gate sills and stilling basin design also would be modified. Construction staging would be changed as well.

(b) Guard wall Extension

To compensate for the dam being moved upstream, an extension of the guard wall is included as an aid to navigation.

(c) Dredging

In existing Pool 3 the new navigation channel would be excavated to 11 ft deep as opposed to nine feet which affects water surface profiles.

b. Project Effects on Water Surfaces

(1) Ordinary High Water

Ordinary High Water would be lowered between miles 11.2 and 23.8 due to replacement of the existing fixed crest dam with a gated structure having lower sills and greater discharge capacity. The profile is shown on PLATE 3-1. The starting elevation at mile 11.3, 724.7, allows a one-foot range for the regulated upper pool above the proposed normal elevation (which is customary).

As shown, ordinary high water also would be lowered from mile 23.8 to 41.5. Besides the replacement of Dam 2, the removal of Locks and Dam 3 and proposed dredging contribute to the reduced water levels in this reach.

(2) 100-Year Flood

For the reasons given in the preceding paragraph, all floods would be reduced above mile 11.2. The 100-year profile is shown on PLATE 3-1.

(3) Real Estate Acquisition Considerations

With floods and ordinary high water being lowered, no flowage easements would be required along the Monongahela River main stem or the Youghiogheny River, classified as a navigable tributary. However, easements would be required on non-navigable tributaries between miles 11.3 and 23.8. The taking line would be based on ordinary high water with a freeboard allowance.

(4) Standard Project Flood

The profile would be virtually unchanged between miles 11.3 and 23.8. A reduction of approximately one foot would occur from mile 23.8 to 41.5. This profile also is plotted on PLATE 3-1.

(5) Navigable Stages and Bridge Clearances

Numerous bridges span the Monongahela River Emsworth pool and Pools 2, 3, and 4. Existing and proposed navigation clearances were evaluated for three conditions. These are normal pool, two-percent exceedence, and maximum navigable at an adjacent lock. Profiles are plotted on PLATE 3-2.

The U.S. Coast Guard standard for normal pool bridge clearance on the Monongahela River above Locks and Dam 2 had been 47.0 ft. However, several existing structures do not meet this criterion and the Smithfield Street Bridge at mile 0.8 in the Emsworth pool provides only 42.5 ft of clearance. Raising Pool 2 five feet as proposed would reduce the clearance available under the Conrail Bridge at mile 11.7 to only 40.6 ft. The recommended plan calls for raising or replacing the channel span of this structure to provide 42.5 ft. This proposal is supported by the towing industry and has resulted in the Coast Guard lowering the Monongahela River clearance standard to 42.5 ft.

Higher flows cause upper pools to rise above fixed crest dams which, together with pool slope, result in reduced bridge clearances. The two-percent exceedence profile has been used as a standard for comparison although it has no regulatory significance on the Monongahela River. PLATE 3-2 shows that the two-percent line would be lowered upstream of mile 11.2 under the recommended plan, indicating the high flow bridge clearance situation would be improved.

Profiles corresponding to the highest maximum navigable stage at an adjacent lock (determined by minimum lock wall freeboard) also are shown on PLATE 3-2. Higher profiles would be associated with the increased lock navigability along with less clearance under bridges. Minimum clearance with the recommended plan would amount to about 28 ft at maximum navigable stages at two points, namely, the Rankin Highway Bridge at mile 8.8 and theDonora - Monnessen Bridge at mile 38.0. Reduced clearances during high flows would hinder many of the towboats presently operating on this reach of the river which range from 17 to 50 ft in height. The higher boats would encounter bridge clearance problems prior to cessation of locking.

(6) Ratings

Stage-discharge rating curves were plotted comparing existing and proposed conditions at several locations. These include Locks and Dam 2 (Braddock, PA); McKeesport, PA; West Elizabeth, PA (near existing Locks and Dam 3); Elrama, PA; Monongahela, PA; and Locks and Dam 4 (Charleroi, PA). They are shown on PLATES 3-3 through 3-8. Although actual stages depend on backwater from the Allegheny and Youghiogheny Rivers, average conditions were assumed for these curves.

(7) Stage Frequencies

Stage-frequency curves were also drawn for representative points and are shown on PLATES 3-9 through 3-14. They cover average recurrence intervals of 0.125 year to 1,000 years. Recommended plan stages are equal to or less than existing stages at all locations for the entire range of frequencies.

c. Mile 11.3 - Gated Dam

(1) Location

The new dam would be located 485 ft upstream of the existing dam to enable its emergency bulkheading system to serve the existing 110 ft land chamber as well as the dam. Another major advantage of the upstream position as opposed to the existing dam axis is the ability to build all of the gate bays in two stages instead of the three anticipated under original Plan 1. Since the construction cofferdams now will not encroach directly upon the existing dam, greater flow capacity exists for the same size cofferdam.

There also are several disadvantages in constructing the new dam upstream, including:

(a) Increased exposure of tows to outdraft, possibly necessitating a guard wall extension.

(b) The need to rebuild a 162 ft portion of the existing upper guard wall which is founded on cells that would be exposed to lower pool and stilling basin turbulence.

(c) The need to remove the existing dam separately, in the wet, instead of within the cofferdams.

(d) A large discharge outlet in this area, belonging to the USX plant on the right bank, would have to be relocated.

(2) Configuration

The dam would be comprised of five tainter gate bays 110 ft wide plus a fixed weir 87.5 ft wide. The weir would be located adjacent to the locks. This layout would enable the existing 56 ft river lock to be replaced at some future date by a 110 ft lock without disturbing the gated portion of the dam. The weir crest would be at normal pool elevation 723.7. Sill elevation of the four gate bays farthest from the locks would be 696.7, i.e., 27 ft below pool, following the Hannibal Dam (Ohio River) design. The feasibility and economics of constructing fewer and/or smaller gates will be investigated prior to initiation of modelling.

(3) Water Quality Gate

The first bay, adjacent to the fixed weir, would have its sill at elevation 714.0. The higher sill is desirable on one gate to enhance reaeration during low flow periods. With the sill four feet above lower pool level and with 30-degree plunge angle of the downstream face, air entrainment and oxygen transfer are expected to be efficient. (WES advice was obtained for this preliminary design.) Discharge capacity of the water quality gate would be approximately 10,000 cfs. The higher sill on a single gate would not adversely affect overall discharge capacity.

(4) Gate Clearance

Low steel of the fully raised tainter gates would be at elevation 760.7, providing approximately 13 ft of clearance above the standard project flood. The five-foot Ohio River criterion would be met.

(5) Stilling Basin

Preliminary stilling basin dimensions were established using procedures in EM 1110-2-1605. The most severe operating condition is that designated No. 2 in the EM, i.e., one gate open full with minimum lower pool. The total discharge would be 48,700 cfs and unit discharge 443 cfs/ft. With the basin at the proposed elevation of 686.7, ten feet below the sill, the recommended 85% of theoretical D2 would be available. A shallower basin might suffice but this may not result in any savings because the founding elevation for the supporting piles is fixed near elevation 655. The optimum basin elevation cost-wise will be determined prior to modelling.

The curve connecting the sill and basin would follow the traditional equation $x^2 = 40\ y$. Length of the level floor would be 67 ft. Two rows of seven-foot high baffle piers would be provided as well as a sloping three-foot high end sill. The dam and stilling basin combined would be 140 ft in length. Stone protection would extend an additional 500 ft downstream tying into recently placed protection below the existing dam.

(6) Proposed Detailed Model

WES has been contacted concerning a physical structure model of the proposed dam. For final design of the dam, stilling basin, and downstream protection, three bays at a scale of 1:30 or 1:36 would be represented. The capability would exist to alter two bays such that either three regular (low sill) gates could be modelled or a combination of the fixed weir, water quality gate, and a single regular gate.

(7) Cofferdams

(a) General

The gated portion of the dam would be built in two stages within cofferdams of steel sheet pile cells and connecting arcs. Construction of the fixed weir and reconstruction of a portion of the adjacent guard wall would be accomplished in a third stage. Cells would be approximately 75 ft in diameter. The assumed top of all cofferdams is elevation 730.5, same as the top of lock walls. Interior berms approximately 62 ft wide also would be required. The cofferdam constrictions would cause significant backwater effects but the 56 ft lock floodway would be employed for supplemental capacity. To assure its reliability during this period, the floodway would be rehabilitated prior to the dam construction. The bulkhead sill would be raised approximately three feet to elevation 705.7, which is 18 ft below the new upper pool.

A floodway will not be needed after the new gated dam is in place. However, the bulkhead placement system will be needed as an emergency closure for the small chamber. Early reconstruction of the structure to allow employment of the floodway during construction of the dam is necessary because the existing system is unreliable to perform its function with any acceptable degree of certainty and its utilization reduces both backwater flood damages throughout the upstream communities and businesses and cofferdam overtopping. Added expenses for a floodway, besides the finance costs of earlier construction, include having to bulkhead to the full height of the lock walls instead of just above normal pool and provisions for scour protection downstream.

(b) First Stage

The abutment and two gate bays would be built during the first stage. A 325 ft opening would remain between the cofferdam and riverwall. The downstream arm would leave a 210 ft "channel" between it and the existing dam. To estimate backwater effects produced by the flow contraction and re-expansion, the 2-D finite element mathematical hydrodynamic model RMA-2 was employed. Two flows were simulated: 40,000 cfs; and 80,000 cfs, the approximate cofferdam overtopping flow with floodway closed. Predicted velocity vectors are shown on PLATE 3-15. A profile on this plate also shows that the water surface at the dam would fall more than two feet from the lock to abutment, indicating water has trouble reaching the far end of the dam because it is shielded by the cofferdam. Simulated water surface elevations upstream of the cofferdam combined with conventional weir flow computations for the floodway, walls, and cells enabled ratings to be developed and stage frequencies constructed for conditions with the floodway open as well. The dam site frequency is shown on PLATE 3-16. It indicates a 0.9-year cofferdam overtopping frequency and average two feet backwater effect with the floodway open. Effects at upstream communities of McKeesport and West Elizabeth are shown on PLATES 3-17 and 3-18, respectively.

<u>(c) Second Stage</u>

The three remaining gate bays would be built during this stage. The upstream and downstream river arms of the second stage cofferdam would connect with the pier between bays 3 and 4 leaving newly-constructed gates nos. 4 and 5 fully operational. The existing dam would remain in place at least during the initial portion of this stage. An RMA-2 analysis similar to Stage 1 was conducted to determine backwater effects. Results are indicated by the stage frequency on PLATE 3-19. The cofferdam overtopping frequency would be 0.8 year and the backwater effect with floodway again would be about two feet. Upstream effects are shown on PLATES 3-20 and 3-21.

Backwater conditions would be relieved by removal of the existing dam at some point during the second stage construction. Conventional procedures were employed to produce the frequency curves shown on PLATES 3-19 through 3-21.

<u>(d) Third Stage</u>

The 87.5-foot fixed weir between the river chamber and gate bay no. 1 would be built during this stage, and a portion of the existing upper guard wall that is founded on cells would be removed and replaced with a concrete gravity section. The area would be isolated by cells connecting the upstream end of the middlewall to the lock-side pier of gate no. 1, and from the downstream side of the pier to the riverwall. The poiree dam at the lower miter gates would be placed to allow the entire chamber to be dewatered. All five of the new tainter gates would be operational during this stage so backwater effects are of no concern.

<u>(e) Navigation Interruptions</u>

Suspensions of navigation due to insufficient lock wall freeboard or floodway usage would be more frequent during the first two stages of dam construction as summarized in TABLE 3-1 below.

TABLE 3-1
L/D 2 - MILE 11.2
NAVIGATION INTERRUPTIONS DURING NEW DAM CONSTRUCTION

Condition	Number of Occurrences/Year	Avg. Duration of Each Occurrence (Days)
Existing	2.0	0.9
1st Stage Coffer	4.5	1.2
2nd Stage Coffer		
Before exist. dam removal	5.0	1.3
After exist. dam removal	0.9	0.8
3rd Stage Coffer	0.5	0.7

(8) Alternatives to Gated Dam

(a) Wicket Dam Alternative

A hydraulically operated wicket dam similar to that proposed for the Olmsted project on the Ohio River will be evaluated as an alternative to tainter gates. The dam would be used only for upper pool control; there is no intent to provide open river navigation over the wickets. If the wickets are ten feet wide, as at Olmsted, approximately 75 would be required. The upper pool ordinarily would be maintained by completely raising or lowering the required number of individual wickets. However, regulation during lower flows would require much finer control. There are several options, including:

(1) Designing the wickets to allow overflow with heads up to one foot.

(2) Designing several wickets for overflow at intermediate positions.

(3) Providing a separate section containing another type of gate or valve(s).

The principal advantage of the wickets (other than construction cost) is the absence of piers to catch runaway barges. The barges can block the gate bays causing backwater flooding and become jammed under the gates preventing closure or bulkhead placement resulting in a loss of upper pool. (Three such incidents have occurred at the Maxwell Dam over the past eight years.)

Besides close pool control, one major disadvantage, hydraulically, would be leakage. Four-inch gaps between wickets are proposed at Olmsted. Such gaps would not be acceptable on the Monongahela River as most of the water during periods of low flow may be needed for lockages in the future. Therefore, good side seals would be required for wickets to be viable. Questions also exist concerning the effects of ice on wickets.

There would be no superstructure or emergency bulkhead system with a wicket dam. Thus, there would be no savings in aligning a wicket dam with the large lock emergency closure. The only major advantage of the upstream dam position over the present axis would be in cofferdamming. It is probable that an additional construction stage would be needed if a wicket dam were built on the present dam axis. However, considering the disadvantages of the upstream location mentioned in Paragraph (1) above, the present axis seems preferable for a wicket dam.

(b) Fixed Crest

A fixed crest dam with a pool raise at existing Locks and Dam 2 was ruled out early in the screening process for the following major reasons:

(1) Flood levels as well as ordinary high water would increase significantly throughout Pool 2 requiring the acquisition of flowage easements at extremely high cost.

(2) Relocation costs would also be prohibitive.

(3) Navigation would be interrupted at least once a month and nearly 20 percent of the time overall due to insufficient lock wall freeboard, which is unacceptable.

d. Mile 11.3 - Upper Approach

(1) Tow Simulator Studies

This site originally achieved a "Recommended" classification owing to the favorable alignment of banks and lock walls. A fixed crest dam located 500 ft upstream of the existing dam and new river lock with extended guard wall were tested. The untested gated option was designated "Feasible" after discussions with WES. This accounts for higher upper approach velocities (as much as 25% greater than with the fixed crest dam) and applies to a plan with no new lock or guard wall and with the new dam on the present axis. WES advised that retaining the present location is preferable to moving the dam upstream where approaching tows would be exposed to stronger outdrafts.

(2) Approach Velocities

A study of the upper approach area was made to obtain a better estimate of velocities with the gated dam. Soundings taken in 1990 provided much more reliable topography than the decades-old data that had been used previously. Pool records were reviewed to determine probable minimum tailwater as a function of discharge which would produce the highest velocities. The one-year frequency flow of 102,500 cfs was chosen for evaluation as it represents the approximate maximum flow that would exist with normal upper pool, elevation 723.7. A 3,700 ft reach beginning at the proposed dam was modelled using the RMA-2 program. Results indicate that velocities within 1,000 ft of the end of the existing guard wall would approach 6.5 ft per second. This exceeds the velocities provided at the newer projects on the middle Monongahela and is slightly higher than previous estimates of mean velocity at this site that were based on old soundings. Although the currents would be directed favorably, it is appropriate at this time to include costs for training structures that may be needed to reduce their magnitudes and guard against outdraft.

(3) Approach Alterations

(a) Dikes

WES suggested that submerged dikes may be desirable to reduce the upper approach velocities. Therefore, a group of five dikes is included in the recommended plan. The downstream-most dike would be located about 1,100 ft upstream of the existing guard wall. Spacing would be 300 ft. They would extend from the right bank approximately 350 ft across the navigation channel. Top elevation would be 711.0, allowing 12.7 ft of depth at low water. The intent is to divert flow riverward resulting in lower velocities between the last dike and lock entrance. The configuration, effectiveness, and even the need for any dikes are somewhat speculative at this time. (Efforts to evaluate effects of the dikes using RMA-2 were unsuccessful.) Such questions would be answered in the proposed general model study.

(b) Guard wall Extension

A 500 ft extension of the upper guard wall is proposed to compensate for moving the dam a similar distance upstream and protect arriving tows from cross-currents. Construction would be via 30 ft diameter cells separated by 20 ft spaces. The wall would be angled 13 degrees with the existing wall and in line with the pier of a railroad bridge. The dog-leg arrangement appears to be necessary to provide a wider lock mouth. Again, the need for and actual design of the wall would be examined in the general model study. However, costs for these items are included to represent channel alterations.

(4) Proposed General Model

A general navigation model at a scale of 1:100 is proposed. The work will be done by WES and will concentrate on the following items:

(a) Navigation conditions in the approaches probably including design of training structures in the upper approach.

(b) Cofferdam configuration and backwater effects.

(c) Floodway discharge capacity and velocities during construction.

(d) Navigability during construction.

e. Mile 41.5 - Locks

(1) Configuration

The position of the riverward 84 ft by 720 ft lock was established in the 1960's when the dam was reconstructed. This chamber would be roughly centered on the dam. A portion of the riverwall on which pier no. 1 is situated was built along with the dam. This "stub wall" contains a culvert and ports for the future filling system. Although it probably would be structurally feasible, there appear to be no good reasons for shifting the lock either upstream or downstream from its intended location. In fact, movement in either direction is likely to cause approach problems.

The land chamber would be offset 85 ft downstream of the river chamber, as at the Maxwell Locks, to avoid having miter gate recesses opposite each other in the middlewall.

(2) Lock Walls

The top elevation of all new walls would be 751.0, same as the stub wall and two feet higher than the walls of the existing locks. Overtopping would occur about once in five years. Navigation would be suspended due to high water once in 3.0 years which is nearly comparable to Maxwell's 3.7-year frequency. Shut downs would occur once in 2.0 years at Locks and Dam 2, after the new dam is constructed.

Upper and lower guard walls would extend the usual one chamber length beyond the miter gates as would the lower guide wall. The upper guard wall would be ported. At present, it is planned that the upper guide wall will extend approximately 1,100 ft above the upper miter gates of the land lock. This conforms to the 1960's plan and model study. The additional length may have been needed for bank stability rather than hydraulics. With the land lock now proposed to be only 84 ft wide rather than the original 110 ft, the face of landwall would now be at least 26 ft more riverward. Thus, bank support may not be needed allowing the wall to be shortened by 300 ft or more. This will be investigated in future detailed site studies as well as the forthcoming general model study.

(3) Filling/Emptying Systems

(a) River Chamber

A bottom lateral system fed through the riverwall would be utilized. The existing portion of the new riverwall contains a 15.5 ft square culvert at elevation 703.0 and six connections leading to future laterals. The system, designed in the 1960's, is identical to the Maxwell Locks. Three additional laterals would be required downstream and two upstream. Spacing is 28 ft with an 84 ft gap between the sixth and seventh laterals. Maximum lift would be 19.8 ft which is very close to Maxwell's 19.5 ft.

The Maxwell system operates smoothly; the only minor problem has been blockage of ports by silt, especially the end laterals. Adjustments to the lateral or port areas might correct this condition. Another reason for possibly modifying the Maxwell-type laterals is that the new lower pool would submerge their tops (elevation 709.5) by only 14.2 ft. This compares with 17 ft at Maxwell and would not meet recent criteria calling for a minimum of 18 ft. More studies are required but it appears the existing stub wall culvert can be utilized since the roof is 5.2 ft below the proposed lower pool. However, the side openings leading to the laterals might have to be modified. Expected filling time is approximately seven minutes and emptying, eight minutes.

(b) Land Chamber

A side port system with culverts in the middlewall and landwall is planned. This type of system is the ordinary choice for a lock with the proposed 19.8 ft lift. It is considered superior to bottom laterals and much more design information is available.

The Gray's Landing and Point Marion systems, with lifts of 15 ft and 19 ft, respectively, provided a basis for the preliminary system design. Culverts would be 10 ft wide by 12 ft high with invert elevation 705.7. Twenty ports at 21-foot spacing would be provided in each wall. Filling and emptying times would be similar to the river lock, mentioned above.

(4) Sills

Since the new locks would be founded on deep bedrock, there would be no problem providing miter and guard sills 18 ft below minimum pool as required by MP HL-89-5.

(5) Cofferdams

(a) River Lock

The river chamber would be built first. The dewatered area would be enclosed by the existing middlewall and two lines of coffer cells connecting both ends of the wall with dam pier no. 2. The top of cofferdam would be even with the existing lock walls at elevation 749.0. Only one of the five bays (no. 1) would be unavailable during this stage. Gate no. 2 would remain fully operational; however, the cofferdam would extend upstream on an angle from pier no. 2, partially shielding this gate. The stage-frequency shown on PLATE 3-22 was developed assuming 75% efficiency for gate no. 2. The computed backwater effect is about one foot at the top of cofferdam (1.8-year frequency), diminishing to one-half foot for major floods.

(b) Land Lock

The new river lock as well as all gates of the dam would be operable during construction of the land lock. The construction area would be isolated by two arms of cells extending from the ends of the new middlewall to the bank. Assumed top of cofferdam is elevation 749.0, giving 2.3-year overtopping protection.

f. Mile 41.5 - Approaches

(1) Tow Simulator Studies

This site was designated "Not Recommended" because entering the lock from either direction was found to be difficult. On the upstream side, the existing spur dike and mooring cells prevent tows from moving as close to the bank as they would like to become positioned for entry. Downstream, there is a sharp bend and highway bridge with center pier which must be negotiated. It was recommended that a relocation of the mooring cells and other approach modifications be tested prior to accepting this site. This testing was not performed because additional information was available from a previous model study (discussed below).

(2) Previous Model

The modelling was done at WES from 1958 to 1963, with results published in TR No. 2-736. Model scale was 1:120. The tested configuration of future locks was very similar to the present recommended plan except that the land chamber was 110 ft wide instead of 84 ft (landwall located approximately 26 ft landward). The presently proposed lower pool level change was not anticipated so the modelled water surface elevations were higher and velocities lower than now expected. However, model conditions were close enough to the recommended plan that the results can be used for preliminary design of approach alterations. The model recognized some of the same problems noted in the tow simulator study, mainly concerning the upper approach. The following recommendations and conclusions were made:

(a) Ports should be provided in the upper guard wall to reduce or eliminate cross currents.

(b) Upper approach velocities would be high. They could be reduced by deepening the channel along the left bank and placing spoil along the right side of the channel upstream of the spur dike.

(c) Fill placement eliminating irregularities along the right bank between the guide wall and spur dike would improve current alignment and facilitate tow movement close to the bank.

(d) Removal of the spur dike would cause some increase in velocities but improve current alignment appreciably.

(e) No serious navigation difficulties were found in the lower lock approach so it can be assumed that no modifications are needed.

(3) Upper Approach Alterations

(a) Upper Guard Wall

The optimum number of ports and cross-sectional areas were not determined in the model although it was found that 13 ports 20 ft wide would produce satisfactory conditions. The recommended plan preliminary layout shows 14 ports approximately 20 ft wide.

(b) Channel excavation/fill

The proposed channel work is taken from TR No. 2-736, "Plan 5." It includes dredging a 200 ft wide channel to invert elevation 713.5 in the left side of the river from the dam to a point about 4,500 ft upstream. Fill would be placed on the right side to elevation 728.5 extending from the spur dike 1,900 ft upstream. Imported gravel or rock fill rather than the dredged material would be used because it would be more stable and less objectionable environmentally. With these channel modifications, the fastest anticipated velocity in the approach area at maximum navigable stage was estimated using the model data. The computed value is 6.5 ft per second which is somewhat high but probably safe with good alignment.

(c) Right Bank Fill

Bank fill to eliminate the shore irregularities from the end of the guard wall to the spur dike is proposed based on the modelling. The assumed toe of fill is on a slight angle to the wall owing to its proposed location being slightly riverward of that modelled, plus the fact that the spur dike itself would be eliminated (see below).

(d) Spur Dike

Based on the tow simulator studies as well as the model, it appears that the advantages of eliminating the spur dike would outweigh the disadvantages. Therefore, its removal is included in the recommended plan.

(4) Proposed General Model

A general navigation model at a scale of 1:100 is proposed. The new study is needed because there are significant differences between the recommended plan and the previous model and the coverage afforded by the old study is not up to present-day standards. WES concurs with the District that a new model would be appropriate. Specific reasons supporting the request for a new general model are listed below:

(a) Water surface elevations would be about two feet lower at high navigable flows than modelled previously.

(b) The land lock would be 84 ft wide instead of 110 ft.

(c) The optimum port arrangement for the upper guard wall needs to be determined.

(d) The decision to remove the spur dike should be confirmed.

(e) The possibility of using submerged dikes in the upper approach instead of a broad fill, which could produce a significant savings in material, should be investigated.

(f) The old model contains no documentation concerning the movement of model tows.

(g) Construction conditions were not covered in the old model.

Besides the items listed above, the usual investigations relating to navigability would be re-examined using current methods.

g. Mile 41.5 - Dam

(1) Scour Problem

It is believed that the scoured derrick stone downstream of the dam is related to a tailwater deficiency at certain gate openings. The broken baffle piers and high end sill also might be contributing factors. Tailwater elevations would be reduced significantly under the recommended plan, worsening the deficiency. Minimum TW/D2 ratios would range from 0.42 at two feet open to 0.91 at full open as compared to values of .70 and 1.02 under present conditions. The end sill velocity for full open would increase by three feet per second to more than 21 ft per second. It appears, therefore, that scour protection requirements would be increased with the recommended plan. However, the severe conditions would not occur until the removal of Locks and Dam 3 which is scheduled to be one of the final items completed. It is planned that the remedial measures for scour would be implemented at the same time. In the interim, erosion would be closely monitored but no major work would be performed downstream unless serious deterioration occurred.

(2) Proposed Alterations

A scour-protection scheme will be developed eventually through modelling. Present cost estimates are based on the assumption that the following measures will be required:

(a) Grout Bags

The downstream area would be graded to a uniform 1 on 3 slope. Two feet of riprap would be placed, covered by a layer of 6.75 ft wide by 2.75 ft high by 20 ft long grout-filled fabric bags.

(b) Baffles

The broken baffles would be repaired. In addition, a second row would be built upstream and positioned opposite the gaps between the existing baffles. This construction would take place in the dry, within a movable enclosure.

(3) Proposed Detailed Model

After discussions with WES, a 1:30 or 1:36 scale structures model of three gate bays is now proposed to evaluate the stilling basin and downstream scour protection. Providing downstream armoring alone will be tested first. Hopefully, this will be sufficient. If not, replacing/adding baffles and altering the end sill would be investigated as these items could be accomplished without large cofferdams. Modifying the basin floor or adding an auxiliary energy dissipator downstream would only be looked at as a last resort.

h. Drainage Pipe Relocations

(1) General

Many culverts in existing Pool 2 will be partially or completely submerged when the pool level is raised five feet. A preliminary list of 36 affected facilities was made by examining old harbor line maps and viewing the banks from a boat. Hydraulic analyses for individual pipes were not performed during this phase of study. However, initial indications are that in most cases the pool raise alone will not affect culvert flow capacity. It appears most pipes' inlets are high, subject to inlet control, and unaffected by the water level at the outlet. Even where outlet control exists the five-foot pool raise may not exceed critical depth with partially-submerged pipes so there would be no loss of effective head. The only situation likely to result in a loss of capacity is with a pipe having little or no slope and totally submerged outlet.

Although culverts' unobstructed capacities may be unaffected, the pool raise may cause increased siltation and eventual loss of capacity if not cleaned out. The increased maintenance under difficult conditions that would be required to keep the pipes open is considered unacceptable. Therefore, it is presently assumed that all culverts that would be at least one-third submerged would be relocated or supplemented. It was also assumed that loss of maintenance access or any submergence of flapgates would also warrant relocations.

(2) Preliminary Estimates

Assumptions concerning replacement pipes, described below, were based on a cursory review of hydraulic design calculations for other recent projects that involved a pool raise. Inverts of all new pipes would be placed above the new pool to prevent blockage. For initial cost estimates, replacement pipes under eight feet in diameter were assumed to require 50 percent greater flow area to compensate for the reduced head. Larger culverts would be replaced or supplemented by ones of similar size.

(3) Design Criteria

Relocations would be provided where both of the following conditions are met:

(a) The pool raise with assumed siltation would result in a reduction in culvert capacity.

(b) Applicable design criteria described below would not be met after the capacity reduction.

Relocated pipes would not necessarily provide the same discharge capacity as presently exists so long as the applicable criteria are met.

The following criteria, which have been utilized for design of similar projects, are proposed for future detailed hydraulic design of culvert relocations:

(a) Highway Culverts

The Pennsylvania Department of Highways criteria for drainage design would apply. Design discharge frequency regarding roadway overflow is 10 years for city streets and local or collector roads, 25 years for limited access freeways and arterials, and 50 years for interstate highways. The allowable headwater is determined by roadway elevation with a small freeboard allowance.

Additionally, a flood hazard evaluation using a flow that may exceed the roadway overflow design discharge is required. This discharge is referred to as the "Designated Q." Its frequency varies from 25 years for rural roads to 50 years for suburban roads to 100 years for urban roads and any culvert longer than 100 ft where there is a potential for flood damages. Maximum HW/D ponding depths also apply to the Designated Q, ranging from 1.25 to 2.0 depending on culvert length, damage potential, and other factors.

(b) Railroad Culverts

Maximum allowable headwater is set at six feet below the base of rail or HW/D of 1.5. Design discharge is the smaller of the 100-year flow or whatever the existing culvert could pass at the same headwater elevation.

Culverts extending beneath both a highway and railroad would need to satisfy criteria for both. There may also be instances where none of the listed criteria clearly apply (plant outlets, sanitary sewers) which may warrant special treatment.

(c) Culvert Tailwater

Tailwater on the culverts depends on the river level which is a function of river discharge and location in the pool. The appropriate river flow(s) to be assumed for comparing present and future culvert capacities requires further study and research.

i. Effects on Turtle Creek Project

(1) General

Turtle Creek is a tributary which drains 147 square miles and enters Pool 2 on the right bank just above the upper guide wall of Locks and Dam 2. A local flood protection project was completed by the Corps of Engineers in 1967 which extends from the mouth several miles upstream. Channel excavation provided an invert elevation of 710.0 from the mouth to station 30+0 which is permanently inundated to a depth of 8.7 ft or more by the navigation pool at elevation 718.7. Slackwater at normal pool extends to approximate station 85+0. Heavy siltation has occurred in this reach. Upstream debris basins and dams are provided to intercept some of the sediment for easier removal, but their maintenance as well as the channel itself has been neglected. Restoration of the project by the Corps has been authorized. Construction is expected to be completed by 1992, after which a new sponsor will be responsible for maintenance.

(2) Design Water Surface

The project design frequency is 280 years. Starting elevation at the Monongahela River for the design profile is 730.0, which corresponds to a river discharge of 125,000 cfs. Since the river would be about a foot lower at this flow after construction of the gated dam, the design water surface would continue to be contained after the proposed work at Locks and Dam 2 provided the channel is maintained.

(3) Siltation

With the proposed pool raise, slackwater would extend an additional 3,500 ft up the Turtle Creek channel to station 120+0. River levels would be higher, except during high flow periods, which would amount to only about five percent of the time overall. Therefore, velocities on the lower reaches of Turtle Creek would be lower, and increased deposition probable. An HEC-6 analysis was performed to confirm this and determine the difference in quantities.

Although very little data is available concerning sediment loads, the channel deposition was monitored by several surveys taken during the 1970's. HEC-6 input describing the as-built channel from the mouth to station 120+0 was prepared. A flow histogram was assembled for the period 1970-1977 using Turtle Creek and Locks and Dam 2 gage records. Initial runs were made to adjust the load curve and gradation as needed to reproduce the deposition history during this period. The adopted load curve gives an average annual yield of 0.26 acre-ft per square mile which is reasonable. Since the aforementioned debris basins and dams were not cleaned during the calibration period, it was assumed that they were totally ineffective. The effect of maintained debris basins was computed by means of a second HEC-6 model for the upper end of the project in which the adopted load curve was used as inflow. A typical year of flows was used to evaluate debris basin effectiveness. The debris basin sediment outflow was then weighed along with estimated loads from the smaller debris dams plus the uncontrolled area to arrive at a load curve representing total load reaching the lower end of the project with debris dams and basins properly maintained.

The difference in channel siltation to be expected with the raised pool was analyzed using the load curve mentioned, a flow histogram representing several consecutive typical years, in conjunction with starting water surface elevations corresponding to either existing or proposed conditions. For existing conditions, the mean pool level, elevation 721.2, was used for most Turtle Creek flows in the histogram. However, starting elevations for higher flows were set to reflect a relationship between high tributary flows and above-average pool stages. This correlation is weak because a storm causing a rise on Turtle Creek may not be widespread enough to affect the river significantly, and even if it is, Turtle Creek usually crests more than one-half day before the river. Uncontrolled conditions would rarely occur after construction of a gated dam, so a constant starting water surface elevation of 724.2, 0.5 ft above minimum pool, was used for all flows in the proposed conditions histogram.

Results of the final series of HEC-6 runs indicate that, in five years, 56,000 cubic yards of sediment would be expected to accumulate in the channel from the mouth to station 120+0, with the present pool, after project restoration. With this amount of sediment, protection afforded by the project would still exceed a 100-year flood. With the proposed pool, the computations show that 47,000 cubic yards could accumulate in only three years, and that four years' accumulation would exceed

56,000 cubic yards. Therefore, to avoid any additional loss of flood protection, the frequency of channel cleanouts would change from five to three years although slightly less material would need to be removed on each occasion.

Besides the increased maintenance frequency, extraction costs would be higher because the work would be conducted in water that is five feet deeper. Also, clearance under a railroad bridge at the mouth would be reduced from 8.5 ft to 3.5 ft, possibly preventing barge access.

j. River Sedimentation and Scour

(1) Sediment Load

Data are available for the USGS Braddock (Locks and Dam 2) gaging station for water year 1974 and less complete data for 1979-1983. Based on these records, average annual yield has been computed to be 0.20 acre-feet per square mile, or slightly less than two million tons. Fine particles make up the bulk of the suspended sediment.

(2) River Surveys

Studies of the lower Monongahela conducted prior to 1991 have relied on soundings dating to 1931. These have been adequate for backwater computations as all indications have been that the riverbed is very stable. A complete set of new soundings was obtained in 1990. A comparison of the 1931 and 1990 data in Pools 2 and 3 confirms that there have been no major changes. Some shifting of sediments is evident and there is an apparent average aggradation over 59 years of one-half to one foot in both pools.

(3) Navigation Channel

(a) Recent Maintenance Dredging

Infrequent dredging is required to maintain the authorized nine-foot depth of the 300 ft navigation channel. This dredging has been limited to a few problem areas generally located at the mouths of tributaries. Over the last 20 years, five spots in Pools 2-4 have been dredged (once each location). They are mile 19.4 (Peters Creek), mile 22, mile 26, mile 32.1 (Pigeon Creek), and mile 41. Dredging contracts provide for one foot of overdredging and two feet of advance maintenance dredging for a total of 12 ft.

(b) Proposed Conditions, Mile 11.3 to 23.8.

Flow velocities would decrease during low water but increase with moderate discharge so it is uncertain how siltation will be affected. However, the proposed five-foot pool raise will provide additional depth which is expected to eliminate future maintenance dredging.

(c) Proposed Conditions, Mile 23.8 to 41.5.

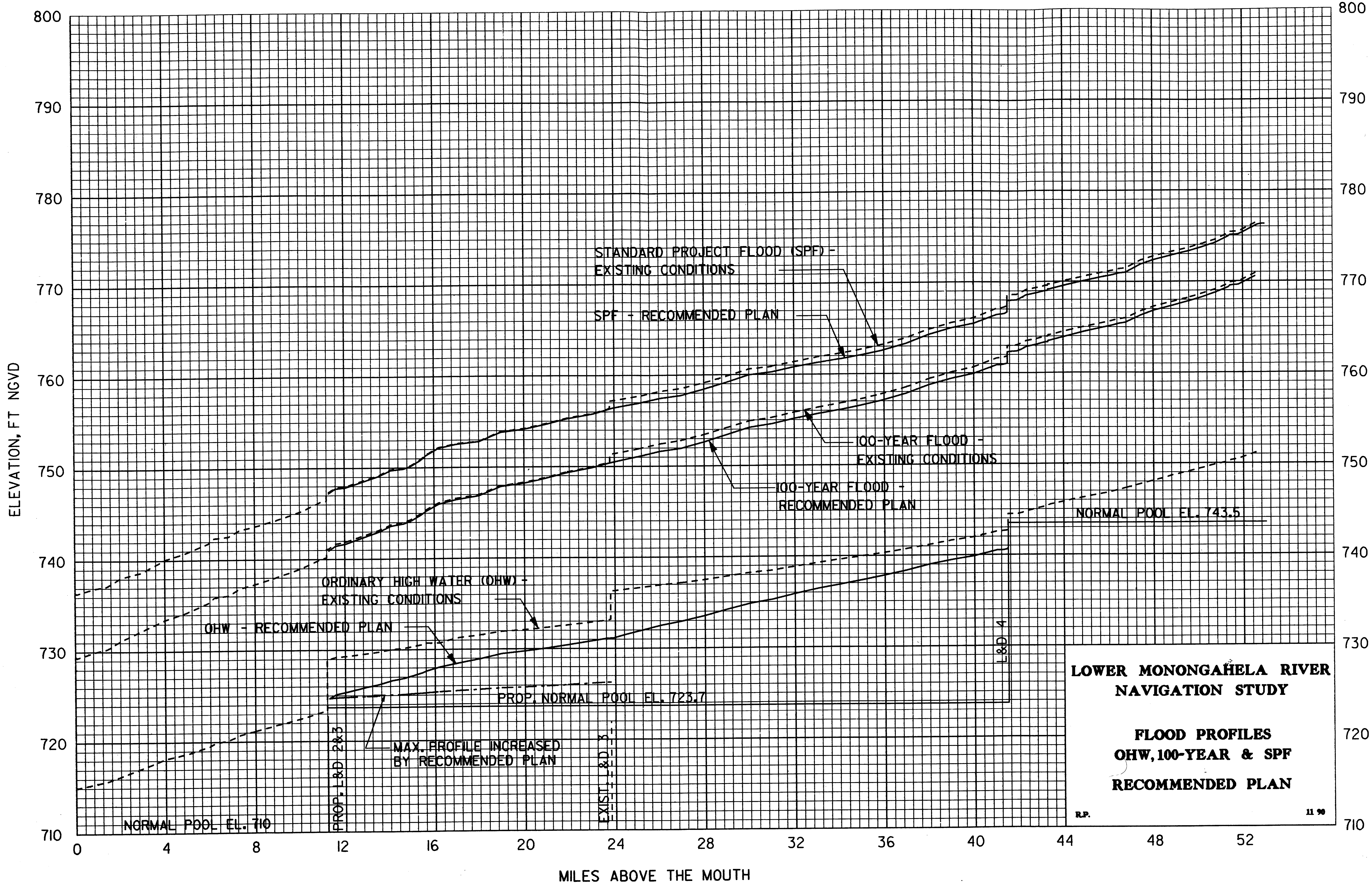
The pool would be lowered 3.2 ft requiring excavation of the navigation channel. The proposed excavation depth is 11 ft below pool, to elevation 712.7, providing two feet more than the authorized draft of nine feet in accordance with the 25 percent allowance specified in ER 1110-2-1458. Minimal dredging would be needed downstream of mile 29, according to the 1990 topography.

Flow velocities would increase due to lowered water surface elevations, which should reduce the tendency for siltation in this reach. The velocity increase would exceed 40 percent during low water, diminishing to 10 percent for a one-year flow, and negligible with a five-year flow.

Experience farther upriver also suggests siltation of the excavated channel is improbable. In the mid 1960's, the pool between miles 56.5 and 61.2 was lowered by 6.4 ft, and the excavated channel has not required any maintenance dredging. Based on these considerations, required maintenance dredging between miles 23.8 and 41.5 is also expected to be minimal.

(4) Bank Scour

Although velocities for moderate flows would increase, as stated in the above paragraph, high flow velocities in existing Pools 2 and 3 would be virtually unchanged. Therefore, tractive force erosion should not increase significantly. However, there may be reaches that are already unstable or that will be destabilized by a pool change that could be affected by the increased velocities. Present cost estimates include an allowance for protecting susceptible reaches, identified from maps and aerial photographs, with stone protection. Field investigations and detailed studies will be required in the future.



STANDARD PROJECT FLOOD (SPF) - EXISTING CONDITIONS
SPF - RECOMMENDED PLAN
100-YEAR FLOOD - EXISTING CONDITIONS
100-YEAR FLOOD - RECOMMENDED PLAN
ORDINARY HIGH WATER (OHW) - EXISTING CONDITIONS
OHW - RECOMMENDED PLAN
NORMAL POOL EL. 743.5
PROP. NORMAL POOL EL. 723.7
MAX. PROFILE INCREASED BY RECOMMENDED PLAN
NORMAL POOL EL. 710
PROP. L&D 2&3
EXIST. L&D 3
L&D 4
ELEVATION, FT NGVD
MILES ABOVE THE MOUTH
LOWER MONONGAHELA RIVER NAVIGATION STUDY
FLOOD PROFILES
OHW, 100-YEAR & SPF
RECOMMENDED PLAN
R.P.
11 90

PLATE 3-1

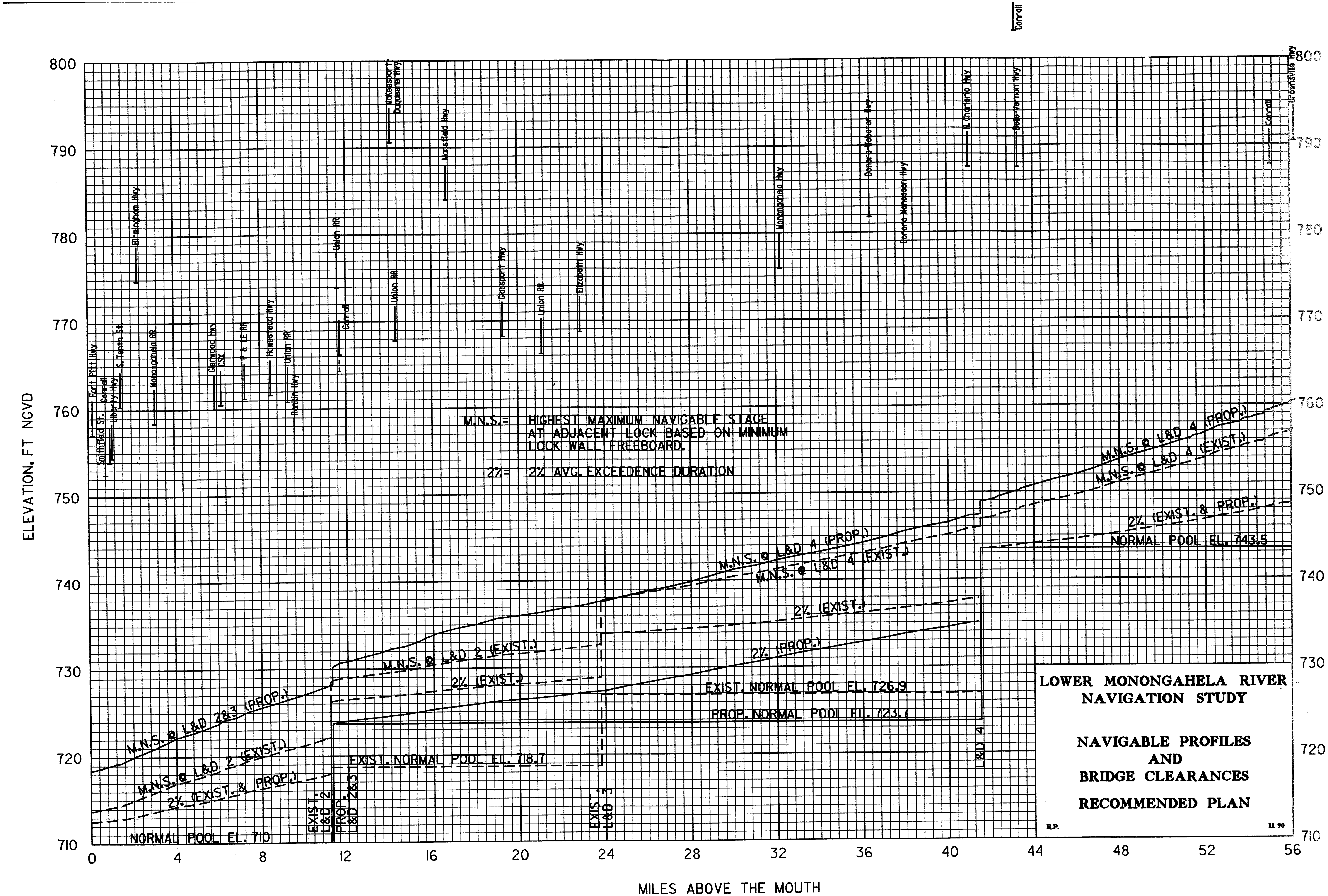
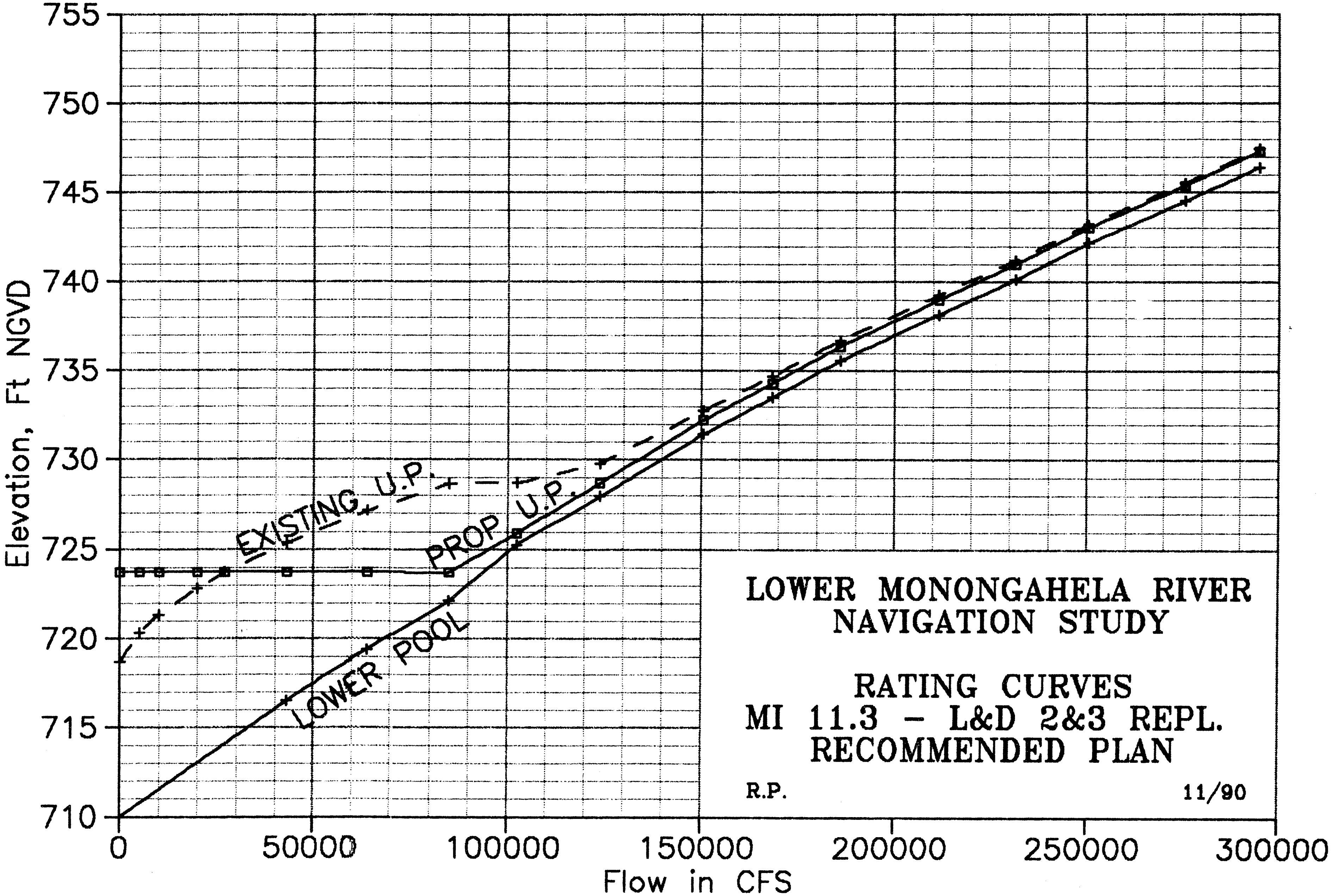

LOWER MONONGAHELA RIVER NAVIGATION STUDY
NAVIGABLE PROFILES AND BRIDGE CLEARANCES
RECOMMENDED PLAN
R.P.
11 90
M.N.S.= HIGHEST MAXIMUM NAVIGABLE STAGE AT ADJACENT LOCK BASED ON MINIMUM LOCK WALL FREEBOARD.
2%= 2% AVG. EXCEEDENCE DURATION
ELEVATION, FT NGVD
MILES ABOVE THE MOUTH
M.N.S. @ L&D 2&3 (PROP.)
M.N.S. @ L&D 2 (EXIST.)
2% (EXIST. & PROP.)
NORMAL POOL EL. 710
EXIST. L&D 2
PROP. L&D 2&3
EXIST. NORMAL POOL EL. 718.7
2% (EXIST.)
EXIST. L&D 3
EXIST. NORMAL POOL EL. 726.9
PROP. NORMAL POOL EL. 723.7
2% (PROP.)
M.N.S. @ L&D 4 (PROP.)
M.N.S. @ L&D 4 (EXIST.)
L&D 4
NORMAL POOL EL. 743.5
Fort Pitt Hwy
Smithfield St.
Conrail
Liberty Hwy
S. Tenth St.
Birmingham Hwy
Monongahela RR
Glenwood Hwy
CSX
P & LE RR
Homestead Hwy
Union RR
Rankin Hwy
Union RR
Conrail
Union RR
McKeesport
Duquesne Hwy
Mansfield Hwy
Glassport Hwy
Union RR
Elizabeth Hwy
Monongahela Hwy
Donora-Webster Hwy
Donora-Monessen Hwy
N. Charleroi Hwy
Belle Vernon Hwy
Conrail
Conrail
Brownsville Hwy

PLATE 3-2


755
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710
Elevation, Ft NGVD
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50000
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150000
200000
250000
300000
Flow in CFS
EXISTING U.P.
PROP. U.P.
LOWER POOL
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
RATING CURVES
MI 11.3 - L&D 2&3 REPL.
RECOMMENDED PLAN
R.P.
11/90

PLATE 3-3

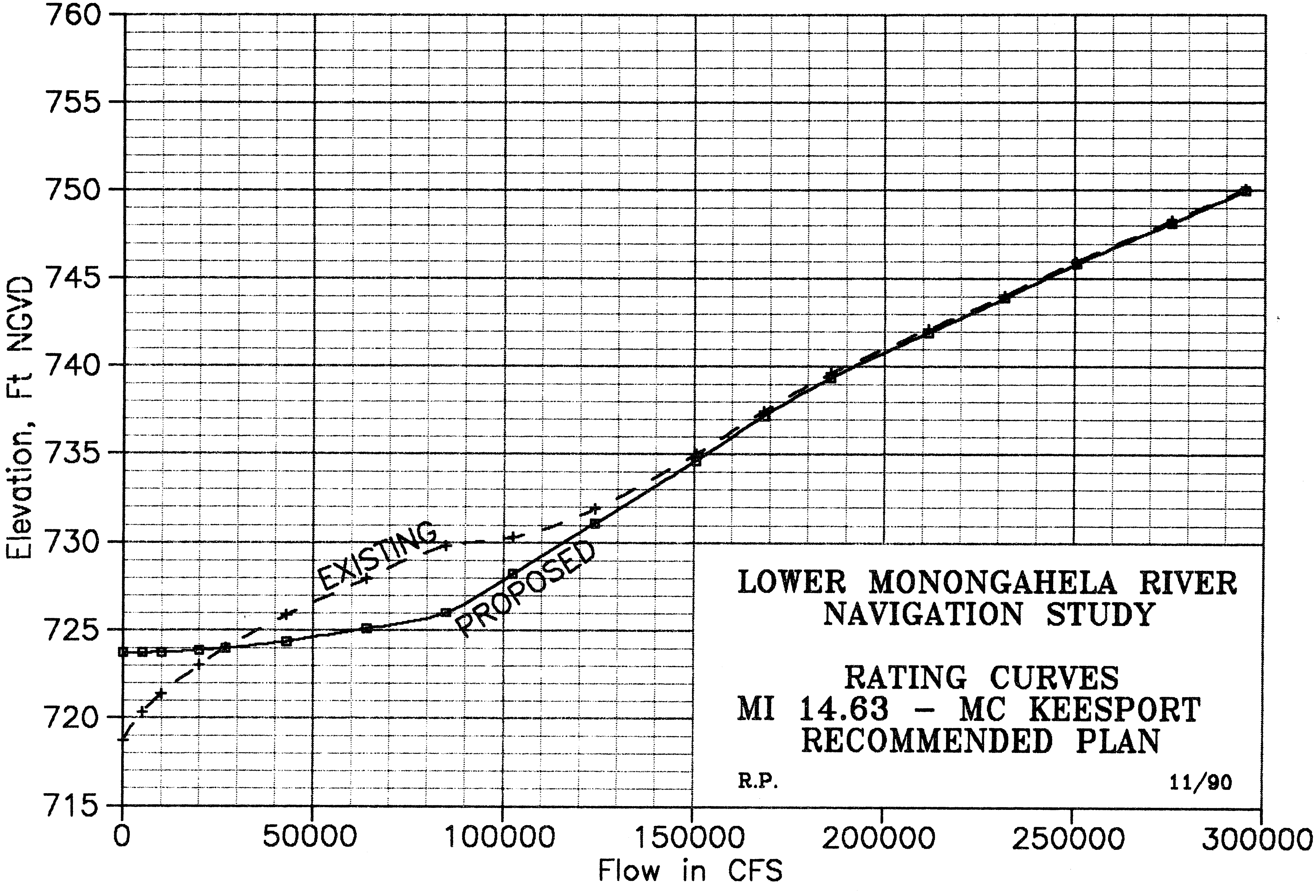
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
RATING CURVES
MI 14.63 – MC KEESPORT
RECOMMENDED PLAN
R.P.
11/90
EXISTING
PROPOSED
Elevation, Ft NGVD
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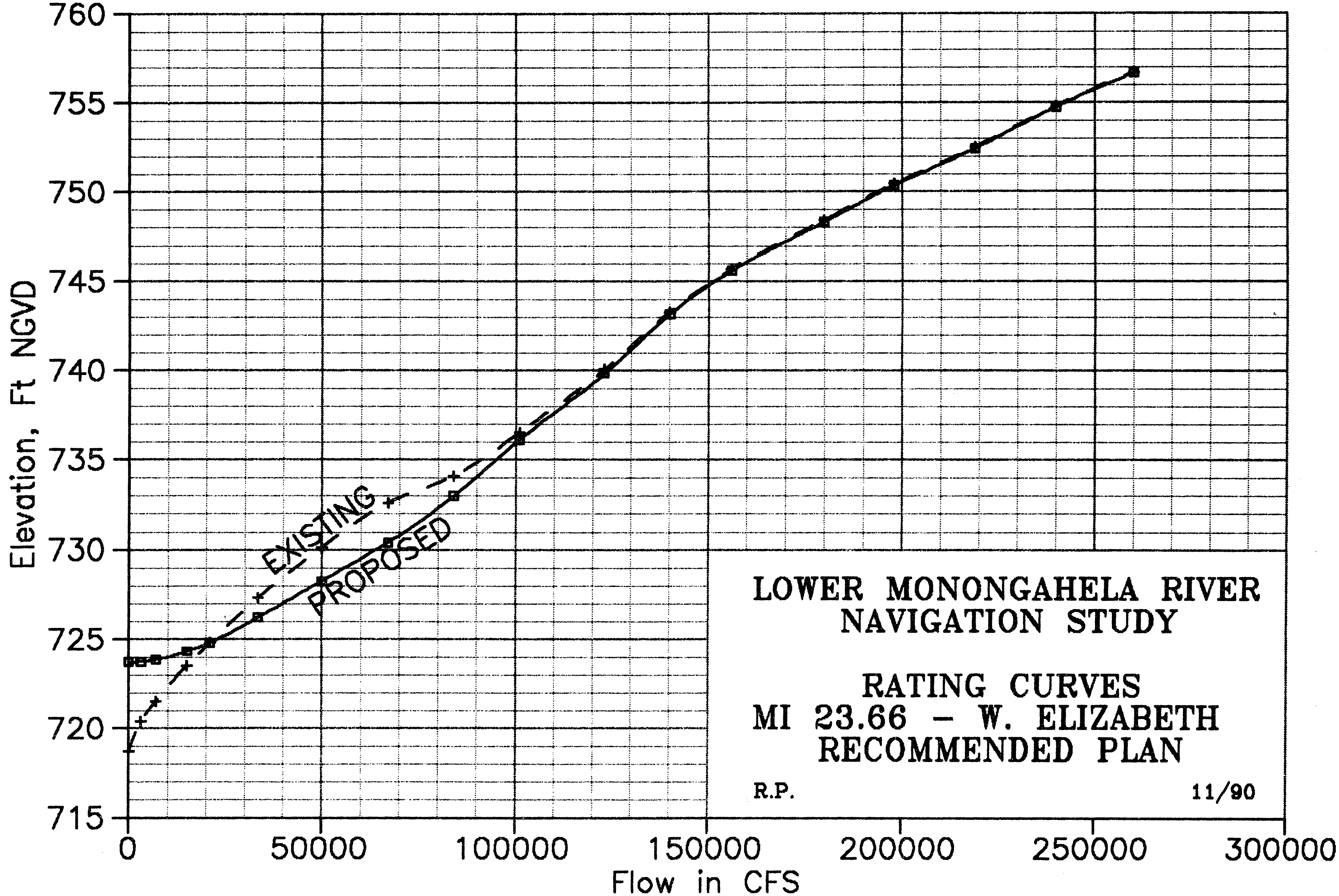
PLATE 3-4



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Elevation, Ft NGVD
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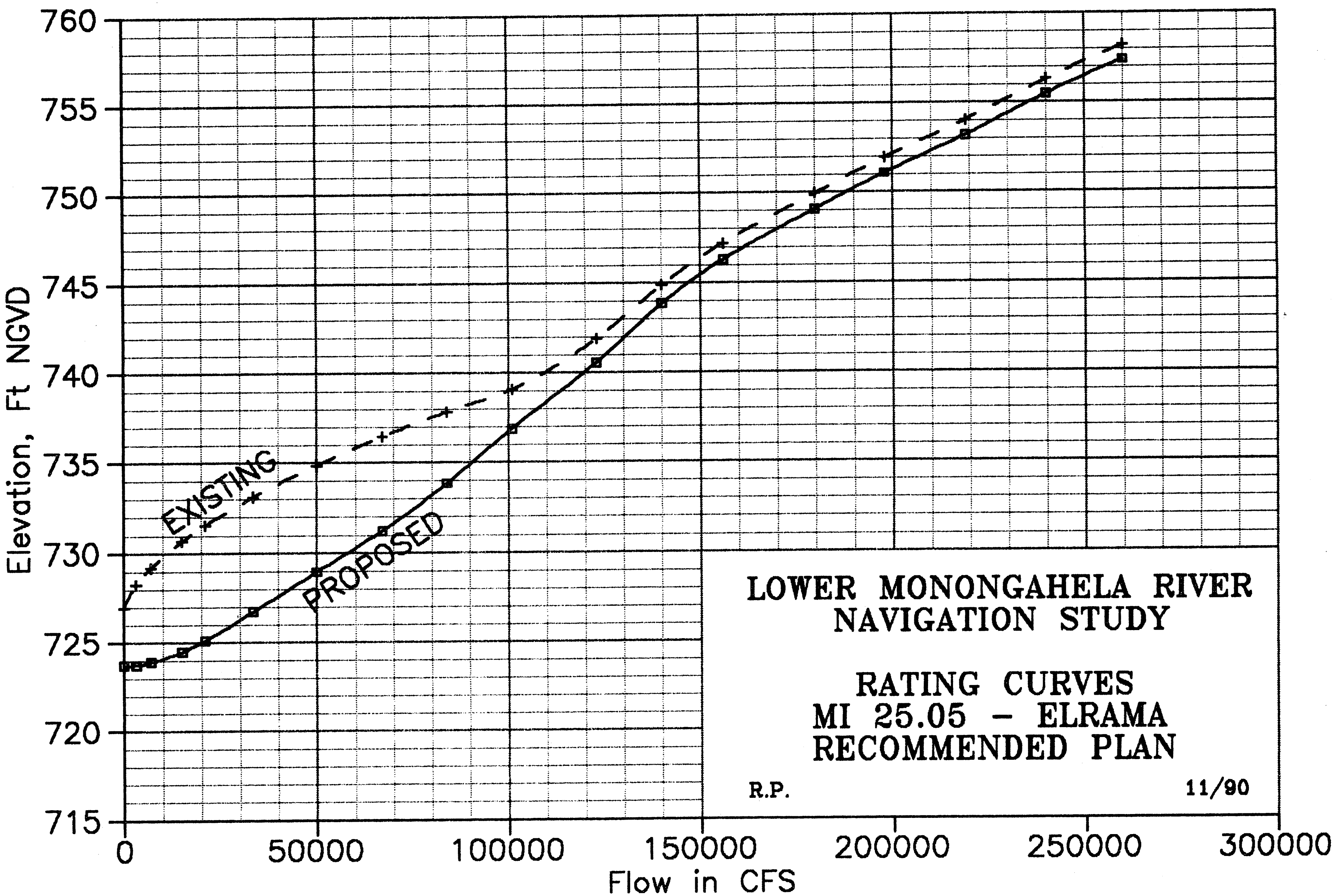
Flow in CFS
EXISTING
PROPOSED
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
RATING CURVES
MI 23.66 – W. ELIZABETH
RECOMMENDED PLAN
R.P.
11/90

PLATE 3-5



LOWER MONONGAHELA RIVER
NAVIGATION STUDY
RATING CURVES
MI 25.05 - ELRAMA
RECOMMENDED PLAN
R.P.
11/90
EXISTING
PROPOSED
Elevation, Ft NGVD
Flow in CFS
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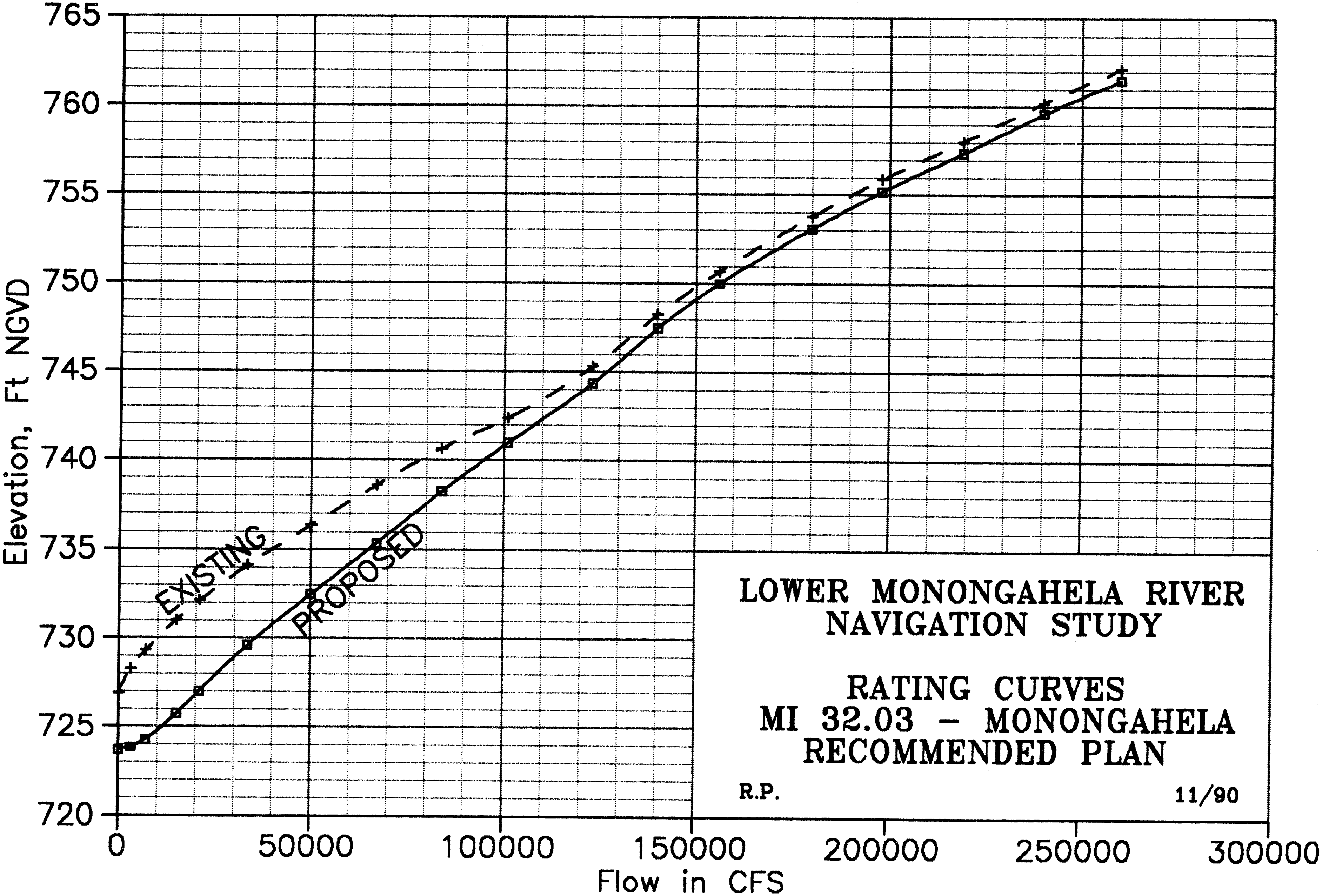
PLATE 3-6



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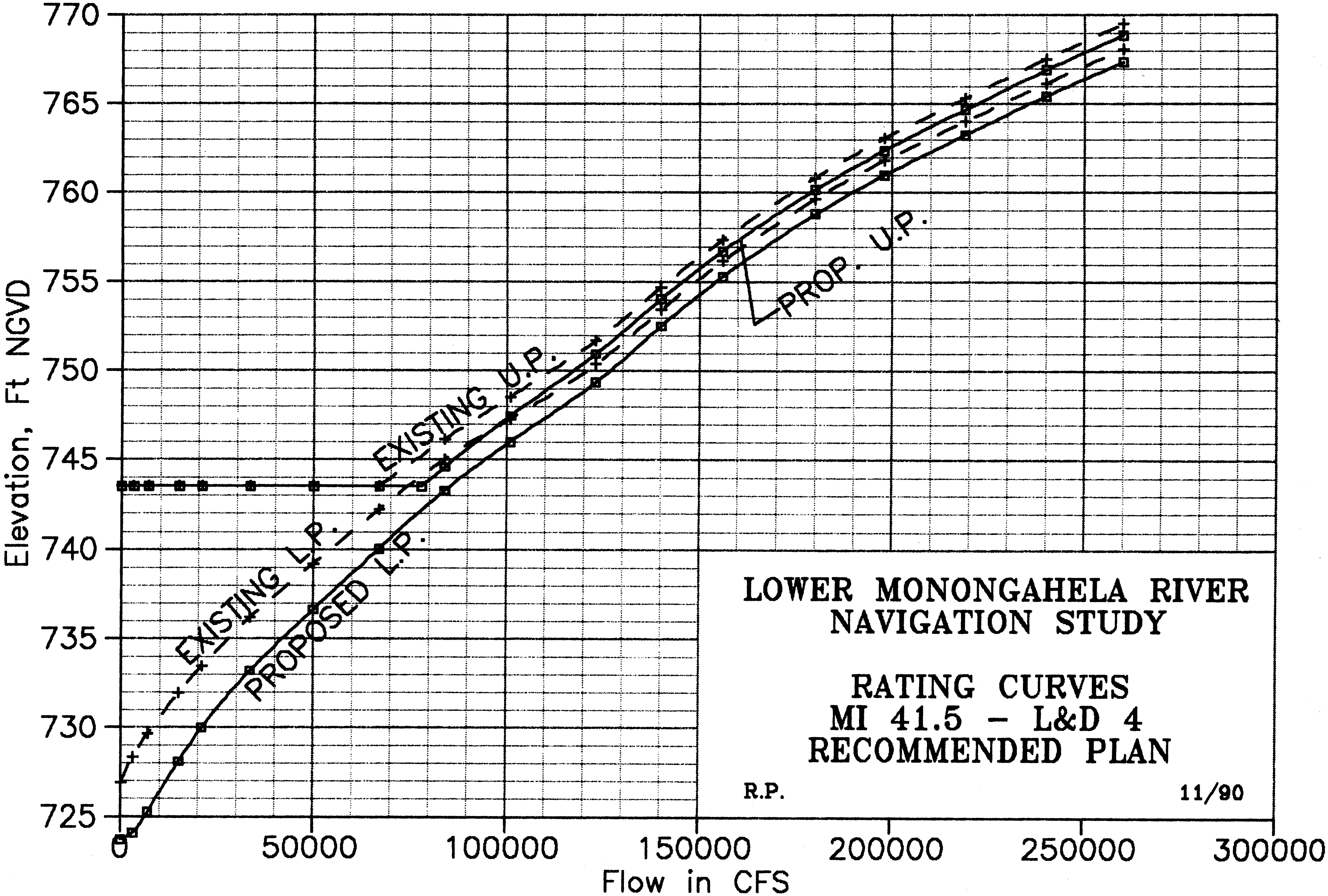
Flow in CFS
EXISTING
PROPOSED
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
RATING CURVES
MI 32.03 - MONONGAHELA
RECOMMENDED PLAN
R.P.
11/90

PLATE 3-7


770
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Elevation, Ft NGVD
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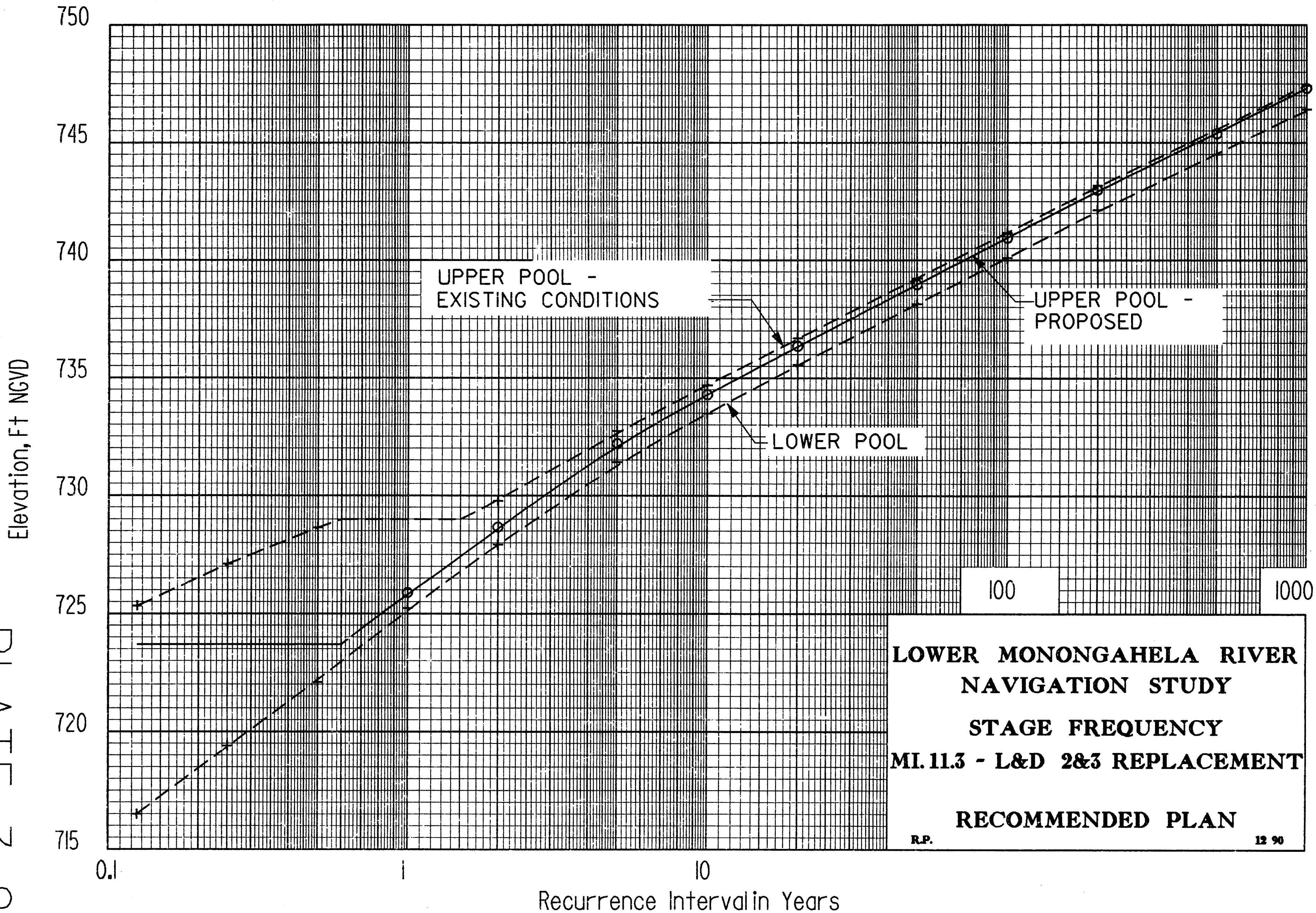
Flow in CFS
EXISTING U.P.
PROP. U.P.
EXISTING L.P.
PROPOSED L.P.
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
RATING CURVES
MI 41.5 - L&D 4
RECOMMENDED PLAN
R.P.
11/90

PLATE 3-8



750
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Elevation, Ft NGVD
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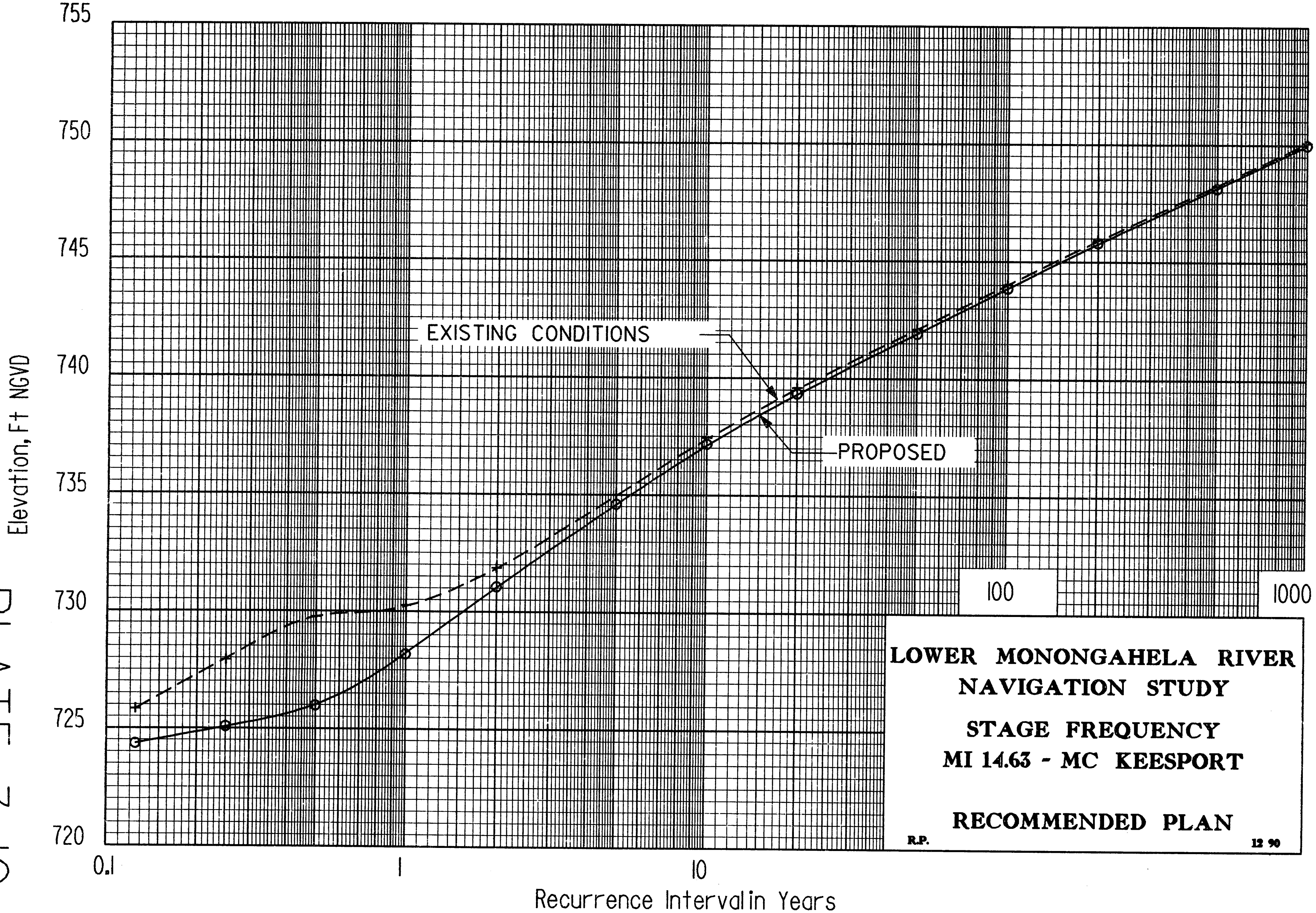
Recurrence Interval in Years
UPPER POOL - EXISTING CONDITIONS
UPPER POOL - PROPOSED
LOWER POOL
LOWER MONONGAHELA RIVER NAVIGATION STUDY
STAGE FREQUENCY
MI. 11.3 - L&D 2&3 REPLACEMENT
RECOMMENDED PLAN
R.P.
12 90

PLATE 3-9



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Elevation, Ft NGVD
EXISTING CONDITIONS
PROPOSED
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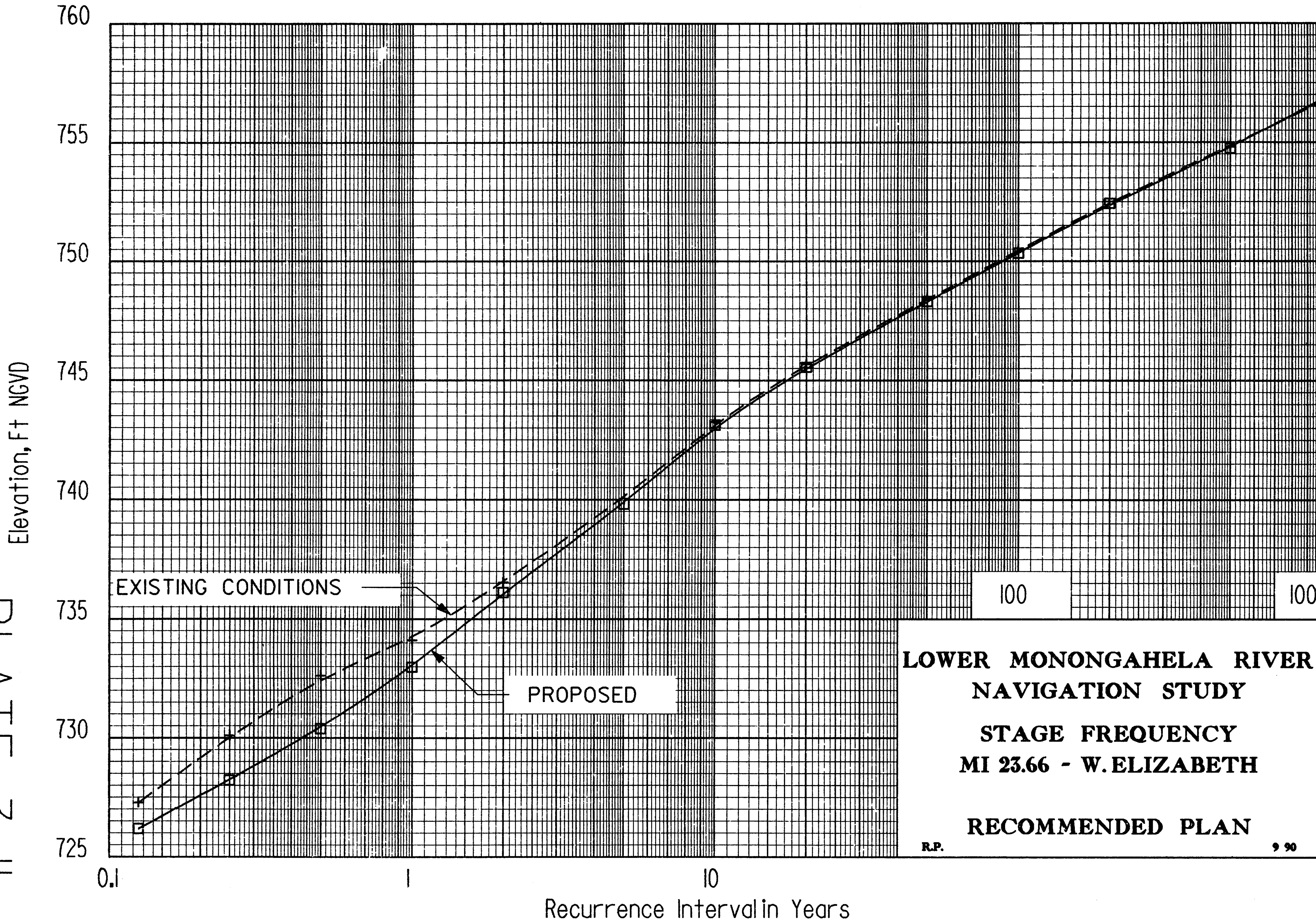
Recurrence Interval in Years
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MI 14.63 - MC KEESPORT
RECOMMENDED PLAN
R.P.
12 90

PLATE 3-10



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Elevation, Ft NGVD
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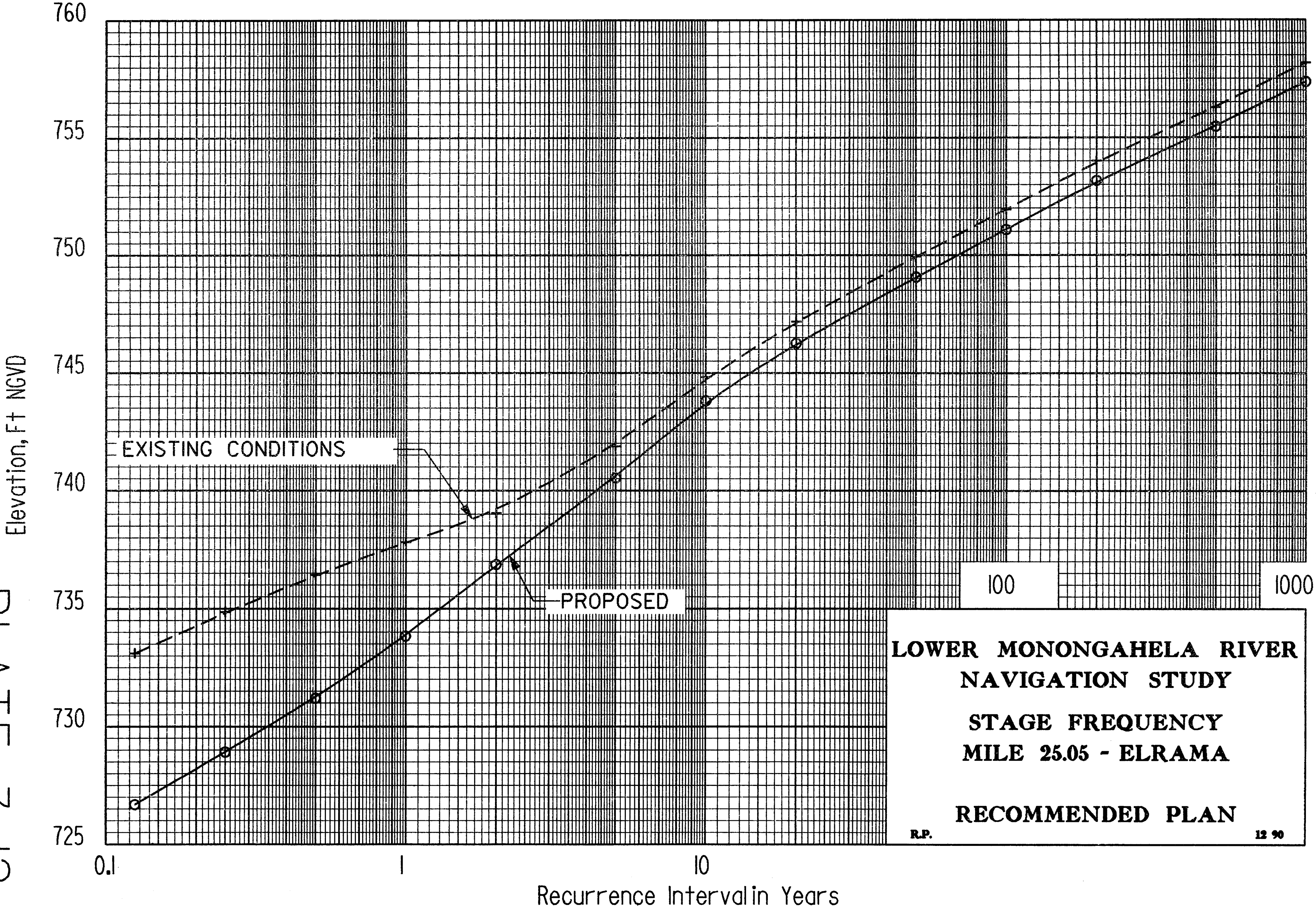
Recurrence Interval in Years
EXISTING CONDITIONS
PROPOSED
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MI 23.66 - W. ELIZABETH
RECOMMENDED PLAN
R.P.
9 90

PLATE 3-11



760
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Elevation, Ft NGVD
EXISTING CONDITIONS
PROPOSED
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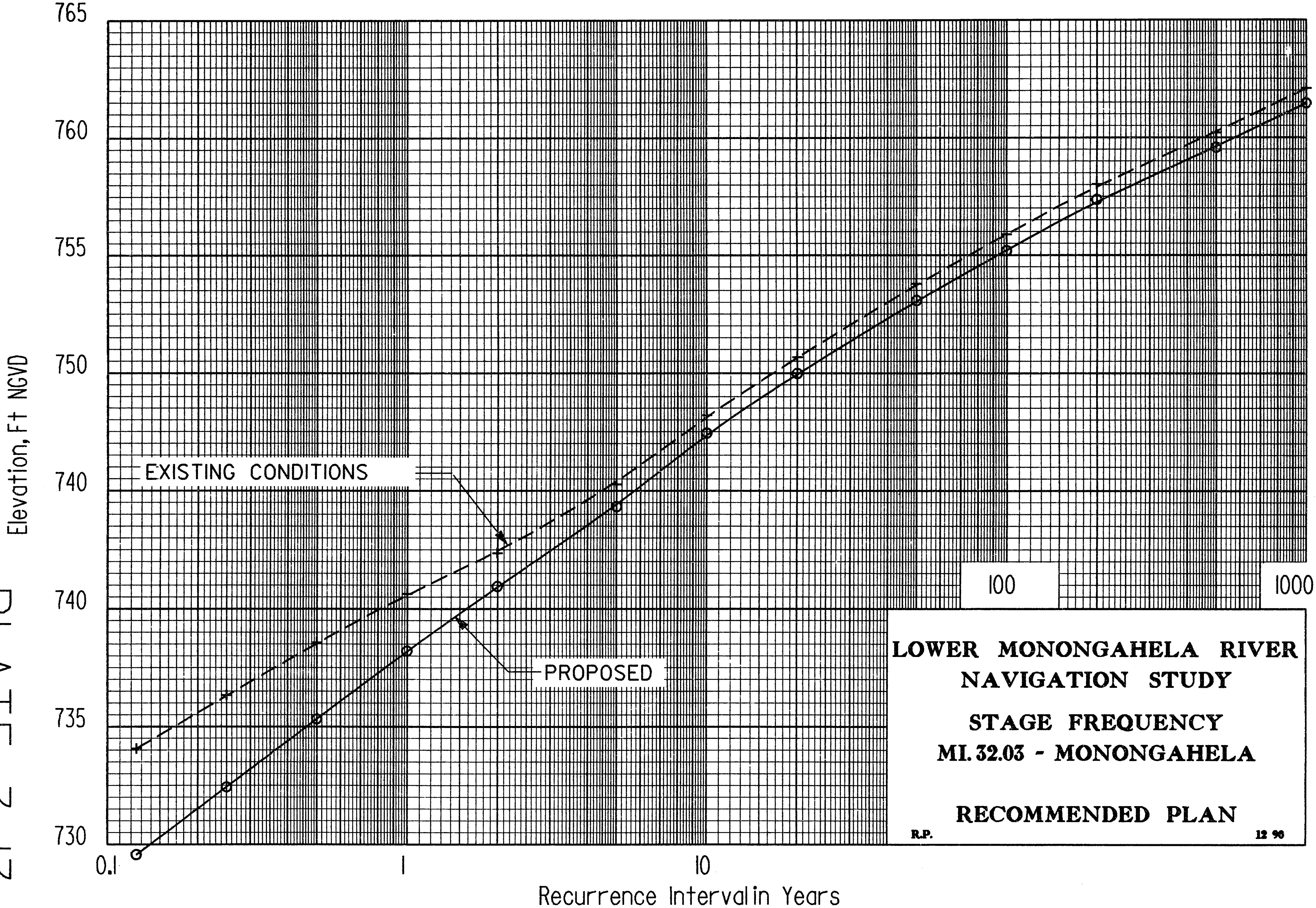
Recurrence Interval in Years
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MILE 25.05 - ELRAMA
RECOMMENDED PLAN
R.P.
12 90

PLATE 3-12

PLATE 3-13



765
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Elevation, Ft NGVD
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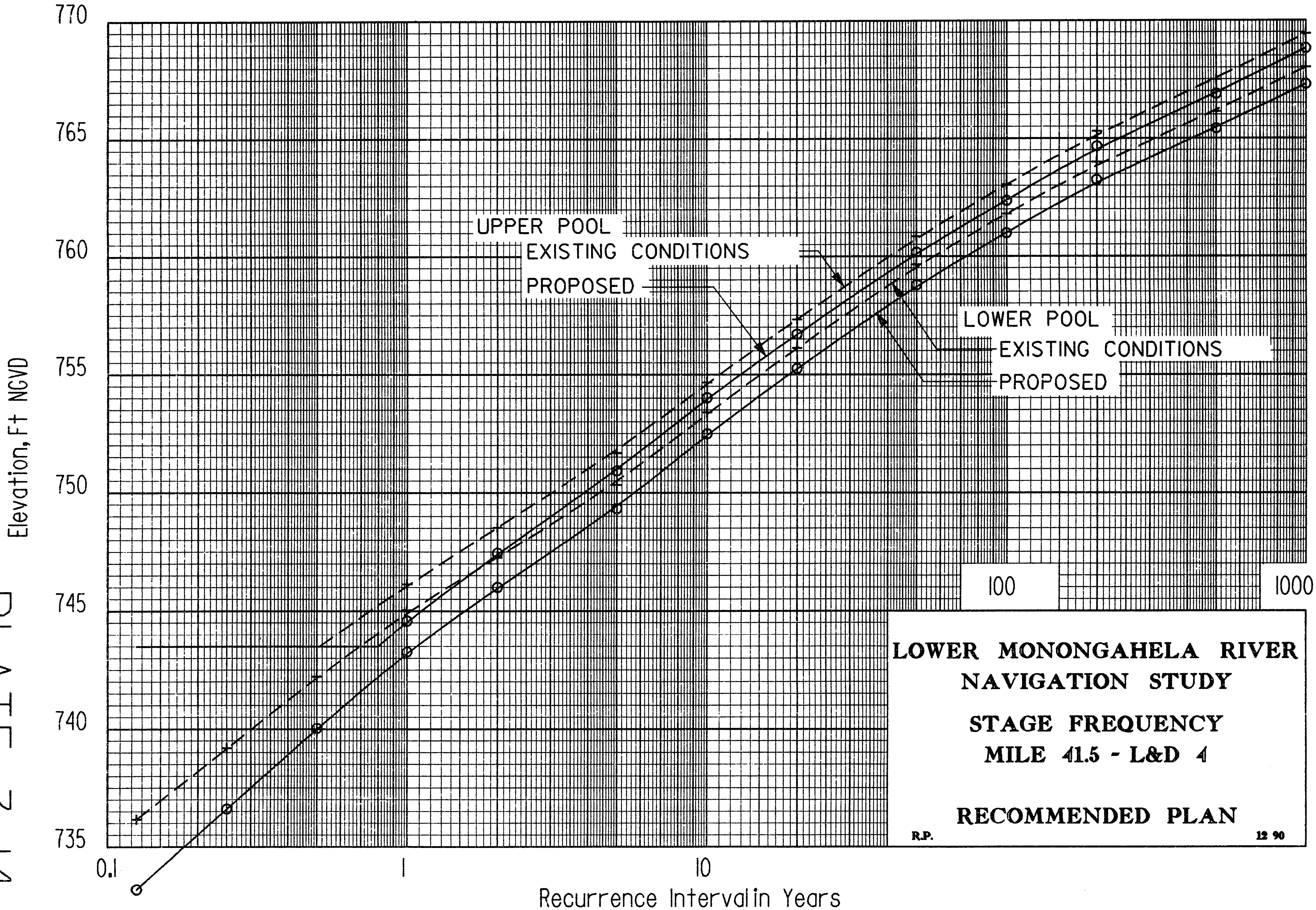
Recurrence Intervalin Years
EXISTING CONDITIONS
PROPOSED
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MI. 32.03 - MONONGAHELA
RECOMMENDED PLAN
R.P.
12 90


770
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Elevation, Ft NGVD
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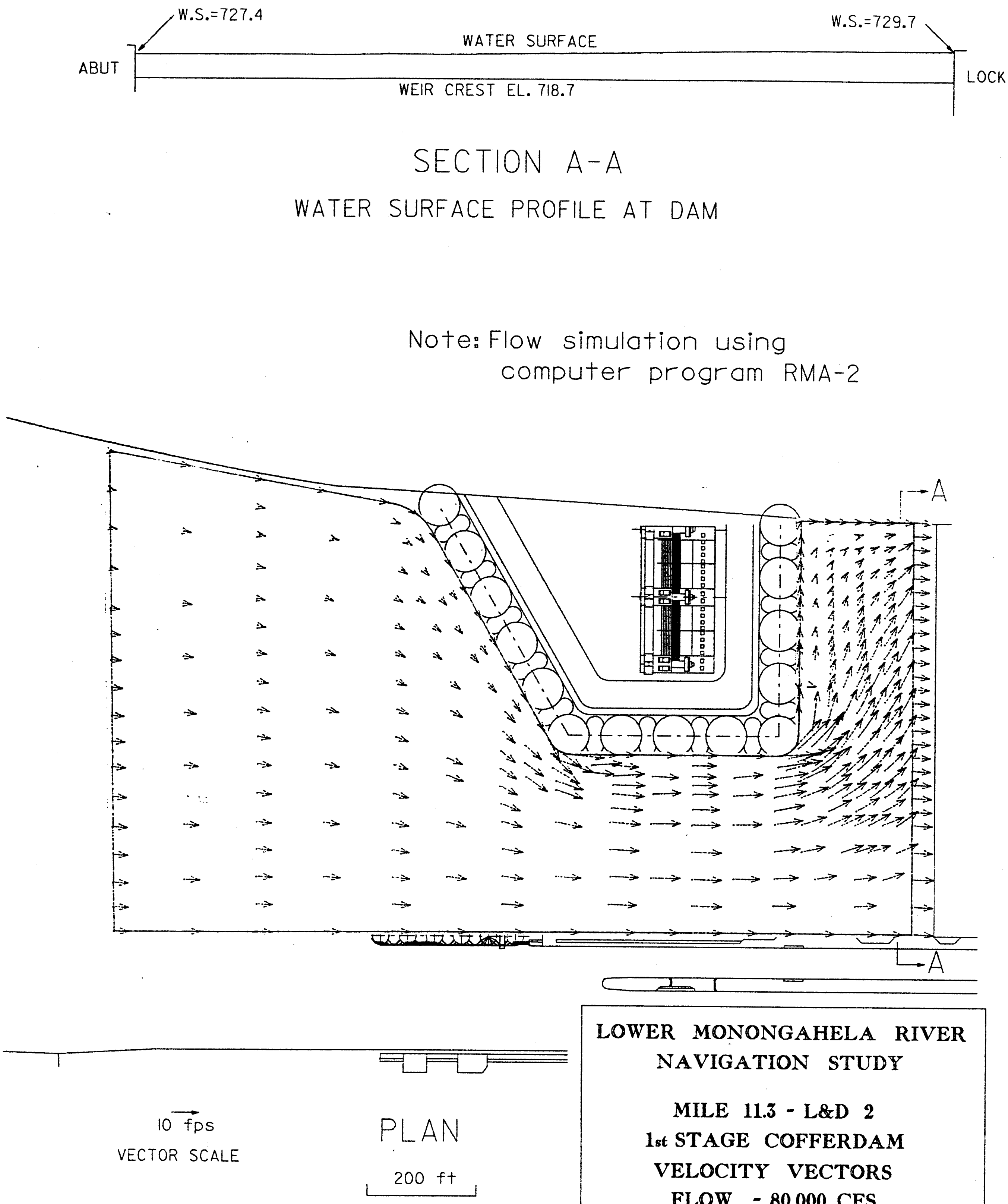
Recurrence Intervalin Years
UPPER POOL
EXISTING CONDITIONS
PROPOSED
LOWER POOL
EXISTING CONDITIONS
PROPOSED
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MILE 41.5 - L&D 4
RECOMMENDED PLAN
R.P.
12 90

PLATE 3-14

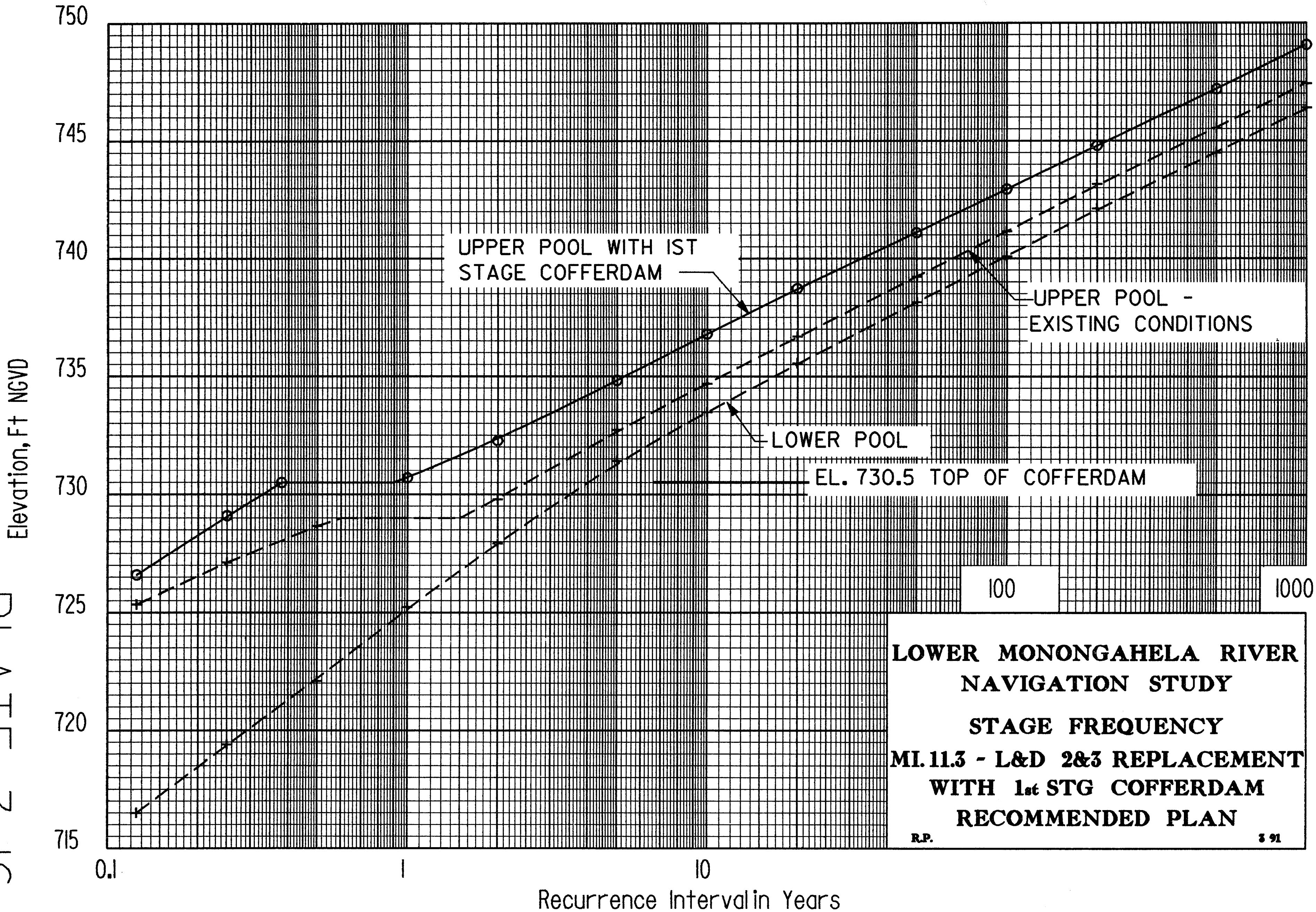


**LOWER MONONGAHELA RIVER
NAVIGATION STUDY**

**MILE 11.3 - L&D 2
1st STAGE COFFERDAM
VELOCITY VECTORS
FLOW - 80,000 CFS**

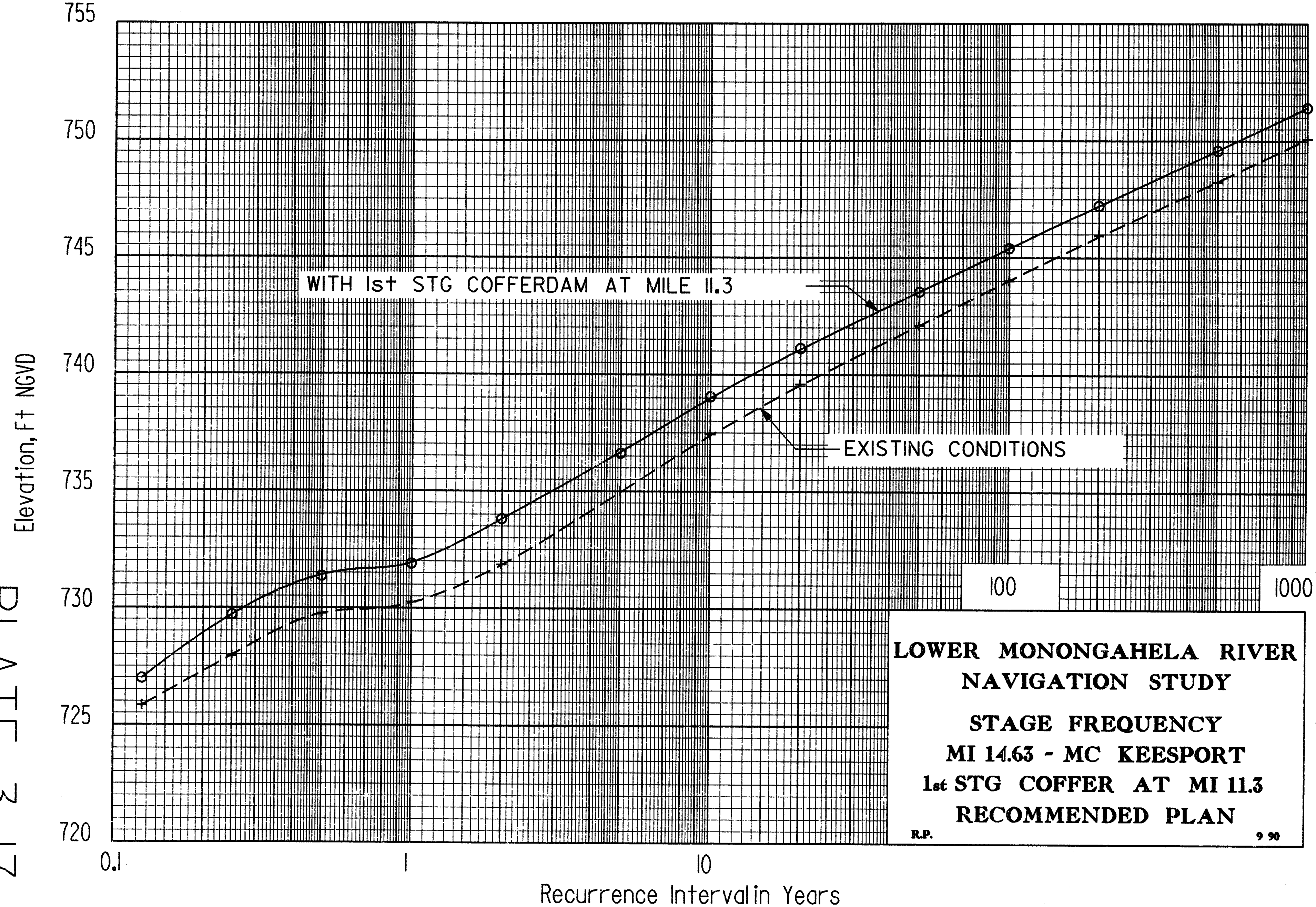
R.P. 9 90

PLATE 3-15



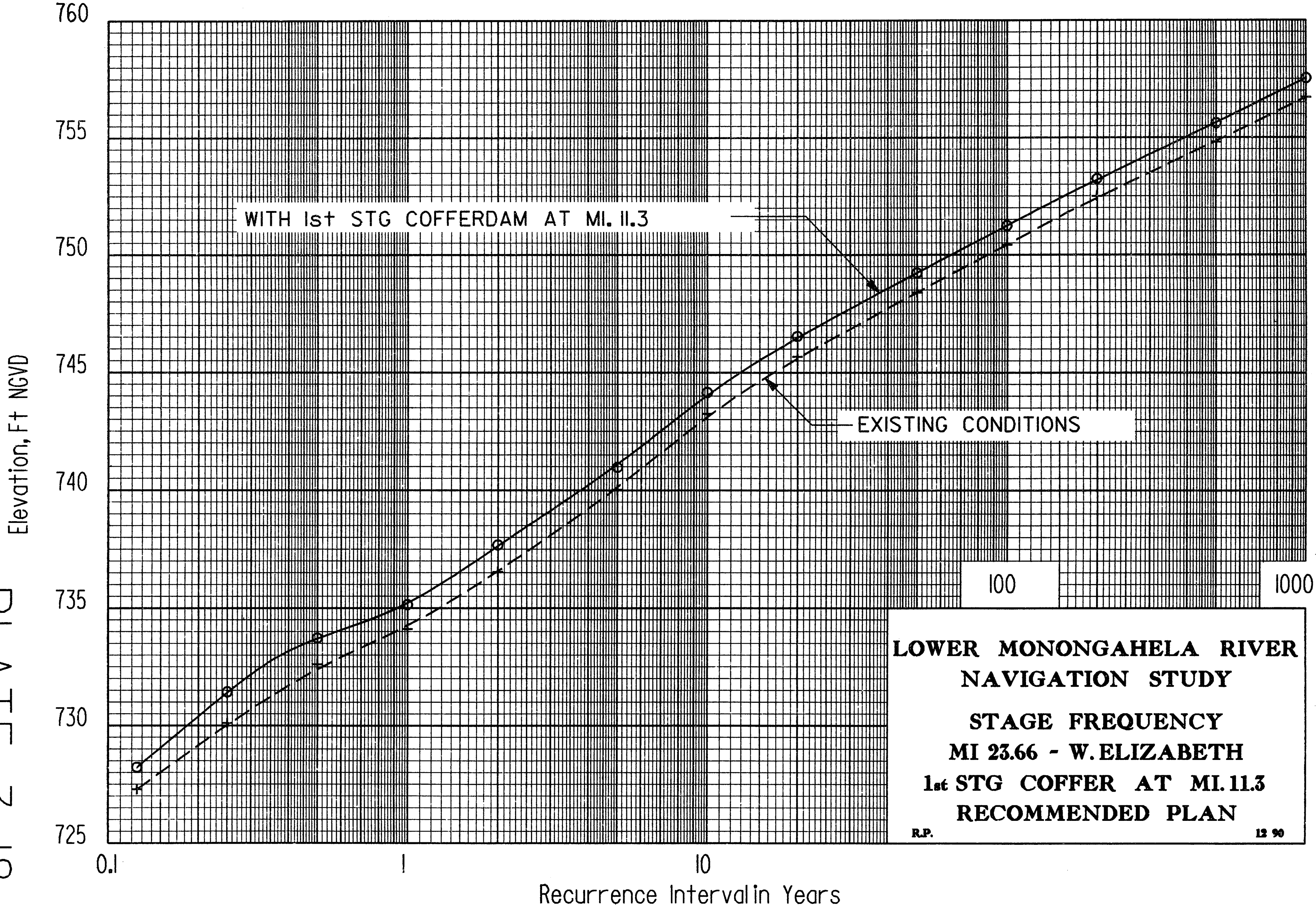
750
745
740
735
730
725
720
715
Elevation, Ft NGVD
0.1
1
10
100
1000
Recurrence Interval in Years
UPPER POOL WITH IST STAGE COFFERDAM
UPPER POOL - EXISTING CONDITIONS
LOWER POOL
EL. 730.5 TOP OF COFFERDAM
LOWER MONONGAHELA RIVER NAVIGATION STUDY
STAGE FREQUENCY
MI. 11.3 - L&D 2&3 REPLACEMENT
WITH 1st STG COFFERDAM
RECOMMENDED PLAN
R.P.
3 91

PLATE 3-16



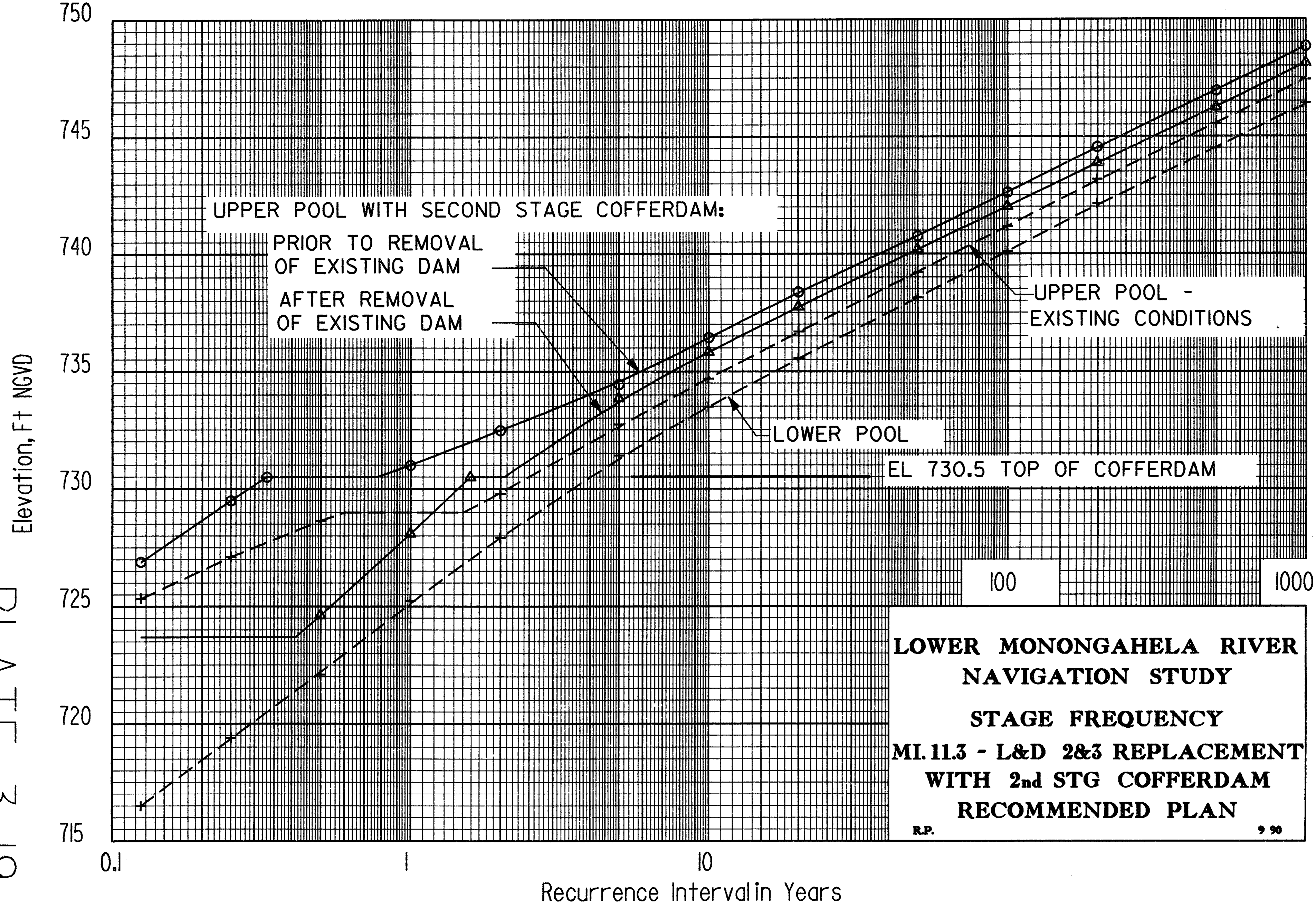
755
750
745
740
735
730
725
720
Elevation, Ft NGVD
0.1
1
10
100
1000
Recurrence Intervalin Years
WITH Ist STG COFFERDAM AT MILE 11.3
EXISTING CONDITIONS
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MI 14.63 - MC KEESPORT
1st STG COFFER AT MI 11.3
RECOMMENDED PLAN
R.P.
9 90

PLATE 3-17



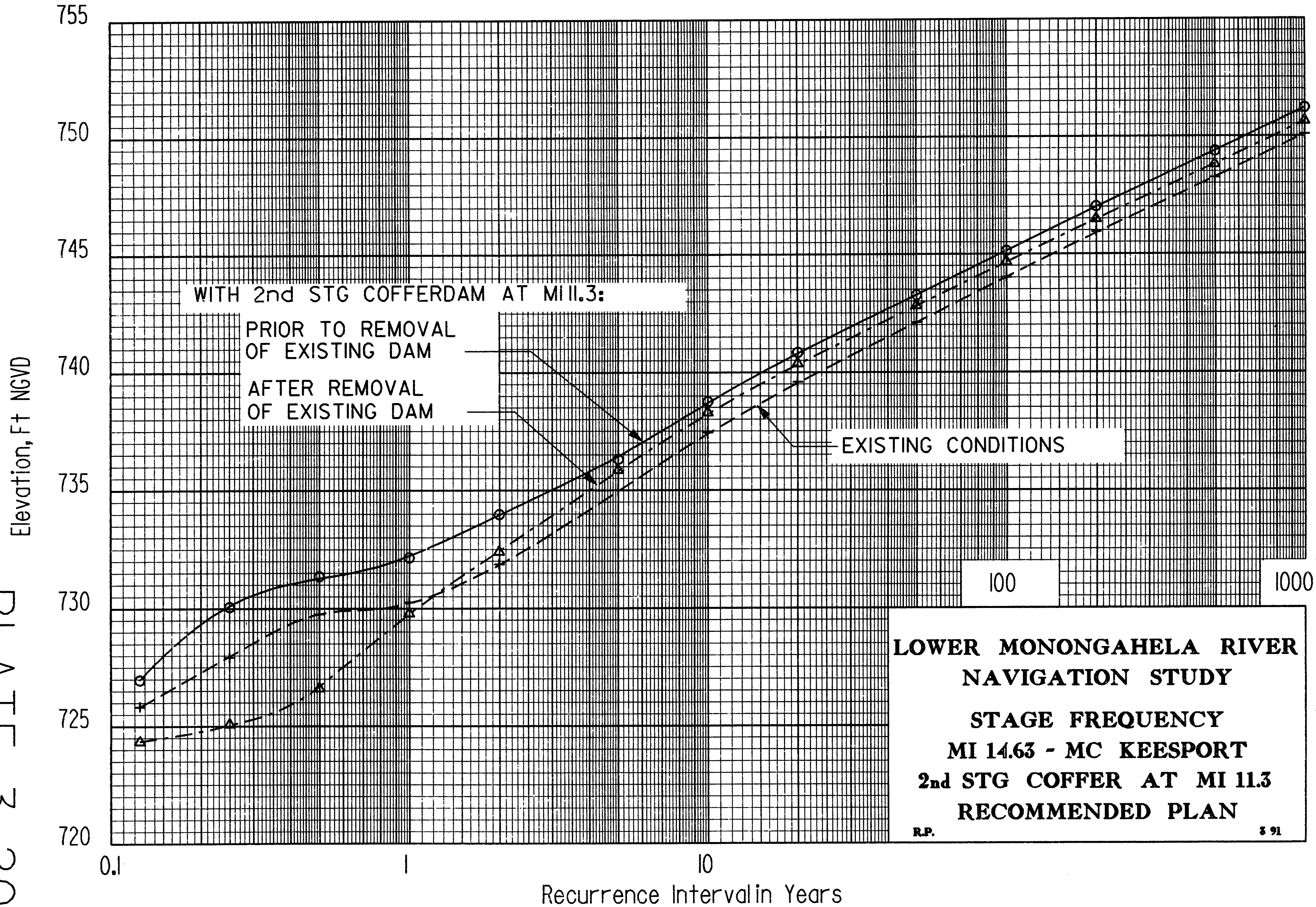
WITH 1st STG COFFERDAM AT MI. 11.3
EXISTING CONDITIONS
Elevation, Ft NGVD
Recurrence Interval in Years
760
755
750
745
740
735
730
725
0.1
1
10
100
1000
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MI 23.66 - W. ELIZABETH
1st STG COFFER AT MI. 11.3
RECOMMENDED PLAN
R.P.
12 90

PLATE 3-18



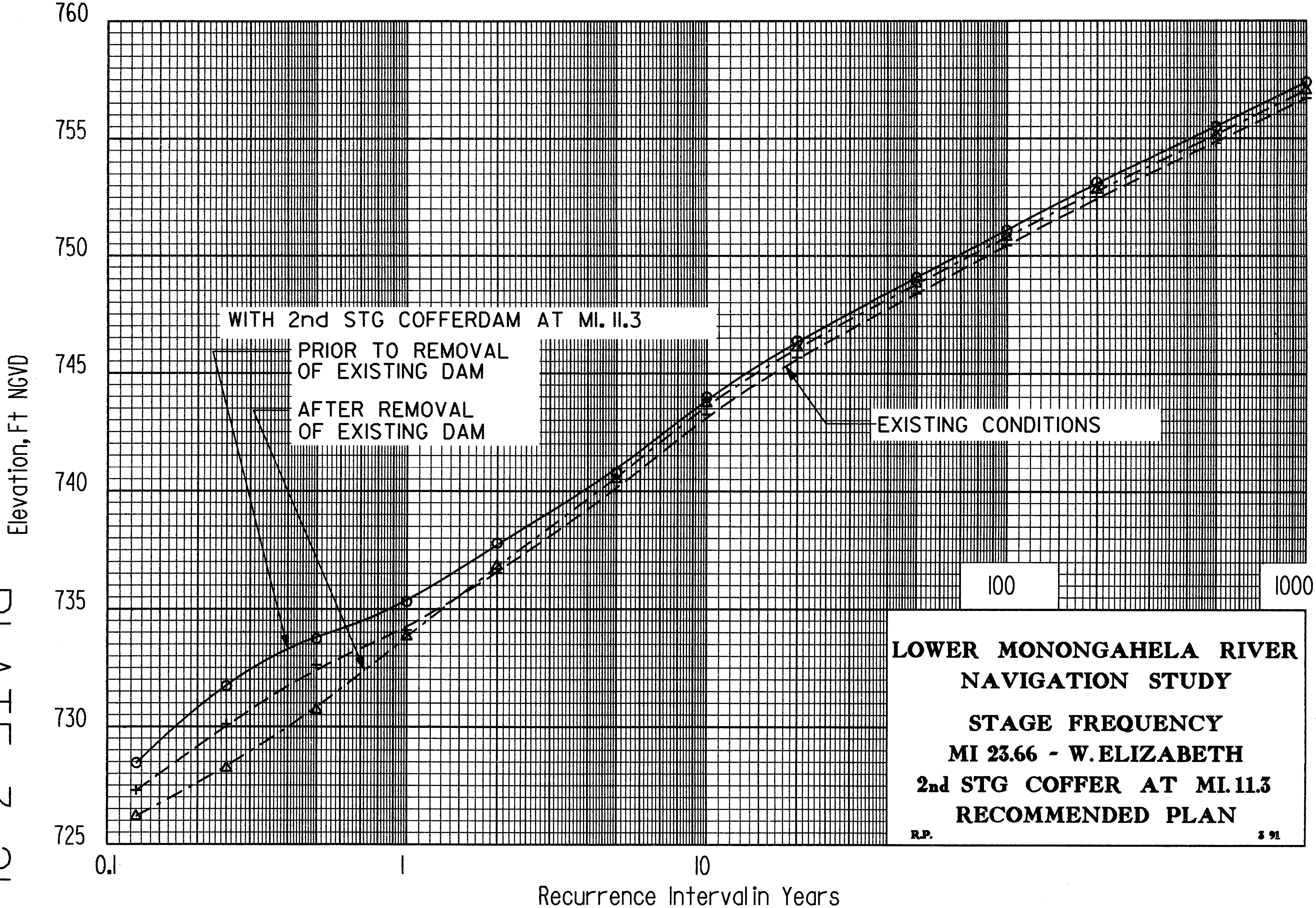
750
745
740
735
730
725
720
715
0.1
1
10
100
1000
Elevation, Ft NGVD
Recurrence Interval in Years
UPPER POOL WITH SECOND STAGE COFFERDAM:
PRIOR TO REMOVAL OF EXISTING DAM
AFTER REMOVAL OF EXISTING DAM
UPPER POOL - EXISTING CONDITIONS
LOWER POOL
EL 730.5 TOP OF COFFERDAM
LOWER MONONGAHELA RIVER NAVIGATION STUDY
STAGE FREQUENCY
MI. 11.3 - L&D 2&3 REPLACEMENT
WITH 2nd STG COFFERDAM
RECOMMENDED PLAN
R.P.
9 90

PLATE 3-19



LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MI 14.63 - MC KEESPORT
2nd STG COFFER AT MI 11.3
RECOMMENDED PLAN
R.P.
3 91
WITH 2nd STG COFFERDAM AT MI 11.3:
PRIOR TO REMOVAL OF EXISTING DAM
AFTER REMOVAL OF EXISTING DAM
EXISTING CONDITIONS
Elevation, Ft NGVD
755
750
745
740
735
730
725
720
0.1
1
10
100
1000
Recurrence Interval in Years

PLATE 3-20

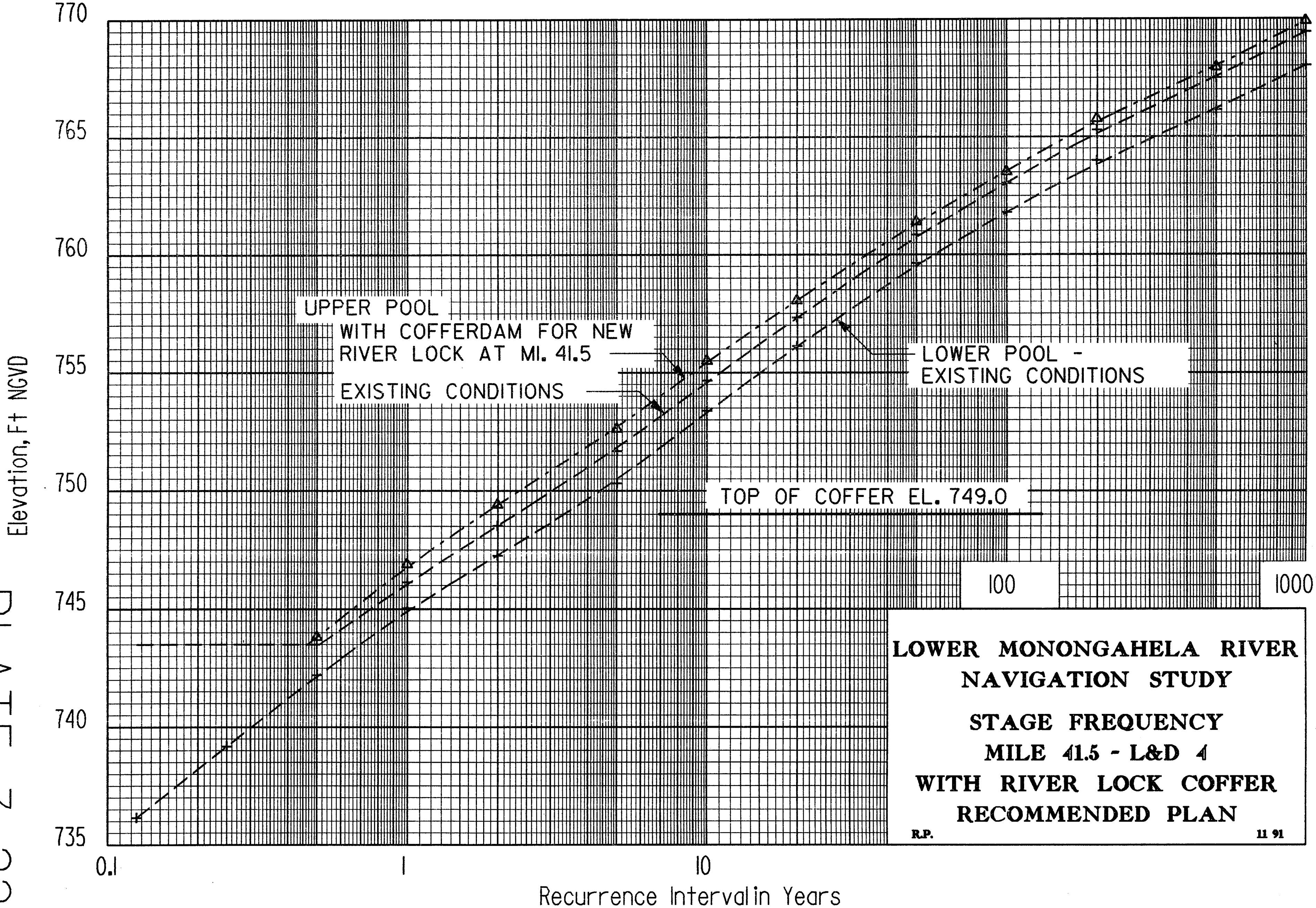


LOWER MONONGAHELA RIVER NAVIGATION STUDY

STAGE FREQUENCY
MI 23.66 - W. ELIZABETH
2nd STG COFFER AT MI. 11.3
RECOMMENDED PLAN

R.P. 3 91

PLATE 3-21



770
765
760
755
750
745
740
735
Elevation, Ft NGVD
0.1
1
10
100
1000
Recurrence Interval in Years
UPPER POOL
WITH COFFERDAM FOR NEW
RIVER LOCK AT MI. 41.5
EXISTING CONDITIONS
LOWER POOL -
EXISTING CONDITIONS
TOP OF COFFER EL. 749.0
LOWER MONONGAHELA RIVER
NAVIGATION STUDY
STAGE FREQUENCY
MILE 41.5 - L&D 4
WITH RIVER LOCK COFFER
RECOMMENDED PLAN
R.P.
11 91

PLATE 3-22

4. Surveying and Mapping Requirements

A study is currently being conducted to develop new topographic maps of the Monongahela River Corridor. Using digital formatting and new soundings, 1" = 200' maps with 5' contours would be available in early 1992. These maps would be utilized during the Planning Engineering and Design stage.

5. Geotechnical

Section I. Replacement of Dam 2

a. Background.

(1) Description

Locks and Dam No. 2 is located on the Monongahela River at River Mile 11.2. The existing structure consists of two lock chambers on the right bank and a non-navigable, fixed crest dam. The locks, constructed between 1951 and 1953, replaced the original locks built between 1902 and 1906. The locks have a lift of 8.7 feet from normal lower pool elevation 710.0 to normal upper pool elevation 718.7. The fixed crest concrete weir dam is 748 feet long, supported on timber piles and rock filled cribbing, and has an upstream cutoff wall constructed from wooden Wakefield piling. The dam is part of the original project construction, and was modified before 1920 by removing the crest gates and raising the weir crest by 3.6 feet.

(2) Proposed Project

The proposed project consists of constructing a non-navigable, high lift, gated dam approximately 500 feet upstream from the existing fixed crest weir. This will raise the normal upper pool approximately five feet from elevation 718.7 to elevation 723.7. Additional work proposed for this project includes removal of the existing fixed crest dam, stabilization of the existing lock walls, and the modification of structures affected by the permanent five foot increase. The removal of Locks and Dam 3 and the dredging of Pool 3 are also included under this proposed project.

b. Subsurface Investigation

(1) Drilling

(a) General

Except for the three borings advanced in 1990, very little information is available on the foundation conditions under the dam. When the dam was constructed some records of the depth to pile refusal were kept but no attempt was made to record the description of bedrock. The location of the borings described below are shown on PLATE 5-1. The logs of the borings are shown on PLATES 5-2, 5-6, 5-7, 5-8, and 5-9.

(b) Lock Reconstruction - 1949 to 1953

Four separate subsurface exploration programs were conducted for the reconstruction of Lock 2 which was completed in 1953. Drilling took place in 1944, 1946, 1947 and 1951. A total of 70 three-inch diameter borings were drilled, mainly in the area of the new lock construction.

(c) Waterways Experiment Station Condition Survey - 1986

An additional exploration program was completed by the Waterways Experiment Station (WES) in 1986 for a condition survey of the lock. A total of six core borings, two 4" diameter and four 6" diameter, were drilled into foundation rock below the existing lock walls. The deepest boring was taken to elevation 611 which is approximately 60 feet below the foundation of the lockwalls. While most of the borings were concentrated around the lock, the information can be extrapolated to describe conditions under the dam.

(d) Feasibility Study Investigation - 1990

Because previous exploration programs had concentrated on the lock area, a limited exploration program was conducted along the axis of the proposed replacement dam. Three borings were drilled along the axis of the proposed dam in August 1990 to obtain at least some minimal information on subsurface conditions at the project. One NXM boring was drilled through 45 feet of soil and 32 feet of rock. Two 4" borings were drilled through a total of 63 feet of soil and 96 feet of rock. Logs for these borings are shown on PLATE 5-2.

(2) Testing

(a) General

The rock units referred to in the following sections are described in Section 5.d.(1). The geologic column on PLATE 5-5 gives the general description of the rock units present at the Lock and Dam 2 site. They have been correlated with the units present at the Lock and Dam 4 site. The Lock 4 geologic units are shown on PLATE 5-18.

(b) WES Testing

Testing for the 1986 WES condition survey report concentrated on the concrete in the lockwalls. A limited number of intact specimens classified as shale were tested for shear strength parameters. The samples were grouped into two categories: "Soft to moderately hard shale", and "moderately hard shale". The first group of samples appears to be from the lowermost part of the Unit 8 strata and the second group is from the upper part of Unit 9. Due to the scatter of the test points, it was decided to plot all the shear test results together and calculate a peak and residual shear envelope for all specimens. The resulting shear envelope is shown on PLATE 5-3.

(c) Current Testing

As part of the subsurface investigation in August 1990, rock core samples were obtained in order to conduct a limited laboratory testing program. A total of 21 core samples were recovered from the two 4" diameter borings, D-2 and D-3. Nine of these samples were from the Unit 8 claystone and 12 were from the Unit 9 siltstone. Laboratory testing, consisting of direct shear and unconfined compression tests, has been completed. A tabulation of the test results is included as Tables 5-1 and 5-2.

c. Site Conditions

(1) Topography

Locks and Dam 2 is situated in a broad floodplain of the Monongahela River. The site is 11.2 miles upstream from the mouth of the river at Pittsburgh, Pennsylvania, and is approximately 2000 feet downstream from the river's confluence with Turtle Creek. The location of the project and general topography of the area is shown on PLATE 5-4.

The floodplain terrace on the right bank, with a nominal surface elevation of 740 feet NGVD, extends for approximately 4 miles, from River Mile 8 to River Mile 12. It's center section is approximately 2000 feet wide, with both the upstream and downstream ends pinching out against the valley walls. Turtle Creek discharges into the Monongahela River at the upstream end of the terrace. The valley wall which borders the floodplain is gently sloping and extends from terrace elevation 740 to bluff elevation 1200. The project is bordered on the right bank by a multi-track railway system owned by the Pittsburgh and Lake Erie Railroad and numerous track sidings which service the adjacent Edgar J. Thompson Steel Mill. Access to the locks is provided by public roads through the residential community of Braddock, PA.

The left bank floodplain terrace, also with a nominal surface elevation of 740 feet NGVD, extends 3 miles upstream from River Mile 11 to River Mile 14. The terrace section at the dam site is approximately 500 feet wide, and pinches out into the steeply sloping valley wall approximately 2000 feet downstream from the existing dam axis. The floodplain between the dam abutment and steep valley wall is heavily utilized by a multi-track railway owned by CONRAIL, and a siding yard which services another steel mill complex located approximately one mile upstream.

(2) General Geology

The Monongahela River in the study area flows north in a series of entrenched meanders through the Kanawha Section of the Appalachian Plateaus Province. Major geologic structure in the region is a series of gently dipping, roughly symmetrical, sub-parallel folds, whose axes strike approximately N 30 to 50 degrees E and plunge gently to the southwest. The project site lies on the west flank of the Duquesne-Fairmont Syncline. The axis of the syncline lies about 4000 feet upstream from the Dam 2 site as shown on PLATE 5-4. Local dip at the site is to the southeast at about 13 feet per 1000 feet.

Rocks exposed in the region belong to Conemaugh and Monongahela formations of Pennsylvanian age. These relatively flat-lying cyclic sediments are chiefly shales and indurated clays, siltstones, limestones and coals. The major economic coal (Pittsburgh Coal) occurs above elevation 1000. It has been mined extensively in the general area but has been eroded and is not present at the project site.

The strata at the project site belong to the upper Glenshaw Formation of the Conemaugh Group, which consists principally of thick beds of claystone, siltstone and thin beds of sandstone and limestone.

(3) Soil

Soils of the floodplain and river channel are interbedded and lensed deposits of normally consolidated alluvial and colluvial materials derived from the weathered and eroded parent rocks of the adjacent valley walls and upper Monongahela River basin. The floodplain terraces on both banks have been disturbed and altered significantly by urban and industrial development. Random fill materials composed of industrial by-products are predominant on the terrace floor, and overlie deep deposits of silty sands and silty gravels. A more detailed description of insitu soils is presented in Section 5.e.

d. Foundation Conditions

(1) Site Stratigraphy

PLATE 5-5 is a generalized geologic column in which the rock layers have been assigned unit numbers to aid in correlation across the site. Since the bedrock at the Dam 2 and Lock 4 sites are from the same general stratigraphic units, the numbers used on this column correspond to those on the general column for the Lock 4 site. It should be noted that, although the strata at the two sites is from the same geologic time period, the lithology and engineering characteristics of the rock can vary considerably.

The borings for the lock reconstruction encountered thick red and gray claystones belonging to Lower Pittsburgh Redbed seam (Unit 8 on the column), a thick siltstone bed (Unit 9) which is part of the Saltsburg Sandstone, and the fossiliferous Woods Run Limestone (Unit 10). The deepest borings ended in gray claystone (Unit 11).

The greater part of the rock beneath the proposed dam axis belongs to the Saltsburg member of the Glenshaw Formation.

(2) Site Structural Geology

As noted in Section 5.c.(2), the project lies on the western limb of a shallow syncline trending to the northeast. The local dip is to the southeast at less than 15 feet per 1000 feet. Since the dam axis roughly parallels the strike of the beds, the apparent dip along the dam axis is nearly flat.

(3) Dam Foundation

Section W-W, PLATE 5-6, is a cross section along the axis of the proposed dam. Included as PLATE 5-7 are profiles along the existing riverwall and middlewall. PLATE 5-8 shows two profiles along the landwall and PLATE 5-9 shows two sections through the locks. PLATES 5-7, 5-8 and 5-9 were prepared for the report on the lock reconstruction. The alluvial deposits above the top of rock have a maximum thickness of 50 feet near the landwall and thin to less than 30 feet under the dam. The top of bedrock is at elevation 670 or below. Rock below the alluvium consists of approximately 10 feet of the Unit 8 claystone underlain by the massive gray Unit 9 siltstone. The top of the siltstone ranges from elevation 655 to 660. Since the number of borings along the proposed dam axis is limited, the 'Top of Firm Rock' line has been set a few feet into the Unit 9 siltstone. For design purposes, a design founding elevation of 650' for the base of the piers is being used.

(4) Abutment Foundation

There is very little information on the bedrock under either the existing or proposed abutment. No information is available from the original construction or from any subsequent reconstruction. Borings drilled for the reconstruction of the abutment in 1951 were not advanced to the top of rock. The sheet and bearing piles for the reconstruction were driven to refusal between elevation 667 and 670. Rock at this elevation should be the Unit 9 siltstone.

(5) Seismic Conditions

ER 1110-2-1806 Earthquake Design and Analysis for Corps of Engineers Projects, dated 16 May 1983, indicates the entire study area to be located in Zone 1 on the seismic zone map. There are no active or inactive faults in the project area and the site is located over 300 kilometers from any seismic zone. There have been no earthquakes reported in the project area. Analysis by the seismic coefficient method will be used to determine the sliding and overturning stability of the structure, assuming a seismic coefficient of five percent of the force of gravity.

(6) Design Assumptions

In order to proceed with the design calculations needed for the present study, some rock strength information was needed well in advance of the completion of the study. After a brief review of the information available, recommendations as to founding elevations and bearing capacity were made. Founding elevation 650 NGVD for the dam piers and a conservative minimum bearing capacity of 100 ksf were recommended. The proportions of the proposed structure were based on the design of similiar structures in the past so design friction and cohesion strength parameters were not needed for this report. Strength parameters for more detailed analysis will be developed from existing data and additional sampling and testing.

e. Soil Conditions

(1) Right Bank

The right bank floodplain terrace was regraded in 1953 after reconstruction of the lock chambers. Approximately forty feet of slag, cinders, random fill and debris were placed behind the landwall after construction, and overlie an additional 30 feet of naturally deposited overburden. The natural overburden materials are composed of three distinct soil zones, with the uppermost zone consisting of a relatively deep plastic layer of soft dark gray clay. The clay contains trace layers of silt, sand, gravel, and organics. Underlying the soft gray clay are interbedded and lensed deposits of brown silty clay and sandy silt. These interbedded layers are of variable thickness, plasticity, and consistency. The bottom most soil zone is a relatively deep layer of sandy silt. This material is of uniform consistency, and increases in layer thickness in the riverward direction. Subsurface profiles and sections showing the soil and rock conditions of the right bank are shown on PLATES 5-7, 5-8, and 5-9.

(2) Channel

Overburden in the river channel ranges from 20 to 30 feet in depth, and is alluvial in origin. The channel materials are defined by two distinct soil zones, with the upper zone consisting of layered and lensed deposits of brown silty sands and silty gravels. The lower soil zone is essentially the same as the lower soil zone of the right bank, and consists of a deep deposit of variably compact brownish gray sandy silt. Subsurface profiles and sections showing the soil and rock conditions of the river channel are shown on PLATE 5-6.

The District, in consultation with the Pennsylvania Department of Environmental Resources' Bureau of Water Quality Management, tested the navigation channel substrate in Pool 3 for the presence of a modified list of EPA priority pollutants (reference: Monongahela River Pool 3, Investigation for the Presence of Priority Pollutants in the Navigation Channel Substrate, Pittsburgh District, USACE, July 1990). This testing concluded that the dredged material from the navigation channel may be considered "clean fill" for purposes of disposal. Despite the heavy industrial history of the lower river, the lack of concentrations of priority pollutants is believed to be related to the relative coarseness of the navigation channel substrate. The finer sediments behind the dams and outside the navigation channel are expected to have a greater affinity for accumulating contaminants. These sediments are in the process of being analyzed and results will be made available when completed.

(3) Left Bank

The left bank floodplain terrace has been disturbed and extensively altered by the random placement of slag, cinders, and industrial debris. These by-product materials predominate the terrace surface and extend to depths exceeding 20 feet, as indicated by the 1953 abutment repair borings.

Borings from the 1953 subsurface investigation are vague, incomplete, and contain very little soils information. The borings did not fully penetrate the slag and cinder fill, therefore no conclusions can be reached concerning the depth and types of soils which underlie the fill on the left bank. Although these materials were not checked for possible hazardous and toxic contaminants, the low probability of finding such residues following the likely decay and deterioration of uncontained by-product materials that were buried for long time periods as well as the substantial expense required to establish a reliable sampling regimen along the Lower Monongahela flood plain terraces, would make random searches for contaminants ill advised and generally uninformative. Where specific needs or indications arise through coordination processes or other channels, confirmatory investigations of identified "red-flag" locations would be undertaken. No such areas have been identified to date.

Boring D-1 from the 1990 subsurface investigation was advanced riverward of the proposed abutment, and indicates that the soils in this area are alluvial and colluvial in origin. The overburden consists of layered and lensed deposits of silty sands, clay, sandy clay, gravelly clay, and gravelly silt. A subsurface section showing the soil and rock conditions in the channel near the abutment is shown on PLATE 5-6.

f. Construction and Excavation Sequence

(1) Construction Sequence

Construction of the proposed project will be accomplished in several phases. The first phase of the project will involve the replacement of the floodway bulkhead. Details of the proposed work are included in Section 8 of the Main Report.

The second phase of work will consist of stabilizing the existing lockwalls and constructing a new gated dam approximately 500 feet upstream from the existing fixed crest dam. The proposed gated dam will be constructed within coffered and dewatered work areas, and will be completed in three stages. The cofferdam for each stage will consist of interlocking cellular sheetpile cells driven through overburden to rock, and filled with granular soil. The cofferdam layout and details for the three stages of dam construction are shown in the Construction Procedure and Water Control Plan Section of the Engineering Technical Appendix, Plate 7-1. A fourth stage will involve modifications to the riverwall and the emergency dam sill in the large chamber.

The third phase of the project will consist of removing the existing concrete dam, foundation piling, and scour protection. The channel bottom will be dredged to elevation 690 from the proposed dam to the existing scour protection toe below the original fixed crest dam.

The final phase of the project consists of dredging in Pool 3, and subsequent removal of Locks and Dam 3. The raising of Pool 2 and removal of Locks and Dam 3 requires that the Pool 3 channel bottom be lowered and dredged to maintain a minimum navigation depth of 9 feet. The lowering of Pool 3 and the required channel bottom dredging in this reach will affect the general operation of Locks and Dam 4 in its present condition. This project feature therefore has been incorporated into the proposed design for the reconstruction and remedial work at Locks and Dam 4

A summary of excavation quantities for the proposed work is shown in Table 5-4.

<u>(2) Construction Excavations</u>

Excavation for construction of the proposed gated dam at Locks and Dam 2 will be performed in three stages within coffered and dewatered excavations. Rock excavation will require line drilling and controlled blasting prior to excavation. The soil and fractured rock will be handled by in-pit backhoes in tandem with a crane mounted clamshell working from the top of the cofferdam cells. The clamshell will transfer the excavated materials onto barges, and the barges will transport the materials to a barge unloading facility where it will be taken to a disposal area.

<u>(3) Removal of Structures</u>

The removal of Dam 2 and Locks and Dam 3 will be performed in the wet. Controlled blasting will be required to demolish the structures, and the concrete rubble will be removed from the river channel using a clamshell working from a floating plant facility. The concrete rubble from both sites will be loaded onto barges and transported to off-site unloading facilities.

<u>(4) Channel and Approach Dredging</u>

Excavation within the channel bottom of Pool 3 and the approach work associated with the temporary floodway at Locks and Dam 2 will be performed in the wet using a crane-mounted clamshell working from a floating plant. Overburden depths in these areas average 35 feet, and no rock excavation is anticipated. The dredge materials are highly saturated sandy and gravelly silts which drain slowly, and will be difficult to handle during disposal operations. These materials will be clamshelled into barges and transported to off-site unloading facilities where they will then be truck-hauled to the disposal site. These materials are in the process of being analyzed to determine the concentration of contaminants. The results will be made available as soon as laboratory analyses are completed.

The proposed dredging will develop a navigable main channel approximately 300 feet wide and 11 feet deep with side slopes of 3 horizontal on 1 vertical. Dredge work associated with developing navigable waterway access to public and private facilities located along the river banks has not been included under this work item.

g. Preliminary Slope Design

(1) Design Considerations

Past exploration programs did not include undisturbed soil sampling and testing, therefore slope design has been limited to engineering judgment based on the natural slopes and District experience with other projects on the Monongahela River.

(2) Construction

The river face of the proposed abutment will be sited more than 80 feet riverward from the existing top of the left bank. Excavation of the left bank for construction of the abutment will require a temporary retaining wall sited approximately 30 feet riverward from the top of bank that is capable of supporting lateral loads from approximately 70 feet of overburden and surcharge loads from the adjacent railroad.

(3) Bank Stability

The existing left bank has been stabilized by the landowners with stone masonry and concrete walls upstream of the existing dam, and steel sheetpile walls downstream. These walls appear to be in good to fair condition; however the design assumptions, construction methods and materials are unknown, and the overall stability of the structures is questionable. Because excavation will be required at the base of these walls for construction of the proposed abutment, the walls will be replaced as necessary with a temporary tie-back wall system prior to construction of the proposed abutment and dam. The existing left bank within the limits of the project, including those walls not replaced, will be stabilized and protected by the placement of compacted granular fill and graded stone along the left bank slope. The encroachment of this bank fill into the river is hydraulically acceptable due to the proposed dam alignment, and location of the abutment relative to the bank.

h. Bank and Scour Protection

(1) General

Graded stone riprap and filter material, purchased from an approved source, will be used to protect critical areas prone to erosion or scour resulting from the altered conditions of the proposed project. The layer thickness and limits of protection for each area have been selected based on past experience with other district projects along the Monongahela River. Final designs will meet the criteria of EM 1110-2-1601.

(2) Riverbanks

The compacted granular fill materials near the left bank abutment will be protected from erosion by the placement of a granular filter and graded stone riprap. Alternatives such as a rock fill in lieu of granular fill, or the utilization of filter cloth in lieu of a granular filter will be investigated in future studies.

Based on prior experience, it is anticipated that the raising of Pool 2 and the lowering of Pool 3, together with the potential for increased rates of drawdown from high flow levels associated with the new gated structure at Dam 2, may destabilize some reaches of riverbanks along these pools. Future studies will define these reaches using detailed field reconnaissance of soil types, existing bank conditions, and proximity of development. Any reach anticipated to be adversely affected will be protected.

(3) Dam

The silty sands and gravels of the channel bottom immediately downstream of the proposed stilling basin will be disturbed by the required dredging, and are highly susceptible to scour erosion. Scour protection will be required along the channel bottom in this area to ensure integrity of the structure. This will be accomplished by the placement of a granular filter and large size riprap. As shown on PLATE 5-10, the protection will extend approximately 460 feet downstream from the proposed dam, and tie into the stone protection below the existing fixed crest dam.

i. Drainage and Seepage

(1) Surface Drainage

Surface drainage landward of the project site will not affect construction of the proposed abutment during Stage 1 of the dam construction. All drainage will be diverted around the excavation during the proposed construction of the abutment by means of berms and ditches.

(2) Underseepage

The sheetpile cells of the cofferdam will be driven to top of rock, and seepage under the cells is expected to be minimal. Seepage from the underlying rock strata is also expected to be minimal due to the low permeability of the claystone and siltstone units. Future exploration work and pressure tests will be performed to confirm this. The seepage of groundwater from the left bank into the excavation during construction of the abutment will be controlled by the temporary tie-back wall, with seepage thru the wall being channeled into sumps and pumped out of the excavation.

Because the granular materials placed along the left bank and behind the proposed abutment will be ineffective in preventing seepage around the dam, a seepage cut-off wall is proposed for the left bank. The proposed seepage cut-off wall will extend landward from the abutment for a sufficient distance to reduce the flow gradient around the abutment.

(3) Dewatering

Seepage through the sheetpile interlocks, monolith joints, and discontinuities in the underlying rock strata will be discharged from the coffered work area by a system of diversion channels, sumps, and pumps. The contractor will be required to design and install a dewatering system to do the work in the dry.

j. Instrumentation

(1) Purpose of Instrumentation

The monitoring program is needed to verify design assumptions, structural performance, and safety. During construction, this purpose will be met through the measurement of cofferdam movements, cofferdam saturation levels and foundation uplifts, slope movements, wall movements, and anchor loads. The readings will be compared to the values used in the stability analysis of each particular structure.

Performance of the completed project will be verified with a monitoring program which measures movements of the dam piers and existing lock walls.

(2) Monitoring During Construction

Cofferdam movements to be monitored include tilting, sliding, and settlement of individual cells and existing wall monoliths. Piezometric levels will be monitored within the coffer cells to define the saturation of the cell fill and uplift pressures below the cells. Movements of the proposed temporary tie back wall on the left bank will be monitored at a sufficient number of points to define the location of a developing failure surface. The loads on the tie back wall anchors will also be monitored throughout the construction period.

(3) Monitoring For Completed Project

Movements of the new dam piers and existing lock walls will be monitored periodically, while piezometric levels behind the landwall will be monitored on a regularly scheduled basis.

(4) Description of Proposed Instrumentation

Precise measurement of horizontal and vertical movements of the cofferdam will be monitored by reference points installed on each structural element relative to control monuments located off the structure. Inclinometer tubes will be installed to measure subsurface lateral movements on select coffer cell elements. Inclinometers will also be used to measure movements behind the temporary retaining wall during construction of the proposed abutment. Observation wells and piezometers will be installed in select coffer cells, monoliths, natural overburden, and rock, to measure saturation and hydrostatic uplift pressures for comparison against design values.

A preliminary instrumentation layout for all stages of dam construction is shown on PLATE 5-11. This layout was used for the purpose of estimating instrumentation quantities and costs, and will be revised in future studies to more accurately reflect the above stated criteria and objectives.

k. Disposal

(1) General

Excavation materials will consist of overburden and channel bottom soils, low quality rock and concrete rubble. These materials are suitable only as random fill. The quantity of fill material produced from the proposed project greatly exceeds the minimal quantities required, and must therefore be disposed of. Industrial and urban development along the riverbanks in this region have virtually eliminated tracts of land large enough for permanent on-site or local disposal; therefore off-site disposal areas were selected. The placement of random fill materials at these proposed disposal sites will require Earth Disturbance Permits issued by the Commonwealth of Pennsylvania. These permits are contingent upon approved Erosion and Sediment Control Plans, and require that each site comply with all regulations specified in the Commonwealth of Pennsylvania's Storm Water Management Act, Solid Waste Management Act, Floodplain Management Act, Dam Safety and Encroachment Act, and the Clean Streams Law, as amended. The disposal site capacity requirements were developed from the summation of the estimated excavation and concrete removal quantities from each project feature combined with a swell factor. The estimated excavation quantities, swell factors, and disposal site capacity requirements, are shown in Table 5-4.

(2) Criteria for Site Selection

Disposal of excess materials from the replacement of Dam 2, the dredging of Pool 3, and removal of Locks and Dam 3, requires the selection and development of economical disposal sites that are environmentally and socially acceptable to the region.

To avoid transportation of construction excavation and dredge materials on public roads, disposal sites were selected such that the barge unloading and staging facilities were accessible to the disposal sites using offroad haulage equipment.

Potential disposal sites meeting this criteria were further evaluated on the basis of site capacity requirements, available undeveloped real estate, and the anticipated impact on surrounding communities, businesses, and adjacent private properties.

From the 15 sites initially selected, 13 were rejected as being unfeasible from a socio-economic, operational, or environmental standpoint. The remaining sites which meet the above criteria are identified as follows:

Disposal Site	River Mile	Bank	Owner
1. Coursin Hill	21	Right	Private
2. Pangburn Hollow	25	Right	Corporate
3. Bunola Run	27	Right	Private
4. Victory Hollow	34	Left	Corporate

Although each site listed above varies in ownerships, land use, and size, the sites are considered comparable in overall scope and function, and adequate in overall logistics, capacity, development, operation, and material handling requirements.

The sites selected for inclusion in the recommended plan (Sites 1 and 3) were designed to a level of detail commensurate with that required for the feasibility Level MCACES Cost Estimate. Due to considerable social, environmental, economic, and design uncertainties associated with the selection and development of disposal sites at this level of study, the District considers those sites not developed in this report (Sites 2 and 4) to be alternatives. The utilization of these sites will be investigated in future studies to determine if social and economic impacts can be reduced while maintaining or decreasing the cost of the developed sites.

(3) Dam 2 Disposal Site

The site targeted for disposal of materials from excavation work at Dam 2 is located in the Coursin Hill area of Lincoln Borough in Allegheny County, Pennsylvania, approximately 8.6 miles upstream from the proposed project. Access will be provided by an off-highway haul road which will run from a proposed barge unloading and material staging facility at River Mile 19.8 to the proposed disposal site. Temporary acquisition and upgrades to an existing unimproved township road will be required in addition to the establishment of approved railroad and highway crossings. The proposed unloading facility, material staging area, haul road, and disposal area are shown on PLATE 5-12.

The proposed Coursin Hill disposal site is situated in the deep valley of a 340-acre drainage basin. The site is undeveloped and heavily vegetated, and contains a perennial stream which flows at the base of the deep "V" shaped valley. The valley walls range from stream bed elevation 720 to bluff elevation 1000 and are steeply to moderately sloped. Slopes range from 1V:4H near the bluff to 1V:2H near the stream channel. Localized variations in the topography include rock outcrops and drainage swales.

(4) Pool 3 Dredge Disposal Site

The site targeted for disposal of materials from the dredging of Pool 3 and the removal of Locks and Dam 3, is located in the Bunola Run area of Forward Township in Allegheny County, Pennsylvania. Access to the Bunola Run site will be provided by an off-highway haul road which will run from a proposed barge unloading and material staging area at River Mile 27 to the proposed disposal area. Temporary acquisition and upgrades to a township road will be required in addition to the establishment of approved railroad and highway crossings. The location of the proposed barge unloading facility, material staging area, haul road, and disposal area are shown on PLATE 5-13.

The Bunola Run Site is situated in the deep valley of a 540-acre drainage basin. The site is heavily vegetated and contains a perennial stream and small tributary which runs along the base of the deep, "V" shaped valley. The site is predominantly undeveloped, with the exception of a few private dwellings, an auto salvage yard, an abandoned stripmine highwall, and an abandoned drift mine entry. A township road runs through the valley, and provides access to these properties, as well as alternate access to several farms and residences located on the upland bluffs. The valley walls range from streambed elevation 730 to bluff elevation 1020, and are steep to moderately sloped. Slopes range from 1V:4H near the bluff to 1V:2H near the stream channel. Localized variations in the topography include rock outcrops and drainage swales.

(5) Description of Proposed Disposal Site Configurations

The proposed Coursin Hill and Bunola Run sites have similar topographic features, and both will be utilized for typical valley fills. A core of free draining materials will be placed in the valley bottom prior to fill placement, and the fill operation will proceed such that materials are placed in horizontal lifts to the proposed fill height. The disposal materials are contained within the "V" shaped valley walls with the exception of the exposed face, which will be sloped at 1V:10H to accommodate a haul road. Waste rock and concrete rubble layers placed within the fill will facilitate internal drainage.

Surface runoff from outside the disturbed areas will be diverted around the site in rock lined ditches located at the valley wall and disposal fill interface. The ditches will be reinstalled at 20 foot intervals as the disposal fill rises. Sediments from the disturbed areas will be contained on-site and controlled primarily with the use of silt fences. Other types of erosion and sediment controls will be utilized where necessary.

Upon completion of the projects the disturbed areas at both sites will be final graded with topsoil, seeded and mulched, and the sediment control facilities will be removed. The public roads at both sites will be reconstructed, under relocation contracts with the respective owners.

l. Future Investigations

(1) General

The project features described above and corresponding quantity estimates will be developed in all future studies using designs which are supported by engineering analysis. Future investigations include, but are not limited to, the collection of project data described below.

(2) Mapping

1:600 Scale topographic maps of the project site and disposal area will be required. Recently acquired river soundings will be incorporated into the topographic maps for the development of accurate and detailed project plans. These plans will be used for illustrating project features and estimating earthwork quantities.

(3) Subsurface Investigations

(a) Soils

Additional subsurface investigations will be required to supplement previous investigations. Disturbed and undisturbed soil sampling and testing are required at specific site locations for determination of soil classification, gradation, water contents, plasticity, shear strength, and permeability. Specific site locations include the area of the proposed abutment, the soils landward of the existing esplanade wall, and the soils within the channel bottom.

(b) Rock

Because there has been very limited subsurface investigation along the axis of the proposed dam, a complete exploratory drilling and testing program consisting of two phases as described below will be undertaken. Time constraints may require some of the work described to be done concurrently, with the results combined into one report.

(1) Objectives of the first phase, which would be completed using NXM diameter borings, will be as follows:

Define the top of rock and the top of firm rock elevations along the axis of the proposed dam.

Prepare a complete geologic section along the dam axis and abutment describing and correlating the types of soil and rock encountered.

Determine the presence of any unusual or detrimental conditions that would require further investigation.

(2) The second phase of the investigation program , which would be accomplished primarily with larger diameter (4 inch) borings, would include the following:

Perform additional drilling to provide data for the development of geologic sections at intervals across the dam and abutment.

Investigate in detail problem areas that were discovered in the initial phase.

Obtain and test a sufficient number of rock core samples to determine the shear strength and bearing capacity of the various strata encountered in the foundation of the dam and abutment.

(4) Disposal Sites

During the public review process considerable local public opposition to the Coursin Hill and Bunola sites was expressed. Future studies of alternative sites will be made to determine if social and environmental impacts can be reduced while maintaining or decreasing the cost of the targeted sites.

Section II. Lock 4 Reconstruction

a. Background

(1) Site Description

Locks and Dam No. 4 is located on the Monongahela River at River Mile 41.5. The existing structure consists of two lock chambers on the right bank and a non-navigable, high lift, gated dam which extends to the left bank. The lock riverwall and the gated dam are connected by a fixed weir section approximately 43 feet in length. Reconstruction of the dam was completed 6 June 1967, and provides a gated crest which raises Pool 4 to normal pool elevation 743.5.

(2) Proposed Project

The proposed project consists of replacing the existing lock chambers with two larger chambers, and performing remedial work on other existing project features which are affected by the new design. The proposed landwall will be constructed in the same location as the existing wall, with the middlewall and riverwall being shifted riverward to accommodate the larger sized chambers. The proposed riverwall will tie into the stub riverwall section near Dam Pier No. 1. This stub wall was constructed during the reconstruction of the dam in anticipation of the eventual lock replacement. Construction of the proposed locks will be completed in a two stage sequence to allow for uninterrupted navigation. A plan view of the project site features including the existing and proposed lock chambers are shown in the Project Design Section of the Engineering Appendix on PLATES 9 and 12, respectively.

b. Subsurface Investigations

(1) Drilling

(a) General

No subsurface investigations were undertaken for this study. The information from previous studies described below has been compiled and used for the preparation of this report. PLATE 5-14 is an overall boring plan of the site showing all the locations of borings from previous subsurface exploration programs. The borings are organized into five groups by date of drilling as listed below:

Borings 1 to 62	1930
'A', 'C' and 'D' Series Borings	1961
'T' Series Borings	1963
'R' Series Borings	1979
Borings FL-1, L-CH-1, S-CH-1	1985

(b) Construction of Existing Lock- 1930

Prior to construction of the present Locks and Dam 4, the site was investigated in 1930. A total of 62 core borings were drilled. Records of these borings lack information on the drilling methods, the diameter of the borings or their exact location. The only information available is in the original driller's boring logs which show only limited soil and rock descriptions. The available information on the location of these borings is an early 1"=100' scale boring plan. This plan was overlaid on the more recent mapping to present the boring locations as shown on PLATE 5-14. Because of this limited information, there may be a considerable margin of error in the locations shown. The borings from this investigation were used to estimate top of rock and correlate subsurface data, and supplement the more detailed 1961 subsurface investigation.

(c) Dam Reconstruction- 1961 and 1963

The purpose of this study was to investigate the subsurface conditions for the replacement of the old dam. Work was therefore concentrated around the dam and abutment. Twenty-one standard penetration and 3" diameter core borings were advanced for a total of 1459.6 linear feet to define subsurface soil and rock conditions for construction of the present gated dam. A total of 850.6 feet of soil was sampled by Standard Penetration Tests (SPT) with undisturbed samples being obtained from Boring A-7 near the abutment. The SPT samples were classified in accordance with the Unified Classification System of U.S. Army Corps of Engineers, Engineering Manual EM 1110-1-1806, dated 9 November 1959.

Borings D-1 through D-8 were advanced through overburden and rock along the axis of the dam, and were used to define foundation conditions for the dam piers. Borings A-1 through A-6 define the subsurface conditions of the abutment, and boring A-7 provided undisturbed samples from the left bank. These undisturbed samples were tested at the Ohio River Division Laboratory and provided results that were used to analyze the stability of the abutment slopes. Borings C-1 through C-6 were advanced through soil and rock to determine the insitu soil and rock conditions behind the landwall in anticipation of future lock construction. The boring locations from the 1961 investigation are shown in plan on PLATE 5-14.

In 1963 five standard penetration and 3" diameter core borings were advanced a total of 281.6 feet using the same procedures and classification system used in the 1961 investigation. Borings T-1 through T-5 were advanced a total of 227.4 feet through soil and were used to determine the foundation conditions of the pile supported access tower. The boring locations are shown in plan on PLATE 5-14.

(d) Waterways Experiment Station Condition Survey - 1985

In 1985 the Waterways Experiment Station (WES) conducted an in-depth project condition survey, concentrating on the condition of the concrete in the existing structure. Three borings, L-CH-1, S-CH-1 and FL-1, were drilled a significant depth into rock and some rock strength testing, described in Section 5.b.(2), was accomplished. Borings L-CH-1 and S-CH-1 were 4" diameter core borings and boring FL-1 was a 6" diameter boring.

(e) Access Road Investigation - 1979

A series of 8 borings (R-1 through R-8) were drilled for the design of a new access road to the lock. The borings, which were advanced by SPT sampling and NXM coring, were relatively shallow and provide limited information on the bedrock conditions.

(2) Testing

A limited amount of rock strength testing was completed as part of the WES Condition Survey in 1985. A total of 16 samples from two borings were tested. The results were grouped by rock type and four failure envelopes were developed. Table 5-3 is a summary of the test results modified from the original table to show stratigraphic unit designations. PLATES 5-15 and 5-16 are graphs of the shear stress vs. normal stress failure envelopes from the WES report.

Unconfined compressive strength tests were attempted on a few rock samples from these borings. Because the fractured state of the specimens resulted in highly variable and unreliable readings the results are not included in this report.

c. General Site Conditions

(1) Topography

The project is located in a narrow floodplain along the right bank of the Monongahela River near River Mile 41.5. The site is situated on a relatively straight section of the river approximately one-half mile upstream from a right bend meander. The floodplain terrace on the right bank, with nominal surface elevation 800 feet above mean sea level, is narrowest at the upstream project limit, and gradually widens to a broad floodplain terrace about 1000 feet wide approximately one mile downstream. The floodplain terrace of the left bank, with nominal surface elevation 780, extends from River Mile 41 to River Mile 42.5. Its center section is approximately 1000 feet wide with both ends pinching out against the valley wall.

The proposed lock reconstruction on the right bank is bordered by an adjacent multi-track railroad and siding yard owned by the Pittsburgh and Lake Erie Railroad, and by Pennsylvania State Highway 906. Adjacent to the highway is a steep valley wall extending from approximate roadway elevation 800 to top of bluff elevation 1140. The general topography of the area is shown on PLATE 5-17.

(2) General Geology

The project is located within the Kanawha Section of the Appalachian Plateau Physiographic Province and is characterized by a thick sequence of cyclically deposited sedimentary rocks that are nearly flat-lying and parallel, with on overall regional dip to the southwest. The site is located on the western flank of the Belle Vernon anticline which trends northeast to southwest, plunging to the southwest. The approximate location of the Belle Vernon anticline is shown on PLATE 5-17. Local dip of rock units underlying the site is approximately 17 feet per 1000 feet to the southeast.

Bedrock consists of essentially flat-lying, interbedded sedimentary rock, chiefly soft claystone, siltstone, sandstone, clay shale, silt shale and some thin limestones, all of which were deposited during the Pennsylvanian Age and are members of the middle Conemaugh Group. The Ames Limestone Member, which occurs around elevation 675 at the site, is a significant marker bed dividing the Casselman Formation (upper Conemaugh Group) from the Glenshaw Formation (lower Conemaugh Group).

The bedrock at the Lock and Dam 4 site is slightly higher, stratigraphically, than the rock at the Lock and Dam 2 site. The Dam 2 site is part of the upper Glenshaw Group.

(3) Soils

Soils of the floodplain are interbedded and lensed deposits of normally consolidated colluvial and alluvial materials derived from the weathered and eroded parent materials of the adjacent valley walls and upper Monongahela River Basin. The floodplain at the site has been raised by the placement of a sandy clay fill for railroad grade adjustments and industrial development. Soils in the channel bottom generally consist of silty sands and gravels, which also underlie deep deposits of interbedded clays and silts on the floodplains. A more thorough description of insitu soils is presented in Section 5.e.

d. Project Foundation Conditions

(1) Site Stratigraphy

The thick red and gray claystones of the Pittsburgh Red Beds are the predominant rock strata occurring under the site. This strata is described in the existing boring logs as a soft to moderately hard indurated clay or clay shale. The Ames Limestone, a gray, hard, fossilferous limestone separates the two major claystone seams. At the base of the lower claystone seam is a hard gray siltstone which is part of the Saltsburg Sandstone Formation. PLATE 5-18 is a generalized geologic column in which the rock layers have been assigned unit numbers to aid in correlation across the site. The bedrock units appear to be continuous over the site, except where they have been eroded. The Unit 5 coal is the only exception. It appears in only three borings under the landwall (See Section N-N, PLATE 5-22).

(2) Site Structural Geology

Based on the available borings and information material, the foundation strata appear to be dipping slightly from the downstream to the upstream end of the project. The limited extent of the Unit 5 coal noted above may indicate some variation in depositional patterns that will be investigated in future studies.

(3) Description of Foundation Conditions

(a) General

The conditions discussed below are shown on profiles and sections on PLATES 5-19 through 5-23. Section K-K (PLATE 5-19) is a profile along the proposed landwall, Section L-L (PLATE 5-20) is a profile along the proposed middlewall. Section N-N (PLATE 5-22) is a cross section of the new locks at the axis of the existing dam. Section M-M (PLATE 5-21) is an upstream cross section and Section P-P (PLATE 5-23) is a downstream cross section.

(b) Riverwall and Landwall

The proposed landwall and riverwall are gravity structures founded on the Unit 7 (Ames) limestone which is shown as 'Upper Firm Rock' on Section N-N (PLATE 5-22). The riverwall will be built as an extension of the stub wall that was constructed with Pier No. 1 during the dam reconstruction. This stub wall and the piers of the existing dam are also founded on this strata. Underlying Unit 7 is a thick bed of indurated clay/claystone (Unit 8) which is the lower part of the Pittsburgh Red Beds strata. The limited strength testing available from the WES report shows a significant variation in residual shear strength between the two failure envelopes developed for this unit. Future investigations may show a need to differentiate parts of this bed into separate units.

(c) Middlewall

The proposed middlewall will be founded on caissons bearing on the Unit 9 siltstone shown as 'Approximate Top of Lower Firm Rock' on the sections. The new middlewall will be constructed in this manner to avoid extensive excavation next to the existing middlewall which will be used as part of the cofferdam for construction of the new middlewall. Stratigraphically, Unit 9 is part of the Upper Saltsburg Sandstone which is generally 15 to 20 feet thick.

(4) Seismic Conditions

ER 1110-2-1806 Earthquake Design and Analysis for Corps of Engineers Projects, dated 16 May 1983, indicates the entire study area to be located in Zone 1 on the seismic zone map. There are no active or inactive faults in the project area and the site is located over 300 kilometers from any seismic zone. There have been no earthquakes reported in the project area. Analysis by the seismic coefficient method will be used to determine the sliding and overturning stability of the structure, assuming a seismic coefficient of five percent of the force of gravity.

(5) Design Assumptions

In order to proceed with the design calculations needed for this study, some rock strength information was needed well in advance of the completion of the study. After a brief review of the information available, recommendations as to founding elevations and bearing capacity were made. Founding elevations of 680 for the landwall and riverwalls and 650 for the middlewall with a conservative minimum bearing capacity of 100 ksf were recommended. The proportions of the proposed structure were based on the design of similiar structures in the past so design friction and cohesion strength parameters were not needed for this report. Strength parameters for more detailed analysis will be developed from existing data and additional sampling and testing.

e. Description of Soils

(1) Right Bank

Overburden on the right bank floodplain ranges in depth from approximately 20 feet near the valley wall to 45 feet near the esplanade. Borings C-1 through C-3 where advanced on the riverward side of State Route 906 and indicate that the overburden consists of colluvial deposits of lean clays, gravelly clays, and sandy clays. The clays are brown in color, and are generally wetter than the plastic limit. Blow counts within the clays do not indicate any soft or extremely wet zones, and the gravel portion of the clay increases with depth.

Borings C-4 through C-6 were advanced adjacent to the esplanade wall, and indicate that the upper layer of material is a random fill consisting of slag, red dog, and concrete rubble. These materials are of poorer quality than the granular fill found in borings adjacent to the landwall, and represent the random backfill materials placed above the cut slope after construction of the existing landwall. Soils below the fill material are layered deposits of brown or gray sandy clay or silty clay, overlying a clayey or silty gravel. Standard penetration tests indicate that the soils are of uniform consistency, with the exception of an isolated zone of soft brown silt in Boring C-6.

Borings T-1 through T-4 were drilled behind the landwall. The granular backfill materials consist of compact silty sands, and silty sandy gravels and overlie the natural soils below the original construction cut slope.

Soil profiles and cross sections showing the subsurface conditions of the right bank are shown on PLATES 5-21 to 5-23. No undisturbed soil samples were taken in this area.

(2) Channel

Overburden in the river channel ranges from 35 to 45 feet in depth, and is alluvial in origin. The soils are defined by two distinct zones, with the top zone consisting of layered and lensed deposits of medium dense to dense, brown gravelly silty sands to depths of approximately 20 feet. These materials overlie a variable deposit of compact gray clayey gravels, and silty gravels. Profiles and cross sections showing the subsurface conditions of the channel bottom are presented on PLATE 5-22.

(3) Left Bank

Overburden in the abutment area and left bank floodplain ranges in depth from 30 to 60 feet respectively, as indicated by borings A-1 through A-7. The natural soils are alluvial in origin, with the overburden being defined by four distinct zones.

Red dog, glass fragments, and cinder fill materials make up the top zone of material, and overlie lensed and layered deposits of brown silty clay and gray sandy silt. The fine grained soils are of uniform consistency, with the exception of the gray sandy silt layers which exhibit lower blow counts. The third and fourth zones are essentially the same as those in the river, a gravelly silty sand overlying a compact clayey gravel.

Undisturbed Shelby tube samples obtained from Boring A-7 during the 1961 investigation were subjected to unconfined compression tests, direct shear S-Tests, and triaxial Q-Tests at the Ohio River Division Laboratory. No attempt was made to correlate shear strength results from the left bank soils with those of the right bank.

f. Construction and Excavation Sequence

(1) Construction Stage 1

The two proposed lock chambers will be constructed separately in a two stage sequence to allow for uninterrupted navigation. Stage 1 of the construction operation will be the construction of a new river chamber within a coffered excavation, with the existing middlewall being used as the main section of the cofferdam. Steel sheet pile cells driven to rock will make up the arms of the cofferdam, extending from the upstream and downstream ends of the wall and tying into Gate Bay 1 of the dam. The proposed Stage 1 cofferdam is shown in the Construction Procedure and Water Control Plan Section of the Engineering Appendix on PLATE 7-2. Upon completion and dewatering of the cofferdam, the proposed middlewall will be constructed within the existing river chamber. The foundation of the existing middlewall is supported on timber piles. The use of this wall as a cofferdam, combined with the limited distance to the excavation limits of the proposed wall, requires that it be temporarily supported during construction. The existing middlewall will therefore be strutted to the existing riverwall, and excavation near the existing middlewall will be minimized by constructing the proposed middlewall on drilled concrete caissons founded on firm rock. Upon completion of the new middlewall, the existing riverwall will be removed and the proposed riverwall will be constructed riverward of the original location. The proposed riverwall will be founded on firm rock, and tie into the monoliths which support dam Pier No. 1. Typical sections showing the existing and proposed wall sections and founding elevations are shown on PLATES 5-19 through 5-23.

(2) Construction Stage 2

Stage 2 of the proposed construction sequence will be completed within a similar coffered excavation. The proposed middlewall constructed during Stage 1 will be used as the riverward section of the Stage 2 cofferdam. Steel sheet pile cells driven to rock will make up the arms of the cofferdam, extending from the upstream and downstream ends of the new middlewall and tying into the right bank as shown in plan on PLATE 7-3 in the Construction Procedure and Water Control Plan Section of the Engineering Appendix. Upon completion and dewatering of the cofferdam, the existing middlewall and landwall will be removed and the proposed landwall will be constructed.

(3) Construction Excavations

The excavation of overburden and rock for construction of the proposed locks will be performed within dewatered cofferdams. Rock excavation and removal of the existing concrete walls and chamber floor will require line drilling and controlled blasting prior to excavation. It is anticipated that the soil, rock, and broken concrete will be handled by in-pit backhoes in tandem with a crane mounted clamshell working from on top of the cells. The clamshell will transfer the excavated material to barges, and the material will be transported to an off-site disposal area.

A summary of excavation quantities for the proposed work is shown in Table 5-4.

(4) Approach Excavations and Dredging

The railroad tracks located near the top of bank along the upper approach provide limited space and access for construction equipment. Excavation for the proposed lock approach protection will therefore be performed by a crane-mounted clamshell working from a floating plant. Excavation upstream of the dam for a proposed pilot channel on the left bank and within the river bottom will also require floating plant operations due to the width and depth of the pilot channel limits. Overburden depths in these areas average 35 feet, and no rock excavation is anticipated. Excavation for the lower approach protection and channel dredging will be performed in a similar manner, with the dredge materials from both proposed work areas being loaded onto barges and transported to an off-site unloading facility.

g. Preliminary Slope Design

(1) Design Considerations

Past exploration programs did not include undisturbed sampling and testing on the right bank, and therefore slope design was limited to engineering judgment based on the natural slopes and District experience with other projects on the Monongahela River.

(2) Construction

During Stage 2 of the proposed construction sequence, excavation behind the existing landwall is limited by the location of the railroad tracks adjacent to the esplanade. The depth of overburden and limited clearance will require construction of a temporary wall capable of supporting lateral loads from over 45 feet of overburden and surcharge loadings from the adjacent railroad.

(3) Approach Slopes

The proposed widening of the land chamber requires modification of the existing approach alignments to accommodate the larger tows. Although riverbank excavation will be minimal, the upper and lower right bank approaches will require the placement of a granular filter and graded stone riprap to protect the riverbanks from prop-wash and scour. Excavation at the toe of the slope will be required for placement of a recessed graded stone toe. End protection at the upstream and downstream protection limits will be included to prevent the revetment from being outflanked by bank loss. No problems are anticipated with the placement of stone protection on uniform slopes flatter than 1V:2.5H; however due to the close proximity of the railroad and the limited contractor's work area in this reach, stone placement will be accomplished from a floating plant.

The existing slopes within the upper approach vary from 1 vertical on 2 horizontal near the top of bank to 1 vertical on 5 horizontal below pool level, with a typical slope height of 40 feet. The alignment of the upper approach in relation to the existing riverbank allows the approach slopes to be uniformly graded at 1 vertical on 3 horizontal by placing compacted granular fill at the toe and on the existing slope face.

The lower approach bottom elevation will be excavated approximately 4 feet to elevation 714.9 to accommodate the proposed drop in pool after Locks and Dam 3 have been removed. The existing slopes within the lower approach vary from 1 vertical on 2 horizontal at the top of slope to 1 vertical on 3 horizontal at pool level. The alignment of the lower approach in relation to the existing riverbanks allows for placement of granular fill on the natural bank to achieve uniform slopes. The proposed approach slopes range from 1 vertical on 3.5 horizontal near the lock chamber, to 1 vertical on 2.5 horizontal near the downstream protection limit.

Typical slopes and stone protection details for the upstream and downstream approaches are shown on PLATE 5-24.

h. Bank and Scour Protection

(1) General

Graded stone riprap will be used to protect critical areas prone to bank losses or scour resulting from the altered conditions of the proposed project, and will be purchased from an approved source. Layer thicknesses and protection limits have been selected based on past experience with other District projects along the Monongahela River. Final designs will meet the criteria of EM 1110-2-1601.

Although the soils on the approach slopes are highly variable, they are predominantly fine grained. Because there is a large difference in size between the soils and the riprap, a multi-layered granular filter will be required to meet soil retention and drainage criteria in areas where compacted granular fill is not placed. The use of bedding material and filter fabric in lieu of a granular filter is generally more cost effective and easier to place, and its use will be investigated in future studies.

(2) Riverbanks

The proposed upper and lower approaches will require protection due to the increase in propwash anticipated from the larger tows and improved approach alignment. The proposed stone protection on the upper approach will extend upstream from the end of the landwall to Station 40+00A, while the proposed protection for the lower approach will extend downstream from the end of the landwall to the State Highway bridge at Station 21+00B. The limits of protection are conservative estimates and the actual limits will be determined after a hydraulic model study has been performed.

A proposed pilot channel on the left bank will also require protection based on the erodibility of the fine grained soils exposed on the slopes, and the near bank velocities determined from the 1966 WES Model Study Report. This reach is primarily affected by flood flow currents and therefore the stone riprap layer thickness is less than that used on the right bank.

(3) Dam

The area immediately downstream of the dam stilling basin near Pier 2 has been scoured. Diver's inspections and soundings indicate that the derrick stones have been displaced or removed in some areas, exposing the sheetpile of the dam apron. Protection is assumed necessary across the entire length of the dam since the downstream pool will be lowered after removal of Locks and Dam 3. The proposed repair and protection of this area consists of dredging a uniform 1 vertical on 3 horizontal slope from the end sill of the stilling basin, and placing concrete filled bags above a granular bedding material. Typical sections showing the existing conditions and proposed typical scour protection detail are shown on PLATE 5-25. Actual protection methods and placement limits will be determined in future studies after a hydraulic model study has been conducted.

i. Drainage and Seepage

(1) Surface Drainage

Surface drainage landward of the project site will not affect construction of the proposed riverwall and middlewall during Stage 1. All drainage will be diverted around the excavation during the proposed construction of the landwall by means of berms and ditches.

(2) Underseepage

The sheetpile cells of the cofferdam will be driven to top of rock, and seepage through the cells is expected to be minimal. The existing middlewall which makes up the main section of the Stage 1 cofferdam is supported on timber piles and will require the installation of a steel sheetpile cutoff adjacent to the wall on the riverward side prior to dewatering. Seepage from the underlying rock strata is expected to be minimal due to the low permeability of the upper clay and clay shale units. Future exploration work and pressure tests will be performed to confirm this.

(3) Dewatering

Seepage through the sheetpile interlocks, monolith joints, and discontinuities in the underlying rock strata will be discharged from the coffered work area by a system of diversion channels, sumps, and pumps. The contractor will be required to design and install a dewatering system to do the work in the dry.

j. Instrumentation

(1) Purpose of Instrumentation

The monitoring program is needed to verify design assumptions, structural performance, and safety. During construction, this purpose will be met through the measurement of cofferdam movements, cofferdam saturation levels and foundation uplifts, slope movements, wall movements, and anchor loads. The readings will be compared to the values used in the stability analysis of each particular structure.

Performance of the completed project will be verified with a monitoring program which measures movements of the existing lock walls and existing dam, and uplift and saturation behind the new landwall.

(2) Monitoring During Construction

Cofferdam movements to be monitored include tilting, sliding, and settlement of individual cells and existing wall monoliths. Piezometric levels will be monitored below and within the coffer cells to define saturation of the cell fill and uplifts in the foundation. Movements of the temporary tie back wall behind the proposed landwall will be measured at a sufficient number of points to define the location of a developing failure surface. The load cells on the tie back wall anchors will also be monitored.

(3) Monitoring For Completed Project

Movements of the new lock wall monoliths and existing dam piers will be monitored periodically, while piezometric levels behind the landwall and uplift pressures in the foundation of the landwall will be monitored on a regularly scheduled basis.

(4) Description of Proposed Instrumentation

Precise measurement of horizontal and vertical movements will be monitored by reference points installed on each structural element relative to control monuments located off the structure. Portable tiltmeters will be used to monitor tilting of the existing middlewall monoliths during construction Stage 1, and the proposed middlewall monoliths during Stage 2. Tiltplates will also be installed and monitored on the temporary retaining wall behind the landwall. Shear strips will be installed across all monolith joints on the existing and proposed middlewalls when they are being utilized as cofferdam sections to measure relative movements. Inclinometer tubes will be installed to measure subsurface lateral movements on each of the cofferdam wall monoliths, and on select coffer cell elements. Inclinometers will also be used to measure movements behind the temporary retaining wall during Stage 2 construction, and document existing conditions along the riverbanks where excavation at the toe is proposed near the railroad surcharges at the top of slope. Observation wells and piezometers will be installed in select coffer cells, monoliths, and natural overburden to measure saturation and hydrostatic uplift pressures for comparison against design values.

The instrumentation layout for both stages of construction is shown on PLATES 5-26 and 5-27. This layout was used for the purpose of estimating instrumentation quantities and costs, and will be revised in future studies to more accurately reflect the above stated criteria and objectives.

k. Disposal

(1) General

Excavation materials will consist of overburden and channel bottom soils, low quality rock and concrete rubble. These materials are considered non-hazardous and are suitable only as random fill. The quantity of fill material produced from the proposed project greatly exceeds the minimal quantities required, and must therefore be disposed of. Industrial and urban development along the riverbanks in this region have virtually eliminated tracts of land large enough for permanent on-site or local disposal, therefore off-site disposal areas were selected. The placement of random fill materials at the proposed disposal site will require an Earth Disturbance Permit issued by the Commonwealth of Pennsylvania. This permit is contingent upon an approved Erosion and Sediment Control Plan, and requires that the site comply with all regulations specified in the Commonwealth of Pennsylvania's Storm Water Management Act, Floodplain Management Act, Dam Safety and Encroachment Act, and the Clean Streams Law (Chapter 102), as amended.

(2) Criteria for Site Selection

The disposal area was selected on the basis of available real estate, anticipated material haulage techniques, and site access. As described in Section 5.f, the materials excavated from the work areas will be loaded onto barges and transported to an unloading facility. To reduce additional material handling requirements, the proposed unloading facility was selected adjacent to an undeveloped tract of land large enough to contain the fill. The disposal site capacity requirements were developed from the summation of the estimated excavation and concrete removal quantities from each project feature combined with a swell factor. The estimated excavation quantities, swell factors, and disposal site capacity requirements are shown in Table 5-4.

(3) Potential Disposal Sites

The site selected for disposal of Lock 4 excavation materials is located along the left bank of the Monongahela River at Dunlevy, PA, approximately 3.5 river miles upstream from the Lock 4 project. This site is located within a wide section of an undeveloped floodplain, and is accessible from the river. Disposal of the surplus random fill materials at the Dunlevy Site can be accomplished by placing the fill on the existing floodplain terrace. The estimated quantity of the Lock 4 disposal fill will raise the existing ground elevation by approximately ten feet. The proposed site location, unloading facility, disposal site configuration, and limits of fill placement, are shown on PLATE 5-28. Due to environmental concerns at this site, an alternative site will be required.

One alternative site chosen for Lock 4 disposal is located on the right bank of the Monongahela River at Bunola, PA, approximately 14.5 river miles downstream from the proposed project site. This site is described in detail in the Dam 2 replacement portion of the Geotechnical Section. Although this alternative site is targeted primarily for the disposal of dredge material from the proposed lowering of Pool 3, it possesses ample additional capacity to accommodate the Lock 4 material. The Pangburn and Victory Hollow sites are also potential alternatives.

l. Future Investigations

(1) General

The project features described above and corresponding quantity estimates will be refined in future studies using designs which are supported by engineering analysis. Future investigations include, but are not limited to, the collection of project data described below.

(2) Mapping

1:600 Scale topographic maps of the project site and disposal area will be required. Recently acquired river soundings will be incorporated into the topographic maps for the development of accurate and detailed project plans. These plans will be used for illustrating project features and estimating earthwork quantities.

(3) Subsurface Investigations

(a) Soils

Additional subsurface investigations will be required to supplement previous investigations. Disturbed and undisturbed soil sampling and testing are required at specific site locations for determination of soil classification, gradation, water contents, plasticity, shear strength, and permeability. Specific site locations include the area behind the landwall, the lock approaches, the overburden supporting the pile foundation of the existing lock walls, and the left bank and channel bottom within the proposed upstream pilot channel.

(b) Rock

While the plates and figures in this report appear to present a considerable amount of information on the subsurface conditions at the site, none of the studies were specific to the proposed project. A complete program of drilling and testing related to the specific features of the project will be necessary. Areas of concern that will be addressed are described below.

1. Site Stratigraphy

Although the stratigraphy at the site appears relatively simple, future drilling and testing programs will be necessary to provide sufficient information to accurately identify and characterize the various rock lithologies existing under the entire site. In particular, detailed information is required on the thickness, lateral distribution and engineering characteristics of Unit 7 (Ames Limestone) and the Unit 9 siltstone because these are the founding strata for the landwall and riverwall and for the middlewall caissons, respectively.

2. Existing Foundation Conditions

Because the existing middlewall will be used as part of the Stage 1 cofferdam, determination of the conditions and rock strengths under the existing middlewall will be critical to the cofferdam design. Other areas of concern are:

The condition of the existing concrete. The WES report may provide sufficient information in this area.

The condition of the rock under the structure and behind the existing landwall. Angle borings may be required to obtain some of this information. The testing program will provide necessary data for design of tieback anchors.

Section III. Effects on Groundwater

The proposed construction will result in rise in pool levels from River Mile 11.2 to 23.8 with a subsequent rise in groundwater levels. The greatest effect on groundwater will be in the permeable alluvial soils adjacent to the river. Water supplied from sources originating in the alluvium could possibly exhibit a reduction in quality due to increased migration of river water into the aquifer. From River Mile 23.8 to 41.5 the proposed lowering of the pool by three feet will cause a decrease in water levels in local wells due to less recharge. As noted above the greatest effect will be on the alluvial deposits adjacent to the channel. The lowered water table will only affect pumping wells which are already near the limits of capacity or wells in which the pump is placed too high in the aquifer. A cursory groundwater impact study was completed by the Nashville District in conjunction with representatives of the Pittsburgh District and the Pennsylvania Department of Environmental Resources. The Nashville study concluded that groundwater fluctuations caused by changes in pool elevation are not expected to greatly impact conditions at HTRW sites within the project area.

LOWER MONONGAHELA L&D #2
RESULTS OF LABORATORY ROCK TESTING

	BORING	ELEVATION	ROCK TYPE	NORMAL STRESS (psi)	PEAK STRESS (psi)	RESIDUAL STRESS (psi)
			Direct Shears with Sliding Friction			
Unit 8	D2/S- 2	665.9-665.0	Claystone	40	266.1	34.2
Unit 8	D2/S- 3	665.0-664.4	Claystone	80	167.8	54.0
Unit 8	D3/S- 3	659.2-658.6	Claystone	120	392.6	113.9
Unit 8	D2/S- 5	663.0-662.5	*Sample Failed Prior to Testing*			
Unit 8	D2/S- 6	661.4-660.9	Claystone	60	67.0	48.5
Unit 8	D3/S- 1	660.7-660.5	Claystone	90	131.0	73.3
Unit 8	D3/S- 2	660.5-660.0	Claystone	120	127.2	68.8
Unit 9	D2/S- 7	657.8-656.9	Siltstone	30	407.7	32.7
Unit 9	D2/S-8A	656.9-655.9	Siltstone	60	485.9	93.6
Unit 9	D2/S-8B	656.9-655.9	Siltstone	90	458.6	86.5
Unit 9	D2/S-9A	655.1-654.1	Siltstone	120	426.8	154.9
Unit 9	D2/S-9B	655.1-654.1	Siltstone	30	269.4	39.5
Unit 9	D2/S-10	651.4-650.9	*Sample Failed Prior to Testing*			
Unit 9	D3/S-4A	658.1-657.1	Siltstone	30	326.1	26.2
Unit 9	D3/S-4B	658.1-657.1	Siltstone	60	494.8	63.9
Unit 9	D3/S-5A	657.1-656.1	Siltstone	90	422.7	89.6
Unit 9	D3/S-5B	657.1-656.1	Siltstone	120	458.1	106.5
Unit 9	D3/S-6A	656.1-655.0	Siltstone	90	433.9	71.3
Unit 9	D3/S-6B	656.1-655.0	Siltstone	120	502.2	ND*

	BORING	ELEVATION	ROCK TYPE	NORMAL STRESS (psi)	PEAK SHEAR STRESS (psi)	RESID. SHEAR STRESS (psi)	ANGLE OF SLIDING FRICTION	C (PSI)
				Three-Stage Direct Shears				
Unit 8	D2/S-1	666.9-666.4	Claystone	40	ND*	16.6	8.12	12.1
Unit 8	D2/S-1	666.9-666.4	Claystone	80		24.9		
Unit 8	D2/S-1	666.9-666.4	Claystone	120		29.6		
Unit 8	D2/S-4	664.4-663.7	Claystone	40		34.5		
Unit 8	D2/S-4	664.4-663.7	Claystone	80	105.8	57.0	33.0	7.5
Unit 8	D2/S-4	664.4-663.7	Claystone	120		86.5		

*ND - Not Determined

TABLE 5-1

Lower Monongahela L&D #2

Unconfined Compression Tests

Boring/ Sample	Elevation	Geologic Unit	Compressive Strength (psi)	Moisture Content %	Unit Wt (pcf)*	E**
D1-S-2	660.6-660.1	Claystone	1250	4.3	156.3	$.06x10^6$
D1-S-3	659.5-658.9	Claystone	988	3.9	156.3	$.06x10^6$
D1-S-1	668.6-668.1	Siltstone	4216	0.9	162.5	
D1-S-4A	655.9-654.7	Siltstone	3221	1.4	165.3	
D1-S-4B	655.9-654.7	Siltstone	2885	1.4		
D1-S-5	654.0-653.3	Siltstone	2847	1.9	162.1	
D1-S-6	653.3-652.7	Siltstone	3045	2.0		
D1-S-7	651.8-651.2	Siltstone	3704	2.0	162.9	
D1-S-8	651.2-650.5	Siltstone	4064	1.8		
D1-S-9	650.4-649.7	Siltstone	4539	1.7		

LOWER MONONGAHELA - COMPRESSIVE STRENGTHS

*pcf - pounds per cubic foot
**E - Elastic Modulus (PSI)

TABLE 5-2

TABLE 5-3

SUMMARY DIRECT SHEAR TEST RESULTS
CONDITION SURVEY OF LOCKS AND DAM NO. 4

Rock Unit	Rock type and Type of Test	Boring No.	Elevation Top	Bottom	Normal Stress tsf	Peak Shear Stress tsf	Peak Shear Strength	Residual Shear Stress tsf	Residual Shear Strength
6	Mod-Hard	S-CH-1	682.4	682.1	3.6	10.0		2.0	
6	Gray Shale	S-CH-1	681.9	681.7	7.2	27.6	$\phi_p = 59^\circ$	3.7	$\phi_r = 15.5$
8	INTACT	F-1	653.5	653.0	7.2	23.1	$c^p = 8.4$ tsf	3.8	$c^r = 0$ tsf
6		S-CH-1	681.3	681.0	10.8	22.3		4.0	
9	Hard Gray Shale	FL-1	648.4	648.0	3.6	15.9		1.1	
9	INTACT	FL-1	648.0	647.7	7.2	30.1	$\phi_p = 69^\circ$	5.6	$\phi_r = 39$
9		FL-1	648.8	648.4	10.8	34.8	$c^p = 8$ tsf	7.0	$c^r = 8$ tsf
8	Hard Gray Shale	FL-1	662.7	662.3	3.6	10.3		2.0	
8	Red Shale	FL-1	662.2	661.8	7.2	16.1	$\phi^p = 53^\circ$	2.8	$\phi_r = 15.5$
8	INTACT	FL-1	661.7	661.3	10.8	20.0	$c^p = 5.8$ tsf	4.0	$c^r = 0$ tsf
6	Mod-Hard	FL-1	682.6	682.3	3.6	7.1		2.1	
8	Red Shale	FL-1	671.3	671.0	3.6	11.6		2.0	
8	INTACT	FL-1	663.6	663.3	3.6	10.1	$\phi^p = 59^\circ$	2.0	$\phi_r = 25.9$
8		FL-1	668.7	668.3	7.2	16.9	$c^p = 4$ tsf	4.0	$c^r = 0$ tsf
8		FL-1	668.0	667.6	7.2	19.9		3.7	
8		FL-1	666.6	666.2	10.8	20.7		5.5	

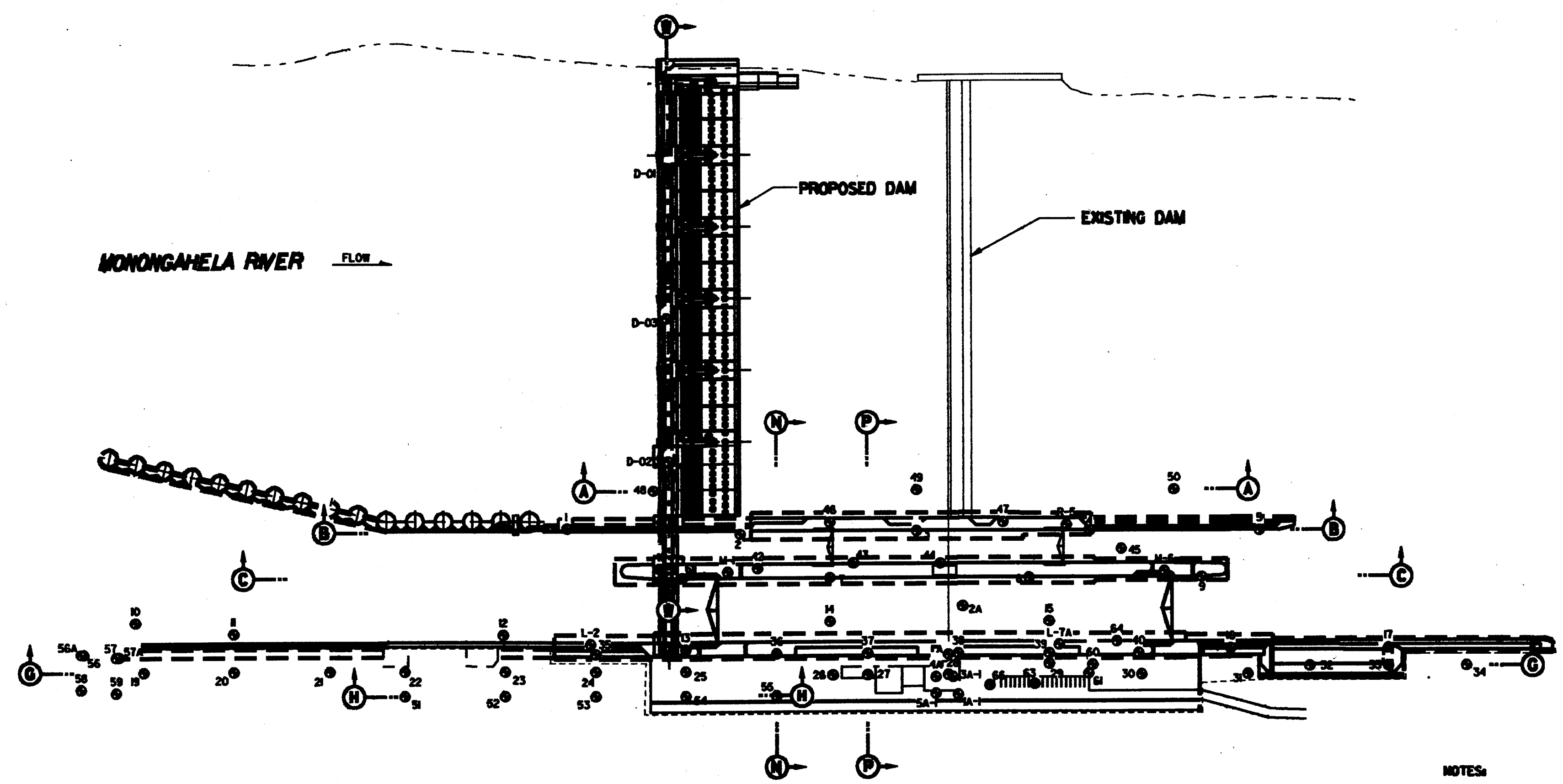
Lower Monongahela River Navigation Study
Engineering Appendix
Geotechnical Section

TABLE 5-4
Summary of Excavation Quantities
and Disposal Site Capacity Requirements

	Excavation Quantity (CY)	Swell Factor (%)	Disposal Quantity (CY)
DAM 2 CONSTRUCTION	------	------	------
Excavation Common	200,900	25	251,125
Excavation Rock	30,400	30	39,520
Channel Dredging	489,400	25	611,750
Dam Removal-Stone	2,400	30	3,120
Dam removal-Concrete	9,600	30	12,480
Riverwall-Concrete	1,100	30	1,430
	------		------
	733,800 CY		919,425 CY

	Excavation Quantity (CY)	Swell Factor (%)	Disposal Quantity (CY)
LOCK & DAM 3 REMOVAL	------	------	------
Cell Material	14,060	25	17,575
Concrete Disposal	42,825	30	55,673
POOL 2 & 3 ADJUSTMENTS			
Dredge	1,670,000	25	2,087,500
Bank Stabilization	94,695	25	118,369
	------		------
	1,821,580 CY		2,279,116 CY

	Excavation Quantity (CY)	Swell Factor (%)	Disposal Quantity (CY)
LOCKS 4 RECONSTRUCTION	------	------	------
Common Excavation	612,000	25	765,000
Rock Excavation	50,200	30	65,260
Appraoch Excavation	28,210	25	35,263
Dredgeing	272,250	25	340,313
Concrete Removal	96,000	30	124,800
	------		------
	1,058,660 CY		1,330,635 CY



PLAN

SCALE: 1" = 100'

NOTES:

1) SEE PLATE 5-2 FOR LOGS OF BORINGS D1, D2, AND D3.
2) SEE PLATES 5-6, 5-7, 5-8, AND 5-9 FOR SECTIONS AND LOGS OF REMAINING BORINGS.

MONONGAHELA RIVER

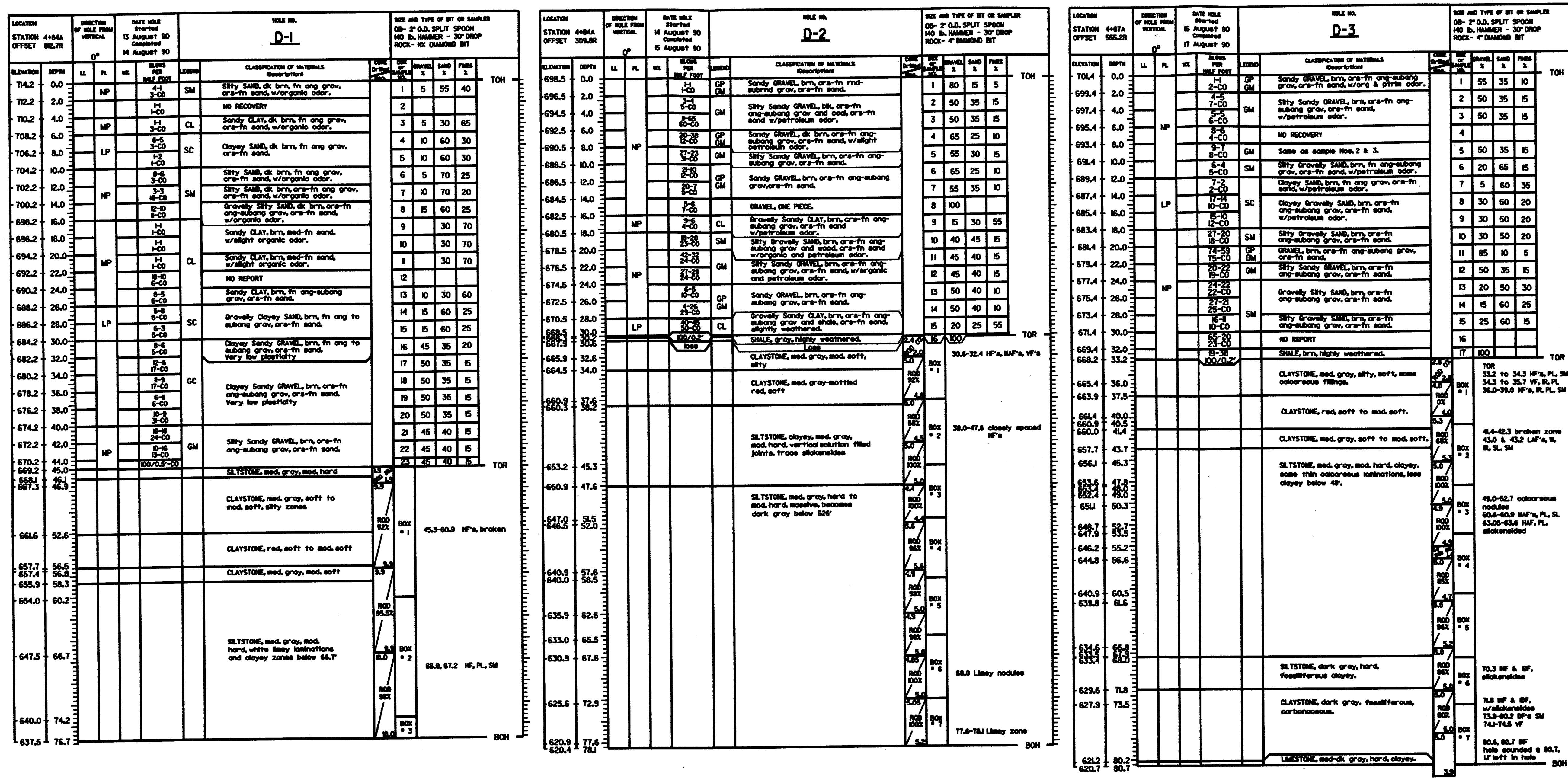
LOCKS AND DAM NO. 2

DAM REPLACEMENT

BORINGS PLAN AND SECTION LOCATIONS

DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
JFB	KAH	JFB		AS SHOWN	037-R54-10/1

PLATE 5-1



REVISION | DATE | DESCRIPTION | BY

GRAPHIC SCALE

5 0 5 10FT

SCALE: 1" = 5'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER

LOCK & DAM NO. 2

FOUNDATION EXPLORATION

DAM REPLACEMENT

BORINGS D-1, D-2, D-3

DESIGNED PJY | DRAWN PJY | CHECKED | DATE | SCALE AS SHOWN | FILE NO. 037-R54-10/3

Lock & Dam #2 Monogahela River

Soft to Moderately & Moderately Hard shale

Unit 8 on Generalized Geologic Column

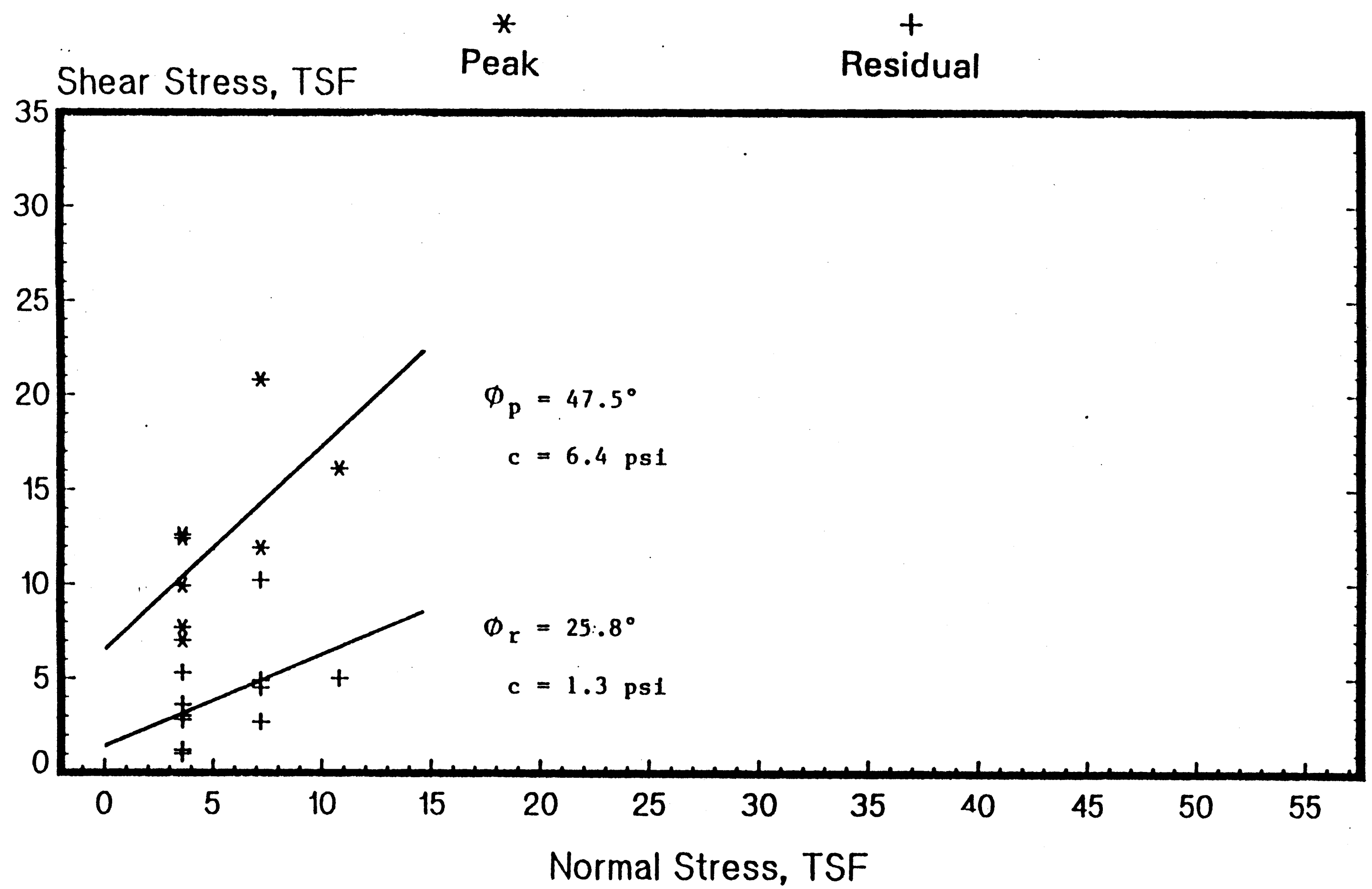
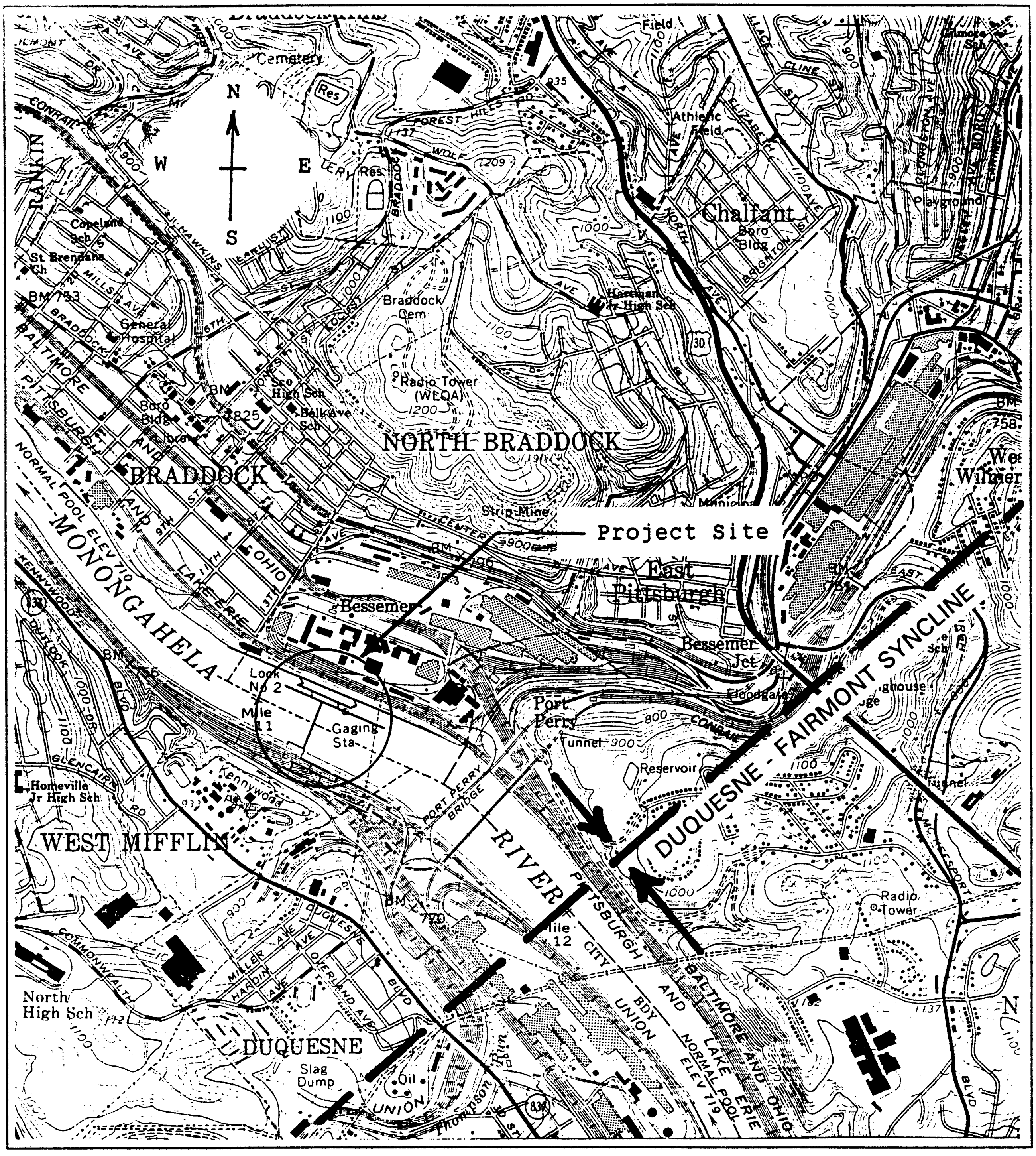


PLATE 5-3



Monongahela River

LOCKS and DAM 2

Topography and General Plan

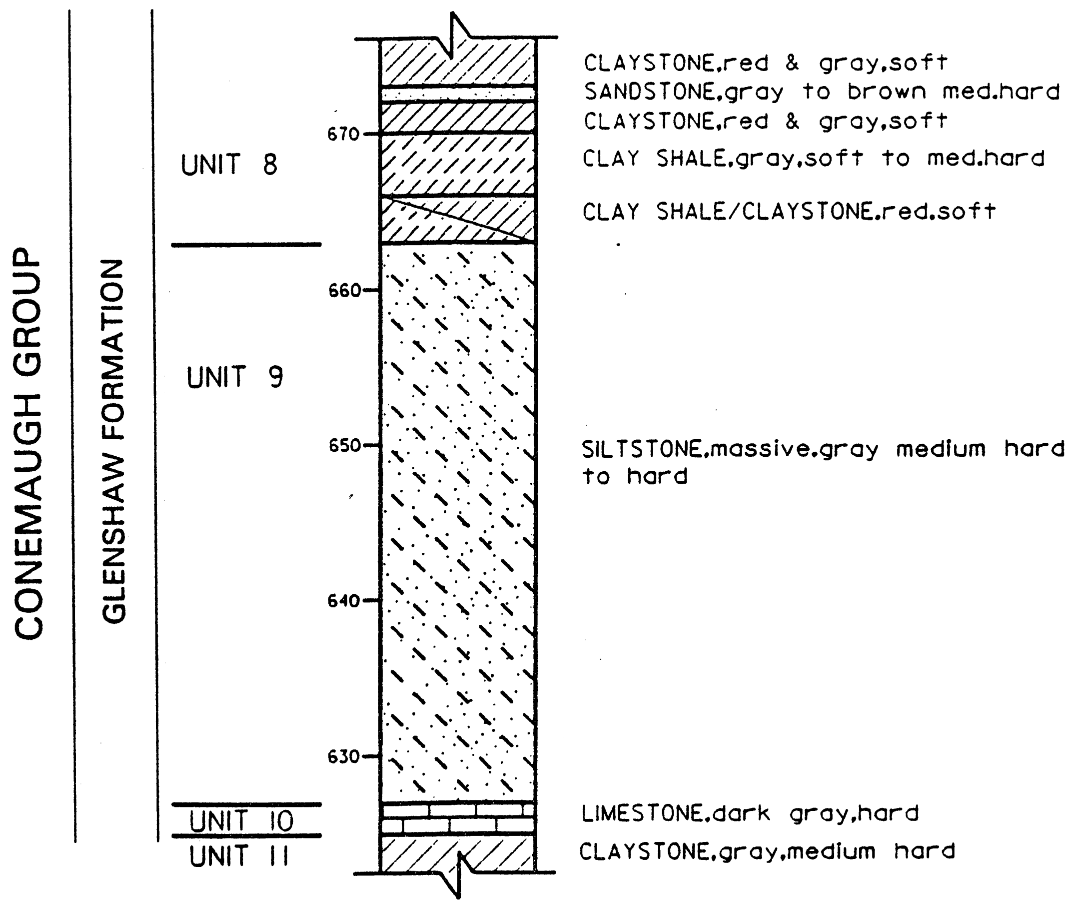
Scale 1" = 2000' (Approx)

PLATE 5-4

LOWER MONONGAHELA RIVER FEASIBILITY STUDY

DAM 2 REPLACEMENT SITE

GENERALIZED GEOLOGIC COLUMN



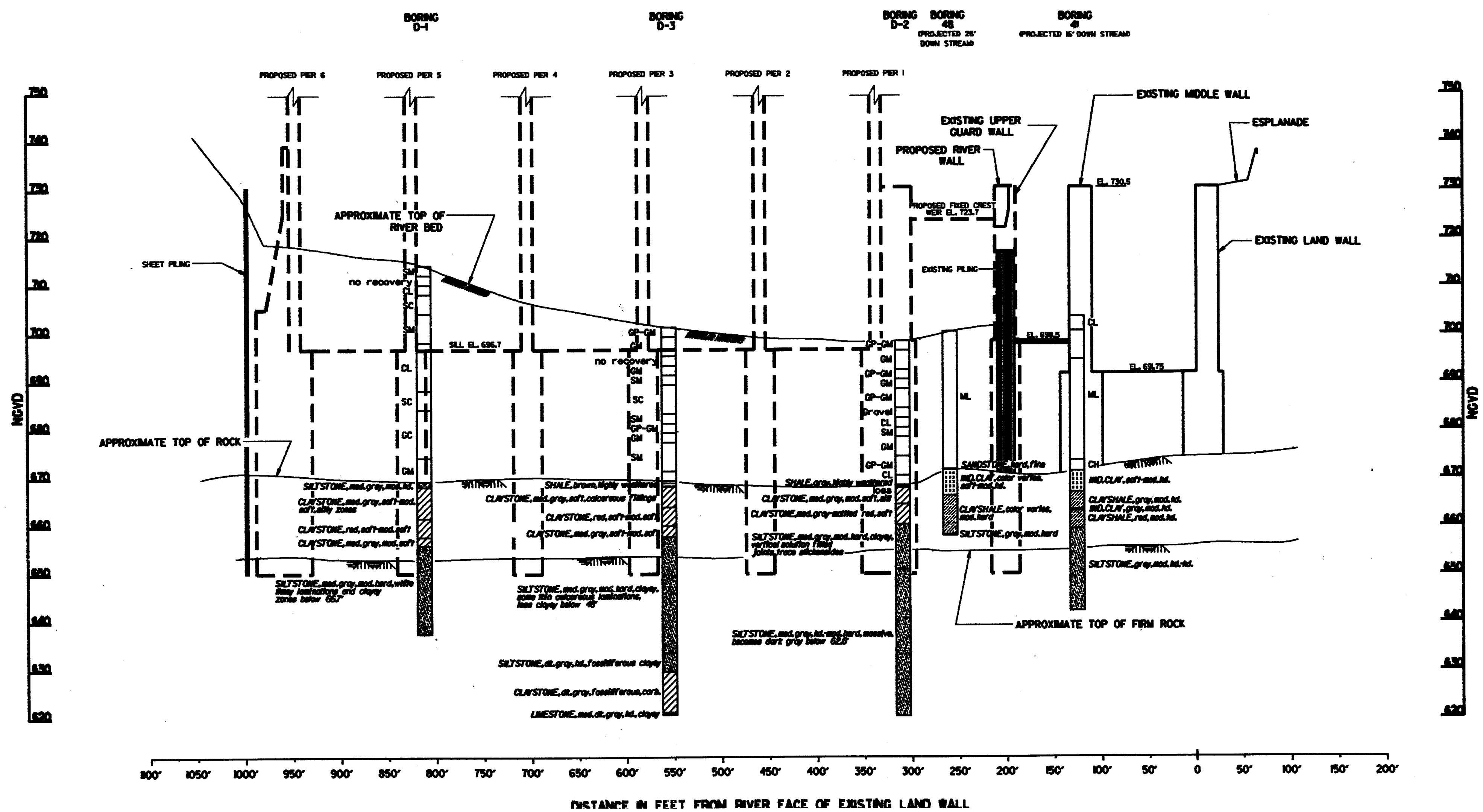
NOTES:

1. Contact elevations are averages, there is considerable variation over the site.

2. All units may not be present over the site.

DWG BY JML 2/90

PLATE 5-5

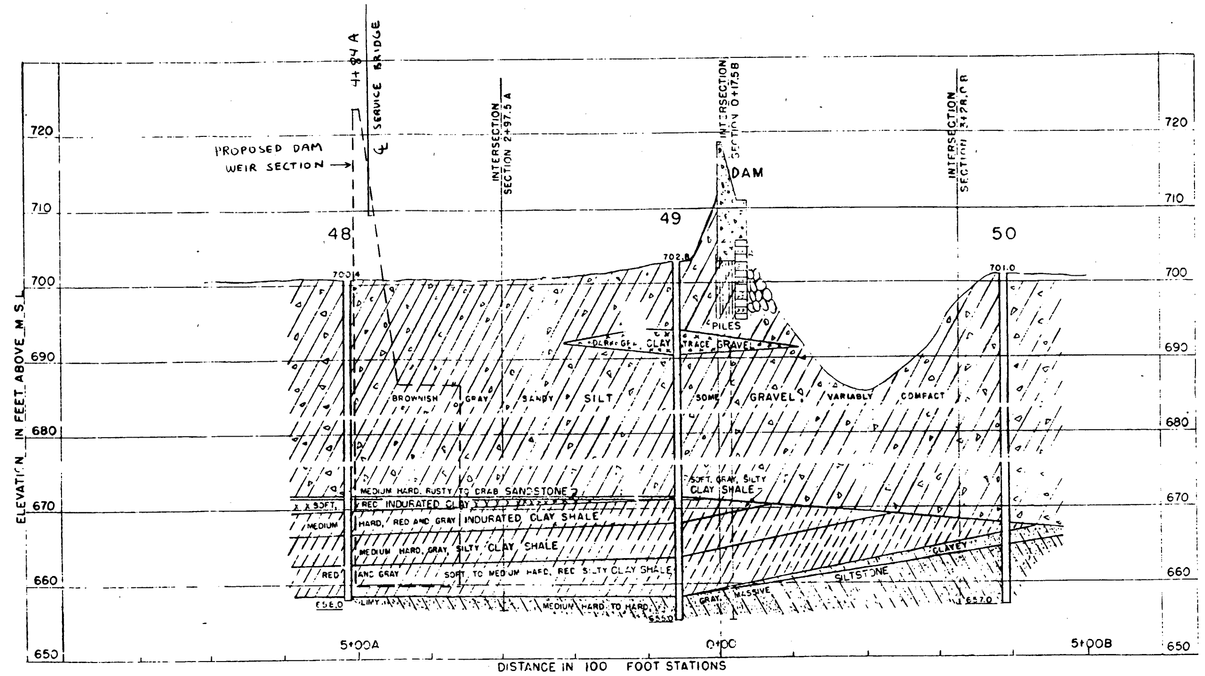


U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER
LOCKS AND DAM NO. 2
DAM REPLACEMENT
SECTION W-W
LOCK STATION 4+84A

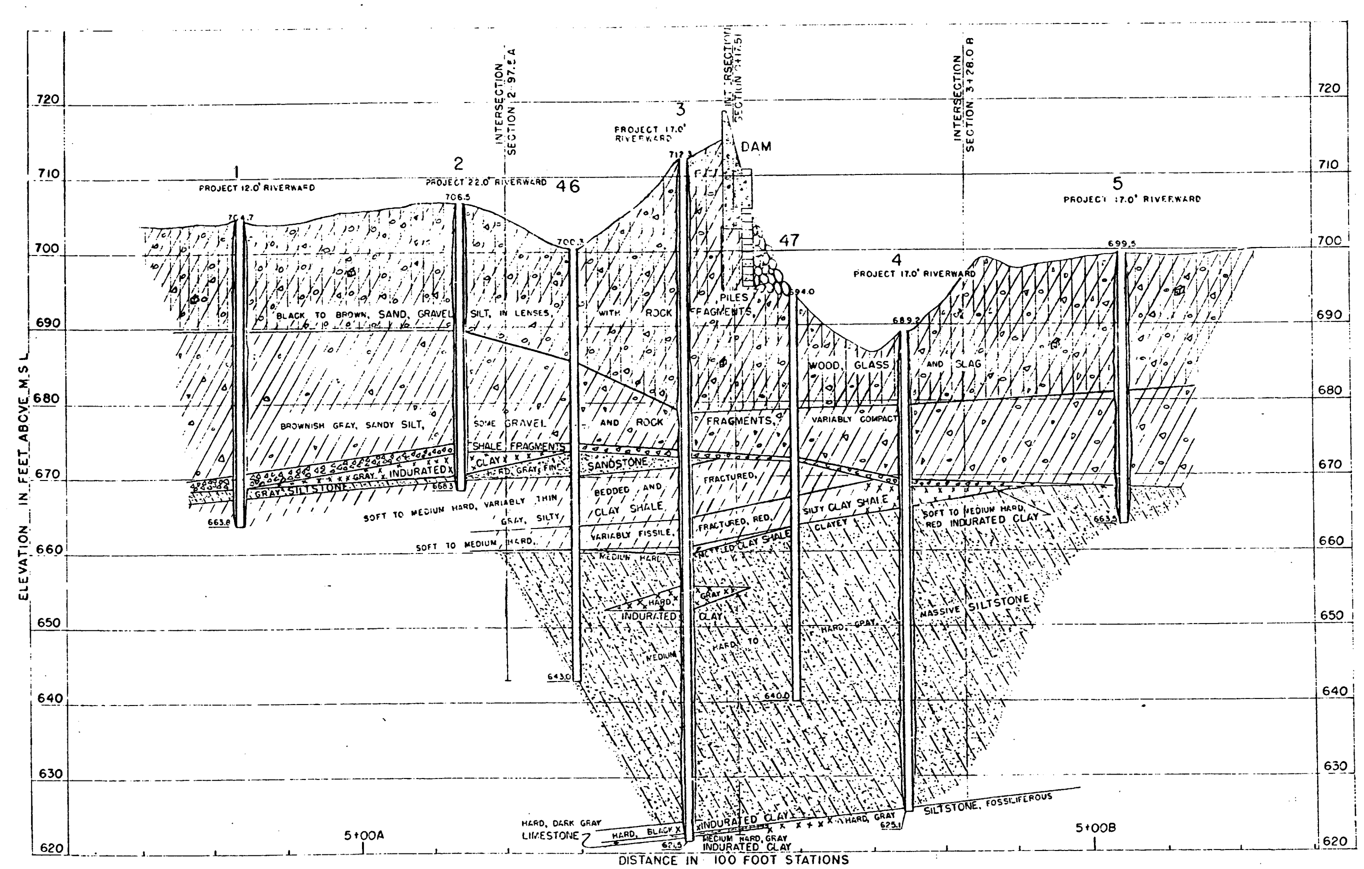
DESIGNED JFB | DRAWN KAH | CHECKED JFB | SCALE AS SHOWN | 037-R54-10/2

PLATE 5-6



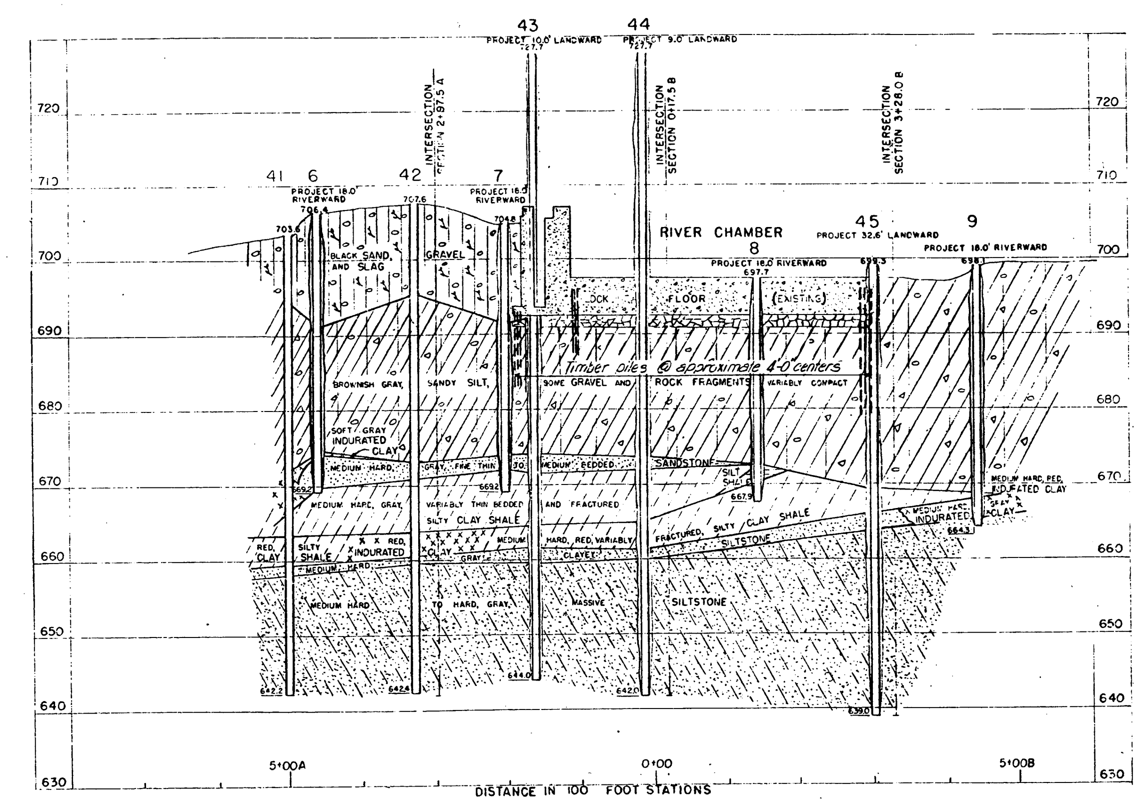
SECTION OFFSET 256.5' RIVERWARD OF RIVER FACE OF NEW LAND WALL

SECTION A-A



SECTION OFFSET 201.5' RIVERWARD OF RIVER FACE OF NEW LAND WALL

SECTION B-B

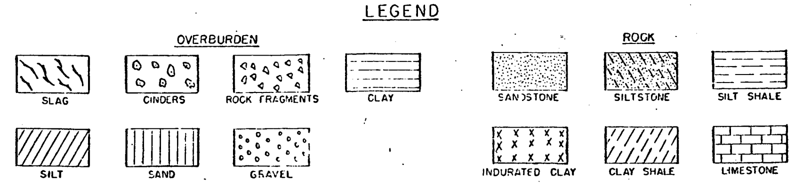


SECTION OFFSET 122.5' RIVERWARD OF RIVER FACE OF NEW LAND WALL

SECTION C-C

PLATE 1

LEGEND



GENERAL NOTES:–
4½" O.D. extra strong drive pipe with 5½" drive shoe driven to elevation shown with 300 lb. hand operated 2 foot stroke drop hammer. Lock wall concrete was cored in holes 43 and 44 and 3½" casing driven to rock.

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE
SCALE: 1" = 200'

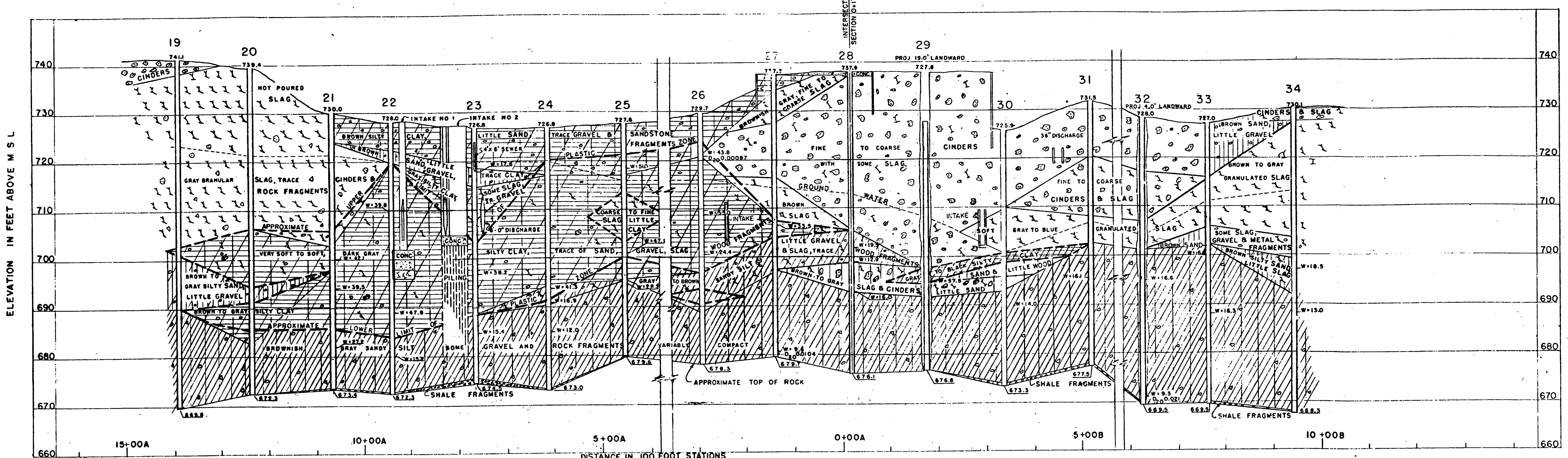
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

DRAWN BY: PATSEY
TRACED BY: RENOUF
CHECKED BY:
SUBMITTED BY: GEOLOGIST
APPROVAL RECOMMENDED: HEAD, ENGINEERING DIVISION
APPROVED FOR:
DATE:

MONONGAHELA RIVER
RECONSTRUCTION OF LOCKS No 2
FOUNDATION EXPLORATION
GEOLOGIC SECTIONS (GENERALIZED)
SECTIONS A-A, B-B, AND C-C

APPROVED: COL. C.E. DISTRICT ENGINEER
DATE: 23 JUNE 1948
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER 037-L2-10/21
SHEET 1 OF 7

PLATE 5-7

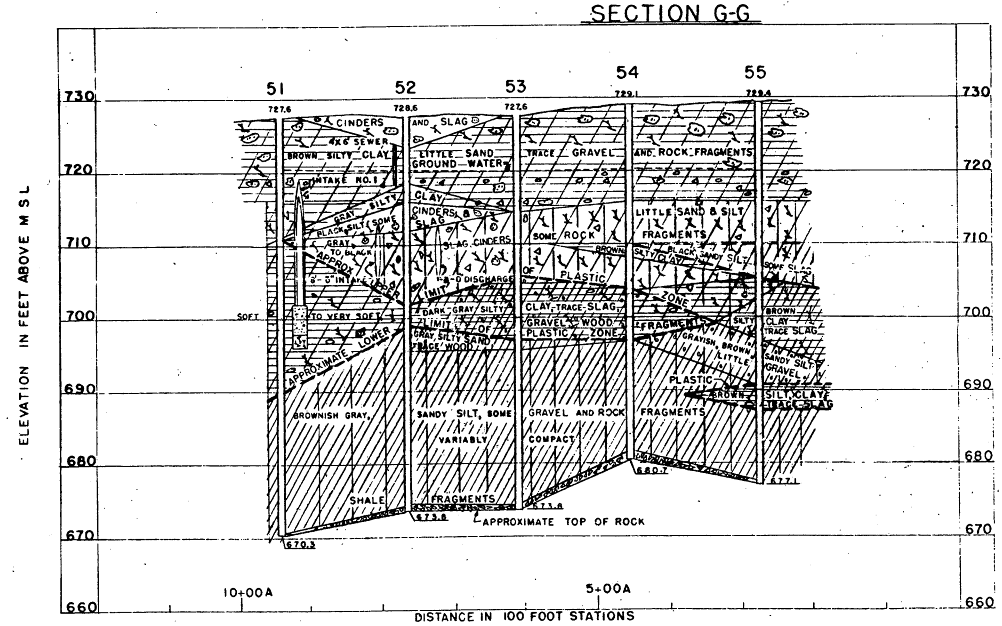


SECTION OFFSET 53.5' LANDWARD OF RIVER FACE OF NEW LAND WALL

SECTION OFFSET 60.5' LANDWARD OF RIVER FACE OF NEW LAND WALL

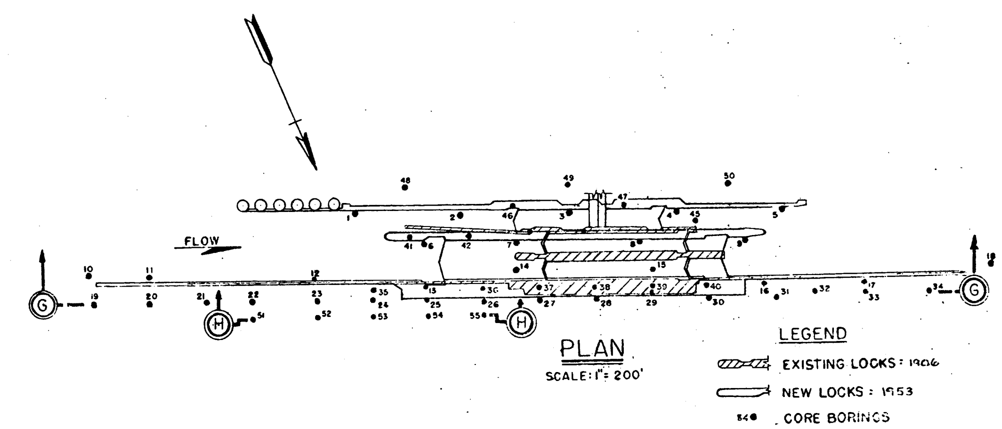
SECTION OFFSET 47.0' LANDWARD OF RIVER FACE OF NEW LAND WALL

SECTION G-G

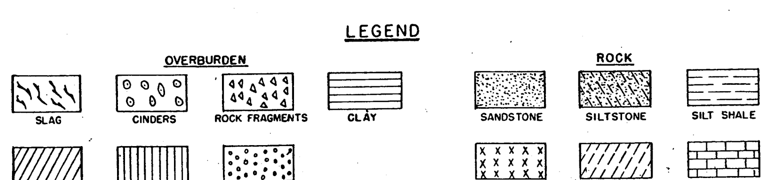


SECTION OFFSET 95.5' LANDWARD OF RIVER FACE OF NEW LAND WALL

SECTION H-H



PLAN
SCALE: 1" = 200'



REVISION	DATE	DESCRIPTION	BY

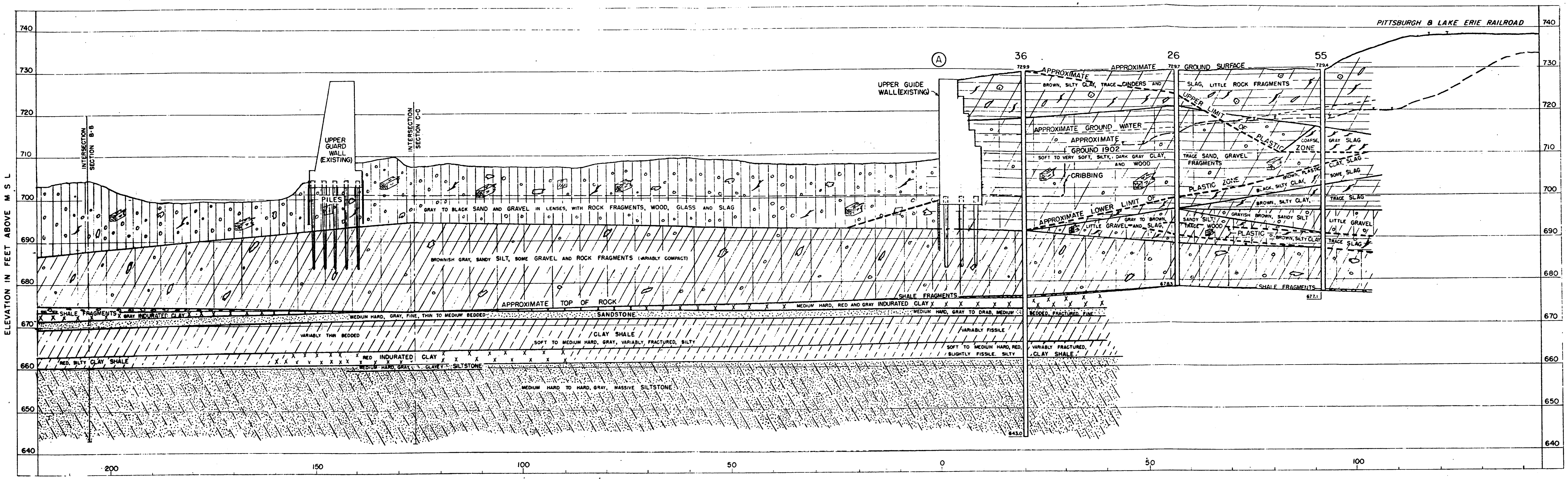
GRAPHIC SCALE
SCALE: 1" = 200'

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

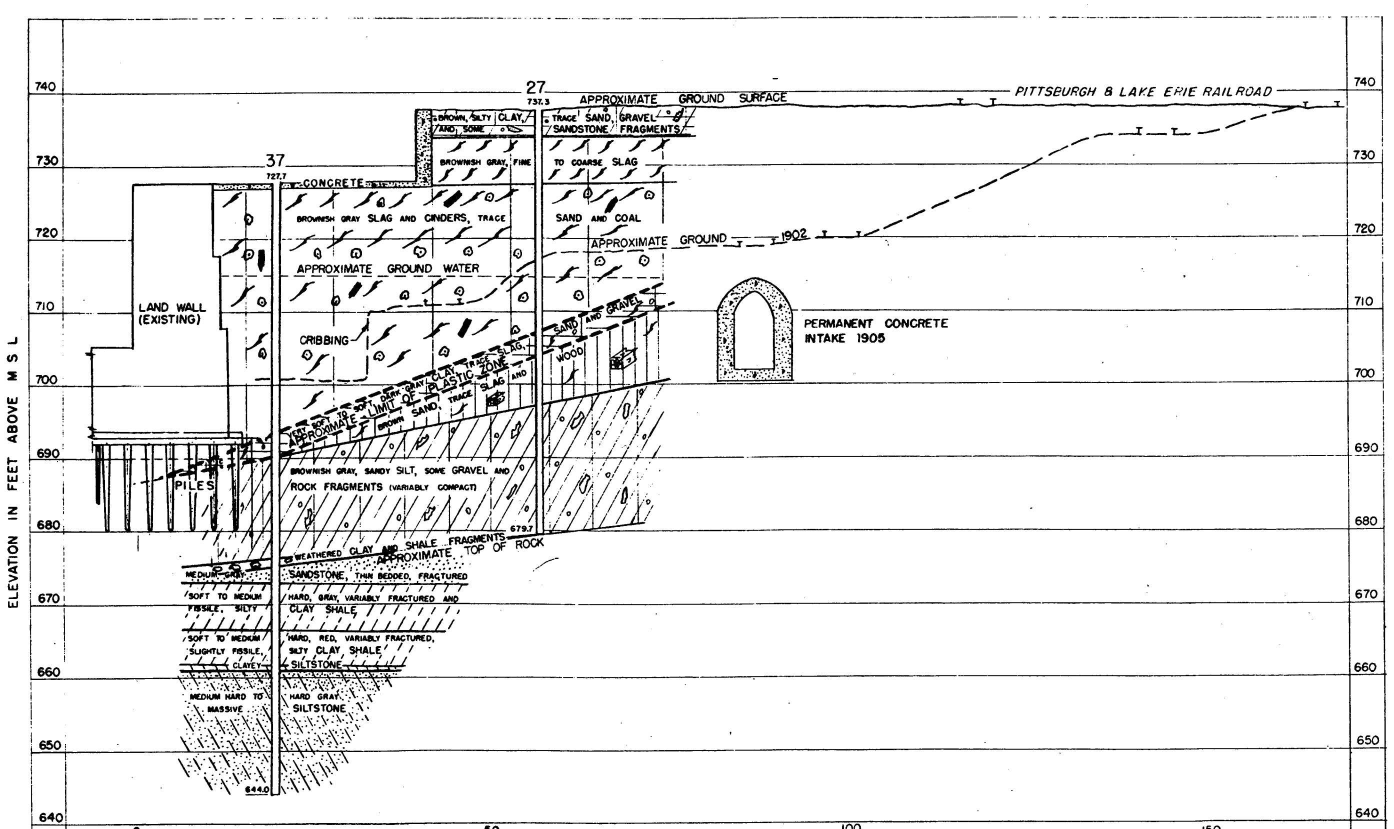
DRAWN BY: PATSEY
TRACED BY: RENOUF
CHECKED BY:
SUBMITTED BY: GEOLOGIST
APPROVAL RECOMMENDED: HEAD ENGINEERING DIVISION
APPROVED: COL. C.E. DISTRICT ENGINEER
APPROVED FOR:
DATE:

MONONGAHELA RIVER
RECONSTRUCTION OF LOCKS No 2
FOUNDATION EXPLORATION
GEOLOGIC SECTIONS (GENERALIZED)
SECTIONS G-G AND H-H

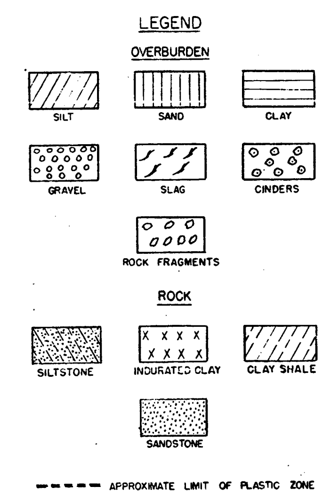
DATE: 23 JUNE 1948
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER
037-L2-19/23

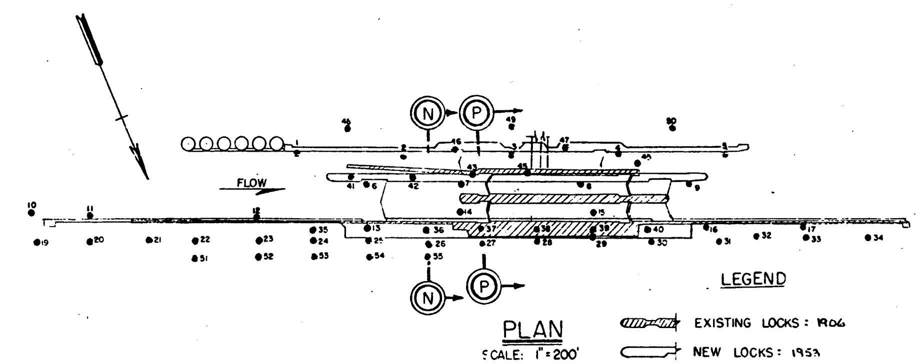


SECTION N-N
STATION 2+97.5A



SECTION P-P
STATION 1+40A





PLAN
SCALE: 1" = 200'

(A) GENERAL NOTE:- Section of upper guide wall and foundation piling in Section N-N assumed from DWG M-5-17.

REVISION	DATE	DESCRIPTION	BY
A	15 JAN 51	SECTION N-N:- UPPER GUIDE WALL REVISED TO SHOW APPARENT CONDITIONS. NOTE ADDED.	

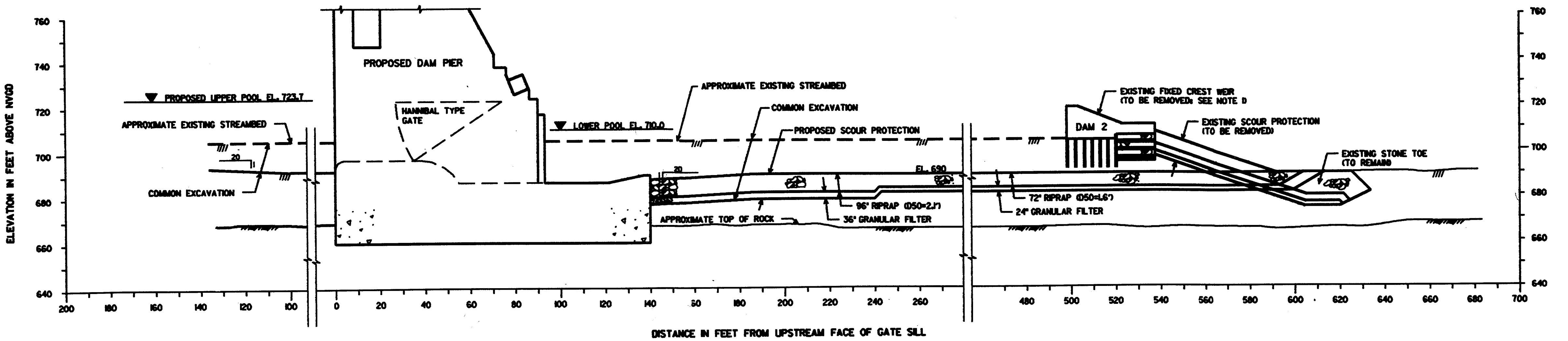
GRAPHIC SCALE
200' 100' 0 200' 400'
SCALE: 1" = 200'

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
RECONSTRUCTION OF LOCKS No 2
FOUNDATION EXPLORATION
GEOLOGIC SECTIONS (GENERALIZED)
SECTIONS N-N AND P-P

DRAWN BY: PATSEY
TRACED BY: PATSEY
CHECKED BY:
SUBMITTED BY: GEOLOGIST
APPROVAL RECOMMENDED: HEAD, ENGINEERING DIVISION
APPROVED: COL. C.E. DISTRICT ENGINEER
DATE: 23 JUNE 1948
APPROVED FOR:
DATE:
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER 037-L2-10/25.1
SHEET 5 OF 7

PLATE 5-9



PROPOSED SCOUR PROTECTION DETAIL

SCALE: 1"=20'

NOTES:

1. REMOVE EXISTING DAM, PILING, ROCK CRIB, AND SCOUR PROTECTION TO EL. 682-±.
2. PLACE NEW FILTER AND RIPRAP TO EL. 690 AND TIE INTO EXISTING STONE TOE.

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

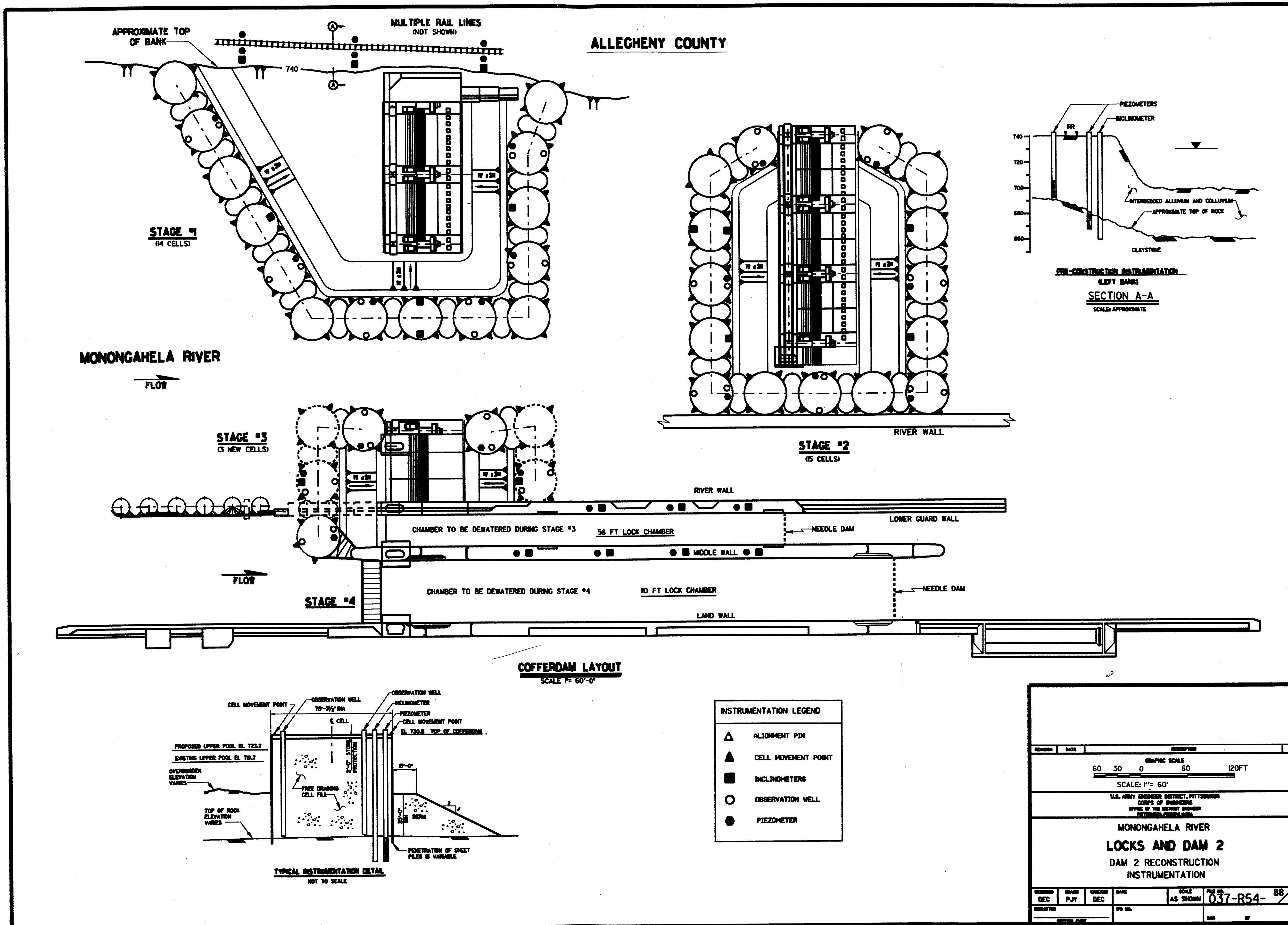
U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER

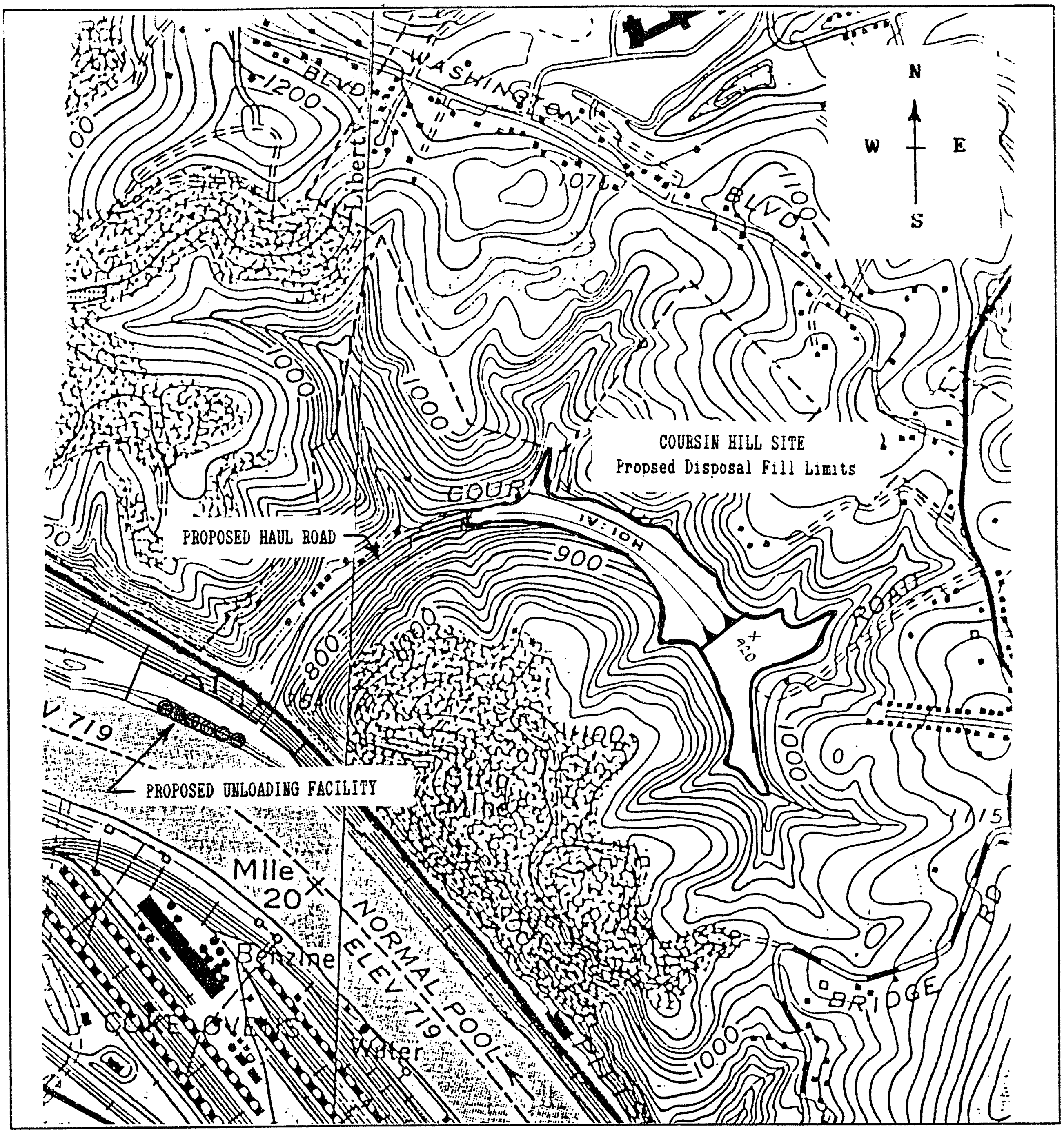
LOCKS AND DAM 2

PROPOSED DAM REPLACEMENT
SCOUR PROTECTION DETAIL

DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
DEC	TLB			AS SHOWN	037-R54- 6/11
SUBMITTED			FD NO.		DWG OF
SECTION CHIEF					



APPROXIMATE TOP OF BANK
MULTIPLE RAIL LINES (NOT SHOWN)
ALLEGHENY COUNTY
740
STAGE #1 (14 CELLS)
MONONGAHELA RIVER
FLOW
STAGE #2 (15 CELLS)
RIVER WALL
PIEZOMETERS
INCLINOMETER
RR
INTERBEDDED ALLUVIUM AND COLLUVIUM
APPROXIMATE TOP OF ROCK
CLAYSTONE
PRE-CONSTRUCTION INSTRUMENTATION (LEFT BANK)
SECTION A-A
SCALE: APPROXIMATE
STAGE #3 (3 NEW CELLS)
RIVER WALL
LOWER GUARD WALL
CHAMBER TO BE DEWATERED DURING STAGE #3
56 FT LOCK CHAMBER
NEEDLE DAM
MIDDLE WALL
FLOW
STAGE #4
CHAMBER TO BE DEWATERED DURING STAGE #4
80 FT LOCK CHAMBER
NEEDLE DAM
LAND WALL
COFFERDAM LAYOUT
SCALE 1"= 60'-0"
CELL MOVEMENT POINT
OBSERVATION WELL
INCLINOMETER
PIEZOMETER
CELL MOVEMENT POINT
EL 730.5 TOP OF COFFERDAM
PROPOSED UPPER POOL EL 723.7
EXISTING UPPER POOL EL 718.7
OVERBURDEN ELEVATION VARIES
FREE DRAINING CELL FILL
TOP OF ROCK ELEVATION VARIES
BERM
PENETRATION OF SHEET PILES IS VARIABLE
TYPICAL INSTRUMENTATION DETAIL
NOT TO SCALE
INSTRUMENTATION LEGEND
ALIGNMENT PIN
CELL MOVEMENT POINT
INCLINOMETERS
OBSERVATION WELL
PIEZOMETER
GRAPHIC SCALE
60 30 0 60 120FT
SCALE: 1"= 60'
U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
MONONGAHELA RIVER
LOCKS AND DAM 2
DAM 2 RECONSTRUCTION
INSTRUMENTATION
DEC
PJY
DEC
AS SHOWN
037-R54- 88/1



Monongahela River

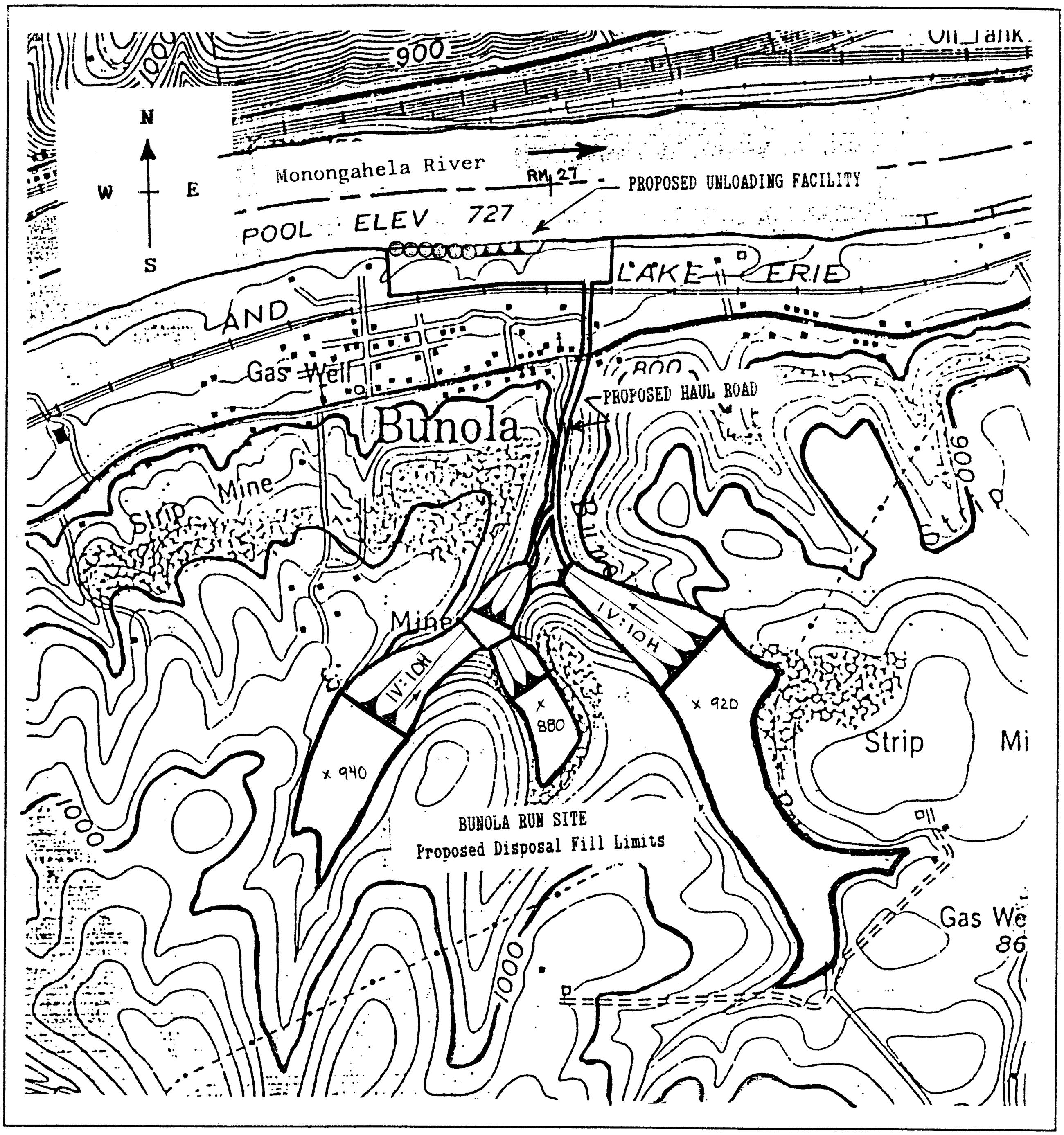
DAM 2 CONSTRUCTION

Coursin Hill Disposal Site

Topography and General Plan

Scale 1" = 1000' (Approx)

PLATE 5-12



Monongahela River

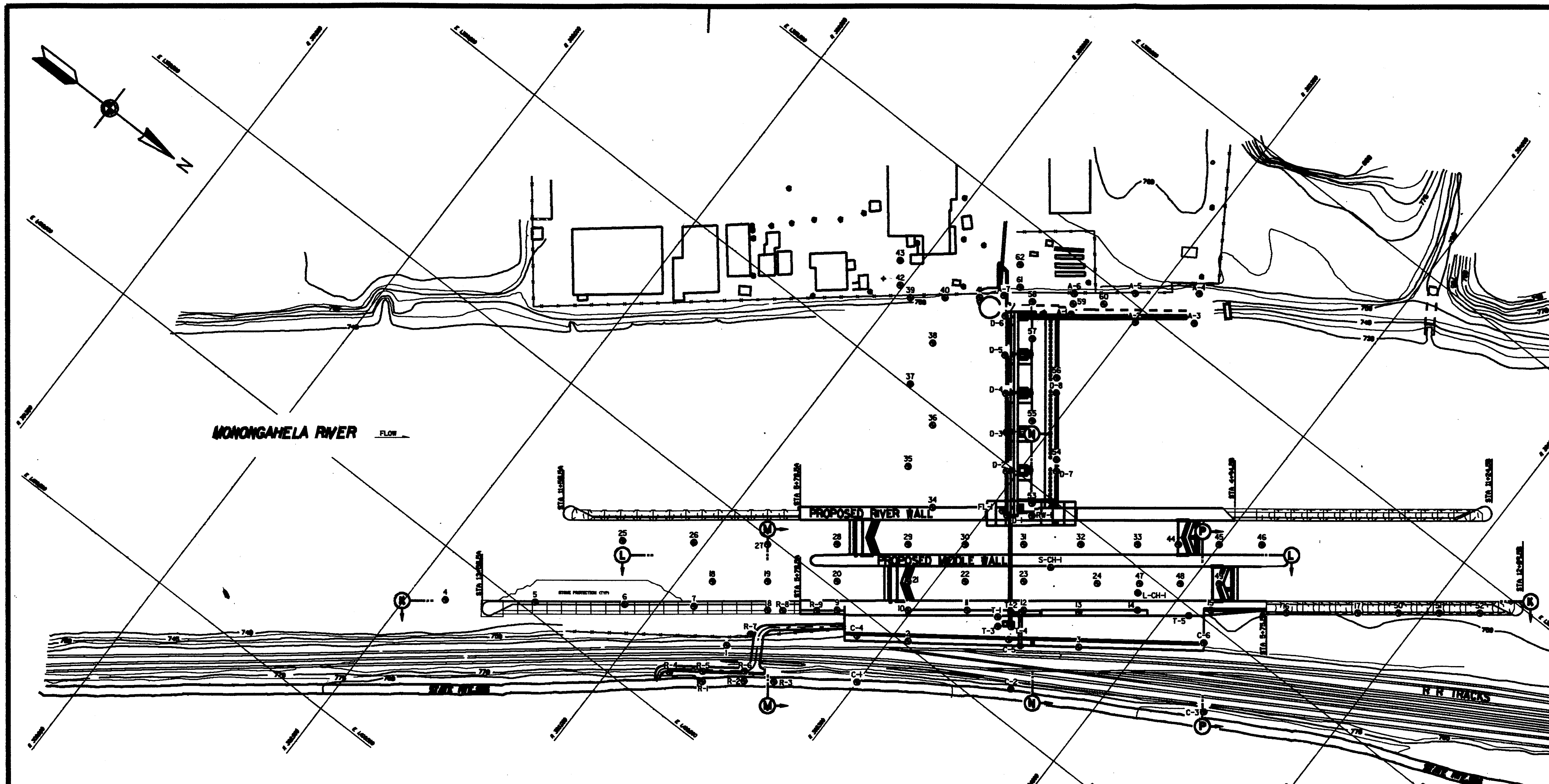
POOL 3 DREDGE

Bunola Run Disposal Site

Topography and General Plan

Scale 1" = 1000' (Approx)

PLATE 5-13



PLAN

SCALE: 1" = 100'

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

100 50 0 100 200FT

SCALE: 1" = 100'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER

LOCKS AND DAM NO. 4

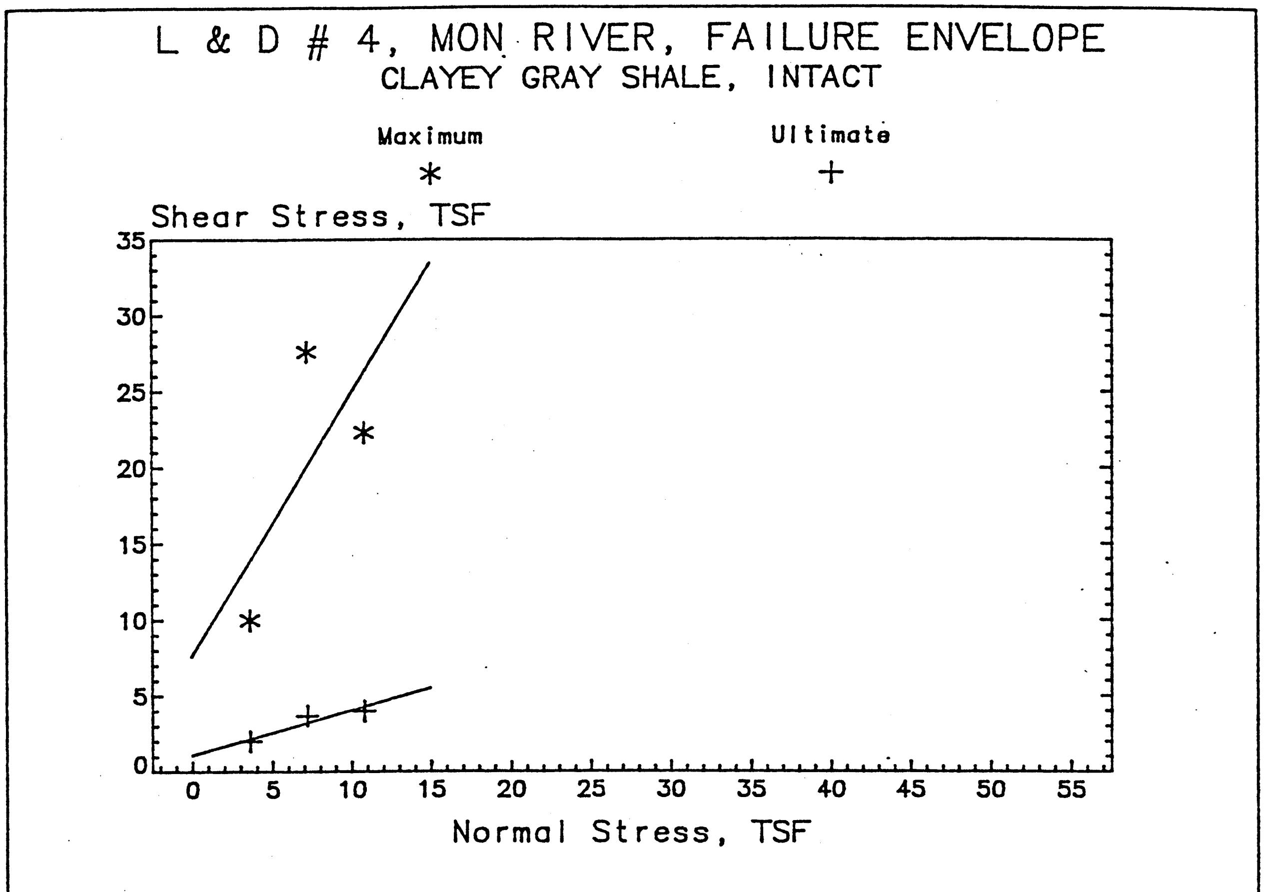
LOCKS REPLACEMENT

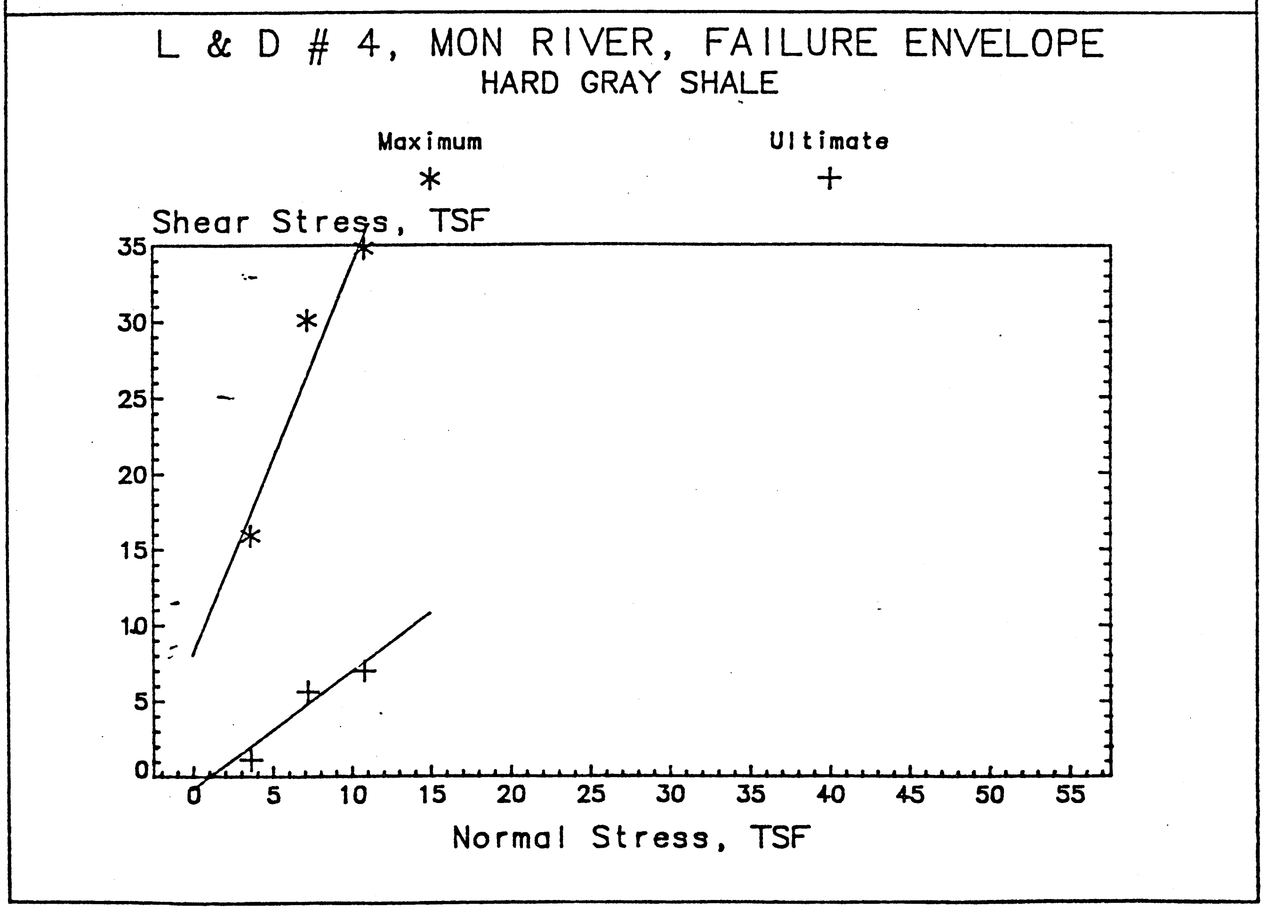
BORING PLAN AND SECTION LOCATIONS

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
JB	KAH	JB		AS SHOWN	037-R54-10/4

SUBMITTED:	IFB NO.	
	DACW59	SHEET OF

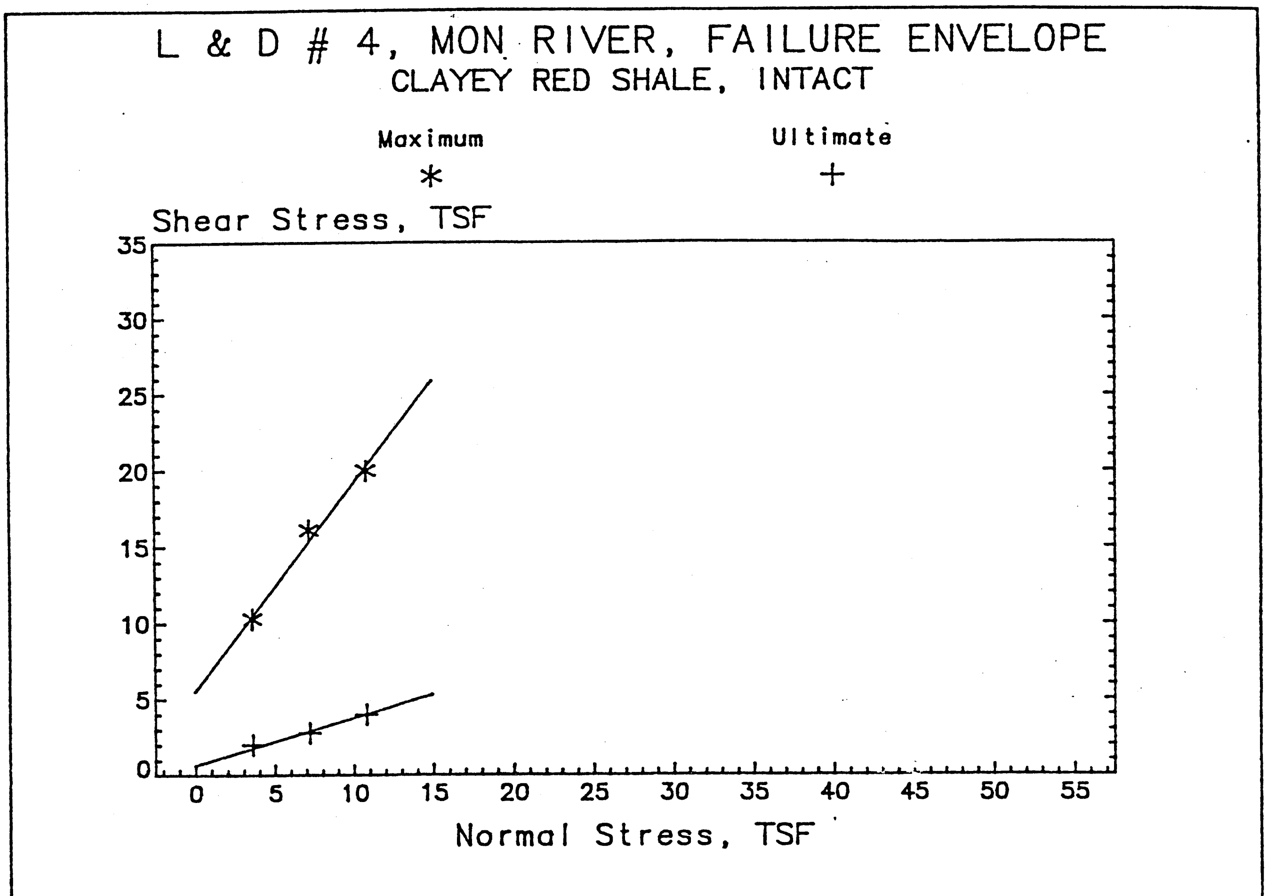
PLATE 5-14

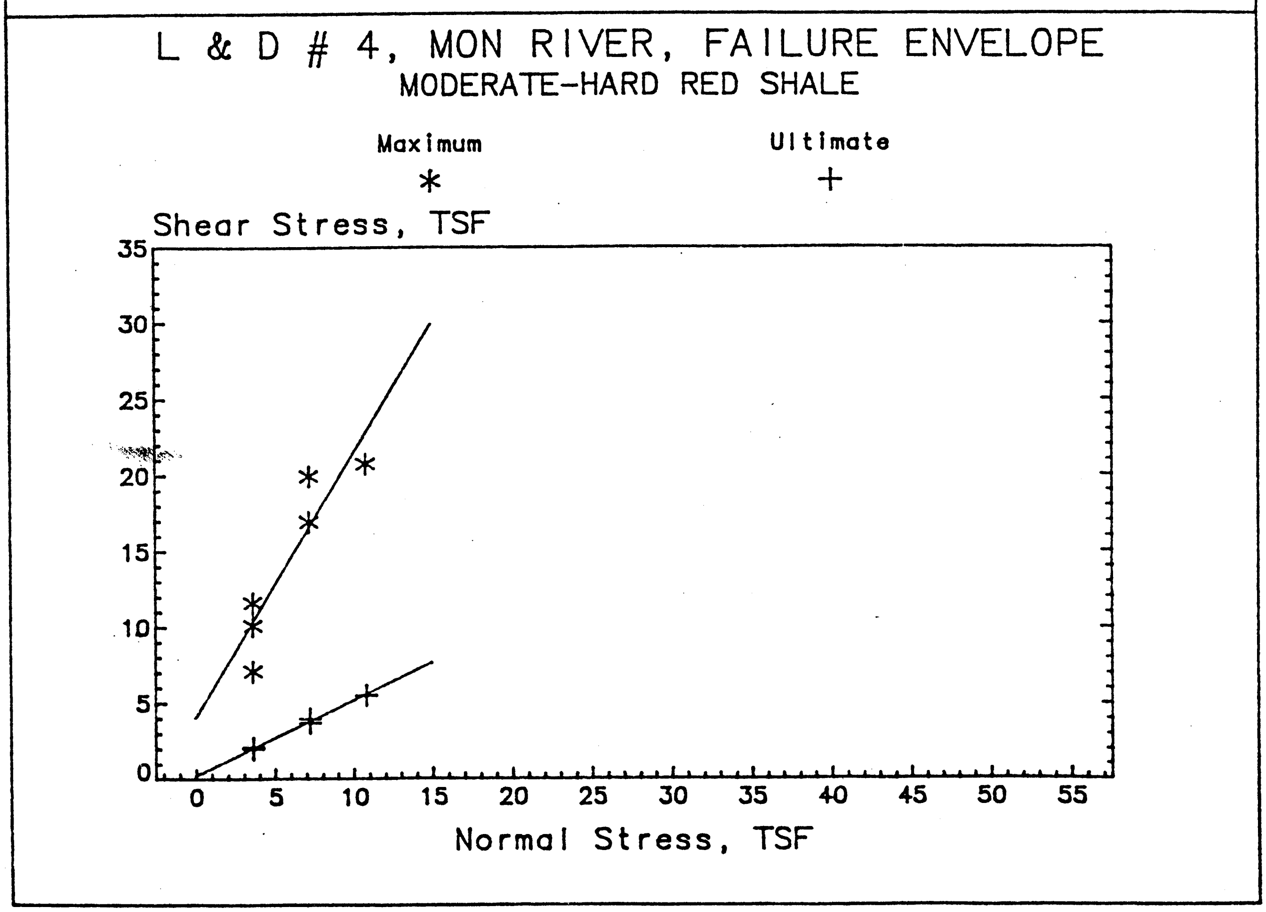




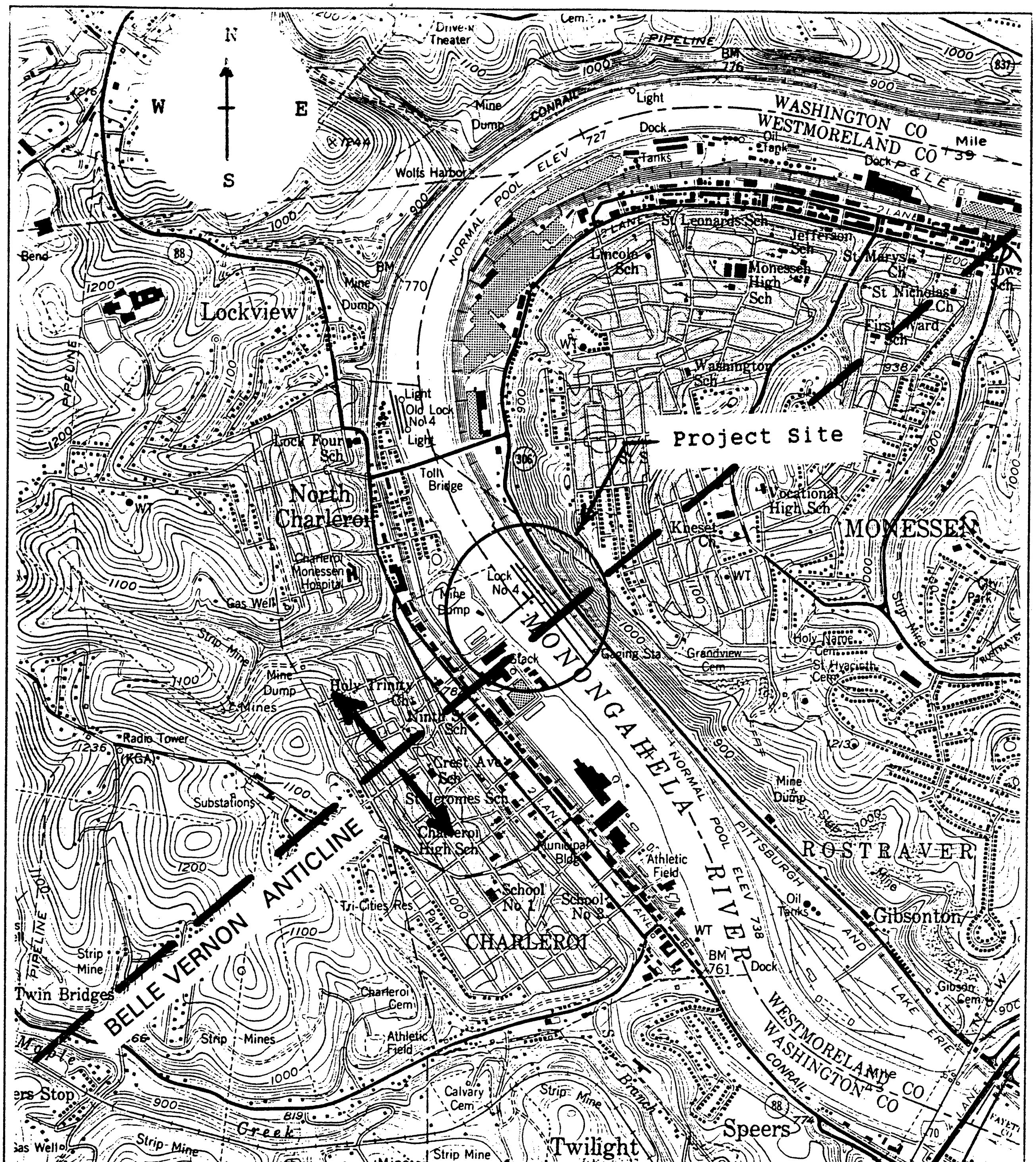
Direct shear test results, failure envelopes, gray shale

PLATE 5-15





Direct shear test results, failure envelopes, red shale



Monongahela River

LOCKS & DAM 4

General Topography

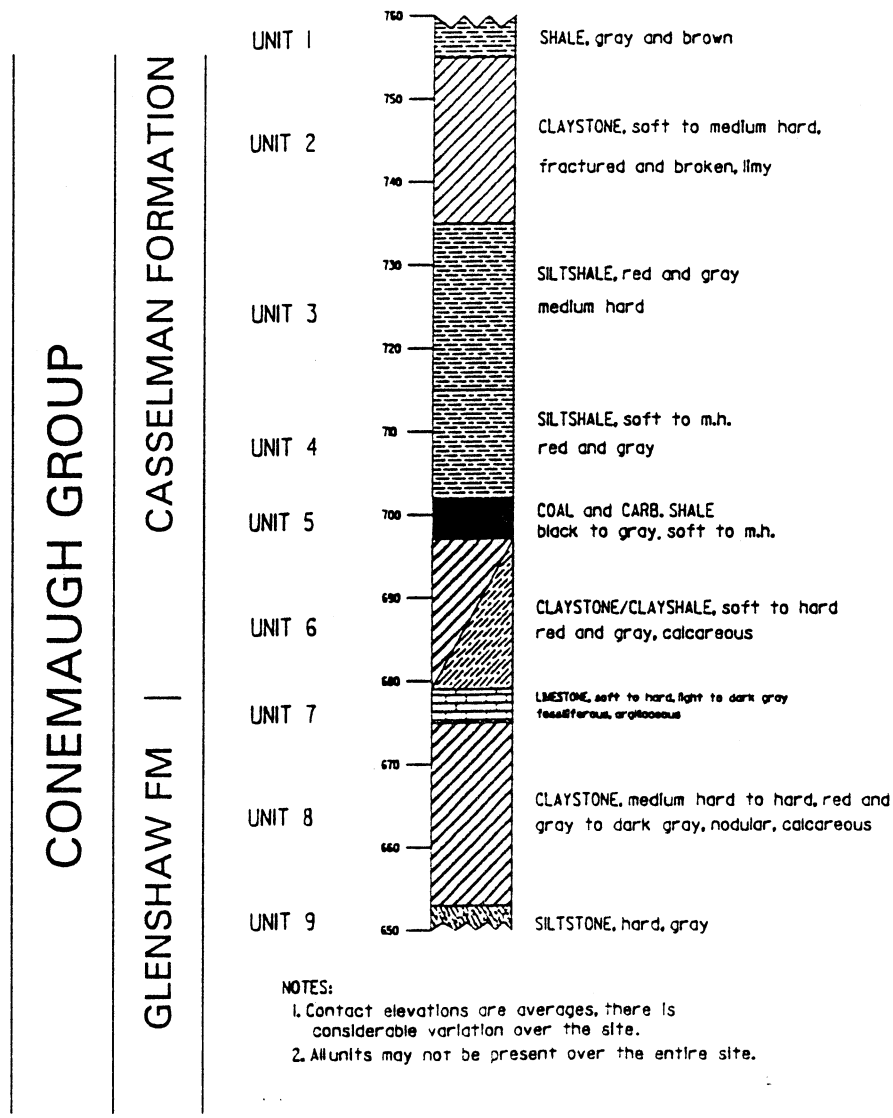
Scale 1" = 2000'

PLATE 5-17

LOWER MONONGAHELA RIVER FEASIBILITY STUDY

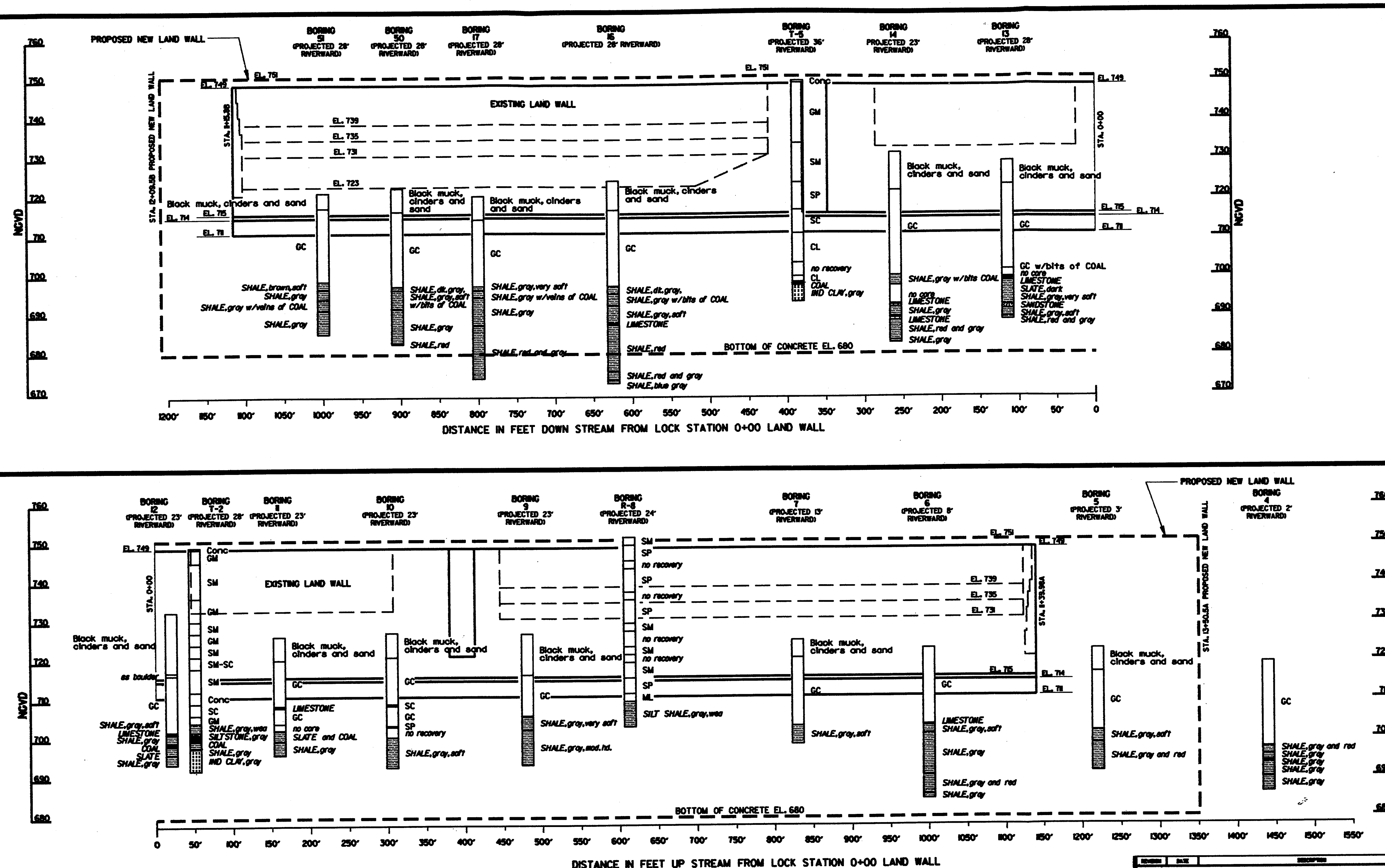
LOCK 4 REPLACEMENT SITE

GENERALIZED GEOLOGIC COLUMN



NOTES:
1. Contact elevations are averages, there is considerable variation over the site.
2. All units may not be present over the entire site.

PLATE 5-18



PROFILE K-K

SCALE: 1" = 50' HORIZONTAL
SCALE: 1" = 10' VERTICAL

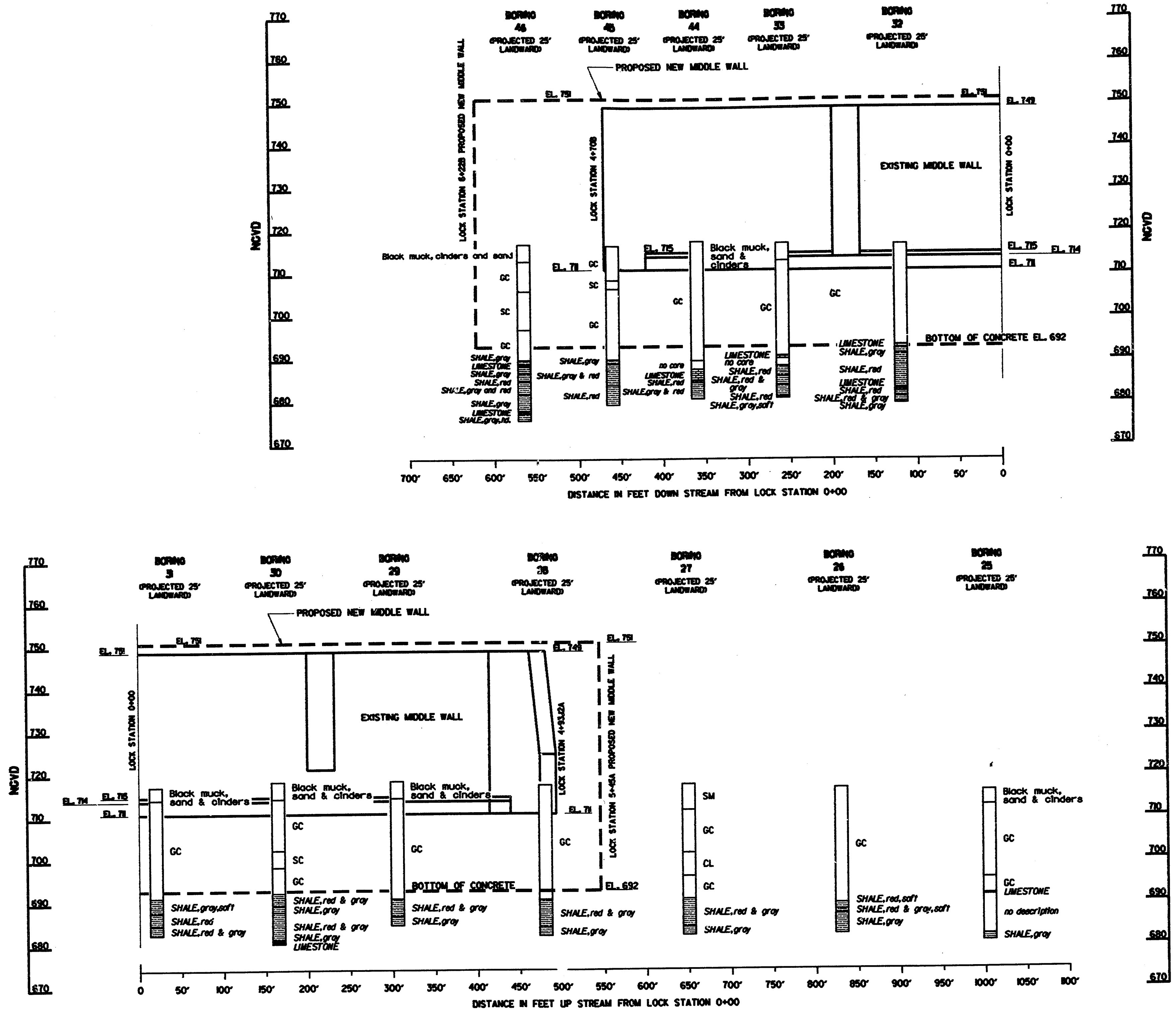
NOTE:
FOR LOCATION OF PROFILE K-K SEE PLATE 5-14.

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER
LOCKS AND DAM NO. 4
LOCKS REPLACEMENT
GEOLOGIC PROFILE
PROFILE K-K

JFB | KAH | JFB | AS SHOWN | 037-R54-10/5

PLATE 5-19



PROFILE L-L

SCALE: 1"=50' HORIZONTAL
SCALE: 1"=10' VERTICAL

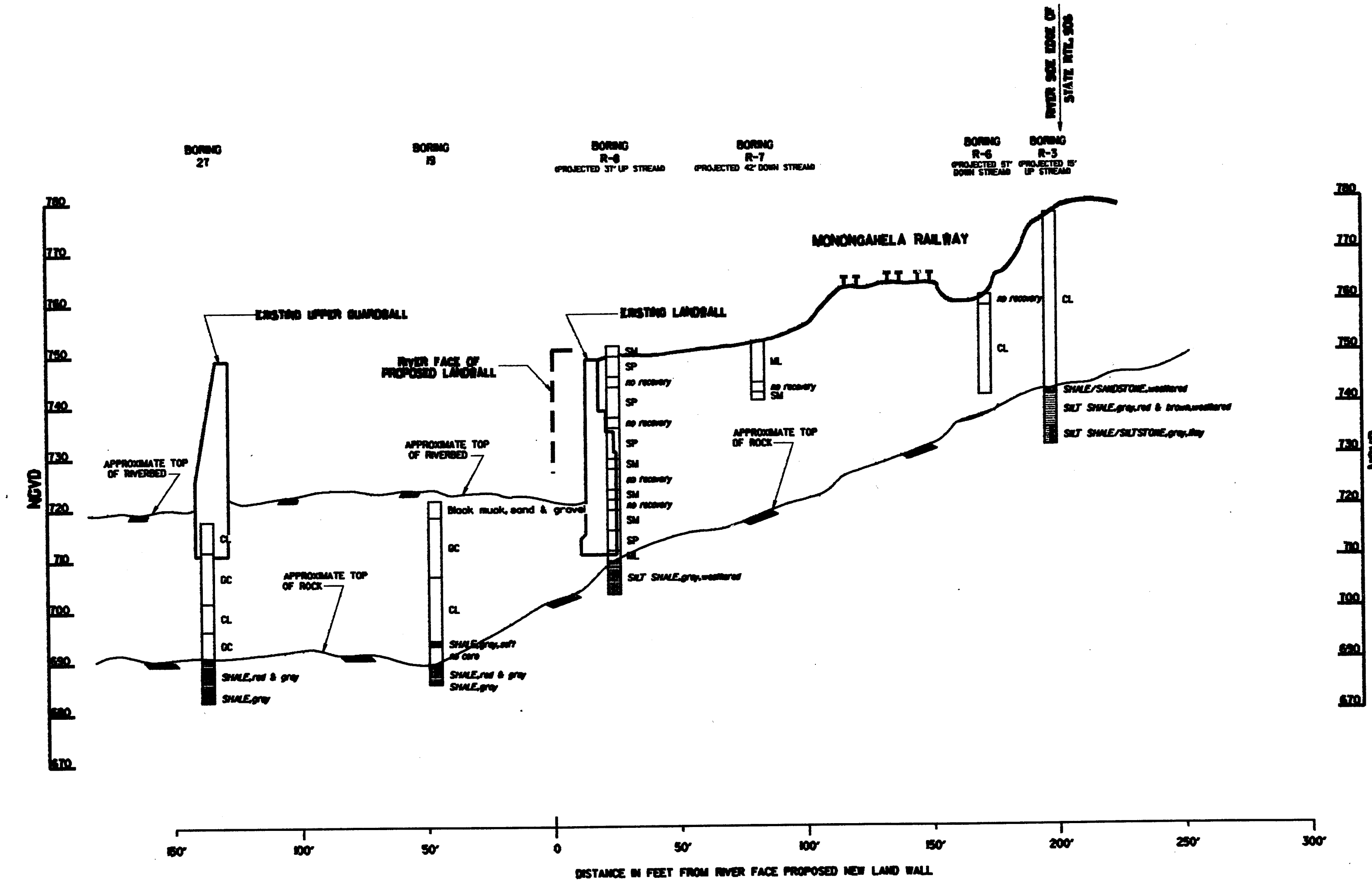
NOTE:
FOR LOCATION OF PROFILE L-L SEE PLATE 5-14.

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER
LOCKS AND DAM NO. 4
LOCKS REPLACEMENT
GEOLOGIC PROFILE
PROFILE L-L

DESIGNED JFB | DRAWN KAH | CHECKED JFB | SCALE AS SHOWN | 037-R54-10/6

PLATE 5-20



SECTION M-M

LOCK STATION 6+50A

SCALE: 1" = 20' HORIZONTAL
SCALE: 1" = 10' VERTICAL

NOTE:
FOR LOCATION OF SECTION M-M SEE PLATE 5-14.

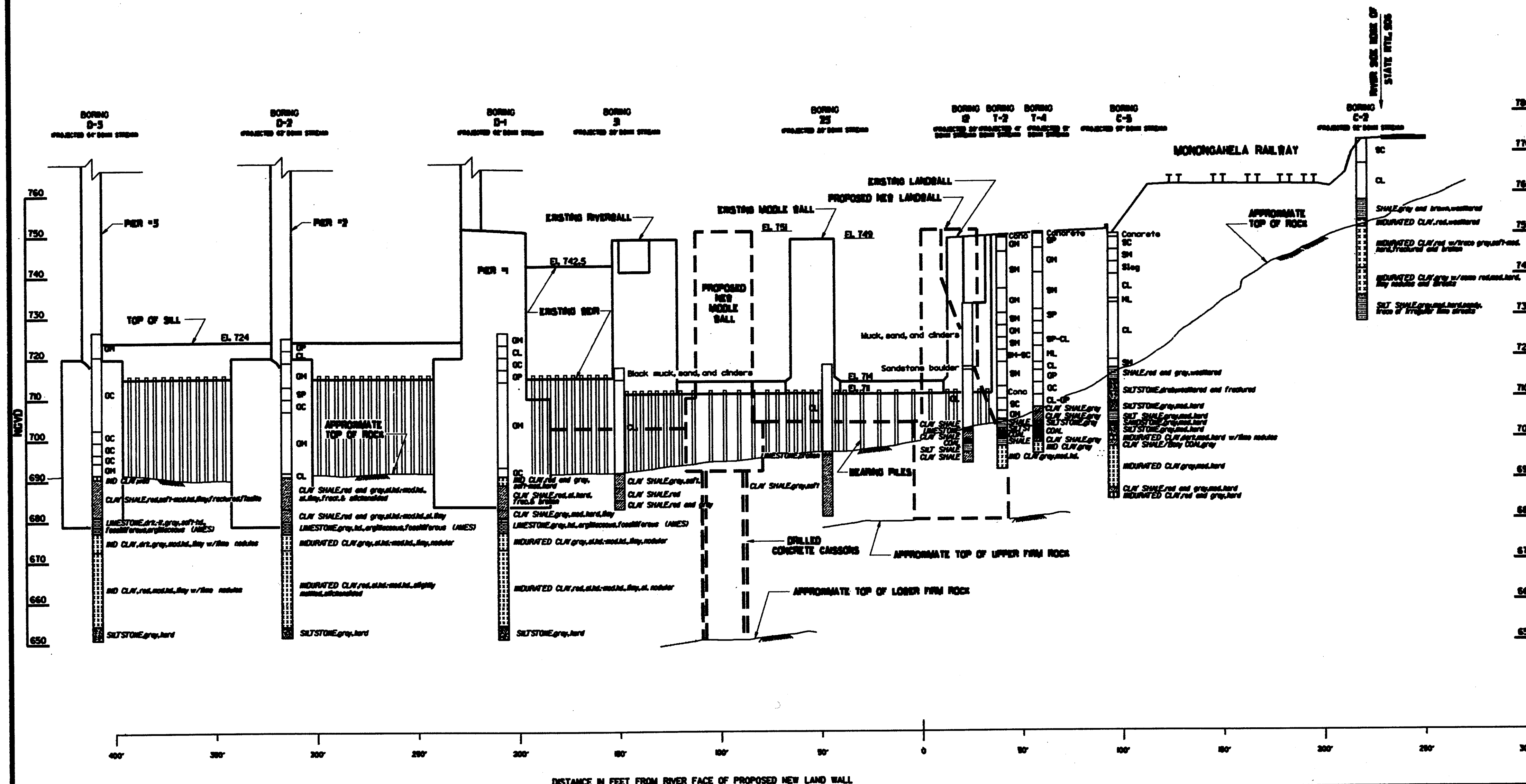
GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER
LOCKS AND DAM NO. 4
LOCKS REPLACEMENT
SECTION M-M
LOCK STATION 6+50A

DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
JFB	KAH	JFB		AS SHOWN	037-R54-10/7

PLATE 5-21



SECTION N-N

LOCK STATION 0+00

SCALE: 1" = 20' HORIZONTAL

SCALE: 1" = 10' VERTICAL

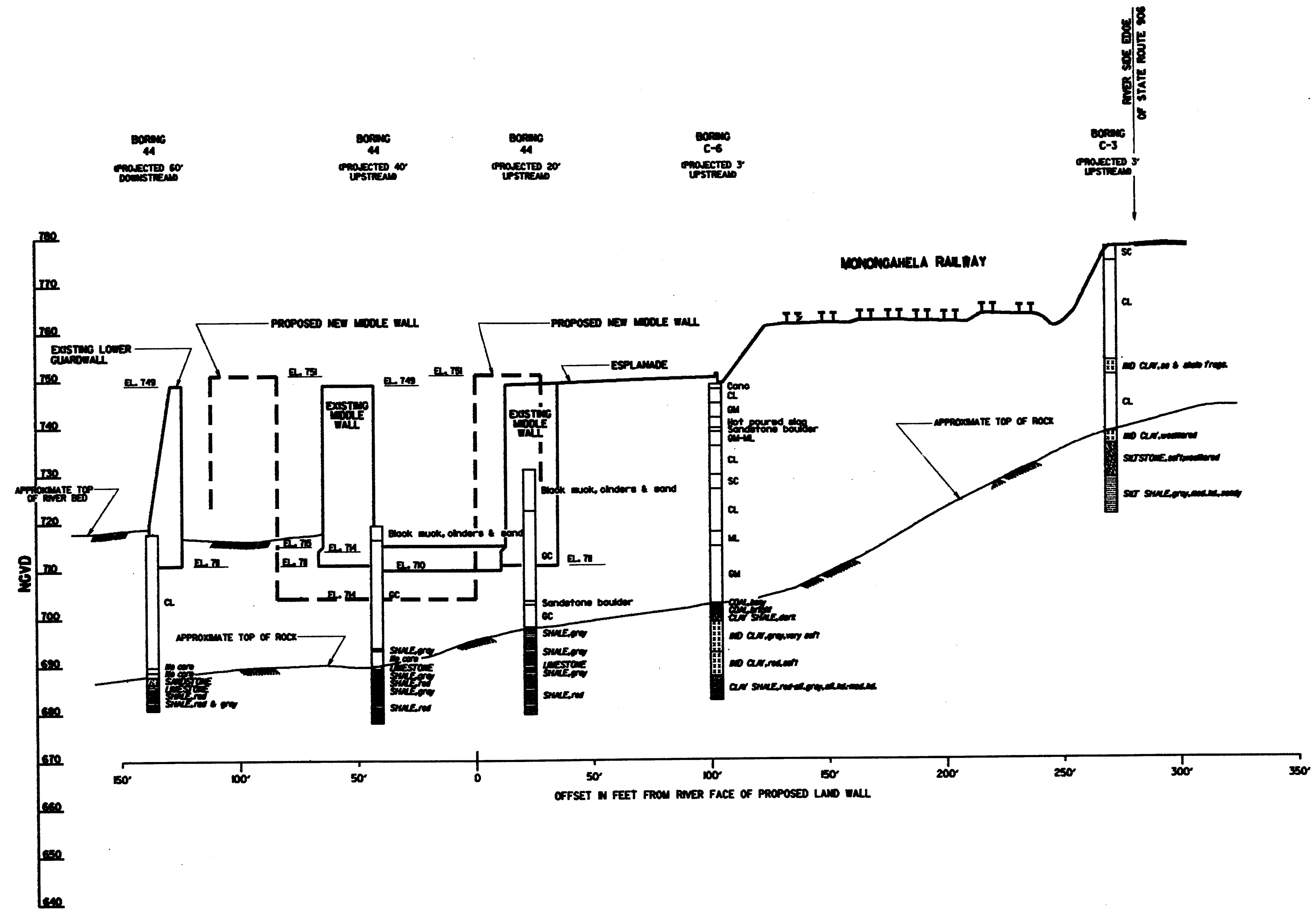
NOTE:

FOR LOCATION OF SECTION N-N SEE PLATE 5-14.

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER
LOCKS AND DAM NO. 4
LOCKS REPLACEMENT
SECTION N-N
LOCK STA. 0+00

DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
JFB	KAH	JFB		AS SHOWN	037-R54-10/8



SECTION P-P
LOCK STATION 4+20B

SCALE: 1" = 20' HORIZONTAL
SCALE: 1" = 10' VERTICAL

NOTE:
FOR LOCATION OF SECTION P-P SEE PLATE 5-14.

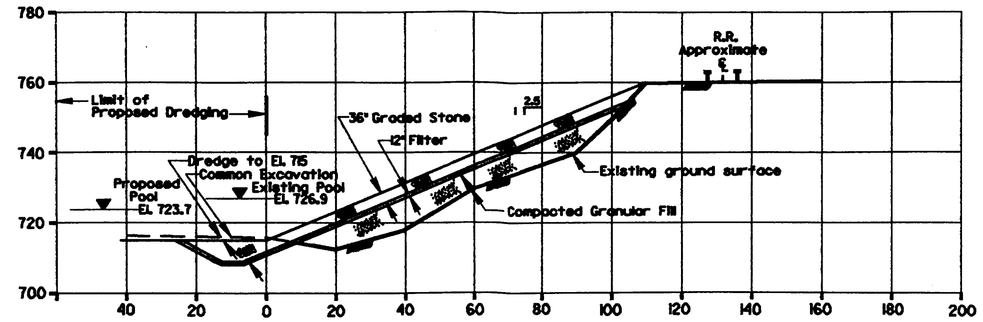
GRAPHIC SCALE
SCALE: 1" = 20'
SCALE: 1" = 10'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

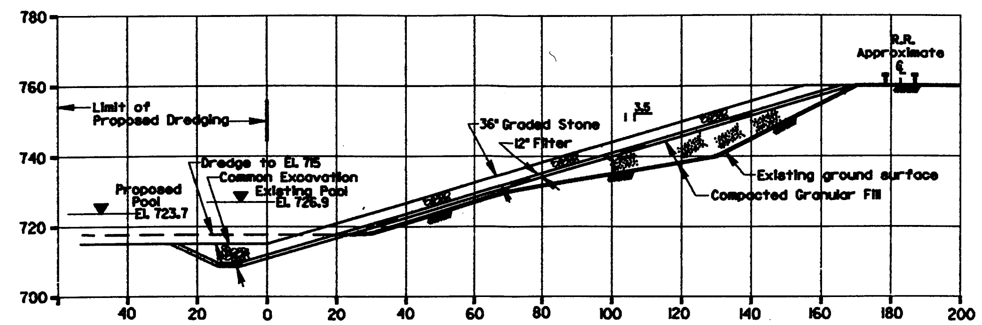
MONONGAHELA RIVER
LOCKS AND DAM NO. 4
LOCKS REPLACEMENT
SECTION P-P
LOCK STATION 4+20B

DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
JFB	KAH	JFB		AS SHOWN	037-R54-10/9

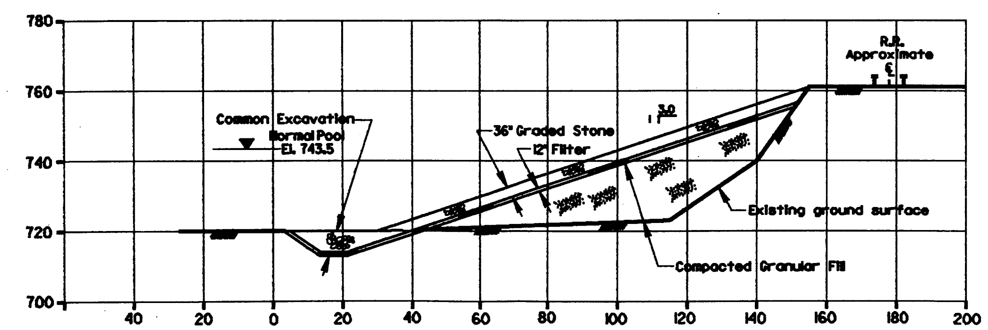
PLATE 5-23



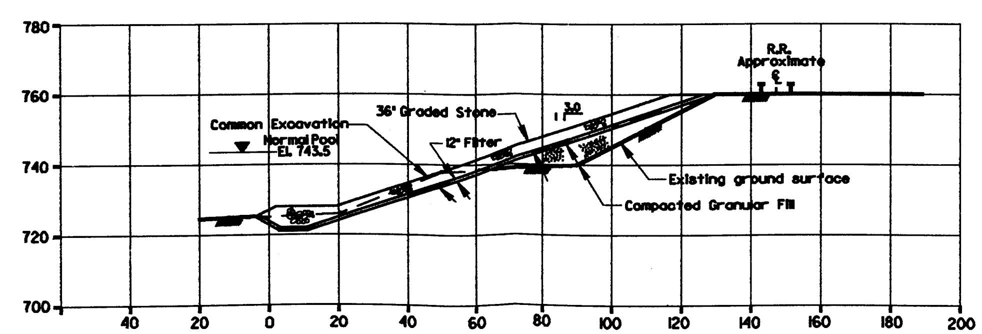
Distance in feet from Dredge Limit
Sta 23+00 B
Lower Approach: Typical Section Sta 22+00 B to 30+00 B



Distance in feet from Dredge Limit
Sta 18+00 B
Lower Approach: Typical Section Sta 15+85 B to 21+00 B



Distance in feet from Projected River Face of Proposed Landwall
Sta 15+00 A
Upper Approach: Typical Section Sta 25+00 A to 10+00 A



Distance in feet from Projected River Face of Proposed Landwall
Sta 31+00 A
Upper Approach: Typical Section Sta 40+00 A to 25+00 A

NOTES:

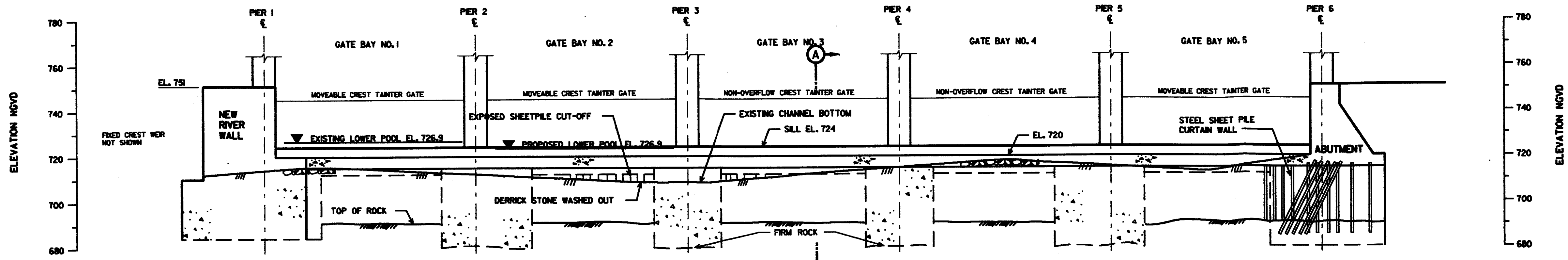
1. X-Sections developed from 1945 topography.
2. Final design for stone protection gradation and thickness will meet criteria of EM 1110-2-1601.
3. Upstream protection limit at Sta. 40+00 A.
4. Downstream protection limit at Sta. 30+00 B.

GRAPHIC SCALE
20 10 0 20 40FT
SCALE: 1"= 20'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER
LOCKS AND DAM 4
PROPOSED LOCKS REPLACEMENT
TYPICAL UPPER AND LOWER APPROACH SECTIONS

DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
DEC	PJY	DEC		AS SHOWN	037-R54- 32/1

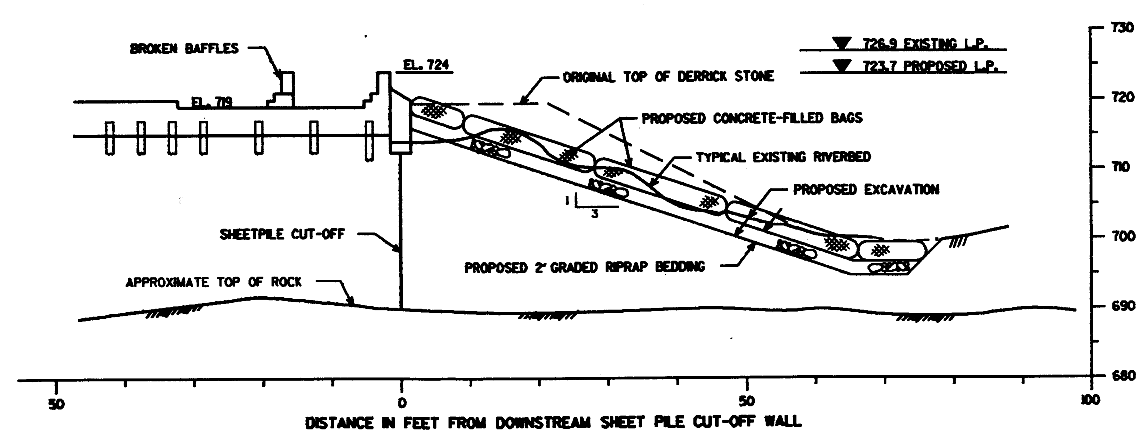


DOWNSTREAM ELEVATION

EXISTING CONDITIONS

SCALE:1"=20'

NOTE: CHANNEL BOTTOM ELEVATION DETERMINED FROM 1987 DIVERS INSPECTION.



SECTION A-A

PROPOSED SCOUR PROTECTION DETAIL

SCALE:1"=10'

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

1" = 20' 1" = 10'

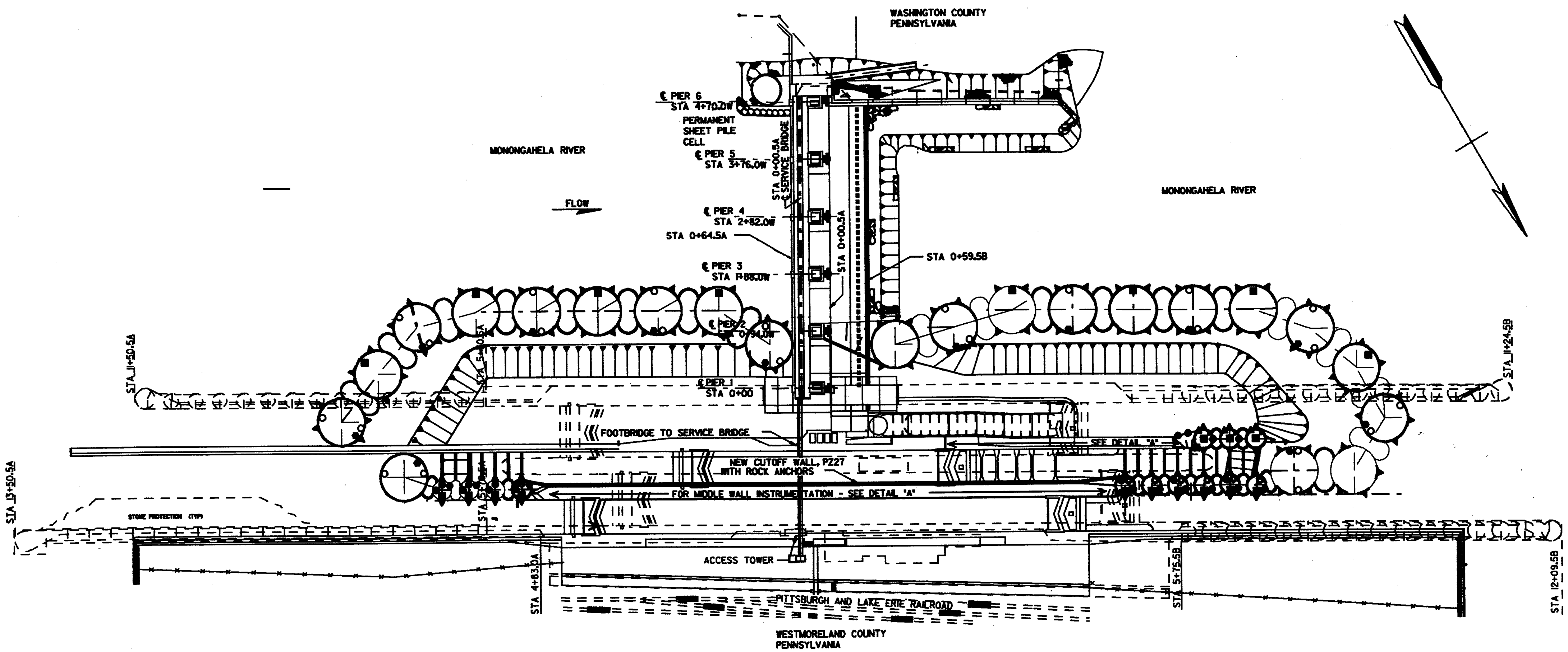
U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS

MONONGAHELA RIVER

LOCKS AND DAM 4

PROPOSED LOCK REPLACEMENT
TYPICAL SCOUR PROTECTION DETAIL

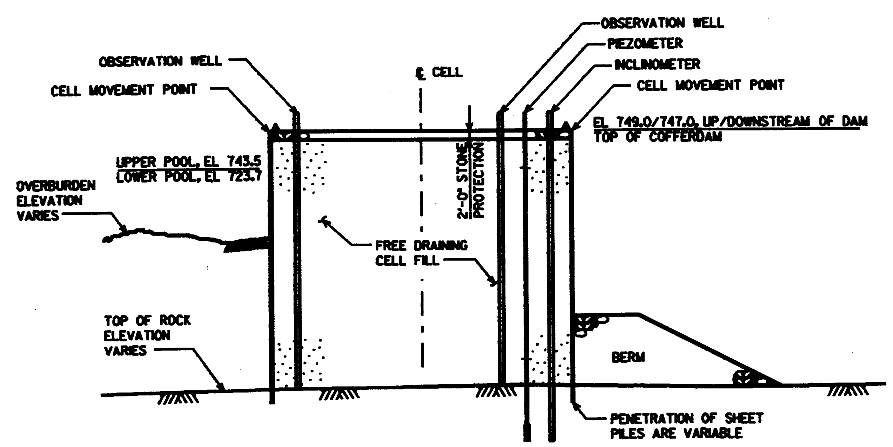
DESIGNED	DRAWN	CHECKED	DATE	SCALE	FILE NO.
DEC	TLB			AS SHOWN	037-R54- 61/2



STAGE I COFFERDAM

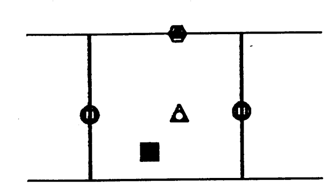
PROPOSED INSTRUMENTATION PLAN

SCALE 1"= 80'



TYPICAL INSTRUMENTATION DETAIL

NOT TO SCALE



DETAIL A

EXISTING MIDDLE WALL MONOLITH INSTRUMENTATION PLAN

NOT TO SCALE

STAGE I
ALIGNMENT PIN
CELL MOVEMENT POINT
INCLINOMETERS
LOAD CELL
OBSERVATION WELL
PIEZOMETER
SHEAR STRIP
TILT PLATE

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

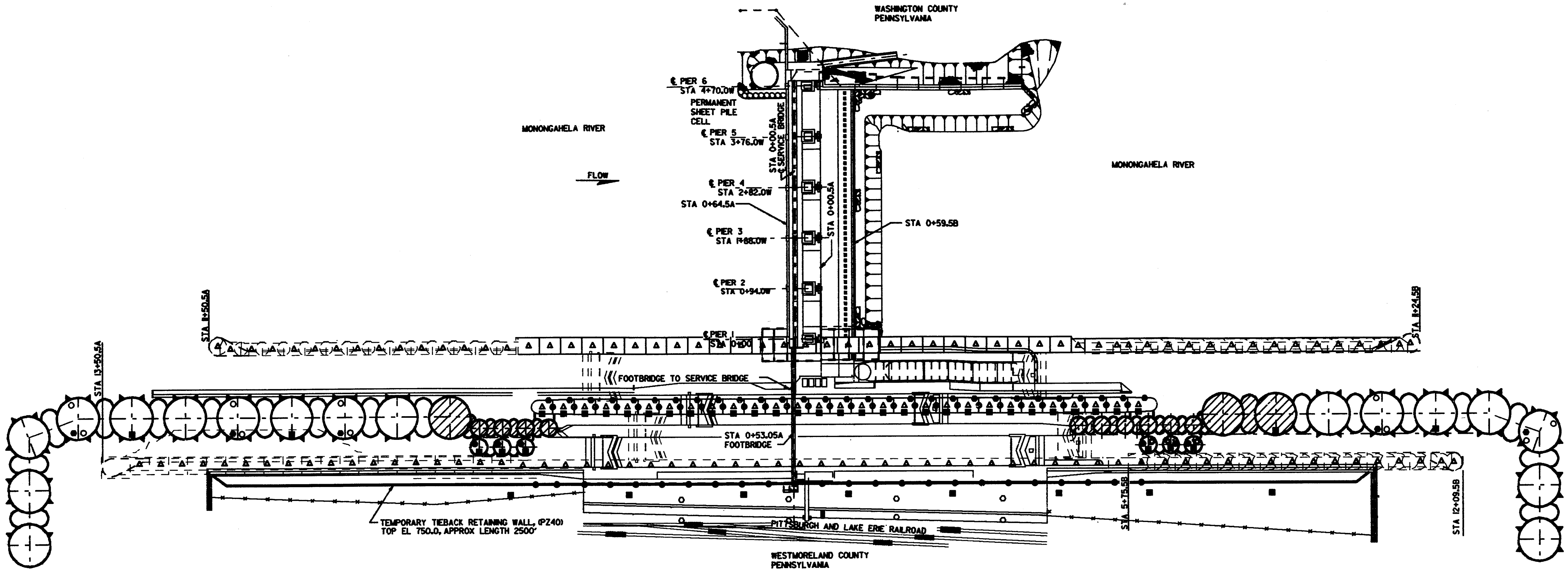
U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER

LOCKS AND DAM 4

COFFERDAM INSTRUMENTATION
STAGE I

DESIGNED: DEC	DRAWN: TLB	CHECKED:	DATE:	SCALE: 1"=80'	FILE NO. 037-R54- 88/2
SUBMITTED:			IFB NO.		SHEET OF



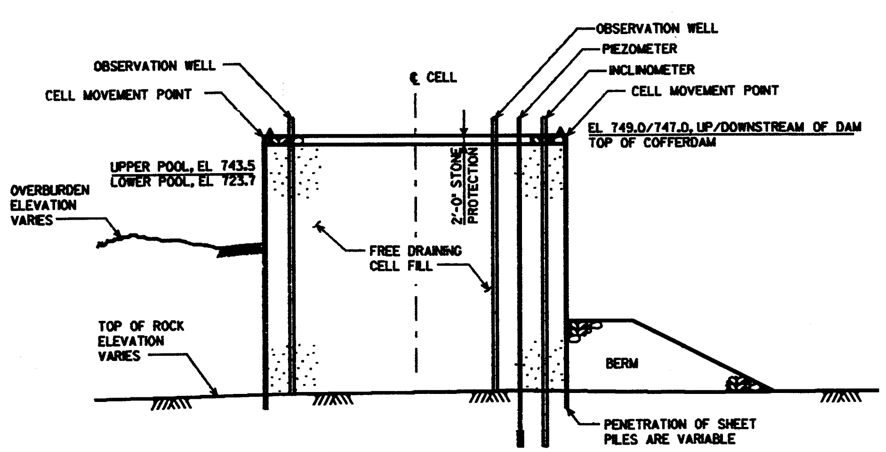
STAGE 2 COFFERDAM

PROPOSED INSTRUMENTATION PLAN

SCALE 1"= 80'

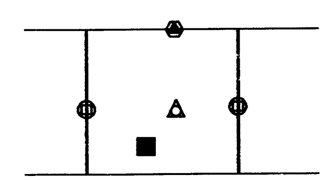
LEGEND:

- FIRST STAGE COFFER CELLS TO REMAIN



TYPICAL INSTRUMENTATION DETAIL

NOT TO SCALE



DETAIL A

PROPOSED MIDDLE WALL MONOLITH

INSTRUMENTATION PLAN

NOT TO SCALE

STAGE 2
△ ALIGNMENT PIN
CELL MOVEMENT POINT
■ INCLINOMETERS
LOAD CELL
○ OBSERVATION WELL
● PIEZOMETER
SHEAR STRIP
TILT PLATE

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE
40' 20' 0 40' 80'
1"= 80'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

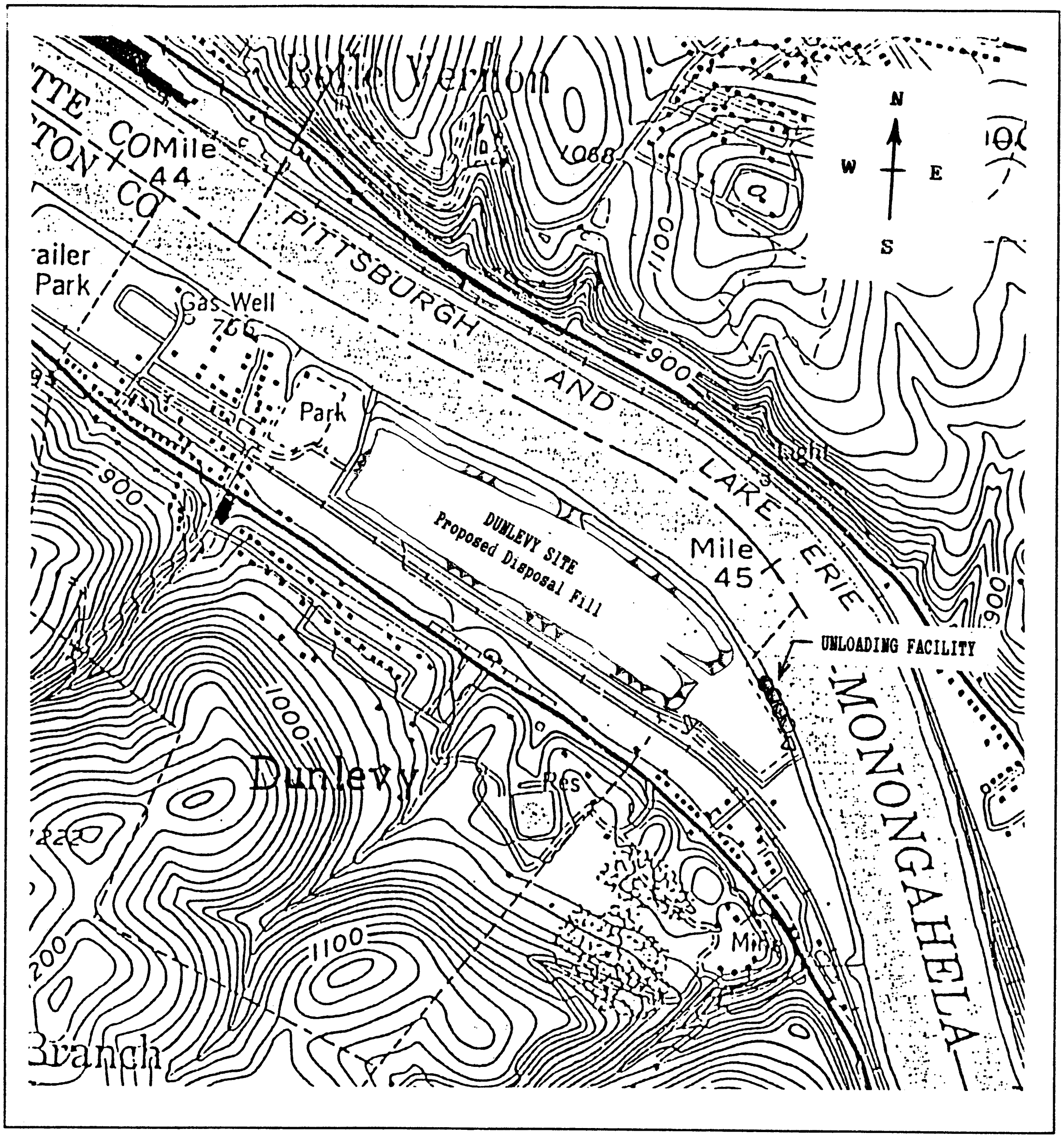
MONONGAHELA RIVER

LOCKS AND DAM 4

COFFERDAM INSTRUMENTATION
STAGE 2

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	FILE NO.
DEC	TLB			AS SHOWN	037-R54- 88/3

SUBMITTED: IFB NO. DWG OF



Monongahela River

DAM 4 CONSTRUCTION

Dunlevy Disposal Site

Topography and General Plan

Scale 1" = 1000' (Approx)

PLATE 5-28

6. Project Design

a. Site Selection and Project Developments

In the final screening phase seven plans along with the without project condition were evaluated. The primary objective was to determine the most appropriate and cost effective means of correcting the deficiencies at Locks and Dams 2, 3, and 4 on the Monongahela River. The selected plan calls for replacing the fixed-crest dam at L/D 2 with a gated dam, removing L/D 3 and replacing the locks at L/D 4. See PLATES 6-1, 6-6 and 6-7 for Location and Vicinity Maps of L/Ds 2, 3 and 4 respectively.

(1) Civil Requirements

(a) Plan components at L/D 2

The existing 748" long fixed-crest Dam 2 would be removed (see PLATE 6-2), including the timber cribbing foundation and the concrete weir. A new gated dam would be constructed along an alignment 485' upstream of the existing Dam 2 (see PLATE 6-3). To compensate for the dam being moved upstream, an extension of the guard wall is included as an aid to navigation. As currently envisioned (see PLATE 6-4), the new non-navigable dam would be a tainter gated structure consisting of five, 110' gate bays with 12' wide piers on 122' centers. Provisions would be made for a future 110' river chamber by constructing a single monolith riverward of the existing riverwall connected by a fixed crest weir. The overall dam length would be 729.5 ft. extending from the river face of the lock riverwall to the river face of the abutment. The piers would be concrete gravity structures founded on rock and the gate bay sill monoliths and fixed crest weir monoliths would be supported by steel H-piles driven to rock. The sill crest elevation for gate bays 2 thru 5 would be set at 696.7 NGVD while that of gate bay 1 would be considerably higher at elevation 714 NGVD +/- to provide for additional downstream reaeration. The crest elevation of the weir would be 723.7 NGVD and the top of the abutment wall would be 739.0 NGVD. The gates would be the non-overflow type with the centerline of trunnion elevation at 727.7 NGVD.

The existing floodway bulkhead structure for the small lock chamber would be removed. The existing bulkhead sill would be repaired and a new bulkhead, hoist and hoist structure would be constructed in the existing location, consisting of a steel hoist structure to raise a single steel bulkhead vertically to its stored position. The bulkhead would be fabricated with welded steel trusses with a skin plate.

The existing locks would be rehabilitated in about the year 2020, to consist of the following major features (see PLATE 6-5): repair to the access road; removal of deteriorated concrete and reinforcement from the wall faces and tops of monoliths; refacing walls and resurfacing tops of monoliths with new reinforced concrete; removal and replacement of all lock gate and valve operating machinery and related equipment; removal and reconstruction of all miter sills; installation of wall armor; replacement of the electrical system and control and operations buildings; abandonment of the existing septic tank-leach field system, installation of an esplanade pump station and connection to a municipal sewage system; and connection to a commercial water distribution system.

Pool 2 would be raised 5.0' above the crest of the existing fixed-crest dam, to elevation 723.7 NGVD. On average, this new pool level would be approximately 2' above normal river levels currently experienced. The permanent pool raise will require bank stabilization at an estimated 11 locations in Pool 2 where the loss of soil stability would adversely affect a shoreside facility. It would also require a variety of Federal and non-Federal relocations in Pool 2 and the acquisition of flowage easements on tributaries to the Monongahela River in Pool 2. These relocations and acquisitions are discussed more fully in Sections 6.b and 6.c, respectively.

(b) Plan Components at L/D 3

Locks and Dam 3 would be removed and Pool 3 would be lowered 3.2' below the crest of the existing fixed-crest dam, to elevation 723.7 NGVD. On average, this new pool level would be approximately 5.5' below normal river levels currently experienced. The permanent pool lowering will require a variety of Federal and non-Federal relocations in Pool 3. These relocations are discussed more fully in section 6.c. The removal would consist of the existing 670' long concrete fixed-crest dam and 18' wide pier in midstream, the 56' X 720' land chamber, the 56' X 360' river chamber, the 391' river chamber extension, and all related operating machinery and equipment. All removal would be to the level of the streambed. During removal of the dam, traffic would be maintained through the open locks. This will require the upper guard sills to be removed first so that tows will have sufficient draft after Pool 3 is lowered 3.2'. Pool 3 would be dredged to a design template 11' below elevation 723.7 NGVD, or the normal pool to be maintained by the new gated dam at L/D 2. The dredging would be completed prior to the lowering of Pool 3.

(c) Plan Components at L/D 4

All facilities related to the existing 56' X 360' river and 56' X 720' land chambers would be removed and replaced with twin 84' X 720' locks chambers (see PLATE 6-8). The existing land chamber would be used to maintain traffic while the new river chamber is being constructed. The new river chamber would then be used while the land chamber and esplanade are being onstructed. At the time of the construction of the gated dam in the mid-1960's a new riverwall section, founded on rock, consisting of 6 monoliths for a total of 224 feet was constructed in anticipation of these future locks. This existing stub riverwall would be extended to form the riverwall for the new 84' river chamber (see PLATE 6-9).

The new lock walls would be concrete gravity structures with a top elevation of 751.0 NGVD, 2' higher than the existing lock walls. The upstream and downstream miter sills are set to provide a minimum of 18 feet of navigational clearance at minimum headwater and tailwater. Both the upstream and downstream chamber gates are steel miter type. Each chamber would have an emergency closure. The emergency bulkhead units would be placed by a hoist traveling on parallel steel girder spans over the lock chambers similar to Point Marion currently under construction. Access to the existing service bridge would be provided by a steel plate girder footbridge spanning the new locks.

The Riverwall and Landwall would be founded on firm rock. The Middlewall would be founded on caissons. Both the upper and lower guard walls would be concrete gravity walls constructed on steel bearing piles enclosed in circular sheet pile cells filled with gravel. The top elevation of the cells would be below minimum headwater and tailwater. The upper guide wall would be constructed on steel H-Piles. The lower guide wall would be founded on diaphragm type continuous sheet piling cells.

The land chamber would use a side port filling and emptying system with 10' by 12' culverts in both the landwall and middlewall. The river chamber will use a lateral filling and emptying system with a 15.5' by 15.5' culvert in the riverwall.

Two new buildings would be constructed at the new locks. A two story operations building would be located on the middlewall. In addition, a service building would be located on the esplanade and associated operating machinery, equipment, and control buildings.

(2) Structural Requirements

The various structural components of the locks (L/D 4) and the dam (L/D 2) would conform with the applicable general criteria set forth in the following sections of the Engineering Manuals below:

Concrete. EM 1110-2-2000, Standard Practice for Concrete, September 1982 and ETL 1110-2-324, Special Design Provisions for Massive Concrete Structures, March 1990

Working Stresses. EM 1110-2-2101, Working Stresses for Structural Design, January 1972, and ETL 1110-2-265 Strength Design Criteria for Reinforced Concrete Hydraulic Structures, September 1981.

Walls. EM 1110-2-2502, Retaining and Floodwalls, Sept. 1989.

Locks. EM 1110-2-2606, Navigation Lock and Dam Design, June 1952. ETL 1110-2-223, Navigation Lock Sill Depths and Hydraulic Loads on Gates, June 1977

Lock Masonry. EM 1110-2-2602, Planning and Design of Navigation Lock Walls and Appurtenances, June 1960.

Dam. EM 1110-2-2200, Gravity Dam Design, September 1958.

Miter Gates. EM 1110-2-2703, Lock Gates and Operating Equipment, February 1984.

Cofferdam. EM 1110-2-2503, Design of Sheet Pile Cellular Structures, September 1989

Stability. ETL 1110-2-22, Design of Navigation Lock Gravity Walls, April 1967, and ETL 1110-2-256, Sliding Stability of Concrete Structures, June 1981.

Loadings. Loadings would be estimated based on the following weights with earth pressures calculated in accordance with EM 1110-2-2502, Retaining Walls.

Material	Unit Weight
Concrete	150 lb/cf
Water	62.5 lb/cf
Moist Earth	113 lb/cf
Saturated Earth	120 lb/cf
Siltstone	160 lb/cf
Silt	115 lb/cf

Uplift. In the proportioning and design of all concrete sections founded on rock, where the resultants of all loads acting on the monolith fall at or within the middle third of the base width, uplift would vary linearly from 100 percent of the head represented by the saturation level in the backfill, or the water level at one side to 100 percent of the head represented by the water level at the other side. Where the resultant of all forces acting on the monolith falls outside the middle third of the base, uplift would be assumed as acting with 100 percent of the head at one side over the inactive base area and to decrease linearly to 100 percent of the head at the other side. Uplift within the body of the lock wall would be assumed to vary linearly from 50 percent of pool or zero at the low water face to 50 percent of pool or saturation level at the high-water face. Uplift on the base of guide and guard walls on cells would be assumed as 100 percent of the water pressure acting on 100 percent of the base area.

Foundations. In general, base widths would be selected to satisfy overturning requirements. Cells driven to rock and supporting cap walls would be designed in accordance with accepted design procedures based on slippage between sheets and fill, interlock tension, sliding stability, and shear failure of fill at center line.

Lock Wall Design. The concrete sections would be proportioned and designed in accordance with the stability criteria set forth in the aforementioned Corps of Engineers' Manuals. The saturation line in the landwall backfill would be assumed to vary linearly from upper pool at the upper gate monolith to lower pool at the lower gate monolith. In addition to the earth and water loads, the lock, guard, and guide walls would be designed for a line pull of 800 lb/ft (12 ton minimum) and the guide and guard walls for an impact of 2,500 lb/ft (60 ton minimum). The riverwall would be subjected to an impact of 800 lb/ft (20 ton minimum) if the moment produces overturning. Line pull and impact would not be assumed to act simultaneously.

(a) L/D 2

The "2 for 3" Plan proposes a gated dam to replace the fixed crest dam at Locks and Dam 2. Pool 2 would be raised 5 feet to elevation 723.7. A gated dam was chosen because the control it provides is essential to minimize impacts to communities and businesses along the river from Braddock to Elizabeth. If the existing dam was replaced by a new fixed crest dam not only would the normal pool elevations rise, but ordinary high water (OHW) and flood elevations would also rise comparably, making this alternative undesirable and uneconomical. A gated dam would raise the normal pool, however, OHW and flood elevations would decrease. Although specific costs were not calculated, experience and good engineering judgement eliminate the fixed crest dam alternative at L/D 2 in the recommended plan. A more detailed analysis to justify the gated dam is not warranted. Many of the features of the new gated dam at L/D 2 are being modeled after that of the Hannibal Locks and Dam, built in the early 1970's.

The axis of the gated dam would be moved 485 feet upstream bringing it in alignment with the 110' lock closure. By doing this the large chamber could be closed with the dam bulkheads and hoist, eliminating a separate closure. Another advantage is the elimination of a cofferdam stage. If the gated dam was built at the existing dam axis, a four stage cofferdam would be required as opposed to the three stage cofferdam which is currently proposed. Moving the axis upstream will, however, require some additional work including rebuilding a portion of the upper guard wall, possibly extending the upper guard wall and relocating a USX outlet. Experience and good engineering judgement indicate moving the dam upstream would be the most economical solution. A more detailed analysis of the location of the gated dam is not warranted.

Although a more detailed analysis of a fixed crest alternative at L/D 2 would not be pursued, The District intends to give further consideration to the possible use of a wicket dam in lieu of the gated structure previously described. A hydraulically operated wicket dam similar to that proposed for the Olmsted project on the Ohio River will be evaluated as an alternative to tainter gates. Such a dam would only be used for upper pool control; there is no intent to provide open river navigation over the wickets. If the wickets are ten feet wide, as at Olmsted, approximately 75 would be required. The upper pool ordinarily would be maintained by completely raising or lowering the required number of individual wickets. However, regulation during lower flows would require much finer control and several options will be evaluated. One advantage of a wicket dam is the absence of piers to catch runaway barges, which typically block the gate bays of a tainter gated structure causing backwater flooding and become jammed under the gates preventing closure or bulkhead placement resulting in a loss of upper pool. (Three such incidents have occurred on the Mon River at the Maxwell Dam over the past eight years.) One major disadvantage with a design similar to the Olmsted Project could be leakage. The 4" gaps between wickets proposed at Olmsted would not be acceptable on the Monongahela River as most of the water during periods of low flow may be needed for lockages in the future. Therefore, good side seals would be required for wickets to be viable. Questions also exist concerning the effects of ice on wickets. The analysis of the validity of a wicket dam would be covered during PED.

The new floodway bulkhead structure at L/D 2 would be modeled after that of the Point Marion Lock currently under construction. The recommended Plan calls for construction of a floodway bulkhead prior to construction of the new gated dam. The existing floodway bulkhead is difficult to operate and unreliable. During construction of the dam, the first two stages of the cofferdam would restrict flow in the river. It is important during this time to have a reliable floodway bulkhead to reduce frequent cofferdam overtopping and flooding to the communities and businesses during construction of the dam. If a floodway is not provided, flooding would be more destructive and costly.

In accordance with ETL 1110-2-324, Special Design Provisions for Massive Concrete Structures, a nonlinear, incremental structural analysis (NISA) would be performed on the dam piers. The results of this analysis would be presented in a separate Design Memorandum entitled "Structural Properties and Special Design Considerations". The remaining analyses and computations would be presented in the Design Memorandum.

<u>(b) L/D 4</u>

In the "2 for 3" Plan new locks at L/D 4 would be constructed in the year 2002. Locks 4 were originally designed for a pool differential of 10.6 feet. When the Gated Dam was constructed in the early 1960's the locks were modified to support a differential of 16.6 feet with the understanding that this would be a temporary condition. In the recommended plan, Pool 3 would be lowered 3.2 feet to elevation 723.7. With the lowering of Pool 3, the differential would become 19.8 feet, almost double what the locks were originally designed for. If the locks are not replaced, a major rehab would be needed. In addition, the modifications described below would be required due to the lowering of Pool 3.

1. With the lower pool at elevation 723.7 feet, the clearance over the lower guard sill would be 7.5 feet, and the clearance over the lower miter sill would be 7.7 feet. Guaranteed channel depth is 9 feet. Consequently, both sills would need to be replaced. In addition, when the miter sill is lowered, new lower miter gates would be required.

2. At the time of the reconstruction of Dam 4 struts were incorporated into the chamber floor to bring high lateral pile loads to acceptable levels. With the lowering of Pool 3 by 3.2 feet, we would again be faced with the problem of high pile loads and instability of the lock walls. This would have to be addressed if the locks were to remain.

3. The chamber floor is at elevation 714.0, which provides 9.7 feet of clearance. Although this is within the guatanteed depth it is "too close for comfort", increasing the possibility of impact damage. Tows would have to move extremely slowly through the chamber possibly causing delays. Because the stabilizing struts are within the chamber floor, any damage could threaten the stability of the lock walls.

4. The filling and emptying system would also cause problems. When the chamber is filling excessive forces would be experienced by the tows. Instead of the water coming into the chamber underneath the tows, it would come out directly against the tows. The elevation of the culverts would create further problems. The top of the culvert is at elevation 727.0. At lower pool this would leave 3.3 feet of air space in the culvert. This air space would become pressurized during the filling and emptying process. This in turn could blow out the lock walls if not remedied. Some type of pressure relief system or alterations to the filling and emptying system would be required.

The lowering of Pool 3 would put Locks 4 in a critical condition. As discussed, the changes required to keep the locks in operation would be complex and costly. Although specific costs were not calculated, the magnitude of the adjustments needed to facilitate this pool change approaches the cost of new locks. Given the concerns about the existing structure, i.e., high pile loads, thin sections and lack of reinforcing, any attempt to rehabilitate and modify Locks 4 with replacement at a later date (2027) in the "2 for 3" Plan is technically indesireable. It would be far more prudent to replace the locks in 2002. A more detailed analysis of the timing of new locks construction is not warranted.

Many of the features of the new locks at L/D 4 were modeled after similar locks at Maxwell Locks and Dam which were constructed in the early 1960's. The filling and emptying systems at Maxwell L/D are both bottom lateral systems. At L/D 4, however, the land chamber will have a side port filling and emptying system. This was modeled after projects at Point Marion and Grays Landing which are currently under construction.

Both the landwall and the riverwalls are founded on firm rock at approximate elevation 680.0. Because of the close proximity of the existing middlewall to the new middlewall, 19 feet, and the need for the existing middlewall to remain while constructing the new middlewall, excavation to firm rock would not be feasible. The new middlewall will therefore be founded on caissons. The bottom of the middlewall would be at elevation 698.0. The caissons would be founded on lower firm rock at approximate elevation 650.0.

In order to construct the new middlewall the existing concrete struts in the river chamber would have to be removed. These struts were added during the reconstruction of Dam 4. At that time the upper pool was raised 6' and the lateral loads on the piles would have exceeded allowable loads. Concrete struts were added to bring these loads to acceptable levels. Without the lateral support provided by these struts, the existing middlewall would have to be stabilized. Struts would be installed between the existing middlewall and riverwall similar to the struts used in the dewatering of Point Marion in 1987. The new middlewall would be constructed to below these stabilizing struts. Struts would then be placed between the new middlewall and the existing middlewall while the remaining portion of the new middlewall and the new riverwall were constructed. Another alternative for stabilizing the middlewall, which will be studied further, is using pin piles to resist the excessive lateral forces.

In accordance with ETL 1110-2-324, Special Design Provisions for Massive Concrete Structures, a nonlinear, incremental structural analysis (NISA) would be performed on the locks. The results of this analysis would be presented in a separate Design Memorandum entitled "Structural Properties and Special Design Considerations". The remaining analyses and computations would be presented in the Design Memorandum.

<u>(3) Electrical and Mechanical Requirements</u>

<u>(a) Electrical Requirements</u>

<u>L/D 2 Floodway Bulkhead.</u> The floodway bulkhead hoist will be rated 460 volts, 3 phase, 60 hertz. Power for the bulkhead hoist would be supplied by a 480 volt feeder from the existing

distribution system. Remote operator stations would be provided on the lockwall for operation of the hoist at lock level and on the bridge walkway.

L/D 2 Gated Dam. The electric service would be upgraded to accommodate the new gate hoist motors and other miscellaneous loads. The normal source of power is through the facilities of the Duquesne Light Company. Power feeders would be extended from a distribution point at the lock across the length of the dam.

L/D 2 Lock Rehab. The electric service would be upgraded to accommodate new lock loads. The normal source of power is provided through the facilities of the Duquesne Light Company. Distribution equipment, conduit, wire, cable, and lock lighting would also require upgrading. The service would be supplied at 277/480 volt, 3 phase, 60 hertz. Power would be provided to the hydraulic package oil pumps, air compressor, service water pump, and other miscellaneous loads.

L/D 4 New Locks. The electric service would be upgraded to accommodate the lock loads and the existing dam loads. The normal source of power is through the facilities of the West Penn Power Company. The service would be supplied at 277/480 volts, 3 phase, 60 hertz. Emergency service would be provided for operation of the hydraulic oil pumps, air compressor, service water pump, elevator motor, the existing dam hoist gate motors and the bulkhead hoist.

(b) Mechanical Requirements

L/D 2 Lock Rehab.

1. New Small Chamber Floodway Bulkhead Hoist. The trestle mounted electric hoist would consist of a driven end with two tandem mounted cable drums and suitable speed reducers interconnected by a drive shaft to drive end unit, similar to the driven end except for a drive motor and brake. The hoist and trestle arrangement would be similar to Point Marion.

2. New Gated Dam Tainter Gate Hoist Machinery. The hoist would consist of a driven end, located in a pier house, consisting of a cable drum, and reducer gearing, interconnected by a drive shaft to a drive unit, located in an an adjacent pier house at the opposite end of the gate, which is similar to the driven end unit except for drive motor and brake. The hoist would be similar to that on Hannibal Dam. A truss type skin plated dam bulkhead would be provided. An electric bulkhead hoist with an included utility locomotive crane would be provided. The bulkhead hoist and locomotive crane would be similar to Hannibal

Dam except that the locomotive crane would be a hydraulic rather than mechanical type.

3. Wicket Dams. Wicket dams including the following inherent wicket problems are being considered as an alternate to Tainter Gates;

(a) Unlike Tainter Gates which are "failsafe" (hoist failure would allow gate to automatically close, thus maintaining pool), Wicket Hoist failure would allow Wickets to open with loss of pool.

(b) Pump and motor controls would be subjected to flooding in their gallery location.

(c) Cylinders exposed to water and debris damage.

(d) Oil leakage could cause EPA problems.

(e) Wicket maintenance would be difficult, expensive, and dangerous since there would be no maintenance bulkhead.

4. Lock Hydraulic Systems. Each lock gate leaf and one local filling or emptying valve would be operated by a package type hydraulic system. The package shall include a motor, pump, and oil reservoir. System pressure would be 800 psi. Joy Stick operated proportional 4-way valves would provide speed control of the miter gates. Filling and emptying valves would be operated at a single speed by pushbuttons and a standard 4-way valve. The system would be similar to that used at Point Marion and Grays Landing.

5. Miter Gate Machinery. The machinery would utilize foot-mounted commercial hydraulic cylinders, conventional sector and rack, sector arm, and strut with coil compression springs. Machinery would be similar to Point Marion and Grays Landing.

6. Valve Machinery. The machinery would utilize trunion mounted commercial hydraulic cylinders directly connected to a conventional rocker and coil spring loaded strut arm. The machinery would be similar to Point Marion and Grays Landing, excepting the cylinder trunion mounting.

L/D 4 New Locks

Hydraulic system and machinery would be similar to that described above for Mon 2.

(c) Utility Service Requirements

Lock 4 will require the following utility services:

Sewerage System. The existing septic tank-leaching field at Lock 4 Mon River would be abandoned. The new system would consist of pump station and a tie-in to the municipal system, Mon

Valley Sanitary Authority. To facilitate this tie-in, a railroad crossing for the pipeline would be required. The tie-in point is along route 906, near the Villa Nova Tavern.

Potable Water System. Lock 4 Mon River presently buys potable water from the Charleroi Water Authority. This water service would be upgraded to meet the requirements of the new facilities planned for the lock.

Natural Gas Service. The new buildings at Lock 4 Mon River would utilize natural gas for heating. This service would be obtained by connecting to the Peoples Gas distribution system. There is a medium pressure gas line on the river side of route 906 that is adequate to service the new lock. To facilitate this tie-in, a railroad crossing for the pipeline would be required.

(4) Hazardous and Toxic Materials

Testing of samples taken from the river channel between Locks 3 and 4 has determined that hazardous and toxic materials would not be a problem. This is the area where the pool would be lowered and dredging would be required to maintain minimum channel depth. The Pennsylvania Department of Environmental Resources, Bureau of Water Quality, was involved in the selection of testing sites for the navigation channel dredged material analysis and in review of the study results. More information can be found in the Draft Environmental Impact Statement which is located in Volume I and in section 11 of this Appendix.

b. Real Estate

(1) Flowage Easements

Ordinary High Water (OHW) would be lowered between miles 11.2 and 23.8 due to replacement of the existing fixed-crest dam with a gated structure having lower sills and greater discharge capacity. OHW would also be lowered from mile 23.8 to 41.5 due to the replacement of Dam 2, the removal of Locks and Dam 3 and dredging in existing Pool 3. For the same reasons, all floods would be reduced above mile 11.2. Thus, with floods and ordinary high water being lowered, no flowage easements would be required along the Monongahela River main stem or the Youghiogheny River, also classified as a navigable tributary, pursuant to the navigation servitude powers of the Federal Government in regulating Section 10 of the Rivers and Harbors Act of 1899. However, easements would be required on non-navigable tributaries between river miles 11.2 and 23.8. The taking line would be based on ordinary high water with a freeboard allowance.

(2) Staging and Disposal Areas and Utility Easements

Lands and interests required for construction of the selected plan include two staging areas, three disposal areas and utility easements at L/D 4. The estates to be acquired are standard estates as prescribed in ER-405-1-12. One non-standard estate, a permanent easement under the tracks and right of way of the railroad is required for construction of the new dam at L/D 2. A brief discussion of each site follows.

(a) Staging Area at Rankin

Located on the right bank approximately 1.6 miles downstream of existing L/D 2, in the vicinity of the Rankin Highway bridge, this site is required for construction of the floodway bulkhead and the dam at L/D 2. It is now a vacant, cleared industrial site. The area contains approximately 10 acres and one ownership. The estate to be acquired is a temporary work area easement. Access to the site is by an existing public road.

(b) Abutment Site at the new dam for L/D 2

The property at the abutment site consists of two distinct areas. The first is the fee area that contains approximately 3 acres and one ownership. An additional one-half acre, more or less, is needed for construction of a cut-off wall under the railroad, to be acquired by a non-standard permanent easement estate. Vehicular access to the fee area is impractical because of the existing railroad yard.

(c) Disposal Site at Coursin Hill

Located on the right bank at approximate river mile 20 in Lincoln Borough, Allegheny County, this site is required for disposal for the construction of the floodway bulkhead and the new dam at L/D 2. The site is presently undeveloped and heavily vegetated and is drained by a perennial stream. Access would be provided by an off highway haul road from a proposed barge unloading and material staging facility. Temporary work area easements and upgrades to the existing unimproved township road would be required, as well as approved railroad and highway grade crossings. The total site area is approximately 118 acres among 15 ownerships. The disposal site contains 9 residential structures that would need to be acquired.

(d) Disposal Site at Bunola

Located along the right bank near river mile 27 in Forward Township, Allegheny County, this site is required for dredging of existing Pool 3 and the removal of existing L/D 3. The site is predominantly undeveloped, with the exception of a few private dwellings, and auto salvage yard, an abandoned stripmine highwall and drift mine entry, and is heavily vegetated. Access would be provided by an off highway haul road from a proposed barge unloading and material staging facility. Temporary work area easements and upgrades to the existing unimproved township road would be required, as well as approved railroad and highway grade crossings. The total site area is approximately 229 acres among 15 ownerships. Five residential structures would need to be acquired.

(e) Staging Area at Charleroi

Located along the left bank approximately 200 feet downstream of existing L/D 4, this site is required for construction of the locks at L/D 4. The site has approximately 600' of river frontage and contains approximately 10 acres and one ownership. Vehicular access to the site is possible from the northern limits of the area to Route 88.

(f) Utility Easements at L/D 4

Utilities to be provided at L/D 4 include a sanitary sewer, gas and water lines. The sanitary sewer runs from an existing manhole downstream of the lock on the right bank, parallel to State Route 306 and then under the railroad tracks to the lock. A perpetual pipeline easement would be required for installation of the sanitary line. The gas and water lines run from main lines under SR 306, under the railroad tracks to the lock. Two license agreements with the railroads would be required for the utility lines.

(g) Disposal Site at Dunlevy

Located on the left bank near river mile 45 in Dunlevy, Washington County, this site is required for the disposal of material from the work at L/D 4. It is part of a wide section of undeveloped floodplain. The site contains an area of approximately 67 acres among one ownership. No structures are involved. Vehicular access is provided by an unnamed public street crossing the railroad tracks to the upstream end of the proposed site. A temporary work area easement would be acquired. Studies indicate that this site is unsuitable from an environmental standpoint. The disposal site at Bunola will be used or an alternative site will be selected.

c. Relocations

The permanent 5' raise of existing Pool 2 to elevation 723.7 NGVD will require the relocation of a railroad bridge, 19 municipal facilities, 24 major storm sewers, 15 commercial shoreside facilities, 1 privately owned water intake and 5 private recreational facilities. The permanent 3.2' lowering of existing Pool 3 to elevation 723.7 NGVD will require the relocation of 12 municipal facilities, 20 commercial shoreside facilities, 3 privately owned water intakes, 13 private recreational facilities and 20 submarine crossings. Tables 6-1 through 6-6 list these facilities. The Conrail Railroad Bridge would be relocated pursuant to Public Law 647 as amended (33 U.S.C. 511-523), commonly referred to as the "Truman-Hobbs Act", which provides for the alteration of railroad and highway bridges when found to be unreasonably obstructive to navigation. All adjustments to privately owned facilities adjoining the mainstem navigable waterway are the responsibility of the owner, pursuant to the navigation servitude powers of the Federal Government in regulating Section 10 of the Rivers and Harbors Act of 1899.

TABLE 6-1
MAJOR STORM SEWERS
POTENTIALLY IMPACTED BY
SELECTED PLAN

Structural Designation	Location (a)
ADJOINING MONONGAHELA RIVER	
2.0	R.M. 11.6 Right Bank
EL-2	R.M. 12.1 Left Bank
7.0	R.M. 13.3 Left Bank
8.0	R.M. 14.2 Right Bank
9.0	R.M. 14.4 Right Bank
ER-7	R.M. 16.2 Right Bank
EL-7	R.M. 19.1 Left Bank
Peter's Creek	R.M. 19.7 Left Bank
EL-8	R.M. 20.7 Left Bank
19.0	R.M. 21.1 Left Bank
EL-9	R.M. 21.5 Left Bank
22.0	R.M. 23.4 Right Bank
ADJOINING TURTLE CREEK	
ETR-2	C.M. 0.2 Right Bank
T-2	C.M. 0.4 Right Bank
ETR-1	C.M. 0.5 Right Bank
Sta 52+80	C.M. 1.0 Right Bank
P-22	C.M. 1.1 Right Bank
Sta 68+65	C.M. 1.3 Right Bank
P-29	C.M. 1.5 Right Bank
ADJOINING YOUGHIOGHENY RIVER	
YA-2	R.M. 1.2 Left Bank
YA-11	R.M. 1.3 Left Bank
YA-10	R.M. 1.5 Left Bank
YA-7	R.M. 2.3 Right Bank
YA-4	R.M. 2.6 Left Bank

(a) From R.M. 11.2-23.6 river raised to elevation 723.7 NGVD
From R.M. 23.6-41.5 river lowered to elevation 723.7 NGVD

TABLE 6-2
MUNICIPAL FACILITIES
POTENTIALLY IMPACTED BY
SELECTED PLAN

Owner	Location (a)
Park	
Borough of Elizabeth	R. M. 22.9 Right Bank
Launching Ramps	
Borough of New Eagle	R. M. 30.1 Left Bank
City of Monongahela	R. M. 32.0 Left Bank
PA Fish Commission	R. M. 33.2 Left Bank
Forward Township	R. M. 34.1 Right Bank
Borough of Webster	R. M. 36.2 Right Bank
Borough of Webster	R. M. 36.4 Right Bank
City of Monessen	R. M. 38.5 Right Bank
Aquatorium	
City of Monongahela	R. M. 31.9 Left Bank
Sanitary Sewers	
City of Duquesne	R. M. 11.5 Left Bank
Borough of Elizabeth	R. M. 22.5 - 23.0 Right Bank
Borough of West Elizabeth	R. M. 22.8 Left Bank
Borough of West Elizabeth	R. M. 22.8 - 23.3 Left Bank
Sanitary Auth. of Elizabeth Twp.	R. M. 4.1 Right Bank (Yough River)
Water Wells	
City of Duquesne	R.M. 12.5 - 12.9 Left Bank
Submarine Crossings	
Borough of Charleroi (2 Crossings)	R.M. 38.7
Borough of Charleroi	R.M. 41.0
Mon Valley Sewage Authority	R.M. 38.4

(a) From R.M. 11.2-23.6 river raised to elevation 723.7 NGVD
From R.M. 23.6-41.5 river lowered to elevation 723.7 NGVD

TABLE 6-2 (CONT.)
MUNICIPAL FACILITIES
POTENTIALLY IMPACTED BY
SELECTED PLAN

Storm Sewers

Structural Designation	Owner	Location
-	City of Duquesne	R.M. 12.4 Left Bank
ER-6	City of McKeesport	R.M. 15.6 Right Bank
11.1	City of McKeesport	R.M. 15.7 Right Bank
EL-5	Borough of Dravosburg	R.M. 16.4 Left Bank
EL-6	Borough of West Mifflin	R.M. 17.0 Left Bank
ER-8	Borough of Glassport	R.M. 17.3 Right Bank
16.0	Borough of Glassport	R.M. 17.8 Right Bank
17.0	PA. Dept. of Transportation	R.M. 18.9 Right Bank
EL-11	Borough of West Elizabeth	R.M. 23.0 Left Bank
ER-10	Borough of Elizabeth	R.M. 23.2 Right Bank
YA-13	City of McKeesport	R.M. 0.1 Left Bank (Yough River)
YA-8	City of McKeesport	R.M. 2.1 Right Bank (Yough River)

TABLE 6-3
SUBMARINE CROSSINGS
POTENTIALLY IMPACTED BY
SELECTED PLAN

Owner	Location (a)
Allegheny Pipeline Co.	R. M. 24.6
Columbia Gas Transmission Co.	R. M. 24.6
Equitable Gas	R. M. 25.4
Consolidated Gas (2 crossings)	R. M. 33.0
Peoples Natural Gas Co. (6 crossings)	R. M. 33.0
N.Y. State Natural Gas (2 crossings)	R. M. 34.0
West Penn Power	R. M. 34.1
Consolidated Natural Gas (2 crossings)	R. M. 34.3
(Unknown Owner)	R. M. 35.1
Manufacturers Heat & Light	R. M. 36.8
Peoples Natural Gas	R. M. 38.7
Peoples Natural Gas	R. M. 40.8

(a) From R.M. 11.2-23.6 river raised to elevation 723.7 NGVD
From R.M. 23.6-41.5 river lowered to elevation 723.7 NGVD

TABLE 6-4
COMMERCIAL SHORESIDE FACILITIES
POTENTIALLY IMPACTED BY
SELECTED PLAN

Owner	Location (a)
Commercial Docks	
Union Railroad Co.	R. M. 11.7-11.9 Left Bank
Union Railroad Co.	R. M. 12.1 Left Bank
Regional Industrial Develmnt Corp.	R. M. 15.0 Right Bank
Davidson Sand & Gravel Co.	R. M. 16.1-16.2 Left Bank
Boswell Oil Co.	R. M. 16.25 Left Bank
St. Clair Supply Co.	R. M. 17.4 Right Bank
C & C Marine Maintenance	R. M. 18.7 Left Bank
Glassport Transportation Center,Inc.	R. M. 19.1 Right Bank
Aristech Chemical Corp.	R. M. 19.4 Left Bank
Guttman	R. M. 21.8 Right Bank
Dillner Storage Co.	R. M. 24.2-24.3 Left Bank
Ashland Petroleum Co.	R. M. 24.6 Left Bank
Lock 3 Oil, Coal & Dock Co.	R. M. 24.8-24.9 Right Bank
Duquesne Light Co.	R. M. 25.0-25.3 Left Bank
Chemply Co.	R. M. 27.8 Right Bank
Mon River Terminal Corp.	R. M. 28.6-28.8 Right Bank
Allegheny Power System	R. M. 29.2-29.4 Left Bank
Mathies Coal Co.	R. M. 29.4-29.7 Left Bank
U.S. Steel Corp.	R. M. 30.1-30.6 Left Bank
Patterson Supply Corp.	R. M. 31.3 Left Bank
Monongahela Iron & Metal Co., Inc.	R. M. 32.7 Left Bank
Riverside Iron & Steel Corp.	R. M. 33.1 Left Bank
Duquesne Slag Products Co.	R. M. 34.3 Left Bank
Babcock & Wilcox Co.	R. M. 37.2-37.3 Right Bank
McGrew Welding Co.	R. M. 38.2 Left Bank
Canastral Construction Co.	R. M. 38.5-38.6 Right Bank
Sharon Steel	R. M. 39.8-40.3 Right Bank
Reserve Petroleum Co.	R. M. 40.9 Left Bank
Barge Facilities	
Union Railroad Co. (Mooring)	R. M. 12.1-12.4 Left Bank
Ingram Barge Co. (Mooring)	R. M. 16.4-17.2 Left Bank
Consolidation Coal Co. (Mooring)	R. M. 22.9-23.4 Left Bank
Clairton Slag Inc. (Loading)	R. M. 23.6-23.7 Left Bank
Hercules Inc. (Loading)	R. M. 23.8 Left Bank
Centofanti Marine (Marineways)	R. M. 24.5 Left Bank
Centofanti Marine (Mooring)	R. M. 24.5-24.6 Left Bank

(a) From R.M. 11.2-23.6 river raised to elevation 723.7 NGVD
From R.M. 23.6-41.5 river lowered to elevation 723.7 NGVD

TABLE 6-5
WATER INTAKES
POTENTIALLY IMPACTED BY
SELECTED PLAN

Owner	Location (a)
U.S. Steel Corp.	R.M. 11.2 Right Bank
Duquesne Light Co.	R.M. 25.1 Left Bank
Pennsylvania American Water Co.	R.M. 25.3 Left Bank
Allegheny Power Systems	R.M. 29.0 Left Bank

(a) From R.M. 11.2-23.6 river raised to elevation 723.7 NGVD
From R.M. 23.6-41.5 river lowered to elevation 723.7 NGVD

TABLE 6-6
RECREATIONAL FACILITIES
POTENTIALLY IMPACTED BY
SELECTED PLAN

Owner	Location (a)
Mon-Valley Speed Club	R. M. 15.9 Right Bank
Unknown	R. M. 16.3 Right Bank
Schiffman	R. M. 16.4 Right Bank
Swift Homes	R. M. 22.4 Right Bank
Elizabeth Boat Club	R. M. 22.8 Right Bank
Pine Run Outboard	R. M. 26.3 Right Bank
Evan Ford Boat Sales	R. M. 26.4 Right Bank
John N. Molner Marina	R. M. 29.1 Right Bank
Beach Club Marina	R. M. 30.9 Left Bank
J. Sminko	R. M. 31.4 Left Bank
Monongahela Marine	R. M. 31.8 Left Bank
Unknown	R. M. 32.6 Left Bank
Marina One	R. M. 32.1 Right Bank
Unknown	R. M. 33.1 Right Bank
Hamel	R. M. 34.3 Right Bank
Frank Irey Marina	R. M. 34.5 Right Bank
Gibson	R. M. 34.6 Right Bank
<u>Launching Ramps</u>	
Blair S. Evans	R. M. 33.2 Right Bank

(a) From R.M. 11.2-23.6 river raised to elevation 723.7 NGVD
From R.M. 23.6-41.5 river lowered to elevation 723.7 NGVD

(1) Conrail Railroad Bridge

The Conrail Railroad Bridge at river mile 11.7 must be relocated to achieve a vertical guide clearance of 42.5 feet as required by the U.S. Coast Guard (CG). In November 1990, the CG formally established the vertical guide clearance at 42.5 feet, reduced from 47.0, for the entire Monongahela River. The relocation would consist of achieving approximately 2.5' of additional vertical clearance by removing the existing channel span and constructing a new channel span with a more efficient structural design for the deck and a higher low steel elevation. It is intended that the design and construction would be performed by the railroad under a relocation contract with the Government. The cost of the relocation would be substantially a Federal cost. The railroad would contribute a portion of the cost based on procedures for apportionment of costs set forth in the Truman-Hobbs Act and adapted for Corps planning programs as outlined in ER 1165-2-25.

(2) Drainage Structures

Many culverts in existing Pool 2 will be partially or completely submerged when the pool level is raised five feet. A preliminary list of approximately 36 affected facilities was made by examining old harbor line maps and viewing the banks from a boat. Hydraulic analyses for individual pipes were not performed during this phase of study. However, it is recognized that the pool raise might reduce capacities of drainage structures in two ways. First, depending on pipe slope and length, the increased water depth at the outlet could be reflected at the inlet end. Secondly, permanent submergence might cause siltation or debris blockage. In most cases, relocation or the installation of supplemental culverts would be necessary to assure adequate performance in the future.

Assumptions concerning replacement pipes were based on a cursory review of hydraulic design calculations for other recent projects that involved a pool raise. Inverts of all new pipes would be placed above the new pool to prevent blockage. For initial cost estimates, replacement pipes under eight feet in diameter were assumed to require 50 percent greater flow area to compensate for the reduced head. Larger culverts would be replaced or supplemented by one of similar size. The following criteria, which have been utilized for design of similar projects, are proposed for future detailed hydraulic design of culvert relocations:

(a) Highway Culverts

The Pennsylvania Department of Transportation criteria for drainage design would apply. Design discharge frequency regarding roadway overflow is 10-years for city streets and local or collector roads, 25-years for limited access freeways and arterials, and 50-years for interstate highways. The allowable headwater is determined by roadway elevation with a small freeboard allowance. Additionally, a flood hazard evaluation using a flow that may exceed the roadway overflow design discharge is required using a discharge with a frequency varying from 25-years for rural roads to 50-years for suburban roads to 100-years for urban roads and any culvert longer than 100 ft where there is a potential for flood damages. Maximum ponding depths ranging from 1.25' to 2.0' depending on culvert length, damage potential, and other factors also apply.

(b) Railroad Culverts

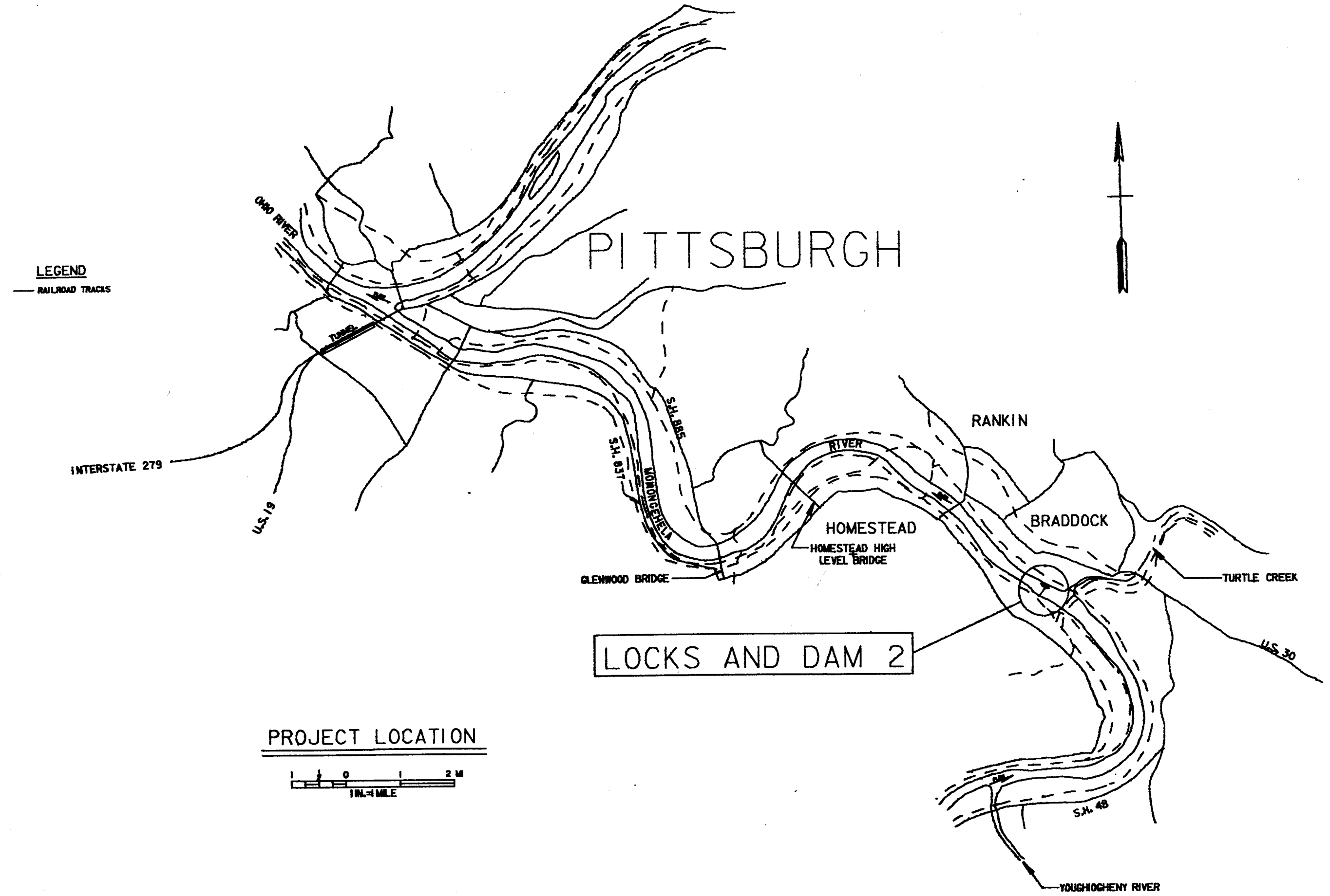
Maximum allowable headwater is set at 6' below the base of rail or a ratio of headwater depth to pipe diameter of 1.5. Design discharge is the smaller of the 100-year flow or whatever the existing culvert could pass at the same headwater elevation. Culverts extending beneath both a highway and railroad would need to satisfy criteria for both. There may also be instances where none of the listed criteria clearly apply (plant outlets, sanitary sewers) which may warrant special treatment.

(3) Effects on Turtle Creek Local Flood Protection Project

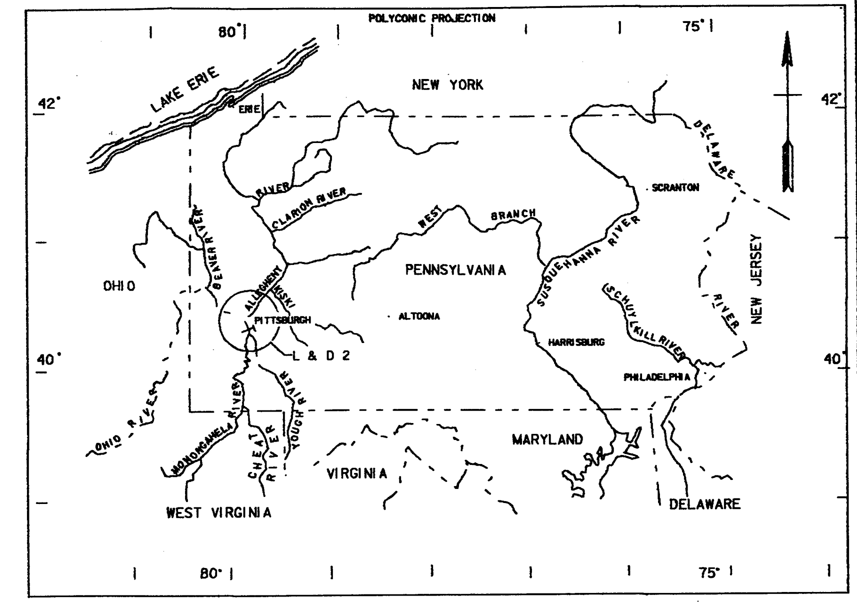
Turtle Creek is a tributary which drains 147 square miles and enters Pool 2 on the right bank just above the upper guide wall of Locks and Dam 2. A local flood protection project completed by the Corps of Engineers in 1967 extends from the mouth several miles upstream. Slackwater of existing normal Pool 2 extends to approximate station 85+0 and heavy siltation has occurred in this reach. Upstream debris basins and dams had been provided to intercept some of the sediment for easier removal, but their maintenance as well as the channel itself has been neglected by the local sponsor. The Pittsburgh District has been authorized to restore the project in cooperation with Allegheny County, the new project sponsor, which is expected to be completed in 1992. The project design frequency is 280 years and the starting elevation at the Monongahela River for the design profile is 730.0 NGVD, which corresponds to a river discharge of 125,000 cfs. Since the river would be about 1' lower at this flow after construction of a gated dam at L/D 2, the design water surface would continue to be contained after the proposed work at Locks and Dam 2, provided the channel is maintained. In addition to the flood protection from high Turtle Creek flows afforded by the Corps' project, an existing pumping station located about a mile from the mouth prevents Monongahela River backwater from causing damage.

However, with Pool 2 raised to elevation 723.7 NGVD with the selected plan, slackwater would extend an additional 3,500 ft up the Turtle Creek channel to station 120+0. River levels would be higher, except during high flow periods, which would amount to only about five percent of the time overall. Therefore, velocities on the lower reaches of Turtle Creek would be lower, and increased deposition probable, The difference in channel siltation to be expected with the raised pool was analyzed and results indicate that, in five years, 54,000 cubic yards of sediment would be expected to accumulate in the channel from the mouth to station 120+0, with the present pool, after project restoration. With this amount of sediment, protection afforded by the project would still exceed a 100-year flood. With the proposed pool, the computations show that 47,000 cubic yards could accumulate in only three years, and that four years' accumulation would exceed 54,000 cubic yards. Therefore, to avoid any additional loss of flood protection, the frequency of channel cleanouts would change from five to three years although slightly less material would need to be removed on each occasion. In addition to the increased maintenance frequency, extraction costs would be higher because the work would be conducted in water hat id deeper. Also, clearance under a railroad bridge at the mouth would be reduced, probably preventing barge access.

The average annual deposition of sediment would be 56,000 cubic yards/5 years or 11,200 cubic yards per year before the increase in pool with the Lower Monongahela River Navigation Project and 15,667 cubic yards per year (47,000 cubic yards/3 years) after the project. The sum results of the navigation project would be an annual increase of 4,467 cubic yards of sediment.

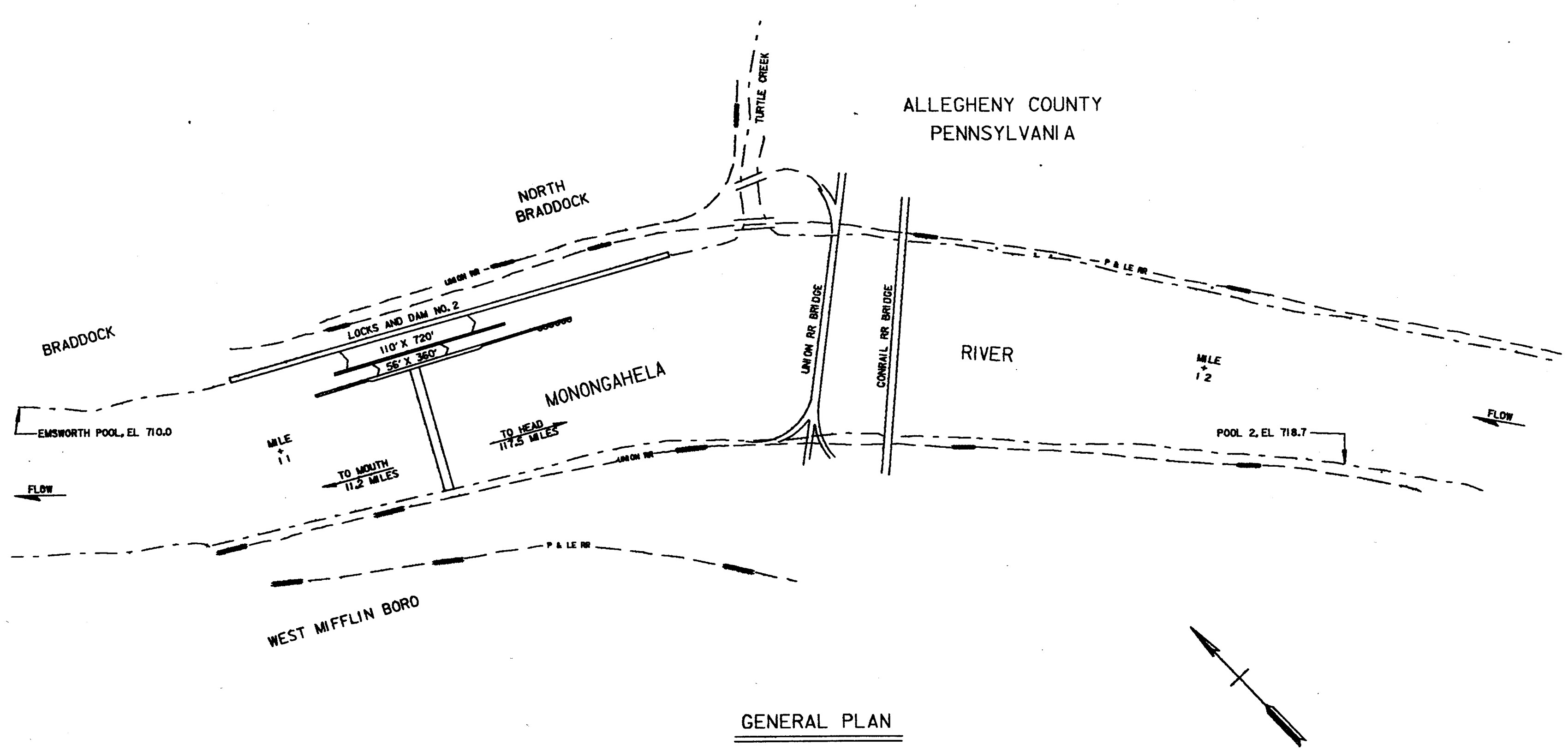


PROJECT LOCATION



VICINITY MAP

SCALE IN MILES



GENERAL PLAN

1" = 400'

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGHELA RIVER
LOCKS AND DAM 2
PROJECT LOCATION, VICINITY MAP
AND GENERAL PLAN

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
WLA	WLA			AS SHOWN	037-R54-3/4

SUBMITTED: SECTION CHIEF | IFB NO. DACW59 | SHEET OF

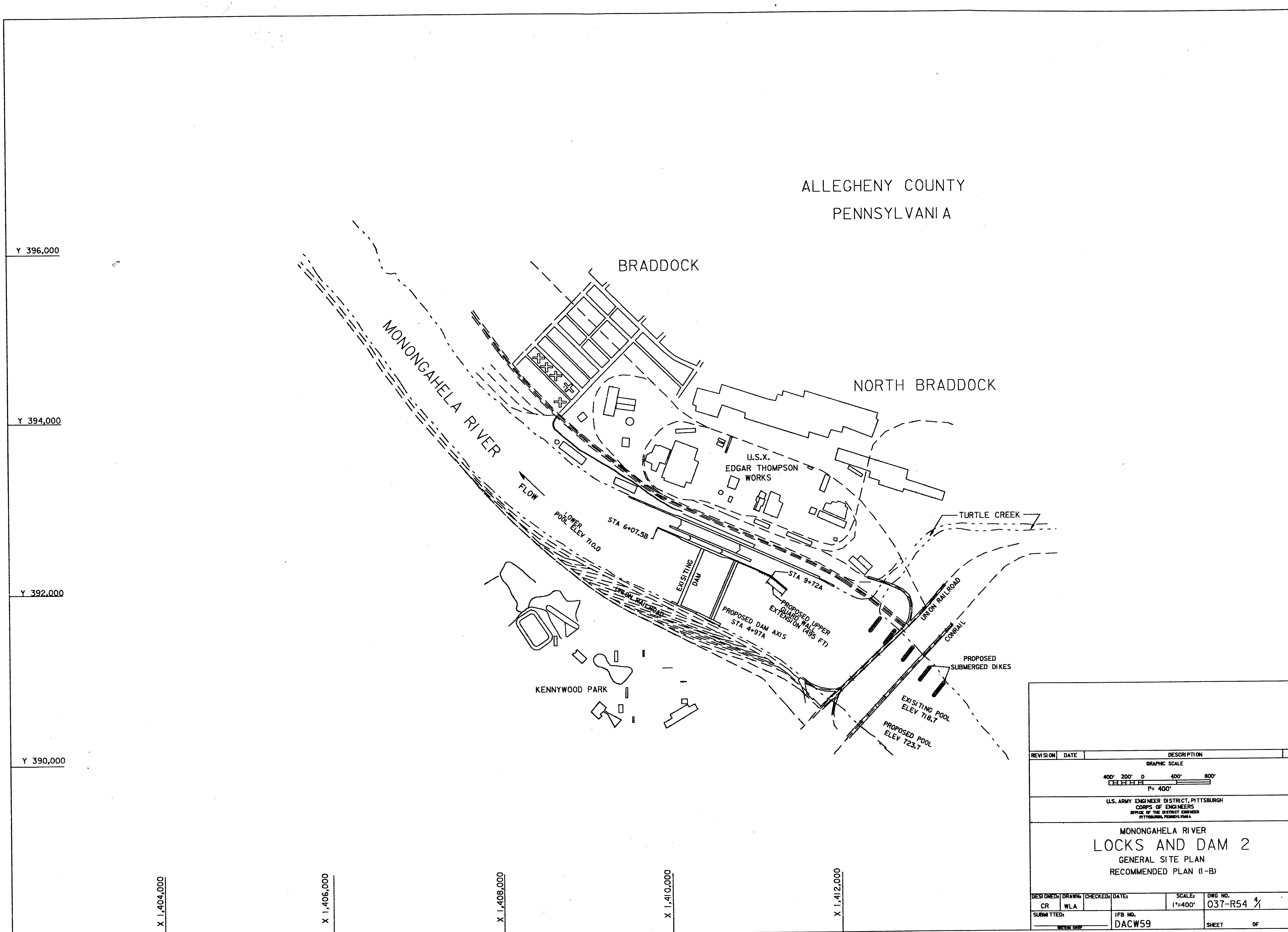
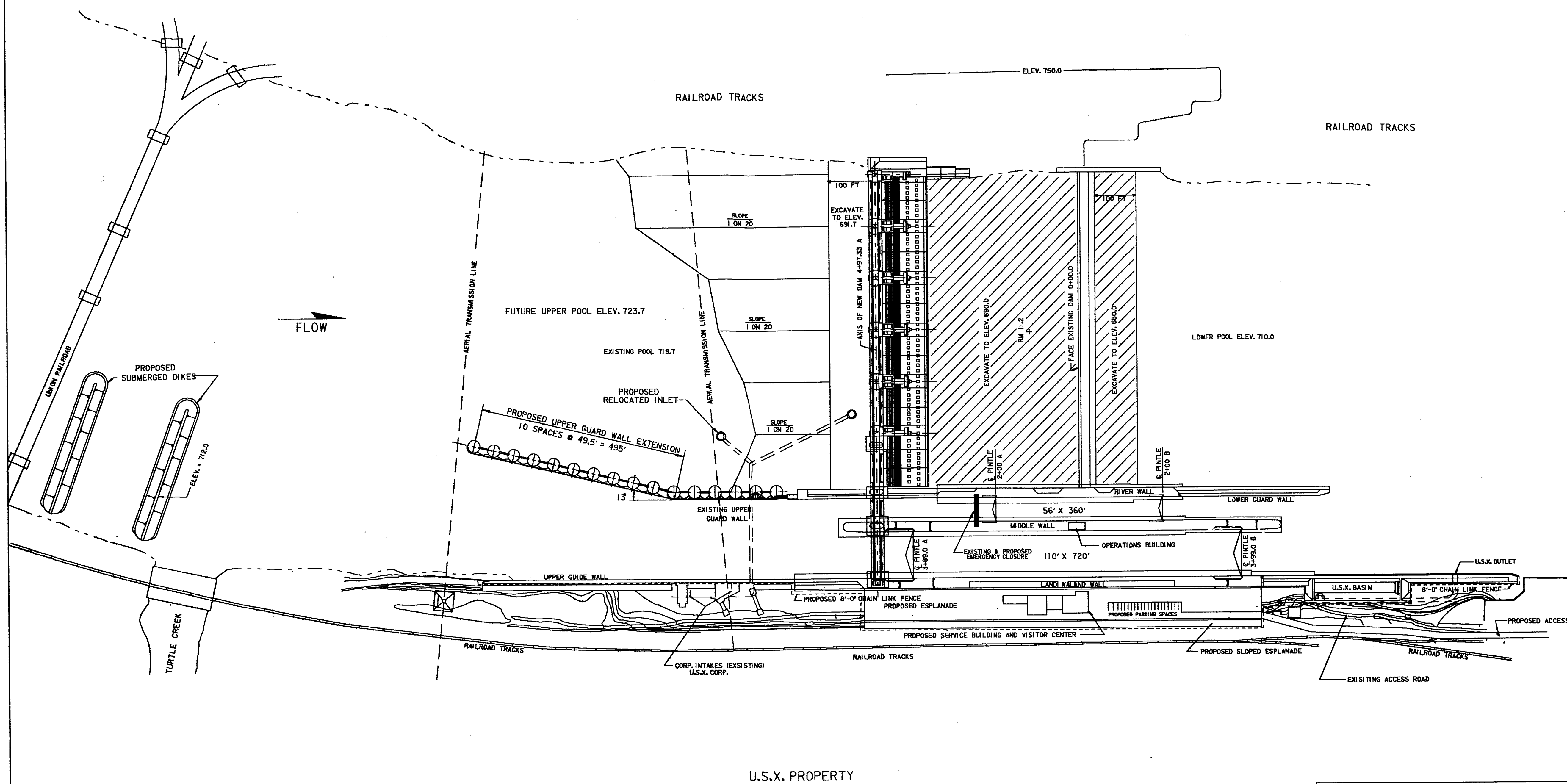

ALLEGHENY COUNTY
PENNSYLVANIA
BRADDOCK
NORTH BRADDOCK
U.S.X.
EDGAR THOMPSON
WORKS
TURTLE CREEK
MONONGAHELA RIVER
FLOW
LOWER POOL ELEV 710.0
STA 6+07.5B
EXISITING DAM
STA 9+72A
PROPOSED UPPER GUARD WALL EXTENSION (495 FT)
PROPOSED DAM AXIS STA 4+97A
UNION RAILROAD
CONRAIL
PROPOSED SUBMERGED DIKES
EXISITING POOL ELEV 718.7
PROPOSED POOL ELEV 723.7
KENNYWOOD PARK
Y 396,000
Y 394,000
Y 392,000
Y 390,000
X 1,404,000
X 1,406,000
X 1,408,000
X 1,410,000
X 1,412,000
REVISION
DATE
DESCRIPTION
BY
GRAPHIC SCALE
400' 200' 0 400' 800'
1"= 400'
U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA
MONONGAHELA RIVER
LOCKS AND DAM 2
GENERAL SITE PLAN
RECOMMENDED PLAN (I-B)
DESIGNED: CR
DRAWN: WLA
CHECKED:
DATE:
SCALE: 1"=400'
DWG NO. 037-R54 4/1
SUBMITTED:
SECTION CHIEF
IFB NO. DACW59
SHEET OF

PLATE 6-2



REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

100' 50' 0 100' 200'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGALELA RIVER

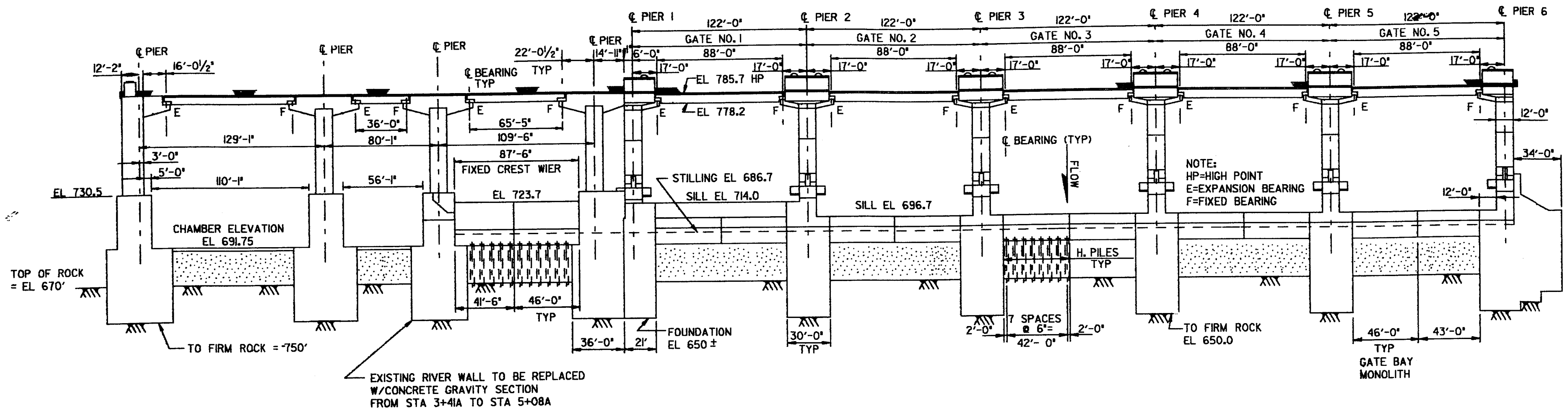
LOCK AND DAM 2

PROPOSED GATED DAM

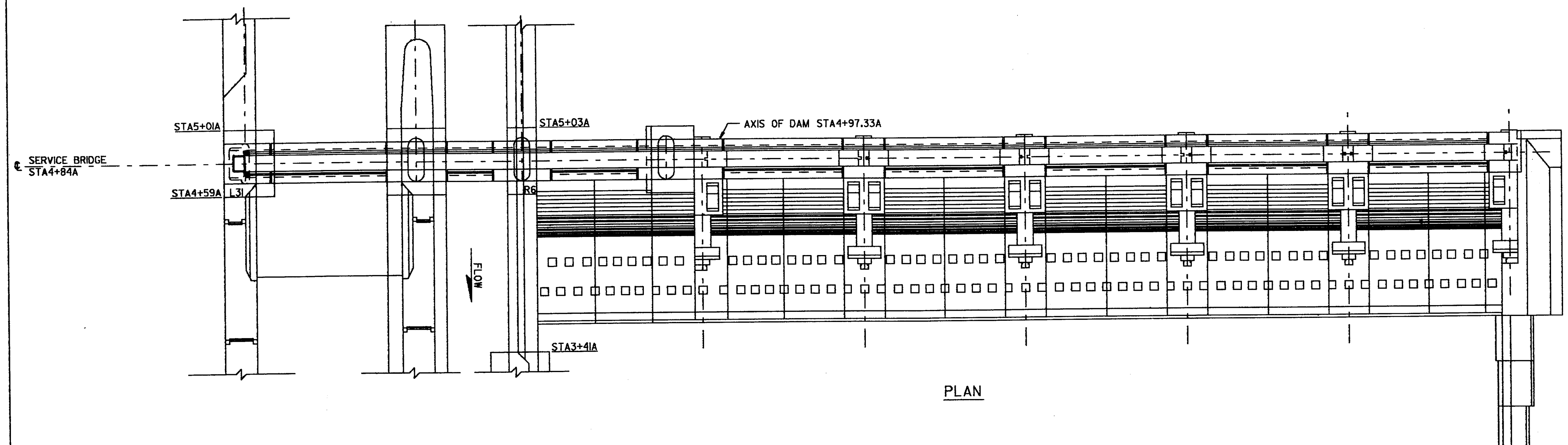
PLAN

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
CR	RWH/ WLA			1"=100	037-R54-½
SUBMITTED:			IFB NO. DACW59		SHEET OF

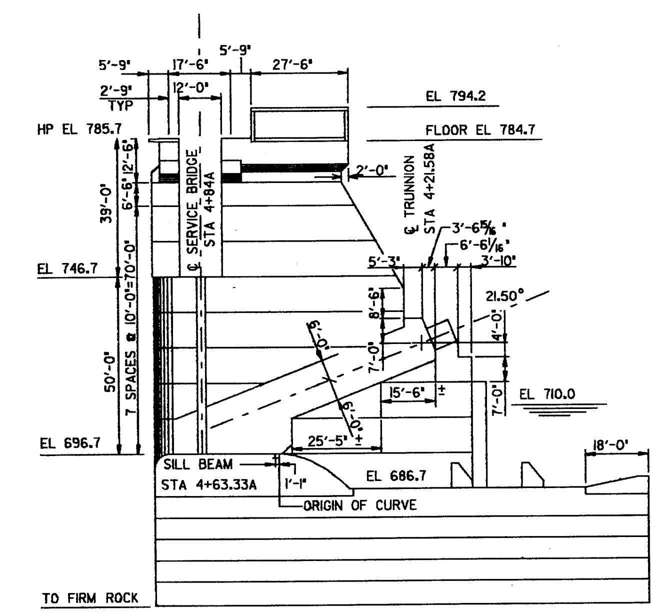
PLATE 6-3



DOWNSRTEAM ELEVATION



PLAN



pier elevation

REVISION	DATE	DESCRIPTION	BY

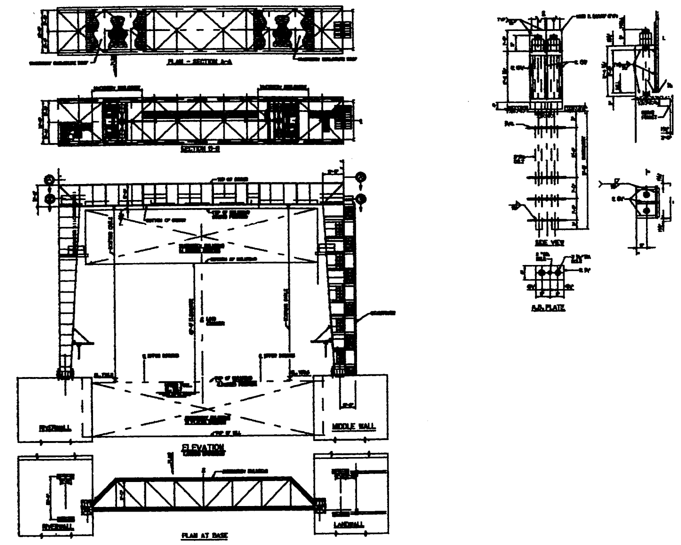
GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
LOCKS AND DAM 2
PROPOSED LOCKS AND DAM 2
PLAN, ELEVATION AND SECTION
X

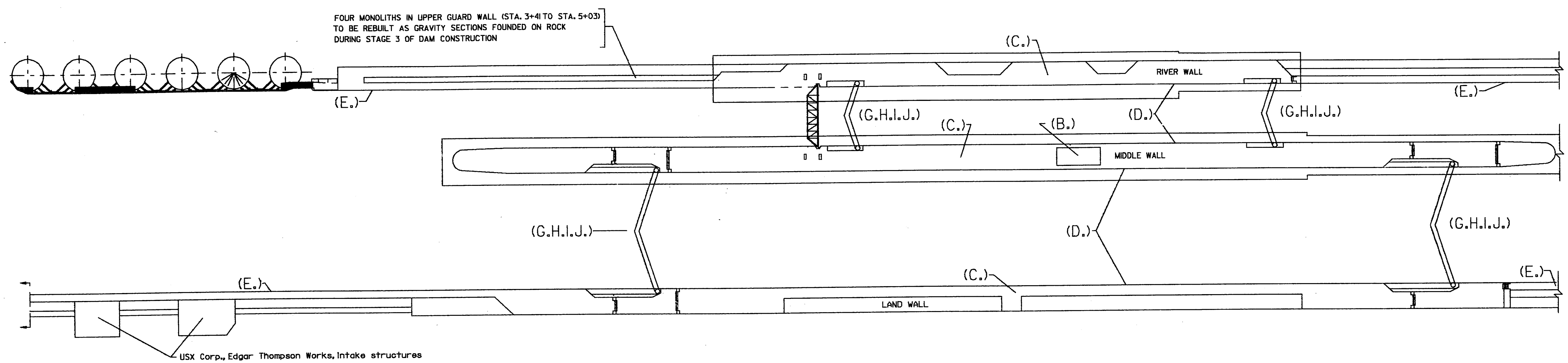
DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
CR	RWH			1"=40'	037-R54- 40/2
SUBMITTED:			IFB NO. DACW59		SHEET OF

SECTION CHIEF



AUXILIARY CHAMBER FLOODWAY BULKHEAD SYSTEM (A.)

NOTE: FOR PLAN, ELEVATION AND DETAILS OF PROPOSED GATED DAM, REFER TO PLATE 6-4



FEATURES OF WORK

A. REPLACE THE FLOODWAY BULKHEAD SYSTEM FOR THE AUXILIARY CHAMBER
B. REPLACE MIDDLE WALL BUILDING
C. RESURFACE TOP OF LOCK WALLS
D. REFACE LOCK WALLS AND INSTALL WALL ARMOR
E. REFACE AND RESURFACE GUIDE AND GUARD WALLS
F. INSTALL FLOATING MOORING BITTS
G. REBUILD MITER SILLS
H. REPLACE MITER GATES
I. REPLACE GATE OPERATING MACHINERY
J. REPLACE GATE ANCHORAGES AND PINTLES
K. REPLACE CULVERT VALVES AND OPERATING EQUIPMENT
L. INSTALL NEW HYDRAULIC SYSTEM
M. REPLACE LOCK POWER AND LIGHTING SYSTEM
N. REPLACE AIR AND WATER SYSTEMS
O. REPLACE TOW HAULAGE SYSTEM

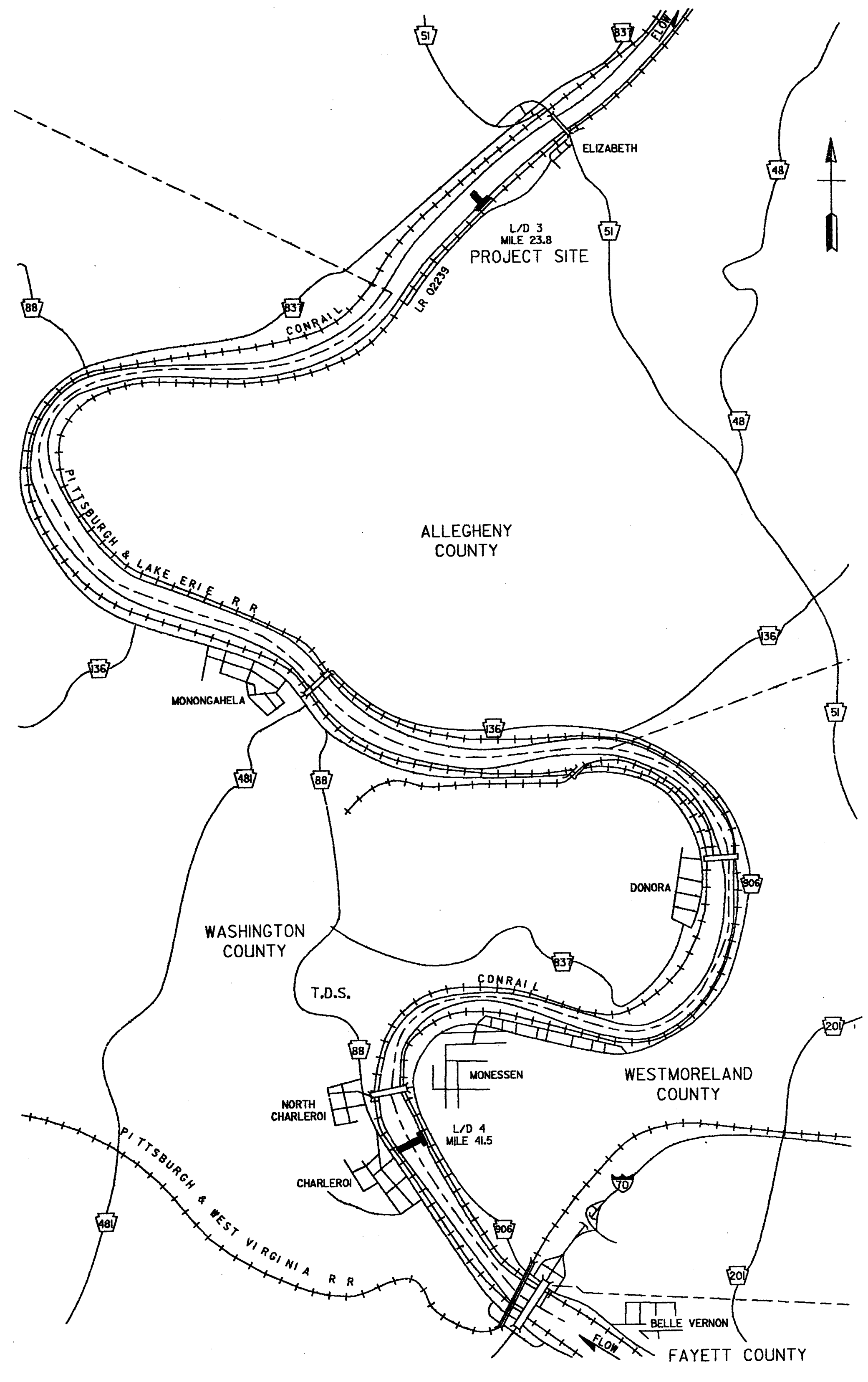
REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

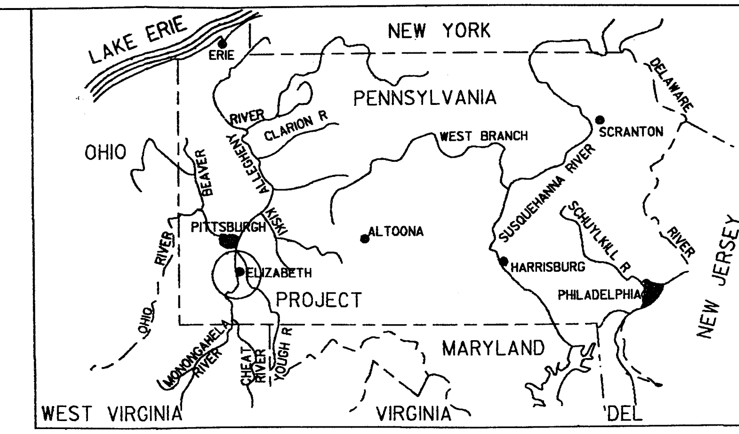
MONONGAHELA RIVER
LOCKS AND DAM 2
PROPOSED REHABILITATION OF LOCKS
PLAN AND SECTION

DESIGNED: TDS	DRAWN: RWH/TDS	CHECKED:	DATE:	SCALE: AS SHOWN	DWG NO. 037-R54-4/4
SUBMITTED: SECTION CHIEF		IFB NO. DACW59		SHEET	OF



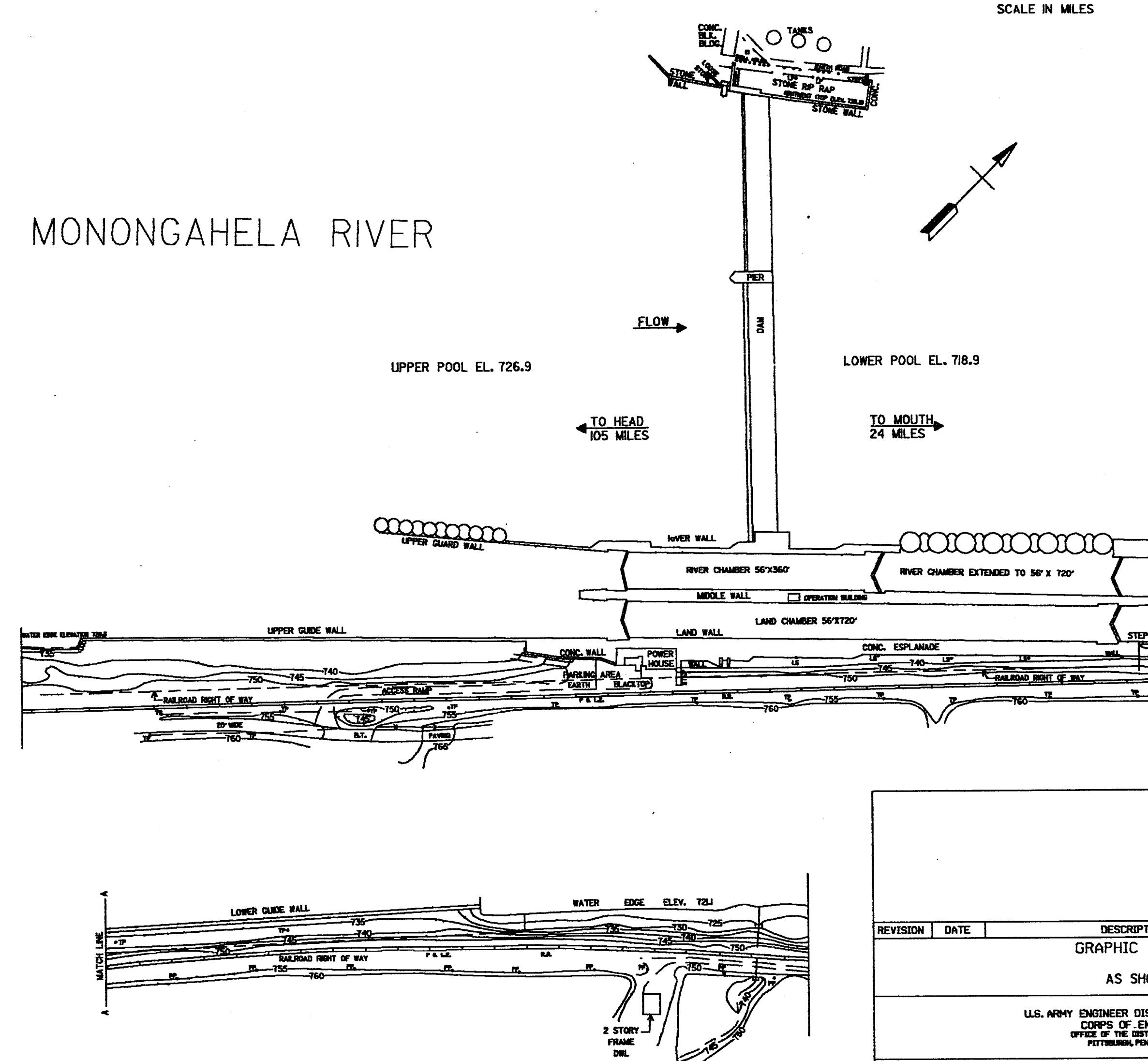
PROJECT LOCATION

½ ¼ 0 ½ 1
SCALE IN MILES



VICINITY MAP

20 40 0 40 80
SCALE IN MILES



LOCKS AND DAM 3 ALLEGHENY CO. PENNSYLVANIA

GENERAL PLAN

50' 25' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

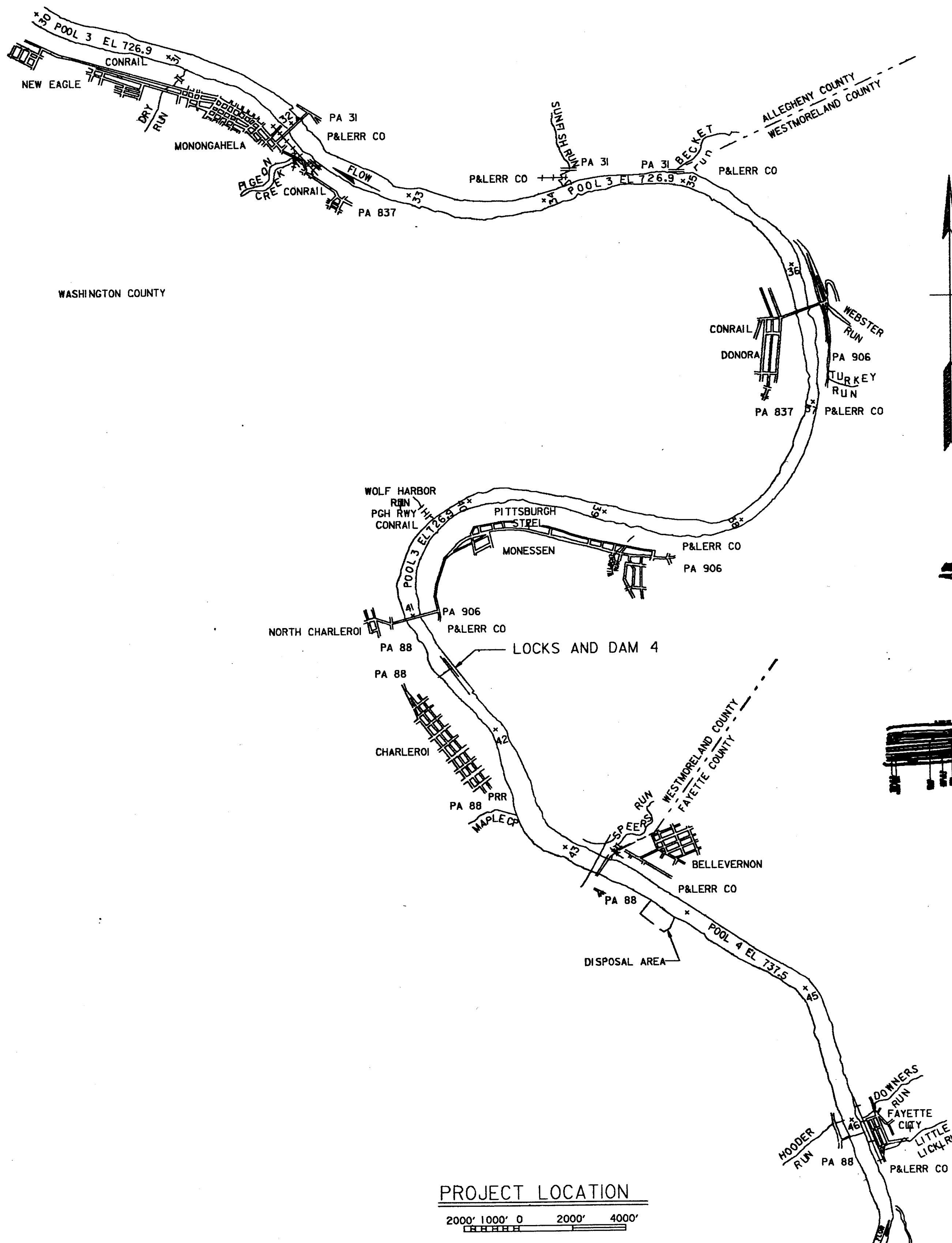
GRAPHIC SCALE

AS SHOWN

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

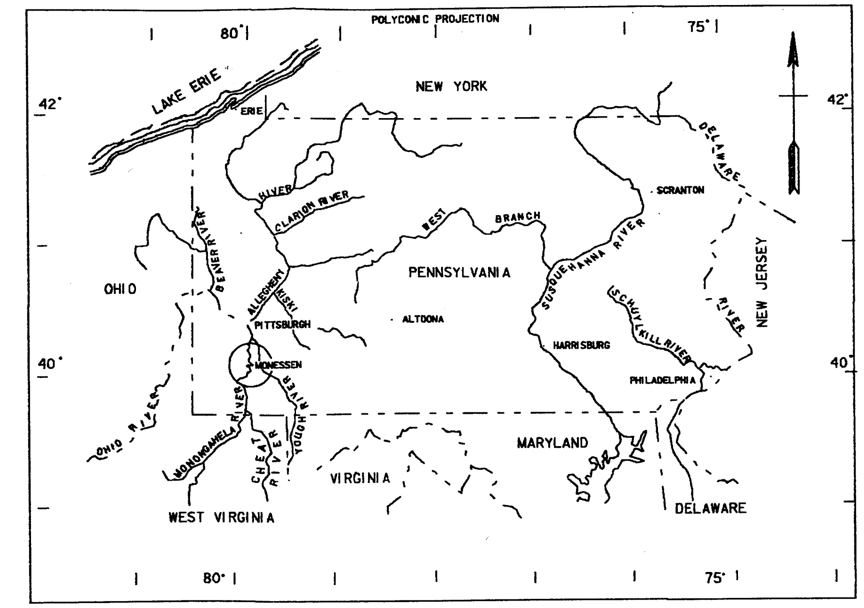
MONONGAHELA RIVER
LOCKS AND DAM 3
PROJECT LOCATION, VICINITY MAP
AND GENERAL PLAN

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	FILE NO.
T.D.S.	T.D.S.	T.D.S.	DEC. 1990	AS SHOWN	037-R54-3/3
SUBMITTED:			IFB NO.		DWG OF
SECTION CHIEF					



PROJECT LOCATION

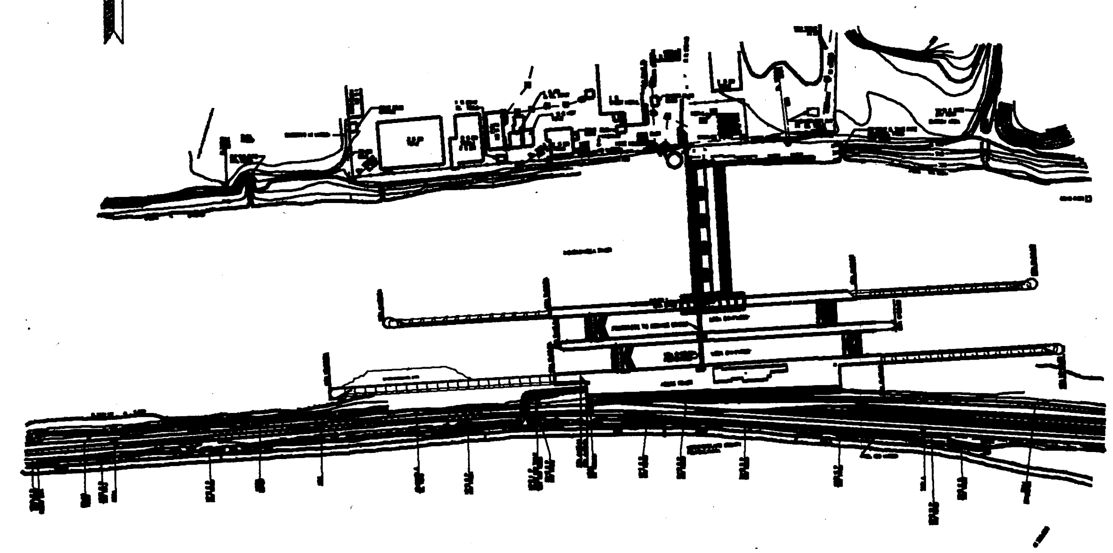
2000' 1000' 0 2000' 4000'



VICINITY MAP

40 20 0 40 80

SCALE IN MILES



GENERAL PLAN

(EXISTING PROJECT)
NO SCALE

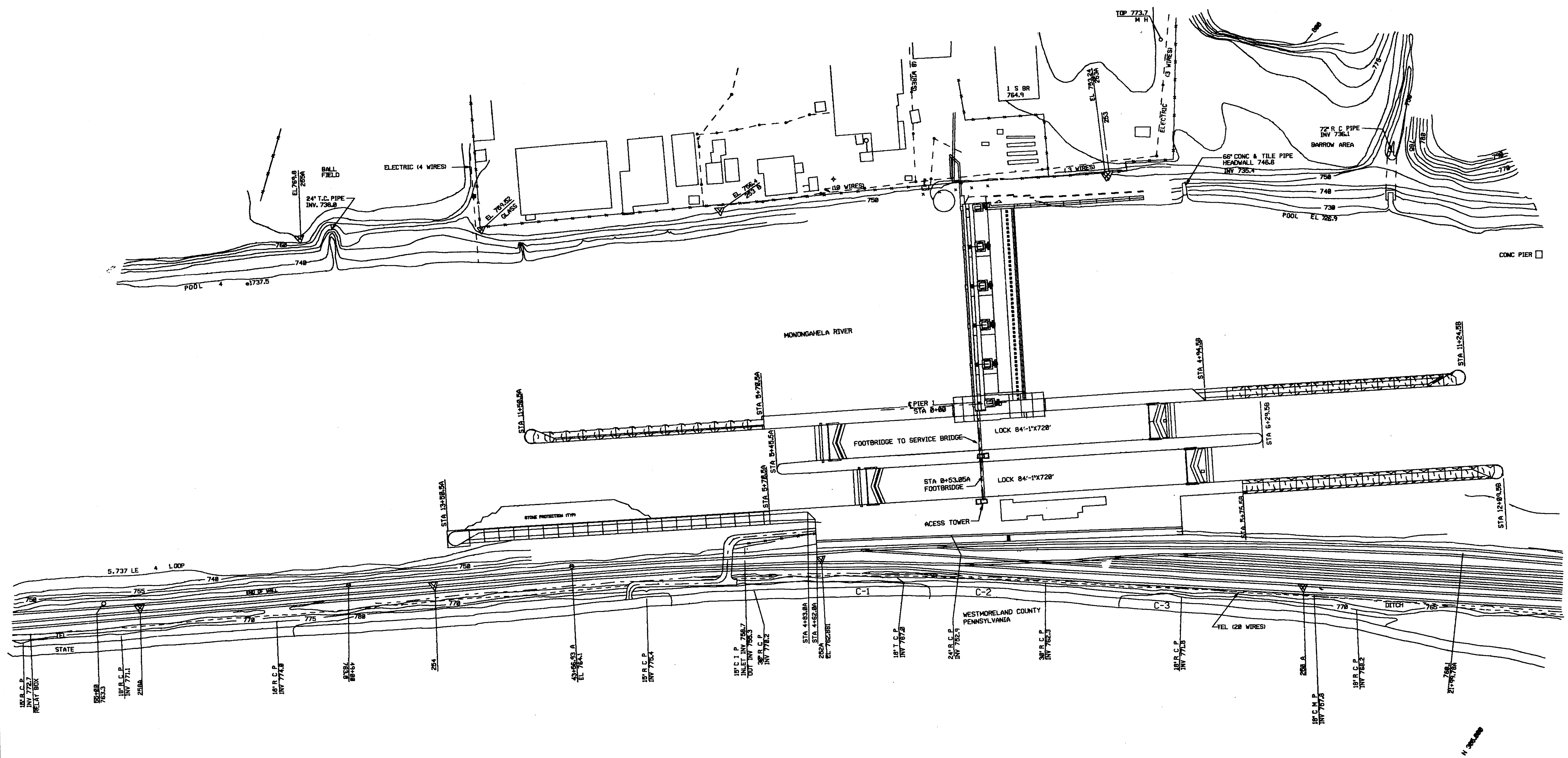
REVISION	DATE	DESCRIPTION	BY
		GRAPHIC SCALE	

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
LOCKS AND DAM 4
PROJECT LOCATION, VICINITY MAP
AND
GENERAL PLAN

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
TDS	RWH			AS SHOWN	037-R54- 3/2
SUBMITTED:			IFB NO. DACW59		SHEET OF

PLATE 6-7



REVISION | DATE | DESCRIPTION | BY

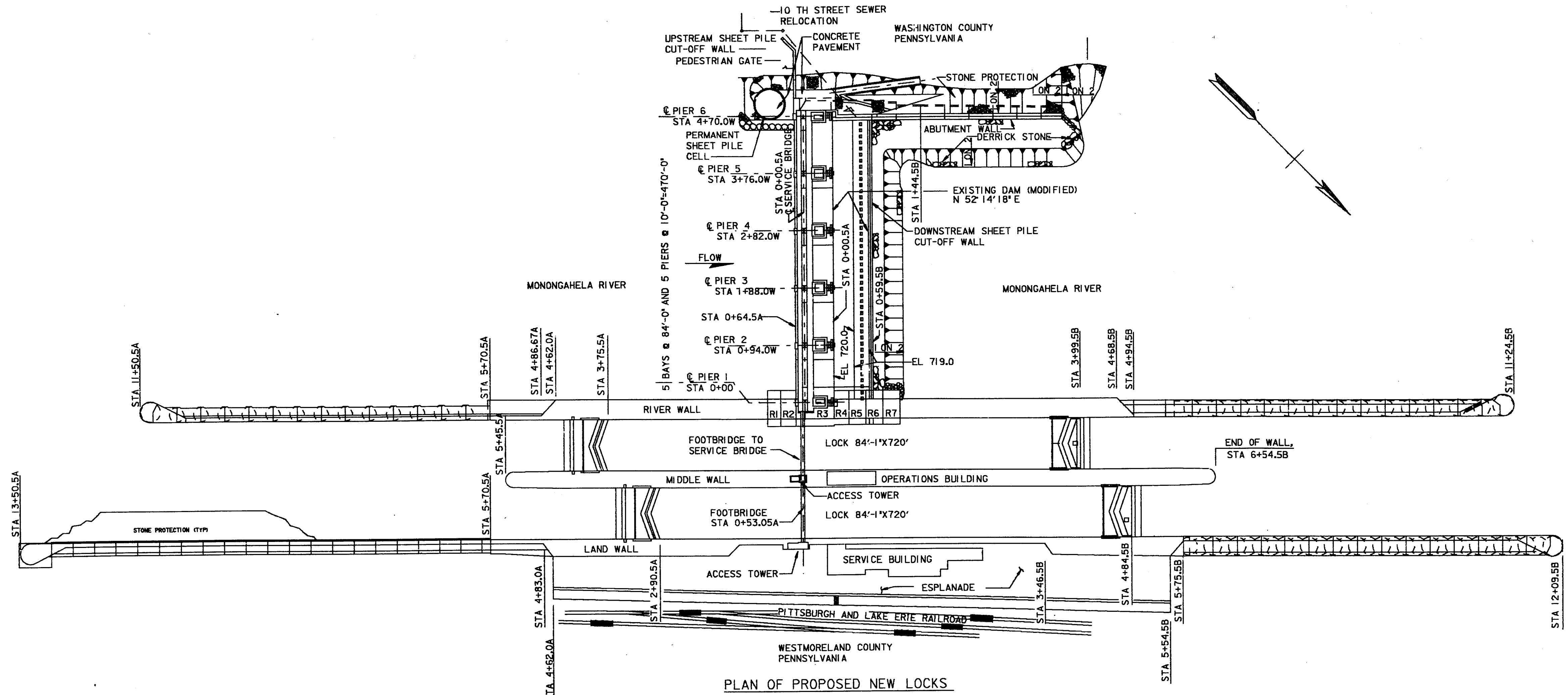
GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
LOCKS AND DAM 4
FUTURE PROPOSED LOCKS AND DAM
GENERAL SITE PLAN

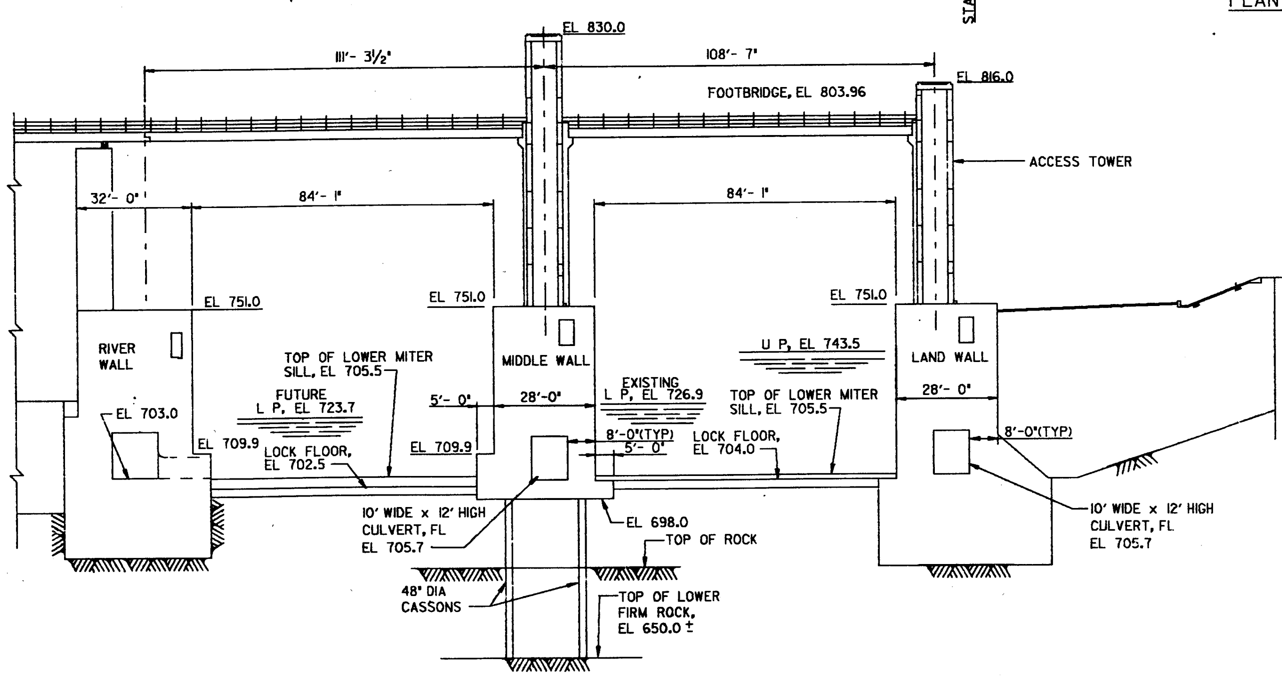
DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
BR	RWH			NO SCALE	037-R54- 4/3
SUBMITTED:			IFB NO. DACW59		SHEET OF

PLATE 6-8



PLAN OF PROPOSED NEW LOCKS

LOCKS AND DAM 4



LOCKS AND DAM 4

SECTION THRU LOCK CHAMBERS

NOTE:
MONOLITHS R1 THRU R7 ARE THE NEW RIVER WALL MONOLITHS CONSTRUCTED AT THE TIME OF THE GATED DAM CONSTRUCTION.

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
LOCKS AND DAM 4
FUTURE PROPOSED LOCKS AND DAM
PLAN AND SECTION

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
X	RWH			1"=80'	037 R54- 20/1
SUBMITTED: SECTION CHIEF			IFB NO. DACW59		SHEET OF

PLATE 6-9

7. Construction Procedure and Water Control Plan

a. L/D 2

The new floodway bulkhead structure at L/D 2 must be completed prior to the start of construction for the new gated dam. This is needed to achieve reliable operation of the small chamber as a floodway during construction of the dam to reduce the surcharge to flood flows caused by cofferdams and the constricted river cross section.

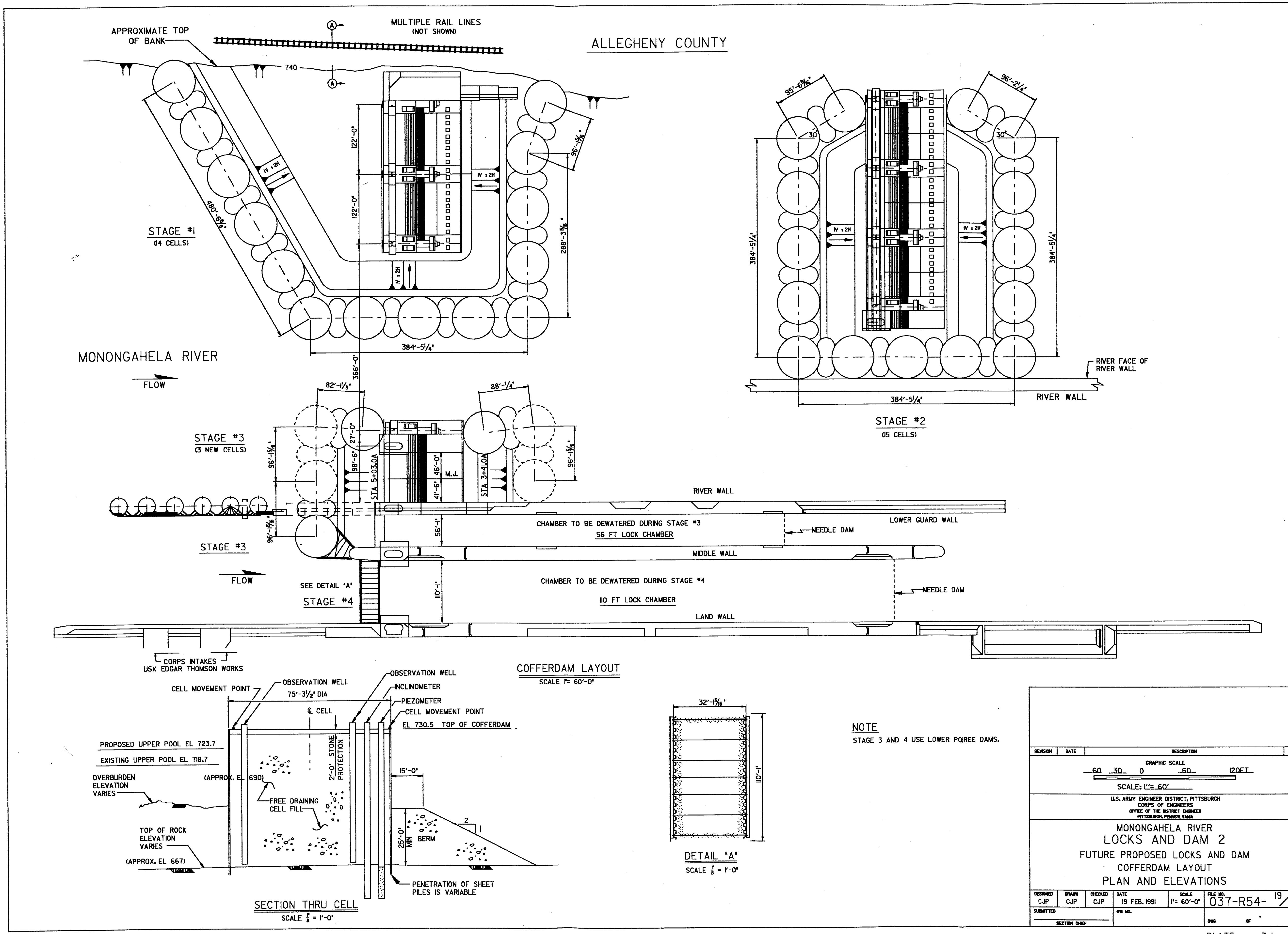
The gated dam at L/D 2 would be constructed using a three stage cofferdam (see PLATE 7-1). Stage one would consist of circular sheet pile cells extending from the abutment side upstream and downstream and tying into the existing dam. During stage one, two gate bays, three piers (piers 4, 5 and 6 which is the abutment pier), and the abutment, would be constructed. Stage two would consist of circular sheet pile cells along the riverwall branching out upstream and downstream and tying into the newly constructed pier 4. During stage two the remaining 3 gate bays and three piers (pier 1, 2 and 3) would be constructed. Because the dam is being moved upstream, portions of the riverwall would require rebuilding. A cofferdam consisting of circular sheet pile cells extending from the riverwall upstream and downstream and tying into the newly constructed pier 2 would be used during stage three. A box cofferdam would also be placed in the river chamber along with the pioree dam at the lower miter gates in order to dewater the river chamber. This cofferdam would allow construction of the fixed crest weir, the new riverwall monoliths and the sills. Finally, a box cofferdam would be placed in the land chamber in order to construct new sills.

The cofferdam cells would be 78.414 feet in diameter. The top of the cell would be at elevation 730.5 and bottom of cell would be at approximate elevation 667.0 making the cells about 63.5 feet high. The cells would be filled with free draining material and capped with two feet of stone protection. A berm 25 feet (minimum) in depth, 15 feet long then tapering in a 1 on 2 slope would be placed against the cells inside of the cofferdam.

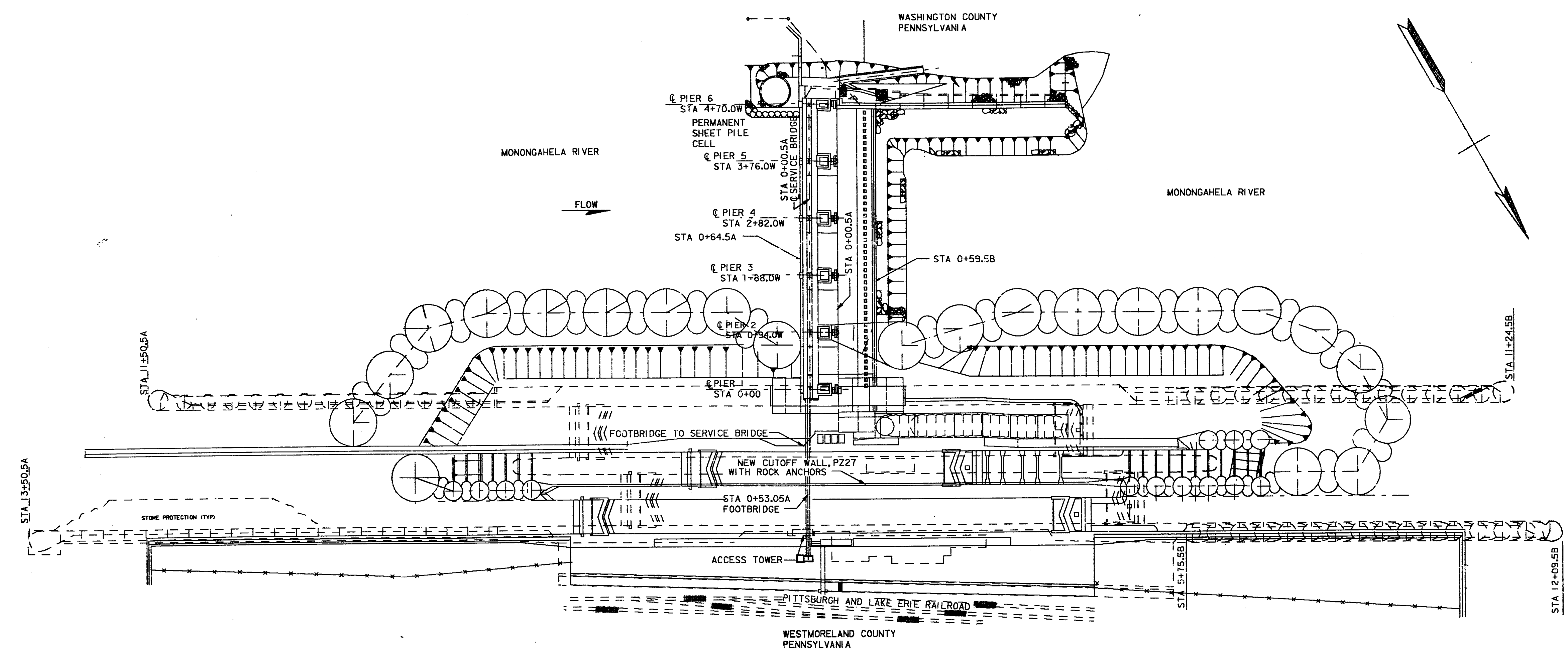
b. L/D 4

The new chambers at Lock 4 would be constructed using a two stage cofferdam. Stage one would use the existing middlewall as the landward cofferdam section (see PLATE 7-2). Circular sheet pile cells would extend upstream and downstream and tie into gate bay one of the existing dam. During stage one, river traffic would use the existing land chamber and the new middlewall would be constructed in the existing river chamber. The new riverwall would then be constructed in alignment with the stub wall previously placed during the construction of the gated dam. Stage two would use the newly constructed middlewall as the riverward section of the cofferdam (see PLATE 7-3). Circular sheet pile cells would extend upstream and downstream and tie into the right bank. During stage two, river traffic would use the new river chamber while the landwall was being constructed.

The cofferdam cells would be either 78.414 or 31.588 feet in diameter. The top of the cell would be at elevation 749.0 upstream of the dam and 747.0 downstream of the dam. Bottom of cell would be at approximate elevation 680.0 making the cells about 69 feet high upstream and 67 feet high downstream. The 31.588 feet diameter cells would be concrete filled and each cell would have two vertical anchors. W14 x 398 struts would be installed between these cells and either the existing riverwall or another cell. The 78.414 feet diameter cells would be filled with free draining material and capped with three feet of concrete. A berm 25 feet (minimum) in depth, 15 feet long then tapering in a 1 on 2 slope would be placed against the cells inside of the cofferdam.



APPROXIMATE TOP OF BANK
MULTIPLE RAIL LINES (NOT SHOWN)
ALLEGHENY COUNTY
740
STAGE #1 (14 CELLS)
480'-6⅝"
122'-0"
122'-0"
1V : 2H
384'-5¼"
288'-3⅜"
96'-1⅜"
366'-0"
MONONGAHELA RIVER
FLOW
STAGE #2 (15 CELLS)
95'-6⅞"
96'-2¼"
30°
384'-5¼"
RIVER FACE OF RIVER WALL
RIVER WALL
82'-⅛"
88'-¼"
27'-0"
STAGE #3 (3 NEW CELLS)
96'-1⅜"
98'-6"
46'-0"
41'-6"
M.J.
STA 5+03.0A
STA 3+41.0A
RIVER WALL
LOWER GUARD WALL
CHAMBER TO BE DEWATERED DURING STAGE #3
56 FT LOCK CHAMBER
NEEDLE DAM
56'-1"
STAGE #3
FLOW
MIDDLE WALL
SEE DETAIL 'A'
STAGE #4
110'-1"
CHAMBER TO BE DEWATERED DURING STAGE #4
110 FT LOCK CHAMBER
NEEDLE DAM
LAND WALL
CORPS INTAKES
USX EDGAR THOMSON WORKS
COFFERDAM LAYOUT
SCALE 1"= 60'-0"
CELL MOVEMENT POINT
OBSERVATION WELL
75'-3½" DIA
℄ CELL
OBSERVATION WELL
INCLINOMETER
PIEZOMETER
CELL MOVEMENT POINT
EL 730.5 TOP OF COFFERDAM
PROPOSED UPPER POOL EL 723.7
EXISTING UPPER POOL EL 718.7
OVERBURDEN ELEVATION VARIES
(APPROX. EL 690)
2'-0" STONE PROTECTION
FREE DRAINING CELL FILL
15'-0"
25'-0" MIN
BERM
2
1
TOP OF ROCK ELEVATION VARIES
(APPROX. EL 667)
PENETRATION OF SHEET PILES IS VARIABLE
SECTION THRU CELL
SCALE ⅛" = 1'-0"
32'-1⅝"
110'-1"
DETAIL "A"
SCALE ⅛" = 1'-0"
NOTE
STAGE 3 AND 4 USE LOWER POIREE DAMS.
REVISION
DATE
DESCRIPTION
BY
GRAPHIC SCALE
60 30 0 60 120FT
SCALE: 1"= 60'
U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA
MONONGAHELA RIVER
LOCKS AND DAM 2
FUTURE PROPOSED LOCKS AND DAM
COFFERDAM LAYOUT
PLAN AND ELEVATIONS
DESIGNED CJP
DRAWN CJP
CHECKED CJP
DATE 19 FEB. 1991
SCALE 1"= 60'-0"
FILE NO. 037-R54- 19/1
SUBMITTED
SECTION CHIEF
IFB NO.
DWG OF



PLAN
SCALE 1"= 80'

NOTE:
PROPOSED LOCK WALLS SHOWN IN HIDDEN LINES

REVISION	DATE	DESCRIPTION	BY

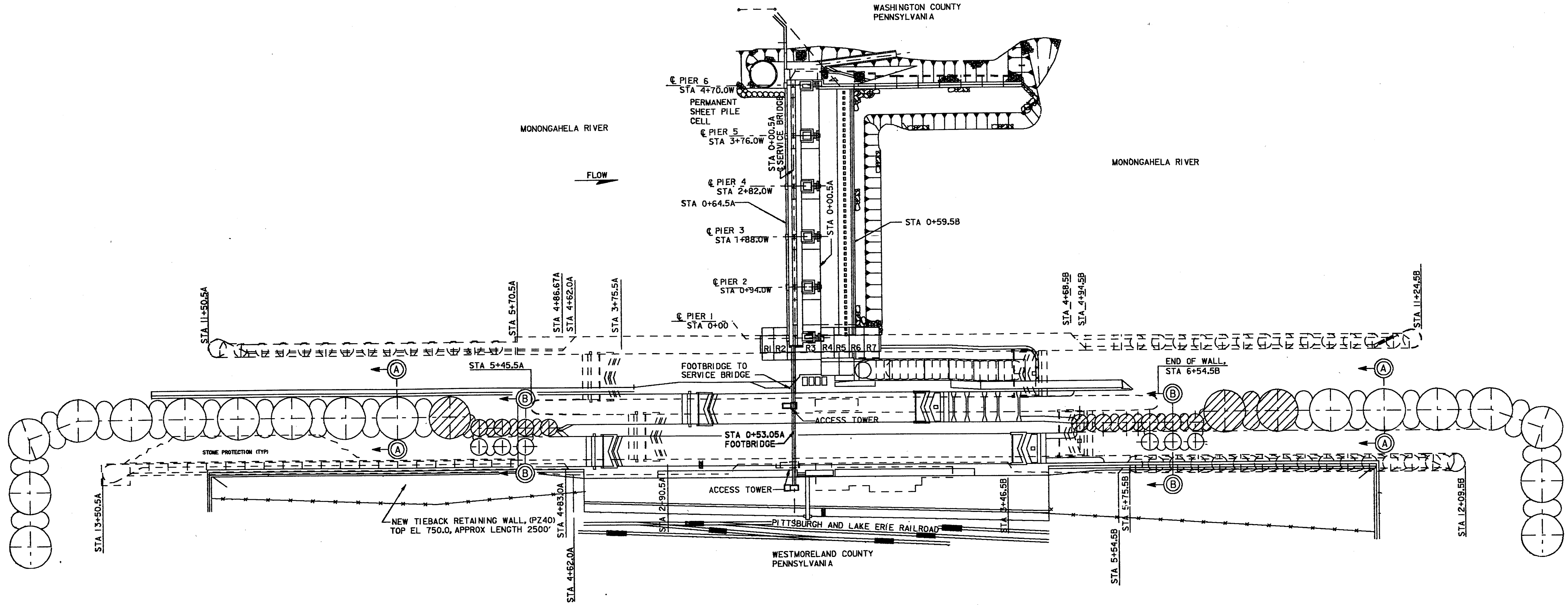
GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
LOCCKS AND DAM 4
FUTURE PROPOSED LOCKS AND DAM
FIRST STAGE COFFERDAM LAYOUT
PLAN

DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
CPO	RWH			1"=80'	037-R54-19/2
SUBMITTED:			IFB NO. DACW59		SHEET OF
SECTION CHIEF					

PLATE 7-2

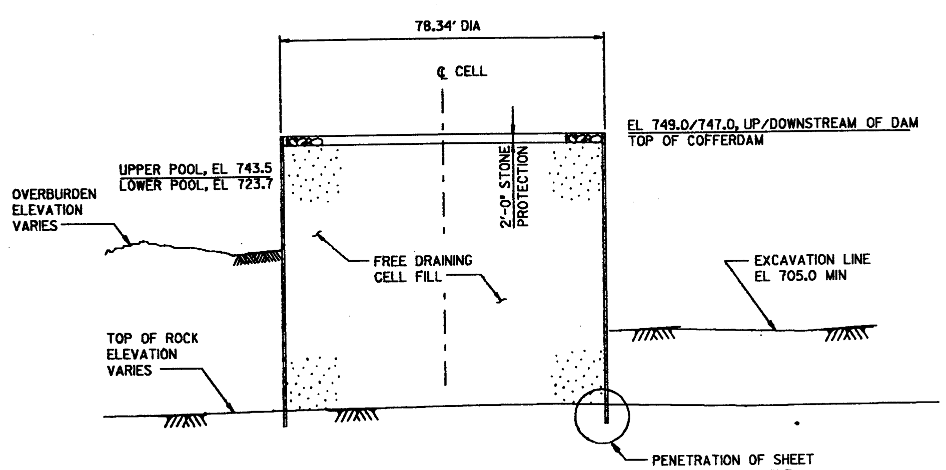


PLAN
SCALE 1" = 80'

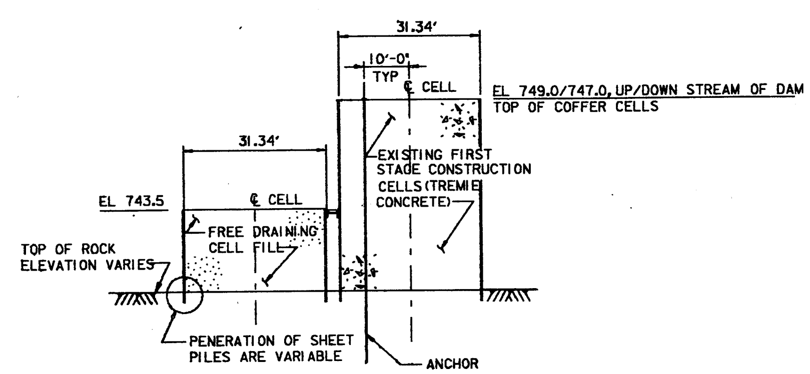
LEGEND:

- FIRST STAGE COFFER CELLS TO REMAIN

NOTE:
PROPOSED LOCK WALL SHOWN IN
HIDDEN LINES



SECTION A-A
SCALE 1/8" = 1'-0"



SECTION B-B
SCALE: 1/16" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE
0 5' 10' 20' 30' 40' — 1/8" = 1'-0"
40' 20' 0 40' 80' — 1" = 80'

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

MONONGAHELA RIVER
LOCKS AND DAM 4
FUTURE PROPOSED LOCKS AND DAM
SECOND STAGE - COFFERDAM LAYOUT
PLAN AND ELEVATIONS

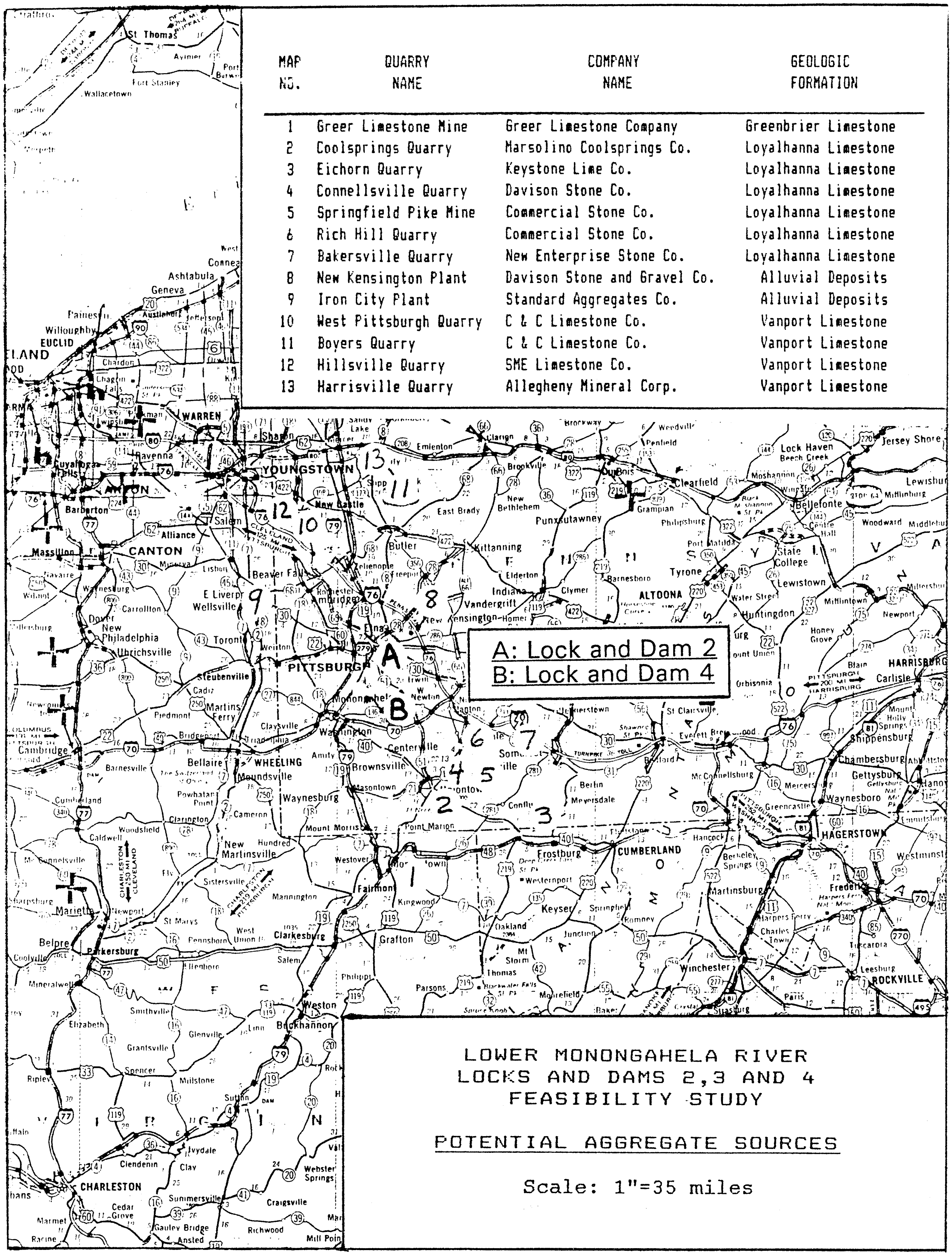
DESIGNED:	DRAWN:	CHECKED:	DATE:	SCALE:	DWG NO.
CPQ	RWH			AS SHOWN	037-R54- 19/3
SUBMITTED:			IFB NO. DACW59		SHEET OF

8. Construction Materials

Potential sources of aggregate, cement and pozzolan are shown on PLATES 8-1, 8-2 and 8-3 respectively. The sources shown were tested in 1987 for the Grays Landing and Point Marion projects and should be capable of supplying suitable materials for the construction of the Dam 2 and Lock 4 projects.

In addition to the aggregate sources listed, consideration will be given to obtaining fine aggregate from natural sand sources available at several commercial operations along the Ohio and Allegheny Rivers. There has been a problem with excessive chert content and coal fines from some of these sources in the past. They will not be considered as potential sources until further testing for the Concrete Materials Design Memorandum is completed. A thermal study, which will include a nonlinear incremental structural analysis, will be done during the preparation of the Concrete Materials Design Memorandum.

MAP NO.	QUARRY NAME	COMPANY NAME	GEOLOGIC FORMATION
1	Greer Limestone Mine	Greer Limestone Company	Greenbrier Limestone
2	Coolsprings Quarry	Marsolino Coolsprings Co.	Loyalhanna Limestone
3	Eichorn Quarry	Keystone Lime Co.	Loyalhanna Limestone
4	Connellsville Quarry	Davison Stone Co.	Loyalhanna Limestone
5	Springfield Pike Mine	Commercial Stone Co.	Loyalhanna Limestone
6	Rich Hill Quarry	Commercial Stone Co.	Loyalhanna Limestone
7	Bakersville Quarry	New Enterprise Stone Co.	Loyalhanna Limestone
8	New Kensington Plant	Davison Stone and Gravel Co.	Alluvial Deposits
9	Iron City Plant	Standard Aggregates Co.	Alluvial Deposits
10	West Pittsburgh Quarry	C & C Limestone Co.	Vanport Limestone
11	Boyers Quarry	C & C Limestone Co.	Vanport Limestone
12	Hillsville Quarry	SME Limestone Co.	Vanport Limestone
13	Harrisville Quarry	Allegheny Mineral Corp.	Vanport Limestone



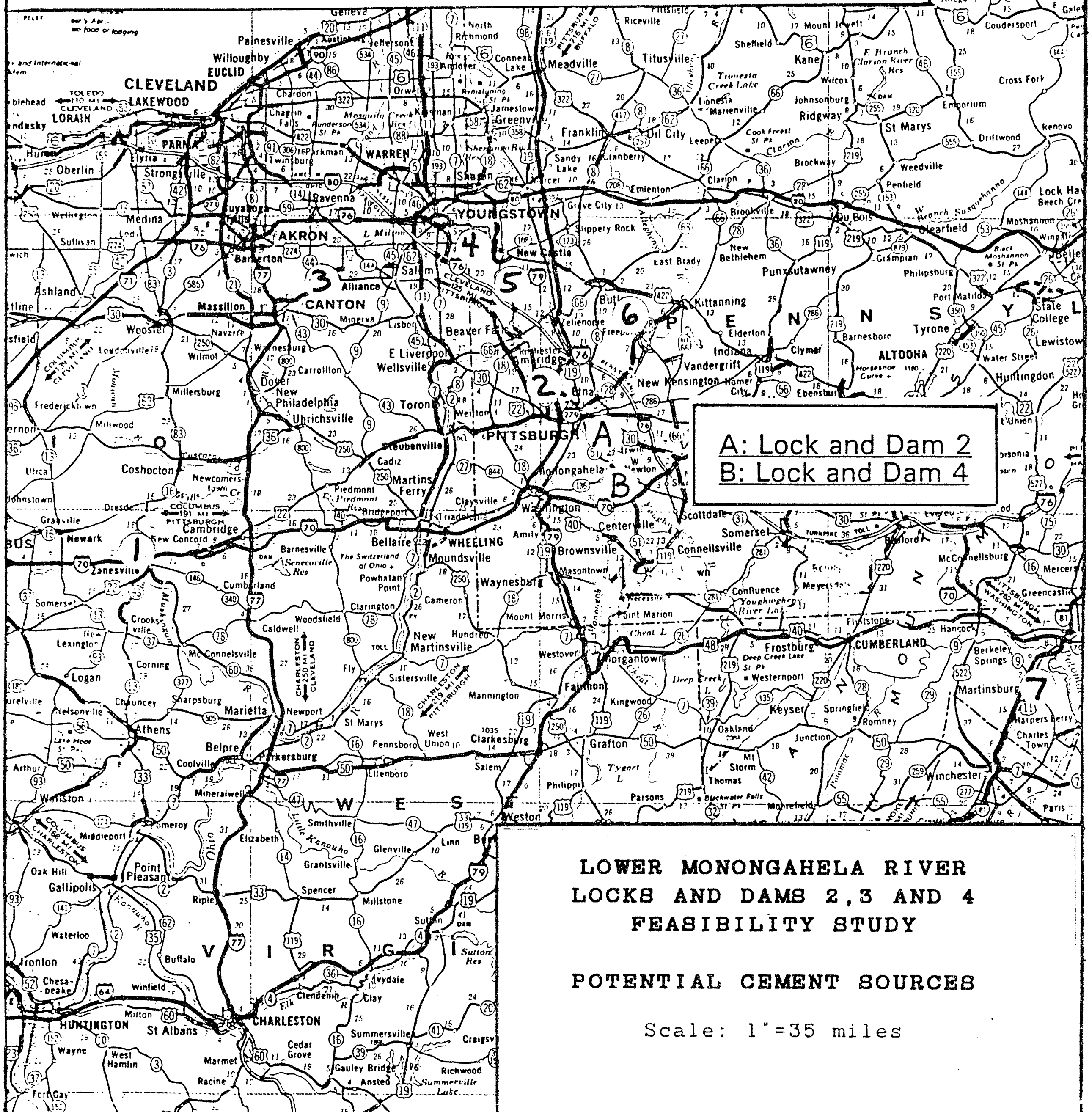
LOWER MONONGAHELA RIVER
LOCKS AND DAMS 2,3 AND 4
FEASIBILITY STUDY

POTENTIAL AGGREGATE SOURCES

Scale: 1"=35 miles

PLATE 8-1

Map No.	Plant Name	Company Name
1	East Fultonham	Columbia Portland Cement Co.
2	Marquette Neville	Lonestar Cement Co.
3	Middlebranch	U.S. (SME) Cement Co.
4	Bessemer	U.S. (SME) Cement Co.
5	Wampum	Medusa Cement Co.
6	West Winfield	Armstrong Cement Co.
7	Martinsburg	Capitol Cement Co.



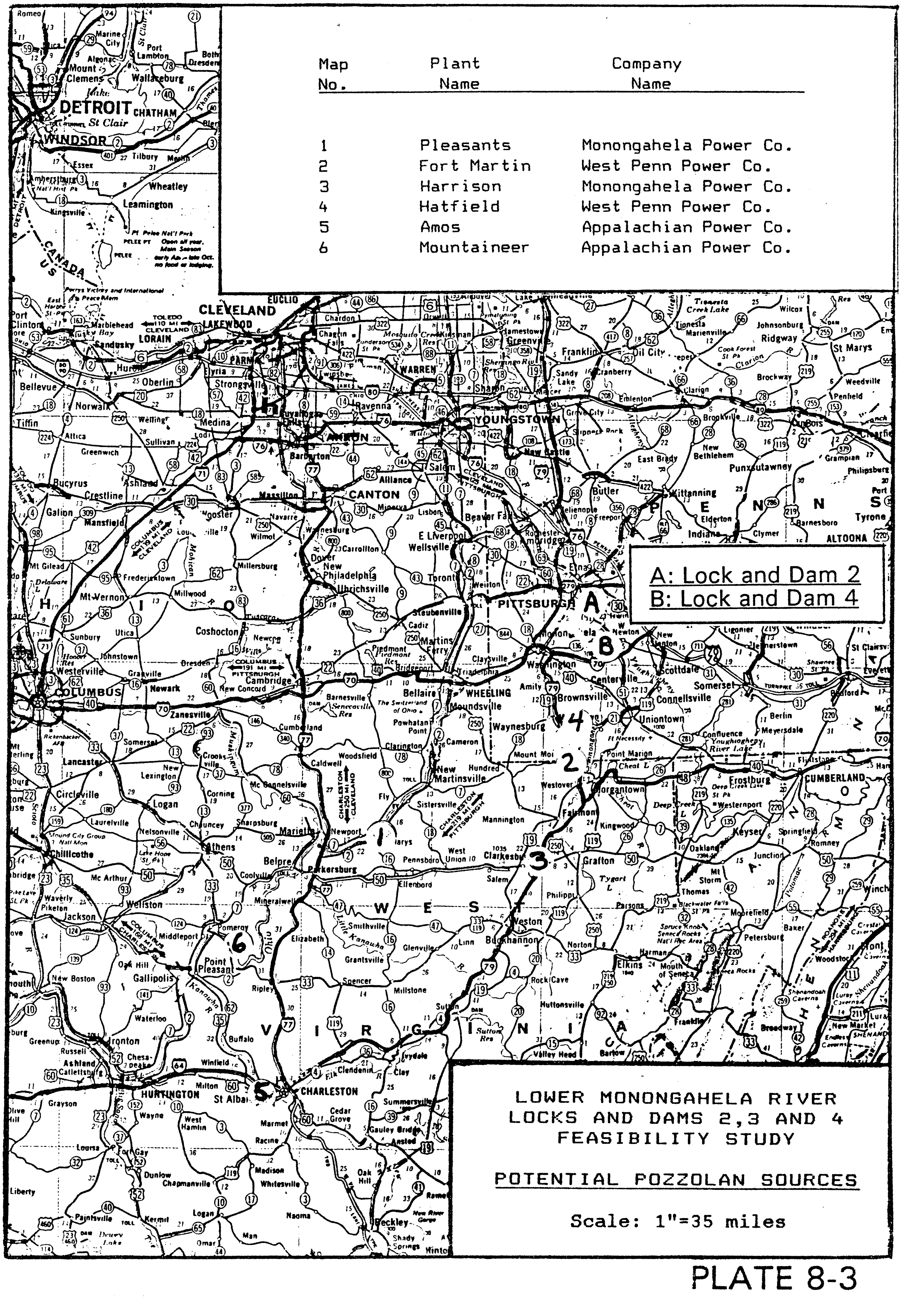
LOWER MONONGAHELA RIVER
LOCKS AND DAMS 2,3 AND 4
FEASIBILITY STUDY

POTENTIAL CEMENT SOURCES

Scale: 1"=35 miles

PLATE 8-2

Map No.	Plant Name	Company Name
1	Pleasants	Monongahela Power Co.
2	Fort Martin	West Penn Power Co.
3	Harrison	Monongahela Power Co.
4	Hatfield	West Penn Power Co.
5	Amos	Appalachian Power Co.
6	Mountaineer	Appalachian Power Co.



LOWER MONONGAHELA RIVER
LOCKS AND DAMS 2,3 AND 4
FEASIBILITY STUDY

POTENTIAL POZZOLAN SOURCES

Scale: 1"=35 miles

PLATE 8-3

9. Cost Estimates

All costs involved in the Recommended Plan is illustrated in Table 9-1 below and is summarized in the attachment at the end of this appendix. More detailed information can be found in the complete M-CACES on file in the Cost Engineering Branch of Engineering Division in the Pittsburgh District Office.

The total estimated Federal first cost of $623,458,000 includes $67,030,000, shown in Table 9-2, for rehabilitation work considered necessary for existing Locks 2 which will be accomplished under existing authorities.

Table 9-1

LOWER MONONGAHELA RIVER NAVIGATION SYSTEM STUDY
RECOMMENDED PLAN
OCTOBER 1991 COST LEVEL

CODE OF ACCOUNT		Construction Costs ($1,000x)	Contingencies ($1,000x)	Construction Costs Including Contingencies ($1,000x)
01.-.-.-	LANDS & DAMAGES	$3,100	$800	$3,900
02.-.-.-	RELOCATIONS			
	Utilities	$10,915	$10,350	$21,265
	Structures	$460	$225	$685
	Railroad	$19,260	$5,740	$25,000
	Major Storm Sewers	$1,230	$620	$1,850
03.-.-.-	RESERVOIRS			
	Removal of L/D #3	$7,000	$2,000	$9,000
04.-.-.-	DAMS			
	Modification of Dam at L/D #4 (Construction of Lock)	$2,200	$500	$2,700
	Construction of Dam at L/D #2	$98,000	$28,000	$126,000
05.-.-.-	LOCKS			
	Rehabilitation of Locks at L/D #2	$40,000	$15,000	$55,000
	Construction of Locks at L/D #4	$184,000	$46,000	$230,000
	Floodway Bulkhead at L/D #2	$3,600	$1,500	$5,100
	Modification to Locks at L/D #2 (Construction of Dam)	$11,300	$2,900	$14,200
06.-.-.-	FISH & WILDLIFE FACILITIES	$1,200	$200	$1,400
09.-.-.-.	CHANNELS AND CANALS			
	Dredging	$27,000	$6,000	$33,000
16.-.-.-	BANK STABILIZATION	$4,315	$1,185	$5,500
18.-.-.-	CULTURAL RESOURCES MANAGEMENT	$780	$390	$1,170
20.-.-.-	PERMANENT OPERATING EQUIPMENT			
	L/D #2 and L/D #4	$325	$80	$405
30.-.-.-	PLANNING, ENGINEERING & DESIGN	$32,220	$10,680	$42,900
31.-.-.-	CONSTRUCTION MANAGEMENT	$42,085	$2,298	$44,383
	SUBTOTAL, FEDERAL COSTS	$488,990	$134,468	$623,458
	SUBTOTAL, NON-FEDERAL COSTS	$111,217	$0	$111,217
	TOTAL, FEDERAL AND NON-FEDERAL COSTS	$600,207	$134,468	$734,675

Table 9-2

LOWER MONONGAHELA RIVER NAVIGATION STUDY
(OCTOBER 1991 COST LEVEL)
REHABILITATION COSTS

CODE OF ACCOUNT	DESCRIPTION	All Costs shown are in $ 1,000 dollars
05	LOCKS	
	Rehab Locks at L/D #2	$40,000
30	PLANNING, ENGINEERING AND DESIGN	4,250
31	CONSTRUCTION MANAGEMENT	6,100
	CONTINGENCIES	16,680
SUBTOTAL, FEDERAL COSTS		$67,030
SUBTOTAL, NON-FEDERAL COSTS		$0
TOTAL, FEDERAL AND NON-FEDERAL COSTS		$67,030

10. Schedule for Design and Construction

Preconstruction, Engineering and Design (PED) activities are currently scheduled to begin in FY 92 and extend through FY 96, with the first construction activity occurring in September 1996. This would consist of the construction of the floodway bulkhead for the small lock chamber at L/D 2. Design and construction would continue through FY 03 with the completion of the work at L/D 4. Rehabilitation work at Locks 2 would resume around the year 2020. The total cost of PED is estimated to be $14.3 million. More detailed information can be found in the Project Management Plan (PMP).

11. HAZARDOUS AND TOXIC WASTE ASSESSMENT

A. Introduction

The principal hazardous and toxic waste (HTW) concerns associated with the modernization of the Lower Monongahela River Navigation System involve: (1) dredging of large quantities of materials from the navigation channel; (2) removal or disturbance of much smaller quantities of nearshore materials from construction sites, lock approach dredging, and areas that might be dredged by others as a consequence of the project; and (3) potential impacts of the project on local upland HTW sites. District studies to determine the presence and possible impacts of HTWs in areas potentially affected by project alternatives have, to date, concentrated on areas where impacts vary considerably between alternatives. Navigation channel dredging in Pool 3 and pool changes along Pools 2 and 3 were considered to be the most crucial of these HTW concerns for project alternative selection purposes, and therefore were emphasized in the Feasibility Phase investigations. More detailed study of the other impacts, which are common to all alternatives, will be undertaken in the PED Phase. All identified concerns are discussed on the following pages.

B. Feasibility Phase Investigations

Plan 1 proposes a significant amount of navigation channel dredging in the upper 9.5 miles of Pool 3 to compensate for the lowering of Pool 3 by about 3.2 feet. Because there was no known data on possible HTW contamination of the navigation channel substrate in this area, the District developed a worst case sampling scenario in consultation with the Pennsylvania Department of Environmental Resources (PADER), Bureau of Water Quality Management.

In January 1990, the District sampled the Pool 3 navigation channel substrate for the presence of a modified list of Environmental Protection Agency (EPA) priority pollutants. Ten-foot sample columns, extracted from the substrate at nine locations between r.m. 23.8 - 41.5, yielded 21 sediment subsamples for chemical analysis. An additional 27 subsamples were taken for physical analysis. All 21 subsamples and ten background waters were examined for priority pollutants at the Corps' Ohio River Division Laboratory in Cincinnati, Ohio. Elutriates from each of the 21 sediment subsamples were analyzed for all of these priority pollutants, with the exception of volatiles. The Cincinnati Laboratory also performed sieve/hydrometer analyses for 24 of the 27 physical substrate subsamples (three subsamples had been analyzed in the field).

The results of the navigation channel substrate investigation demonstrate that with the exception of some scattered and relatively thin lenses of dense clays, the navigation channel substrate of Pool 3 primarily consists of coarse sand and gravel sized particles. Because of known problems in the navigation system with flesh contamination of bottom feeding fish, e.g., carp and catfish, polychlorinated biphenyls (PCBs) and the pesticide chlordane were of special interest. No pesticides were found, however, and minute amounts of PCB arochlors were detected only at two stations. The only notable concentration of PCBs (69 ug/kg) was found at the interface of one of the three dense clay lenses observed in two of the nine sample columns. These lenses were found at stations and depths outside of the area to be disturbed by dredging for Plan 1.

Perhaps because of the coarseness of the substrate, the sediments of the navigation channel substrate proved to be remarkably clean of priority pollutant contaminants. This worst case analysis indicates that dredged material from the navigation channel may be considered clean fill and that the dredging, handling, and disposal of this material would not require special precautions to protect the health and safety of the public. Further information on this study may be found in the Pittsburgh District report, Monongahela River Pool 3. Investigation for the Presence of Priority Pollutants in the Navigation Channel Substrate, July 1990.

C. PED Phase Investigations

While no HTW problems were encountered during the District's extensive 1990 Feasibility Phase studies, these investigations specifically excluded testing of sediments outside the navigation channel, and it is possible that contaminated pockets of fine sediments may have accumulated in more sheltered areas of the river. Such areas might include deposits behind dams which would be disturbed by project construction and lock approach dredging. In addition, it is possible that the project may necessitate dredging by others at docks, landings and river crossings where some HTW problems could be encountered. The results of the navigation channel study cannot be extrapolated to the river in general because of the anticipated heterogeneity of the substrate. Therefore, additional testing of the construction sites and approaches is scheduled during the PED Phase. However, as discussed on the following pages, available information (including cursory HTW sampling, bore log observations, and screening of permit testing requirements) strongly suggests that any construction site, other nearshore, or upland HTW problems that might yet emerge during this phase would be localized and involve limited quantities of contaminated sediments. It is most probable that these could either be avoided, or handled at a cost which would not affect the plan alternative selection.

C (1). Construction Sites

Potential river sediment disturbances at L/D 4 are related to construction of new locks and dredging of the upper approach channel. The tributary drainage is largely rural. The only immediate potential industrial source of HTWs is the Corning Glass Works near the left bank abutment which will not be disturbed. The absence of state-mandated HTW testing requirements for Section 10 Permits in the vicinity of L/D 4 also suggests that HTW problems at this site are unlikely to be encountered.

Locks and Dam 3 will be removed and there are documented HTW groundwater pollution problems at two locations near the left bank abutment of L/D 3, the Ashland Oil storage and Hercules-Picco manufacturing operations. The Hercules-Picco Plant site is immediately adjacent to the abutment and is the single most significant HTW concern identified with the Lower Monongahela River navigation modernization program. For this reason, the District plans to leave the L/D 3 abutment in place. It is not known if contamination extends beyond the immediate L/D 3 abutment area, and it is possible that some accumulated sediments behind the dam near the left bank may require special handling and disposal considerations.

Dam 2 will be removed, a new replacement structure will be constructed, and upper approach dredging will be necessary. The L/D 2 construction area is located downstream of the confluence of Turtle Creek, and the Turtle Creek Valley is a known source of PCB contaminants. In addition, this project is downstream of the USX Clairton Works coking operation, and its associated BTX plant, which is a documented source of both volatile organic compound (VOC) and polyaromatic hydrocarbon (PAH) priority pollutants. Nevertheless, cursory 1991 worst case testing of both bulk and elutriate priority pollutants from a 17-foot deep core sample of fine sediments collected above the L/D 2 left bank abutment, indicates that the L/D 2 construction site is not significantly degraded by HTWs.

C (2). <u>Tentative Sampling Plan to Assess the Chemical Quality of Nearshore Sediments Along the Lower Monongahela River Project Area.</u>

The table below outlines the tentative PED Phase sediment sampling plan:

Construction Area	Number of Core Samples	Core Sample Station Locations
L/D 2	2 - Left Bank	1 - Above Existing Abutment 1 - At Replacement Abutment
	2 - Right Bank	1 - In Approach Channel 1 - Above Dam
L/D 3	2 - Left Bank	1 - Above Abutment 1 - Below Abutment
	1 - Mid Channel	1 - Above Dam
	1 - Right Bank	1 - Above Dam
L/D 4	1 - Right Bank	1 - Above Fixed Weir Section
	2 - Left Bank	1 - Above Dam at Lower End of Dredging 1 - Upper End of Dredging

The approximate locations of each proposed core sampling station are described above. Final station locations will be field adjusted to collect the finest deposits of substrate material present in each identified area of interest. Sampling will be accomplished by using a floating plant and a driller, who are both now available under open-end contracts to the Geotechnical Branch. Core depths would be drilled to a maximum of 10 feet, with minimum partitioning of each core into top and bottom subsamples. Additional subsamples will be taken from the cores if clay lenses or other suspicious strata are encountered.

These sampling locations are intended to represent worst case situations for sediment removal. The L/D 3 left bank abutment stations, for instance, are in the shadow of the Hercules-Picco HTW site. If these worst case samples prove to be clean, according to the latest approved protocol for sediment testing, further sampling would not be warranted. On the other hand, if significant contamination of any of the worst case samples is demonstrated, the results would be utilized to define the degree and extent of necessary additional sampling.

The estimated costs for sample analyses of a total of 28 subsamples from the 11 cores, each subsample requiring three analytical runs at $1,400 per run, is $118,000. In addition, the floating plant, drilling rig, crews, and other associated expenses would cost approximately $50,000. Hired labor expenses would be about $25,000, for a total cost of $193,000.

Further consultation with appropriate resource agencies may result in some modifications of this proposed sampling plan and cost estimate.

C (3). <u>Dredging by Others</u>

As previously discussed, a nearshore sediment sampling plan has been prepared that will be coordinated with the Pennsylvania Department of Environmental Resources (PADER), and undertaken during the PED project phase. This plan would entail sampling a series of both left and right bank sediment cores at each of the three navigation dams in the study area, and would compliment the analyses that already have been completed along the navigation channel. All nearshore sediment analyses would employ a new testing protocol that recently has been approved by the PADER for dredged materials.

Besides site specific construction applications, the results obtained from the proposed nearshore sediment investigations also would be used for determining whether nearshore sediment contamination is widespread in the study reach of the Monongahela River. If such widespread HTW contamination is demonstrated, additional nearshore testing would be initiated with a focus on private dock sites that would require compensatory dredging as a consequence of the lowering of Pool 3. The absence of state-mandated HTW testing requirements for Section 10 Permits in the project area, however, suggests that widespread HTW contamination at docks and landings currently is not considered to be a problem by the responsible regulatory agencies.

D. <u>Potential Impacts of the Project on Local Upland HTW Sites</u>

An inventory of known hazardous and toxic waste sites within a one-quarter mile landward distance of the tops of both the left and right banks of the Monongahela River along the study reach (including the proposed dredge disposal areas) was compiled from the U.S. Environmental Protection Agency's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). Possible HTW sites along the expanded Turtle

Creek and Youghiogheny River embayments of Pool 2 were not considered in the initial review, but will be included in an updated inventory (Plates 11-1 to 11-4 show that the potential impact area extends approximately 11.2 miles upstream on the Youghiogheny River and 1.4 miles on Turtle Creek). The initial review yielded 22 potentially affected hazardous and toxic waste sites. The list subsequently was reviewed by the Pennsylvania Department of Environmental Resources (PADER) for the purpose of determining its completeness and whether any of the listed sites could be impacted by the proposed navigation improvement project. PADER identified four sites that could be impacted by the navigation project:

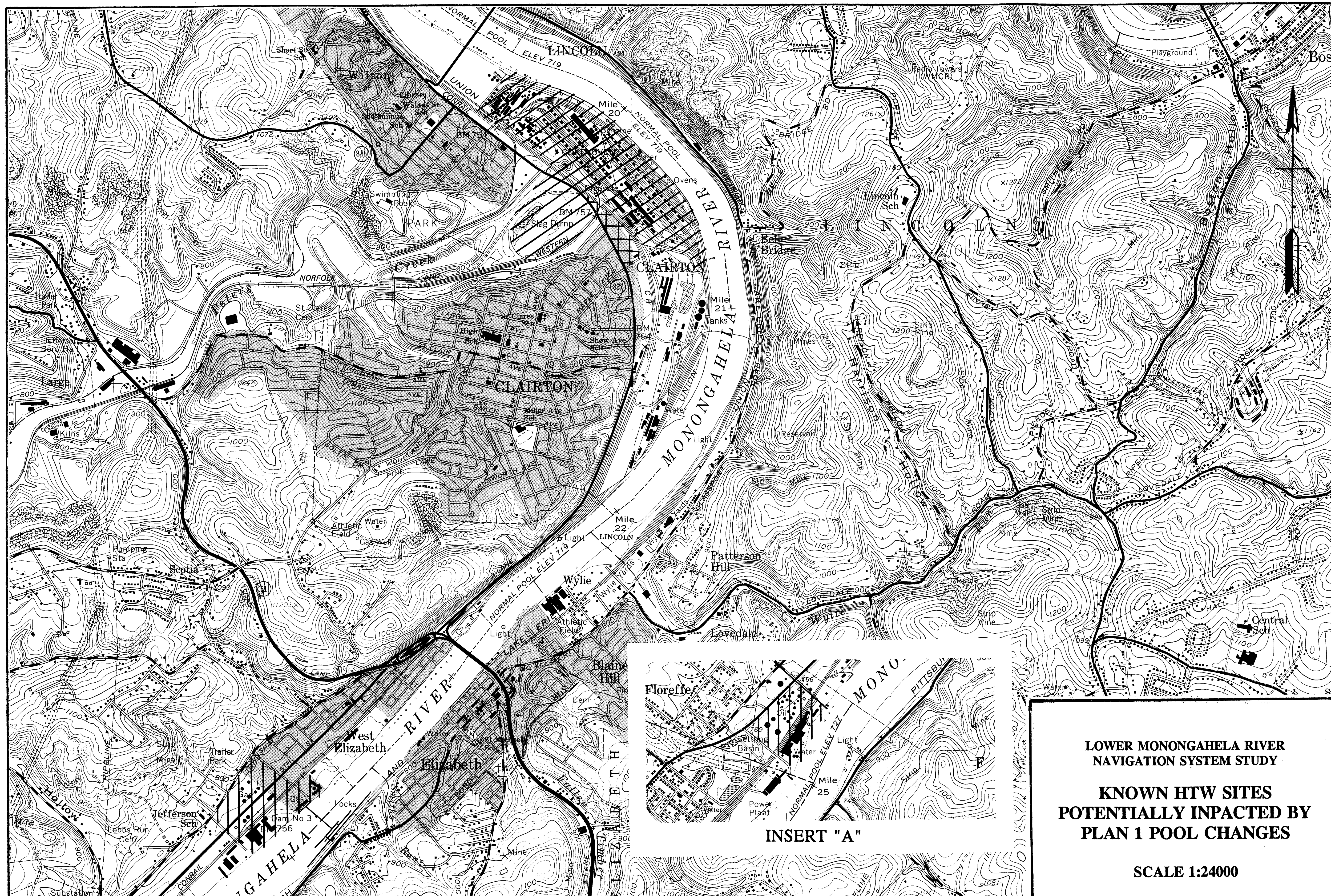
1. USX Clairton Works, including Peters Creek Lagoon (r.m. +/- 20.5)
2. Hercules Plant adjacent to USX (r.m. +/- 20.5)
3. Hercules Plant at West Elizabeth (r.m. +/- 23.6)
4. Ashland Petroleum Co. upstream of West Elizabeth (r.m. +/- 24.0).

A rise in average water levels in Pool 2 could affect the first two sites and part of the third, while the lowered average levels in Pool 3 could affect the remainder of the third and fourth.

These sites have been researched, using files from PADER, and subsequently visited by Corps personnel. Some of the features which potentially could be impacted by the changes in water levels involve the cleanup efforts for presently existing contamination. These are: monitoring/extraction wells, groundwater interceptor trenches, and a proposed vapor extraction system. There should be only minor impacts to these facilities. The interceptor trenches may be impacted the most since more river seepage would have to be pumped from the trenches and treated, though this still may be a minor impact. The groundwater levels are not changing enough to significantly impact efficiency or operability of the proposed Vapor Extraction System. Monitoring/extraction wells should be impacted only slightly. A drop or rise of a few feet in the groundwater levels should be within range of the screens of most wells.

A few additional facilities that concerned PADER should not experience any significant impacts. The Hercules plant near USX is not presently operating. No specific impact can therefore be determined at present, though it is doubtful that any negative effects would occur. It is not thought that the slight rise in groundwater levels in the area of USX would have any impact on the Peters Creek Lagoon (USX Clairton Works), which is appreciably above the present pool location. At the third and fourth sites, lowering of groundwater levels could expose a few more feet of soil to petroleum contamination.

At this time, after review of the evidence and with the tentative concurrence of PADER, it has been concluded that any impacts to the previously mentioned sites would be minimal. However, when evaluating this conclusion, it should be understood that very little time was available for a detailed study, and there is a great deal of information which has not yet been thoroughly examined.

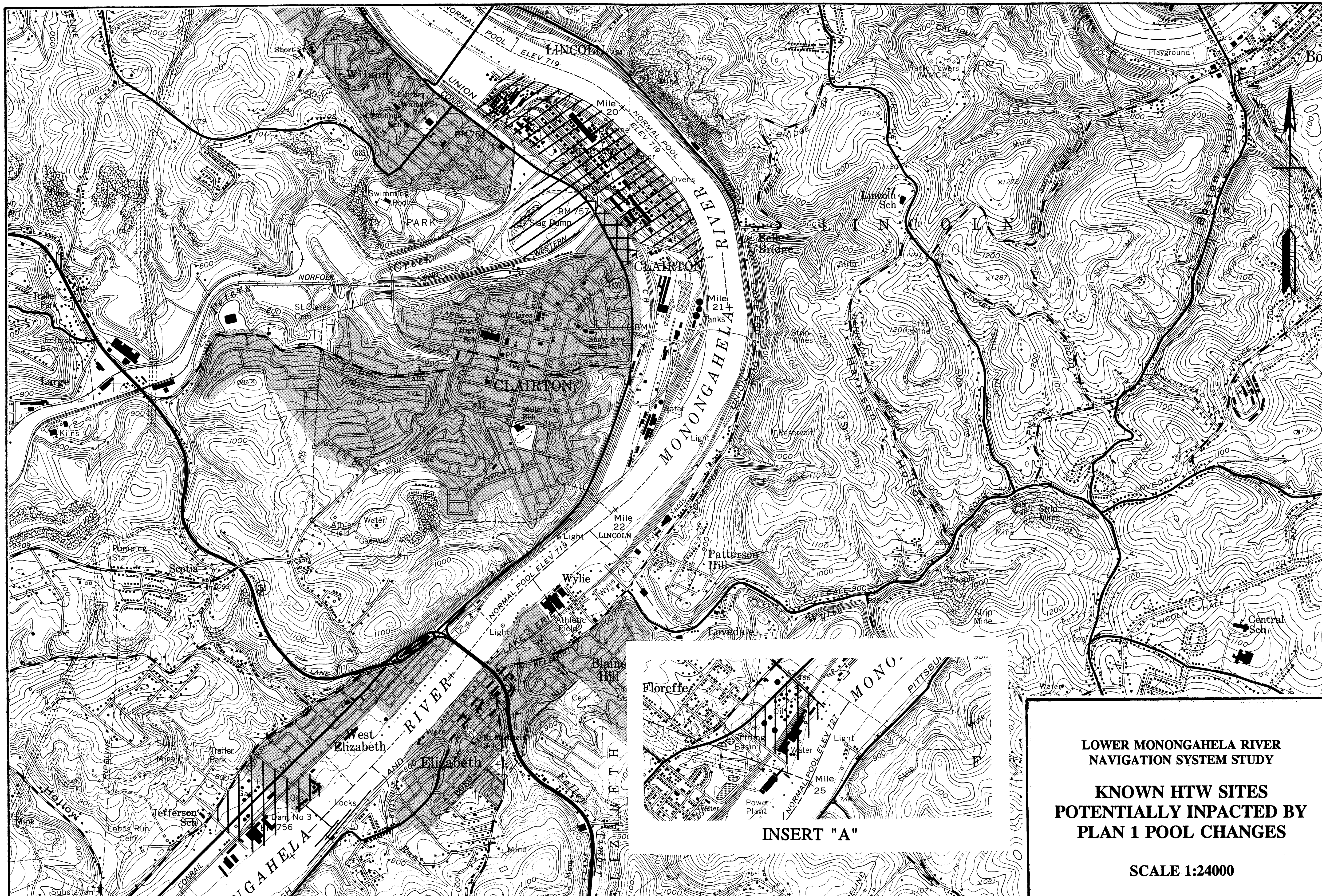


LOWER MONONGAHELA RIVER NAVIGATION SYSTEM STUDY

KNOWN HTW SITES POTENTIALLY INPACTED BY PLAN 1 POOL CHANGES

SCALE 1:24000

SEE INSERT "A"



LOWER MONONGAHELA RIVER NAVIGATION SYSTEM STUDY

KNOWN HTW SITES POTENTIALLY INPACTED BY PLAN 1 POOL CHANGES

SCALE 1:24000

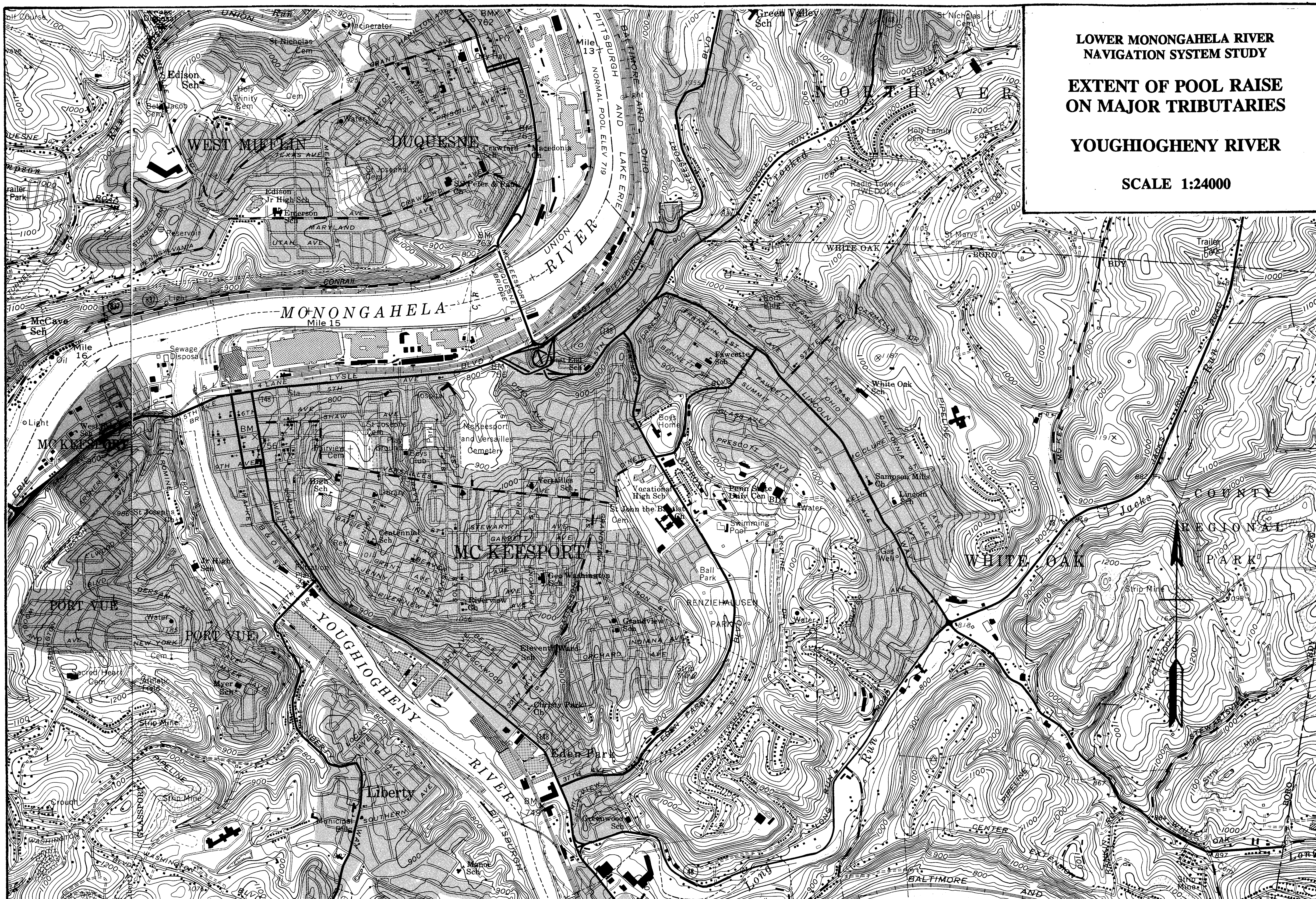
SEE INSERT "A"

LOWER MONONGAHELA RIVER
NAVIGATION SYSTEM STUDY

EXTENT OF POOL RAISE ON MAJOR TRIBUTARIES

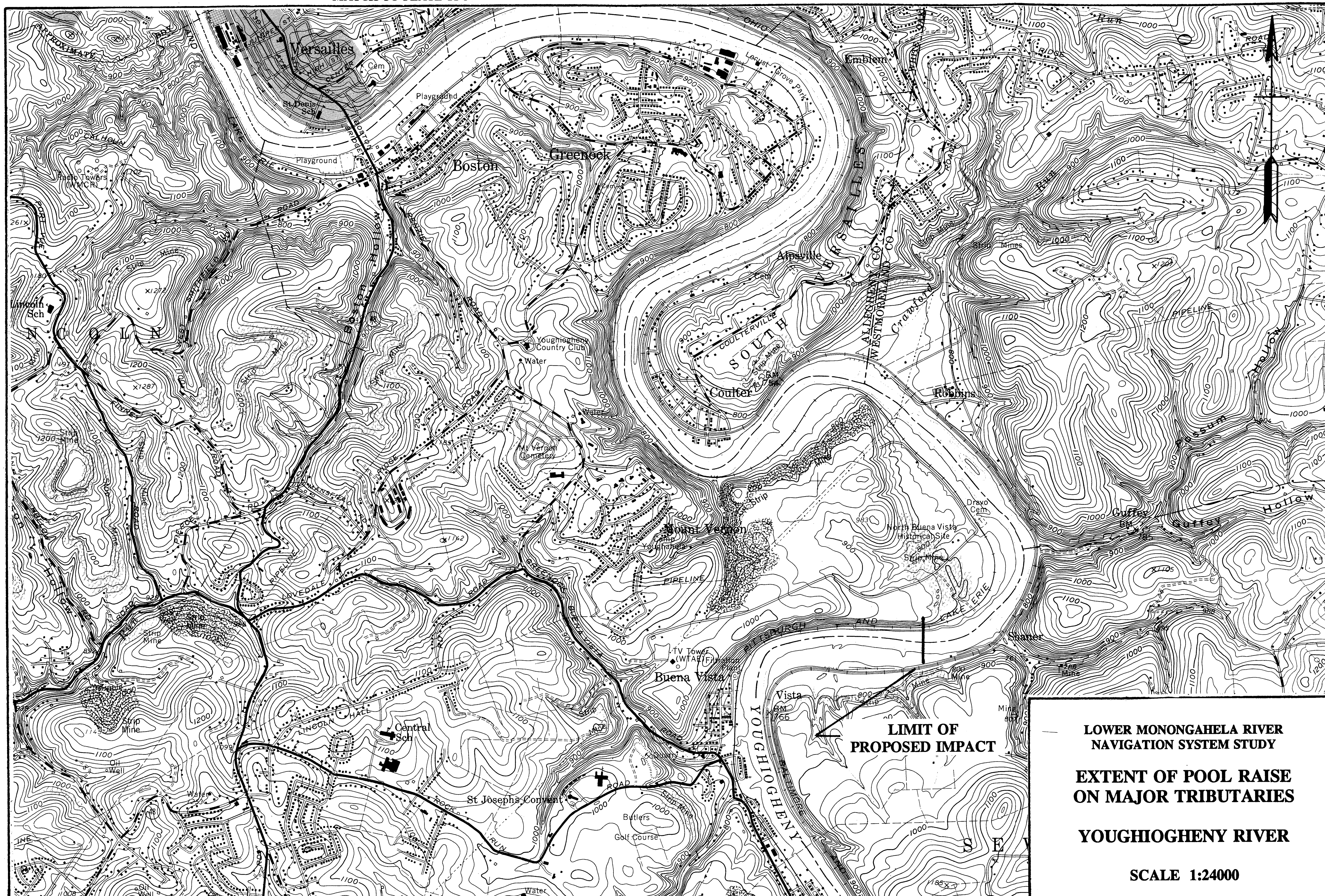
YOUGHIOGHENY RIVER

SCALE 1:24000



MATCH TO PLATE 11-4

MATCH TO PLATE 11-3



LOWER MONONGAHELA RIVER NAVIGATION SYSTEM STUDY

EXTENT OF POOL RAISE ON MAJOR TRIBUTARIES

YOUGHIOGHENY RIVER

SCALE 1:24000

ATTACHMENT

RECOMMENDED PLAN

COST ESTIMATES

Lower Monongahela River Navigation Study

Cost Estimates for Recommended Plan

Table of Contents

01 LANDS AND DAMAGES

A summary for this Code of Account is provided below.

01 Lands and Damages	$ 3,100,000
Contingencies	800,000
TOTAL	$ 3,900,000

Explanation of Contingencies

Contingencies for this code of account was developed by the functional chief that provided these costs associated with this code of account and are delineated for hired labor and anticipated flowage easement payments.

LANDS AND DAMAGES

01.-.-.- LANDS AND DAMAGES		
01.A.-.- Pre-Authorization Planning	$20,000	
01.A.9.- Contingencies		$4,000
01.B.-.- Post-Authorization Planning	$102,100	
01.B.9.- Contingencies		$21,000
01.D.-.- Acquisitions	$492,000	
01.D.9.- Contingencies		$100,000
01.E.-.- Condemnation (Post-DT Filing)	$14,900	
01.E.9.- Contingencies		$3,000
01.F.-.- Appraisals	$253,800	
01.F.9.- Contingencies		$50,000
01.G.-.- Audits	$17,100	
01.G.9.- Contingencies		$3,500
01.H.-.- Relocation Assistance	$9,200	
01.H.9.- Contingencies		$2,000
01.J.-.- Disposals	$7,100	
01.J.9.- Contingencies		$1,500
01.M.-.- Real Estate Receipts/Payments	$2,200,000	
01.M.9.- Contingencies		$600,000
	~~	~~~~~~~~~~~~
TOTAL	$3,116,200	$785,000
TOTAL (ROUNDED)	$3,100,000	$800,000

02 RELOCATIONS

A summary of this Code of Account is provided below.

02	Utilities	$ 10,915,000
02	Structures	460,000
02	Railroads	19,260,000
02	Storm Sewers	1,230,000
	Contingencies	16,935,000
	TOTAL	$ 48,800,000

Explanation of Contingencies

Individual contingencies for each line item were determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. A 30% contingency was applied to the relocation estimate for the railroad bridge due to confidence in the preliminary design and quantities as submitted by the railroad, and reviewed and estimated by the Corps. Where relocation of major storm sewers occurs outside navigable servitude and quantity calculations were based on less than complete data, a 50% contingency was applied. The contingencies applied to municipal facilities within the navigable servitude varies from 100 - 200% and is dependent upon existing site conditions, type of construction procedure required, access, and incomplete general data on the pipe.

LOWER MONONGAHELA NAVIGATION STUDY - FEDERAL RELOCATIONS
PUBLIC FACILITIES WITHIN NAVIGABLE SERVITUDE
OCTOBER 1991 COST LEVEL

	DESCRIPTION	QUANTITY	UNIT	TOTAL AMOUNT INCL CONTINGENCY
02.3.2.-	UTILITIES			
02.3.2.-	Mon Valley Sewage Authority	1	JOB	$1,350,000.00
02.3.2.-	City of Duquesne	1	JOB	$660,000.00
02.3.2.-	West Elizabeth Boro Sewage	1	JOB	$2,500,000.00
02.3.2.-	Elizabeth Boro Sewage	1	JOB	$1,425,000.00
02.3.2.-	Elizabeth Township Sewage	1	JOB	$300,000.00
02.3.2.-	Borough of Charleroi (Submarine Crossings)	1	JOB	$2,100,000.00
02.3.2.-	Borough of Charleroi (Submarine Crossings)	1	JOB	$1,050,000.00
02.3.2.-	Structure EL6, RM 17 - Left Bank	1	JOB	$1,990,000.00
02.3.2.-	Structure ER8, RM 17.3 - Right Bank	1	JOB	$1,170,000.00
02.3.2.-	Structure 17, RM 18.9 - Right Bank	1	JOB	$1,400,000.00
02.3.2.-	Structure ER6, RM 15.6 - Right Bank	1	JOB	$275,000.00
02.3.2.-	Structure 16, RM 17.8 - Right Bank	1	JOB	$270,000.00
02.3.2.-	Structure EL10, RM 22.8 - Left Bank	1	JOB	$135,000.00
02.3.2.-	Structure EL5, RM 16.4 - Left Bank	1	JOB	$2,550,000.00
02.3.2.-	Structure EL11, RM 23.0 - Left Bank	1	JOB	$270,000.00
02.3.2.-	Structure ER10, RM 23.2 - Right Bank	1	JOB	$380,000.00
02.3.2.-	Structure 11.1, RM 15.7 - Right Bank	1	JOB	$100,000.00
02.3.2.-	Structure YA13, RM 0.1 Yough - Left Bank	1	JOB	$415,000.00
02.3.2.-	Structure YA8, RM 2.1 Yough - Right Bank	1	JOB	$2,935,000.00
02.3.3.-	STRUCTURES			
02.3.3.-	Riverfront Park, Borough of Elizabeth	1	JOB	$400,000.00
02.3.3.-	Aquatorium, City of Monongahela	1	JOB	$190,500.00
02.3.3.-	Boat Launching Ramp, New Eagle Borough	1	JOB	$30,000.00
02.3.3.-	Boat Launching Ramp, City of Monongahela	1	JOB	$30,000.00
02.3.3.-	Boat Launching Ramp, PA Fish Commission	1	JOB	$30,000.00
02.3.3.-	Boat Launching Ramp, Forward Township	1	JOB	$30,000.00
02.3.3.-	Boat Launching Ramp, Borough of Webster	1	JOB	$1,500.00
02.3.3.-	Boat Launching Ramp, Borough of Webster	1	JOB	$1,500.00
02.3.3.-	Boat Launching Ramp, City of Monessen	1	JOB	$1,500.00
	TOTAL CONSTRUCTION COST, INCLUDING CONTINGENCIES			$21,990,000.00

LOWER MONONGAHELA RIVER NAVIGATION STUDY
RAILROAD BRIDGE RELOCATION - October 1991 Cost Level

	DESCRIPTION	QUANTITY	UNIT	PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OH & PROFIT	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
	*** RAILROAD RELOCATION ***									
02.-.-.-	RELOCATIONS									
02.2.1.B	Railroad Traffic Detour	1	JOB	$23,228	$136,691	$405,000	$565,000.00	$565,000.00	30%	$734,500.00
02.2.3.B	Track Relocation	1	JOB	$0	$0	$80,000	$80,000.00	$80,000.00	30%	$104,000.00
02.2.3.B	Track Reprofile	1	JOB	$5,605	$18,869	$15,000	$40,000.00	$40,000.00	30%	$52,000.00
02.2.K.C	Concrete, Pier Encasement	1,200	CY	$778,932	$1,251,908	$455,000	$2,070.00	$2,484,000.00	30%	$3,229,200.00
02.2.K.C	Concrete, Pier Rehabilitation	200	CY	$111,276	$178,844	$25,200	$1,575.00	$315,000.00	30%	$409,500.00
02.2.L.E	Remove & Replace Main Span (Steel)	4,000,000	LBS	$2,199,780	$2,436,750	$4,275,000	$2.25	$9,000,000.00	30%	$11,700,000.00
02.2.L.E	Remove & Replace North Approach Span (Steel)	2,400,000	LBS	$1,466,520	$1,624,500	$2,280,000	$2.25	$5,400,000.00	30%	$7,020,000.00
02.2.L.E	Rehabilitation South Approach Span (Steel)	640,000	LBS	$488,840	$541,500	$550,000	$2.50	$1,600,000.00	30%	$2,080,000.00
02.2.L.E	Raise South Approach Spans	1	JOB	$0	$0	$1,050,000	$1,050,000.00	$1,050,000.00	30%	$1,365,000.00
02.2.L.F	Timber Deck	1,665	EA	$42,968	$302,853	$405,000	$450.00	$749,250.00	30%	$974,025.00
02.2.R.-	Communication & Signal Work	1	JOB	$0	$0	$50,630	$50,000.00	$50,000.00	30%	$65,000.00
02.2.R.-	Utility Work	1	JOB	$0	$0	$65,000	$65,000.00	$65,000.00	30%	$84,500.00
	TOTAL COST							$21,398,250.00		$27,817,725.00
									30%	
								ROUNDED		$27,800,000.00

TOTAL RAILROAD BRIDGE RELOCATION (ROUNDED):

FEDERAL RELOCATION COST, 90%	$19,260,000	30%	$25,000,000
NON-FEDERAL RELOCATION COST, 10%	$2,140,000		

LOWER MONONGAHELA NAVIGATION STUDY
FEDERAL RELOCATIONS - STORM SEWERS
OCTOBER 1991 COST LEVEL

	DESCRIPTION	QUANTITY	UNIT	TOTAL AMOUNT INCL CONTINGENCY
02.3.2.-	UTILITIES			
02.3.2.-	Structure T2, RM +- 1.0 Turtle - Right Bank	1	JOB	$470,000.00
02.3.2.-	Structure ETR2, RM .2 Turtle - Right Bank	1	JOB	$260,000.00
02.3.2.-	Structure ETR1, RM .5 Turtle - Right Bank	1	JOB	$280,000.00
02.3.2.-	Structure RM 1.0 Turtle - Right Bank	1	JOB	$220,000.00
02.3.2.-	Structure P22, RM 1.1 Turtle - Right Bank	1	JOB	$230,000.00
02.3.2.-	Structure RM 1.3 Turtle - Right Bank	1	JOB	$230,000.00
02.3.2.-	Structure P29, RM 1.5 Turtle - Right Bank	1	JOB	$160,000.00
	TOTAL CONSTRUCTION COST, INCLUDING CONTINGENCIES			$1,850,000.00

03 RESERVOIRS

A summary of this Code of Account is provided below.

03	Removal of L/D 3	$ 7,000,000
	Contingencies	2,000,000
	TOTAL	$ 9,000,000

Explanation of Contingencies

Individual contingencies for each line item was determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. When reasonable confidence in the quantities and unit cost for this stage of the project was determined, a 25% contingency was applied. In instances where the quantity calculation was based on incomplete data, a 30% contingency was applied.

LOWER MONONGAHELA RIVER NAVIGATION STUDY
REMOVAL OF L/D #3 - October 1991 Cost Level

	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD AND PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OVERHEAD &PROFIT	TOTAL AMOUNT	CONTIN-GENCY	TOTAL AMOUNT INCL CONTINGENCY
	*** RESERVOIRS ***									
03.0.-.-	RESERVOIRS									
03.0.1.B	REMOVAL OF L/D #3	1	JB	$1,620,847	$2,451,521	$304,067	$6,000,000.00	$6,000,000.00	30%	$7,800,000.00
03.0.1.B	SHEET PILING REMOVAL	55,890	SF	$111,016	$133,987	$0	$6.00	$335,340.00	30%	$435,942.00
03.0.1.B	EXCAVATION (CELLS)	14,060	CY	$37,310	$21,988	$0	$6.00	$84,360.00	30%	$109,668.00
03.0.1.B	CONCRETE (CELLS)	770	CY	$7,273	$35,572	$0	$70.00	$53,900.00	25%	$67,375.00
03.0.1.B	REMOVAL OF TIMBER FENDERS	1	JB	$12,165	$26,040	$0	$50,000.00	$50,000.00	25%	$62,500.00
03.0.1.B	EQUIPMENT REMOVAL	1	JB	$6,036	$15,965	$0	$30,000.00	$30,000.00	25%	$37,500.00
	TOTAL COST							$6,553,600.00		$8,512,985.00
	DISTRIBUTED COSTS	$922,900	OR	14.1%						
	PRIMES PROFIT	9.3%							30%	
								ROUNDED		$9,000,000.00

CONSTRUCTION OF THE GATED DAM AT MONONGAHELA LOCKS AND DAM 2
(Including the Modification to portions of the Locks)

A summary of the Code of Accounts for the completion of this contract is provided below.

		Construction Costs	Contingencies
04	Dam	$98,000,000	$28,000,000
05	Locks	11,300,000	2,900,000
		-----------	-----------
	Total	$109,300,000	$30,900,000

EXPLANATION OF CONTINGENCIES

Individual contingencies for each line item were determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. When reasonable confidence in the design, quantities, and unit cost, for this stage of project was determined, a 25% contingency was applied. Justification for any deviations from the basic percentage are included below.

04.2.D.- Earthwork for Structures. A 75% contingency was applied to the Dredging since it is still unknown, although unlikely, that hazardous and toxic waste may be present in this material.

04.2.2.- Concrete Overflow Section. A 100% contingency was applied to the Concrete Slurry Wall since this is heavily dependent upon further investigation.

04.2.3.- Apron, Stilling Basin and Deflectors. A contingency of 50% was used for Removal of the Existing Dam - Wood, Stone, and Fill. This item is an unknown.

04.2.4.- Embedded Metal Work. A contingency of 50% was applied to the Swinging Walkways since the number required has not been finalized.

LOWER MON NAVIGATION STUDY
RM 11.2, CONSTRUCTION OF GATED DAM
(OCTOBER 1991 PRICE LEVEL)

	DESCRIPTION	QUANTITY	UNIT	PLANT (WITHOUT OVERHEAD & PROFIT)	LABOR (WITHOUT OVERHEAD & PROFIT)	MATERIALS (WITHOUT OVERHEAD & PROFIT)	UNIT PRICE INCLUDING ALL OH&P (ROUNDED)	TOTAL AMOUNT	CONTI GENCY	TOTAL AMOUNT INCL CONT.
04.2.-.-	SPILLWAY DAM									
04.2.A.-	MOBILIZATION AND PREPARATORY WORK	1	JOB	$914,801	$1,359,956	$3,829,758	$7,300,000.00	$7,300,000.00	25%	$9,125,000.00
04.2.B.-	CARE AND DIVERSION OF WATER									
04.2.B.B	Cofferdams	1	JOB	$5,744,856	$4,527,140	$8,041,102	$21,250,000.00	$21,250,000.00	25%	$26,562,500.00
04.2.B.B	Cofferdam Overtopping	1	JOB	$0	$0	$320,000	$320,000.00	$320,000.00	25%	$400,000.00
04.2.B.Q	Cofferdam Instrumentation	1	JOB	$13,995	$165,891	$301,620	$600,000.00	$600,000.00	25%	$750,000.00
04.2.D.-	EARTHWORK FOR STRUCTURES									
04.2.D.B	Expl Drilling, Mobilization & Demobilization	1	JOB	$1,824	$1,422	$0	$4,600.00	$4,600.00	25%	$5,750.00
04.2.D.B	Expl Drilling, Drilling Without Coring	900	LF	$10,258	$7,996	$0	$25.00	$22,500.00	25%	$28,125.00
04.2.D.B	Expl Drilling, Core Drilling, 4" Dia Cores	1,200	LF	$27,354	$21,323	$0	$55.00	$66,000.00	25%	$82,500.00
04.2.D.B	Expl Drilling, Seal Exploration Holes w/Cement	1,500	CWT	$1,691	$14,941	$6,000	$20.00	$30,000.00	25%	$37,500.00
04.2.D.B	Erosion Control at the Disposal Area	1	JOB	$115,672	$348,934	$677,186	$1,400,000.00	$1,400,000.00	25%	$1,750,000.00
04.2.D.B	Clearing and Grubbing	3	ACRE	$1,019	$4,557	$0	$2,200.00	$6,600.00	25%	$8,250.00
04.2.D.B	Stripping	3,900	CY	$2,786	$7,230	$0	$3.00	$11,700.00	25%	$14,625.00
04.2.D.B	Excavation, Common	200,900	CY	$1,302,098	$954,726	$0	$13.00	$2,611,700.00	25%	$3,264,625.00
04.2.D.B	Excavation, Rock	30,400	CY	$229,044	$291,900	$27,200	$22.00	$668,800.00	25%	$836,000.00
04.2.D.B	Presplitting, Line Drilling	54,400	SF	$30,864	$90,496	$33,968	$3.00	$163,200.00	25%	$204,000.00
04.2.D.B	Pervious Backfill, Gated Dam & Abutment	3,100	CY	$2,953	$6,080	$46,500	$21.00	$65,100.00	25%	$81,375.00
04.2.D.B	Random Backfill, Gated Dam & Abutment	22,300	CY	$38,626	$66,988	$0	$6.00	$133,800.00	25%	$167,250.00
04.2.D.B	Impervious Backfill, Gated Dam & Abutment	770	CY	$1,321	$1,938	$4,620	$12.00	$9,240.00	25%	$11,550.00
04.2.D.B	Select Rock Fill at Abutment	5,900	CY	$5,719	$11,026	$118,000	$27.00	$159,300.00	25%	$199,125.00
04.2.D.B	Stone Protection at Abutment	3,100	CY	$11,983	$10,434	$52,836	$30.00	$93,000.00	25%	$116,250.00
04.2.D.B	Choke Material at Abutment	1,600	CY	$2,357	$4,940	$24,000	$23.00	$36,800.00	25%	$46,000.00
04.2.D.B	Dredging Above and Below the Dam	489,400	CY	$2,264,750	$1,824,171	$0	$11.00	$5,383,400.00	75%	$9,420,950.00
04.2.D.B	Derrickstone, 2.7 foot diameter	21,800	CY	$105,684	$79,230	$463,100	$40.00	$872,000.00	25%	$1,090,000.00
04.2.D.B	Derrickstone, 1.5 foot diameter	61,400	CY	$297,794	$223,135	$1,167,270	$38.00	$2,333,200.00	25%	$2,916,500.00
04.2.D.B	Filter Material	29,700	CY	$75,039	$47,696	$466,988	$26.00	$772,200.00	25%	$965,250.00

04.2.E.-	FOUNDATION WORK									
04.2.E.B	Foundation Prep, Primary Clean-up	5,100	SY	$7,456	$65,080	$0	$18.00	$91,800.00	25%	$114,750.00
04.2.E.B	Foundation Prep, Final Clean-up	4,110	SY	$9,811	$92,265	$0	$30.00	$123,300.00	25%	$154,125.00
04.2.E.B	Foundation Prep, Protective Coating for Rock	54,400	SF	$3,368	$17,865	$9,792	$1.00	$54,400.00	25%	$68,000.00
04.2.E.B	Foundation Prep, Temporary Earth Cover	4,110	SY	$3,881	$13,411	$0	$5.00	$20,550.00	25%	$25,687.50
04.2.E.C	Foundation Prep, Dental Treatment, Mortar	5	CY	$836	$4,640	$215	$1,400.00	$7,000.00	25%	$8,750.00
04.2.E.C	Foundation Prep, Dental Treatment, Mortar	15	CY	$2,509	$13,919	$645	$1,400.00	$21,000.00	25%	$26,250.00
04.2.E.C	Foundation Prep, Dental Treatment, Concrete	50	CY	$2,987	$16,570	$2,150	$500.00	$25,000.00	25%	$31,250.00
04.2.E.C	Foundation Prep, Dental Treatment, Concrete	150	CY	$8,961	$49,709	$6,450	$500.00	$75,000.00	25%	$93,750.00
04.2.E.C	Foundation Grouting	3,800	CY	$110,789	$607,845	$415,220	$350.00	$1,330,000.00	25%	$1,662,500.00
04.2.E.C	H-piles	26,800	LF	$165,935	$696,542	$303,871	$50.00	$1,340,000.00	25%	$1,675,000.00
04.2.E.C	Steel Sheet Piling w/Anchors	23,400	SF	$1,207,799	$1,468,065	$987,620	$190.00	$4,446,000.00	25%	$5,557,500.00
04.2.E.C	Steel Sheet Piling, Dam Cutoff Wall	9,200	LF	$15,800	$19,681	$137,115	$22.00	$202,400.00	25%	$253,000.00
04.2.2.-	CONCRETE OVERFLOW SECTION									
04.2.2.C	Conc Gravity Sect- < El. 678.7, Pier Monolith	21,000	CY	$374,089	$1,120,415	$873,002	$135.00	$2,835,000.00	25%	$3,543,750.00
04.2.2.C	Conc Gravity Sect- > El. 678.7, Pier Ovrflow Sect	5,910	CY	$112,093	$359,532	$247,879	$145.00	$856,950.00	25%	$1,071,187.50
04.2.2.C	Conc Gravity Sect- < El. 678.7, Abutment	8,630	CY	$153,748	$460,570	$357,655	$135.00	$1,165,050.00	25%	$1,456,312.50
04.2.2.C	Conc Gravity Sect- > El. 678.7, Abutment	6,630	CY	$126,794	$425,796	$278,982	$150.00	$994,500.00	25%	$1,243,125.00
04.2.2.C	Conc Gravity Sect- > El. 678.7, Abut Ovrflow Sect	830	CY	$16,198	$54,176	$35,181	$155.00	$128,650.00	25%	$160,812.50
04.2.2.C	Conc Gravity Sect- < El. 678.7, Abut. Ext.	2,640	CY	$47,207	$141,715	$109,613	$135.00	$356,400.00	25%	$445,500.00
04.2.2.C	Conc Gravity Sect- > El. 678.7, Abut. Ext.	2,730	CY	$48,357	$143,013	$113,213	$135.00	$368,550.00	25%	$460,687.50
04.2.2.C	Concrete-Abutment Cut-off Wall	880	CY	$16,785	$54,839	$37,021	$145.00	$127,600.00	25%	$159,500.00
04.2.2.C	Concrete-Slurry Wall beyond Cut-off	1,290	CY	$16,698	$29,749	$77,100	$120.00	$154,800.00	100%	$309,600.00
04.2.2.C	Concrete-Fixed Weir, Overflow Section	5,640	CY	$107,918	$343,842	$236,852	$145.00	$817,800.00	25%	$1,022,250.00
04.2.2.C	Concrete-Gate Bays, Overflow Section	19,100	CY	$363,295	$1,194,283	$796,521	$150.00	$2,865,000.00	25%	$3,581,250.00
04.2.2.C	Concrete-Gated Dam Piers, Pier Concrete	15,400	CY	$349,361	$1,026,847	$643,063	$160.00	$2,464,000.00	25%	$3,080,000.00
04.2.2.C	Concrete-Gated Dam Piers, High Strength	2,780	CY	$63,202	$186,021	$130,947	$165.00	$458,700.00	25%	$573,375.00
04.2.2.C	Conc in Recesses to Install Embedded Metal	320	CY	$13,754	$45,255	$14,116	$275.00	$88,000.00	25%	$110,000.00
04.2.2.C	Concrete, Miscellaneous	100	CY	$4,227	$12,054	$4,264	$250.00	$25,000.00	25%	$31,250.00
04.2.2.C	Portland Cement	770,500	CWT	$0	$0	$3,082,000	$5.00	$3,852,500.00	25%	$4,815,625.00
04.2.2.C	Pozzolan, Gated Dam & Appurtenances	127,430	CF	$0	$0	$89,198	$1.00	$127,430.00	25%	$159,287.50
04.2.2.C	Drill Holes and Grout Dowels	15,730	LF	$195,733	$156,348	$7,865	$28.00	$440,440.00	25%	$550,550.00
04.2.2.C	Steel Reinforcement, Dowels	200,240	LBS	$0	$0	$50,060	$0.40	$80,096.00	25%	$100,120.00
04.2.2.C	Steel Reinforcement, Rebar	2,873,000	LBS	$34,663	$277,274	$731,433	$0.50	$1,436,500.00	25%	$1,795,625.00
04.2.2.C	Waterstops, Gated Dam	670	LF	$129	$6,371	$8,033	$26.00	$17,420.00	25%	$21,775.00
04.2.3.-	APRON, STILLING BASIN AND DEFLECTORS									
04.2.3.B	Remove Existing Dam - Wood, Stone, & Fill	2,400	CY	$27,066	$56,603	$0	$50.00	$120,000.00	50%	$180,000.00
04.2.3.C	Remove Existing Dam - Concrete	9,620	CY	$189,194	$373,138	$32,444	$90.00	$865,800.00	25%	$1,082,250.00

04.2.3.C	Conc Gravity Sect- > El. 678.7, Abut Stlg Bsn Sect	630	CY	$12,422	$41,309	$26,838	$155.00	$97,650.00	25%	$122,062.50
04.2.3.C	Conc Gravity Sect- > El. 678.7, Pier Stlg Bsn Sect	3,570	CY	$68,392	$230,195	$150,264	$150.00	$535,500.00	25%	$669,375.00
04.2.3.C	Concrete-Gate Bays, Stilling Basin Section	11,680	CY	$250,882	$672,240	$483,695	$145.00	$1,693,600.00	25%	$2,117,000.00
04.2.3.C	Concrete-Fixed Weir, Stilling Basin Section	3,110	CY	$66,669	$219,005	$131,695	$160.00	$497,600.00	25%	$622,000.00
04.2.2.C	Concrete-Baffles	490	CY	$15,824	$47,591	$20,916	$210.00	$102,900.00	25%	$128,625.00
04.2.4.-	EMBEDDED METAL WORK									
04.2.4.E	Test Recesses & Embedded Metal Emerg Blkhd	1	JOB	$967	$5,330	$0	$7,500.00	$7,500.00	25%	$9,375.00
04.2.4.E	Dam Emerg Blkhd Embedded Metal Recess & Sills	1	JOB	$31,356	$77,874	$324,040	$520,000.00	$520,000.00	25%	$650,000.00
04.2.4.E	Doors and Frames, Piers 1 and 6	1	JOB	$322	$1,777	$850	$3,500.00	$3,500.00	25%	$4,375.00
04.2.4.E	Downstream Bulkhead Embedded Metal	1	JOB	$23,517	$58,406	$13,950	$115,000.00	$115,000.00	25%	$143,750.00
04.2.4.E	Bridge and Pier Handrailing	1	JOB	$322	$1,777	$2,649	$5,700.00	$5,700.00	25%	$7,125.00
04.2.4.E	Swinging Walkways	1	JOB	$484	$6,382	$7,360	$17,000.00	$17,000.00	50%	$25,500.00
04.2.4.E	Misc Metal for Doors and Frames	50,700	LBS	$22,630	$90,455	$101,400	$5.00	$253,500.00	25%	$316,875.00
04.2.4.Q	Common Water and Air Pipeline	1	JOB	$1,714	$13,146	$5,812	$30,000.00	$30,000.00	25%	$37,500.00
04.2.5.-	GATES, STOPLOGS AND EQUIPMENT									
04.2.5.E	Tainter Gate, Furnish and Install	5	EACH	$305,646	$753,885	$5,725,726	$1,650,000.00	$8,250,000.00	25%	$10,312,500.00
04.2.5.E	Tainter Gate Anchorage & Trunnion Girders	1	JOB	$246,938	$373,912	$497,280	$1,350,000.00	$1,350,000.00	25%	$1,687,500.00
04.2.5.E	Tainter Gate Embedded Metals Sills & Side Sills	1	JOB	$57,332	$133,679	$200,326	$470,000.00	$470,000.00	25%	$587,500.00
04.2.5.E	Tainter Gate Operating Machinery	1	JOB	$204,231	$599,782	$2,500,020	$4,000,000.00	$4,000,000.00	25%	$5,000,000.00
04.2.5.P	Bulkhead Dogging Assembly	1	JOB	$15,678	$38,937	$65,613	$145,000.00	$145,000.00	25%	$181,250.00
04.2.R.-	ASSOCIATED GENERAL ITEMS									
04.2.R.B	Government Field Office	1	JOB	$10,788	$84,880	$188,383	$350,000.00	$350,000.00	25%	$437,500.00
04.2.R.B	Project Information Sign	1	JOB	$13	$536	$1,000	$2,000.00	$2,000.00	25%	$2,500.00
04.2.R.C	Machinery Houses	1	JOB	$7,554	$86,145	$53,380	$180,000.00	$180,000.00	25%	$225,000.00
04.2.R.E	Service Bridge	1	JOB	$122,312	$427,352	$3,831,445	$5,300,000.00	$5,300,000.00	25%	$6,625,000.00
04.2.R.P	Maintenance Bulkhead Crane	1	JOB	$0	$0	$310,000	$370,000.00	$370,000.00	25%	$462,500.00
04.2.R.R	Power and Lighting System	1	JOB	$39,717	$481,743	$382,326	$1,300,000.00	$1,300,000.00	25%	$1,625,000.00
05.-.-.-	LOCKS									
05.0.1.-	APPROACH CHANNELS									
05.0.1.B	Construct Dikes- Random Rock Fill	4,200	CY	$10,081	$22,382	$0	$10.00	$42,000.00	25%	$52,500.00
05.0.1.B	Construct Dikes- Graded Riprap	18,000	CY	$27,039	$60,343	$306,646	$35.00	$630,000.00	25%	$787,500.00
05.0.1.B	Construct Dikes- Underwater Excavation	5,700	CY	$29,140	$27,001	$0	$12.00	$68,400.00	25%	$85,500.00
05.0.1.C	Upper Guard Wall Extension	1	JOB	$432,023	$438,218	$926,758	$2,200,000.00	$2,200,000.00	25%	$2,750,000.00

05.0.3.-	APPROACH WALLS, UPPER AND LOWER									
05.0.3.C	Concrete-Future Riv Wall Mono.	4,640	CY	$88,163	$290,237	$194,373	$150.00	$696,000.00	25%	$870,000.00
05.0.3.C	Concrete-Existg Riv Wall Mono,Sta 3+41A-Sta 5+03A	12,960	CY	$294,740	$883,815	$546,489	$160.00	$2,073,600.00	25%	$2,592,000.00
05.0.4.-	LOCK STRUCTURE									
05.0.4.B	Remove Existing Blkhd Structure	1	JOB	$13,390	$53,524	$0	$80,000.00	$80,000.00	25%	$100,000.00
05.0.4.B	Remove Existing Riverwall - Arc	1	JOB	$122,914	$118,885	$0	$290,000.00	$290,000.00	25%	$362,500.00
05.0.4.B	Remove Existing Riverwall - Concrete	1,100	CY	$31,277	$66,530	$11,256	$120.00	$132,000.00	25%	$165,000.00
05.0.4.B	Stabilize Existing Lock Structure	1	JOB	$411,982	$492,993	$283,348	$1,700,000.00	$1,700,000.00	25%	$2,125,000.00
05.0.4.C	Concrete-Lock Wall Piers	2,140	CY	$48,922	$144,569	$90,409	$160.00	$342,400.00	25%	$428,000.00
05.0.4.C	Waterstops, Future Riv Wall Mono.	300	LF	$58	$2,874	$3,624	$26.00	$7,800.00	25%	$9,750.00
05.0.4.C	Alter Emerg Blkhd Recesses & Sills 110' Chamber	1	JOB	$200,387	$429,763	$378,731	$1,200,000.00	$1,200,000.00	25%	$1,500,000.00
05.0.4.E	Embedded Metal,Future Riv Wall Mono, Emerg Blkhd	22,590	LBS	$10,083	$40,303	$45,180	$5.00	$112,950.00	25%	$141,187.50
05.0.4.E	Corner Protection, Future Riv Wall Mono	8,220	LBS	$4,272	$8,440	$9,002	$3.00	$24,660.00	25%	$30,825.00
05.0.4.E	Wall Armor, Future Riv Wall Mono	45,890	LBS	$23,820	$46,888	$37,281	$3.00	$137,670.00	25%	$172,087.50
05.0.4.E	Misc Metal, Future Riv Wall Mono	16,660	LBS	$7,454	$29,795	$41,750	$6.00	$99,960.00	25%	$124,950.00
05.0.4.N	New Emergency Bulkhead	1	JOB	$102,924	$147,075	$982,431	$1,500,000.00	$1,500,000.00	25%	$1,875,000.00
								$109,629,666.00	27.6%	$139,879,132.50

Prime Contractor's Overhead	$8,514,619.00	OR	10.7%
Prime Contractor's Profit on His Own Work			8.7%
Prime Contractor's Profit on Subcontracted Work			7.0%
Subcontractor's Overhead and Profit on His Own Work			25.0%
Prime Contractor's Overhead on Subcontracted Work	$620,800.00	OR	6.0%

CODE OF ACCOUNTS SUMMARY, ROUNDED

04	DAM	$98,000,000.00	28.6%	$126,000,000.00
05	LOCKS	$11,300,000.00	25.7%	$14,200,000.00

CONSTRUCTION OF THE LOCKS AT MONONGAHELA LOCKS AND DAM 4
(Including the Modification to portions of the Dam)

A summary of the Code of Accounts for the completion of this contract is provided below.

		Construction Costs	Contingencies
04	Dam	$ 2,200,000	$ 500,000
05	Locks	184,000,000	46,000,000
		------------	-----------
	Total	$186,200,000	$46,500,000

EXPLANATION OF CONTINGENCIES

Individual contingencies for each line item were determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. When reasonable confidence in the design, quantities, and unit cost, for this stage of project was determined, a 25% contingency was applied. Justification for any deviations from the basic percentage are included below.

05.0.C.- Permanent Access Roads & Parking. A 15% contingency was applied to the Traffic Signs since this item should not vary.

05.0.B.- Care and Diversion of Water. A 15% contingency was applied to the cofferdam since a detailed design has been completed and the founding elevations have been determined. A 15% contingency was applied to the Sealing of the Existing Monoliths Joints since this is an accurate quantity. A 50% contingency was applied to the Stabilization of the Existing Middlewall since this item is dependent upon conditions that will be determined at the time of construction.

05.0.D.- Earthwork for Structures A 15% contingency was applied to the removal of the existing buildings since this is a known quantity. A 35% contingency was applied to the Common Excavation and the Rock Excavation since the exact quantities may vary due to site conditions. A 50% contingency was applied to Presplitting. Since this is in the area of the existing Middlewall, it is dependent upon further investigation.

05.0.1.- Approach Channels. A 15% contingency was used for Removal of the Spur Dikes since this is an existing structure and little if any variance will be encountered. A 100% contingency was applied to Approach Excavation and Dredging since it has not been verified, although it is highly unlikely that hazardous and toxic wastes may be present in this material.

05.0.2.- <u>Guard and Guide Walls, Upper and Lower.</u> A contingency of 15% was applied to the Removal of Concrete for the Upper and Lower, Guard and Guide Walls since this quantity is known.

05.0.4.- <u>Lock Structure.</u> A contingency of 15% was applied to the concrete removal items and other line items for which the quantities are well defined.

05.0.5.- <u>Lock Gates and Operating Machinery.</u> A 15% contingency was used for the Removal of the Existing 56' Chamber Lock Gates since this operation has been completed in the past and is unlikely to change.

05.0.6.- <u>Culvert Valves and Operating Machinery.</u> A 15% contingency was used for the Removal of the Existing Culvert Valves since this is a known quantity.

05.0.R.- <u>Associated General Items.</u> A contingency of 15% was applied to line items for which little variance can be anticipated.

05.0.N.- <u>Building, Project Operations.</u> A 35% contingency was applied to the two major buildings that will be constructed since at this time the final design has not been determined.

04.0.R.- <u>Associated General Items.</u> A contingency of 15% was applied to the construction of the Elevator since the work required here has been designed and will not vary.

LOWER MON NAVIGATION STUDY
LOWER MON, RM 41.5, TWIN 84' x 720' LOCK CHAMBERS
(OCTOBER 1991 COST LEVEL)

ACCOUNT NO.	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIAL	UNIT PRICE INCLUDING OH&P (ROUNDED)	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
05.-.-.-	LOCKS									
05.0.A.-	MOBILIZATION, DEMOBILITATION & PREPARATORY WORK									
05.0.A.A	MOBILIZATION & PREPARATORY WORK	1	JOB	$167,099	$513,598	$1,375,035	$2,400,000.00	$2,400,000.00	25%	$3,000,000.00
05.0.C.-	PERMANENT ACCESS ROADS & PARKING									
05.0.C.B	EXCAVATION FOR ACCESS ROAD & PARKING AREA	1,310	CY	$6,185	$6,673	$0	$12.00	$15,720.00	25%	$19,650.00
05.0.C.B	RANDOM FILL, ACCESS ROAD & PARKING AREA	7,500	CY	$25,263	$36,211	$0	$10.00	$75,000.00	25%	$93,750.00
05.0.C.B	SUBBASE, ACCESS ROAD & PARKING AREA	350	CY	$289	$902	$5,362	$30.00	$10,500.00	25%	$13,125.00
05.0.C.B	CRUSHED AGGR BASE COURSE, ACCESS ROAD & PARKING AREA	250	CY	$207	$644	$4,500	$35.00	$8,750.00	25%	$10,937.50
05.0.C.B	# 57 AGGR BASE COURSE, ACCESS ROAD & PARKING AREA	250	CY	$207	$644	$3,815	$30.00	$7,500.00	25%	$9,375.00
05.0.C.B	BINDER COURSE	2,650	SY	$1,715	$2,205	$7,595	$7.00	$18,550.00	25%	$23,187.50
05.0.C.B	BITUMINOUS PRIME COAT	2,650	SY	$200	$200	$935	$1.00	$2,650.00	25%	$3,312.50
05.0.C.B	BITUMINOUS WEARING COURSE	2,650	SY	$1,320	$1,815	$5,940	$5.00	$13,250.00	25%	$16,562.50
05.0.C.B	MILL SURFACE, ACCESS ROAD	550	SY	$0	$0	$55	$0.50	$275.00	25%	$343.75
05.0.C.B	PRECAST UNDERDRAINS, 4" PERFORATED PVC	1,000	LF	$552	$7,319	$3,520	$16.00	$16,000.00	25%	$20,000.00
05.0.C.B	PIPE UNDERDRAIN OUTLETS	1	JOB	$331	$4,392	$1,065	$8,000.00	$8,000.00	25%	$10,000.00
05.0.C.B	PRECAST CONCRETE PARKING BUMPERS	18	EA	$19	$26	$406	$35.00	$630.00	25%	$787.50
05.0.C.B	GUIDE RAIL, TYPE 2-W	900	LF	$337	$597	$9,099	$15.00	$13,500.00	25%	$16,875.00
05.0.C.J	PARKING LINES	700	LF	$26	$228	$22	$0.50	$350.00	25%	$437.50
05.0.C.K	TRAFFIC SIGNS	1	JOB	$81	$684	$756	$2,000.00	$2,000.00	15%	$2,300.00
05.0.B.-	CARE & DIVERSION of WATER									
05.0.B.B	SHEETPILE RETAINING WALL	1	JOB	$323,847	$407,531	$7,711,536	$10,000,000.00	$10,000,000.00	25%	$12,500,000.00
05.0.B.B	COFFERDAMS	1	JOB	$8,165,875	$7,224,614	$14,001,915	$35,000,000.00	$35,000,000.00	15%	$40,250,000.00
05.0.B.B	COFFERDAM OVERTOPPING	1	JOB	$0	$0	$172,600	$180,000.00	$180,000.00	15%	$207,000.00
05.0.B.B	DEWATERING	1	JOB	$927,200	$668,439	$5,000	$1,900,000.00	$1,900,000.00	25%	$2,375,000.00
05.0.B.B	SEALING EXISTING MONOLITH JOINTS	1,000	LF	$9,412	$50,691	$1,250	$90.00	$90,000.00	15%	$103,500.00
05.0.B.B	DRILLED FOUNDATION CAISSONS, MIDDLE WALL	11,520	LF	$527,760	$514,579	$11,520	$130.00	$1,497,600.00	25%	$1,872,000.00
05.0.B.B	STABILIZATION OF EXISTING MIDDLEWALL	1	JOB	$626,719	$673,026	$109,012	$1,500,000.00	$1,500,000.00	50%	$2,250,000.00
05.0.B.C	DEFORMED STEEL BARS FOR CAISSONS, MIDDLE WALL	1,832,650	LBS	$6,647	$67,997	$458,000	$0.50	$916,325.00	25%	$1,145,406.25
05.0.B.C	CONCRETE IN-PLACE CAISSONS, MIDDLE WALL	5,400	CY	$129,670	$237,519	$325,520	$180.00	$972,000.00	25%	$1,215,000.00
05.0.B.N	COFFERDAM INSTRUMENTATION	1	JOB	$52,032	$538,664	$1,189,053	$2,500,000.00	$2,500,000.00	25%	$3,125,000.00
05.0.B.N	PERMANENT INSTRUMENTATION	1	JOB	$662	$15,158	$10,514	$38,000.00	$38,000.00	25%	$47,500.00
05.0.D.-	EARTHWORK FOR STRUCTURES									
05.0.D.B	CLEARING & STRIPPING	1	JOB	$1,013	$1,610	$0	$3,000.00	$3,000.00	25%	$3,750.00
05.0.D.B	HANDLING VEGETATION	1	JOB	$471	$855	$0	$1,500.00	$1,500.00	25%	$1,875.00
05.0.D.B	EROSION & SEDIMENTATION CONTROL	1	JOB	$57,158	$171,650	$260,156	$580,000.00	$580,000.00	25%	$725,000.00
05.0.D.B	REMOVAL OF ADMINISTRATION BUILDING	1	JOB	$2,269	$7,783	$0	$12,000.00	$12,000.00	15%	$13,800.00
05.0.D.B	REMOVAL OF POWER HOUSE	1	JOB	$1,561	$5,053	$0	$8,000.00	$8,000.00	15%	$9,200.00
05.0.D.B	RIVERBANK PROTECTION, LEFT BANK, GRADED STONE	44,460	CY	$198,293	$147,181	$756,330	$30.00	$1,333,800.00	25%	$1,667,250.00

05.0.D.B	RIVERBANK PROTECTION, LEFT BANK, GRANULAR FILL	14,130	CY	$42,905	$33,118	$197,820	$25.00	$353,250.00	25%	$441,562.50
05.0.D.B	EXPL DRILLING, MOBILIZATION & DEMOBILIZATION	1	JOB	$1,824	$1,422	$0	$4,700.00	$4,700.00	25%	$5,875.00
05.0.D.B	EXPL DRILLING, DRILLING WITHOUT CORING	5,000	LF	$56,987	$44,423	$0	$30.00	$150,000.00	25%	$187,500.00
05.0.D.B	EXPL DRILLING, CORE DRILLING, 4" DIA. CORES	4,500	LF	$102,578	$79,962	$0	$58.00	$261,000.00	25%	$326,250.00
05.0.D.B	EXPL DRILLING, SEALED EXPLORATION HOLES WITH CEMENT	1,700	CWT	$1,916	$16,933	$11,900	$25.00	$42,500.00	25%	$53,125.00
05.0.D.B	COMMON EXCAVATION, LOCK & APPURTENANCES	612,000	CY	$3,774,919	$2,772,414	$0	$12.00	$7,344,000.00	35%	$9,914,400.00
05.0.D.B	ROCK EXCAVATION, LOCK & APPURTENANCES	50,200	CY	$349,590	$411,921	$48,320	$20.00	$1,004,000.00	35%	$1,355,400.00
05.0.D.B	PRESPLITTING, LOCK & APPURTENANCES	7,025	SY	$33,780	$98,449	$40,665	$35.00	$245,875.00	50%	$368,812.50
05.0.D.B	GRANULAR BACKFILL, LOCK & APPURTENANCES	103,000	CY	$70,342	$150,875	$1,442,000	$20.00	$2,060,000.00	25%	$2,575,000.00
05.0.D.B	RANDOM BACKFILL, LOCK & APPURTENANCES	132,250	CY	$241,063	$305,917	$66,125	$6.00	$793,500.00	25%	$991,875.00
05.0.D.B	ADDITIONAL ROLLING FOR COMPACTION	100	HR	$3,497	$2,736	$0	$75.00	$7,500.00	25%	$9,375.00

05.0.E.- FOUNDATION WORK

05.0.E.B	FOUNDATION PREP, PRELIMINARY CLEANUP	18,900	SY	$27,416	$239,300	$0	$17.00	$321,300.00	25%	$401,625.00
05.0.E.B	FOUNDATION PREP, FINAL CLEANUP	17,200	SY	$41,056	$386,123	$0	$30.00	$516,000.00	25%	$645,000.00
05.0.E.B	FOUNDATION PREP, PROTECTIVE COATING FOR ROCK SURFACES	112,200	SF	$6,661	$34,627	$17,952	$0.70	$78,540.00	25%	$98,175.00
05.0.E.B	FOUNDATION PREP, TEMPORARY EARTH COVER	17,200	SY	$19,404	$67,055	$0	$6.00	$103,200.00	25%	$129,000.00
05.0.E.B	FOUNDATION PREP, GROUT, MOBILIZATION & DEMOBILIZATION	1	JOB	$1,539	$3,997	$0	$6,600.00	$6,600.00	25%	$8,250.00
05.0.E.B	FOUNDATION PREP, GROUT,DRILLING GROUT HOLES, 1-1/2" DIA	1,300	LF	$3,335	$8,660	$325	$11.00	$14,300.00	25%	$17,875.00
05.0.E.B	FOUNDATION PREP, GROUT, PLACING CEMENTITIOUS GROUT	100	HR	$1,664	$12,325	$11	$168.00	$16,800.00	25%	$21,000.00
05.0.E.B	FOUNDATION PREP, GROUT, CEMENT IN GROUT	300	CF	$0	$0	$972	$4.00	$1,200.00	25%	$1,500.00
05.0.E.B	FOUNDATION PREP, DENTAL TREATMENT, CONCRETE	50	CY	$2,987	$16,570	$2,150	$520.00	$26,000.00	25%	$32,500.00
05.0.E.B	FOUNDATION PREP, DENTAL TREATMENT, MOTAR	20	CY	$418	$2,320	$1,080	$230.00	$4,600.00	25%	$5,750.00

05.0.G- DRAINAGE

05.0.G.B	ESPLANADE TRENCH & PIPE DRAINAGE SYSTEM	1	JOB	$6,666	$49,266	$37,047	$130,000.00	$130,000.00	25%	$162,500.00
05.0.G.B	CORRUGATED METAL PIPE, 12" DIA.	200	LF	$261	$2,393	$1,960	$30.00	$6,000.00	25%	$7,500.00
05.0.G.B	CORRUGATED METAL PIPE, 15" DIA.	500	LF	$599	$5,484	$5,526	$33.00	$16,500.00	25%	$20,625.00
05.0.G.B	CORRUGATED METAL PIPE, 36" DIA.	100	LF	$223	$2,044	$2,450	$68.00	$6,800.00	25%	$8,500.00
05.0.G.B	END SECTION FOR 15" DIA. CMP	2	EA	$208	$1,127	$250	$1,100.00	$2,200.00	25%	$2,750.00
05.0.G.B	ENDWALL FOR 36" DIA. CMP	2	EA	$185	$1,563	$400	$1,500.00	$3,000.00	25%	$3,750.00
05.0.G.B	INLET BOX, MODIFIED TYPE I	2	EA	$185	$1,563	$970	$1,900.00	$3,800.00	25%	$4,750.00
05.0.G.B	AREA INLETS	3	EA	$248	$2,760	$897	$1,900.00	$5,700.00	25%	$7,125.00
05.0.G.B	60" DIA. HALF-CIRCLE BITUMINOUS CMP	200	LF	$1,395	$9,777	$45,252	$400.00	$80,000.00	25%	$100,000.00

05.0.1.- APPROACH CHANNELS

05.0.1.B	UNCLASSIFIED EXCAVATION, APPROACHES	28,210	CY	$156,924	$126,312	$0	$11.00	$310,310.00	100%	$620,620.00
05.0.1.B	COMPACTED GRANULAR FILL, APPROACHES	45,530	CY	$112,809	$96,859	$637,420	$22.00	$1,001,660.00	25%	$1,252,075.00
05.0.1.B	GRADED STONE RIPRAP, APPROACHES	70,540	CY	$257,873	$199,002	$1,200,098	$30.00	$2,116,200.00	25%	$2,645,250.00
05.0.1.B	GRANULAR FILTER, APPROACHES	24,400	CY	$70,487	$55,755	$366,000	$24.00	$585,600.00	25%	$732,000.00
05.0.1.B	ROCK & GRAVEL FILL	204,000	CY	$494,903	$375,352	$3,062,414	$23.00	$4,692,000.00	25%	$5,865,000.00
05.0.1.B	STONE PROTECTION, RIGHT BANK	15,400	CY	$68,771	$51,947	$262,446	$30.00	$462,000.00	25%	$577,500.00
05.0.1.B	GRANULAR FILL, RIGHT BANK RIPRAP	6,900	CY	$24,793	$21,752	$103,500	$26.00	$179,400.00	25%	$224,250.00
05.0.1.B	DREDGING	272,250	CY	$1,513,952	$1,204,936	$0	$12.00	$3,267,000.00	100%	$6,534,000.00
05.0.1.B	MOORING PIERS	1	JOB	$32,915	$49,880	$104,718	$220,000.00	$220,000.00	25%	$275,000.00
05.0.1.B	REMOVAL OF SPUR DIKE	1	JOB	$35,770	$38,148	$0	$85,000.00	$85,000.00	15%	$97,750.00

05.0.2.- GUARD & GUIDE WALLS, UPPER & LOWER

05.0.2.B	CONC RMVL, GUIDE & GUARD WALLS, UPPER & LOWER	29,000	CY	$488,030	$714,715	$80,920	$55.00	$1,595,000.00	15%	$1,834,250.00
05.0.2.B	GUARD WALLS CELLS, UPPER & LOWER	1	JOB	$480,346	$576,517	$1,721,639	$3,300,000.00	$3,300,000.00	25%	$4,125,000.00
05.0.2.B	LOWER GUIDE WALL CELLS	1	JOB	$213,495	$345,411	$1,173,729	$2,000,000.00	$2,000,000.00	25%	$2,500,000.00

05.0.2.B	SHEETPILE BULKHEAD, GUARD WALLS	30,670	SF	$92,981	$126,122	$247,127	$18.00	$552,060.00	25%	$690,075.00
05.0.2.C	DEFORMED STEEL, GUIDE & GUARD WALLS	552,000	LBS	$6,658	$53,255	$138,000	$0.50	$276,000.00	25%	$345,000.00
05.0.2.C	CONCRETE CAP WALL, GUARD WALLS	32,200	CY	$887,780	$2,720,001	$1,492,609	$190.00	$6,118,000.00	25%	$7,647,500.00
05.0.2.C	CONCRETE UPPER GUIDE WALL	13,520	CY	$294,032	$757,319	$558,295	$140.00	$1,892,800.00	25%	$2,366,000.00
05.0.2.C	CONCRETE, TREMIE, GUARD WALLS, LOWER GUIDE WALL	2,480	CY	$41,657	$39,340	$136,400	$110.00	$272,800.00	25%	$341,000.00
05.0.2.C	WATER REDUCING ADMIXTURE	3,500	CY	$0	$0	$20,000	$7.00	$24,500.00	25%	$30,625.00
05.0.2.C	PORTLAND CEMENT	181,240	CWT	$0	$0	$724,960	$5.00	$906,200.00	25%	$1,132,750.00
05.0.2.C	POZZOLAN	56,100	CF	$0	$0	$31,416	$1.00	$56,100.00	25%	$70,125.00
05.0.2.C	CORE HOLES, UPPER GUARD WALL END CELL	175	LF	$2,128	$1,658	$0	$25.00	$4,375.00	25%	$5,468.75
05.0.2.E	WALL ARMOR	968,350	LBS	$183,225	$387,140	$786,373	$2.00	$1,936,700.00	25%	$2,420,875.00
05.0.2.E	MISC. METAL, STEEL	17,400	LBS	$7,558	$14,996	$15,646	$3.00	$52,200.00	25%	$65,250.00
05.0.2.E	CORNER PROTECTION	146,700	LBS	$607	$4,002	$151,551	$1.50	$220,050.00	25%	$275,062.50
05.0.2.E	CHECK POSTS	40	EA	$2,570	$7,234	$33,336	$1,300.00	$52,000.00	25%	$65,000.00
05.0.2.E	LINE HOOKS AND GUARDS	48	EA	$1,315	$10,131	$73,312	$2,100.00	$100,800.00	25%	$126,000.00
05.0.2.E	STEEL SHEET PILING, TYPE PS-27.5 CUTOFF WALL	1,110	LF	$9,364	$13,022	$19,351	$45.00	$49,950.00	25%	$62,437.50
05.0.4.-	LOCK STRUCTURE									
05.0.4.B	REMOVAL OF NEEDLE DAM	1	JOB	$12,736	$13,667	$0	$30,000.00	$30,000.00	15%	$34,500.00
05.0.4.B	CONCRETE REMOVAL, LOCK WALLS & APPURTENANCES	67,000	CY	$1,111,839	$1,616,866	$199,048	$55.00	$3,685,000.00	15%	$4,237,750.00
05.0.4.B	CHAMBER FLOOR WEEP HOLES	31,240	LF	$83,970	$224,465	$9,060	$12.00	$374,880.00	25%	$468,600.00
05.0.4.B	DRILL & GROUT ANCHORS FOR CHAMBER FLOOR STRUTS	15,400	LF	$35,050	$121,398	$5,698	$13.00	$200,200.00	25%	$250,250.00
05.0.4.C	WATERSTOPS, LOCK WALLS & APPURTENANCES	13,500	LF	$2,617	$129,330	$153,900	$25.00	$337,500.00	25%	$421,875.00
05.0.4.C	DEFORMED STEEL BARS, LOCK WALLS & APPURTENANCES	4,057,000	LBS	$48,930	$391,406	$1,014,250	$0.50	$2,028,500.00	25%	$2,535,625.00
05.0.4.C	CONCRETE IN-PLACE, GRAVITY MONOLITHS	216,540	CY	$5,177,747	$13,894,554	$9,154,465	$155.00	$33,563,700.00	25%	$41,954,625.00
05.0.4.C	CONCRETE IN-PLACE, SILLS & PIPE & CABLE CROSSOVERS	22,100	CY	$721,257	$1,438,541	$922,083	$165.00	$3,646,500.00	25%	$4,558,125.00
05.0.4.C	CONCRETE IN-PLACE, DEFLECTORS	110	CY	$3,973	$34,832	$5,593	$480.00	$52,800.00	25%	$66,000.00
05.0.4.C	CONCRETE IN-PLACE, RECESSED & OTHER 2ND POUR WORK	340	CY	$44,434	$76,482	$18,491	$490.00	$166,600.00	25%	$208,250.00
05.0.4.C	CONCRETE IN-PLACE, LOCK CHAMBER FLOOR STRUTS & SLAB	23,540	CY	$574,919	$1,542,473	$959,840	$155.00	$3,648,700.00	25%	$4,560,875.00
05.0.4.C	PORTLAND CEMENT, LOCK WALLS & APPURTENANCES	986,030	CWT	$0	$0	$3,944,120	$5.00	$4,930,150.00	25%	$6,162,687.50
05.0.4.C	EXPANSIVE HYDRAULIC CEMENT	420	TN	$1,965	$19,994	$646,380	$1,900.00	$798,000.00	25%	$997,500.00
05.0.4.C	POZZOLAN	227,110	CF	$0	$0	$126,375	$1.00	$227,110.00	25%	$283,887.50
05.0.4.C	MONOLITH JOINT GROUTING	80	CF	$902	$7,969	$2,000	$160.00	$12,800.00	25%	$16,000.00
05.0.4.E	WALL ARMOR, LOCK WALLS	840,960	LBS	$3,625	$24,067	$750,200	$1.00	$840,960.00	25%	$1,051,200.00
05.0.4.E	CORNER PROTECTION LOCK WALLS	535,000	LBS	$3,206	$21,361	$552,856	$1.50	$802,500.00	25%	$1,003,125.00
05.0.4.E	MISCELLANEOUS METAL, STEEL	316,000	LBS	$4,651	$31,034	$476,800	$2.00	$632,000.00	25%	$790,000.00
05.0.4.E	MISC METAL, STAINLESS STEEL	226,760	LBS	$736	$4,789	$1,133,800	$6.00	$1,360,560.00	25%	$1,700,700.00
05.0.4.E	MISC METAL, STAINLESS STL CLAD PLATE	46,200	LBS	$150	$976	$231,000	$6.00	$277,200.00	25%	$346,500.00
05.0.4.E	CHECK POSTS, LOCK WALLS	42	EA	$653	$5,011	$34,932	$1,100.00	$46,200.00	15%	$53,130.00
05.0.4.E	LINE HOOKS & GUARDS, LOCK WALLS	128	EA	$3,663	$28,032	$195,384	$2,100.00	$268,800.00	15%	$309,120.00
05.0.4.E	BULKHEAD RECESS FILLERS	1	JOB	$2,579	$19,659	$97,936	$140,000.00	$140,000.00	15%	$161,000.00
05.0.4.E	FLOATING MOORING BITTS	14	EA	$9,401	$78,583	$368,942	$40,000.00	$560,000.00	15%	$644,000.00
05.0.4.E	MAINTENANCE BULKHEAD EMBEDDED METALS	1	JOB	$428	$2,834	$88,689	$100,000.00	$100,000.00	15%	$115,000.00
05.0.4.N	EMERGENCY BULKHEAD HOIST STRUCTURE	1	JOB	$38,552	$214,265	$469,200	$850,000.00	$850,000.00	25%	$1,062,500.00
05.0.5.-	LOCK GATES & OPERATING MACHINERY, UPPER & LOWER									
05.0.5.B	REMOVAL OF 56' CHAMBER LOCK GATES, UPPER AND LOWER	1	JOB	$52,810	$63,366	$0	$140,000.00	$140,000.00	15%	$161,000.00
05.0.5.E	UPPER LOCK GATES	1	JOB	$53,351	$165,293	$1,091,800	$1,500,000.00	$1,500,000.00	25%	$1,875,000.00
05.0.5.E	LOWER LOCK GATES	1	JOB	$60,266	$247,253	$1,678,600	$2,400,000.00	$2,400,000.00	25%	$3,000,000.00
05.0.5.E	EMERGENCY BULKHEAD & APPURTENANCES	1	JOB	$24,389	$131,598	$717,267	$1,100,000.00	$1,100,000.00	25%	$1,375,000.00
05.0.5.E	LOCK GATE OPERATING MACHINERY	8	EA	$52,917	$515,296	$620,335	$175,000.00	$1,400,000.00	25%	$1,750,000.00

05.0.6.- CULVERT VALVES & OPERATING MACHINERY

05.0.6.B	REMOVAL OF EXISTING CULVERT VALVES	1	JOB	$9,676	$9,747	$0	$23,000.00	$23,000.00	15%	$26,450.00
05.0.6.E	TAINTER VALVES & EMBEDDED METALS	6	EA	$60,158	$325,193	$494,957	$175,000.00	$1,050,000.00	25%	$1,312,500.00
05.0.6.E	TAINTER VALVE BULKHEADS & EMBEDDED METALS	1	JOB	$12,234	$89,167	$156,618	$310,000.00	$310,000.00	25%	$387,500.00
05.0.6.Q	TAINTER VALVE, OPERATING MACHINERY	6	EA	$41,576	$357,711	$370,559	$150,000.00	$900,000.00	25%	$1,125,000.00

05.0.7.- PIPING SYSTEM

05.0.7.Q	WATER DISTRIBUTION SYSTEM	1	JOB	$7,902	$38,335	$17,110	$90,000.00	$90,000.00	25%	$112,500.00
05.0.7.Q	GAS DISTRIBUTION SYSTEM	1	JOB	$999	$6,602	$2,410	$15,000.00	$15,000.00	25%	$18,750.00
05.0.7.Q	SANITARY SEWAGE SYSTEM	1	JOB	$16,347	$74,676	$39,315	$185,000.00	$185,000.00	25%	$231,250.00
05.0.7.Q	PIPE SUPPORTS	1	JOB	$4,758	$31,688	$16,310	$75,000.00	$75,000.00	25%	$93,750.00
05.0.7.Q	PACKAGED TYPE HYDRAULIC SYSTEM	8	EA	$16,067	$133,483	$210,296	$65,000.00	$520,000.00	25%	$650,000.00
05.0.7.Q	COMPRESSED AIR SYSTEM	1	JOB	$21,032	$130,969	$153,976	$440,000.00	$440,000.00	25%	$550,000.00
05.0.7.Q	SERVICE WATER SYSTEM	1	JOB	$5,725	$46,374	$30,897	$120,000.00	$120,000.00	25%	$150,000.00
05.0.7.Q	AIR COMPRESSOR & DRYER	1	JOB	$3,219	$19,365	$45,404	$95,000.00	$95,000.00	25%	$118,750.00

05.0.8.- POWER & LIGHTING SYSTEMS

05.0.8.R	POWER LIGHTING & SIGNAL SYSTEM	1	JOB	$51,923	$916,580	$764,750	$2,500,000.00	$2,500,000.00	25%	$3,125,000.00
05.0.8.R	STANDBY GENERATOR UNIT	1	JOB	$0	$0	$77,250	$110,000.00	$110,000.00	25%	$137,500.00

05.0.R.- ASSOCIATED GENERAL ITEMS

05.0.R.A	GOVERNMENT FIELD OFFICE	1	JOB	7,328.00	83,798.00	188,383.00	$330,000.00	$330,000.00	15%	$379,500.00
05.0.R.A	JANITORAL SERVICES	1	JOB	17,304.00	63,600.00	0.00	$95,000.00	$95,000.00	25%	$118,750.00
05.0.R.A	TEMPORARY UTILITIES AND OPERATING FACILITIES	1	JOB	77,484.00	390,175.00	245,811.00	$800,000.00	$800,000.00	25%	$1,000,000.00
05.0.R.B	CHAIN LINK FENCE, 4-FT.	200	LF	397.00	1,930.00	2,083.00	$27.00	$5,400.00	25%	$6,750.00
05.0.R.B	CHAIN LINK FENCE, 8-FT.	2,300	LF	$3,672	$15,254	$20,560	$20.00	$46,000.00	25%	$57,500.00
05.0.R.B	SLIDE GATE, 12-FT, ELECTRIC OPERATED	1	JOB	$171	$2,469	$10,400	$16,000.00	$16,000.00	25%	$20,000.00
05.0.R.B	DOUBLE SWING GATE 15-FT., MANUALLY OPERATED	1	JOB	$43	$445	$850	$1,600.00	$1,600.00	25%	$2,000.00
05.0.R.B	SLIDE GATE, 12 FT., MANUALLY OPERATED	1	JOB	$43	$445	$1,200	$2,000.00	$2,000.00	25%	$2,500.00
05.0.R.B	SEEDING AND MULCHING	3	AC	$701	$934	$3,228	$2,000.00	$6,000.00	25%	$7,500.00
05.0.R.B	PROJECT SIGNS	1	JOB	$69	$1,025	$2,977	$5,000.00	$5,000.00	15%	$5,750.00
05.0.R.B	FLAG POLE & BASE	1	JOB	$234	$2,125	$6,875	$11,000.00	$11,000.00	15%	$12,650.00
05.0.R.B	NO. 57 AGGREGATE BASE COURSE FOR ESPLANADE	1,700	CY	$35,880	$5,232	$23,648	$45.00	$76,500.00	25%	$95,625.00
05.0.R.B	RAILROAD FLAGMEN	30	DAY	$399	$15,900	$0	$650.00	$19,500.00	25%	$24,375.00
05.0.R.C	DEFORMED STEEL BARS, ESPLANADE MISCELLANEOUS	42,000	LBS	$23,220	$13,684	$10,180	$0.05	$2,100.00	25%	$2,625.00
05.0.R.C	STEEL WELDED WIRE REINFORCEMENT, ESPLANADE PAVING	53,000	LBS	$27,863	$16,421	$19,332	$1.50	$79,500.00	25%	$99,375.00
05.0.R.C	CONCRETE, ESPLANADE PAVING, 6-INCHES THICK	9,035	SY	$4,226	$116,071	$84,564	$28.00	$252,980.00	25%	$316,225.00
05.0.R.C	CONCRETE, SIDEWALK PAVING, 4-INCHES THICK	1,020	SY	$720	$17,921	$7,620	$30.00	$30,600.00	25%	$38,250.00
05.0.R.C	CONCRETE CURBING	1,020	LF	$612	$15,233	$1,853	$20.00	$20,400.00	25%	$25,500.00
05.0.R.C	CONCRETE, ESPLANADE MISCELLANEOUS	650	CY	$3,240	$80,645	$36,765	$220.00	$143,000.00	25%	$178,750.00
05.0.R.E	STEEL IRON CASTINGS	25,000	LBS	$3,322	$22,381	$137,479	$8.00	$200,000.00	25%	$250,000.00
05.0.R.E	ALUMINIUM PLANKING	6,100	SF	$4,005	$149,493	$106,177	$50.00	$305,000.00	15%	$350,750.00
05.0.R.E	ALUMINUM COVER PLATES	265	SF	$90	$3,359	$12,376	$70.00	$18,550.00	15%	$21,332.50
05.0.R.E	ALUMINUM RABBET ANGLES	2,610	LF	$444	$13,685	$16,772	$15.00	$39,150.00	15%	$45,022.50
05.0.R.E	GUARD FENCE	9,365	LF	$28,335	$69,940	$304,650	$50.00	$468,250.00	25%	$585,312.50
05.0.R.E	HANDRAIL - 2" DIA., TOP SURFACE MOUNTED	405	LF	$850	$12,423	$19,188	$95.00	$38,475.00	25%	$48,093.75
05.0.R.E	PIPE HANDRAIL - 2" DIA., ESPLANADE	75	LF	$196	$2,867	$2,637	$90.00	$6,750.00	25%	$8,437.50
05.0.R.E	DISTANCE MARKERS	1	JOB	$53	$1,944	$2,170	$5,000.00	$5,000.00	25%	$6,250.00

05.0.R.E	LIFEBOAT LOWERING FACILITIES	1	JOB	$6,857	$10,189	$31,200	$58,000.00	$58,000.00	25%	$72,500.00
05.0.R.E	WORK FLAT ROLLING BITT ASSEMBLY	1	JOB	$367	$3,719	$3,966	$10,000.00	$10,000.00	25%	$12,500.00
05.0.R.E	REMOVE & REINSTALL TOW HAULAGE & RETRIEVER SYSTEM	1	JOB	$2,700	$25,469	$0	$35,000.00	$35,000.00	25%	$43,750.00
05.0.R.P	EMERGENCY BULKHEAD HOIST	1	JOB	$0	$0	$1,626,000	$2,000,000.00	$2,000,000.00	25%	$2,500,000.00
05.0.N.-	BUILDING, PROJECT OPERATIONS									
05.0.N._	LANDWALL BUILDING	1	JOB	$45,121	$419,770	$333,352	$1,100,000.00	$1,100,000.00	35%	$1,485,000.00
05.0.N._	MIDDLEWALL BUILDING	1	JOB	$11,456	$99,967	$85,939	$280,000.00	$280,000.00	35%	$378,000.00
05.0.N._	CONTROL SHELTERS	4	EA	$7,184	$59,724	$27,760	$34,000.00	$136,000.00	25%	$170,000.00
05.0.N._	PUMP SHELTERS	2	EA	2,517.00	$18,620	$9,388	$22,000.00	$44,000.00	25%	$55,000.00
05.0.N._	UPPER GAGING STATION	1	JOB	$133	$7,232	$3,260	$15,000.00	$15,000.00	25%	$18,750.00
04.-.-.-	DAMS									
04.1.-.-	MAIN DAM									
04.1.1.-	CONCRETE DAM, NON OVERFLOW SECTION									
04.1.1.C	DEFORMED STEEL BARS, FOOTBRIDGE ACCESS TOWER	68,000	LBS	$3,530	$10,499	$18,156	$0.50	$34,000.00	25%	$42,500.00
04.1.1.C	CONCRETE IN-PLACE, FOOTBRIDGE ACCESS TOWER	500	CY	$45,774	$122,709	$19,490	$450.00	$225,000.00	25%	$281,250.00
04.1.1.C	PORTLAND CEMEMT, FOOTBRIDGE ACCESS TOWER	2,600	CWT	$0	$0	$7,859	$4.00	$10,400.00	25%	$13,000.00
04.1.1.E	FOOTBRIDGE	1	JOB	$7,991	$36,820	$96,635	$170,000.00	$170,000.00	25%	$212,500.00
04.1.1.E	TEMPORARY FOOTBRIDGE	1	JOB	$2,010	$4,191	$194,000	$240,000.00	$240,000.00	25%	$300,000.00
04.1.1.N	MISC. ITEMS FOR FOOTBRIDGE ACCESS TOWER	1	JOB	$2,254	$31,501	$66,053	$120,000.00	$120,000.00	25%	$150,000.00
04.1.3.-	APRON, STILLING BASIN AND DEFLECTORS									
04.1.3.B	DAM SCOUR PROTECTION, GRADED STONE	2,200	CY	$7,678	$15,559	$58,630	$45.00	$99,000.00	25%	$123,750.00
04.1.3.B	DAM SCOUR PROTECTION, GROUT FILLED BAGS	3,040	CY	$188,480	$279,680	$468,160	$370.00	$1,124,800.00	25%	$1,406,000.00
04.0.R.-	ASSOCIATED GENERAL ITEMS									
04.0.R.P	ELEVATOR	1	JOB	$68	$4,311	$87,600	$130,000.00	$130,000.00	15%	$149,500.00
	TOTAL CONSTRUCTION COSTS :							$186,471,085.00	25%	$232,900,737.50

PRIME CONTRACTOR'S DISTRIBUTED COST ON PRIME'S WORK	$15,273,209	OR	10.7%
PRIME CONTRACTOR'S PROFIT ON PRIME'S WORK			8.8%
PRIME CONTRACTOR'S DISTRIBUTED COST ON SUBCONTRACTOR'S WORK	$857,200	OR	7.3%
PRIME CONTRACTOR'S PROFIT ON SUBCONTRACTOR'S WORK			7.5%
SUBCONTRACTOR'S OVERHEAD AND PROFIT ON HIS WORK			25.0%

CODE OF ACCOUNTS TOTALS (ROUNDED)

05	LOCK	$184,000,000.00	25%	$230,000,000.00
04	DAM	$2,200,000.00	23%	$2,700,000.00

05 LOCKS

A summary of this Code of Account is provided below.

05 Locks (Rehabilitation of L/D #2)	$ 40,000,000
Contingencies	15,000,000
TOTAL	$ 55,000,000

Explanation of Contingencies

Individual contingencies for each line item were determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. When reasonable confidence in the design, quantities, and unit cost, for this stage of project was determined, a 25% contingency was applied. Justification for any deviations from the basic percentage are included below.

05.0.A.A Mobilization, Demobilization & Preparatory Work. A 50% contingency was applied to Mobilization & Preparatory Work since specific quantities were not developed for dredging a suitable berthing area for Contractor plant and equipment.

05.0.B.- Care & Diversion of Water. A 50% contingency was applied to all items in this subfeature. Specific quantities were not developed for this work; the cost was based on similar work done for Dashields L/D rehabilitation.

05.0.2.- Guard & Guide Walls, Upper & Lower. A 50% contingency was applied to all line items in this subfeature. The quantities developed were not based on a recent survey of structural deterioration and the proposed rehabilitation work is scheduled for the year 2020.

05.0.4.- Lock Structure. A 50% contingency was applied to all line items (except building demolitions) in this subfeature. The quantities developed were not based on recent survey of structural deterioration and the proposed rehabilitation is scheduled for the year 2020.

05.0.7.- Piping Systems. A 35% contingency was applied to all line items in this subfeature. Specific quantities were not developed for the piping systems; the cost was based on similar work for Dashields L/D rehabilitation.

ACCOUNT NO.	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIAL	UNIT PRICE INCLUDING OVERHEAD & PROFIT	TOTAL AMOUNT	CONT	TOTAL AMOUNT INCLUDING CONTINGENCY
05.-.-.-	LOCKS									
05.0.A.-	MOBILIZATION, DEMOBILIZATION & PREPARATORY WORK									
05.0.A.A	MOBILIZATION & PREPARATORY WORK	1	JOB	$87,468	$165,258	$133,350	$490,000.00	$490,000.00	50%	$735,000
05.0.A.A	SWITCH BOAT NO. 1	105	DAYS	$209,344	$498,094	$14,438	$8,000.00	$840,000.00	25%	$1,050,000
05.0.A.A	SWITCH BOAT NO. 2	105	DAYS	$209,344	$498,094	$14,438	$8,000.00	$840,000.00	25%	$1,050,000
05.0.C.-	PERMANENT ACCESS ROADS & PARKING									
05.0.C.B	UNCLASSFIED EXCAVATION FOR PARKING AREA	4,000	CY	$18,843	$20,328	$1,288	$13.00	$52,000.00	25%	$65,000
05.0.C.B	CRUSHED AGGREGRATE BASE COURSE FOR PARKING AREA, 4"	240	CY	$273	$853	$5,981	$35.00	$8,400.00	25%	$10,500
05.0.C.B	NO. 57 AGGREGATE COURSE FOR PARKING AREA, 6"	360	CY	$411	$1,281	$7,567	$30.00	$10,800.00	25%	$13,500
05.0.C.B	BITUMINOUS PRIME COAT	2,160	SY	$276	$276	$1,290	$1.00	$2,160.00	25%	$2,700
05.0.C.B	BITMINOUS BINDER COURSE	2,160	SY	$1,932	$2,484	$8,556	$7.00	$15,120.00	25%	$18,900
05.0.C.B	BITUMINOUS WEARING COURSE	2,160	SY	$1,490	$2,049	$6,707	$6.00	$12,960.00	25%	$16,200
05.0.C.B	PAVED SHOULDER, TYPE 3	160	SY	$2,732	$309	$1,892	$18.00	$2,880.00	25%	$3,600
05.0.C.B	PRECAST CONCRETE PARKING BUMPERS	45	EA	$60	$813	$1,268	$55.00	$2,475.00	25%	$3,094
05.0.C.B	GUIDE RAIL, TYPE 2-W	345	LF	$161	$286	$4,438	$16.00	$5,520.00	25%	$6,900
05.0.C.B	PAVEMENT BASE DRAINS	810	LF	$559	$7,411	$3,494	$16.00	$12,960.00	25%	$16,200
05.0.C.J	PARKING LINES	1,000	LF	$44	$388	$38	$0.50	$500.00	25%	$625
05.0.C.K	TRAFFIC SIGNS	1	JOB	$101	$855	$945	$2,200.00	$2,200.00	25%	$2,750
05.0.B.-	CARE & DIVERSION of WATER									
05.0.B.B	56 FT CHAMBER SHUTDOWN	1	JOB	$111,025	$118,976	$257,510	$600,000.00	$600,000.00	50%	$900,000
05.0.B.B	FIRST 110 FT CHAMBER SHUTDOWN	1	JOB	$197,913	$228,875	$607,297	$1,300,000.00	$1,300,000.00	50%	$1,950,000
05.0.B.B	SECOND 110 FT CHAMBER SHUTDOWN	1	JOB	$15,113	$21,149	$255,010	$365,000.00	$365,000.00	50%	$547,500
05.0.B.B	OVERTOPPING	1	JOB	$0	$0	$135,000	$135,000.00	$135,000.00	50%	$202,500
05.0.G.-	DRAINAGE									
05.0.G.B	ESPLANADE TRENCH & PIPE DRAINAGE SYSTEM	1	JOB	$6,466	$26,935	$76,694	$125,000.00	$125,000.00	25%	$156,250
05.0.G.B	COMBINATION STROM SEWER AND UNDERDRAIN	950	LF	$1,839	$13,346	$25,225	$50.00	$47,500.00	25%	$59,375
05.0.G.B	TYPE E-S ENDWALL	2	EA	$720	$2,189	$1,163	$2,400.00	$4,800.00	25%	$6,000
05.0.G.B	TYPE "S" INLETS	5	EA	$1,201	$3,649	$2,238	$1,500.00	$7,500.00	25%	$9,375
05.0.G.B	SUBSURFACEDRAIN OUTLET AND ENDWALL	1	JOB	$104	$1,373	$259	$2,000.00	$2,000.00	25%	$2,500
05.0.G.B	END SECTION - 16 GAGE FOR 18" PIPE	1	EA	$29	$378	$40	$500.00	$500.00	25%	$625
05.0.2.-	GUARD & GUIDE WALLS, UPPER & LOWER									
05.0.2.B	CONCRETE REMOVAL, FACE OF GUIDE & GUARD WALLS, 12"	3,930	SY	$90,519	$386,001	$19,671	$160.00	$628,800.00	50%	$943,200
05.0.2.B	CONCRETE REMOVAL, TOP OF GUIDE & GUARD WALLS, 12"	580	CY	$27,099	$211,698	$275	$525.00	$304,500.00	50%	$456,750
05.0.2.B	DRILL HOLES AND GROUT DOWELS	3,200	LF	$85,596	$45,505	$4,352	$23.00	$73,600.00	50%	$110,400
05.0.2.C	CONCRETE REPAIR, FACE OF GUIDE & GUARD WALLS, 12"	3,930	SY	$108,896	$641,180	$131,672	$285.00	$1,120,050.00	50%	$1,680,075

05.0.2.C	CONCRETE RESURFACE, TOP OF GUIDE & GUARD WALLS, 12"	580	CY	$68,363	$177,889	$52,331	$655.00	$379,900.00	50%	$569,850
05.0.2.C	DEFORMED STEEL BARS FOR REINFORCEMENT	152,000	LBS	$17,864	$80,734	$53,200	$1.00	$152,000.00	50%	$228,000
05.0.2.C	DOWELS	1,750	LBS	$253	$916	$490	$1.00	$1,750.00	50%	$2,625
05.0.2.E	WALL ARMOR, STRAIGHT RUN	675,000	LBS	$347,233	$780,840	$541,541	$3.00	$2,025,000.00	50%	$3,037,500
05.0.2.E	CORNER PROTECTION	165,000	LBS	$72,579	$174,834	$178,091	$3.00	$495,000.00	50%	$742,500
05.0.2.E	CHECK POSTS, GUIDE & GUARD WALLS, UPPER & LOWER	38	EA	$2,137	$11,093	$30,425	$1,500.00	$57,000.00	50%	$85,500
05.0.2.E	LINE HOOKS & GUARDS	60	EA	$1,536	$18,782	$93,120	$2,400.00	$144,000.00	50%	$216,000
05.0.2.E	MISCELLANEOUS METAL	27,650	LBS	$10,951	$23,474	$24,885	$3.00	$82,950.00	50%	$124,425
05.0.2.E	THREADED BAR CRACK REPAIRS	1	JOB	$7,776	$28,406	$3,958	$50,000.00	$50,000.00	50%	$75,000
05.0.3.-	APPROACH WALLS, UPPER & LOWER									
05.0.3.B	SPUD BARGES	105	DAYS	$2,035	$11,114	$347,780	$4,400.00	$462,000.00	25%	$577,500
05.0.4.-	LOCK STRUCTURE									
05.0.4.B	DEMOLITION OF LANDWALL BUILDING	1	JOB	$2,313	$8,838	$0	$14,000.00	$14,000.00	25%	$17,500
05.0.4.B	DEMOLITION OF MIDDLE WALL OPERATIONS BUILDING	1	JOB	$13,191	$11,440	$100	$32,000.00	$32,000.00	25%	$40,000
05.0.4.B	DEMOLITION OF CONTROL SHELTER (4)	1	JOB	$3,753	$3,203	$0	$9,000.00	$9,000.00	25%	$11,250
05.0.4.B	CONCRETE REMOVAL, FACE OF LOCK WALLS, 12"	7,350	SY	$168,929	$722,642	$36,741	$160.00	$1,176,000.00	50%	$1,764,000
05.0.4.B	CONCRETE REMOVAL, TOP OF LOCK WALLS, 12"	1,920	CY	$90,488	$701,079	$940	$525.00	$1,008,000.00	50%	$1,512,000
05.0.4.B	CONCRETE REMOVAL, RECESS & OTHER MISC. CONCRETE	1,100	CY	$95,597	$511,867	$1,716	$700.00	$770,000.00	50%	$1,155,000
05.0.4.B	REMOVAL OF DEBRIS FROM 56 FT CHAMBER	80	CY	$430	$695	$22	$18.00	$1,440.00	50%	$2,160
05.0.4.B	REMOVAL OF DEBRIS FROM 110 FT CHAMBER	320	CY	$1,719	$2,782	$90	$18.00	$5,760.00	50%	$8,640
05.0.4.B	DRILL HOLES AND GROUT DOWELS, LOCK WALLS	90,550	LF	$243,243	$1,287,640	$123,148	$23.00	$2,082,650.00	50%	$3,123,975
05.0.4.C	CONCRETE REPAIR, FACE OF LOCK WALLS, 12"	7,350	SY	$212,499	$1,107,188	$247,059	$270.00	$1,984,500.00	50%	$2,976,750
05.0.4.C	CONCRETE RESURFACE, TOP OF LOCK WALLS, 12"	1,920	CY	$195,064	$526,983	$168,251	$600.00	$1,152,000.00	50%	$1,728,000
05.0.4.C	CONCRETE REPAIR , RECESS & OTHER MISC. CONCRETE	1,100	CY	$142,544	$455,994	$94,126	$800.00	$880,000.00	50%	$1,320,000
05.0.4.C	DEFORMED STEEL BARS FOR REINFORCEMENT, LOCK WALLS	228,000	LBS	$26,796	$121,101	$63,840	$1.00	$228,000.00	50%	$342,000
05.0.4.C	STEEL WWF REINFORCEMENT,CONCRETE,LOCK WALLS	20,150	LBS	$2,234	$17,494	$8,745	$2.00	$40,300.00	50%	$60,450
05.0.4.C	DOWELS, LOCK WALLS	56,125	LBS	$8,121	$29,370	$15,715	$1.00	$56,125.00	50%	$84,188
05.0.4.C	GROUTING CRACKS IN LOCK WALLS	20	CF	$136	$845	$189	$75.00	$1,500.00	50%	$2,250
05.0.4.C	SHOTCRETE-MONOLITH JOINT REPAIR	500	LF	$2,242	$6,088	$5,321	$35.00	$17,500.00	50%	$26,250
05.0.4.C	SHOTCRETE-REPAIR FACE OF LOCK WALLS	2,600	SY	$67,696	$181,714	$187,878	$215.00	$559,000.00	50%	$838,500
05.0.4.E	WALL ARMOR, STRIAGHT RUN, RUN LOCK WALLS	464,000	LBS	$239,224	$558,192	$372,259	$3.00	$1,392,000.00	50%	$2,088,000
05.0.4.E	WALL ARMOR, CORNER PROTECTION, LOCK WALLS	115,000	LBS	$51,820	$123,509	$123,309	$3.00	$345,000.00	50%	$517,500
05.0.4.E	PLATE ARMOR	30,000	LBS	$8,949	$14,936	$22,936	$2.00	$60,000.00	50%	$90,000
05.0.4.E	CHECK POSTS, LOCK WALLS	120	EA	$6,748	$35,030	$96,349	$1,500.00	$180,000.00	50%	$270,000
05.0.4.E	LINE HOOKS & GUARDS, LOCK WALLS	71	EA	$1,818	$22,225	$110,354	$2,400.00	$170,400.00	50%	$255,600
05.0.4.E	MISCELLANEOUS METAL, LOCK WALLS	59,350	LBS	$23,507	$50,386	$53,415	$3.00	$178,050.00	50%	$267,075
05.0.5.-	LOCK GATES & OPERATING MACHINERY, UPPER & LOWER									
05.0.5.E	REMOVE & RELACE UPPER LOCK GATES, 56 FT CHAMBER	1	SET	$22,247	$51,298	$390,600	$590,000.00	$590,000.00	25%	$737,500
05.0.5.E	REMOVE & REPLACE LOWER LOCK GATES, 56 CHAMBER	1	SET	$22,247	$51,298	$458,000	$675,000.00	$675,000.00	25%	$843,750
05.0.5.E	REMOVE & RELACE UPPER LOCK GATES, 110 FT CHAMBER	1	SET	$50,000	$200,000	$721,540	$1,200,000.00	$1,200,000.00	25%	$1,500,000
05.0.5.E	REMOVE & REPLACE LOWER LOCK GATES, 110 CHAMBER	1	SET	$50,000	$200,000	$867,200	$1,400,000.00	$1,400,000.00	25%	$1,750,000
05.0.5.Q	REMOVE & REPLACE GATE OPERATING MACHINERY, 56 FT CHAMBER	4	EA	$49,324	$374,240	$132,138	$160,000.00	$640,000.00	25%	$800,000
05.0.5.Q	REMOVE & REPLACE GATE OPERATING MACHINERY, 110 FT CHAMBER	4	EA	$50,281	$460,921	$337,838	$245,000.00	$980,000.00	25%	$1,225,000
05.0.5.E	REMOVE & REPLACE GATE ANCHORAGES, 56 FT CHAMBER	4	EA	$2,242	$30,106	$24,368	$18,000.00	$72,000.00	25%	$90,000
05.0.5.E	REMOVE & REPLACE GATE ANCHORAGES, 110 FT CHAMBER	4	EA	$1,984	$33,094	$34,660	$22,000.00	$88,000.00	25%	$110,000
05.0.5.E	MITER SILL, PINTLE & QUION REPAIRS, 56 FT CHAMBER	1	JOB	$12,493	$110,865	$71,899	$250,000.00	$250,000.00	25%	$312,500
05.0.5.E	MITER SILL, PINTLE & QUION REPAIRS, 110 FT CHAMBER	1	JOB	$9,378	$84,208	$61,382	$200,000.00	$200,000.00	25%	$250,000
05.0.5.R	CATHODIC PROTECTION, GATE LEAVES	8	EA	$27,328	$395,104	$162,560	$85,000.00	$680,000.00	25%	$850,000

05.0.6.-	CULVERT VALVES & OPERATING MACHINERY									
05.0.6.E	REMOVE & REPLACE BUTTERFLY VALVES	6	EA	$72,393	$422,709	$600,000	$210,000.00	$1,260,000.00	25%	$1,575,000
05.0.6.Q	REMOVE & REPLACE VALVE OPERATING MACHINERY	6	EA	$66,524	$318,688	$287,500	$130,000.00	$780,000.00	25%	$975,000
05.0.7.-	PIPING SYSTEM									
05.0.7.Q	HYDRAULIC SYSTEM	1	JOB	$72,601	$653,071	$734,250	$1,700,000.00	$1,700,000.00	35%	$2,295,000
05.0.7.Q	COMPRESSED AIR PIPING SYSTEM	1	JOB	$26,285	$199,760	$124,988	$400,000.00	$400,000.00	35%	$540,000
05.0.7.Q	PIPE SUPORTS	1	JOB	$31,234	$96,338	$30,420	$180,000.00	$180,000.00	35%	$243,000
05.0.7.Q	SERVICE WATER PIPING SYSTEM	1	JOB	$6,188	$49,613	$19,313	$85,000.00	$85,000.00	35%	$114,750
05.0.7.Q	SEWAGE COLLECTION SYSTEM	1	JOB	$24,576	$104,220	$50,594	$205,000.00	$205,000.00	35%	$276,750
05.0.7.Q	WATER DISTRIBUTION SYSTEM	1	JOB	$9,878	$47,919	$21,388	$90,000.00	$90,000.00	35%	$121,500
05.0.8.-	POWER & LIGHTING SYSTEMS									
05.0.8.R	REPLACE LOCK ELECTRICAL SYSTEM	1	JOB	$36,024	$553,179	$317,975	$1,000,000.00	$1,000,000.00	25%	$1,250,000
05.0.R.-	ASSOCIATED GENERAL ITEMS									
05.0.R.A	GOVERNMENT FIELD OFFICE	1	JOB	$6,779	$55,861	$58,800	$155,000.00	$155,000.00	25%	$193,750
05.0.R.A	TEMPORARY UTILITIES AND OPERATING FACILITIES	1	JOB	$2,510	$7,105	$1,780	$15,000.00	$15,000.00	25%	$18,750
05.0.R.B	CHAIN LINK FENCE	1,200	LF	$2,765	$11,585	$13,400	$30.00	$36,000.00	25%	$45,000
05.0.R.B	CONCRETE REMOVAL, ESPLANDE PAVEMENT, 12"	7,100	SY	$23,042	$94,040	$682	$20.00	$142,000.00	25%	$177,500
05.0.R.B	UNCLASSIFIED EXCAVATION FOR ESPLANDE	15,775	CY	$66,361	$71,589	$5,079	$12.00	$189,300.00	25%	$236,625
05.0.R.B	COMMON EXCAVATION FOR CONCRETE SLOPE PROTECTION	390	CY	$1,066	$1,492	$126	$9.00	$3,510.00	25%	$4,388
05.0.R.B	#57 AGGREGATE SUBBASE FOR ESPLANDE, 8"	1,950	CY	$43,056	$6,278	$27,126	$50.00	$97,500.00	25%	$121,875
05.0.R.B	#57 AGG BASE CRSE FOR CONCRETE SLOPE PROTECTION	60	CY	$0	$0	$835	$18.00	$1,080.00	25%	$1,350
05.0.R.B	SEEDING AND MULCHING	1	AC	$234	$311	$1,076	$2,000.00	$2,000.00	25%	$2,500
05.0.R.C	DEFORMED STEEL BARS FOR CONCR REINF, ESPLANADE MISC.	380,000	LBS	$4,653	$119,523	$91,314	$1.00	$380,000.00	25%	$475,000
05.0.R.C	DEFORMED STEEL BARS FOR CONCRETE SLOPE PROTECTION	28,200	LBS	$367	$9,436	$6,867	$1.00	$28,200.00	25%	$35,250
05.0.R.C	CONCRETE, ESPLANDE PAVING, 8"	8,900	SY	$4,226	$116,071	$108,000	$35.00	$311,500.00	25%	$389,375
05.0.R.C	CONCRETE, SLOPE PROTECTION, 6"	1,106	CY	$2,348	$64,484	$60,940	$145.00	$160,370.00	25%	$200,463
05.0.R.E	REMOVAL OF EQUIMENT, MISCELLANEOUS METAL & GUARD FENCE	1	JOB	$9,782	$35,162	$0	$57,000.00	$57,000.00	25%	$71,250
05.0.R.E	ALUMINUM PLANKING	5,070	SF	$3,285	$122,618	$88,111	$55.00	$278,850.00	25%	$348,563
05.0.R.E	ALUMINUM COVER PLATES	210	SF	$90	$3,359	$9,700	$80.00	$16,800.00	25%	$21,000
05.0.R.E	ALUMINUM RABBET ANGLES	2,610	LF	$444	$13,685	$16,772	$15.00	$39,150.00	25%	$48,938
05.0.R.E	GUARD FENCE	6,850	LF	$958	$44,539	$223,128	$50.00	$342,500.00	25%	$428,125
05.0.R.E	ALUMINUM PIPE HANDRAIL - 1-1/2" DIA	75	LF	$261	$3,823	$4,150	$140.00	$10,500.00	25%	$13,125
05.0.R.E	ALUMINUM HANDRAIL - 2" DIA	395	LF	$784	$11,468	$13,509	$80.00	$31,600.00	25%	$39,500
05.0.R.E	DISTANCE MARKERS	50	EA	$53	$1,944	$2,700	$120.00	$6,000.00	25%	$7,500
05.0.R.P	TOW HAULAGE & RETRIEVER SYSTEM	1	JOB	$2,608	$25,301	$311,070	$430,000.00	$430,000.00	25%	$537,500
05.0.R.P	PAINT EXISTING MISCELLANEOUS METAL ON LOCKS	1.00	JOB	$29,505	$178,113	$133,736	$280,000.00	$280,000.00	25%	$350,000
05.0.N.-	BUILDING, PROJECT OPERATIONS									
05.0.N.-	LANDWALL SERVICE BUILDING	1	JOB	$40,336	$351,359	$273,102	$760,000.00	$760,000.00	25%	$950,000
05.0.N.-	CONTROL STATION SHELTERS	4	EA	$6,810	$54,716	$27,763	$25,000.00	$100,000.00	25%	$125,000
05.0.N.-	MIDDLE WALL OPERATIONS BUILDING	1	JOB	$9,302	$77,398	$51,126	$160,000.00	$160,000.00	25%	$200,000
	TOTAL, CONSTRUCTION COSTS:							$39,713,910	39%	$55,081,581
05.0.0.-	MAIN AND AUXILIARY LOCKS TOTAL (ROUNDED):									$55,000,000

PRIME CONTRACTOR'S DISTRIBUTED COST ON PRIME'S WORK	$3,704,000	OR	16.5%
PRIME CONTRACTOR'S PROFIT ON PRIMES WORK			9.05%
PRIME CONTRACTOR'S DISTRIBUTED COST ON SUBCONTRACTOR'S WORK	$777,000	OR	7.7%
PRIME CONTRACTOR'S PROFIT ON SUBCONTRACTOR'S WORK			6.07%

05 LOCKS

A summary of this project under this Code of Account is provided below.

05	Locks (Floodway Bulkhead at L/D #2)	$ 3,600,000
	Contingencies	1,500,000
	TOTAL	$ 5,100,000

Explanation of Contingencies

Individual contingencies for each line item were determined by Cost Engineering Branch. When reasonable confidence in the quantities and unit cost for this stage of the project was determined, a 25% contingency was applied. In instances where the quantity calculation was based on incomplete data, a 50% or 300% contingency was applied, as appropriate.

LOWER MONONGAHELA NAVIGATION STUDY

FLOODWAY BULKHEAD AT L/D #2 - October 1991 Cost Level

*** FLOODWAY BULKHEAD L/D 2 ***

	DESCRIPTION	QUANTITY	UNIT	PLANT (WITHOUT OVERHEAD AND PROFIT)	LABOR (WITHOUT OVERHEAD AND PROFIT)	MATERIALS (WITHOUT OVERHEAD AND PROFIT)	UNIT PRICE INCLUDING OVERHEAD &PROFIT	TOTAL AMOUNT	CONTINGENCY	TOTAL AMOUNT INCL CONTINGENCY
05.-.-.-	LOCKS									
05.0.A.-	Mobilization & Prep. Work	1	JB	$28,973	$54,307	$5,000	$120,000.00	$120,000.00	25%	$150,000.00
05.0.B.B	Cofferdam	1	JB	$124,967	$132,674	$141,051	$500,000.00	$500,000.00	25%	$625,000.00
05.0.B.B	Cofferdam Overtopping	2	EA	$0	$0	$60,000	$35,000.00	$70,000.00	25%	$87,500.00
05.0.4.B	Remove Existing Structure	1	JB	$35,285	$69,261	$5,967	$150,000.00	$150,000.00	50%	$225,000.00
05.0.4.C	Remove & Replace 12" Top Concrete (Em Bkd Sill)	1	JB	$61,262	$83,495	$12,000	$210,000.00	$210,000.00	300%	$840,000.00
05.0.4.N	Emergency Bulkhead Hoist Structure	1	JB	$35,694	$197,868	$391,384	$830,000.00	$830,000.00	25%	$1,037,500.00
05.0.5.E	Emergency Bulkhead & Appurtenances	1	JB	$103,151	$131,679	$240,699	$630,000.00	$630,000.00	25%	$787,500.00
05.0.R.P	Emergency Bulkhead	1	JB	$0	$0	$813,000	$1,100,000.00	$1,100,000.00	25%	$1,375,000.00
	TOTAL COST							$3,610,000.00		$5,127,500.00
	DISTRIBUTED COSTS	$766,800	OR	21.2%						
	PRIMES PROFIT	9.1%							42%	
								ROUNDED		$5,100,000.00

06 FISH AND WILDLIFE FACILITES

A summary of this Code of Account is provided below.

06	Fish & Wildlife Facilities	$ 1,200,000
	Contingencies	200,000
	TOTAL	$ 1,400,000

Explanation of Contingencies

Individual contingencies for each line item was determined by Cost Engineering Branch. A 15% contingency was determined to be sufficient for this part of the project and was based on the level of detail available at this time for a typical project of this scope.

LOWER MONONGAHELA NAVIGATION STUDY

FISH AND WILDLIFE FACILITIES - October 1991 Cost Level

DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OVERHEAD &PROT	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
*** FISH & WILDLIFE FACILITIES ***									
06.-.-.- FISH & WILDLIFE FACILITIES									
06.1.-.- Low Flow Gate at L/D #2	1	JB	$0	$0	$175,000	$175,000.00	$175,000.00	15%	$201,250.00
06.1.-.- Air Entrainment System at L/D #4	1	JB	$0	$0	$125,000	$125,000.00	$125,000.00	15%	$143,750.00
06.3.-.- Instream Fish Habitat	1	JB	$356,728	$144,720	$0	$500,000.00	$500,000.00	15%	$575,000.00
06.3.-.- Habitat Restoration at Disposal Areas	1	JB	$21,342	$89,412	$90,000	$200,000.00	$200,000.00	15%	$230,000.00
06.3.-.- Wetlands Restoration at Disposal Areas	1	JB	$149,020	$35,570	$15,000	$200,000.00	$200,000.00	15%	$230,000.00
TOTAL COST							$1,200,000.00		$1,380,000.00
								15%	
							ROUNDED		$1,400,000.00

09 CHANNELS AND CANALS

A summary of this Code of Account is provided below.

09	Channels and Canals	$ 27,000,000
	Contingencies	6,000,000
	Total	$ 33,000,000

Explanation of Contingencies

Individual contingencies for each line item were determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. Where reasonable confidence in the design, quantities, and unit cost, for this stage of project was determined, a 25% contingency was applied. No contingencies over 25% were used in this estimate. An average contingency of 25% was applied.

LOWER MON NAVIGATION STUDY
DREDGING, RM 23.8 to RM 41.5
(OCTOBER 1991 COST LEVEL)

	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OH & PROFIT (ROUNDED)	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
09.-.-.-	CHANNELS AND CANALS									
09.0.A.-	MOBILIZATION, DEMOBILIZATION & PREPARATORY WORK									
09.0.A.A	MOBILIZATION & PREPARATORY WORK	1	JOB	$1,074,075	$853,211	$1,800,354	$4,700,000.00	$4,700,000	25%	$5,875,000.00
09.0.1.-	TRAFFIC CONTROL									
09.0.1.B	RAILROAD TRAFFIC CONTROL	1	JOB	$8,778	$349,800	$0	$450,000.00	$450,000	25%	$562,500.00
09.0.1.B	HIGHWAY TRAFFIC CONTROL	1	JOB	$8,778	$349,800	$0	$450,000.00	$450,000	25%	$562,500.00
09.0.2.-	CHANNELS									
09.0.2.B	EXCAVATION, COMMON	1,670,000	CY	$8,778,702	$5,065,642	$0	$10.00	$16,700,000	25%	$20,875,000.00
09.0.5.-	DISPOSAL AREA									
09.0.5.B	SITE CLEARING	110	AC	$9,781	$40,980	$0	$500.00	$55,000	25%	$68,750.00
09.0.5.B	STONE LINED DIVERSION CHANNELS	54,000	LF	$60,848	$353,970	$2,239,650	$50.00	$2,700,000	25%	$3,375,000.00
09.0.5.B	GRASS LINED DIVERSION DITCH	6,500	LF	$2,636	$19,884	$32,906	$10.00	$65,000	25%	$81,250.00
09.0.5.B	SEDIMENT TRAPS	15	EA	$5,791	$12,369	$0	$1,300.00	$19,500	25%	$24,375.00
09.0.5.B	ROCK BARRIERS	30	EA	$3,380	$19,665	$2,970	$1,000.00	$30,000	25%	$37,500.00
09.0.5.B	SILT BARRIER FENCE	65,000	LF	$18,870	$127,445	$33,313	$3.00	$195,000	25%	$243,750.00
09.0.5.B	STRAW BALES	2,300	LF	$811	$5,833	$6,728	$6.00	$13,800	25%	$17,250.00
09.0.5.B	TEMPORARY SEEDING	110	AC	$6,786	$48,813	$41,250	$1,000.00	$110,000	25%	$137,500.00
09.0.5.B	PERMANENT SEEDING	110	AC	$83,370	$151,250	$595,925	$8,000.00	$880,000	25%	$1,100,000.00
09.0.R.-	ASSOCIATED GENERAL ITEMS									
09.0.R.B	HAUL ROAD IMPROVEMENTS	1	JOB	$39,830	$72,110	$35,565	$160,000.00	$160,000	25%	$200,000.00
	TOTAL, CONSTRUCTION COSTS:							$26,528,300.00	25%	$33,160,375.00

09.0.-.- CHANNELS AND CANALS (ROUNDED): $33,000,000.00

PRIME CONTRACTOR'S DISTRIBUTED COST ON PRIME'S WORK	$3,023,625	OR	16.5%
PRIME CONTRACTOR'S PROFIT ON PRIME'S WORK			8.35%
PRIME CONTRACTOR'S DISTRIBUTED COST ON SUBCONTRACTOR'S WORK	$174,200	OR	4.3%
PRIME CONTRACTOR'S PROFIT ON SUBCONTRACTOR'S WORK			5.08%

16 BANK STABILIZATION

A summary of this Code of Account is provided below.

16	Bank Stabilization	$ 4,315,000
	Contingencies	1,185,000
	TOTAL	$ 5,500,000

Explanation of Contingencies

Individual contingencies for each line item was determined by Cost Engineering Branch with the concurrence of the District element responsible for the design quantities. A 25% contingency was applied because of reasonable confidence in the quantities and unit cost for this stage of the project.

LOWER MON NAVIGATION STUDY

BANK STABILIZATION - October 1991 Cost Level

DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OH &PROFIT	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
*** LOWER RIVER MILES ***									
16.-.-.- RM 12.5, RIGHT BANK									
16.0.1.B EXCAVATION	11,845	CY	$33,955	$22,118	$0	$10.00	$118,450.00	25%	$148,062.50
16.0.2.B FILTER MATERIAL, 6"	5,635	CY	$26,924	$33,610	$77,040	$35.00	$197,225.00	25%	$246,531.25
16.0.2.B STONE PROTECTION	14,160	CY	$82,765	$77,456	$244,705	$40.00	$566,400.00	25%	$708,000.00
16.-.-.- RM 17.4, RIGHT BANK									
16.0.1.B CLEARING & GRUBBING	1.40	AC	$534	$2,235	$0	$2,500.00	$3,500.00	25%	$4,375.00
16.0.1.B EXCAVATION	735	CY	$2,122	$1,382	$0	$20.00	$14,700.00	25%	$18,375.00
16.0.2.B FILTER MATERIAL, 6"	1,860	CY	$8,975	$11,203	$25,428	$40.00	$74,400.00	25%	$93,000.00
16.0.2.B STONE PROTECTION	4,955	CY	$31,120	$29,921	$85,767	$45.00	$222,975.00	25%	$278,718.75
DISTRIBUTED COSTS	$164,800	OR	13.8%				$1,197,650.00		$1,497,062.50
PRIMES PROFIT	8.3%							25%	
							ROUNDED		$1,500,000.00

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LOWER MON NAVIGATION STUDY

BANK STABILIZATION - October 1991 Cost Level

	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OH &PROFIT	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
	*** RIVER ACCESS ***									
16.-.-.-	RM 14.6, LEFT BANK									
16.0.1.B	CLEARING & GRUBBING	2.00	AC	$2,404	$4,690	$0	$4,600.00	$9,200.00	25%	$11,500.00
16.0.1.B	EXCAVATION	12,800	CY	$95,340	$52,109	$0	$15.00	$192,000.00	25%	$240,000.00
16.0.2.B	FILTER MATERIAL, 6"	4,655	CY	$26,061	$23,152	$63,640	$45.00	$209,475.00	25%	$261,843.75
16.0.2.B	STONE PROTECTION	14,550	CY	$106,682	$87,838	$251,371	$50.00	$727,500.00	25%	$909,375.00
16.-.-.-	RM 17.5, LEFT BANK									
16.0.1.B	CLEARING & GRUBBING	1.00	JB	$1,202	$2,345	$0	$5,000.00	$5,000.00	25%	$6,250.00
16.0.1.B	EXCAVATION	1,570	CY	$11,918	$6,514	$0	$25.00	$39,250.00	25%	$49,062.50
16.0.2.B	FILTER MATERIAL, 6"	1,480	CY	$9,723	$8,157	$20,235	$50.00	$74,000.00	25%	$92,500.00
16.0.2.B	STONE PROTECTION	3,200	CY	$27,983	$24,527	$55,549	$55.00	$176,000.00	25%	$220,000.00
16.-.-.-	RM 20.7, LEFT BANK									
16.0.1.B	CLEARING & GRUBBING	1.00	JB	$601	$1,173	$0	$2,500.00	$2,500.00	25%	$3,125.00
16.0.1.B	EXCAVATION	280	CY	$3,973	$2,172	$0	$30.00	$8,400.00	25%	$10,500.00
16.0.2.B	FILTER MATERIAL, 6"	245	CY	$3,241	$2,719	$3,350	$60.00	$14,700.00	25%	$18,375.00
16.0.2.B	STONE PROTECTION	615	CY	$9,439	$9,342	$10,903	$65.00	$39,975.00	25%	$49,968.75
16.-.-.-	RM 23, LEFT BANK									
16.0.1.B	CLEARING & GRUBBING	1.00	AC	$1,202	$2,345	$0	$5,000.00	$5,000.00	25%	$6,250.00
16.0.1.B	EXCAVATION	7,740	CY	$55,615	$30,397	$0	$15.00	$116,100.00	25%	$145,125.00
16.0.2.B	FILTER MATERIAL, 6"	965	CY	$9,657	$7,457	$13,194	$55.00	$53,075.00	25%	$66,343.75
16.0.2.B	STONE PROTECTION	3,865	CY	$32,570	$27,798	$66,961	$55.00	$212,575.00	25%	$265,718.75
16.-.-.-	RM 23.45, RIGHT BANK									
16.0.1.B	EXCAVATION	3,230	CY	$23,835	$13,027	$0	$20.00	$64,600.00	25%	$80,750.00
16.0.2.B	FILTER MATERIAL, 6"	620	CY	$6,416	$4,738	$8,476	$60.00	$37,200.00	25%	$46,500.00
16.0.2.B	STONE PROTECTION	2,465	CY	$23,331	$20,556	$42,840	$60.00	$147,900.00	25%	$184,875.00
...	DISTRIBUTED COSTS	$314,900	OR	14.8%				$2,134,450.00		$2,668,062.50
	PRIMES PROFIT	8.4%							25%	
								ROUNDED		$2,700,000.00

LOWER MON NAVIGATION STUDY

BANK STABILIZATION - October 1991 Cost Level

	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OH &PROFIT	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
	*** YOUGH & MON RIVER CONFLUENCE ***									
16.-.-.-	RM 15.6, CONFL OF MON & YOUGH									
16.0.1.B	CLEARING & GRUBBING	0.30	AC	$178	$745	$0	$5,000.00	$1,500.00	25%	$1,875.00
16.0.1.B	EXCAVATION	370	CY	$1,417	$3,497	$0	$20.00	$7,400.00	25%	$9,250.00
16.0.2.B	FILTER MATERIAL, 6"	450	CY	$2,244	$2,801	$6,152	$50.00	$22,500.00	25%	$28,125.00
16.0.2.B	STONE PROTECTION	810	CY	$6,384	$7,664	$14,251	$60.00	$48,600.00	25%	$60,750.00
16.-.-.-	END OF 8th AVE, YOUGH RIVER									
16.0.1.B	EXCAVATION	445	CY	$1,700	$4,196	$0	$20.00	$8,900.00	25%	$11,125.00
16.0.2.B	FILTER MATERIAL, 6"	240	CY	$2,244	$2,801	$3,281	$50.00	$12,000.00	25%	$15,000.00
16.0.2.B	STONE PROTECTION	525	CY	$4,344	$6,043	$9,359	$60.00	$31,500.00	25%	$39,375.00
	DISTRIBUTED COSTS	$41,300	OR	31.2%				$132,400.00		$165,500.00
	PRIMES PROFIT	9.3%							25%	
								ROUNDED		$200,000.00

LOWER MON NAVIGATION STUDY

BANK STABILIZATION - October 1991 Cost Level

	DESCRIPTION	QUANTITY	UNIT	WITHOUT OVERHEAD & PROFIT PLANT	LABOR	MATERIALS	UNIT PRICE INCLUDING OH &PROFIT	TOTAL AMOUNT	CONT.	TOTAL AMOUNT INCLUDING CONTINGENCY
	*** UPPER RIVER MILES ***									
16.-.-.-	RM 20.8, RIGHT BANK									
16.0.1.B	CLEARING & GRUBBING	6.55	AC	$2,312	$9,686	$0	$2,300.00	$15,065.00	25%	$18,831.25
16.0.1.B	EXCAVATION	55,500	CY	$154,920	$100,915	$0	$6.00	$333,000.00	25%	$416,250.00
16.0.2.B	FILTER MATERIAL, 6"	2,760	CY	$13,462	$16,805	$37,734	$40.00	$110,400.00	25%	$138,000.00
16.0.2.B	STONE PROTECTION	8,045	CY	$47,633	$44,992	$139,082	$40.00	$321,800.00	25%	$402,250.00
16.-.-.-	RM 21.9, LEFT BANK									
16.0.1.B	CLEARING & GRUBBING	1.10	AC	$356	$1,490	$0	$2,500.00	$2,750.00	25%	$3,437.50
16.0.1.B	EXCAVATION	625	CY	$2,122	$1,382	$0	$20.00	$12,500.00	25%	$15,625.00
16.0.2.B	FILTER MATERIAL, 6"	335	CY	$2,244	$2,801	$4,580	$50.00	$16,750.00	25%	$20,937.50
16.0.2.B	STONE PROTECTION	645	CY	$4,344	$6,043	$11,419	$60.00	$38,700.00	25%	$48,375.00
	DISTRIBUTED COSTS	$134,650	OR	15.8%				$850,965.00		$1,063,706.25
	PRIMES PROFIT	8.3%							25%	
								ROUNDED		$1,100,000.00

18 CULTURAL RESOURCES MANAGEMENT

A summary of this Code of Account is provided below.

18	Cultural Resources	$ 780,000
	Contingencies	390,000
	TOTAL	$ 1,170,000

Explanation of Contingencies

Contingencies for items under this code of account was determined by the functional chief responsible for this part of the project and was based on the level of detail available at this time. Contingencies for contracts were generally between 25 and 100% (see attached breakdown) and hired labor was approximately 25%, based on the assumed scope of work known and anticipated.

CULTURAL RESOURCES MANAGEMENT

18.-.-.-	CULTURAL RESOURCES MANAGEMENT		
18.-.-.-	Planning	$780,500	
18.0.Z.-	Contingencies		$385,945
		~~	~~~~~~~~~~~~
	TOTAL	$780,500	$385,945
	TOTAL (ROUNDED)	$780,000	$390,000

20 PERMANENT OPERATING EQUIPMENT

A summary of this Code of Account is provided below.

20	Permanent Op Equip.	$ 325,000
	Contingencies	80,000
	TOTAL	$ 405,000

Explanation of Contingencies

Contingencies for items under this code of account was determined by the functional chief responsible for this part of the project and was based on the level of detail available at this time for a typical project of this scope.

PERMANENT OPERATING EQUIPMENT

	LOCK & DAM 2		
20.0.-.-	Permanent Operating Equipment	$161,930	
20.0.Z.-	Contingencies		$40,500
	LOCK & DAM 4		
20.0.-.-	Permanent Operating Equipment	$161,930	
20.0.Z.-	Contingencies		$40,500
		~~	~~~~~~~~~~~~
	TOTAL	$323,860	$81,000
	TOTAL (ROUNDED)	$325,000	$80,000

30 PLANNING, ENGINEERING AND DESIGN

A summary of this Code of Account is provided below.

30	P, E, & D	$ 32,220,000
	Contingencies	10,680,000
	TOTAL	$ 42,900,000

Explanation of Contingencies

Contingencies for this code of account was developed by the functional chief that provided these costs associated with this code of account, and are delineated for hired labor, contracts, testing, and miscellaneous supplies based on the level of detail available at this time for a typical project of this scope.

L&D 2 - FLOODWAY BULKHEAD

30.-.-.-	PLANNING,ENGINEERING & DESIGN		
30.G.-.-	Feature Design Memorandum	$100,869	
30.G.Z.-	Contingencies		$11,335
30.H.-.-	Plans and Specifications	$219,873	
30.H.Z.-	Contingencies		$24,045
30.J.-.-	Engineering during Construction	$148,120	
30.J.Z.-	Contingencies		$15,300
30.M.-.-	Cost Engineering	$26,400	
30.M.Z.-	Contingencies		$5,500
30.N.-.-	Construction and Supply Contract Award Activities	$13,473	
30.N.Z.-	Contingencies		$16,802
30.P.-.-	Project Management	$51,436	
30.P.Z.-	Contingencies		$5,145
30.Z.-.-	Miscellaneous Activities	$18,000	
30.Z.Z.-	Contingencies		$3,600
	TOTAL	$578,171	$81,727
	TOTAL (ROUNDED)	$580,000	$80,000

L&D 2 - GATED DAM

30.-.-.-	PLANNING,ENGINEERING & DESIGN		
30.E.-.-	Design Related Engineering	$1,562,912	
30.E.Z.-	Contingencies		$221,111
30.F.-.-	General Design Memorandum	$969,765	
30.F.Z.-	Contingencies		$116,838
30.G.-.-	Feature Design Memorandum	$2,046,555	
30.G.Z.-	Contingencies		$231,420
30.H.-.-	Plans and Specifications	$2,519,307	
30.H.Z.-	Contingencies		$317,007
30.J.-.-	Engineering during Construction	$2,258,308	
30.J.Z.-	Contingencies		$268,055
30.M.-.-	Cost Engineering	$204,800	
30.M.Z.-	Contingencies		$49,340
30.N.-.-	Construction and Supply Contract Award Activities	$92,047	
30.N.Z.-	Contingencies		$50,736
30.P.-.-	Project Management	$133,336	
30.P.Z.-	Contingencies		$13,350
30.Z.-.-	Miscellaneous Activities	$112,404	
30.Z.Z.-	Contingencies		$3,340,900
	TOTAL	$9,899,434	$4,608,757
	TOTAL (ROUNDED)	$9,900,000	$4,600,000

L&D 2 - REHABILITATION

30.-.-.-	PLANNING,ENGINEERING & DESIGN		
30.G.-.-	Feature Design Memorandum	$1,250,200	
30.G.Z.-	Contingencies		$75,940
30.H.-.-	Plans and Specifications	$1,702,066	
30.H.Z.-	Contingencies		$178,600
30.J.-.-	Engineering during Construction	$893,100	
30.J.Z.-	Contingencies		$54,640
30.M.-.-	Cost Engineering	$174,787	
30.M.Z.-	Contingencies		$42,590
30.N.-.-	Construction and Supply Contract Award Activities	$68,933	
30.N.Z.-	Contingencies		$19,472
30.P.-.-	Project Management	$50,000	
30.P.Z.-	Contingencies		$0
30.Z.-.-	Miscellaneous Activities	$113,000	
30.Z.Z.-	Contingencies		$1,012,600
	TOTAL	$4,252,086	$1,383,842
	TOTAL (ROUNDED)	$4,250,000	$1,380,000

L&D 3 - DEMOLITION

30.-.-.- PLANNING,ENGINEERING & DESIGN		
30.E.-.- Design Related Engineering	$57,000	
30.E.Z.- Contingencies		$8,550
30.G.-.- Feature Design Memorandum	$418,408	
30.G.Z.- Contingencies		$43,757
30.H.-.- Plans and Specifications	$502,942	
30.H.Z.- Contingencies		$53,264
30.J.-.- Engineering during Construction	$171,670	
30.J.Z.- Contingencies		$18,187
30.M.-.- Cost Engineering	$67,000	
30.M.Z.- Contingencies		$17,000
30.N.-.- Construction and Supply Contract Award Activities	$17,385	
30.N.Z.- Contingencies		$19,398
30.P.-.- Project Management	$9,040	
30.P.Z.- Contingencies		$900
30.Z.-.- Miscellaneous Activities	$45,000	
30.Z.Z.- Contingencies		$9,000
TOTAL	$1,288,445	$170,056
TOTAL (ROUNDED)	$1,300,000	$170,000

DREDGING

30.-.-.-	PLANNING,ENGINEERING & DESIGN		
30.E.-.-	Design Related Engineering	$150,000	
30.E.Z.-	Contingencies		$50,000
30.G.-.-	Feature Design Memorandum	$285,504	
30.G.Z.-	Contingencies		$30,843
30.H.-.-	Plans and Specifications	$228,472	
30.H.Z.-	Contingencies		$25,835
30.J.-.-	Engineering during Construction	$137,664	
30.J.Z.-	Contingencies		$13,767
30.M.-.-	Cost Engineering	$13,200	
30.M.Z.-	Contingencies		$2,750
30.N.-.-	Construction and Supply Contract Award Activities	$14,657	
30.N.Z.-	Contingencies		$10,610
30.P.-.-	Project Management	$19,720	
30.P.Z.-	Contingencies		$2,000
30.Z.-.-	Miscellaneous Activities	$9,000	
30.Z.Z.-	Contingencies		$1,800
	TOTAL	$858,217	$137,605
	TOTAL (ROUNDED)	$860,000	$140,000

L&D 4 - LOCK

30.-.-.- PLANNING,ENGINEERING & DESIGN		
30.E.-.- Design Related Engineering	$1,403,812	
30.E.Z.- Contingencies		$204,011
30.G.-.- Feature Design Memorandum	$2,046,272	
30.G.Z.- Contingencies		$234,364
30.H.-.- Plans and Specifications	$3,618,866	
30.H.Z.- Contingencies		$438,758
30.J.-.- Engineering during Construction	$2,426,721	
30.J.Z.- Contingencies		$273,737
30.M.-.- Cost Engineering	$190,737	
30.M.Z.- Contingencies		$50,840
30.N.-.- Construction and Supply Contract Award Activities	$233,323	
30.N.Z.- Contingencies		$122,482
30.P.-.- Project Management	$59,376	
30.P.Z.- Contingencies		$6,000
30.Z.-.- Miscellaneous Activities	$181,454	
30.Z.Z.- Contingencies		$1,772,950
TOTAL	$10,160,561	$3,103,142
TOTAL (ROUNDED)	$10,200,000	$3,100,000

L&D 4 - SCOUR PROTECTION

30.-.-.-	PLANNING,ENGINEERING & DESIGN		
30.G.-.-	Feature Design Memorandum	$148,328	
30.G.Z.-	Contingencies		$15,257
30.H.-.-	Plans and Specifications	$184,536	
30.H.Z.-	Contingencies		$18,558
30.J.-.-	Engineering during Construction	$67,328	
30.J.Z.-	Contingencies		$7,433
30.M.-.-	Cost Engineering	$19,700	
30.M.Z.-	Contingencies		$5,000
30.N.-.-	Construction and Supply Contract Award Activities	$17,385	
30.N.Z.-	Contingencies		$16,346
30.P.-.-	Project Management	$7,740	
30.P.Z.-	Contingencies		$800
30.Z.-.-	Miscellaneous Activities	$22,500	
30.Z.Z.-	Contingencies		$4,500
	TOTAL	$467,517	$67,894
	TOTAL (ROUNDED)	$470,000	$70,000

RELOCATIONS

30.-.-.- PLANNING,ENGINEERING & DESIGN		
30.E.-.- Design Related Engineering	$241,600	
30.E.Z.- Contingencies		$20,000
30.G.-.- Feature Design Memorandum	$989,224	
30.G.Z.- Contingencies		$89,091
30.H.-.- Plans and Specifications	$1,546,300	
30.H.Z.- Contingencies		$194,888
30.J.-.- Engineering during Construction	$449,504	
30.J.Z.- Contingencies		$66,950
30.M.-.- Cost Engineering	$93,950	
30.M.Z.- Contingencies		$25,000
30.N.-.- Construction and Supply Contract Award Activities	$47,487	
30.N.Z.- Contingencies		$40,728
30.P.-.- Project Management	$69,936	
30.P.Z.- Contingencies		$9,500
30.Z.-.- Miscellaneous Activities	$203,750	
30.Z.Z.- Contingencies		$455,750
TOTAL	$3,641,751	$901,907
TOTAL (ROUNDED)	$3,640,000	$900,000

PLANNING EFFORT

30.-.-.- PLANNING,ENGINEERING & DESIGN		
30.A.-.- Planning	$304,000	
30.A.Z.- Contingencies		$30,000
30.D.-.- Planning	$540,064	
30.D.Z.- Contingencies		$165,516
30.G.-.- Feature Design Memorandum	$156,120	
30.G.Z.- Contingencies		$39,030
30.N.-.- Construction and Supply Contract Award Activities	$10,400	
30.N.Z.- Contingencies		$2,600
30.Z.-.- Miscellaneous Activities	$12,000	
30.Z.Z.- Contingencies		$3,000
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TOTAL	$1,022,584	$240,146
TOTAL (ROUNDED)	$1,020,000	$240,000

31 CONSTRUCTION MANAGEMENT

A summary of this Code of Account is provided below.

31	S & A	$ 42,085,000
	Contingencies	2,298,000
	TOTAL	$ 44,383,000

Explanation of Contingencies

Contingencies for this code of account was determined by the functional chief that provided these costs associated with this code of account and are delineated for hired labor and supplies based on the level of detail available at this time for a typical project of this scope.

L&D 2 - FLOODWAY BULKHEAD

31.-.-.-	CONSTRUCTION MANAGEMENT		
31.B.-.-	Contract Administration	$161,870	
31.B.Z.-	Contingencies		$8,000
31.D.-.-	Review of Shop Drawings	$152,862	
31.D.Z.-	Contingencies		$11,500
31.E.-.-	Inspection and Quality Assurance	$193,167	
31.E.Z.-	Contingencies		$9,600
31.H.-.-	Contractor Initiated Claims and Litigations	$19,028	
31.H.Z.-	Contingencies		$950
31.P.-.-	Project Management	$48,880	
31.P.Z.-	Contingencies		$5,000
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	TOTAL	$575,807	$35,050
	TOTAL (ROUNDED)	$575,000	$35,000

L&D 2 - GATED DAM

31.-.-.- CONSTRUCTION MANAGEMENT		
31.B.-.- Contract Administration	$1,203,222	
31.B.Z.- Contingencies		$59,800
31.D.-.- Review of Shop Drawings	$2,594,700	
31.D.Z.- Contingencies		$151,480
31.E.-.- Inspection and Quality Assurance	$2,423,471	
31.E.Z.- Contingencies		$121,500
31.F.-.- Project Office Operation	$399,572	
31.F.Z.- Contingencies		$20,000
31.H.-.- Contractor Initiated Claims and Litigations	$105,254	
31.H.Z.- Contingencies		$5,200
31.J.-.- Government Initiated Claims and Litigations	$40,126	
31.J.Z.- Contingencies		$2,000
31.P.-.- Project Management	$90,640	
31.P.Z.- Contingencies		$9,100
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TOTAL	$6,856,985	$369,080
TOTAL (ROUNDED)	$6,900,000	$370,000

L&D 2 - LOCK REHABILITATION

31.-.-.-	CONSTRUCTION MANAGEMENT		
31.B.-.-	Contract Administration	$1,165,933	
31.B.Z.-	Contingencies		$58,000
31.D.-.-	Review of Shop Drawings	$2,080,270	
31.D.Z.-	Contingencies		$94,600
31.E.-.-	Inspection and Quality Assurance	$2,331,731	
31.E.Z.-	Contingencies		$117,000
31.F.-.-	Project Office Operation	$399,572	
31.F.Z.-	Contingencies		$20,000
31.H.-.-	Contractor Initiated Claims and Litigations	$105,254	
31.H.Z.-	Contingencies		$5,200
31.J.-.-	Government Initiated Claims and Litigations	$40,126	
31.J.Z.-	Contingencies		$2,000
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	TOTAL	$6,122,886	$296,800
	TOTAL (ROUNDED)	$6,100,000	$300,000

L&D 3 - DEMOLITION

31.-.-.- CONSTRUCTION MANAGEMENT		
31.B.-.- Contract Administration	$231,116	
31.B.Z.- Contingencies		$12,000
31.D.-.- Review of Shop Drawings	$146,567	
31.D.Z.- Contingencies		$12,200
31.E.-.- Inspection and Quality Assurance	$424,248	
31.E.Z.- Contingencies		$22,000
31.F.-.- Project Office Operation	$85,987	
31.F.Z.- Contingencies		$4,300
31.H.-.- Contractor Initiated Claims and Litigations	$58,647	
31.H.Z.- Contingencies		$3,000
31.P.-.- Project Management	$7,120	
31.P.Z.- Contingencies		$700
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TOTAL	$953,685	$54,200
TOTAL (ROUNDED)	$950,000	$55,000

DREDGING

31.-.-.- CONSTRUCTION MANAGEMENT		
31.B.-.- Contract Administration	$70,211	
31.B.Z.- Contingencies		$3,500
31.D.-.- Review of Shop Drawings	$11,106	
31.D.Z.- Contingencies		$550
31.E.-.- Inspection and Quality Assurance	$282,050	
31.E.Z.- Contingencies		$14,100
31.P.-.- Project Management	$40,800	
31.P.Z.- Contingencies		$4,100
TOTAL	$404,167	$22,250
TOTAL (ROUNDED)	$400,000	$20,000

L&D 4 - LOCK

31.-.-.-	CONSTRUCTION MANAGEMENT		
31.B.-.-	Contract Administration	$2,872,867	
31.B.Z.-	Contingencies		$143,800
31.D.-.-	Review of Shop Drawings	$6,612,858	
31.D.Z.-	Contingencies		$494,080
31.E.-.-	Inspection and Quality Assurance	$6,041,706	
31.E.Z.-	Contingencies		$301,800
31.F.-.-	Project Office Operation	$907,735	
31.F.Z.-	Contingencies		$45,000
31.H.-.-	Contractor Initiated Claims and Litigations	$223,440	
31.H.Z.-	Contingencies		$11,000
31.J.-.-	Government Initiated Claims and Litigations	$50,262	
31.J.Z.-	Contingencies		$2,500
31.P.-.-	Project Management	$108,160	
31.P.Z.-	Contingencies		$11,000
	TOTAL	$16,817,028	$1,009,180
	TOTAL (ROUNDED)	$16,800,000	$1,000,000

BANK STABILIZATION

31.-.-.- CONSTRUCTION MANAGEMENT		
31.B.-.- Contract Administration	$86,288	
31.B.Z.- Contingencies		$4,300
31.D.-.- Review of Shop Drawings	$24,918	
31.D.Z.- Contingencies		$1,250
31.E.-.- Inspection and Quality Assurance	$245,399	
31.E.Z.- Contingencies		$12,300
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TOTAL	$356,605	$17,850
TOTAL (ROUNDED)	$360,000	$18,000

RELOCATIONS

31.-.-.-	CONSTRUCTION MANAGEMENT		
31.B.-.-	Contract Administration	$2,729,649	
31.B.Z.-	Contingencies		$136,270
31.D.-.-	Review of Shop Drawings	$2,117,011	
31.D.Z.-	Contingencies		$105,380
31.E.-.-	Inspection and Quality Assurance	$4,490,705	
31.E.Z.-	Contingencies		$226,100
31.F.-.-	Project Office Operation	$191,222	
31.F.Z.-	Contingencies		$9,500
31.H.-.-	Contractor Initiated Claims and Litigations	$393,688	
31.H.Z.-	Contingencies		$19,850
31.P.-.-	Project Management	$35,880	
31.P.Z.-	Contingencies		$3,500
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	TOTAL	$9,958,155	$500,600
	TOTAL (ROUNDED)	$10,000,000	$500,000

NON-FEDERAL RELOCATION COSTS

UTILITIES

	LOCATION	ESTM. COST PLAN 1 ($1,000)
WATER INTAKES:		
U.S. STEEL	11.2 R	$500.0
DUQUESNE	25.1 L	$6,900.0
WEST PA WATER	25.3 L	$5,500.0
ALLEGHENY POWER	29.0 L	$9,900.0
	SUBTOTAL	$22,800.0
SUBMARINE CROSSINGS:		
ALLEGHENY PIPELINE	24.6	$1,400.0
COLUMBIA GAS	24.6	$3,500.0
EQUITABLE GAS	25.4	$1,325.0
CONSOLIDATED GAS (2)	33.0	$1,200.0
PEOPLES NATURAL GAS (6)	33.0	$1,025.4
N.Y. STATE NATURAL GAS (2)	34.0	$1,400.0
WEST PENN POWER	34.1	$700.0
CONSOLIDATED GAS (2)	34.3	$1,200.0
UNKNOWN OWNER	35.1	$700.0
MFRS HEAT & LIGHT	36.8	$700.0
PEOPLES NATURAL GAS	38.7	$700.0
PEOPLES NATURAL GAS	40.8	$700.0
	SUBTOTAL	$14,550.4
	TOTAL, CONSTRUCTION COSTS:	$37,350.4

NON-FEDERAL RELOCATION COSTS

STRUCTURES

	LOCATION	ESTM COST PLAN 1 ($1,000)
PRIVATE DOCKS:		
MON-VALLEY SPEED CLUB	15.9 R	$15.0
UNKNOWN	16.3 R	$1.0
SCHIFFMAN	16.4 R	$1.0
SWIFT HOMES	22.4 R	$2.0
ELIZABETH BOAT CLUB	22.8 R	$8.0
PINE RUN OUTBOARD	26.3 R	$15.0
EVAN FORD BOAT SALES	26.4 R	$1,500.0
JOHN N. MOLNER MARINA	29.1 R	$15.0
BEACH CLUB MARINA	30.9 L	$50.0
J. SMINKO	31.4 L	$50.0
MONONGAHELA MARINA	31.8 L	$20.0
UNKNOWN	32.6 L	$15.0
MARINA ONE	32.1 R	$1,000.0
UNKNOWN	33.1 R	$15.0
HAMEL	34.3 R	$2.0
FRANK IREY MARINA	34.5 R	$40.0
GIBSON	34.6 R	$3.0
	SUBTOTAL	$2,752.0
LAUNCHING RAMPS:		
BLAIR S. EVANS	33.2 R	$15.0
	SUBTOTAL	$15.0
BARGE MOORING:		
UNION R.R	12.1-12.4 L	$3,000.0
INGRAM BARGE	16.4-17.2 L	$1,000.0
CONSOL	22.9-23.4 L	$24.6
CENTOFANTI MARINE	24.5-24.6 L	$200.0
	SUBTOTAL	$4,224.6
BARGE LOADING FACILITY:		
CLAIRTON SLAG	23.6-23.7 L	$100.0
HERCULES PICCO	23.8 L	$1,360.0
	SUBTOTAL	$1,460.0
MARINEWAYS:		
CENTOFANTI MARINE	24.5	$450.0
	SUBTOTAL	$450.0

COMMERCIAL DOCKS:

UNION R.R	11.7-11.9 L	$200.0
UNION R.R.	12.1 L	$7,400.0
REG. IND. DEVEL.	15.0 R	$50.0
DAVIDSON S&G	16.1-16.2 L	$60.0
BOSWELL OIL	16.25 L	$1,000.0
ST. CLAIR SUPPLY CO.	17.4 R	$50.0
C&C MARINE MAINT.	18.7 L	$50.0
GLASSPORT TRANS. CTR.	19.1 R	$200.0
ARISTECH CHEM. CORP.	19.4 L	$86.0
GUTTMAN	21.8 R	$110.0
DILLNER	24.2-24.3 L	$1,000.0
ASHLAND	24.6 L	$1,225.0
LOCK 3 O&C	24.8-24.9 R	$1,000.0
DUQUESNE	25.0-25.3 L	$8,100.0
CHEMPLY	27.8 R	$250.0
MON. RIVER TERM.	28.6-28.8 R	$1,300.0
ALLEGHENY POWER	29.2-29.4 L	$5,100.0
MATHIES COAL	29.4-29.7 L	$950.0
U.S. STEEL	30.1-30.6 L	$7,500.0
PATTERSON SUPPLY	31.3 L	$50.0
MON. IRON & METALS	32.7 L	$125.0
RIVERSIDE I&S	33.1 L	$50.0
DUQUESNE SLAG PROD. CO.	34.3 L	$800.0
BABCOCK & WILCOX	37.2-37.3 R	$5.0
MCGREW WELDING	38.2 L	$10.0
CANASTRAL CONST.	38.5-38.6 R	$200.0
SHARON STEEL	39.8-40.3 R	$1,300.0
RESERVE PET.	40.9 L	$100.0
	SUBTOTAL	$38,271.0
	TOTAL, CONSTRUCTION COSTS:	$47,172.6

NON-FEDERAL RELOCATION COSTS

STORM SEWERS

	LOCATION	ESTM. COST PLAN 1 ($1,000)
STORM SEWERS:		
P & LE RAILROAD	11.6 R	$9.5
UNION RAILROAD	12.1 L	$1,030.4
USX	13.1 L	$595.4
UNKNOWN	14.2 R	$888.0
NATIONAL TUBE	14.4 R	$275.0
UNKNOWN	16.2 R	$112.6
USX	19.1 L	$915.0
UNKNOWN	19.7 L	$9,371.0
USX	20.7 L	$775.0
USX	21.1 L	$2,728.0
UNKNOWN	21.5 L	$1,245.0
P & LE RAILROAD	23.4 R	$287.1
STEEL MET	1.2 YOUGH L	$1,360.0
STEEL MET	1.3 YOUGH L	$1,025.0
STEEL MET	1.5 YOUGH L	$771.0
CSX	2.3 YOUGH R	$2,076.0
P & LE RAILROAD	2.6 YOUGH L	$1,090.0
	SUBTOTAL	$24,554.0
	TOTAL, CONSTRUCTION COSTS:	$24,554.0

LOWER MONONGAHELA RIVER NAVIGATION SYSTEM STUDY

APPENDIX

REAL ESTATE

U.S. Army Engineering District, Pittsburgh
Corps of Engineers
Pittsburgh, Pennsylvania

FEASIBILITY REPORT FOR THE
LOWER MONONGAHELA RIVER NAVIGATION SYSTEM

TABLE OF CONTENTS

This Real Estate section summarizes the real estate requirements for the recommended plan (Plan No.1), the "without project" scenario and the best three for three plan (Plan No. 4). The plans are comprised of various combinations of fee along with flowage, work area, utility and road easements. Estates are standard as prescribed in ER-405-1-12, Chapter 5, with the exception of a permanent easement for construction of the new dam at L/D 2. A non-standard estate is required for the construction of a cut-off wall under the tracks and right of way of the railroad. The wall will become a permanent part of the project and is to prevent water from by-passing the dam in times of high water. A perpetual right to construct, maintain and operate the wall as part of the project is required. Fee is not desirable because no permanent rights on the surface of the land are needed. As a result, taking the property and eliminating a portion of the railroad yard is not prudent. The proposed non-standard estate will be included in the REDM for approval.

The project areas are geographically situated upstream of Pittsburgh along the reach of the lower Monongahela River, between approximate river mile 6 in Allegheny County and river mile 40 near North Charleroi in Washington County, Pennsylvania. The entire stretch of river is densely utilized and is the major means of coal transportation from the area to markets along the Ohio and Mississippi Rivers and ultimately, for overseas export. The area is a mix of heavy industrial, light industrial, commercial, residential, recreational and support facilities. The topography of the affected areas consists mostly of bottomland and riverbank, with the exception of Plan No. 4. It involves the acquisition of some highly developed commercial property.

Severance damages have been considered on all partial acquisitions. Mineral values are considered to be subordinate to the highest and best use of the land and have been merged with the land values.

All three plans require acquisition of the fee area at L/D 2 and all of the temporary work area easements and temporary road easements. These areas are described more extensively in the discussion of the recommended plan. In addition, the "without project" plan and Plan No. 4 require acquisition of mitigation land and a permanent road easement for access to one of the two sites.

The following is a brief discussion and cost estimate for each of the plans that were considered for modernization of the Lower Monongahela River Navigation System.

RECOMMENDED PLAN

PLAN NO. 1

The recommended plan involves the rehabilitation of the locks at existing L/D 2 at R.M. 11.2 and construction of a new gated dam and auxiliary chamber floodway. Locks and Dam 3, located at R.M. 23.8, would be removed. The locks at L/D 4, located at R.M. 41.5, would be rehabilitated and the dam would be replaced. Pool 2 would be raised 5 feet from existing L/D 2 up to existing L/D 3. Pool 3 would be lowered 3.2 feet from existing L/D 3 to L/D 4. One fee tract affecting 3 acres would be required for the abutment site of the new dam at L/D 2. Thirty-three temporary work area easement tracts would be required for disposal and staging areas. A non-standard permanent easement estate would be required for construction of the dam at L/D 2 affecting approximately one acre and one ownership. A permanent utility easement would also be required at L/D 4. Flowage easements would only have to be acquired on the non-navigable tributaries of the Monongahela and Youghiogheny Rivers between existing L/D's 2 and 3, the area of the pool raise. All acquisitions and relocations will be accomplished in accordance with Public Law 91-646. The total number of tracts to be acquired is 100 containing an acreage of approximately 480 acres.

Flowage Easements

Construction of the new gated dam at L/D 2 and the subsequent pool raise requires acquisition of flowage easements on the non-navigable tributaries of the Monongahela River, between R.M.'s 11.2 and 23.8 and the Youghiogheny River from R.M. 0 to R.M. 11, as shown on Plate Nos. 6 & 6A. Since existing OHW is not being raised, flowage easements are not required on the main stems of the rivers. The flowage easements will affect 60 ownerships containing an area of approximately 35 acres. The highest and best use of the land is considered to be its present uses as riverbank support land. The estate to be acquired is a standard perpetual flowage easement.

Staging Area at Rankin:

This site is located on the right bank of the Monongahela River approximately 1.6 miles downstream of existing L/D 2, in the vicinity of the Rankin Highway Bridge, as shown on Plate No. 1. It is required for construction of the floodway bulkhead and the dam at L/D 2. The staging area is a vacant cleared industrial site. The area contains approximately 10 acres, one ownership and 1,000 feet of river frontage. The highest and best use of the land is considered to be industrial riverfront property. The estate to be acquired is a temporary work area easement. Access to the site is by an existing public road.

Abutment Site at the new dam for L/D 2:

The property at the abutment site consists of two areas, as shown on Plate No. 1. The first is the fee area that contains approximately 3 acres and one ownership. An additional acre, more or less, is needed for construction of a cut-off wall under the railroad. The site is adjacent to and part of an extensive railroad yard. The area can best be characterized as riverbank industrial support land with no improvements. A non-standard permanent easement estate would be acquired to construct the cut-off wall.

Disposal Site at Coursin Hill:

The Coursin Hill site is located on the right bank at approximately River Mile 20, as shown on Plate No. 2. It is required for construction of the floodway bulkhead and the new dam at L/D 2. The site contains a total of 118 acres and has two distinct areas and several different land uses. The first area is industrial/commercial riverfront property that contains an unloading facility. The second area is the disposal site. It contains approximately 17 acres of residential property and 97 acres of steep wooded hillside. Access to the disposal sites would be via a Township Road. Modifications and adjustments to the township road would be by relocation contract. The estates to be acquired would be temporary work area easements and temporary road easements. Should additional permanent road easements be required, land costs will be included in the relocation contract. A new railroad grade crossing will be required to connect the unloading dacility to the haul road. The highest and best use of the land is considered to be its present uses. This site involves acquisition of nine residential dwellings and support structures.

Disposal Site at Bunola:

The Bunola Disposal site is located along the right bank near river mile 27, as shown on Plate No. 3. It is required for dredging of existing L/D 3 pool area and the removal of existing L/D 3. The site contains a total of 229 acres, 15 ownerships and also has two distinct areas and several different land uses. The first area consists of approximately 12 acres of industrial riverfront property containing an unloading facility. The second area is comprised of 7 acres of residential property, 206 acres of steep wooded hillside and 4 acres as support land for an existing roadway. Access to the disposal site would be via a State Secondary Route. Modifications and adjustments to the State Route would be by relocation contract. The estates to be acquired would be temporary work area easements and temporary road easements. should additional permanent road easements be required, land costs will be included in the relocation contract. A new railroad grade crossing will be required. The highest and best use of the land is considered to be its present uses. This site involves acquisition of 5 single family residential dwellings with support structures and 1 commercial maintenance shop.

Staging area at Charleroi:

The staging area at Charleroi is located along the left bank approximately 200 feet downstream of existing L/D 4, as shown on Plate No. 4. It is required for construction of the locks at L/D 4. The site has approximately 600 feet of river frontage and contains approximately 10 acres and one ownership. The highest and best use of the land is considered to be its present use as industrial riverfront property. The land is a cleared industrial site. The estate to be acquired is a temporary work area easement. Vehicular access to the site is from the northern limits of the area at Route 88.

Utility Easement Areas at L/D 4:

Utilities to be provided at L/D 4 include a sanitary sewer and gas and water lines, as shown on Plate No. 4. The sanitary sewer runs from an existing manhole downstream of the lock on the right bank, parallel to State Route 306 and then under the railroad tracks to the lock. The gas and water lines run from main lines under SR 306, under the railroad tracks to the lock. The estate to be acquired is a perpetual utility line easement. The real estate required contains a total of 1 acre and two ownerships. The highest and best use of the land is considered to be its present use as railroad and commercial support land. No relocations or acquisition of improvements is involved.

Disposal Site at Dunlevy:

The Dunlevy disposal area is located on the left bank near river mile 45, as shown on Plate No. 5. It is required for the disposal of material from the work at L/D 4. The site has about 3,000 feet of river frontage and contains an area of approximately 67 acres and one ownership. No structures or relocations are involved. The site is a level, partially wooded parcel containing two baseball fields. The highest and best use of the property is considered to be light industrial. Vehicular access is provided by an unnamed public street crossing the railroad tracks at the upstream end of the proposed site. A temporary work area easement will be acquired.

RECOMMENDED PLAN

GROSS ESTIMATE

FEE		$ 60,000
PERMANENT EASEMENT		$ 15,000
TEMPORARY WORK AREA EASEMENTS		$1,743,500
FLOWAGE EASEMENTS		$ 32,000
PERMANENT UTILITY EASEMENT		$ 1,200
SEVERANCE DAMAGES		$ 313,000
	Sub-Total	$2,164,700
CONTINGENCIES		$ 610,300
TOTAL OF ESTIMATED REAL ESTATE VALUE		$2,775,000
RELOCATION ASSISTANCE		$ 475,000
ADMINISTRATIVE COSTS		$ 650,000
	GRAND TOTAL	$3,900,000

WITHOUT PROJECT

The "without project" scenario requires significant Real Estate involvement because of the work that needs to be done to the existing structures. This work includes: the rehabilitation of the locks and replacement of the dam at L/D 2 at Braddock; the replacement of the locks and dam at L/D 3 at Elizabeth and the rehabilitation of the locks at L/D 4 at Rostraver. The replacement dam at L/D 3 would, because of its smaller size, raise OHW in its pool. Accordingly, flowage easements have to be acquired. Construction of the new lock chambers at L/D 3 requires acquisition and excavation of the land along the upstream approach to the lock. The excavation will affect wildlife. As a result, two sites of fee land have to be acquired for mitigation: one site requires a permanent road easement for access.

Acquisition for all of the structures includes the following: 48.00 acres of fee property affecting three ownerships; 434 acres of temporary work area easements and 33 ownerships; 4 acres and 3 ownerships of permanent easements; 2 acres and 1 ownership of permanent road easement and flowage easements containing approximately 150 acres and 366 ownerships.

WITHOUT PROJECT

COST ESTIMATE

FEE		$ 521,000
TEMPORARY WORK AREA EASEMENTS		$1,069,000
PERMANENT EASEMENTS		$ 22,700
FLOWAGE EASEMENTS		$2,845,000
RELOCATION ASSISTANCE		$ 612,000
SEVERANCE DAMAGES		$ 145,400
IMPROVEMENTS		$ 588,000
ADMINISTRATIVE COSTS		$2,050,000
	TOTAL	$7,853,100
CONTINGENCIES		$2,134,650
	GRAND TOTAL	$9,987,750
	SAY	10,000,000

PLAN NO. 4

This plan calls for the rehabilitation of L/D 2 at its existing location at R.M. 11.2 and construction of a new auxiliary chamber floodway and fixed crest dam. Lock and Dam 3 at R.M. 23.8 would be removed and replaced by twin locks and a fixed crest dam at R.M. 24.6. The area required for construction of the new locks will affect wildlife. As a result, some land has to be acquired for mitigation. New twin locks would be constructed at existing L/D 4 at R.M. 41.5. The only pool change would be the lowering of pool 3 by 8.2 feet from existing L/D 3 at R.M. 23.8 upstream to the new site at R.M. 24.6.

One fee tract containing three acres is required for the abutment site at existing L/D 2, R.M. 11.2, while 13 fee tracts covering 46 acres and two permanent road easement tracts covering approximately one-half acre are required for the new site of L/D 3. The mitigation land consists of two sites containing an area of 45 fee acres and two ownerships plus two acres and one ownership as permanent road easement access to one of the sites. No flowage easements are required.

PLAN NO. 4

COST ESTIMATE

FEE	$ 936,000
TEMPORARY WORK AREA EASEMENTS	$ 1,069,000
PERMANENT EASEMENTS	$ 22,700
RELOCATION ASSISTANCE	$ 312,000
SEVERANCE DAMAGES	$ 150,500
IMPROVEMENTS	$ 1,493,000
ADMINISTRATIVE COSTS	$ 285,000
TOTAL	$ 4,268,200
CONTINGENCIES	$ 1,112,275
GRAND TOTAL	$ 5,380,475
SAY	$ 5,400,000

PLAN NO. 2

This plan involves the rehabilitation of the locks and construction of a new fixed crest dam at L/D 2; construction of new locks and dam approximately 1.8 miles downstream of existing site to replace L/D 3; construct new locks at L/D 4. The new dam at L/D 3 will raise the pool 8.2 feet from river mile 22 to 23.8. This alternative is comprised of: five tracts totalling 35 acres; thirty-three temporary work area easement tracts covering 434 acres for disposal and staging areas; 148 permanent flowage easement tracts covering approximately 105 acres would be required for the pool raise.

PLAN NO. 2

COST ESTIMATE

FEE	$ 171,000
TEMPORARY WORK AREA EASEMENTS	$ 1,069,000
PERMANENT EASEMENTS	$ 16,000
FLOWAGE EASEMENTS	$ 1,566,000
RELOCATION ASSISTANCE	$ 762,000
SEVERANCE DAMAGES	$ 170,000
IMPROVEMENTS	$79,241,000
ADMINISTRATIVE COSTS	$ 930,000
TOTAL	$83,925,000
CONTINGENCIES	$33,570,000
GRAND TOTAL	$117,495,000
SAY	$117,500,000

PLAN NO. 3

This plan is essentially the same as the "without project" scenario. The same real estate involvement is required for this alternative. The work includes: the rehabilitation of the locks and replacement of the dam at L/D 2 at Braddock; the replacement of the locks and dam at L/D 3 at Elizabeth and the rehabilitation of the locks at L/D 4 at Rostraver. The replacement dam at L/D 3 would, because of its smaller size, raise OHW in its pool. Accordingly, flowage easements have to be acquired. Construction of the new lock chambers at L/D 3 requires acquisition and excavation of the land along the upstream approach to the lock. The excavation will affect wildlife. As a result, two sites of fee land have to be acquired for mitigation: one site requires a permanent road easement for access.

Acquisition for all of the structures includes the following: 48.00 acres of fee property affecting three ownerships; 434 acres of temporary work area easements and 33 ownerships; 4 acres and 3 ownerships of permanent easements; 2 acres and 1 ownership of permanent road easement and flowage easements containing approximately 150 acres and 366 ownerships.

PLAN NO. 3

COST ESTIMATE

FEE		$ 521,000
TEMPORARY WORK AREA EASEMENTS		$1,069,000
PERMANENT EASEMENTS		$ 22,700
FLOWAGE EASEMENTS		$2,845,000
RELOCATION ASSISTANCE		$ 612,000
SEVERANCE DAMAGES		$ 145,400
IMPROVEMENTS		$ 588,000
ADMINISTRATIVE COSTS		$2,050,000
	TOTAL	$7,853,100
CONTINGENCIES		$2,134,650
	GRAND TOTAL	$9,987,750
	SAY	10,000,000

PLAN NO. 5

This plan calls for the removal of existing L/D 2 at R.M. 11.2 and the construction of new twin locks and a fixed crest dam at R.M. 22.2. The pool would be lowered 8.7 feet from the existing location upstream to the new site at R.M. 22.2 and raised 8.2 feet from the new site upstream to existing L/D 3 at R.M. 23.8. Lock and Dam 3 would be removed and new twin locks would be constructed at existing L/D 4 at R.M. 41.5. Four fee tracts comprising 31.13 acres would be required for the new locks and dam at R.M. 22.2 while no additional fee land would be required at existing L/D 4; thirty-three temporary work area easement tracts covering 434 acres would be required for disposal and staging areas and approximately 149 permanent flowage easement tracts covering 101 acres would be required for the pool raise.

PLAN NO. 5

COST ESTIMATE

FEE		$ 171,000
TEMPORARY WORK AREA EASEMENTS		$ 1,069,000
PERMANENT EASEMENTS		$ 16,000
FLOWAGE EASEMENTS		$ 1,566,000
RELOCATION ASSISTANCE		$ 762,000
SEVERANCE DAMAGES		$ 170,000
IMPROVEMENTS		$79,241,000
ADMINISTRATIVE COSTS		$ 930,000
	TOTAL	$83,925,000
CONTINGENCIES		$33,570,000
	GRAND TOTAL	$117,495,000
	SAY	$117,500,000

PLAN NO. 6

This plan calls for the rehabilitation of L/D 2 at its existing location at R.M. 11.2 and the construction of a new auxiliary chamber floodway and fixed crest dam. Lock and Dam 3 at R.M. 23.8 would be removed and replaced by new twin locks and gated dam at R.M. 34.0. Existing L/D 4 at R.M. 41.5 would be removed. Existing pool 3 would be lowered 8.2 feet from the existing site at R.M. 23.8 upstream to the new site at R.M. 34.0. The remaining part of existing pool 3 would be raised 16.6 feet from the new site at R.M. 34.0 upstream to existing L/D 4 at R.M. 41.5. One fee tract containing 3 acres is required for the abutment site at existing L/D 2, R.M. 11.2, while 23 tracts covering 60 acres are required for the new site at R.M. 34.0; thirty-three temporary work area easement tracts covering 434 acres are required for disposal and staging areas and 260 permanent flowage easement tracts covering 96 acres are required for the pool raise.

PLAN NO. 6

COST ESTIMATE

FEE		$ 270,000
TEMPORARY WORK AREA EASEMENTS		$1,069,000
FLOWAGE EASEMENTS		$ 256,000
RELOCATION ASSISTANCE		$ 512,000
SEVERANCE DAMAGES		$ 166,000
IMPROVEMENTS		$1,634,000
ADMINISTRATIVE COSTS		$1,395,000
	TOTAL	$5,302,000
CONTINGENCIES		$1,288,000
	GRAND TOTAL	$6,590,000
	SAY	$6,600,000

PLAN NO.7

This plan calls for the rehabilitation of L/D 2 at its existing location at R.M. 11.2 and construction of a new auxiliary chamber floodway and fixed crest dam. Lock and Dam 3 at R.M. 23.8 would be removed and replaced by new twin locks and gated dam at R.M. 34.0. Existing L/D 4 at R.M. 41.5 would be removed. Existing pool 2 would be raised 5 feet while existing pool 3 would be lowered 3.2 feet upstream to the new site at R.M. 34.0. The remaining portion of existing pool 3 would be raised 16.6 feet from the new site at R.M. 34.0 upstream to existing L/D 4 at R.M. 41.5. One fee tract containing 3 acres is required for the abutment site at existing L/D 2, R.M. 11.2; thirty-three temporary work area easement tracts covering 434 acres are required for disposal and staging areas and 320 permanent flowage easement tracts covering 126 acres are required for the raising of pool 2 and part of pool 3. Flowage easements are required only on the non-navigable tributaries of the Monongahela and Youghiogheny Rivers in pool 2.

PLAN NO. 7

COST ESTIMATE

FEE		$ 270,000
TEMPORARY WORK AREA EASEMENTS		$1,069,000
FLOWAGE EASEMENTS		$ 306,000
RELOCATION ASSISTANCE		$ 562,000
SEVERANCE DAMAGES		$ 200,000
IMPROVEMENTS		$1,634,000
ADMINISTRATIVE COSTS		$1,595,000
	TOTAL	$5,636,000
CONTINGENCIES		$1,413,000
	GRAND TOTAL	$7,049,000
	SAY	$7,100,000

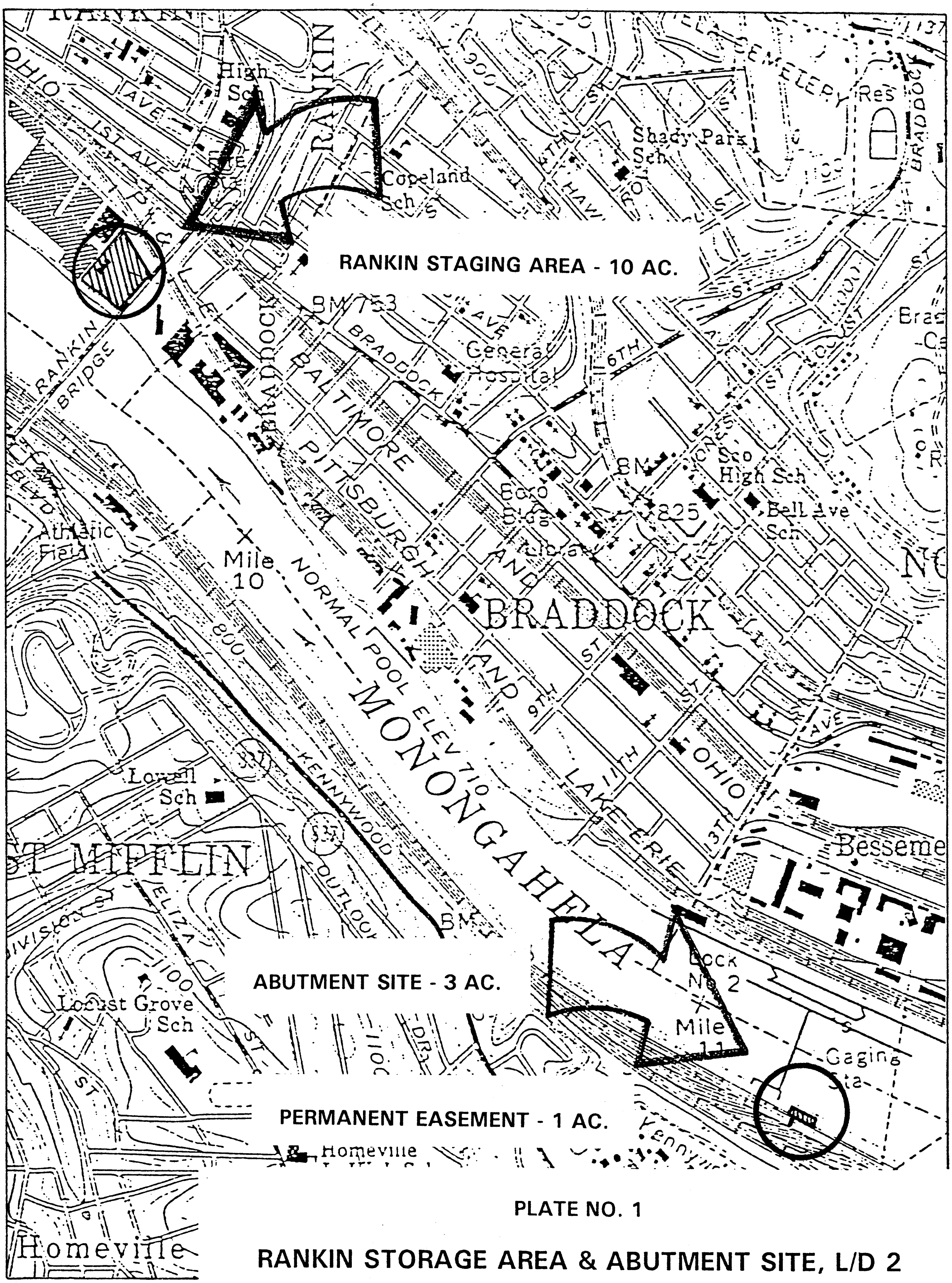


PLATE NO. 1

RANKIN STORAGE AREA & ABUTMENT SITE, L/D 2

1" = 1000'

March 1991

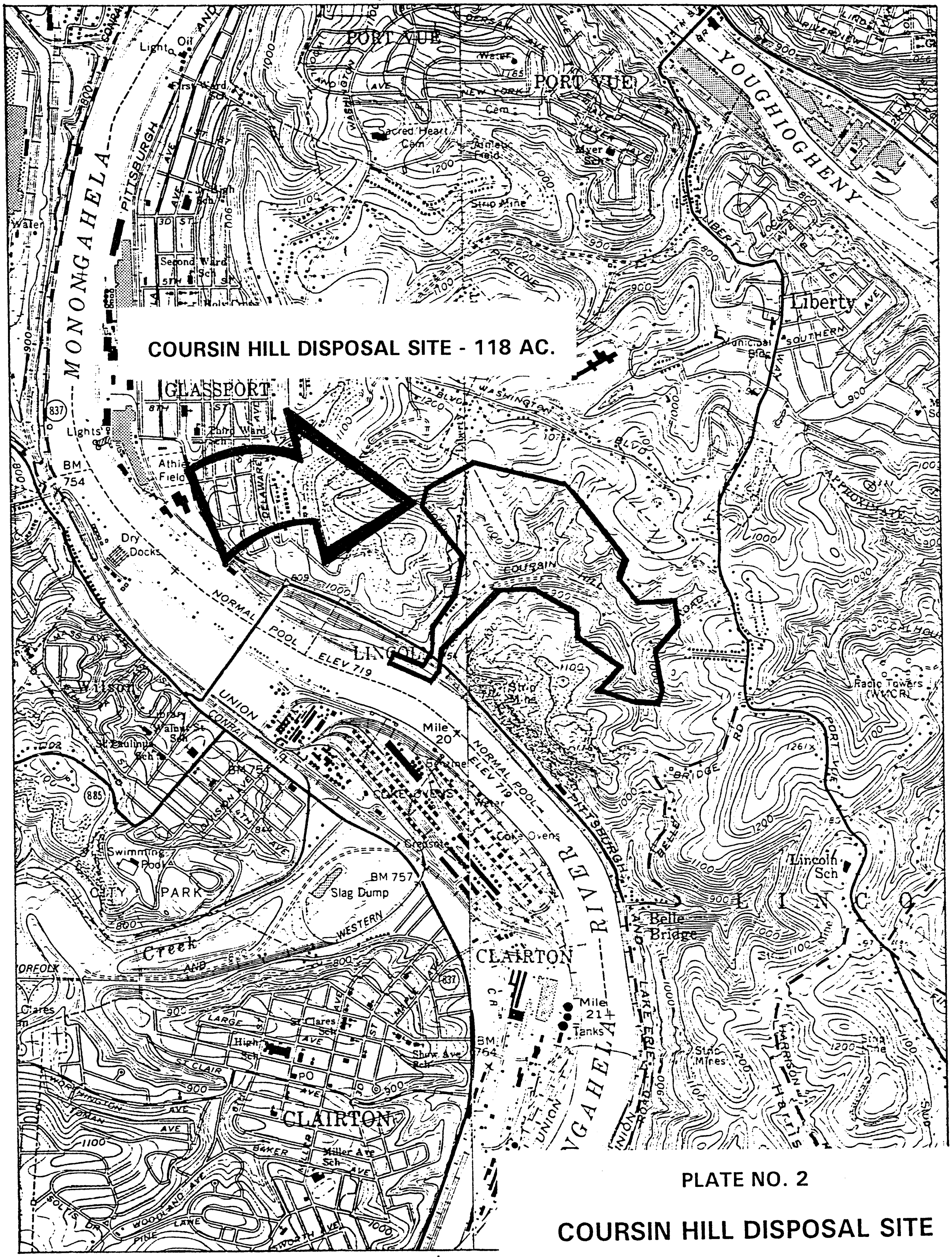


PLATE NO. 2

COURSIN HILL DISPOSAL SITE

1" = 2000'

March 1991

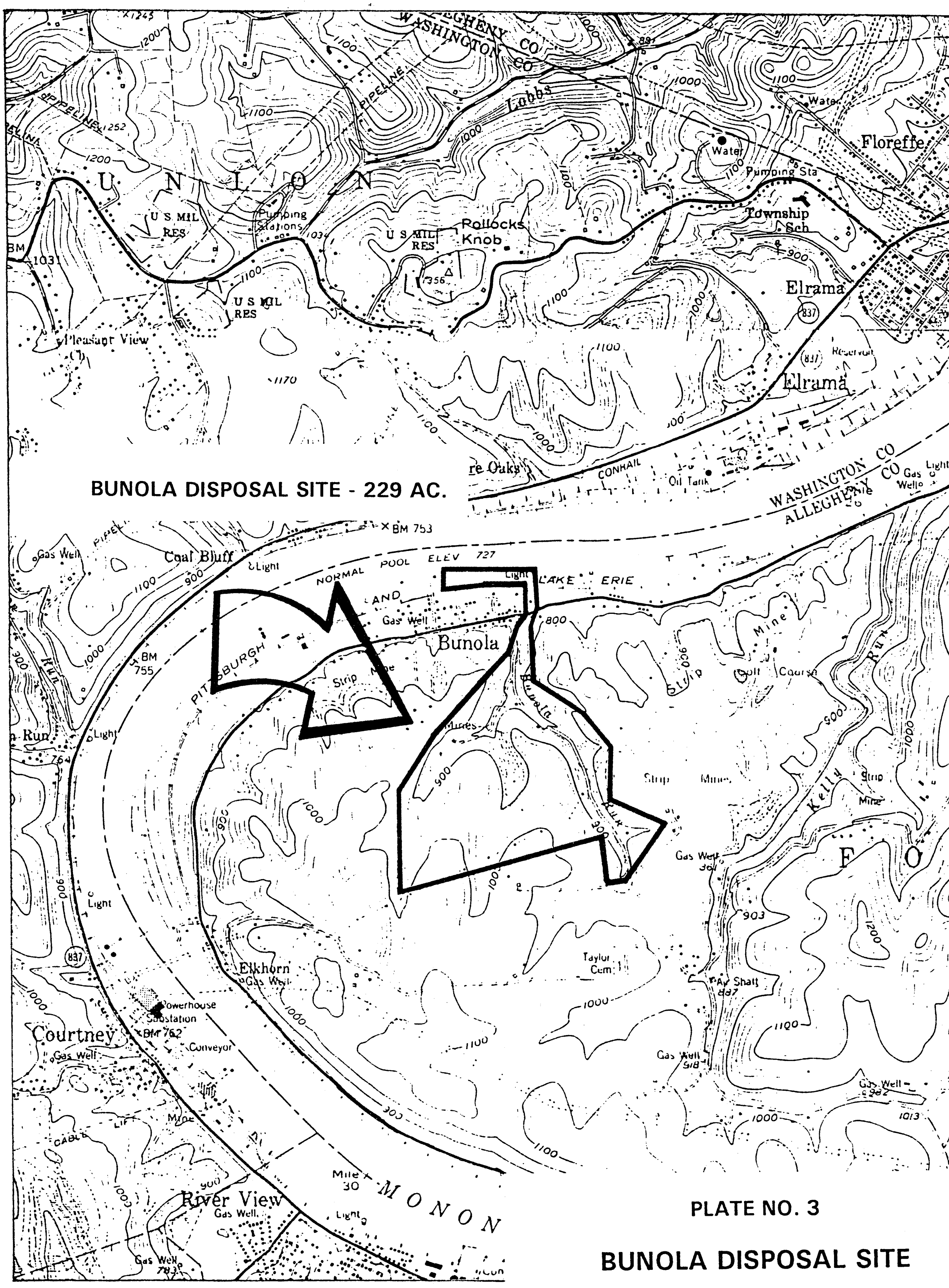


PLATE NO. 3

BUNOLA DISPOSAL SITE

1" = 2000'

March 1991

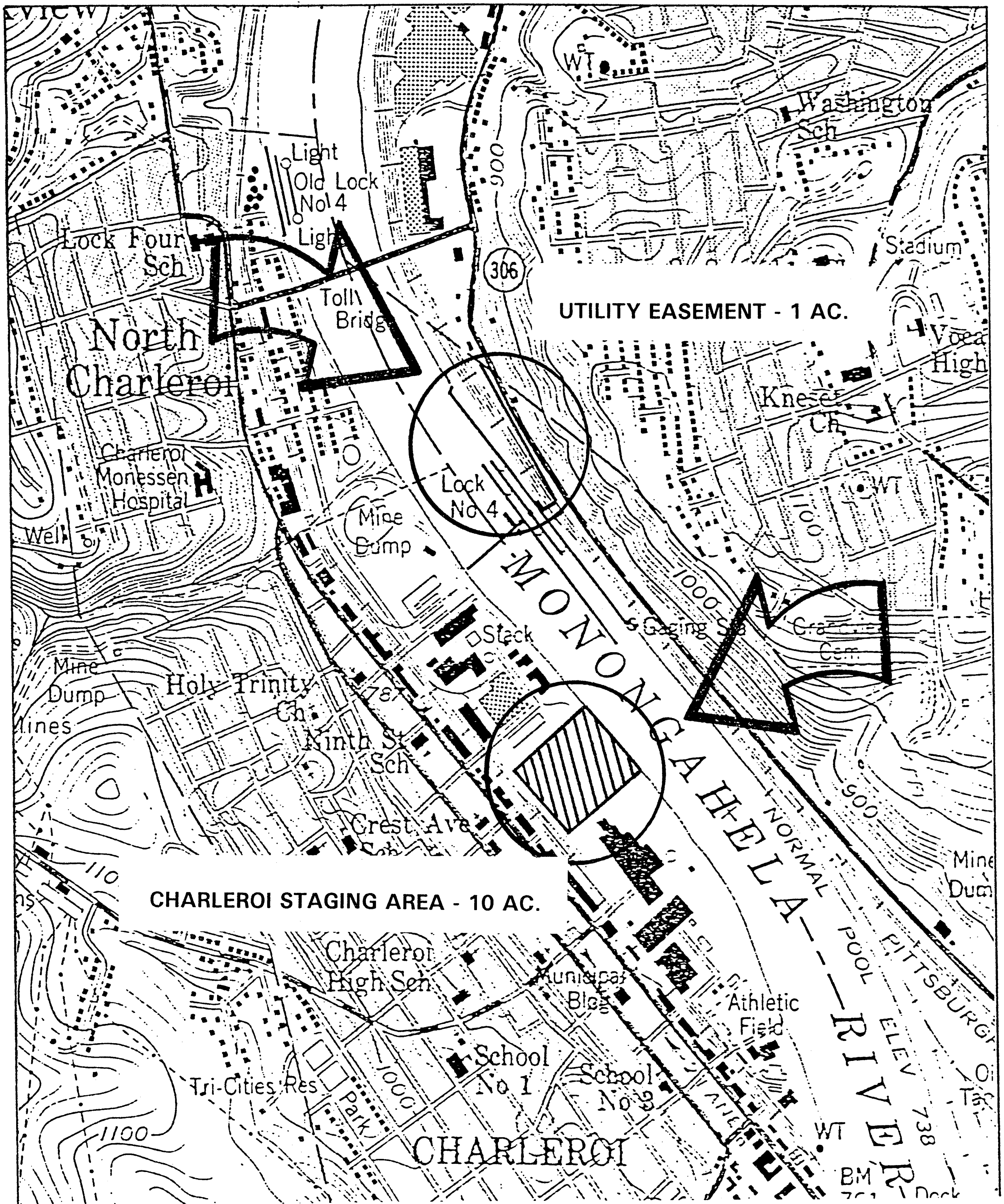


PLATE NO. 4

CHARLEROI STAGING AREA & UTILITY EASEMENT, L/D 4

1" = 1000'

March 1991

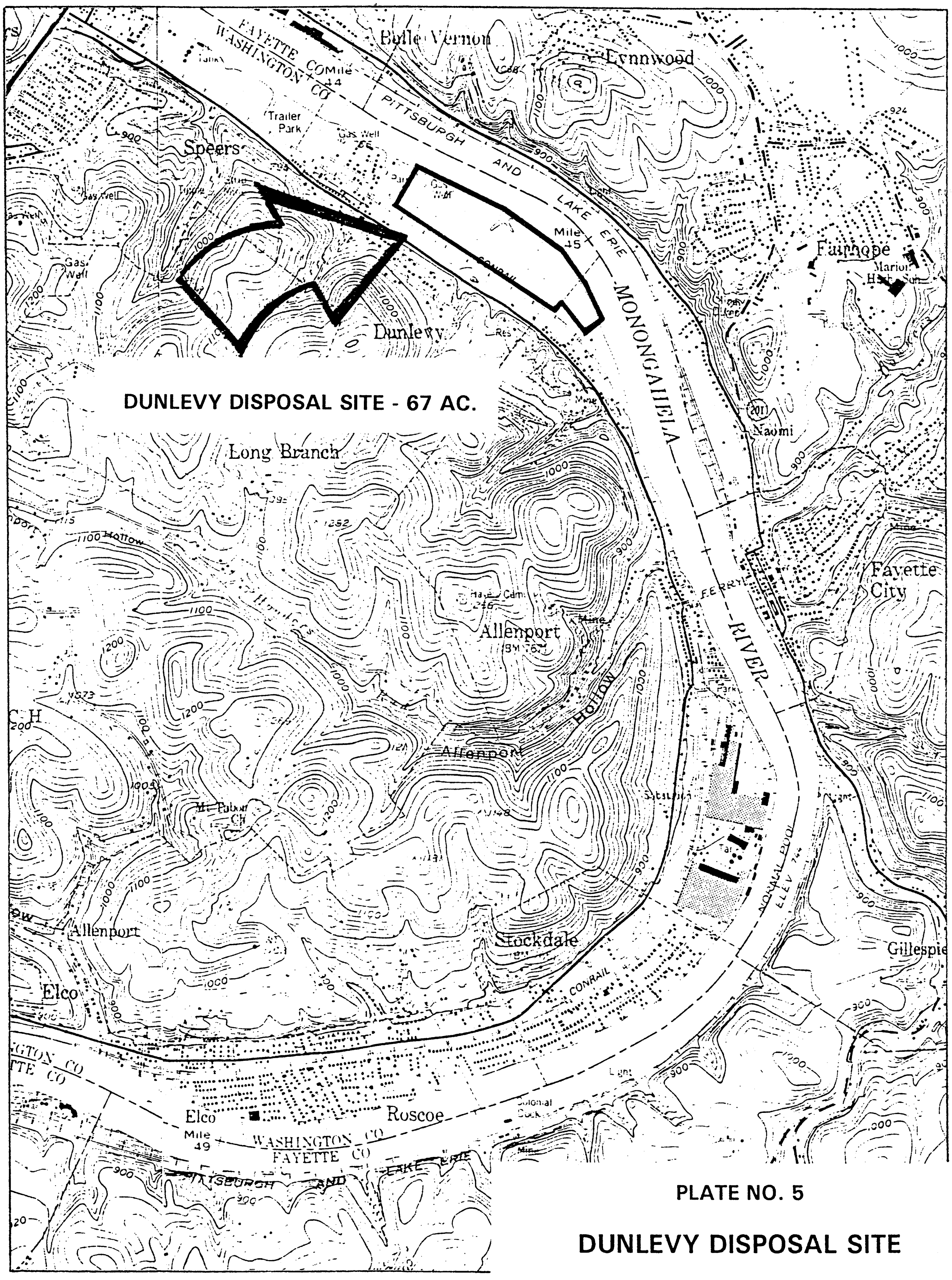
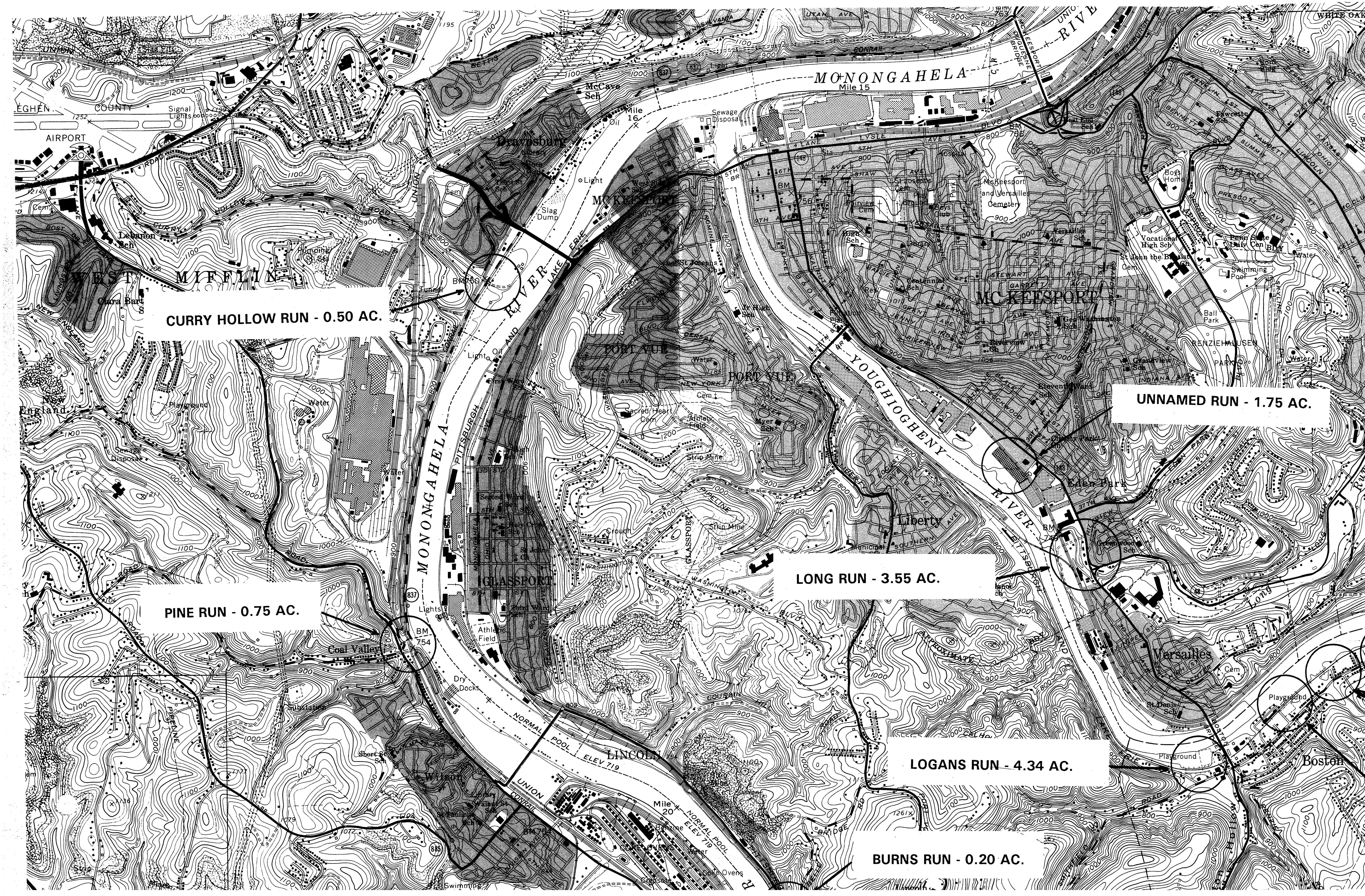


PLATE NO. 5

DUNLEVY DISPOSAL SITE

1" = 2000'

March 1991


CURRY HOLLOW RUN - 0.50 AC.
PINE RUN - 0.75 AC.
UNNAMED RUN - 1.75 AC.
LONG RUN - 3.55 AC.
LOGANS RUN - 4.34 AC.
BURNS RUN - 0.20 AC.
MONONGAHELA RIVER
YOUGHIOGHENY RIVER
MC KEESPORT
PORT VUE
GLASSPORT
WEST MIFFLIN
Dravosburg
Liberty
Versailles
Boston
Coal Valley
Wilson
Lincoln
Eden Park
New England
AIRPORT
RENZIEHAUSEN PARK

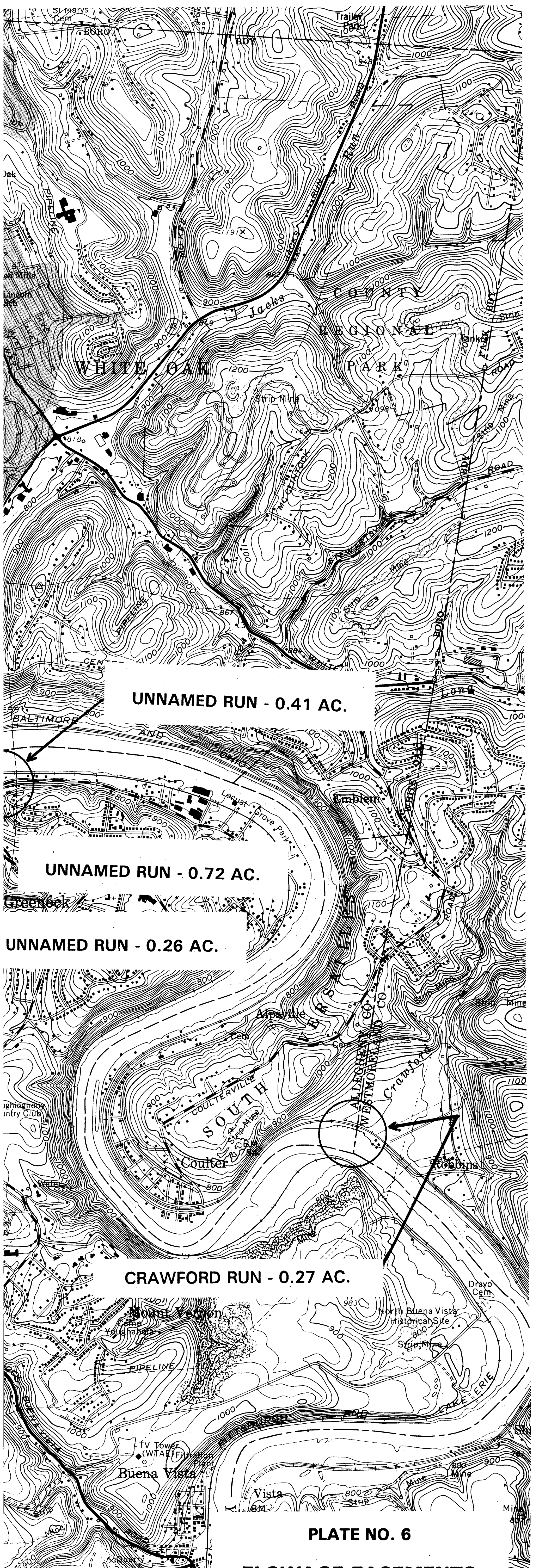
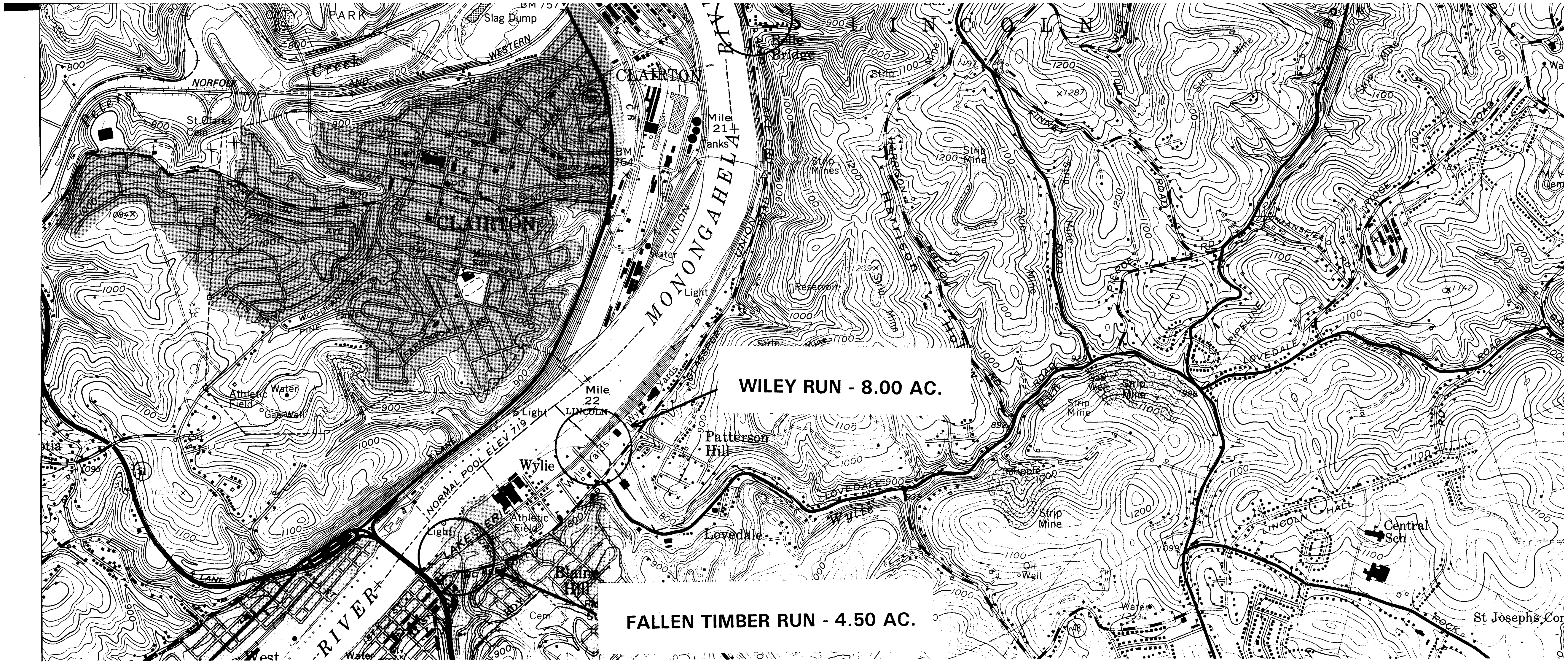


PLATE NO. 6

FLOWAGE EASEMENTS

1" = 2000' March 1991


WILEY RUN - 8.00 AC.
FALLEN TIMBER RUN - 4.50 AC.
CLAIRTON
MONONGAHELA
RIVER
LINCOLN
Patterson Hill
Lovedale
Wylie
Blaine Hill
Central Sch
St Josephs Cem
NORMAL POOL ELEV 719
Mile 22
Mile 21
Slag Dump
Strip Mine
Athletic Field

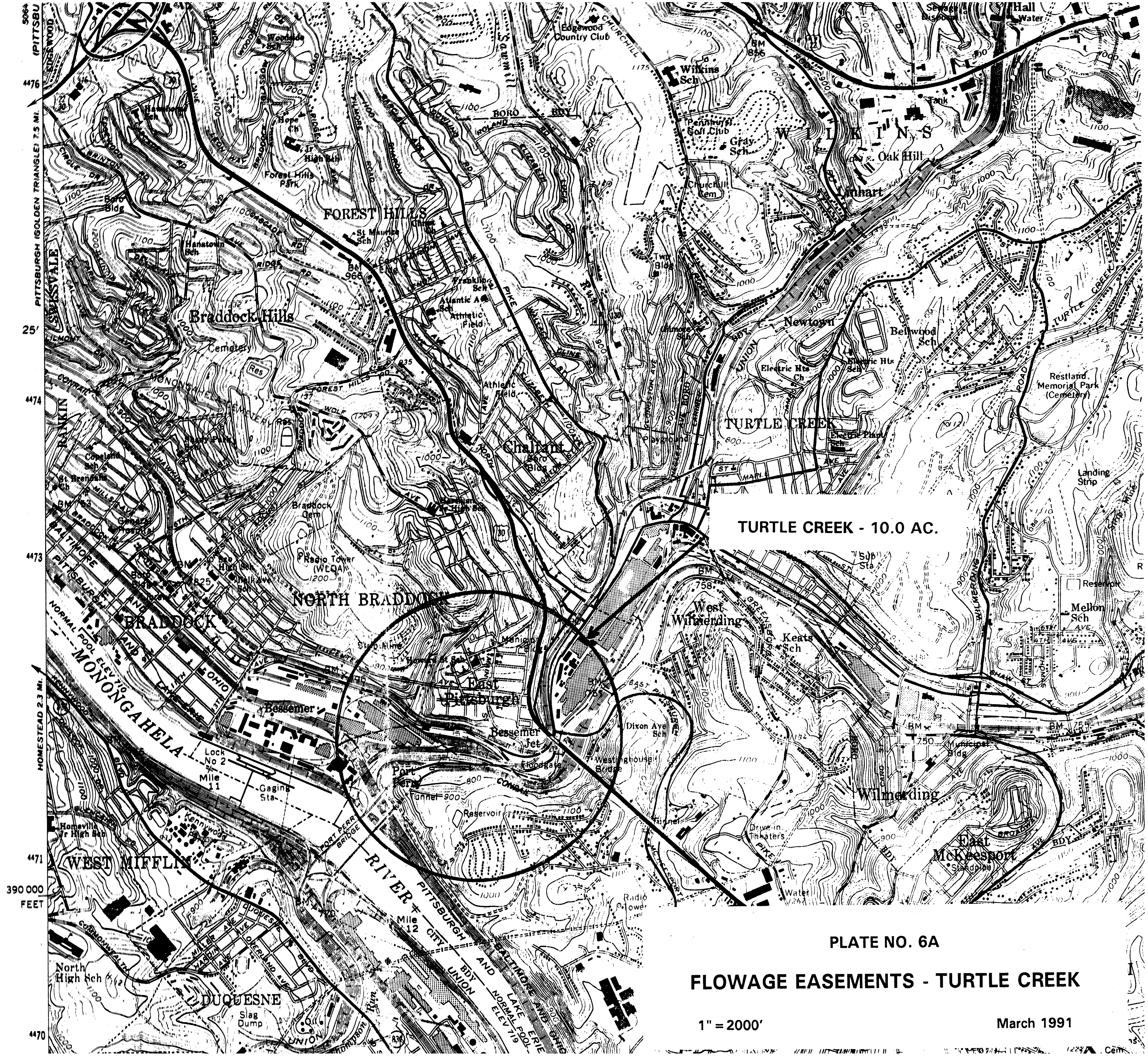


PLATE NO. 6A

FLOWAGE EASEMENTS - TURTLE CREEK

1" = 2000'

March 1991