Chapter 3
Hydraulic Features

Section I
Filling and Emptying

3-1. Project Type

Hydraulic design addresses all features relating to filling and emptying the lock chamber. Decisions based on specific authorization requirements (constraints, Table 2-1) narrow hydraulic options.

a. Maximum navigation lift. This value determines design type as previously shown in Figure 1-2. For maximum lift near 10 ft, conservative design practice is to use a low-lift rather than a very-low-lift design type. Similarly, for maximum lift near 40 ft, conservative practice is to use a high-lift rather than a low-lift design type. For low-usage locks or for projects with significant variation in lift, economic considerations warrant less conservative design. Lifts greater than 100 ft exceed CE operating experience.

b. Chamber navigation constraints. Project identification studies (Chapter 2) identify four constraints relative to chambering:

(1) Vessel characteristics (types, drafts).

(2) Clear chamber width.

(3) Usable chamber length.

(4) Operation time (economics).

These constraints, compared with existing lock data (Appendix B, EP 1105-2-11, item U2, etc.), establish design status compared to CE operating experience. Model- and prototype-tested geometries (see Appendix C and CORPS computer program database H5300) establish status compared to CE verifiable laboratory and field experience. An overview of operating conditions for five specific CE design types is provided in Table 3-1; traffic is different mixes of commercial tows and recreational vessels.

3-2. Design Type

The following designations for type of lock filling systems are used throughout this EM.

LC = loop culvert(s)
LCSG = loop culvert(s) and sector gate
SG = sector gates
SP = side ports
SPF = side ports with flume
MP = multiport system
BL1 = centered lateral-manifolds; one culvert
BL2 = centered lateral-manifolds; two culverts
BLC = centered lateral-manifolds; high-lift modified
SBLC = split lateral-manifolds
OC = longitudinal centered and ported culvert

HB4 = horizontal flow divider; 4 longitudinal manifolds
HB8 = horizontal flow divider; 8 longitudinal manifolds
VB4 = vertical flow divider; 4 longitudinal manifolds
VB8 = vertical flow divider; 8 longitudinal manifolds

New projects are compared in terms of lift, chamber geometry, and navigation constraints with existing designs listed in Table 3-1; however, site-specific conditions may require a different design. For each lift category, the design type is judged as matching, modified, or new as follows.

a. Very-low-lifts (0-10 ft). For matching *sector gate* (SG) designs, sill and floor elevations and gate operation schedules are from specific model-tested designs (Appendix C). Modified designs to accommodate small chamber-dimension changes (when geometric similarity is essentially retained) can be reliably determined from existing designs. New designs (due to unusual or more stringent navigation constraints, untested end-filling devices, or major changes in chamber dimensions) require laboratory testing and evaluation to determine chamber performance. Low-lift design types (*b* below) are conservative alternatives for very-low-lift projects.

b. Low-lifts (10-30/40 ft). For matching or modified *side-port* (SP) designs, sill and floor elevations and valve schedules are from design criteria (see Appendix D). For two-culvert projects the choice of lateral culverts (BL2) as compared to side ports has been an economic consideration (structural cost, chamber maintenance, and excavation costs are major factors); the side-port system is least-cost for the ongoing Gallipolis new main lock (110 by 1,200 ft, 23-ft normal lift). Unfortunately, existing BL2 designs have unfavorable single-culvert operating characteristics which tend to preclude their use for new projects (paragraph 3-3). For one-culvert projects (auxiliary or alternative locks) a lateral design (BL1) is used. Because of the broad extent of testing and experience with these types of locks, a need for a new design is considered unlikely. However, were a site-specific situation to require more rigid requirements on chamber performance or to require alternate culvert geometries (due to an unusual site-specific constraint, for example) then an alternative design could be justified. The alternate design would probably be similar in concept to the existing high-lift designs and would require extensive laboratory testing and evaluation to determine chamber performance (item 74, for example).

c. High-lifts (30/40-100 ft). For matching balanced flow designs for both four manifolds (HB4) and eight manifolds (HB8), sill and floor elevations and valve schedules are from design criteria (see Appendix E). Matching designs must agree in detail; that is, in addition to chamber dimensions, ports, baffles, sills, etc., are to be sized and shaped according to either HB4 or HB8 existing details. The complete culvert-to-chamber (crossover culvert) system must also match in geometric detail. Any change constitutes a modified design which, as for a new high-lift design, requires laboratory testing and evaluation in terms of chamber performance and of reliability and durability of the total design.

3-3. Lateral Culverts

Concepts similar to the BL2 design have been tested and are in operation at numerous projects. Unlike side-port designs, inconsistency in geometric detail for lateral-culvert designs (note BLC, BL1, BL2, and SBLC in Appendix B, Table B-1) precludes the development of broad design criteria. The following factors have caused lateral culverts (including the BL2 design) to be viewed as less acceptable than side-port systems (for low-lift) or longitudinal systems (for high-lift).

a. Slow valving. Four-minute or greater valve times have been used extensively; rapid operation requires more rapid valving.

Table 3-1
Experience with Recommended Designs (Geometries Constructed Since 1950)

Type	No. of Similar Locks	Chamber Clear Width ft	Usable Length ft
	Very-Low-Lift Designs (Maximum Lift[a] < 10 ft)		
Sector gate (SG)	1	86	600
	1	84	600
	1	75	1,200
	1	75	1,150
	1	75	800
	1	56	800
	1	45	800
	7	30	90
	7	30	90
Temporary (SPF)	2	110	1,200
Total	**23**		
	Low-Lift Designs (Maximum Lift[b] < 30/40 ft)		
Side port (SP)	10	110	1,200
	67	110	600
	10	84	600
	22	56	360
Laterals (BL2)	7	110	1,200
	6	110	600
	2	84	720
Laterals (BL1)	7	110	600
Total	**131**		
	High-Lift Designs (Maximum Lift > 40 ft); Longitudinal Manifolds		
4-manifold (HB4)	2	110	600
8-manifold (HB8)	1[c]	86	675
Total	**3**		

Notes:
[a] Lifts greater than 10 ft are experienced at many of these projects.
[b] Lift experienced during actual operations extends up to about 37 ft; commercial traffic is primarily 9-ft-draft tows.
[c] Lower Granite Lock became operational in 1975; tows up to 14-ft draft use this project.

b. Rigid valve times. The valve time established during testing (*a* above) cannot be reduced without a significant deterioration in chamber performance.

c. Harmonic oscillations. Natural oscillations of the chamber water surface appear (item 71) to be excessively stimulated, leading to large hawser forces.

d. Synchronous valving. Any valving other than two-valve fully synchronized valving causes chamber performance to severely deteriorate in terms of oscillations (*c* above) and free tow movement.

3-4. Features

The design considers each of the following six compatible systems.

a. Intake system. Conditions in the upper approach channel are concurrently resolved by hydraulic design, navigation facility and safety, operations, and other multipurpose or multidiscipline concerns. Guide and guard walls are specific items of major concern to navigation. Intake manifold, trash rack, and transition conduit are hydraulic design features.

b. Filling valve system. Valve design is a hydraulic concern as are the valve well, bulkheads, air vent, and flow-passage designs. Hydraulic loadings required for structural and mechanical detail design are required in addition to flow parameters needed solely for lock filling and emptying.

c. Culvert-to-chamber system. The culvert, manifold(s), ports, and transitions are hydraulic design features. Chamber navigation conditions (expressed as turbulence, hawser stress, and vessel drift) are highly influenced by culvert-to-chamber geometry.

d. Chamber system. Features making up the lock chamber, such as the upper and lower gates and navigation and operation aids, are concurrently resolved by hydraulic design, navigation facility and safety, operations, and other design functions. The lock sill and chamber floor elevations, manifold recesses, and baffles are hydraulic features.

e. Emptying valve system. The listing of features is the same as for the filling valve (see *b* above).

f. Outlet system. Conditions within the lower approach channel are, as for the upper approach, multipurpose and multidiscipline concerns. The transition conduit and outlet manifold and baffles and energy dissipator are hydraulic design features.

The features within each system are modified during design for each site-specific lock. The systems for each basic design type (very-low-lift, low-lift, and high-lift locks) are distinctly different; and within each design type, certain features are varied when necessary to resolve project constraints.

3-5. Recent Designs

Projects of each of the seven design types listed in Table 3-1 have recently been designed. Each of the types and the corresponding feature locations (paragraph 3-4) are shown in Plates 3-1 through 3-8 as summarized in Table 3-2. The vertically split balanced flow system was evaluated for the New Bonneville lock, item 89, for both 4 and 8 manifold systems.

Section II
Appurtenant Concerns

3-6. General

Constraints, such as those listed previously in Table 2-1, result in design features that are resolved concurrently with the design of the basic filling-and-emptying system. Constraints and resulting features vary on a project-to-project basis; specific needs leading to common appurtenant concerns are described in the following paragraphs with design detail for major items included in Chapter 7.

Table 3-2
Design Types and Example Project Locations

Plate No.	Design Type Symbol	Design Type	Project Lock	Key Reference Studies Item, Appendix A
3-1	SG	Sector Gate	Vermilion; Gulf Intracoastal Waterway	20: WES TM 2-309 36: WES TR 2-556
3-3	SP	Side Port	Willow Island Main	51: WES TR 2-678
			Lock; Ohio River	57: WES TR 2-713
3-4	SP	Side Port	Ozark; Arkansas River	61: WES TR 2-743 72: WES MP H-75-7
3-5	BL2	Bottom Lateral (2 culverts)	Belleville Main Lock; Ohio River	46: STP No. 66 43: STP No. 74
3-6	BL1	Bottom Lateral (1 culvert)	Willow Island Auxiliary; Ohio River	17: STP No. 52 23: STP No. 59
3-7	VB4	Vertically Split Balanced Flow (4 Manifolds)	Bay Springs; Tenn-Tombigbee Waterway	78: WES TR H-78-19
3-8	VB8	Vertically Split Balanced Flow (8 manifolds)	Lower Granite; Snake River	79: BHL TR No. 126-1

3-7. Navigation Aids

These devices are recessed into the lock wall, flush-mounted on the wall face, or located on the upper surface of the wall. The objective is to provide assistance to navigation (for all anticipated vessel types) commensurate with clear chamber width and minimum maintenance. Examples are floating mooring bitts, ladders, line hooks, check posts, ring bolts, and staff gages.

3-8. Surge Reduction

Currents and water-surface elevations in the upper and lower approaches to the chamber are major concerns to navigation. For canals and smaller waterways these surge effects, during both filling-and-emptying, are severe constraints to hydraulic design (EM 1110-2-1606). Coordination involving both navigation (EM 1110-2- 1611) and hydraulic studies is needed in order to determine locations of intakes and outlets, alignment and types of guide and guard walls, and geometries of the approach canals such that surge effects are acceptable to navigation. In the event that these effects cannot be resolved at acceptable costs, then the hydraulic filling or emptying operation times may be extended either by valving or by using a less efficient hydraulic system. Alternatives to slowing the systems, such as using storage basins (surge reduction basins) adjacent to intakes or outlets, are noted in Chapter 5.

3-9. Impact Barriers

Protection of the upper or lower gates from collision by navigation vessels is the primary objective. Wood, rubber, and metal fenders and bumpers are used on gates, on key locations along guide and guard walls, and on the exposed surfaces of the recessed gates as inexpensive and repairable energy absorbers. Protective equipment is discussed in EM 1110-2-2602.

3-10. Water Saving

Environmental or economic factors may require design features directed toward minimizing the quantity of water transferred during lockage. The problem is addressed at three stages in project life:

a. Preliminary studies for the selection of number of chambers and chamber sizes may result in including either a small hydraulic lock or a mechanical lift for smaller (normally recreational) vessels.

b. During design, consideration of either adding an extra set of lower gates (to permit fractional chamber operation) or including a water-saving chamber (to permit saving a fraction of the water normally lost during emptying for use during filling) may be warranted. Neither has been feasible for CE locks. Staged-lifts (item 07) normally use less water than single-lift locks at an expense in operating costs and transit time.

c. During operation, lockage procedures directed toward reducing the number of operations required for passing a mix of vessel sizes result in water-savings benefits.

3-11. Dewatering

Maintenance is the primary objective. Scheduled inspections require full and partial dewatering of the lock chamber and most flow passages. Provisions to facilitate pumping for elevations below lower pool should be provided. Closure is during static conditions and is normally accomplished by means of bulkheads. Canal bulkheads above and below the upper and lower, respectively, chamber gates are used to isolate the chamber gates. Culvert bulkheads above and below each valve are used to isolate the culvert valves. Hydraulic design emphasis, particularly for high-lift locks, is to shape and locate the culvert bulkhead slots for minimum disturbance to the flow with no cavitation at the boundary while satisfying sealing and structural requirements during closure.

3-12. Emergency Closure

Risk associated with failure of the upper miter gates may justify the installation of devices for closure of the chamber during free-surface flow directly over the upper sill. Various closure devices are available as described in EM 1110-2-2703 and EM 1110-2-2602. For a highly developed waterway, such as areas along the middle reaches of the Ohio River, significant monetary losses and other hazards could result from unrestricted flow. The three principal sources of loss are:

a. Loss of pool upstream from the lock.

b. Possible flood damage downstream from the lock.

c. Loss to shipping, recreation, and other project purposes on both pools, particularly in the upstream pool.

The high-lift locks and dams along the Columbia and Snake Rivers in Washington and Oregon provide a contrast to the Ohio River emergency situation. These dams create relatively large deep reservoirs that are used to produce hydropower. Free flow through a lock at one of these projects does not constitute a major portion of the total riverflow and the loss of reservoir storage results primarily in a loss of power production.

3-13. Debris Control

Material that drifts along waterways includes sediment, damaged barges, timber, ice floes, etc. Chamber siting and guide and guard wall design (see EM 1110-2-1611) influence the extent to which waterway debris tends to enter the upper approach. These materials are of concern to navigation; valve, gate, and flow passage operation; and general maintenance of chamber and approaches.

Primary hydraulic concerns are:

a. Flow patterns and operational procedures directed toward flushing surface (floating) material over the upper sill, through the lock chamber, and out of the lower approach.

b. Trash bars and trashracks at culvert intakes designed for exclusion of submerged materials from the filling-and-emptying system.

c. Selection and design of the gates (see EM 1110-2-2703) and sills for reliable operation in the presence of both surface and submerged debris and for maintenance removal of unusual materials.

d. Identification of locations along the flow passage boundaries and the chamber floor at which long-term accumulations, physical damage, and other major inspection and maintenance concerns exist.

3-14. Ice Control

Recent interest in year-round navigation has led to specialized studies of winter lockage problems. The interest is directed toward navigation problems in general and includes lock design and maintenance techniques. These are reviewed in Chapter 7 and specific guidance is included in EM 1110-2-1612.

SECTOR GATE LOCK
(SG)

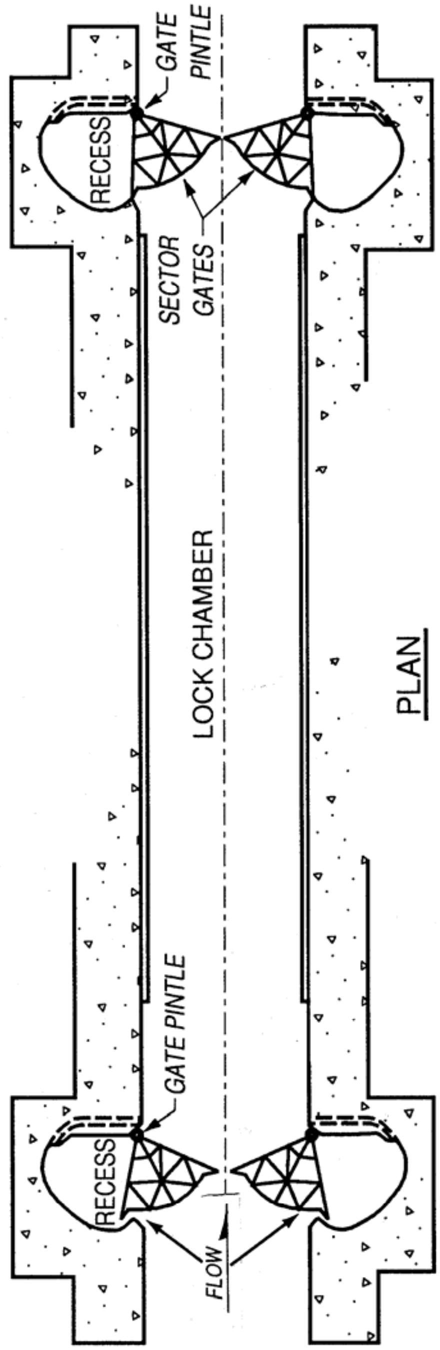


Plate 3-1

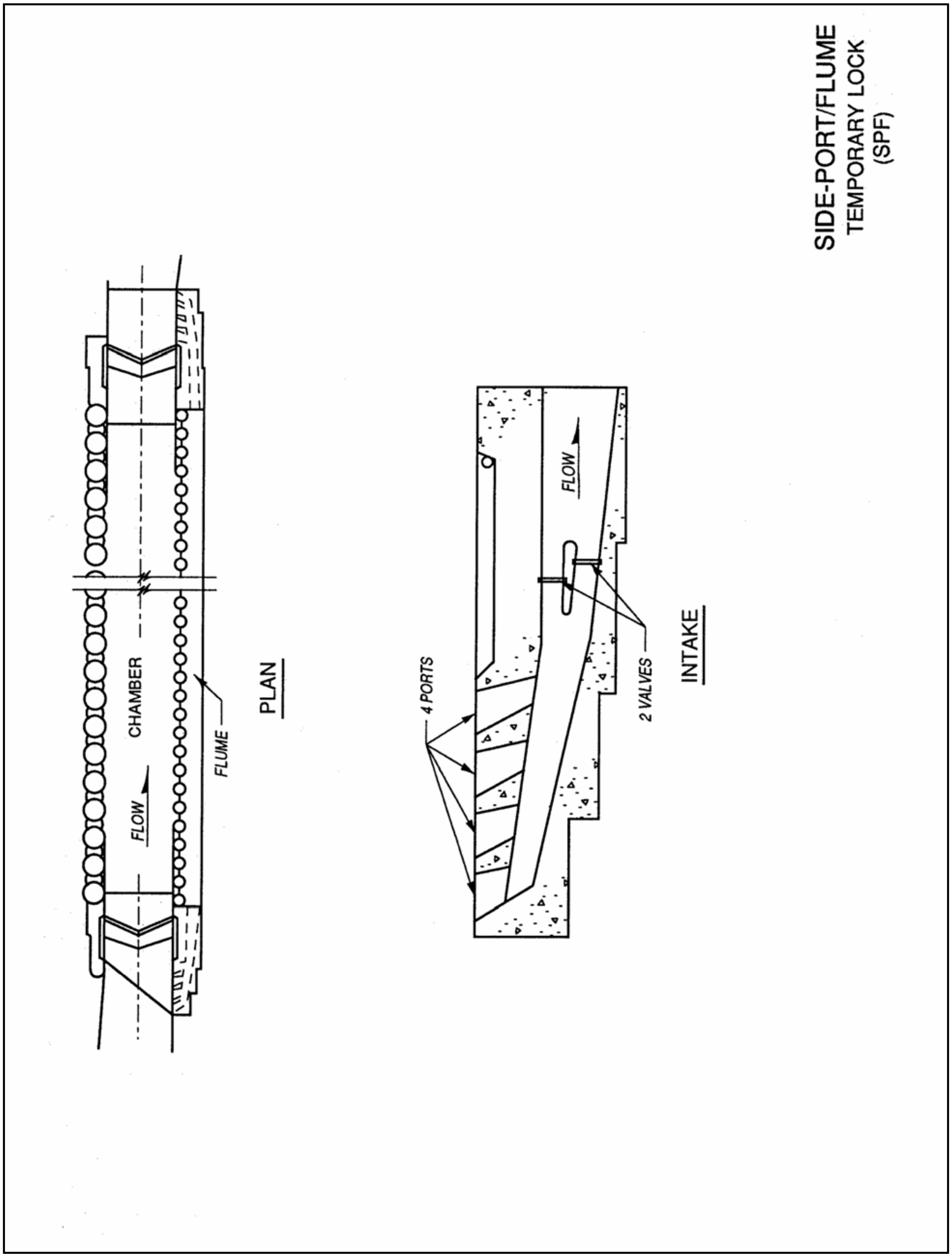

SIDE-PORT/FLUME
TEMPORARY LOCK
(SPF)
CHAMBER
FLOW
FLUME
PLAN
4 PORTS
FLOW
2 VALVES
INTAKE

Plate 3-2

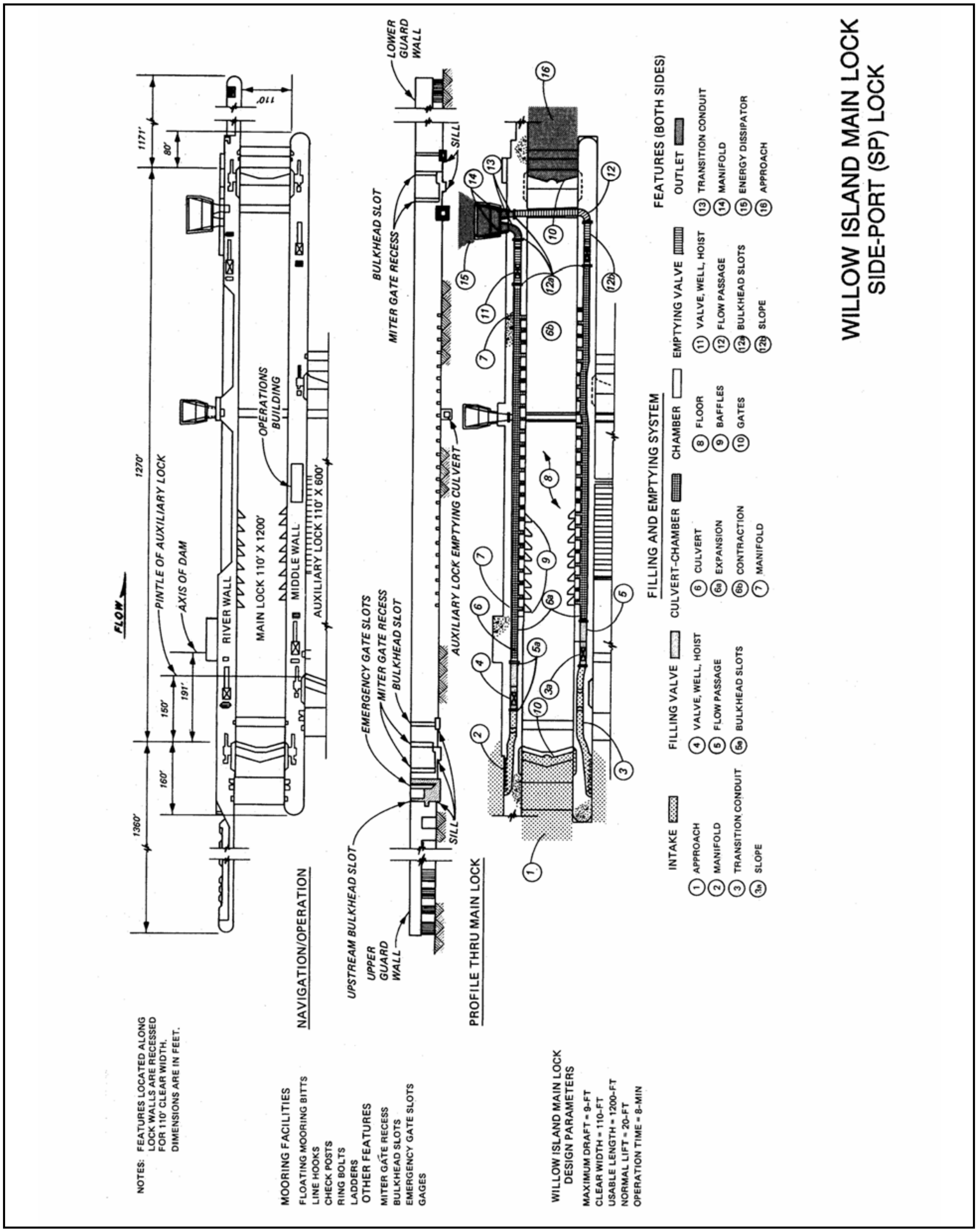

NOTES: FEATURES LOCATED ALONG LOCK WALLS ARE RECESSED FOR 110' CLEAR WIDTH. DIMENSIONS ARE IN FEET.
FLOW
1360'
1270'
1171'
160'
150'
191'
80'
110'
PINTLE OF AUXILIARY LOCK
AXIS OF DAM
RIVER WALL
MAIN LOCK 110' X 1200'
OPERATIONS BUILDING
MIDDLE WALL
AUXILIARY LOCK 110' X 600'
NAVIGATION/OPERATION
MOORING FACILITIES
FLOATING MOORING BITTS
LINE HOOKS
CHECK POSTS
RING BOLTS
LADDERS
OTHER FEATURES
MITER GATE RECESS
BULKHEAD SLOTS
EMERGENCY GATE SLOTS
GAGES
UPSTREAM BULKHEAD SLOT
UPPER GUARD WALL
EMERGENCY GATE SLOTS
MITER GATE RECESS
BULKHEAD SLOT
SILL
AUXILIARY LOCK EMPTYING CULVERT
BULKHEAD SLOT
MITER GATE RECESS
SILL
LOWER GUARD WALL
PROFILE THRU MAIN LOCK
WILLOW ISLAND MAIN LOCK DESIGN PARAMETERS
MAXIMUM DRAFT = 9-FT
CLEAR WIDTH = 110-FT
USABLE LENGTH = 1200-FT
NORMAL LIFT = 20-FT
OPERATION TIME = 8-MIN
FILLING AND EMPTYING SYSTEM
INTAKE
1 APPROACH
2 MANIFOLD
3 TRANSITION CONDUIT
3a SLOPE
FILLING VALVE
4 VALVE, WELL, HOIST
5 FLOW PASSAGE
5a BULKHEAD SLOTS
CULVERT-CHAMBER
6 CULVERT
6a EXPANSION
6b CONTRACTION
7 MANIFOLD
CHAMBER
8 FLOOR
9 BAFFLES
10 GATES
EMPTYING VALVE
11 VALVE, WELL, HOIST
12 FLOW PASSAGE
12a BULKHEAD SLOTS
12b SLOPE
FEATURES (BOTH SIDES)
OUTLET
13 TRANSITION CONDUIT
14 MANIFOLD
15 ENERGY DISSIPATOR
16 APPROACH
WILLOW ISLAND MAIN LOCK
SIDE-PORT (SP) LOCK

Plate 3-3

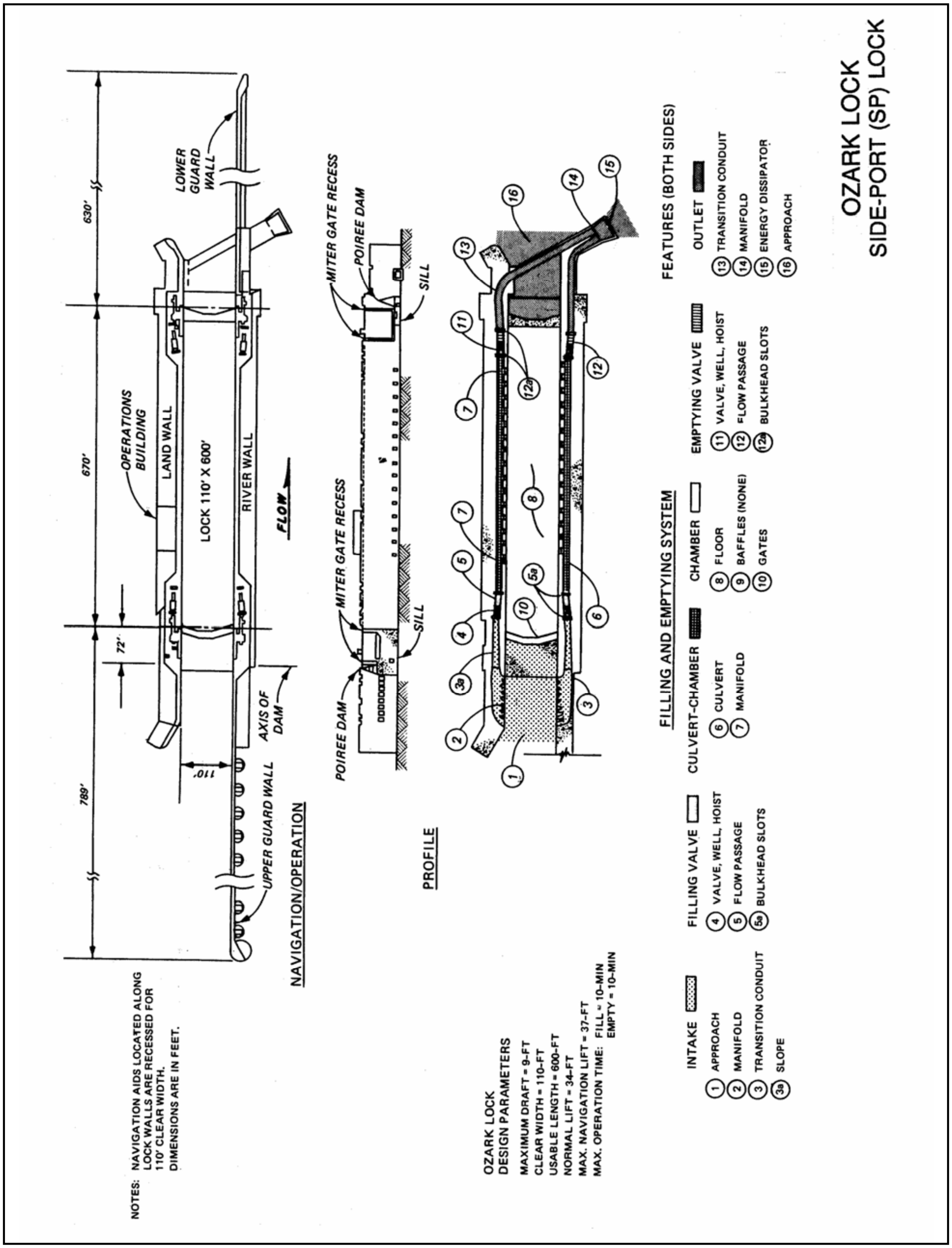
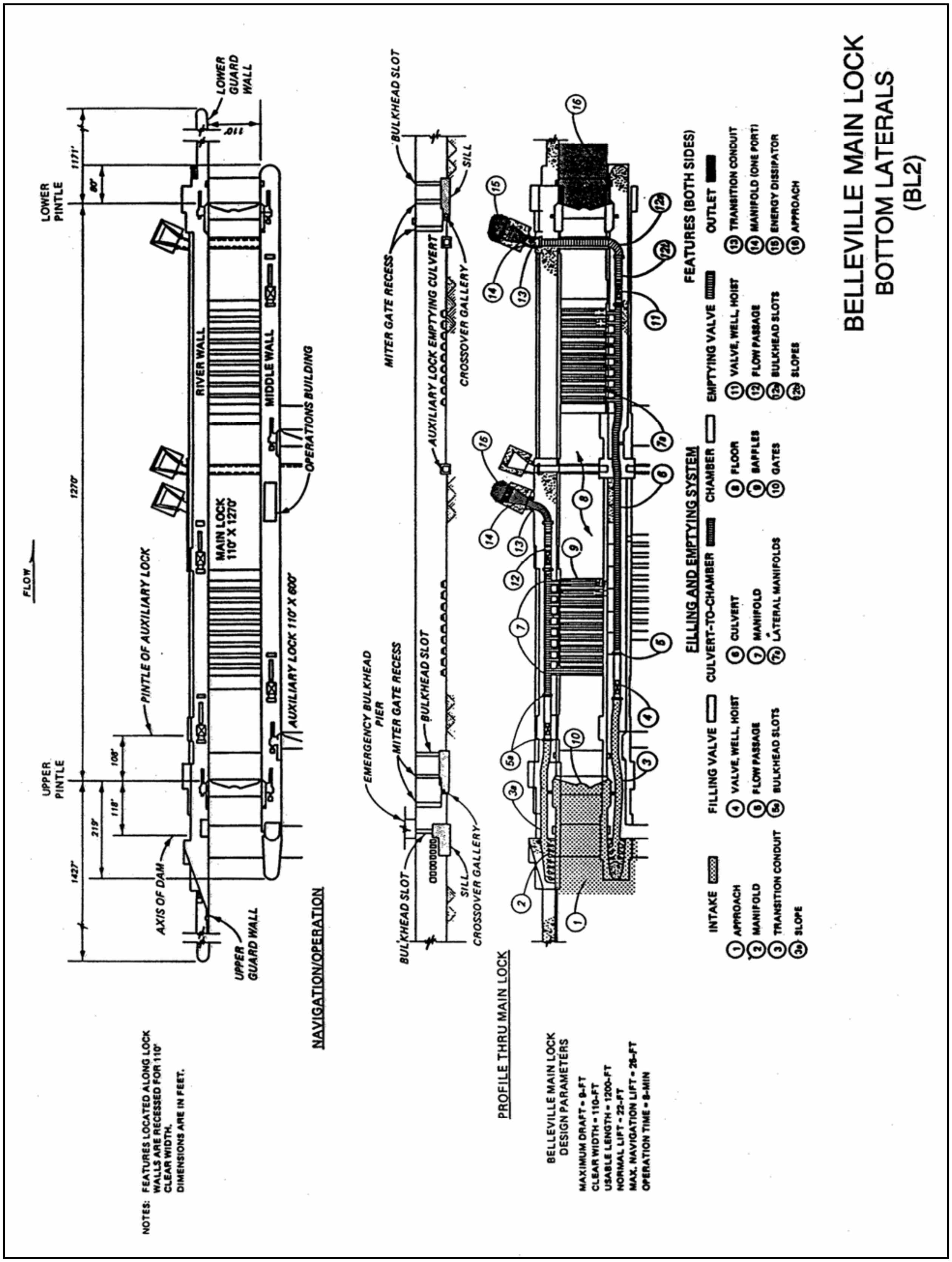

OZARK LOCK
SIDE-PORT (SP) LOCK
NOTES: NAVIGATION AIDS LOCATED ALONG LOCK WALLS ARE RECESSED FOR 110' CLEAR WIDTH.
DIMENSIONS ARE IN FEET.
789'
670'
630'
72'
110'
LOWER GUARD WALL
OPERATIONS BUILDING
LAND WALL
LOCK 110' X 600'
RIVER WALL
FLOW
AXIS OF DAM
UPPER GUARD WALL
NAVIGATION/OPERATION
MITER GATE RECESS
POIREE DAM
SILL
PROFILE
OZARK LOCK
DESIGN PARAMETERS
MAXIMUM DRAFT = 9-FT
CLEAR WIDTH = 110-FT
USABLE LENGTH = 600-FT
NORMAL LIFT = 34-FT
MAX. NAVIGATION LIFT = 37-FT
MAX. OPERATION TIME: FILL = 10-MIN
EMPTY = 10-MIN
FILLING AND EMPTYING SYSTEM
INTAKE
1 APPROACH
2 MANIFOLD
3 TRANSITION CONDUIT
3a SLOPE
FILLING VALVE
4 VALVE, WELL, HOIST
5 FLOW PASSAGE
5a BULKHEAD SLOTS
CULVERT-CHAMBER
6 CULVERT
7 MANIFOLD
CHAMBER
8 FLOOR
9 BAFFLES (NONE)
10 GATES
EMPTYING VALVE
11 VALVE, WELL, HOIST
12 FLOW PASSAGE
12a BULKHEAD SLOTS
FEATURES (BOTH SIDES)
OUTLET
13 TRANSITION CONDUIT
14 MANIFOLD
15 ENERGY DISSIPATOR
16 APPROACH

Plate 3-4


BELLEVILLE MAIN LOCK
BOTTOM LATERALS
(BL2)
NAVIGATION/OPERATION
PROFILE THRU MAIN LOCK
FLOW
LOWER PINTLE
UPPER PINTLE
LOWER GUARD WALL
UPPER GUARD WALL
AXIS OF DAM
PINTLE OF AUXILIARY LOCK
RIVER WALL
MIDDLE WALL
MAIN LOCK 110' X 1270'
AUXILIARY LOCK 110' X 600'
OPERATIONS BUILDING
1427'
219'
118'
106'
1270'
80'
1171'
110'
BULKHEAD SLOT
MITER GATE RECESS
EMERGENCY BULKHEAD PIER
SILL
CROSSOVER GALLERY
AUXILIARY LOCK EMPTYING CULVERT
FILLING AND EMPTYING SYSTEM
INTAKE
1 APPROACH
2 MANIFOLD
3 TRANSITION CONDUIT
3a SLOPE
FILLING VALVE
4 VALVE, WELL, HOIST
5 FLOW PASSAGE
5a BULKHEAD SLOTS
CULVERT-TO-CHAMBER
6 CULVERT
7 MANIFOLD
7a LATERAL MANIFOLDS
CHAMBER
8 FLOOR
9 BAFFLES
10 GATES
EMPTYING VALVE
11 VALVE, WELL, HOIST
12 FLOW PASSAGE
12a BULKHEAD SLOTS
12b SLOPES
OUTLET
13 TRANSITION CONDUIT
14 MANIFOLD (ONE PORT)
15 ENERGY DISSIPATOR
16 APPROACH
FEATURES (BOTH SIDES)
NOTES: FEATURES LOCATED ALONG LOCK WALLS ARE RECESSED FOR 110' CLEAR WIDTH.
DIMENSIONS ARE IN FEET.
BELLEVILLE MAIN LOCK DESIGN PARAMETERS
MAXIMUM DRAFT = 9-FT
CLEAR WIDTH = 110-FT
USABLE LENGTH = 1200-FT
NORMAL LIFT = 22-FT
MAX. NAVIGATION LIFT = 26-FT
OPERATION TIME = 8-MIN

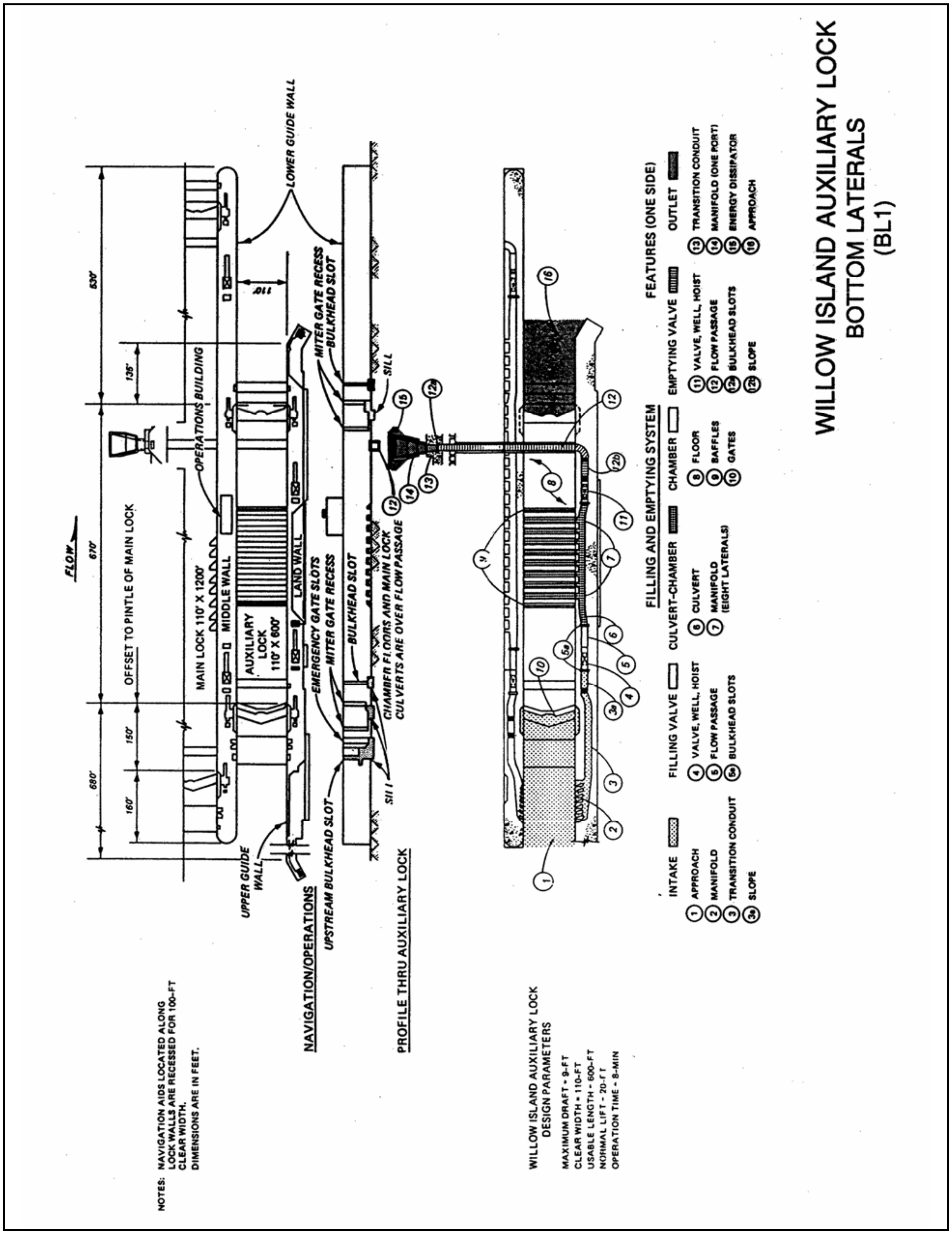
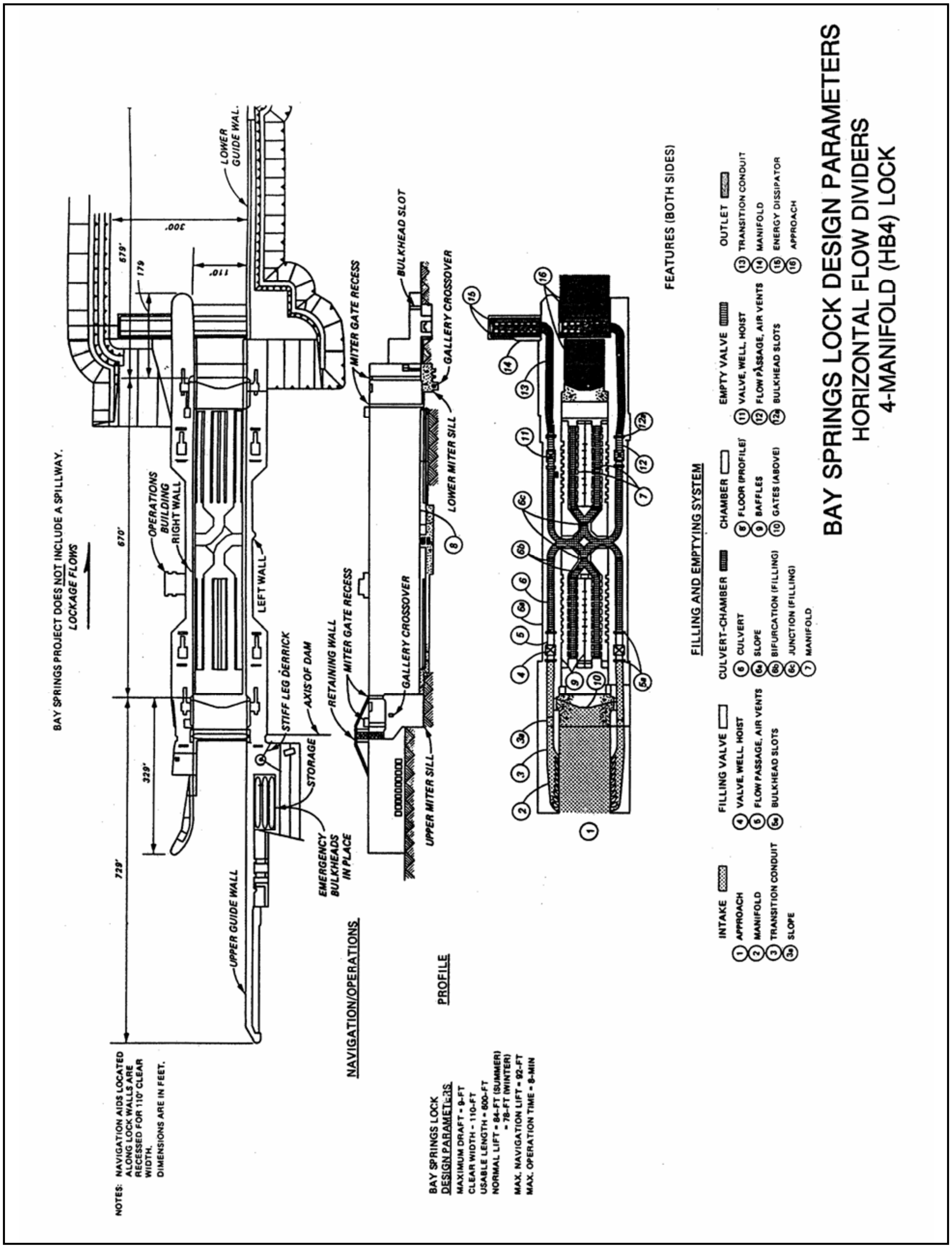

WILLOW ISLAND AUXILIARY LOCK
BOTTOM LATERALS
(BL1)
NOTES: NAVIGATION AIDS LOCATED ALONG LOCK WALLS ARE RECESSED FOR 100-FT CLEAR WIDTH.
DIMENSIONS ARE IN FEET.
NAVIGATION/OPERATIONS
PROFILE THRU AUXILIARY LOCK
WILLOW ISLAND AUXILIARY LOCK
DESIGN PARAMETERS
MAXIMUM DRAFT - 9-FT
CLEAR WIDTH - 110-FT
USABLE LENGTH - 600-FT
NORMAL LIFT - 20-FT
OPERATION TIME - 8-MIN
FLOW
OFFSET TO PINTLE OF MAIN LOCK
680'
160'
150'
670'
135'
530'
110'
MAIN LOCK 110' X 1200'
MIDDLE WALL
AUXILIARY LOCK 110' X 600'
LAND WALL
OPERATIONS BUILDING
UPPER GUIDE WALL
LOWER GUIDE WALL
UPSTREAM BULKHEAD SLOT
EMERGENCY GATE SLOTS
MITER GATE RECESS
BULKHEAD SLOT
MITER GATE RECESS
BULKHEAD SLOT
CHAMBER FLOORS AND MAIN LOCK CULVERTS ARE OVER FLOW PASSAGE
SILL
SILL
INTAKE
1 APPROACH
2 MANIFOLD
3 TRANSITION CONDUIT
3a SLOPE
FILLING VALVE
4 VALVE, WELL, HOIST
5 FLOW PASSAGE
5a BULKHEAD SLOTS
FILLING AND EMPTYING SYSTEM
CULVERT-CHAMBER
6 CULVERT
7 MANIFOLD (EIGHT LATERALS)
CHAMBER
8 FLOOR
9 BAFFLES
10 GATES
EMPTYING VALVE
11 VALVE, WELL, HOIST
12 FLOW PASSAGE
12a BULKHEAD SLOTS
12b SLOPE
FEATURES (ONE SIDE)
OUTLET
13 TRANSITION CONDUIT
14 MANIFOLD (ONE PORT)
15 ENERGY DISSIPATOR
16 APPROACH

Plate 3-6


BAY SPRINGS PROJECT DOES NOT INCLUDE A SPILLWAY.
LOCKAGE FLOWS
NOTES: NAVIGATION AIDS LOCATED ALONG LOCK WALLS ARE RECESSED FOR 110' CLEAR WIDTH.
DIMENSIONS ARE IN FEET.
729'
670'
579'
329'
179
300'
110'
OPERATIONS BUILDING
RIGHT WALL
UPPER GUIDE WALL
LOWER GUIDE WAL.
LEFT WALL
STIFF LEG DERRICK
STORAGE
AXIS OF DAM
EMERGENCY BULKHEADS IN PLACE
NAVIGATION/OPERATIONS
RETAINING WALL
MITER GATE RECESS
MITER GATE RECESS
GALLERY CROSSOVER
BULKHEAD SLOT
UPPER MITER SILL
LOWER MITER SILL
GALLERY CROSSOVER
PROFILE
BAY SPRINGS LOCK
DESIGN PARAMETERS
MAXIMUM DRAFT = 9-FT
CLEAR WIDTH - 110-FT
USABLE LENGTH = 600-FT
NORMAL LIFT = 84-FT (SUMMER)
= 78-FT (WINTER)
MAX. NAVIGATION LIFT = 92-FT
MAX. OPERATION TIME = 8-MIN
FEATURES (BOTH SIDES)
FILLING AND EMPTYING SYSTEM
INTAKE
1 APPROACH
2 MANIFOLD
3 TRANSITION CONDUIT
3a SLOPE
FILLING VALVE
4 VALVE, WELL, HOIST
5 FLOW PASSAGE, AIR VENTS
5a BULKHEAD SLOTS
CULVERT-CHAMBER
6 CULVERT
6a SLOPE
6b BIFURCATION (FILLING)
6c JUNCTION (FILLING)
7 MANIFOLD
CHAMBER
8 FLOOR (PROFILE)
9 BAFFLES
10 GATES (ABOVE)
EMPTY VALVE
11 VALVE, WELL, HOIST
12 FLOW PASSAGE, AIR VENTS
12a BULKHEAD SLOTS
OUTLET
13 TRANSITION CONDUIT
14 MANIFOLD
15 ENERGY DISSIPATOR
16 APPROACH
BAY SPRINGS LOCK DESIGN PARAMETERS
HORIZONTAL FLOW DIVIDERS
4-MANIFOLD (HB4) LOCK

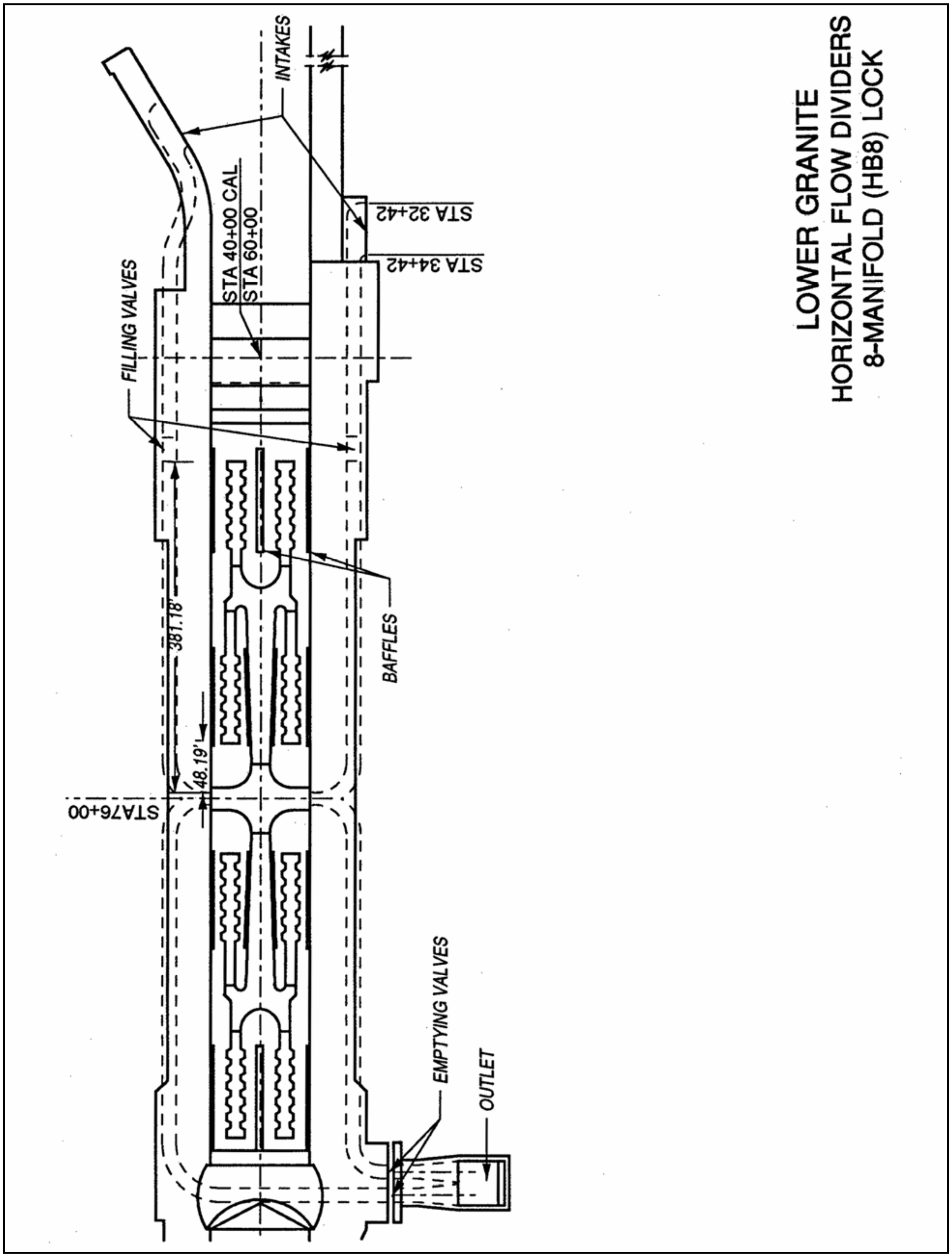

LOWER GRANITE
HORIZONTAL FLOW DIVIDERS
8-MANIFOLD (HB8) LOCK
INTAKES
STA 40+00 CAL
STA 60+00
STA 32+42
STA 34+42
FILLING VALVES
381.18'
48.19'
STA76+00
BAFFLES
EMPTYING VALVES
OUTLET

Plate 3-8