NAME OF SOP	LAST UPDATED
Backfill of Borings in or near levees	18 Nov 2013
Poles - Penetrations - Levees	06 Sep 2013
Repair of Monolith Joint Material	13 Jun 2013
Pressure Pipes - Up and Over Existing Earthen Levees	04 Mar 2013
Protective Coating of Steel Closure Components	01 Mar 2013
Benching and Compaction	09 Jan 2013
Backfill of Animal Burrows	24 Sep 2012
Gravity Pipes thru Existing Earthen Levees - Open Cut Only	30 Apr 2012
Tree and Vegetation Removal	13 Apr 2012
Routing of Electrical Lines Up and Around Levees Floodwalls PS	21 Nov 2011
Abandon & Seal Existing Pipes	15 Sep 2011
Sliplining Existing Pipes Through Levee Structures	22 Aug 2011
Belting Replacement	26 Jan 2011
New Pressure Pipes Passing Thru Existing Casings in Closure Sills or Floodwall	10 Jan 2011
New Pressure Pipes Passing Thru Existing Floodwalls	10 Jan 2011
New Pressure Pipes Passing Thru New Floodwalls	10 Jan 2011
Pressure Pipes - thru Existing Gate Closures as New Construction	10 Jan 2011
Levee Signage	13 Dec 2010
Emergency Closure Provisions During Construction (on Ohio)	06 Dec 2010
Closure Anchorage Recesses	02 Dec 2010
External Waterstop	02 Dec 2010
Fiber Optic, Electrical, other Non-pressure Lines -- Up and Over Existing Levees	02 Dec 2010
Floodwall painting and murals	02 Dec 2010
Repair of Spalled or Cracked Concrete	02 Dec 2010
Sealing Fiber Optic Lines through a Concrete Floodwall	02 Dec 2010
Sealing Fiber Optic Lines Up and Over Existing Levees	02 Dec 2010
Greenway Walking Trails	01 Dec 2010
Abandon Wells and Piezometers	30 Nov 2010
Closure Sealing	30 Nov 2010
Drainage Fill for Pipe Penetrations (reverse filter)	30 Nov 2010
Emergency Closure Provisions During Construction (not on Ohio)	30 Nov 2010
Fences	30 Nov 2010
Filling abandoned railroad slots in closures	30 Nov 2010
Practice Closure Construction	30 Nov 2010

STANDARD OPERATING PROCEDURE
TO
ABANDON AND SEAL AN EXISTING PIPE

Revised 15 September 2011

Abandonment and sealing of pipes requires a USACE Levee System Permit and appropriate project plans and specifications are submitted with the permit application. In addition to the normal Levee Safety Team permit review, USACE Hydraulics and Hydrology staff will review these permits to ensure that any permanent pipe abandonment does not create any adverse flooding conditions.

Procedures and specifications to abandon in place an existing pipe shall be as follows: The existing pipe shall be cleaned and completely filled with a shrinkage-compensating grout. Cleaning the pipe maximizes the potential for a good bond between the host pipe and grout. Small quantity applications shall meet the requirements of ASTM C-1107 such as SIKA 212, Edoco Grout or approved equal (see information below for the Specs on these products). Large quantity applications shall be filled using 3000 psi sanded grout with a shrinkage compensating admixture such as SIKA Intraplast N, BASF Tetraguard AS20, or approved equal. The pipe shall be completely filled and the quantity of grout required to fill the pipe should be determined in advance to equal the volume of the inside of the pipe for its full length between the inlet and outlet headwalls. Filling of the pipe should be monitored and inspected to ensure the pipe has been completely filled for its entire length .

Edoco Grout:
http://67.192.65.138/weavecmsresources//c_TechData_sheets/TDS_Edoco2/E_NFNSGrout_TDS.pdf

SikaGrout 212 Grout:
http://www.sikaconstruction.com/tds-cpd-SikaGrout212-us.pdf

Sika Intraplast-N:
http://www.sika.ca/con-tds-intraplastn-ca.pdf

BASF Tetraguard AS 20:
http://www.basf-admixtures.com/en/products/shrinkage_reducing/tetraguard_as20/Pages/default.aspx

STANDARD OPERATING PROCEDURE
TO
ABANDON WATER WELLS AND PIEZOMETERS

15 September 2010

This Standard Operating Procedure provides guidance for abandoning water wells (including relief wells, production wells, monitoring wells, observation wells and piezometers) that are located within the right-of-way of federal levees. In addition to these requirements, well abandonment must be performed in accordance with all Federal, State, and Local regulations.

Three methods are available for abandonment. Method 1 is preferred and must be used unless a demonstration is made that it is not feasible in a specific situation. In that case, Method 2 may be used with approval of the Louisville Engineer District Levee Safety Officer (LSO). Special circumstances may require development of a site-specific abandonment procedure (Method 3).

A Permit or Letter of No Objection is required for well abandonment.

Method 1: Overdrill and Grout

The preferred protocol for abandonment is to overdrill the well with drilling tools that are larger diameter than the original bore hole, and then grout the resulting borehole. This method requires the removal of the well casing and screen; if this is not possible, then Method 2 must be utilized. Overdrilling shall reach a depth of at least two ft below the depth of the original borehole. Grout shall be extended from the bottom of the overdrilled borehole to three ft below the ground surface. The remainder of the borehole is then filled to the ground surface with compacted soil similar to the surrounding soil. Measures must be taken to ensure that the borehole does not collapse prior to grout placement.

Method 2: Grout

The alternative method for well abandonment (not preferred) is to place grout in the well casing to a depth of three ft below the ground surface. The casing is then cut off three ft below the ground surface and a six-inch thick portland cement concrete plug is placed over the cut off casing. The excavation is then filled to the ground surface with compacted soil similar to the surrounding soil.

Method 3: Special Procedures

In the event that site-specific circumstances preclude the use of Methods 1 or 2, an alternative abandonment plan may be submitted to the Louisville Engineer District LSO for consideration and approval. The plan must provide a level of sealing consistent with Methods 1 or 2.

Grout Materials

Grout materials shall consist of either bentonite grout or cement-bentonite grout. Bentonite grout shall consist of high-solids bentonite mixed with water in accordance with the manufacturer's recommendations. Cement-bentonite grout shall consist of a mixture of portland cement with 3-5% bentonite added, mixed with no more than six gallons of water per 94 pounds of portland cement.

Grout Placement

Grout shall be placed by pumping through a tremmie pipe. The tremmie pipe shall extend to the bottom of the borehole (Method 1) or well casing (Method 2) and the grouting shall proceed from the bottom upward as the tremmie pipe is withdrawn.

Documentation

Well abandonment documentation shall be submitted to the Louisville Engineer District LSO upon completion of the abandonment. That documentation shall include the well identification, location coordinates, method used for abandonment, details of the abandonment (well depth, overdrill depth, overdrill auger diameter, quantity of grout used, etc.), and a map showing the well location.

STANDARD OPERATING PROCEDURE
FOR
BACKFILL OF ANIMAL BURROWS IN OR NEAR LEVEES

29 July 2008

Holes and/or animal burrows are sealed by pumping a high solids bentonite clay grout (Cetco PureGold grout or equivalent) with a tremie pipe from bottom to top of the burrow. In order for this mixture to properly set and provide the necessary seal it is critical that the manufacturers mixing instructions be strictly followed (typically not more that 15 gallons of water per 50 pound sack of bentonite). The outer two feet of the burrow is backfilled with soil.

STANDARD OPERATING PROCEDURE
FOR
BACKFILL OF BORINGS IN OR NEAR LEVEES

11 March 2011

Method 1: Boreholes shall be backfilled with granulated bentonite in not greater than one-foot increments. The volume of bentonite required to fill the borehole shall be determined in advance to equal the volume of material removed during boring. Bridging of borehole cavity during bentonite placement can occur; therefore, sounding of borehole shall be performed to confirm backfill material has reached the bottom of the borehole. If dry conditions cannot be maintained, coated bentonite pellets shall used. The upper two feet of the borehole shall be backfilled with auger cuttings to allow establishment of vegetation.

Method 2: Grout the boreholes using the tremie method and a mixture of powdered bentonite and water which will set to a consistency of a stiff soil with a maximum permeability of 10^{-7} cm/sec.

STANDARD OPERATING PROCEDURE
FOR
CLOSURE BELTING REPLACEMENT

26 January 2011

Some of the levee projects within the Louisville District were constructed as long as 70 years ago. These older projects have certain items that are wearing out or are no longer functioning as designed. One such item is the gasket material used to create a water-tight seal between closure pieces, and between the closure components and the abutments or concrete sills. This SOP addresses one solution for replacement of these gasket materials, which are generically referred to as "belting".

Levee Projects in the Ohio River basin built in the 1940's and 1950's were originally supplied with belting material which is a composite of fabric and rubber. The original belting is robust, durable and has a long shelf life. This material has also been reported to be difficult to work with and lacks flexibility in cold weather. The original belting has a very high durometer and does not compress easily; thus it is not an ideal material for providing quality water-tight seals. The material is typically suffering from a combination of aging and excessive use. Additionally some original pieces of belting material may be missing. In all cases local sponsors may be seeking a replacement.

Local sponsors are encouraged to replace originally supplied belting and seal materials as part of routine Operations and Maintenance. The recommended new seal materials shall be blended neoprene with a durometer (hardness) between 55 and 70.

The new material should be equivalent to Commercial Grade Neoprene No. 264 from GARLOCK RUBBER TECHNOLOGIES AN ENPRO INDUSTRIES COMPANY located in PARAGOULD, AR. (additional specification provided below). "Skirtboard" material of similar specification is an acceptable substitute for the Neoprene. The skirtboard should have the same hardness and similar tensile strength and elongation to provide the proper seal. Local sponsors are encouraged to work with their local or regional supplier of building materials, and should get a technical representative to assist them in getting the material that meets these specifications.

The seal sizes should match original dimensions provided on the as built drawings or closure installation diagrams if possible, but should not be oversized in the length or width dimensions more than ¼-inch without special approval. *Typically* 3/16- to ¼-inch should be an adequate thickness for stoplogs and inset slots in closure abutment walls. 3/8- to 9/16-inch should be an adequate thickness for the closure to sill belting replacement. Again it is emphasized that the replacement seal material should match the original dimensions. For closure seal material, "One size does not fit all", as there are many different closure designs, and often there are several different designs even within the same project. Therefore care should be taken to test fit sample pieces before large amounts of the new materials are purchased.

Although the new material is expected to provide a better seal than the original belting, it is likely not as durable. Material with moderate ultra violet (UV) light resistance is required. Even with

moderate UV resistance, the new seals should be kept out of direct sunlight as much as possible. Typically increasing the UV resistance will decrease the flexibility of the new belting materials. Care should be exercised while installing the closure using the new material, as impacting a panel on the seals could cause tears in the material.

The seal material should be ordered from the supplier in lengths that match the original belting materials. The pieces should seamlessly cover each closure surface with one continuous piece. Seamed pieces are discouraged as these could produce leaks during high water events.

It is recommended that the original belting material not be discarded. If possible it should be kept readily available for use in the event the new neoprene seals are damaged during closure installation.

Neoprene Distributors that have shown interest:

General Rubber & Plastics Co
3118 Preston Hwy / Louisville, KY / 40213
(502) 635-2605

Henry A Petter Supply Co.
5110 Charter Oak / Dr. Paducah, KY / 42001
800-626-3940

Commercial Grade Neoprene No. 264 from:

Garlock Rubber Technologies an Enpro Industries Company
P. O. Box 1000 / Paragould, AR 72451 / 870-239-4051

Style	Style #264
Elastomer	Blended neoprene, nitrile and SBR rubbers
Color	Black
Durometer (Shore A)	55-65
Typical Tensil (Minimum,)psi [bar]	1,100 (800), [76 (55)]
Finish	Smooth
Ultimate Elongation (% Min.)	300
Approx. Wt. 1/16" [1.6mm], Lbs/Yd² [kg/m²]	3.9 [2.1]
Width Inches, [mm]*	Up to 72 [1829]
Standard Gauge Inches, [mm]*	1/32 thru 2 [0.8 thru 50.8]
Temperature Range	-20°F to +190°F [-29°C to +88°C]
Pressure Maximum 1/8" [3.2 mm], psig[bar]	150 [10]
Oil Resistance	Moderate

Sheet Rubber Tolerances	**Tolerance**	
Thickness	**Inches**	**mm**
1/32" (0.8 mm)	± .012	± 0.3
1/16" (1.6 mm) but not including 1/8" (3.2 mm)	± .016	± 0.4
1/8" (3.2 mm) but not including 3/16" (4.8 mm)	± .020	± 0.5
3/16" (4.8 mm) but not including 3/8" (9.5 mm)	± .031	± 0.8
3/8" (9.5 mm) but not including 9/16" (14.3 mm)	± .047	± 1.2
9/16" (14.3 mm) but not including 3/4" (19.1 mm)	± .063	± 1.6
3/4" (19.1 mm) but not including 1" (25.4 mm)	± .093	± 2.4
1" (25.4 mm) and over ± 10%	± 10%	

Width	**Tolerance**	
36" (914 mm) and over	± 1"	± 25.4

Standard Operating Procedure
for
Benching and Compaction for Levee and Floodwall Modifications

30 November 2010

1. Placing backfill *within the levee embankment* will require the following:

a) The surface of the levee shall be stripped of organics and topsoil to a depth of approximately 6 inches prior to benching the levee sideslope.
b) The existing levee embankment shall be over-excavated in all directions by benching 1 ft vertical and 3 ft horizontal into stiff undisturbed soil. A level bottom surface day-lighting toward the levee toe shall be provided from which the upward benching on the sides shall initiate. Benching may have to be performed by hand methods or using small-scale excavation equipment.
c) The levee soil on which the backfill is to be placed should not be excavated until immediately before backfilling, and shall not be allowed to become overly wet or dry while exposed. The surface area of the benches shall be scarified as necessary to ensure a good bond between the existing soil and the backfill material.
d) Backfill material must be low permeability soils - impermeable soils (e.g. SC, CL or CL-ML with an estimated hydraulic conductivity less than 1 x10^{-5} cm/sec) in accordance with ASTM 2488 - USCS classification system.
e) Backfill material shall be placed in loose lifts with thicknesses not to exceed 8-inches and compacted in the holes to a minimum 95 percent Standard Proctor density determined at optimum moisture content according to ASTM D-698. Moisture control limits are to be within -1% to +3% of optimum.
f) The finished riverside or landside slope of the levee shall be graded to match the existing levee slopes upstream and downstream. A site-specific grading plan must be approved for projects where the final grade differs from the original grade.
g) The disturbed areas shall be seeded and covered with a bio-degradable geotextile when final grading is complete.

2. Placing backfill materials *outside the projected levee slopes but within a minimum of 15 feet of the toe of the Levee or face of the Floodwall* requires the following:

a) Backfill material must be low permeability soils - impermeable soils (e.g. SC, CL or CL-ML with an estimated hydraulic conductivity less than 1 x10-5 cm/sec) in accordance with ASTM 2488 - USCS classification system.
b) Backfill shall be placed in loose lifts with thicknesses not to exceed 8-inches and compacted in the holes to a minimum 95 percent Standard Proctor density determined at optimum moisture content according to ASTM D-698, unless otherwise directed. Moisture control limits are to be within -1% to +3% of optimum.
c) The disturbed areas shall be seeded and covered with a bio-degradable geotextile when final grading is complete.

STANDARD OPERATING PROCEDURE
FOR
CLOSURE ANCHORAGE RECESSES

2 December 2010

Local Sponsors shall be responsible for maintaining the anchorage recesses for movable closures. These are often referred to as "pin boxes". The embedded metals in the boxes are painted structural steel, with the exception of the vertical plates through which the anchorage pins pass; these are fabricated from corrosion resisting stainless steel.

The steel covers should be bolted down to prevent theft of the covers and damage to the structural components within the boxes. If the cover plate is damaged or bent, it should be replaced with a new checkered cover plate matching the original thickness, dimensions and material specification. Any missing bolts should be replaced. If any of the threaded bolt holes in the dust boxes have become stripped, they should be re-tapped for a larger bolt size and the old bolts should be replaced. Each cover plate should have a perimeter gasket; these should be replaced as necessary to minimize entry of dirt and water into the recesses.

The recesses shall be kept free and clear of water and debris. For pin boxes that have drainage holes, the drainage system shall be checked to verify it is operating effectively each year.

The Local Sponsor is responsible to keep a protective coating of paint on the structural steel. The following paint system is recommended:

Corps of Engineers Zinc-Rich Impacted Immersion Coating

Surface Prep: White Metal Blast per SSPC-SP5/NACE 1, 1.5 - 2.5 mil profile

One Coat: Zinc Clad 108 @ up to 2.5 mils dft. in one double spray coat
One Coat: V-766e Gray Vinyl @ up to 2 mils dft. in one double spray coat
One Coat: V-766e White Vinyl @ up to 2 mils dft. in one double spray coat
One Coat: V-766e Gray Vinyl @ up to 2 mils dft. in one double spray coat

For pin boxes that do *not* have drainage holes, an additional measure to protect the steel components is to fill the recess with a mixture of 10W30 motor oil and mill saw dust. The mixture should be predominantly sawdust with enough oil to provide a coating that protects the metal components but not enough to make the mixture take a liquid consistency. Commercially available products such as Qwik-Sorb® or similar may be used instead of sawdust.

STANDARD OPERATING PROCEDURE
FOR
PERMANENT SEALING OF ROAD/RAILROAD CLOSURES THROUGH LEVEE EMBANKMENTS

30 NOVEMBER 2010

This Standard Operating Procedure (SOP) provides guidance for permanent sealing of road/railroad closures when the closure is no longer needed. This allows the Local Sponsor to cease Operations and Maintenance activities for the closure. A sponsor must submit in writing a request for a Letter of No Objection (LNO) from USACE for approval prior to initiation of any field activity.

Permanent sealing of a closure in an earthen levee section may be performed by filling the closure opening with compacted fill in accordance with the *Standard Operating Procedure for Benching and Compaction Requirements for Levees and Floodwalls*. When the closure walls are left in place, benching is not required. Other methods may be used when approved by the Louisville District Levee Safety Officer (LSO).

If a closure storage vault is located within the earthen levee, it is first sealed by permanently attaching the door, such as by welding, and then filling the vault from the top with sand, sand and gravel, flowable fill, concrete, or other material that may be approved by the LSO. Placement of this material must be performed so that a compacted fill is constructed.

The recommended construction sequence for this effort is:

1. Prior to placement of fill materials, the closure sill must be opened and cleaned and all foreign material removed from the closure footprint (Figure 1A).
2. A “C” channel section is fabricated to loosely fit the closure slots in the concrete closure walls so that the channel is flush with the concrete face when installed.
3. The “C” channel extends above the concrete wall and is constructed with a hole or other attachment point in the section extending above the wall (Figure 1B).
4. Engineered fill is placed in lifts until the closure grades match the surrounding grades. One compaction test is required per lift.
5. The “C” channel is removed, and an “I” beam is inserted into the closure slot so that one flange extends into the fill materials. This beam is cut to fit flush with the top of the concrete wall (Figure 1C).

6. Void spaces around the “I” beam are then filled with flowable fill (per State DOT specification requirements) or cement-bentonite grout.
7. The “I” beam must be installed to form a barrier to prevent seepage along the concrete wall-soil fill interface.

The Local Sponsor supervises the permanent sealing of the closure and submits documentation of the process to the Louisville Engineer District Levee Safety Program Manager.

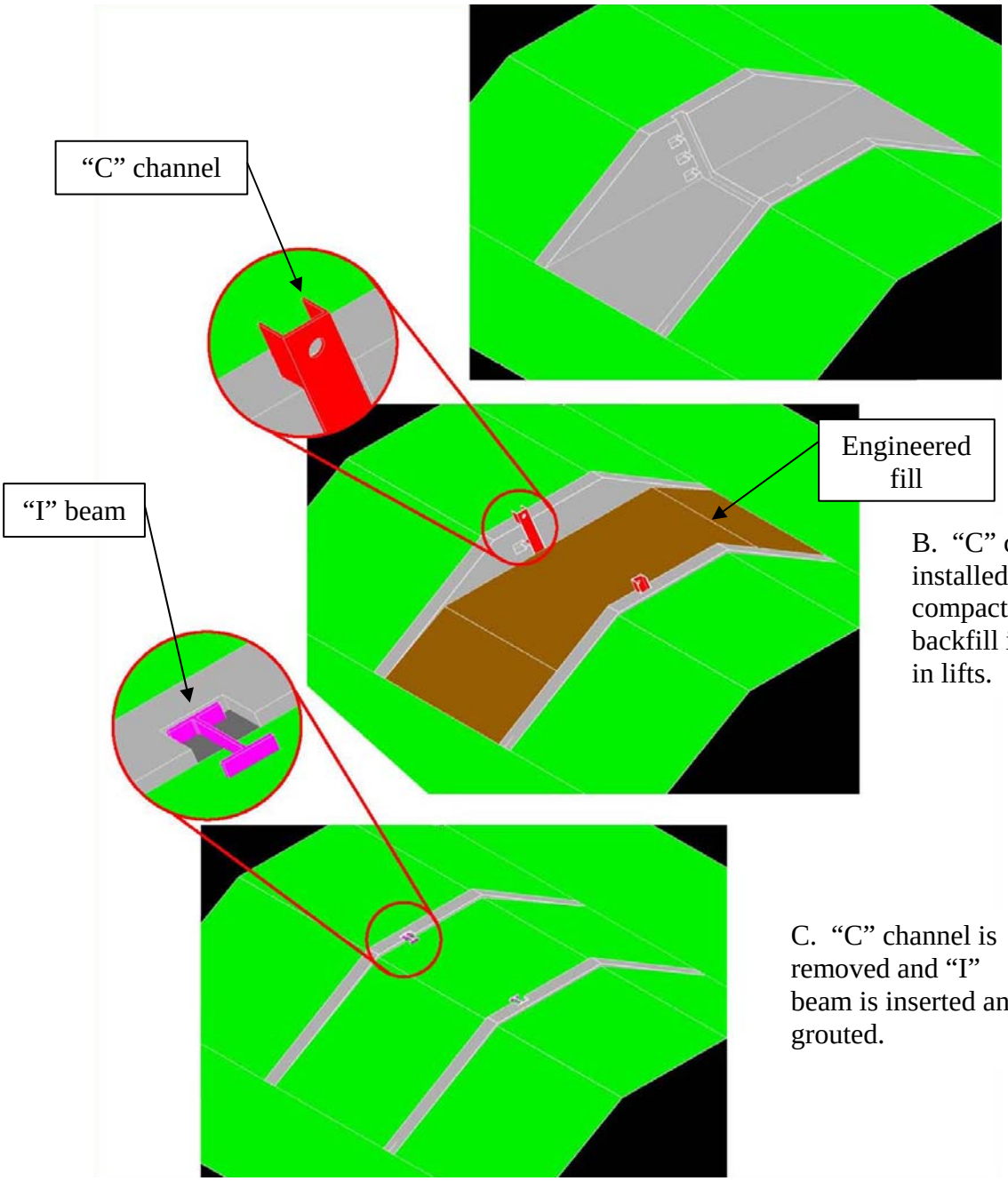


Figure 1. Permanent Sealing of an Existing Closure - Process.

STANDARD OPERATING PROCEDURE FOR LANDSIDE DRAINAGE FILL CONSTRUCTION FOR LEVEE PIPE PENETRATIONS FOR NEW CONSTRUCTION

30 November 2010

1) General

a) **Drainage Fill Requirement**: Drainage fill is required by Engineer Manual 1110-2-1913 *Design and Construction of Levees*, Section 8-5.b(2). Drainage fill consisting of permeable granular material is placed on the landside of a levee pipe penetration (Figure 1) to provide drainage for water that may pass along the surface of the pipe from the riverside during flooding conditions. The drainage fill minimizes the transportation of fine soil material, provides controlled exit for water seeping along the pipe, and increases the integrity of the levee embankment.

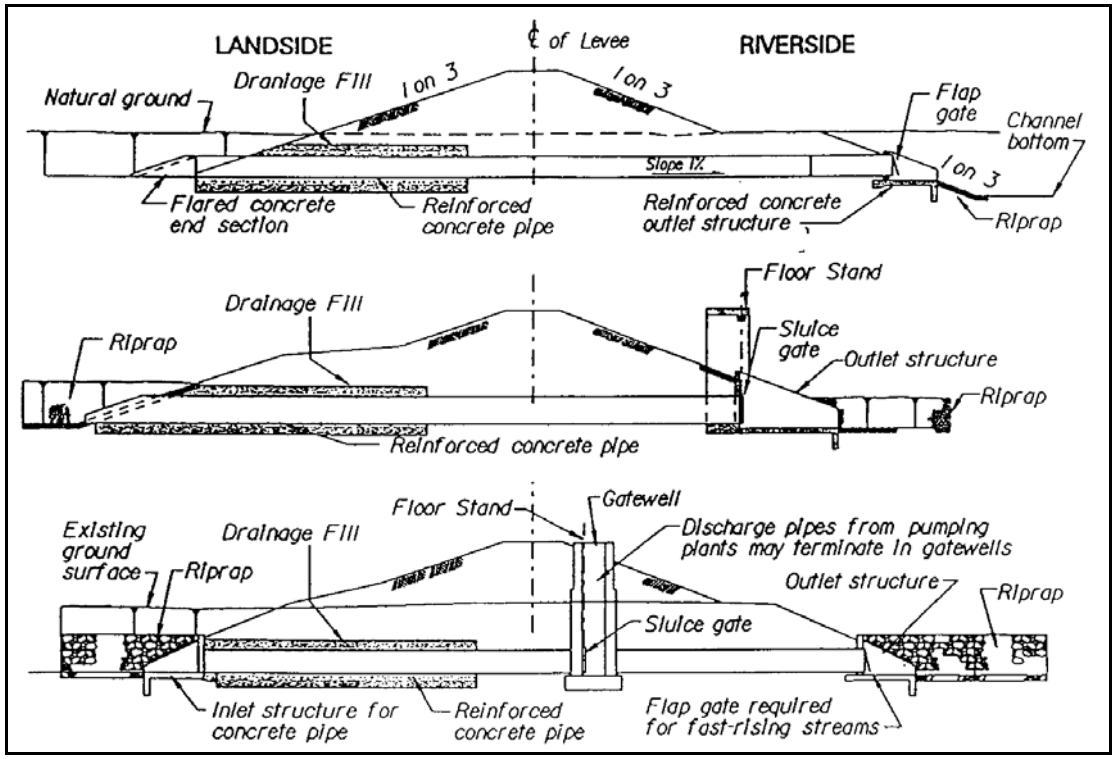


Figure 1. Typical sections of drainage structures through levees. From EM 1110-2-1913.

b) **USACE Levee Safety Letter of No Objection (LNO)**: Written approval from the USACE Levee Safety Officer is required before any work is performed on the levee.

c) **A/E Construction Drawings and Specifications:** Proposed levee pipe penetrations with landside drainage fill a designed by competent licensed engineers and the submittal of a complete set of project plans and specifications is required before USACE Levee Safety Officer (LSO) approval is granted. The submittal contains sufficient detail to demonstrate compliance with this Standard Operating Procedure (SOP).

2) Drainage Fill Design and Installation

a) **Drainage Fill Dimensions**: Drainage fill in new pipe construction is placed around the landside one-third of the pipe length. Drainage fill extends eighteen inches away from the pipe in all directions (Figure 2).

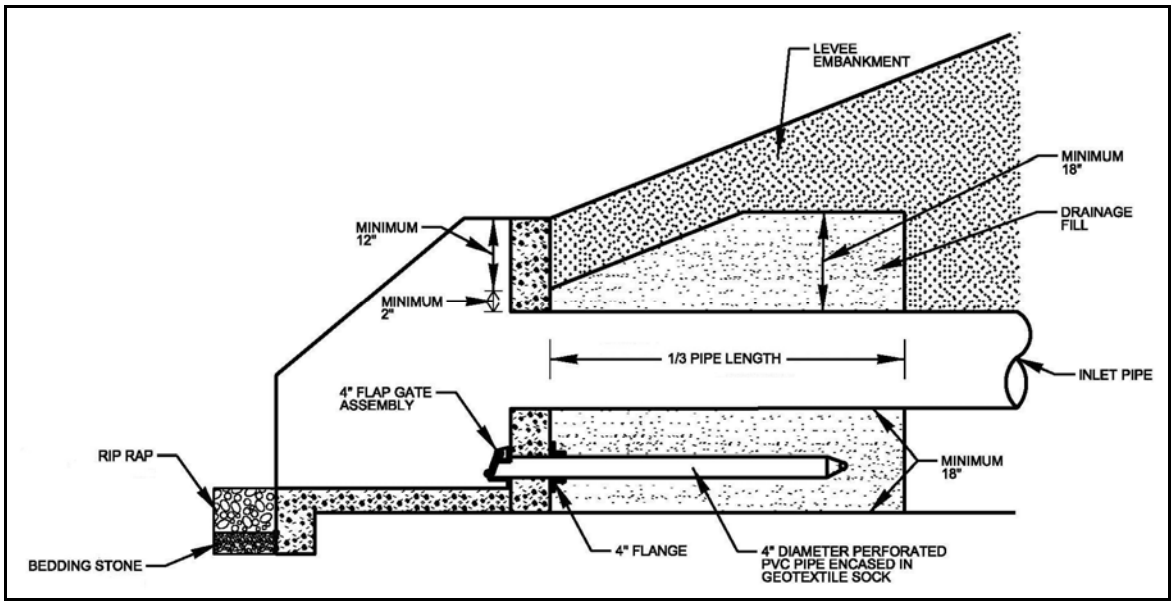


Figure 2. Typical construction details of drainage fill interface with headwall/wingwall.

b) **Interface with Headwall/Wingwalls:** Drainage fill extends to the landside headwall/wingwalls, and is tapered above the pipe so that the thickness decreases from eighteen inches to a minimum of two inches over the crown of the pipe. The headwall extends above the pipe to a height so that a minimum of twelve inches of levee embankment material is placed over the drainage fill (Figure 2). Standard State transportation agency headwall design dimensions are generally not suitable for levee use. Project specific headwall designs are required, based on this SOP.

c) **Drainage Fill Cover:** Drainage fill does not daylight and is covered by a minimum of one foot of low permeability levee embankment material. This requirement minimizes the possibility of drainage fill becoming saturated from landside ponding of interior drainage.

d) **Drainage Through Headwall/Wingwall:** Two four-inch diameter drainage ports (weepholes) through the headwall/wingwall are drilled or cast-in-place to accommodate drainage from the drainage fill. One port is typically located on either side of the pipe. Both ports are placed as low on the headwall/wingwall as possible.

The drainage ports are covered on the headwall face with a four-inch cast iron flap gate to minimize infiltration of ponded interior drainage into the drainage fill.

A minimum four-foot long, four-inch diameter slotted PVC drainage pipe with geotextile filter sock is attached to a bolted-on or cast-in-place steel flange on the levee side of the headwall/wingwall. A four-inch plug is placed on the distal end of the PVC pipe. The PVC pipe and geotextile assembly is securely fastened to the flange using silicon caulking and a stainless steel hose clamp. Headwalls with angled wingwalls require a Schedule 40 elbow between the flange and the perforated PVC pipe so that the perforated PVC pipe is oriented parallel to the drainage pipe (Figure 3).

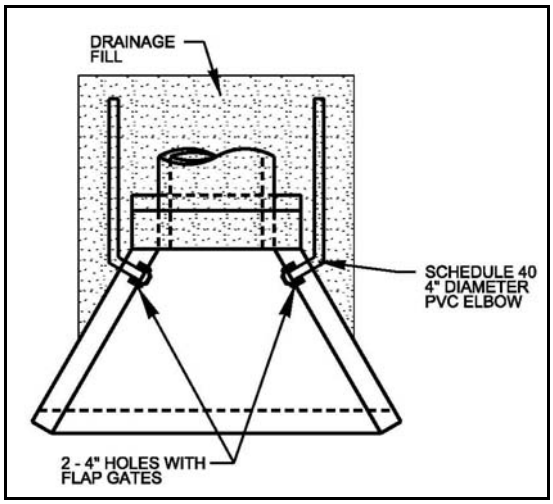


Figure 3. PVC elbows used to align drainage fill drain pipe parallel to pipe penetration.

3) **Drainage Fill Compaction**: Drainage fill is compacted in six-inch thick loose lifts with a vibratory plate compactor. Care is taken to not damage the pipe during compaction. Water is added to the drainage fill if needed to maintain a damp

condition to achieve compaction. Drainage fill should not be compacted in a saturated or frozen condition.

4) Materials

a) **Drainage Fill Material:** Drainage fill material is selected to ensure that surrounding levee embankment material does not move into the drainage fill pore space and clog the drainage fill. Concrete sand meeting the gradation requirements of ASTM C-33, or concrete sand meeting State transportation agency gradation specifications, is used unless otherwise specified by USACE.

b) **Flap Gates**: Four-inch flap gates are constructed of cast iron with bronze seats and brass hinge pins. The flap gate has a tab with a hole for attachment of a hold-open chain. The flap gate assembly is mechanically attached to the headwall/wingwall.

c) **PVC Pipe**: Four-inch diameter perforated PVC pipe meets the requirements of ASTM D2729 - 03 *Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings*.

d) **Geotextile Filter Sock:** The four-inch diameter perforated PVC pipe and plug is encased in geotextile filter sock material meeting the requirements of ASTM D6707 - 06 *Standard Specification for Circular-Knit Geotextile for Use in Subsurface Drainage Applications*.

e) **Metal Components:** Metal components are either stainless steel or are painted, powder coated, galvanized, or otherwise protected from corrosion. Flange bolts and cast-in-place anchors are minimum $^{5}/_{8}$-inch diameter.

STANDARD OPERATING PROCEDURE
FOR
EMERGENCY CLOSURE DURING CONSTRUCTION PROJECTS NOT ON THE OHIO RIVER

30 November 2010

Provisions for the flood level or flood event that trigger the construction of a temporary emergency closure should be determined during the permit review process. COE Hydrology & Hydraulics (H&H) Design personnel review the base elevations of a proposed closure and then, using this information along with the rate of river rise, provide a trigger elevation that is incorporated into construction contract documents regarding the Emergency Closure Plan.

In regards to the Emergency Closure Plan, the floodgate contractor will be required to provide the method of temporary closure to the Corps of Engineers for approval once the contract has been awarded. If required as a result of a potential flood event, the emergency closure has to be in place within a time limit determined by H&H based upon the trigger elevation and of notification by the Local Sponsor. Due to the fact that the crest of a flood often rises, falls and then rises again, the closure system would need to be designed to be flexible - in other words it must have the capacity to be raised if necessary to match the top elevation of the rest of the flood protection system. This also means the structural elements (if the temporary closure is structural) would need to have the capacity to resist the full height flood. This does not mean that all structural components providing protection up to the full floodwall height would need to be installed for every flood event. Calculations must be provided to show that the temporary closure can withstand a full height flood.

The construction contractor must be able to provide evidence that their proposed emergency closure system consists of components that are either already in their possession, or are obtainable within the time determined by H&H, and that they can also provide the means and methods, including manpower, required to have all components in place based upon the trigger elevation.

For most cases, the emergency closure would likely only be required to be constructed to the projected flood crest elevation plus five feet or so. The extra height provides a safety margin to include both freeboard for wave run up and uncertainty. COE Hydraulics reviewers should make that determination.

STANDARD OPERATING PROCEDURE
FOR
EMERGENCY CLOSURE DURING CONSTRUCTION PROJECTS ON THE OHIO RIVER

30 November 2010

Provisions for the flood level or flood event that trigger the construction of a temporary emergency closure should be determined during the permit review process. USACE Hydrology & Hydraulics (H&H) Design personnel review the base elevations of a proposed closure and then, using this information along with the rate of river rise, provide a trigger elevation that is incorporated into construction contract documents regarding the Emergency Closure Plan.

In regards to the Emergency Closure Plan, the floodgate contractor will be required to provide the method of temporary closure to the Corps of Engineers for approval once the contract has been awarded. If required as a result of a potential flood event, the emergency closure has to be in place within 72 hours of notification by the Local Sponsor. Because the crest of a flood often rises, falls and then rises again, the closure system would need to be designed to be flexible - in other words it must have the capacity to be raised if necessary to match the top elevation of the rest of the flood protection system. This also means the structural elements (if the temporary closure is structural) would need to have the capacity to resist the full height flood. This does not mean that all structural components providing protection up to the full floodwall height would need to be installed for every flood event. Calculations must be provided to show that the temporary closure can withstand a full height flood.

The construction contractor must be able to provide evidence that their proposed emergency closure system consists of components that are either already in their possession, or are obtainable within the 72 hour time frame, and that they can also provide the means and methods, including manpower, required to have all components in place within the same time frame.

For most cases, the emergency closure would likely only be required to be constructed to the projected flood crest elevation plus five feet or so. The extra height provides a safety margin to include both freeboard for wave run up and uncertainty. USACE Hydraulics reviewers should make that determination.

STANDARD OPERATING PROCEDURE
FOR
FLOODWALL REPAIRS: PLACEMENT OF EXTERNAL WATERSTOPS

2 December 2010

Flood protection structures including floodwalls, pumping stations, gatewells, etc., require periodic inspection as prescribed by the Regulations. Concrete structures should be checked for spalling, porosity, cracking, settlement, and failures of monolith expansion-joint seals.

This document provides general guidance for the placement of external waterstops where differential movement between adjacent floodwall monoliths has caused the joints to open excessively, resulting in tearing or other severe damage to the existing waterstops. Damage that has occurred as a result of unusual or unexpected conditions should be brought to the attention of USACE and a determination can usually be made regarding the cause and a plan for repair can be developed. Additionally no large external waterstop placement project should be undertaken without prior approval of USACE.

External Waterstops

Deflections and settlement often exceed the capacity of the existing waterstops to adjust to the differential movements. Without remediation of the failed waterstops the resulting leakage could be unacceptable. Thus the project may not have the capacity to perform as authorized. At joints where the maximum differential offset (measured either vertically or horizontally) exceeds one and one-half inches (1½"), the installation of an external waterstop is required.

The external water stop scheme shown in Figure 1 (entitled "Typical Section at Joints") is a means of correcting for torn water stops, open joints, and possible earth cracking over the key because of thin heel cover or excessive movements. Sheet piling shown in the figure is only necessary to provide additional cutoff to compensate for loss of part or the entire normal seepage path between earth and the waterside face of the key. Such a condition is extremely unusual and therefore installation of an added sheet pile cutoff under the riverside end of the floodwall base is not part of this standard procedure.

The recommended reconstruction consists of adding a new rubber or PVC center-bulb waterstop embedded into two new external reinforced concrete pilaster-type structures. Reinforcement for the two concrete pilasters will be doweled into the riverside of the existing wall in two parts, and then two separate concrete placements will be made. This provides assurance that the ½-inch expansion joint is maintained throughout the wall cross-section. The joint will need to be filled with pre-formed joint filler material. *This repair will generally extend from the tops of the walls down to the bottoms of the riverside keyways.* Thus a significant excavation will be required. A typical section is shown as Section C-C in Figure 2. In addition to the details shown, an external sealant should be applied to protect the joint filler material from weathering. A photograph of some completed external waterstop pilasters is shown in Figure 3.

An alternative external waterstop is presented in Section C_1-C_1, in Figure 4, and a photograph of a completed alternative external waterstop is shown in Figure 5. The alternative method of installation requires less materials and is generally easier to construct. *This repair also generally extends from the tops of the walls down to the bottoms of the riverside keyways.* Thus a significant excavation will be required.

As shown in Figure 7-9a, b, and c of EM 1110-2-2502, Retaining and Flood Walls, for yielding foundations a U-shaped (type "U") water stop should enclose almost the entire base and a center bulb (type "Y") water stop, located in the stem, is joined to the U-shaped water stop at the bottom of the stem. Experience has shown that a center bulb or dumbbell water stop located within the base section is likely to allow excessive seepage. Between monoliths on a foundation requiring a seepage cutoff, the center bulb water stop in the stem should be extended to tie into the cutoff, and the type U water stop around the base should be deleted. The earth surface on which a type U water stop is installed must be firm and smooth, with no chips, sags, humps, clods, or loose debris that would prevent intimate contact between the water stop and soil.

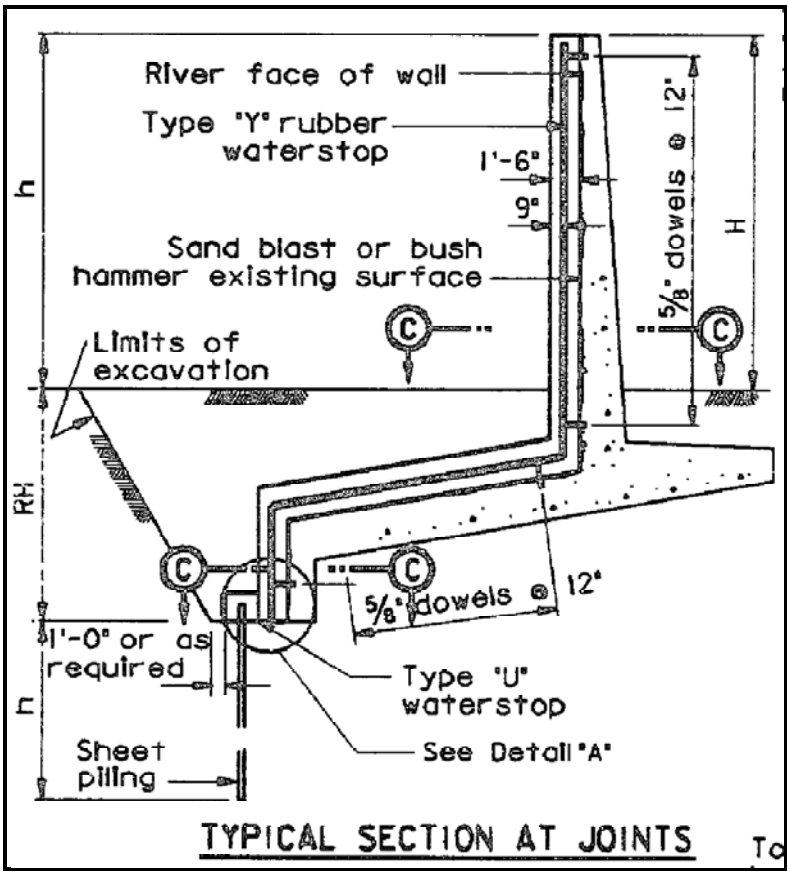


Figure 1

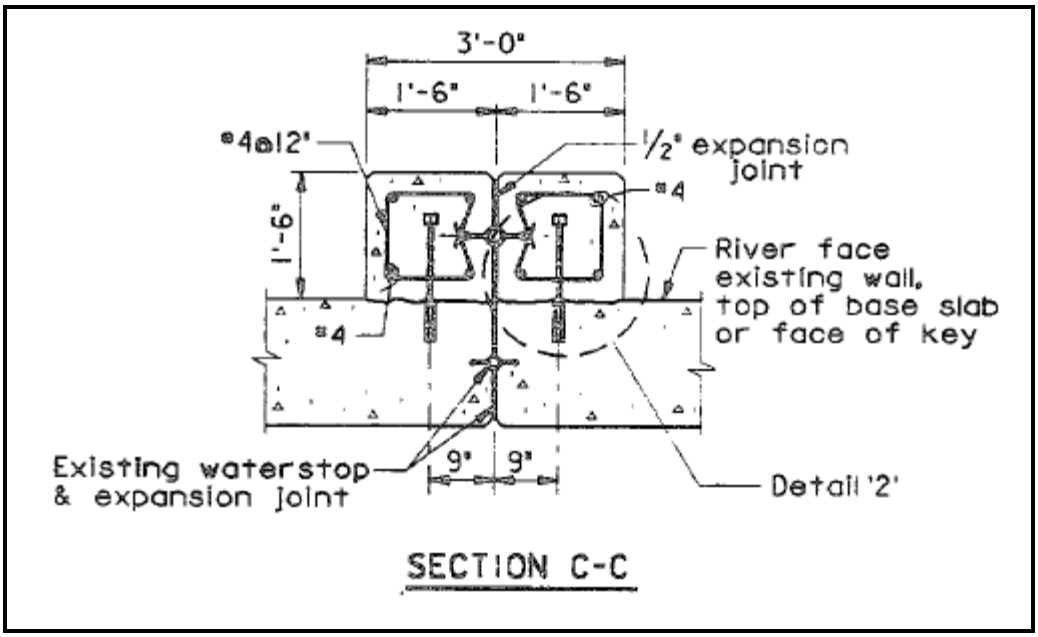


Figure 2

Figure 3: Three external waterstop pilasters on riverside of Newport, KY floodwall

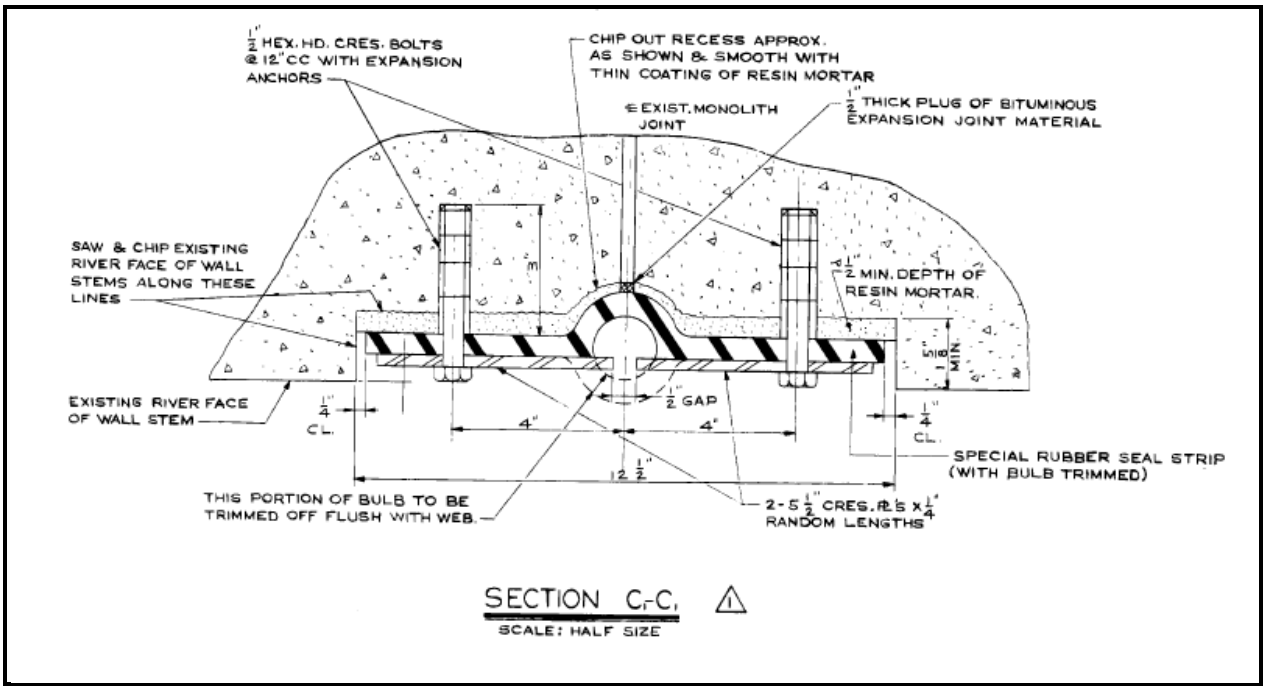


Figure 4

Figure 5: Alternative external waterstop on riverside of Newport, KY floodwall

STANDARD OPERATING PROCEDURE
FOR
FENCE ENCROACHMENTS INTO RIGHT –OF-WAYS OR EASEMENTS ESTABLISHED FOR ALL RECOGNIZED GOVERNMENT LEVEES/FLOODWALL PROJECTS

30 November 2010

Reference to an Operations Manual for Local Flood Protection Projects (LFPP) within the Louisville District, Appendix A, titled "Flood Control Regulations; Maintenance and Operation of Flood Control Works", Section 208.10, (a) General, Item (7) which states the following:

> "The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works."

Based on the above requirement, the Louisville District has developed additional guidance relative to fence construction that encroaches into the right-of-ways or easements of LFPP projects. This guidance is as follows:

1. The government preferred layout of property owner fencing to any LFPP within the Louisville District Rehabilitation and Inspection Program (RIP) is that all fence lines be terminated immediately before or at the levee right-of-way or easement line. This provides the most uninhibited access for inspection personnel and greatest flexibility to monitor LFPP's during a flood event.

2. In the event a property owner(s) wishes to secure their property by extending an existing or a proposed fence that will encroach into a Sponsor's LFPP's Right-of-Way or Easement, then the Sponsor may locally authorize a property owner to extend the fence to the face of a concrete floodwall provided; Each fence extension incorporates a gate that maintains a minimum 10'-0" clear opening within the width of the encroachment allowing the uninhibited access along the floodwall Right-of-Way and/or easement for authorized personnel and equipment free passage at all times. Therefore, it will be necessary to install the aforementioned gate in fences that currently encroach on LFPP Right-of-Ways and Easements or have the existing encroachments removed. If a gate is desired to be locked by a property owner, then said property owner will be required to purchase a lock FROM the Sponsor of whom will maintain the only key to said lock. This allows only authorized personnel free uninterrupted/uninhibited access to its LFPP at all times. Addresses with accompanying digital photos for each fence encroachment authorized by the Sponsor must be provided to the Sponsor.

3. Any new fences proposed to be constructed within an LFPP's Right-of-Way or Easement shall be approved and authorized by the Sponsor prior to its placement. Direct attachment to any portion of any concrete floodwall is strictly prohibited.

In addition to the above where permits for fence encroachments into LFPP's "MAY" have been authorized reference to Permit Form - ORL Form 803 dated 18 August 1971, paragraph 3 states the following:

> "The structure or operation covered by this permit may be damaged, removed or destroyed by the permitter in time of flood emergency if such action is determined by the permitter to be necessary in order to preserve life or property or prevent damage or impairment to the use or safety of the flood protection structure, and the permitter shall not be liable to the permittee for such damage or destruction."

Based on this information, the local sponsor has the authority to remove <u>any structure</u> including fences which prohibit access within LFPP's right-of-ways or easements established for the flood protection structure during a flood event which may impair flood fight efforts.

It is the responsibility of a Local Sponsor to manage the fences within the guidelines above.

STANDARD OPERATING PROCEDURE
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
FIBER OPTIC, ELECTRICAL, AND OTHER NON-PRESSURE LINES
UP AND OVER EXISTING EARTHEN LEVEES

2 December 2010

1. All non-pressure pipes will be required to go up and over existing levee embankments where excavations do not go below the freeboard zone.

2. Sleeving/casing around the outside of the non-pressure pipes going up and over earthen levees will be required. The limits of the sleeving/casing shall be a distance of 2-feet outside the land and riverside levee toes.

3. Permit submittal shall show:

    a. Backfill material under, around and over the non-pressure pipe must be low permeability soils - impermeable soils (e.g. SC, CL or CL-ML with an estimated hydraulic conductivity less than 1 x10^{-5} cm/sec) in accordance with ASTM 2488 - USCS classification system.
    b. Backfill material under, around and over the non-pressure pipe must be carefully placed and compacted. This material shall be placed in loose lifts with thicknesses not to exceed 6-inches and compacted in the disturbed area to a minimum 95 percent Standard Proctor density determined at optimum moisture content according to ASTM D-698. Moisture control limits are to be within -1% to +3% of optimum.
    c. The finished riverside or landside slope of the levee shall be graded to match the existing levee slopes upstream and downstream of the trench where the disturbance occurred.
    d. All disturbed areas shall be seeded and covered with a bio-degradable geotextile.

4. Permit submittal shall include pipe materials to be used.

5. Sealing of sleeving/casing to go up and over levee – Reference SOP titled “Sealing Fiber Optic Lines inside a Sleeve/Casing up and over an Existing Levee Embankment”.

6. If non-pressure pipe requires a depth of embedment deeper than the design freeboard limits, additional material can be added over the top of the pipe and smooth graded in with the levee embankment to allow for proper mowing of the levee crown and side slopes. (See comment #1 for additional information).

7. Permit submittal shall include a cross-section of the levee embankment affected by proposed placement of new non-pressure pipe and a plan of the levee right of way at the same location.

8. Permit submittal shall include the ACOE As-Built stationing where the proposed non-pressure pipe crossing will occur.

Standard Operating Procedure
for
Filling of Abandoned Railroad Slots in Closures

30 November 2010

Each of the slots to receive concrete fill placement should be prepared to provide a minimum 1/8-inch surface profile. This may be accomplished using high pressure water jet tools, roto-hammers or other scarifying equipment. Since this concrete is mature and fully cured, it is expected to be very hard and this roughening process will not be easily accomplished. If water jetting is used, this will require much higher water pressure than is used to simply pressure clean a surface. The purpose here is to provide a surface that promotes an excellent bond between the newly placed concrete infill and the existing older concrete.

The next step is to drill in and epoxy in place a series of vertical dowels. These should be #6 deformed reinforcement bars meeting the length requirement below:

Required dowel length = depth of slot + 8”

Rebars are placed in one-inch diameter by 12-inch deep drilled holes. These should be spaced approximately 18 inches on center in each slot. Immediately prior to placing the dowel, clean hole of dust and other deleterious material with a high pressure air hose. Fill hole halfway with grout. Insert dowel in hole by rotating it at least one complete turn while tapping it down. If necessary add more grout to fill hole.

After the epoxy has cured to reach mature strength in accordance with the manufacturer's recommendations, the slots should be cleaned one more time. Prepare surfaces of slots by high pressure water cleaning. Remove dust, dirt, and any loosely bonded material resulting from the previous work. Ensure slot surfaces are free of standing water prior to concrete placement.

Concrete mixture proportions are the responsibility of the Contractor. Specified compressive strength f'_c shall be 3,000 psi at 28 days. The maximum nominal size coarse aggregate is 3/4 inch. The concrete mix should includes a shrinkage compensating admixture. The air content shall be between 4.5 and 7.5 percent with a slump between 2 and 5 inches. The maximum water cement ratio shall be 0.50.

Sampling of fresh concrete for testing shall be in accordance with ASTM C 172. Test concrete for compressive strength at 7 and 28 days for each design mix. Concrete test specimens shall conform to ASTM C 31/C 31M. Perform Compressive strength testing conforming to ASTM C 39/C 39M.

Ensure that the concrete is properly consolidated, finished, protected, and cured.

STANDARD OPERATING PROCEDURE
FOR
FLOODWALL PAINTING AND MURALS

2 December 2010

Floodwall painting should be performed in accordance with the following requirements:

1. A sealant is applied to the portions of the concrete floodwall to be utilized for the mural. The sealant should be an acrylic sealer, meeting the requirements of Federal Specifications TT-C-555B, and should be applied in accordance with the manufacturer's recommendations.

2. A quality exterior primer and latex paint (meeting the requirements of Federal Specification TT-P-19) having a flat finish should be utilized for painting the mural, with the primer and paint applies in accordance with the manufacturer's recommendations.

3. If an entity other than the local sponsor wants to paint the floodwall, an agreement between the local sponsor and any entity wanting to paint the mural should be prepared. The agreement shall include a provision for "restoring" the floodwall (repainting or cleaning), if in the future the entity no longer wishes to maintain the mural project.

STANDARD OPERATING PROCEDURE
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
GRAVITY PIPES THROUGH EXISTING EARTHEN LEVEES
OPEN CUT ONLY

11 April 2011

1. Permit submittal shall discuss the size and slopes of the open cut or shoring of the excavation for the gravity pipe thru the existing earthen levee.

2. Permit submittal shall include results of testing for 0% pipe leakage between the limits defined by the two points located 15 feet out from each levee toe. A gravity line shall be pressure tested to no less than a test limit of 20 psi. This pressure test limit is subject to review and possible revision by the Corps of Engineers (COE) Mechanical Engineer during the permit review process, depending on the pipe material, joint type, etc.

3. Submittal shall provide a detail of the mechanical pipe joints/couplings to be used between the limits defined by the two points located 15 feet out from each levee toe.

4. Submittal shall include a cross-section of the levee embankment affected by proposed placement of new pipe and a plan of the levee right-of-way at the same location.

5. Submittal shall include the As-Built stationing where the proposed pipe will be located.

6. *The need for a secondary closure structure on a gravity pipe requires that USACE Hydraulic Engineer review information during the permit process to make this determination.* The following paragraph provides the permittee some insight into the requirements for the need or a secondary closure.

a. Flap gates shall be mounted to a headwall constructed at the riverside ends of all gravity pipes. For river systems that are not subject to flash flooding, the emergency closure system (i.e. sluice gates) shall also be provided with a gatewell housing a sluice gate. The gatewell shall be located on the riverside of the levee crown, at a point approximately 1/3 of the distance from the riverside levee toe to the landside toe. The first step in evaluating the pipe is to determine if there is even the potential for damages to occur in the interior. If the base flood elevation were below the zero damage elevation, there would be no need for a gatewell regardless of the pipe size. When the base flood elevation is above the zero damage elevation in the interior, an evaluation is necessary. In these cases, if the pipes are less than 36-inches in diameter, it is unlikely for the

inflow rate to be sufficient enough that emergency measures could not be employed to either inhibit the flow or utilize portable pumps. Therefore, for all pipes less than 36-inches, the flap gates alone are considered sufficient. For pipes 36-inches in diameter and greater, emergency measures to either inhibit the backflow or utilize portable pumps to pump the river water out of the interior are not considered to be reliable enough to prevent interior flooding. However, if there was an existing pump station these pump plants could keep up with the inflow from the river and prevent interior flooding. Therefore, for pipes 36-inches and greater, a gatewell with a sluice gate would be considered necessary if there was not a pump plant in the area that could handle the backflows without there being damages.

7. Submittal shall contain information regarding the piping materials to be used between the limits defined by the two points located 15 feet out from each levee toe. Corrugated metal pipe (CMP) is not allowed for new construction in levees.

8. Permit submittal shall show:

a. Backfill around gravity pipes shall be according to EM 1110-2-1913 Chapter 8, paragrapgh 8-5.b.(2) and Figure 8-5. From the outlet headwall to 1/3 the distance to the inlet headwall in areas where backfill compaction is difficult to achieve, flowable, low strength concrete fill has been used to encapsulate pipes in narrow trenches. The landside 1/3 length of pipe shall be backfilled using a landside blanket filter.
b. Low strength concrete or flowable fill material shall be placed 6-inches below and above the pipe and typically 12-inches minimum or ½ the pipe diameter (whichever is greater) on either side of the proposed pipe.
c. Material shall have a minimum compressive strength of 300 psi in 28 days.

9. Pipe loading calculations shall be performed on the proposed pipe per EM 1110-2-2902 titled “Conduits, Culverts, and Pipes” prior to approval of pipe materials.

10. Reference link to document below EM 1110-2-1913:

http://140.194.76.129/publications/eng-manuals/em1110-2-1913/toc.htm

Standard Operating Procedure
for
Greenway Walking Trails and Bike Paths on Levees

30 November 2010

1) General:

a) **USACE Levee Safety Letter of No Objection (LNO)**: Written approval from the USACE Levee Safety Officer is required before any work is performed on the levee.
b) **A/E Construction Drawings and Specifications:** All proposed levee trails shall be designed by competent licensed engineers and the submittal of a complete set of project plans and specifications is required before USACE Levee Safety Officer approval is granted.
c) **Notification of Utility Companies**: All local utility companies shall be contacted in the vicinity of proposed construction to allow for utility relocations.
d) **Work Easements and Right-of-Entries**: Permission from property owners shall be acquired.

2) Trail Design:

a) **Trail Width**: Trail widths shall not be permitted to exceed the existing width of the levee crown and in no instance be allowed wider then 12 feet.
b) **Bollards/Lighting**: Bollard and lighting bases shall be encapsulated in concrete. These shall not exceed a two foot embedment depth and shall be constructed of a suitable, safe, permanent material.
c) Bollards or gates are required at all access points to allow only authorized vehicle traffic.

3) Earthwork:

a) **Excavation**:
100-year protection levees: The levee crown shall not be excavated beyond minimal stripping of sod. The stripped crown shall be proof rolled before any aggregate stone is placed for the subbase. If excessive pumping or rutting occurs the material shall be removed and replaced with suitable material from an approved borrow location.

500-year protection levees: All suitable material that is excavated free of sod, excess stone, or other organic material shall be stored for reuse to facilitate final grading and for use as fill on overbuilt ramp sections. The excavated crown shall be proof rolled before any aggregate stone is placed for the subbase. If excessive pumping or rutting occurs the material shall be removed and replaced with suitable material from an approved borrow location.

b) **Fill Material:**
100-year protection levees: All material to be utilized for fill on levee slopes or low spots in the crown shall be acceptable cohesive material (USCS CL, CL-ML, or SC) and all necessary laboratory and field tests required for compaction verification shall be performed. Existing slopes shall be compacted to 95% Standard Proctor per ASTM D698. Loose lifts shall be limited to 6" for all work on the levee. Proof rolling shall be utilized. All low areas of the levee crown shall be raised to the As-Built Elevation.

500-year protection levees: All material to be utilized for fill on levee slopes shall be of acceptable cohesive material (USCS CL, CL-ML, or SC) and all necessary laboratory and field tests shall be performed to insure proper compaction is met. Constructed ramps/slopes shall be compacted to 95% Standard Proctor per ASTM D698. Fill material shall be compacted loose lifts not to exceed 6-inches for all work on the levee. Proof rolling shall be utilized.

c) **Benching of Ramps:** Ramps that extend from the levee toe to the levee crown (or any portion thereof) shall be benched into the existing levee to create a continuous well-integrated soil mass in accordance with the Louisville District *Benching Procedures within Levee Embankments* SOP. All benching shall coincide with the existing slope and consist of approved material compacted to 95% Standard Proctor per ASTM D698. The most common benching dimensions are given for a 10' horizontal length and a 3.33' rise. The benching slope shall coincide with the existing embankment slope and shall not be steeper than 3 (H):1 (V). Loose-lift thickness shall be limited to 6" for all work on the levee crown.
d) **Soil Stabilization:** Spray on Adhesives and Calcium chloride shall not be used as a soil stabilization method on the levee embankment. If the levee is too wet as determined by the COR or if visible rutting or pumping is occurring work on site shall be stopped until conditions improve as determine by COR.
e) **Maintain Positive Drainage**: All paths and trails shall have a minimum 2% transverse slope to drain water down slope. Water shall not be allowed to pond at or near the levee/ramp toe and shall have adequate drainage measures undertaken to reasonably prevent ponding water. Ramps and other soil structures that are added to the existing levee must drain away from the levee. Interior drainage between the levee and the ramp is not permitted.
f) **Pumping Station Air Vent and Siphons:** These structures are typically located between two and four feet below the levee crown with their risers protruding out of the ground. These Structures shall not be removed from the levee trail to facilitate construction. Photos of the structures shall be taken before work so that the condition of the structures can be assessed after work is completed. No excavations shall be permitted deeper then 1 foot below the levee crown in these locations.
g) **Pipes**: Pipes or culverts shall not be removed without USACE permission.

4) Subgrade:

a) **Compacted Aggregate Base**: Compacted aggregate subbase shall be placed in accordance with State DOT Specifications. Compacted aggregate shall not be placed below the 100-year protection elevation.
b) **Stripping**: The levee crown shall be stripped of all vegetation. Vegetation stripping shall be limited to 2 feet beyond the intended trail width.
c) **Grading/Compaction:** Compacted aggregate shall be placed above ground. Each lift of aggregate shall be compacted with a suitable roller or vibrating compactor until the base is compacted to 95% Standard Proctor per ASTM D698.
d) **Base Course Depth**: The base course shall not exceed 12 inches in depth. The aggregate shall be compacted with sloped edges on a maximum 1:1 slope. The base of the sloped edges shall be a minimum of 12" from the crown's edge.
e) **Base Side Slopes**: Side slopes shall be compacted and placed in lifts simultaneously with all other aggregates.
f) **Geotextiles**: The use of Contech, Tensar BX1100 Geogrid Fabric or equivalent is recommended to reduce the amount of stone required.

5) Pavement:

a) **Pavement**: All pavement shall be constructed in accordance with State DOT Specifications for Hot Mix Asphalt (HMA) Pavement and shall be maintained by such recommendations.
b) **Thickness**: A uniform thickness of asphalt shall be placed to include both surface and intermediate courses.
c) **Asphalt Cover:** Asphalt Cover shall completely cover compacted aggregate subbase including the sloped edge portion.
d) **Approved Castings:** Asphalt Pavement shall not be placed such that it covers or conceals any structures necessary for successful operation or maintenance of the levee including but not limited to survey monuments, valves, relief wells, manholes, closure structures, toe drains, etc. If covering such components is necessary, approved castings shall be utilized to provide access.

A typical installation is provided in Figure 1. Installations on the levee crest can utilize slab construction, while installations in areas that may become saturated must include a footer extending below frost line. Note that a bond-breaker separation must be installed between the monument and the concrete slab to prevent the monument from moving with the slab/footer.

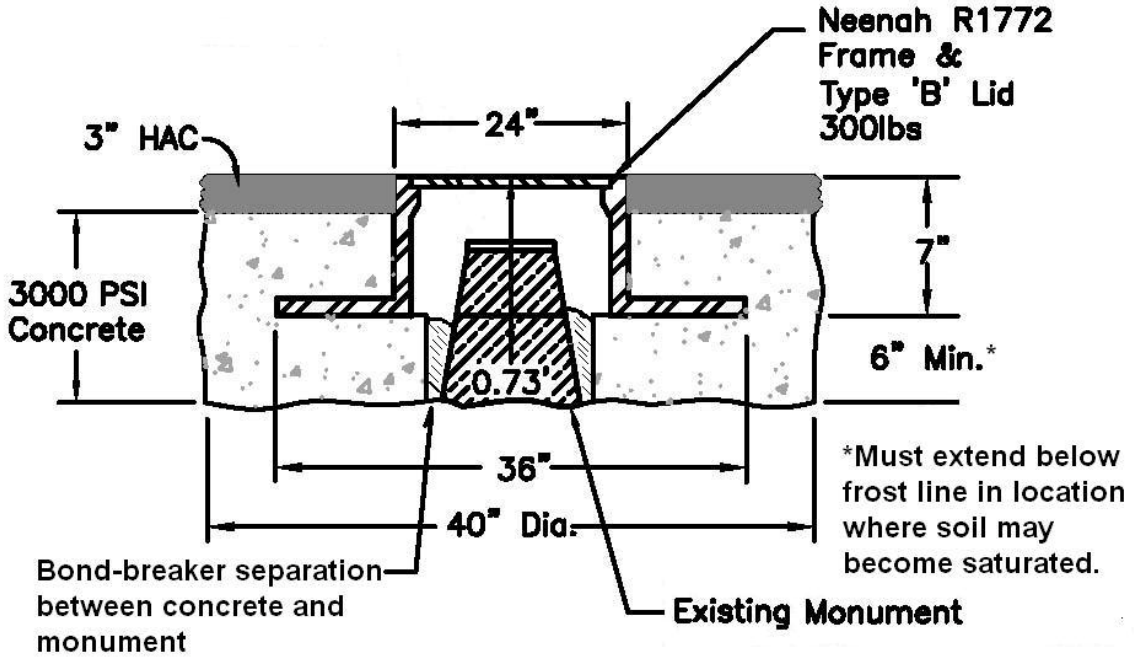


Figure 1. Typical manhole protection for existing monument.

6) Landscaping and Seeding:

a) Landscaping and Seeding shall be accomplished in accordance with the Operations and Maintenance Manual for the subject Project.

7) ADA Requirements:

a) All ADA Requirements shall be in compliance with recommendations from : *Part II Architectural and Transportation Barriers Compliance Board 36 CFR Part 1195 Architectural Barriers Act (ABA) Accessibility Guidelines for Outdoor Developed Areas; Proposed Rule (June 20, 2007)* and shall comply with all future revisions.
b) ADA requirements for all other parking and facility needs shall be met as needed.
c) Signage indicating handicapped access and other vital information shall be included per State Manual on Uniform Traffic Control Devices recommendation.

STANDARD OPERATING PROCEDURE
FOR
LEVEE SIGNAGE

28 April 2010

1) General

This Standard Operating Procedure (SOP) provides guidelines for the design and installation of signage at levees. General guidance for the materials and content of signs may be taken from of the Federal Highway Administration *Manual on Uniform Traffic Control Devices* (MUTCD), which is available at http://mutcd.fhwa.dot.gov/index.htm, and in the US Forest Service Engineering manual EM 7100-25 Sign and Poster Guidelines for the Forest Service, available at http://www.fs.fed.us/t-d/pubs/htmlpubs/em7100-15/index.htm . An example of a suitable sign is provided in Figure 1.

Each Local Sponsor may develop guidance for their Local Flood Protection Project that is consistent with local guidelines, ordinances, and themes for signage. Retroreflective signs are recommended. All signs and posts should be constructed of durable, long lasting, and low-maintenance materials. Signs should be located to minimize any impacts to inspection, operation and maintenance or ability to perform efforts during high water or flood events

Figure 1. Typical levee signage example.

STANDARD OPERATING PROCEDURE
FOR
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
NEW PRESSURE PIPES PASSING THROUGH EXISTING CASINGS IN CLOSURE SILLS OR FLOODWALL STEMS

10 January 2011

This SOP is to be used when a new pressure pipe is to replace an existing pressure pipe and will pass through the concrete floodwall (either through a closure sill or through a stem of the floodwall) within an existing larger diameter cast-in-place casing. Permits for this type of work will be technically reviewed and approved by the US Army Corps of Engineers (USACE). The following are a list of requirements which must be met for permit approval:

1. The annular space between the host pipe (casing) and the pressure pipe shall be sealed. The type of seal should be selected based on the comparative outside diameters of the two pipes. The sealant may be either a mechanical sealing device as described in paragraph A below, or a chemical sealant, as described in paragraph B below or a cementitious grout as described in paragraph C below.

A. If a mechanical annular space sealer can be used, it shall be as manufactured by either "Link-Seal" (as manufactured by Thunderline Link-Seal) or "Pipe Linx" (as manufactured by Calpico, Inc.). If one of these products is available for the two pipe diameters involved in the replacement, then the annular space between the new high pressure pipe and the casing must be filled with the appropriate sized "Link-Seal" or "Pipe Linx", installed in accordance with manufacturer's recommendations. One sealing device shall be installed on each side of the floodwall, with the outside limit of each sealing device located as close as possible to the outer limit of the floodwall concrete, but also in accordance with manufacturer's recommendations.

B. A chemical annular space sealant may be required because the annular space is too large for a mechanical device. If this is the case, after final placement of the pressure pipe within the casing, the entire length of casing shall be filled with SEMCO PR-821 two-part urethane closed cell foam, or another product with the following equivalent salient characteristics. The product may be one that when mixed will expand in volume to form a closed cell foam with a density of 2 to 5 lbs. per cubic foot. The product should reach full strength within one hour after application. The product should exhibit excellent mechanical adhesion to most surfaces without primers and must have good resistance to alkalis, dilute acids, moisture, rot, and rodents.

C. For cases where there is a large annular space (larger than 3-inches) a specialty shrinkage compensating cementitious grout should be used. Two products are to be used together. First, a product should be applied that promotes a good bond between the grout and both

the casing pipe and high pressure pipe. Sikadur 32 (or approved equal) is such a product. The product shall be brushed onto the outside of the new high pressure pipe and also brushed onto the surface of the casing pipe. At each end of the pipe, a bulkhead shall be installed prior to placement of the grout. Then a grout such as SikaGrout300 (or approved equal) shall be pumped into the annular space through a port installed in one of the bulkheads. An inspection port shall be installed at the bulkhead end opposite of the grout port. Both products shall be applied in accordance with manufacturer recommendations. Filling of the annular space shall be monitored and inspected to insure that the space has been completely filled for its entire length.

2. Permit submittal shall include pipe materials and the procedures to install the pipe.

3. Provide a detailed cross-section, including location/station, of the proposed pressure pipe to be installed thru the existing floodwall or closure sill, including pipe geometry, trench details, valve locations, etc. All features involved in the project modification shall be shown.

4. Shut off valves are required for the pressure pipes on the landside and riverside of the floodwall. Valves must be located within 15 ft of the floodwall.

5. The permit submittal shall include results of testing for 0% pipe leakage between the two shutoff valves. Pressure test to 200 psi or 150% of working pressure, which ever is greater. This pressure test limit is subject to review and possible revision by the Corps of Engineers (COE) Mechanical Engineer during the permit review process.

STANDARD OPERATING PROCEDURE
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
NEW PRESSURE PIPES PASSING THRU EXISTING FLOODWALL STEMS

10 January 2011

The structural design engineer should review the reinforcement drawings for the particular wall section that the proposed utility is to pass thru. If the primary reinforcement on the tension side of the stem is spaced at 12-inches c-c, then a pipe of up to 8-inches may be permitted to pass thru. If the primary reinforcement on the tension side of the stem is spaced at 6-inches c-c, then a pipe of up to 4-inches may be permitted to pass thru. This will be technically reviewed and approved by the USACE structural engineer. The following are a list of requirements which must be met for permit approval:

1. The utility passage thru the floodwall shall be thru the stem only - not thru the base nor thru the key below the base.

2. At the location in the floodwall where the utility crossing is to be made, a trench must be excavated on both sides of the floodwall allowing sufficient clearance for coring equipment to be properly mounted;

3. The hole shall be cored thru the floodwall (from riverside to landside of the floodwall) and the wall of the resulting hole shall be smooth. Holes drilled using rotary percussion tools should not be permitted. Holes must be circular.

4. The core hole diameter shall be selected based on the outside diameter of the utility pipe in conjunction with the smallest "Link-Seal" (as manufactured by Thunderline Link-Seal) or "Pipe Linx" (as manufactured by Calpico, Inc.) that will fit; and the pipe must be installed thru the floodwall with the annular space between the pipe and the smooth-walled cored hole containing a "Link-Seal" or "Pipe Linx", installed in accordance with manufacturer's recommendations on both sides of the floodwall.

5. Permit submittal shall include pipe materials. Pipe materials shall be either ductile iron with a polyethylene coating or steel pipe cleaned primed and painted with USACE formula -200A or equal. These materials must be used between 15 feet out from levee toes.

6. All pressure piping will be either Steel Pipe or Ductile Iron and have Flexible Mechanical Couplings or Restrained Joints. Mechanical couplings or restrained joints will not be allowed inside the floodwall. The following is a list of acceptable manufacturers for the types of pipe listed:

    a. *Steel Pipe – Flexible Type Couplings
        i. Dresser Style 38
        ii. Conform to ASTM S1476, type 2 class 3 stainless steel (Straub - Flex will meet this requirement)
        * These type couplings require an external type restraint harness designed and installed in accordance with AWWA M11.

    b. Ductile Iron Pipes – Flexible Restraint Joints
        i. US Pipe TR Flex
        ii. American Ductile Iron Pipe – Flex Ring
        iii. EBAA Iron MEGALUG Series 1100

7. Provide a detailed cross-section, including location/station, of the proposed pressure pipe to be installed thru the existing floodwall stem, including pipe geometry, trench details, valve locations, etc. All features involved in the project modification shall be shown.

8. Shut off valves are required for the pressure pipes on the landside and riverside of the floodwall. Valves must be located within 15 ft of the floodwall.

9. The permit submittal shall include results of testing for 0% pipe leakage between the shutoff valves. Pressure test to 200 psi or 150% of working pressure which ever is greater. This pressure test limit is subject to review and possible revision by the USACE) Mechanical Engineer during the permit review process.

If the permittee is proposing to install a pipe greater than 8-inches in diameter thru an existing floodwall, a modification to the floodwall may be necessary, as this would likely require cutting of two adjacent primary reinforcement elements. To avoid a structural modification the permittee must submit design calculations based on "As Built" drawings and the latest Corps reinforced concrete design guidance to determine whether coring a larger diameter hole is possible without modification to the existing wall. Possible modifications include installation of a structural buttress or counterfort, or installing structural bridging across the hole that redistributes the bending moments.

STANDARD OPERATING PROCEDURE
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
NEW PRESSURE PIPES PASSING THRU NEW FLOODWALL STEMS

10 January 2011

1. New pipes passing thru new floodwalls shall be thru the stem only – not thru the base nor thru the key below the base.

2. New pipe shall have a sleeve equipped with a pipe ring and extend approximately 5 ft on either side of the floodwall. Then annular space between the sleeve and the pipe shall contain a "Link Seal" or approved equal installed in accordance with manufacturer's recommendations on both sides of the floodwall.

3. Shut off valves are required on the landside and riverside of the floodwall for pressure pipes. Valves must be located within 15 ft of the floodwall. The location of the shut off valves shall be shown on the detail cross-section provided with the permit submittal.

4. The permit submittal shall include a plan for testing for 0% pipe leakage between the shutoff valves (as-built submittals shall include the testing results). Pressure test to 200 psi or 150% of working pressure which ever is greater. This pressure test limit is subject to review and possible revision by the Corps of Engineers (COE) Mechanical Engineer during the permit review process.

5. As part of the permit, a detailed cross-section of the proposed pressure pipe to be constructed thru a new floodwall monolith will need to be provided.

6. Permit submittal shall include pipe materials. Pipe materials shall be either ductile iron with a polyethylene coating or steel pipe cleaned primed and painted with Corps of Engineers (COE) formula - 200A or equal. These materials must be used between the shutoff valves.

7. All pressure piping will be either Steel Pipe or Ductile Iron and have Flexible Mechanical Couplings or Restrained Joints. Mechanical couplings or restrained joints will not be allowed inside the floodwall. The following is a list of acceptable manufacturers for the types of pipe listed:

    a. *Steel Pipe – Flexible Type Couplings
        i. Dresser Style 38
        ii. Conform to ASTM S1476, type 2 class 3 stainless steel (Straub - Flex will meet this requirement)
        * These type couplings require an external type restraint harness designed and installed in accordance with AWWA M11.

    b. Ductile Iron Pipes – Flexible Restraint Joints
        i. US Pipe TR Flex
        ii. American Ductile Iron Pipe – Flex Ring
        iii. EBAA Iron MEGALUG Series 1100

STANDARD OPERATING PROCEDURE
FOR
GENERAL GUIDANCE ON POLES AND PENETRATIONS IN OR NEAR (WITHIN 15 FT OF LEVEE TOE) *LEVEE EMBANKMENTS* OR NEAR (WITHIN 8 FT OF BASE OF FLOODWALL) *FLOODWALLS*

6 April 2010

LEVEE EMBANKMENTS

Existing Poles/penetrations

1. If poles/penetrations are located in the **riverside** levee embankment or near the "riverside toe" of a levee (within 15 feet of the levee toe) – these poles/penetrations can stay whether they are in the levee embankment and do not penetrate into the foundation below the levee, in the levee embankment and penetrate into the foundation below the levee, or are within 15 feet of the riverside toe of the levee. The reason for this is because there should not be an increased seepage path through the levee embankment to the landside of the levee which could ultimately cause a failure of the embankment.
2. If poles/penetrations are in the **landside** slope of a levee and do not penetrate below the foundation of the levee, these poles/penetrations can remain. Assuming the levee embankment is constructed out of impermeable soils (e.g. - SC, CL, ML), then no piping resulting in a possible levee failure could be caused because of the location of these poles/penetrations in the landside levee embankment.
3. If poles/penetrations are in the levee embankment or near the **landside** toe of the levee (within 15 feet of the levee toe) and penetrate below the foundation of the levee - then a review of the boring logs from the As-Built/Construction drawings would need to be accomplished. As long as there is **impermeable** (e.g. - SC, CL, ML) soils below the levee and extends a minimum of 15 feet outside the levee toe and the pole does not penetrate below this zone and there is a minimum of 3 feet of a impermeable soil below the bottom of the pole before reaching a permeable soil then these poles/penetrations can remain.
4. If there are poles/penetrations which are in or near the **landside** slope of the levee (within 15 feet of the levee toe) and penetrate below the foundation of the levee or the landside seepage blanket - then a review the boring logs from the As-Built/Construction drawings would need to be accomplished. If the logs show impermeable soils but the pole extends below into a permeable soil (e.g. - SP, GP, SW, GW) zone, then these poles/penetrations must be removed. Also, if there is **no impermeable** soil below the levee then these poles/penetrations must be removed. The reason for this is because if floodwaters seep through or under the levee embankment to the locations where these poles/penetrations are located, then these penetrations could provide areas where waters could seep along the

surface of these poles/penetrations causing embankment materials to be removed from under the levee resulting in a possible failure of the embankment.

Note: **Guy wires** are also considered penetrations and shall be reviewed using the above 4 items.

FLOODWALLS

Existing Poles/penetrations

1. If poles/penetrations are located on the **riverside** within 8 feet of the base of a floodwall – these poles/penetrations can stay. The reason for this is because it is not likely that the riverside location of these poles would not decrease the seepage path under the floodwall to the landside causing supporting foundation materials to be removed from under the floodwall resulting in a possible failure of the floodwall.
2. If poles/penetrations are within 8 feet of the base of the **landside** floodwall and penetrate below the foundation of the floodwall then a review of the boring logs from the As-Built/Construction drawings would need to be accomplished. As long as there is **impermeable** (e.g. - SC, CL, ML) soils below the floodwall that extends a minimum of 3 feet below the pole/penetration before reaching a permeable soil then these poles/penetrations can remain. However, if the logs show impermeable soils but the pole/penetration extends below into a permeable soil (e.g. - SP, GP, SW, GW) zone, then these poles/penetrations must be removed. Also, if there is no impermeable soil below the foundation of the floodwall, then these poles/penetrations must be removed. The reason for this is because if floodwaters seep under the floodwall to the locations where these poles/penetrations are located, then these penetrations could provide areas where waters could seep along the surface of these poles/penetrations causing supporting foundation materials to be removed from under the floodwall resulting in a possible failure of the floodwall.

New Poles/penetrations

1. No New Poles/penetrations allowed without permit approval depending on their location relative to the levee embankment and a review of the boring logs from the As-Built /Construction drawings.

Backfill Procedures for Removed Poles/Penetrations

Once an existing pole or penetration is removed, the remaining hole should be backfilled using one of the following methods:

Method 1: Backfill. Vertical holes shall be backfilled with granulated bentonite in not greater than 1-foot increments. Bridging of the cavity during bentonite placement can

occur; therefore, soundings of hole shall be performed to confirm backfill material has reached the bottom of the hole. If dry conditions cannot be maintained, coated bentonite pellets shall used. The upper two feet of the hole shall be backfilled with soil to allow establishment of vegetation.

Method 2: Backfill. The holes will be grouted. Grout the holes using the tremie method and a VOLCLAY Grout which will set to a consistency of a stiff soil with a permeability of 10^{-7} to 10^{-8} cm/sec.

TABLE 11.1 Recommended Pole-Setting Depths in Soil and Rock for Various Lengths of Wood Poles

Length of pole, ft	Setting depth in soil, ft	Setting depth in rock, ft
25	5.0	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0
65	8.5	6.0
70	9.0	6.0
75	9.5	6.0
80	10.0	6.5
85	10.5	7.0
90	11.0	7.5
95	11.0	7.5
100	11.0	7.5
105	12.0	8.0
110	12.0	8.0
115	12.0	8.0
120	13.0	8.5
125	13.0	8.5
130	13.0	8.5
135	14.0	9.0

Source: Commonwealth Edison Company.

STANDARD OPERATING PROCEDURE
FOR
PRACTICE CLOSURE CONSTRUCTION

30 November 2010

Local Sponsors shall be responsible for documenting their practice closure construction process. Prior to construction of a closure, two photographs are taken to record an overview of pre-closure site conditions of both landside and riverside. With approximately half of the closure constructed, a second set of photographs are taken of both landside and riverside. When the closure has been completely constructed, a final overview photograph set is taken to document the post-closure site conditions both landside and riverside. As the closure is being constructed special care is taken to document and photograph any problems that may arise during practice installation. All photos and documentation are submitted to USACE for review.

STANDARD OPERATING PROCEDURE
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
PRESSURE PIPES – UP AND OVER EXISTING EARTHEN LEVEES

7 January 2011

1. All pressure pipes are required to go up and over existing levee embankments where excavations do not go below the freeboard zone. Three methods are recognized for pressure pipe crossings:

    a. Shallow excavation (three ft maximum) and pipe burial, using appropriate benching and compaction as specified in the SOP for *Excavation Benching and Backfill Compaction for Levee and Floodwall Modifications*.

    b. Removal of vegetative zone, pipe placement on levee surface, and pipe covered using an over-built section. The overbuilt section shall be constructed with 1(V):10(H) sideslopes and a crest area over the pipe that is at least 12 ft wide. All longitudinal and transverse transitions between slopes and crests of the overbuilt section shall be rounded on a two-ft radius to facilitate mowing.

    c. Alternate methods specifically proposed for situations where the two methods above are not practical.

    If pressure pipe require a depth of embedment deeper than the design freeboard limits, additional material can be added over the top of the pipe and smooth graded in with the levee embankment to allow for proper mowing of the levee crown and side slopes.

2. Pipe jacking or directional drilling through a levee or underlying cohesive soil is not permitted.

3. No sleeving/casing around the outside of pressure pipes going up and over earthen levees is required.

4. Shut off valves shall be provided on the landside and riverside of an earthen levee embankment within 15 ft from the levee toes, measured along the pipe. The location of the shut off valves shall be shown on the detailed cross-section provided with the permit submittal.

5. The permit submittal shall include details on the following items:

    a. Construction drawings showing the details of all proposed activities within 15 ft of the levee toes including any trench details, a cross-section of the levee

embankment affected by proposed placement of new pipe and any associated structures (shut off valves), a current plan of the levee right of way at the same location, and a copy of the as-built drawing sheet(s) for the permit location with the proposed pipe crossing location/station indicated.

b. Calculations demonstrating that the pipe installation is appropriate for live loads generated by a fully-loaded tri-axial dump truck.

c. Pipe leakage testing plan for 0% pipe leakage between the two shut-off valves). Pressure test to 200 psi or 150% of working pressure, which ever is greater. This pressure test limit is subject to review and possible revision by the Corps of Engineers (COE) Mechanical Engineer during the permit review process. The as-built documentation shall include results of testing.

d. Proposed pipe materials shall be either ductile iron with a polyethylene coating or steel pipe that is cleaned, primed, and painted with Corps of Engineers (COE) formula C200A or equal. These materials must be used between 15 feet out from levee toes. Other pipe materials will be considered on a case-by-case basis.

e. Steel pipe joints shall be flexible t  couplings with an external type restraint harness designed and installed in accordance with AWWA M11:

   i. Dresser Style 38
   ii. Conform to ASTM S1476, type 2 class 3 stainless steel (Straub - Flex will meet this requirement)

f. Ductile iron pipes shall use flexible restraint joints:

   i. US Pipe TR Flex
   ii. American Ductile Iron Pipe – Flex Ring
   iii. EBAA Iron MEGALUG Series 1100

6. Backfill materials both around the pipe and used in any construction associated with an over-built section shall be acceptable low-permeability soil, ~~low-strength/low-slump cementitious mixtures, or other approved low-permeability~~ materials. ~~Cementitious mixtures shall have strength characteristics similar to the surrounding soil to ensure that it can be excavated using a conventional backhoe, and the design shall include seep collars cast along with the backfill~~. The backfill placed between 15 feet out from levee toes shall be placed six inches below and above the pipe and typically 12 inches minimum or ½ the pipe diameter whichever is greater on either side of the proposed pipe.

STANDARD OPERATING PROCEDURE
FOR
UTILITY PENETRATIONS IN LEVEES AND FLOODWALLS
PRESSURE PIPES – THROUGH EXISTING GATE CLOSURES AS NEW CONSTRUCTION

6 January 2011

1) The pressure pipe must be sleeved totally through the gate sill. The gate valves must be located outside the pipe sleeve. Sleeve must be equipped with pipe ring and be approximately 5 ft either side of the gate sill and shall be poured in place with gate closure sill. The annular space between the sleeve and the pipe shall contain "Link Seal" or approved equal on both sides of the gate sill.

2) Permit submittal shall include pipe materials. Pipe materials shall be either ductile iron with a polyethylene coating or steel pipe cleaned primed and painted with Us Army Corps of Engineers (USACE) Formula-200A or equal. These materials must be used between the shutoff valves.

3) All Pressure piping will be either Steel Pipe or Ductile Iron and have Flexible Mechanical Couplings or Restrained Joints. The following is a list of acceptable manufacturers for the types of pipe listed:

a. *Steel Pipe – Flexible Type Couplings
- i. Dresser Style 38
- ii. Conform to ASTM S1476, type 2 class 3 stainless steel (Straub - Flex will meet this requirement)
  - * These type couplings require an external type restraint harness designed and installed in accordance with AWWA M11.

b. *Ductile Iron Pipes – Flexible Restraint Joints*
- i. US Pipe TR Flex
- ii. American Ductile Iron Pipe – Flex Ring
- iii. EBAA Iron MEGALUG Series 1100

4) Provide a detailed cross-section of pressure pipe to be installed in gate closure sill, including location/station.

5) Shut off valves are required on the landside and riverside of the floodwall. Valves must be located within 15 ft of the floodwall. The location of the shut off valves shall be shown on the detail cross-section provided with the permit submittal.

6) Permit Submittal shall include results of testing between the shutoff valves for 0% pipe leakage and the testing requirements are the following: Pressure test to 200 psi or 150% of working pressure which ever is greater. This pressure test limit is subject to review and possible revision by USACE Mechanical Engineer during the permit review process.

7) The following are the requirements which must be met to Reestablish Concrete Gate Sill

a) The concrete shall have a minimum f'_c (compressive strength) of 4,000 psi at 28 days

b) The concrete shall have a maximum water to cementitious material ratio, (w/c), of 0.45
c) The coarse aggregate shall meet the quality and gradation requirements of ASTM C33, Class 4S. The contractor should provide recent (within 1 year) test results to show that it meets this criteria.
d) The fine aggregate shall meet the gradation and quality requirements of ASTM C33. The contractor should provide recent (within 1 year) test results to show that it meets this criteria.
e) The concrete mix proportions should be reviewed by USACE.
f) The concrete shall contain a minimum of 20% of the total cementitious content as fly ash.
g) The contractor should provide USACE with the most recent mill certifications for the cement and fly ash.

8) Permit shall include the following information either on the drawings or in the specifications:

a) Prior to concrete placement, the contractor shall re-establish the continuity of the cut reinforcing steel by installation of lapped or mechanically spliced bars. Sufficient concrete shall be removed around the existing bars to either side of the utility cut to allow for either lap or mechanical splicing in accordance with ACI 318 requirements. If lap splices are used, the lap length shall be determined by the contractor in accordance with ACI 318 requirements. A mechanical splice such as the "Zap Screwlok" or similar is preferred by USACE as it minimizes the amount of concrete removal. This work must be done for every reinforcing bar that was cut. Once the reinforcement installation has been completed, then concrete can be placed to re-establish the sill. The lap splicing bars shall be the same as the ones cut from the closure sill.

STANDARD OPERATING PROCEDURE
FOR
PROTECTIVE COATING OF STEEL CLOSURE COMPONENTS

2 December 2010

Flood protection structures including floodwalls, pumping stations, closure structures, etc., require periodic inspection as prescribed by the Regulations. Closure components, sills, closure abutments, wing walls and storage vaults should be checked for compliance.

This document provides general guidance for the application of new protective coating systems to steel closure components with failing protective coatings. Please note that paint failure that has occurred as a result of unusual loadings should be brought to the attention of USACE and a determination can usually be made regarding the cause and a plan for repair can be developed. Additionally no large paint repair job should be undertaken without prior approval of USACE.

USACE strongly recommends that steel closure components, both fixed embedded steel components and movable steel components, be protected with the Corps System 5-E-Z, which is a "Zinc-Rich Impacted Immersion Coating" vinyl paint system; this is described below. This system requires that the primer be applied directly to the base metal that has been adequately repaired.

In some cases it may be more economical and environmentally feasible to cold-apply a coal tar protective coating system such as Corps System 7. This system may be more attractive because it is easier to apply and does not require as thorough a blast preparation as less user-friendly vinyl systems. Moreover, local flood-protection projects are given to local authorities, who are responsible for the maintenance of the completed project, and the maintenance of surfaces painted with cold-applied coal tar epoxy is more within their capabilities and experience. In essence, the recommended System 7 is more user-friendly and surface tolerant to the inexperienced applicator.

Adequate preparation requires complete removal of any old existing paint system or primer, including lead primers. Because lead paint dust is a hazardous material, removal of an existing lead paint system should be undertaken in a controlled environment which includes the capability to capture and dispose properly the lead paint dust and the blast media.

Preparation

System 5-E-Z: The steel components should be sandblasted to "White Metal" in accordance with SSPC-SP5/NACE 1; this should result in a 1.5 - 2.5 mil blast profile. Clean surfaces to be painted before applying paint or surface treatments. Remove deposits of grease or oil in accordance with SSPC SP 1, prior to mechanical cleaning. Solvent cleaning shall be accomplished with mineral spirits or other low toxicity solvents

having a flash point above 100 degrees F. Use clean cloths and clean fluids to avoid leaving a thin film of greasy residue on the surfaces being cleaned. Protect items not to be prepared or coated from damage by the surface preparation methods. Machinery shall be protected against entry of blast abrasive and dust into working parts. Cleaning and painting shall be so programmed that dust or other contaminants from the cleaning process do not fall on wet, newly painted surfaces, and surfaces not intended to be painted shall be suitably protected from the effects of cleaning and painting operations.

System 7: Cleaning of the metal surfaces can be accomplished by (1) SSPC SP 6/NACE No.3 Commercial Blast Cleaning or (2) by SSPC SP 3 Power Tool Cleaning or SSPC SP 7/NACE No.4 Brush-Off Blast Cleaning. Only one of the alternative methods should be specified. The Commercial blast cleaning assures better performance of the coating; however it should only be used where a coating vendor can easily accomplish it. For most components, power tool or brush-off blast cleaning is considered adequate since it will, in all probability, be more in keeping with the standard practice of the applicator. For touch-up paints, cleaning should be by the solvent and wire-brush method.

Application

1. Paint shall be applied only to surfaces that are above the dew point temperature and that are completely free of moisture as determined by sight and touch. Paint shall not be applied to surfaces upon which there is detectable frost or ice. Except as otherwise specified, the temperature of the surfaces to be painted and of air in contact therewith shall be not less than 45 degrees F during paint application nor shall paint be applied if the surfaces can be expected to drop to 32 degrees F or lower before the film has dried to a reasonably firm condition. During periods of inclement weather, painting may be continued by enclosing the surfaces and applying artificial heat, provided the minimum temperatures and surface dryness requirements prescribed previously are maintained. Paint shall not be applied to surfaces heated by direct sunlight or other sources to temperatures that will cause detrimental blistering, pin holing, or porosity of the film.
2. The finished coating shall be free from holidays, pinholes, bubbles, runs, drops, ridges, waves, laps, excessive or unsightly brush marks, and variations in color, texture, and gloss. Application of initial or subsequent coatings shall not commence until the responsible engineer (or sponsor's representative) has verified that atmospheric conditions and the surfaces to be coated are satisfactory. Each paint coat shall be applied in a manner that will produce an even, continuous film of uniform thickness. Edges, corners, crevices, seams, joints, welds, rivets, corrosion pits, and other surface irregularities shall receive special attention to ensure that they receive an adequate thickness of paint. Spray equipment shall be equipped with traps and separators and where appropriate, mechanical agitators, pressure gauges, pressure regulators, and screens or filters. Air caps, nozzles, and needles shall be as recommended by the spray equipment manufacturer for the material being applied.
3. **System 5-E-Z**: Paint shall be spray applied to an average dry film thickness of a minimum of 175 microns for the completed system, and the thickness at any point shall not be less than 140 microns. The dry film thickness of the zinc-rich primer shall be approximately 63 microns. The specified film thickness shall be attained in any event.

Attaining the specified film thickness by applying fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not cause an increase in pinholes, bubbles, blisters, or voids in the dried film and also provided that not more than 50 microns (dry film thickness) per double spray coat nor more than 25 microns per single spray pass of non-zinc paint shall be applied at one time.

4. **System 7** The materials shall be heavily applied by brush or with heavy-duty spray equipment at a coverage rate that will give a minimum total dry film thickness of 500 microns at any point for the completed system. The paint shall not be thinned unless recommended by the manufacturer. If brushed, the final strokes shall be at right angles to those of the preceding coat. Application and drying time between coats shall be as recommended by the coating manufacturer.
5. Generally, entire surface areas of closure gates, trusses, panels, purlins, etc., should be treated as though subject to immersion (e.g., painted overall with the same system) even though exposed only in part to floodwaters.
6. Minimum drying periods after final coat prior to immersion shall be: vinyl-type paint systems at least 3 days, and cold-applied coal tar systems at least 7 days. Minimum drying periods shall be increased twofold if the drying temperature is below 65 degrees F and/or if the immersion exposure involves considerable abrasion.

Commentary on Sequence of Work

Welding should not be performed on previously painted surfaces. Welding in the vicinity of previously painted surfaces shall be conducted in a manner to prevent weld spatter from striking the paint and to otherwise reduce coating damage to a minimum; paint damaged by welding operations shall be restored to original condition. Surfaces to be painted that will be inaccessible after construction, erection, or installation operations are completed shall be painted before they become inaccessible.

Coating Systems

Corps of Engineers System 5-E-Z: Zinc-Rich Impacted Immersion Coating

Surface Prep: White Metal Blast per SSPC-SP5/NACE 1, 1.5 - 2.5 mil profile

One Coat: Zinc Clad 108 @ up to 2.5 mils 63.5 microns dft. in one double spray coat
One Coat: V-766e Gray Vinyl @ up to 2 mils 50.8 microns dft. in one double spray coat
One Coat: V-766e White Vinyl @ up to 2 mils 50.8 microns dft. in one double spray coat
One Coat: V-766e Gray Vinyl @ up to 2 mils 50.8 microns dft. in one double spray coat

Corps of Engineers System 7: Cold-Applied Coal Tar Coating

Surface Prep: Alternate 1: SSPC SP 3 Power Tool Cleaning or SSPC SP 7/NACE No.4 Brush-Off Blast Cleaning
Alternate 2: SSPC SP 6/NACE No.3 Commercial blast cleaning
1st Coat: SSPC Paint 33 (Coal Tar Mastic, Cold-Applied)
2nd Coat: SSPC Paint 33 (Coal Tar Mastic, Cold-Applied)
3rd Coat: SSPC Paint 33 (Coal Tar Mastic, Cold-Applied)

STANDARD OPERATING PROCEDURE
FOR
REPAIR OF MONOLITH JOINT MATERIAL

2 December 2010

Flood protection structures including floodwalls, pumping stations, gatewells, etc., require periodic inspection as prescribed by the Regulations. Concrete structures should be checked for spalling, porosity, cracking, and failures of monolith expansion-joint seals.

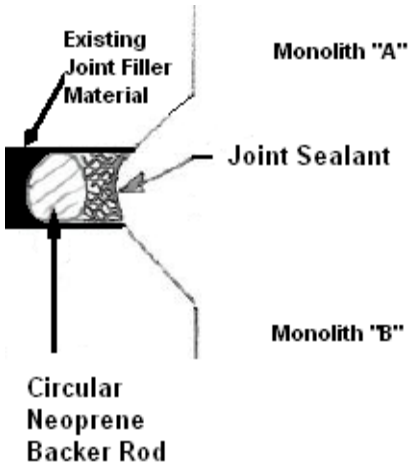
This document provides general guidance for the repair of monolith expansion or contraction joints. Please note that damage to joint sealant that has occurred as a result of vandalism may be repaired using these same recommendations. Damage that has occurred as a result of unusual or unexpected loadings should be brought to the attention of USACE and a determination can usually be made regarding the cause and a plan for repair can be developed. Additionally no large monolith joint repair/replacement project should be undertaken without prior approval of USACE.

Replacement of Joint sealant

Joint sealant is the external component of a concrete monolith joint system. It should be repaired or replaced if it becomes damaged or has deteriorated. As the joint sealant for a project begins to deteriorate, usually as a result of age, it will become apparent that it has lost its elasticity. The sealant material may be cracked, may have separated from the adjacent concrete surfaces, may be falling out of the joint, and there may be gaps of all sizes and shapes in the joint sealant. The old joint sealant should be removed to bare, clean concrete. Use of chemicals to remove traces of the old sealant is permissible. After removal of the old sealant is completed, the joint filler material should be visible. If the joint filler material is not in acceptable condition, the replacement process is far more complex and is described in a subsequent section of this document. Assuming the joint filler material is found to be in acceptable condition, the process to replace the joint sealant should continue. A new circular backer rod should be placed in the exposed joint, with its back pressed directly against the existing joint filler material, to ensure that the thickness of the center of the new sealant will be thinner than the edges where the sealant bonds to each adjacent concrete monolith. It is important that the backer rod be installed as close to parallel to the concrete monolith surface as possible to ensure uniform thickness of the joint sealant.

The new joint sealant material should be a gunnable or caulkable material meeting the requirements of ASTM C 920, Type S (Single Component) or Type M (Multi Component); Grade NS (a non-sag or gunnable sealant that permits application in joints on vertical surfaces without sagging or slumping when applied at temperatures between 4.4 and 50°C (40 and 122°F)); Class 50 (a sealant that when tested for adhesion and cohesion under cyclic movement shall withstand an increase and decrease of at least 50 % of the joint width as measured at the time of application); and Use NT (a sealant designed for use in joints located in non-traffic areas).

Application of the sealant should follow manufacturer's recommendations. The finished cross section of the joint sealant should look roughly as shown in the sketch below (the sketch shows a partial cross-section, looking down through the edge of the joint near the exterior face). Note that the intent is that the cross-section of the Joint Sealant should be thinnest at the centerline of the joint, and thickest at the two edges where the sealant is to adhere to the concrete monoliths. By installing the sealant in this precise way, the stresses on the joint sealant (caused by shortening of the monoliths in cold weather) will be highest in the center, which should ensure that the sealant does not pull away from the concrete.



Replacement of Expansion Joint Filler

The replacement of expansion joint filler material is generally a significant task best left to specialty contractors. The reason is primarily due to the difficulties typically encountered when attempting to remove the old joint filler material. A variety of different filler materials may be encountered, ranging from asphalt mixes (that become nearly rigid in cold weather but flow and become difficult to cut out in hot weather); to cardboard (which is often easy to remove with high pressure water jetting); to recycled rubber sheeting (which was typically bonded to one of the monolith faces with an adhesive). Removal of very stubborn materials with power saws has been accomplished successfully on some projects, but there is a high risk of causing destruction of the original copper, rubber or PVC center waterstop using this method. All efforts should be made to avoid damaging the waterstop.

Note that contraction joint filler material is not to be replaced. This thickness of contraction joint filler material is very thin, and removal is not possible without removal of some portion of the concrete monoliths – a very expensive and time consuming process. During the original floodwall construction a thin bond breaker was painted onto the end surface of a completed monolith; the subsequent monolith's concrete was poured directly against this face.

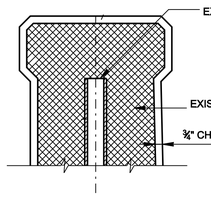
To replace expansion joint filler material the following steps should be followed (visuals for these steps can be seen in the drawing entitled, "Floodwall Monolith Expansion Joint Replacement"). The first step is to remove all existing joint sealant and joint filler material from the joint. Again great care should be exercised to avoid disturbance and damage to the existing copper, rubber or PVC waterstop. Hand tools and/or water jet can be used. This is to be done on

both wall faces. If damage to the waterstop has occurred within a joint, it is recommended that a 1-inch bead of a gunnable expansion joint filler be applied directly against the waterstop over the full height of the monolith stem. Acceptable gunnable expansion joint filler products include Sikaswell S-2 or Deneef Swellseal Gungrade, or approved equal; these are one-part polyurethane swelling water stop products. Application of such a product should be done only on the riverside.

Once this has been done, install new neoprene backer rods to fill the open voids between the center waterstops and the exteriors of the monolith faces; the backer rods are relatively easy to stuff into the narrow joints, and should be installed to within approximately 1 inch of the inside corner of the chamfer. For most standard floodwall cross sections, it is estimated that 10 to 12 pieces of backer rod will be the required on the landside, and, if the gunnable expansion joint material was applied, 8 to 10 pieces on the riverside. If no gunnable expansion joint material was applied, 10 to 12 pieces would be required on the riverside. See note 5 below for backer rod specifications. After the backer rods have been installed, care should be taken to ensure that the outermost backer rod has a semicircular profile on the outer surface. The next step is to install a joint sealant meeting the requirements outlined in a previous paragraph to the outermost backer rod. This is to be done on both wall faces. Finally, install an additional backer rod and a second application of the sealant. This is to be done to both wall faces.

Notes:

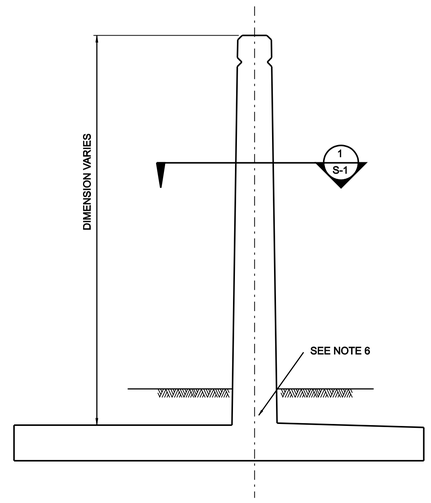
1. Remove existing expansion joint material down to ground surface.
2. All copper, rubber or PVC water stop shall be protected and retained.
3. Before joint work is initiated, concrete should be clean and sound. Abrasive methods may be used.
4. The joint filler replacement procedure described above for typical wall cross section shall be carried across the top of the wall to prevent the infiltration of rainwater.
5. Backer rod shall be ASTM C1330 Type B cylindrical with flexible sealant backing composed of by-cellular material as defined in terminology ASTM C717. Diameter of backer rod shall be approximately 25% larger than the joint width.
6. Removal of existing joint filler and sealant using jet tools will likely also remove some joint filler and sealant below grade. A pourable or injectable flexible joint filler shall be placed to replace any material lost below grade.



TYPICAL EXPANSION JOINT SECTION - EXISTING CONDITION
SCALE: NONE

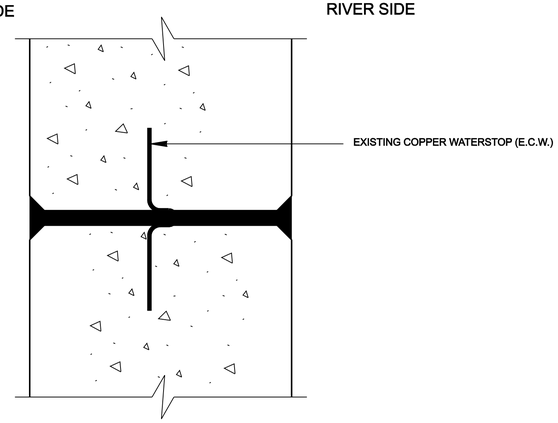
NOTES:

1. REMOVE EXISTING EXPANSION JOINT MATERIAL DOWN TO GROUND SURFACE.
2. ALL COPPER EXPANSION JOINT WATER SEAL SHALL BE RETAINED.
3. BEFORE JOINT WORK IS INITIATED, CONCRETE SHOULD BE CLEAN AND SOUND. ABRASIVE METHODS SHOULD BE USED.
4. REPAIR PROCEDURE DESCRIBED IN STEPS 3 - 5 FOR TYPICAL WALL CROSS SECTION SHALL BE CARRIED ACROSS THE TOP OF THE WALL TO PREVENT THE INFILTRATION OF RAINWATER.
5. BACKER ROD SHALL BE ASTM C1330 TYPE B CYLINDRICAL FLEXIBLE SEALANT BACKING COMPOSED OF BI-CELLULAR MATERIAL AS DEFINED IN TERMINOLOGY ASTM C717. DIAMETER OF BACKER ROD SHALL BE APPROXIMATELY 25% LARGER THAN THE JOINT WIDTH.
6. REMOVAL OF EXISTING JOINT FILLER AND SEALANT USING WATER JET TOOLS WILL LIKELY ALSO REMOVE SOME JOINT FILLER AND SEALANT BELOW GRADE. A POURABLE OR INJECTABLE FLEXIBLE JOINT FILLER SHALL BE PLACED TO REPLACE ANY MATERIAL LOST BELOW GRADE.



TYPICAL SECTION
NOT TO SCALE

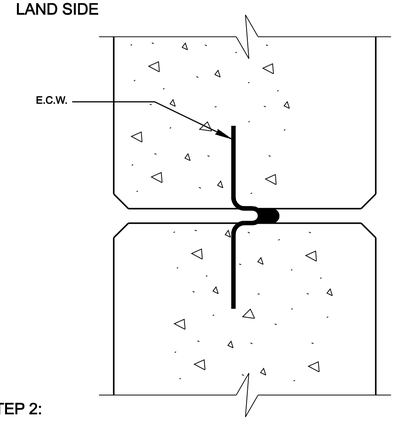
LAND SIDE RIVER SIDE



STEP 1:

REMOVE ALL EXISTING JOINT SEALANT AND JOINT FILLER MATERIAL FROM JOINT. DO NOT DISTURB EXISTING COPPER WATERSTOP. HAND TOOLS AND/OR WATER JET CAN BE USED. THIS IS TO BE DONE ON BOTH WALL FACES.

LAND SIDE RIVER SIDE

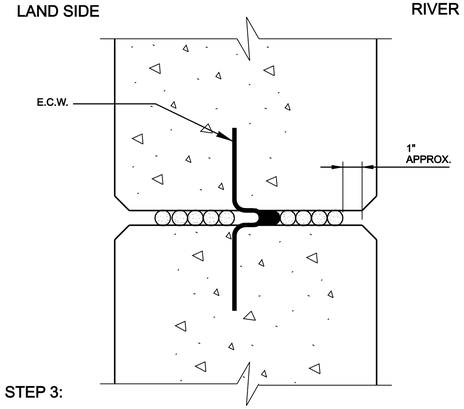


STEP 2:

INSTALL A 1-INCH BEAD OF GUNNABLE EXPANSION JOINT FILLER - SIKASWELL S-2 OR DENEEF SWELLSEAL GUNGRADE OR APPROVED EQUAL ONE PART POLYURETHANE SWELLING WATER STOP. THIS IS TO BE DONE ONLY ON THE RIVERSIDE.

REPAIR STEPS 1 -5 (1/S-1)
NOT TO SCALE

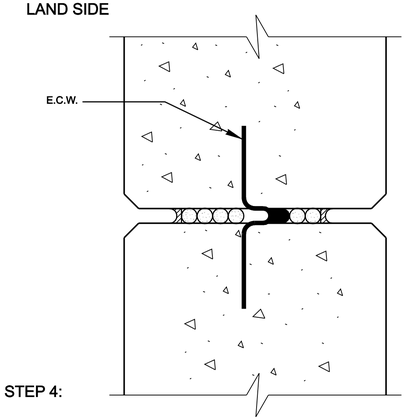
LAND SIDE RIVER SIDE



STEP 3:

INSTALL NEW BACKER RODS TO FILL OPEN VOID TO WITHIN APPROX. 1 INCH OF INSIDE CORNER OF CHAMFER. AN ESTIMATED 10 TO 12 PIECES OF BACKER ROD WILL BE REQUIRED ON LAND SIDE, 8 TO 10 PIECES ON THE RIVER SIDE. SEE GENERAL NOTE 5 FOR BACKER ROD SPECIFICATIONS.

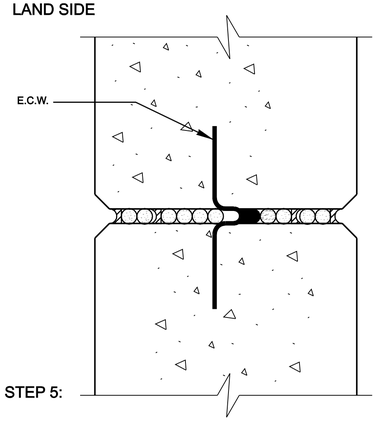
LAND SIDE RIVER SIDE



STEP 4:

INSTALL DOW 790 SILICONE SEALANT OR EQUAL TO OUTERMOST BACKER ROD. THIS IS TO BE DONE ON BOTH WALL FACES.

LAND SIDE RIVER SIDE



STEP 5:

INSTALL ADDITIONAL BACKER ROD AND A SECOND APPLICATION OF DOW 790 SILICONE SEALANT OR EQUAL. THIS IS TO BE DONE ON BOTH WALL FACES.

US Army Corps of Engineers
Louisville District

Revisions			
Symbol	Description	Date	Appr.

Designed by: T. SULLIVAN | Date: NOV. 2007
Drawn by: C. WARREN | Scale:
Checked by: C. NEUTZ | Drawing code:
Project Engineer/Architect: T. SULLIVAN | Date: AUG. 2007

TYPICAL T-WALL REPAIR SECTION & DETAILS

OHIO RIVER
LOUISVILLE, KY
TYPICAL T-WALL REPAIR

Sheet reference number: S-1
Sheet ___ of ___

PLOT DATE: $$$datetime
FILENAME: $$$pathname

STANDARD OPERATING PROCEDURE
FOR
REPAIR OF SPALLED OR CRACKED CONCRETE

2 December 2010

Flood protection structures including floodwalls, pumping stations, gatewells, etc., require periodic inspection as prescribed by the Regulations. Concrete structures should be checked for spalling, porosity, cracking, and failures of expansion-joint seals.

This document provides general guidance for the repair of concrete flood protection structures that have spalled or cracked concrete. Please note that cracks or spalls that have occurred as a result of unusual loadings should be brought to the attention of USACE and a determination can usually be made regarding the cause and a plan for repair can be developed. Additionally no large concrete repair job should be undertaken without prior approval of USACE.

Spall Repair

"Spalling" is defined as a condition where a piece of the completed concrete surface has been removed. Spalling may be caused by an impact from a vehicle or tool, or it may be caused by "pop-out" from the expansion of piece of unsuitable coarse aggregate. Spalling may also occur when the underlying reinforcement is located too close to the concrete's outer surface. In some unusual cases, spalls have been observed where a piece of large structural steel was left within the concrete forms and impinged on the required rebar cover. Another cause of spalling is when concrete has cracked as a result of shrinkage or some other stress, and water enters the rigid concrete matrix via the cracking. Freezing of water in the cracks is a common cause of spalling. When spalling is present on a structure and is not repaired, progressively greater damage may be expected to be caused to the structure over time. The required cover for the underlying reinforcement steel is compromised when a section of concrete has been removed. It should therefore be repaired as soon as possible.

(1) Repair concrete surfaces with shallow spalling – less than one inch in depth - with special cements designed to permit carrying the patch to a "feathered" edge. A line of products suitable for this kind of repair is available from CTS Cements under the "DOT" brand name.

(2) Patch deeply spalled concrete with ordinary concrete made with cement; the mixture should be as similar as possible to the original concrete, but with the addition of a shrinkage compensating admixture. Saw cut the concrete around the spalled area to a depth of approximately three-quarter inch, being careful not to cut underlying reinforcing steel; remove a roughly rectangular area that encompasses the entire spall, and remove the concrete to a fairly uniform depth. Roughen the sides of the saw cut area to promote a bond between the original concrete and the new concrete. Concrete must be free of materials such as paint, oil, curing compound, bond breaker, or any material that will inhibit bonding. Mechanically remove loose,

unsound, contaminated concrete. Clean any exposed reinforcing steel by sandblasting or other mechanical means to achieve a “white metal” finish. Thoroughly clean extraneous material such as dirt, loose chips, and dust from concrete surface. If compressed air is used, it shall be free of oil. Concrete surface shall be saturated with potable water. Standing water shall be removed from surface to achieve a saturated-surface-dry (SSD) condition. Then fill the removed area with fresh concrete. A very low slump or zero slump “dry patch” mortar such as is used to repair shallow defects in new concrete is suitable for repair of spalls on vertical or near vertical surfaces. A concrete mix with excessive cement will tend to shrink. It is further suggested that a curing compound be added in accordance with manufacturer’s recommendations to reduce drying shrinkage.

Spall Prevention

Keep cracked concrete from spalling by sealing the surface with a soluble reactive silicate concrete treatment product such as "ChemTec One" or “CEMSEAL 55” or an approved equivalent product. The approved sealant will be a sodium silicate based product formulated for application by spray, roller or brush to new or old concrete. The approved product will chemically react with soluble calcium compounds (free lime) and form insoluble calcium silicates resulting in a dense, breathable, synthetic quartz-type material. The approved product will protect concrete surfaces from abrasion, freeze-thaw damage and chloride ion intrusion. The approved product will stop water seepage when the seepage is not caused by cracking or other structural flaws and will strengthen, harden, densify, dustproof and waterproof concrete permanently.

Crack Repair

Cracks also tend to lead to more serious damage, especially when structures are exposed to heavy freezing. Therefore, it is important that all cracks be repaired immediately on discovery. Cracks should be repaired by undertaking a sequenced sealing and repair program. Cracks on the top surface of the floodwall should be sealed first to prevent the further intrusion of water into the substrate. Cracks on the top, nearly horizontal surface should be repaired using either a cement-based grout or an injectable epoxy compound, depending on the crack width. Injected epoxy crack filler should be applied in strict accordance with the manufacturer’s recommendations. After all cracks have been filled and the crack filler has cured, the top surface should be sealed using the material described in “Spall Prevention” above.

After the top surface’s cracks have been filled and sealed, it is suggested that a delay of at least 72 hours be allowed for previously infiltrated water to drain out of the wall. Then cracks on the vertical side surfaces of the wall should be sealed using either a cement-based grout or an injectable epoxy compound, again depending on the crack width. Again it is important that injected epoxy crack filler should be applied in strict accordance with the manufacturer’s recommendations. Cracks down to approximately 0.0010-inches in thickness may be repaired with some of the injectable epoxy crack repair materials available on the market. Cracks less than this thickness generally will not allow the infiltration of water into the substrate and therefore do not warrant repairs.

Cracks on vertical or near vertical surfaces should be repaired starting from the bottom and proceeding up to the top. The epoxy filler should be injected through ports installed in drilled holes that are spaced evenly along the length of the crack. When epoxy begins to flow out of the port directly above the port into which the epoxy is being injected, it is time to stop the injection in that port. The injecting nozzle is removed from the port and that port is capped. Then the injection process begins again into the next port above, and the sequence is repeated until the top. After all cracks have been filled, the vertical surfaces should be sealed using the material described in “Spall Prevention” above. Sealing of the vertical wall faces may require the sodium silicate based sealant to be sprayed on.

STANDARD OPERATING PROCEDURE
FOR
ROUTING OF ELECTRICAL LINES OVER AND AROUND FLOODWALLS, LEVEES AND PUMP STATIONS

21 November 2011

This Standard Operating Procedure provides guidance for the clearances and routing of both Utility and Sponsor Owned electrical power lines over and around federal levees, floodwalls, and pump stations. For illustrative purposes, reference details 1 through 3 of this SOP.

Where it is impractical to route electrical lines over levee embankments, the Standard Operating Procedure titled "Utility Penetrations in Levees and Floodwalls – Fiber Optic, Electrical, and Other Non-Pressure Lines Up and Over Existing Earthen Levees" shall be utilized.

CASE 1: Utility Owned Power Lines

Electrical lines owned by local utility shall be governed by the latest version of NSI/IEEE C2 – National Electrical Safety Code. Clearance requirements (both vertical and horizontal) are separated per voltage levels and levee system component as outlined in Pages 2 through 8 of this SOP.

CASE 2: Sponsor Owned Power Lines

Electrical lines owned by local sponsor shall be governed by latest version of NFPA 70 – National Electrical Code. Clearance requirements (both vertical and horizontal) are separated per voltage levels and levee system components as outlined in Pages 9 and 10 of this SOP.

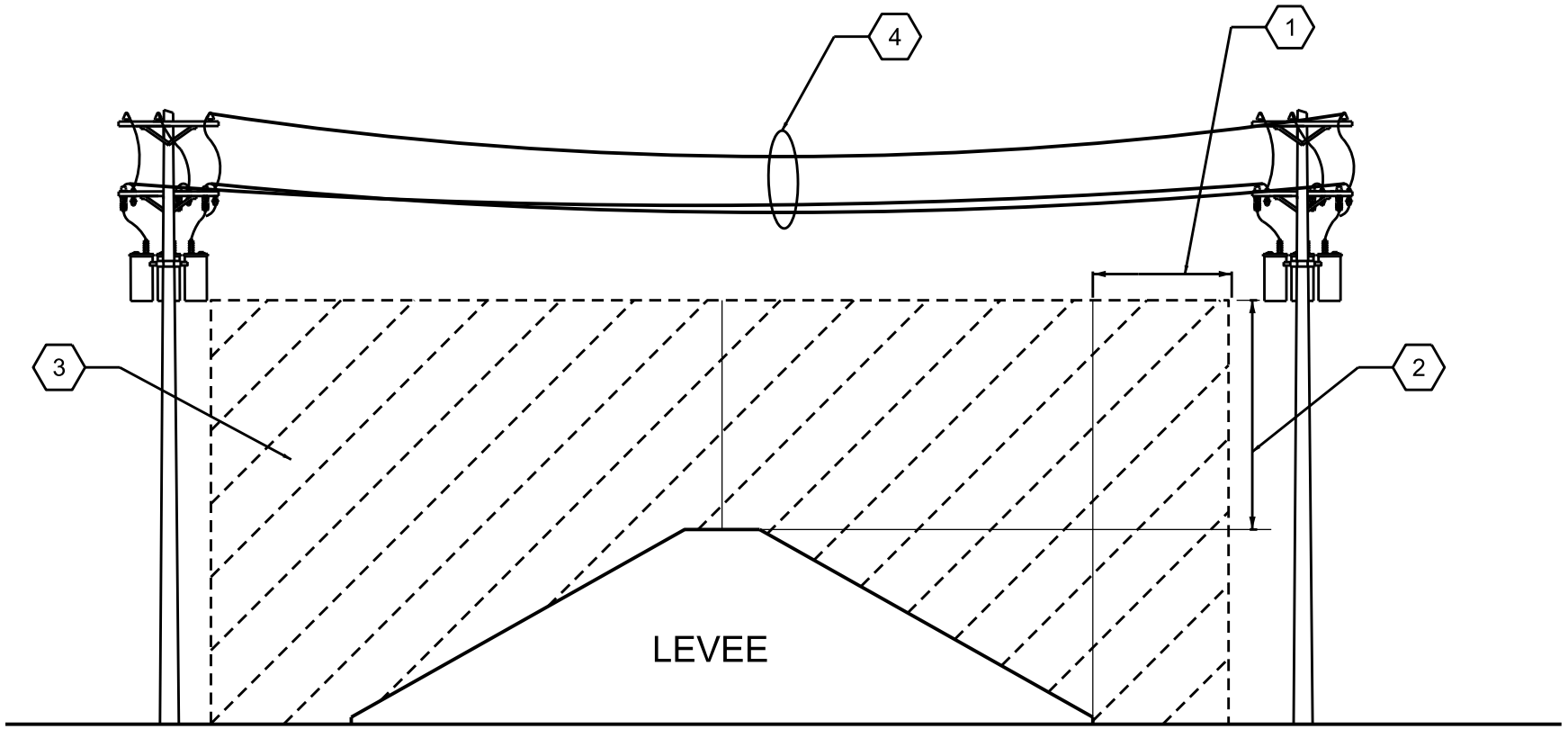
GENERAL NOTES

1. FOR CLEARANCE VALUES, SEE IEEE C2 TABLE 232-1 FOR UTILITY OWNED LINES, AND MFPA 70 TABLES 225.60 FOR SPONSOR OWNED LINES.

2. HORIZONTAL CLEARANCES AROUND LEVEE DETERMINED BY ELECTRIC POLE BASE REQUIREMENTS AND 15' TOE CLEARANCE REQUIREMENTS.

SHEET KEYNOTES

1. HORIZONTAL CLEARANCE REQUIREMENTS
2. VERTICAL CLEARANCE REQUIREMENTS
3. AREA OF CLEARANCE FOR ELECTRICAL LINES
4. ELECTRICAL LINES IN QUESTION



DETAIL #1 FOR ELECTRICAL LINE CLEARANCE

NOT TO SCALE

As of 12/2013

US Army Corps of Engineers
Louisville District

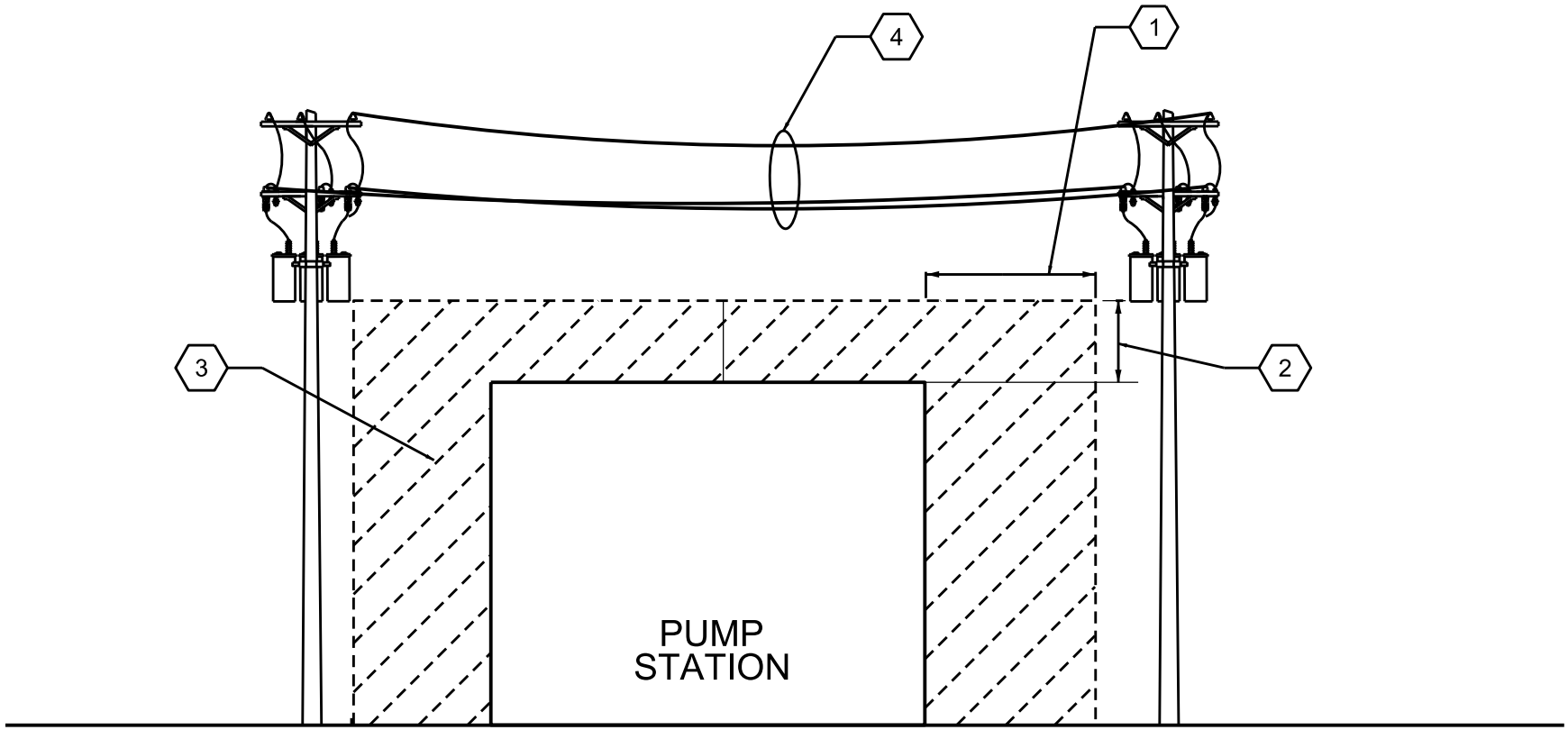
GENERAL NOTES

1. FOR CLEARANCE VALUES, SEE IEEE C2 TABLE 232-1 FOR UTILITY OWNED LINES, AND MFPA 70 TABLES 225.60 FOR SPONSOR OWNED LINES.

2. HORIZONTAL CLEARANCES AROUND LEVEE DETERMINED BY ELECTRIC POLE BASE REQUIREMENTS AND 15' TOE CLEARANCE REQUIREMENTS.

SHEET KEYNOTES

1. HORIZONTAL CLEARANCE REQUIREMENTS
2. VERTICAL CLEARANCE REQUIREMENTS
3. AREA OF CLEARANCE FOR ELECTRICAL LINES
4. ELECTRICAL LINES IN QUESTION



DETAIL #2 FOR ELECTRICAL LINE CLEARANCE AT PUMP STATION

NOT TO SCALE

US Army Corps of Engineers
Louisville District

As of 12/2013

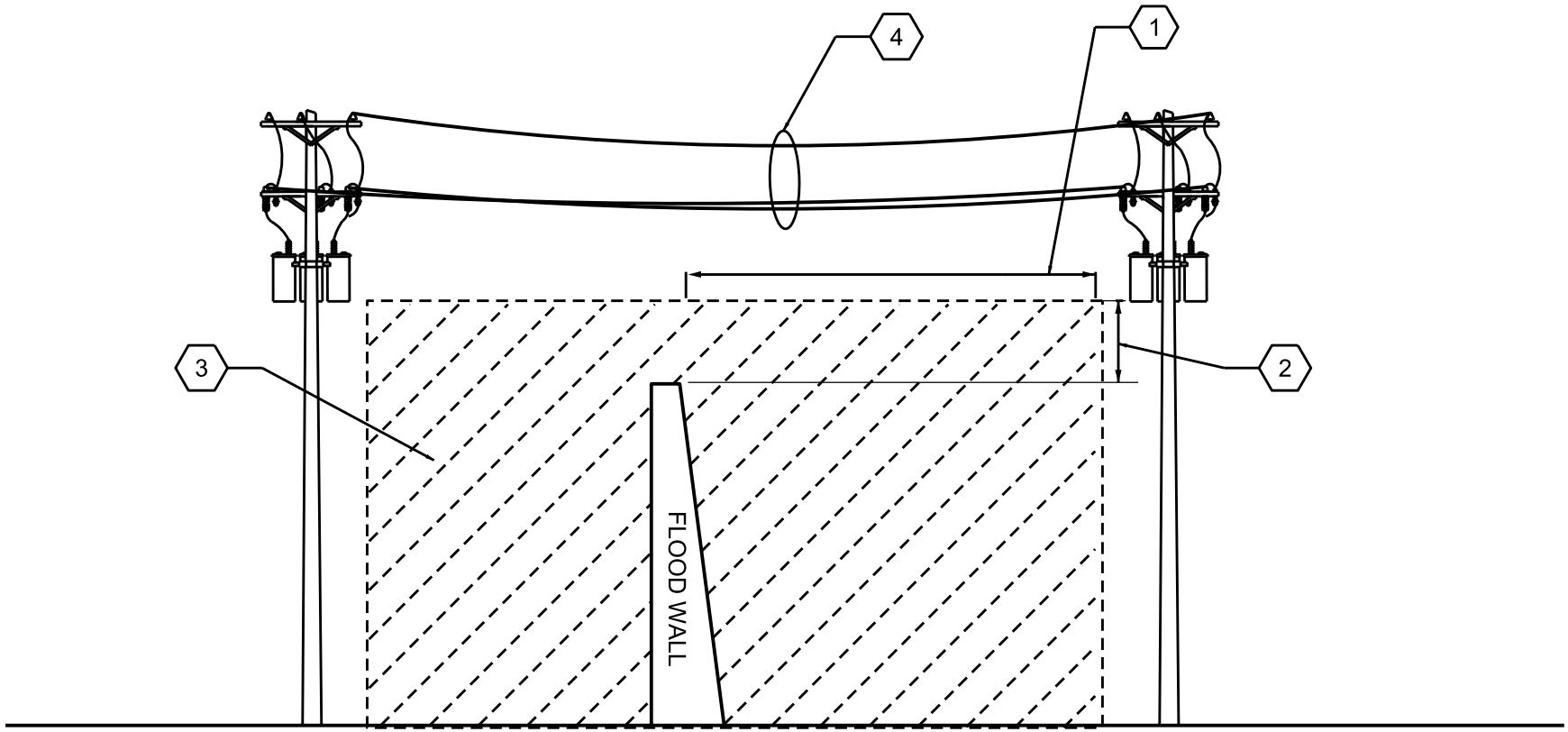
GENERAL NOTES

1. FOR CLEARANCE VALUES, SEE IEEE C2 TABLE 232-1 FOR UTILITY OWNED LINES, AND MFPA 70 TABLES 225.60 FOR SPONSOR OWNED LINES.

2. HORIZONTAL CLEARANCES AROUND LEVEE DETERMINED BY ELECTRIC POLE BASE REQUIREMENTS AND 15' TOE CLEARANCE REQUIREMENTS.

SHEET KEYNOTES

1. HORIZONTAL CLEARANCE REQUIREMENTS
2. VERTICAL CLEARANCE REQUIREMENTS
3. AREA OF CLEARANCE FOR ELECTRICAL LINES
4. ELECTRICAL LINES IN QUESTION



DETAIL #3 FOR ELECTRICAL LINE CLEARANCE AT FLOOD WALL

NOT TO SCALE

US Army Corps of Engineers
Louisville District

As of 12/2013

CASE 1: Utility Owned Power Lines

Electrical lines owned by local utility shall be governed by the latest version of NSI/IEEE C2 – National Electrical Safety Code. Clearance requirements (both horizontal and vertical) are separated per voltage levels and levee system component as indicated below:

0 – 22kV Voltage Range: Levee Clearance Requirements

Levee clearances shall be determined by ANSI/IEEE C2 Table 232-1 (Modified 11/15/11) – Vertical Clearances of Wires, Conductors, and Cables Above Ground, Roadway, Rail or Water Surfaces (Reference Attached Table 232-1).

0 – 22kV Voltage Range: Pump Station and Floodwall Clearance Requirements

Pump station and floodwall clearances shall be determined by ANSI/IEEE C2 Table 234-1 – Clearance of Wires, Conductors, Cables, and Unguarded Rigid Lives Parts Adjacent but not attached to Buildings and Other Installations Except Bridges, shown below.

> 22kV Voltage Range

For routing of electrical lines with voltages exceeding 22kV, the following sections in ANSI/IEEE C2 – National Electrical Safety Code have calculation methods for required clearances:

- Levees – 232.C – Additional clearances for wires, conductors, cables, and unguarded rigid live parts of equipment – Part 1 – Voltages exceeding 22kV
- Floodwalls and pump stations – 234.G – Additional clearances for voltages exceeding 22kV for wires, cables, and unguarded rigid live parts.

Table 232-1 (Modified 16 November 2011)
Vertical clearance of wires, conductors, and cables above ground, roadway, rail, or water surfaces [25]

(Voltages are phase to ground for effectively grounded circuits and those other circuits where all ground faults are cleared by promptly de-energizing the faulted section, both initially and following subsequent breaker operations. See the definitions section for voltages of other systems.
See Rules 232B1, 232C1a, and 232D4.)

Nature of surface underneath wires, conductors, or cables	Insulated communication conductors and cable: messengers: overhead shield/ surge-protection wires: grounded guys: ungrounded guys exposed to 0 to 300 V [11, 15]: neutral conductors meeting Rule 230E1: supply cables meeting Rule 230C1 (ft)	Noninsulated communication conductors: supply cables of 0 to 750 V meeting Rule 230C2 or 230C3 (ft)	Supply cables over 750 V meeting Rule 230C2 or 230C3: open supply conductors, 0 to 750 V [3]: ungrounded guys exposed to over 300 V to 750 V [14] (ft)	Open supply conductors, over 750 V to 22 kV: ungrounded guys exposed to 750 V to 22 kV [14] (ft)	Trolley and electrified railroad contact conductors and associated span or messenger wires	
					0 to 750 V to ground (ft)	Over 750 V to 22 kV to ground (ft)
When wires, conductors, or cables cross over or overhang						
1. Railroad on levee crown (except electrified railroads using overhead trolley conductors) [2, 16, 22]	23.5	24.0	24.5	26.5	22.0 [4]	22.0 [4]
2. Roads, streets, and other areas on levee crown subject to truck traffic [23]	15.5	16.0	16.5	18.5	18.0 [5]	20.0 [5]
3. Driveways, parking lots, and alleys [23]	15.5 [3, 11]	16.0 [7, 11]	16.5 [7]	18.5	18.0 [5]	20.0 [5]
4. Other land traversed by vehicles, such as cultivated, grazing, forest, orchids, etc. [24]	15.5	16.0	16.5	18.5	-	-
5. Spaces and ways subject to pedestrians or restricted traffic only [9]	9.5	12.0 [8]	12.5 [8]	-	16.0	18.0
6. Water areas not suitable for sailboating or where sailboating is prohibited [21]	14.0	14.5	15.0	-	-	-

1. Where subways, tunnels, or bridges require it, less clearance above ground or rails than required by Table 232-1 may be used locally. The trolley and electrified railroad contact conductor should be graded very gradually from the regular construction down to the reduced elevation.
2. For wires, conductors, or cables crossing over mine, logging, and similar railways that handle only cars lower than standard freight cars, the clearance may be reduce3d by an amount equal to the difference in height between the highest loaded car handled and 20 ft, but the clearance shall not be reduced below that required for street crossings.
3. Does not include neutral conductors meeting Rule 230E1.
4. In communities where 21 ft has been established, this clearance may be continued if carefully maintained. The elevation of the contact conductor should be the same in the crossing and next adjacent spans. (See Rule 225D2 for conditions that must be met where uniform height above rail is impractical.)
5. In communities where 16 ft has been established for trolley and electrified railroad contact conductors 0 to 750 V to ground, or 18 ft for trolley and electrified railroad contact conductors exceeding 750 V, or where local conditions make it impractical to obtain the clearance given in the table, these reduced clearances may be used if carefully maintained.
6. This footnote not used in this edition.
7. Where the height of a residential building does not permit its service drop(s) to meet these values, the clearances over residential driveways only may be reduced to the following:

		(ft)
(a)	Insulated supply service drops limited to 300 V to ground	12.5
(b)	Insulated drip loops of supply service drops limited to 300 V to ground	10.5
(c)	Supply service drops limited to 150 V to ground and meeting Rule 230C1 or 230C3	12.0
(d)	Drop loops only of service drops limited to 150 V to ground and meeting Rule 230C1 or 230C3	10.0
(e)	Insulated communication service drops	11.5

8. Where the height of a residential building does not permit its service drop(s) to meet these values, the clearances may be reduced to the following:

		(ft)
(a)	Insulated supply service drops limited to 300 V to ground	10.5
(b)	Insulated drip loops of supply service drops limited to 300 V to ground	10.5
(c)	Supply service drops limited to 150 V to ground and meeting Rule 230C1 or 230C3	10.0
(d)	Drop loops only of service drops limited to 150 V to ground and meeting Rule 230C1 or 230C3	10.0

9. Spaces and ways subject to pedestrians or restricted traffic only are those areas where riders on horses or other large animals, vehicles, or other mobile units exceeding a total height of 8 ft are prohibited by regulation or permanent terrain configurations, or are otherwise not normally encountered nor reasonably anticipated.
10. Where a supply or communication line along a road is located relative to fences, ditches, embankments, etc., so that the ground under the line would not be expected to be traveled except by pedestrians, the clearances may be reduced to the following values:

		(ft)
(a)	Insulated communication conductor and communication cable	9.5
(b)	Conductors of other communication circuits	9.5
(c)	Supply cables of any voltage meeting Rule 230C1, supply cables limited to 150 V to ground	9.5
(d)	Insulated supply conductors limited to 300 V to ground	12.5
(e)	Guys	9.5

11. No clearance from ground is required for anchor guys not crossing tracks, rails, streets, driveways, roads, or pathways.
12. This clearance may be reduced to 13 ft for communication conductors and guys.
13. Where this construction crosses over or runs along alleys, driveways, or parking lots not subject to truck traffic this clearance may be reduced to 15 ft.
14. Underground guys and ungrounded portions of span guys between guy insulators shall have clearances based on the highest voltage to which they may be exposed due to a slack conductor or guy.
15. Anchor guys insulated in accordance with Rule 279 may have the same clearance as grounded guys.
16. Adjacent to tunnels and overhead bridges that restrict the height of loaded rail cars to less than 20 ft, these clearances may be reduced by the difference between the highest loaded rail car handled and 20 ft, if mutually agreed to by the parties at interest.
17. For controlled impoundments, the surface area and corresponding clearances shall be based upon the design high-water level.
18. For uncontrolled water flow areas, the surface area shall be that enclosed by its annual high-water mark. Clearances shall be based on the normal flood level; if available, the 10-year flood level may be assumed as the normal flood level.
19. The clearance over rivers, streams, and canals shall be based upon the largest surface area of any 1-mi-long segment that includes the crossing. The clearance over a canal, river, or stream normally used to provide access for sailboats to a larger body of water shall be the same as that required for the larger body of water.
20. Where an overwater obstruction restricts vessel height to less than the applicable reference height given in Table 232-3, the required clearance may be reduced by the difference between the reference height and the overwater obstruction height, except that the reduced clearance shall be not less than that required for the surface area on the line-crossing side of the obstruction.

21. Where the US Army Corps of Engineers, or the state, or surrogate thereof has issued a crossing permit, clearances of that permit shall govern.
22. See Rule 234I for the required horizontal and diagonal clearances to rail cars.
23. For the purpose of this rule, trucks are defined as any vehicle exceeding 8 ft in height. Areas not subject to truck traffic are areas where truck traffic is not normally encountered nor reasonably anticipated.
24. Communication cables and conductors may have a clearance of 15 ft where poles are back of curbs or other deterrents to vehicular traffic.
25. The clearance values shown in this table are computed by adding the applicable Mechanical and Electrical (M & E) value of Table A-1 to the applicable Reference Component of Table A-2a of Appendix A.
26. When designing a line to accommodate oversized vehicles, these clearance values shall be increased by the difference between the known height of the oversized vehicle and 14 ft.

Levees shall be considered “roads, streets, and other areas subject to truck traffic”, due to maintenance accessibility and other access requirements. Clearance distances shall be selected per voltage levels and the type of cable, conductor, or wire.

Table 234-1 (Modified 16 November 2011)

Clearance of wires, conductors, and cables, and unguarded rigid live parts adjacent but not attached to buildings and other installations except bridges [12]

(Voltages are phase to ground for effectively grounded circuits and those other circuits where all ground faults are cleared by promptly de-energizing the faulted section, both initially and following subsequent breaker operations. See the definitions section for voltages of other systems. Clearances are with no wind displacement except where stated in the footnotes below.

See Rules 232B1, 232C1a, and 232D4.)

Clearance of	Insulated communication conductors and cables: messengers: surge-protection wires: grounded guys: ungrounded guys exposed to 0 to 300 V [11]; neutral conductors meeting Rule 230E1: supply cables meeting Rule 230C1 (ft)	Supply cables of 0 to 750 V meeting Rule 230C2 or 230C3 (ft)	Unguarded rigid live parts 0 to 750 V: non-insulated communication conductors; ungrounded equipment cases, 0 to 750 V; ungrounded guys exposed to open supply conductors of over 300 V to 750 V [5] (ft)	Supply cables over 750 V meeting Rule 230C2 or 230C3; open supply conductors, 0 to 750 V (ft) [15]	Unguarded rigid live parts, over 750 V to 22 kV; ungrounded equipment cases, 750 V to 22 kV; ungrounded guys exposed to over 750V to 22 kV [5] (ft)	Open supply conduct - ors, over 750 V to 22 kV (ft)
1. Buildings - Pump Stations						
a. Horizontal						
(1) To walls, projections, and guarded windows	4.5 [1, 2, 7]	5.0 [1, 2]	5.0 [1, 2]	5.5 [1, 2, 9]	7.0 [1, 2]	7.5 [1, 2, 10, 11]
(2) To unguarded windows [8]	4..5	5.0	5.0	5.5 [9]	7.0	7.5 [10, 11]
(3) To balconies and areas readily accessible to pedestrians [3]	4.5	5.0	5.0	5.5 [9]	7.0	7.5 [10, 11]
b. Vertical						
(1) Over or under roofs or projections not readily accessible to pedestrians [3]	3.0	3.5	10.0	10.5	12.0	12.5

Table 234-1 (Modified 16 November 2011) – *(continued)*
Clearance of wires, conductors, and cables, and unguarded rigid live parts adjacent but not attached to buildings and other installations except bridges [12]

(Voltages are phase to ground for effectively grounded circuits and those other circuits where all ground faults are cleared by promptly de-energizing the faulted section, both initially and following subsequent breaker operations. See the definitions section for voltages of other systems. Clearances are with no wind displacement except where stated in the footnotes below.
See Rules 232B1, 232C1a, and 232D4.)

Clearance of	Insulated communication conductors and cables: messengers: surge-protection wires: grounded guys: ungrounded guys exposed to 0 to 300 V [11]; neutral conductors meeting Rule 230E1: supply cables meeting Rule 230C1 (ft)	Supply cables of 0 to 750 V meeting Rule 230C2 or 230C3 (ft)	Unguarded rigid live parts 0 to 750 V: non-insulated communication conductors; ungrounded equipment cases, 0 to 750 V; ungrounded guys exposed to open supply conductors of over 300 V to 750 V [5] (ft)	Supply cables over 750 V meeting Rule 230C2 or 230C3; open supply conductors, 0 to 750 V (ft) [15]	Unguarded rigid live parts, over 750 V to 22 kV; ungrounded equipment cases, 750 V to 22 kV; ungrounded guys exposed to over 750V to 22 kV [5] (ft)	Open supply conduct - ors, over 750 V to 22 kV (ft)
(2) Over or under balconies and roofs readily accessible to pedestrians [3]	10.5	11.0	11.0	11.5	13.0	13.5
(3) Over roofs accessible to vehicles but not subject to truck traffic [6]	10.58	11.0	11.0	11.5	13.0	13.5
(4) Over roofs accessible to truck traffic [6]	15.5	16.0	16.0	16.5	18.0	18.5
2. Floodwalls and other installations not classified as buildings or bridges						
a. Horizontal [4]						
(1) To portions that are readily accessible to pedestrians [1]	4.5	5.0	5.0 [1, 2]	5.5 [9]	7.0 [1, 2]	7.5 [10, 11]
(2) To portions that are not readily accessible to pedestrians [3]	3.0	3.5	5.0 [1, 2]	5.5 [1, 2, 9]	7.0 [1, 2]	7.5 [1, 2, 10, 11]

Table 234-1 (Modified 16 November 2011) – *(continued)*
Clearance of wires, conductors, and cables, and unguarded rigid live parts adjacent but not attached to buildings and other installations except bridges [12]

(Voltages are phase to ground for effectively grounded circuits and those other circuits where all ground faults are cleared by promptly de-energizing the faulted section, both initially and following subsequent breaker operations. See the definitions section for voltages of other systems. Clearances are with no wind displacement except where stated in the footnotes below.
See Rules 232B1, 232C1a, and 232D4.)

Clearance of	Insulated communication conductors and cables: messengers: surge-protection wires: grounded guys: ungrounded guys exposed to 0 to 300 V [11]; neutral conductors meeting Rule 230E1: supply cables meeting Rule 230C1 (ft)	Supply cables of 0 to 750 V meeting Rule 230C2 or 230C3 (ft)	Unguarded rigid live parts 0 to 750 V: non-insulated communication conductors; ungrounded equipment cases, 0 to 750 V; ungrounded guys exposed to open supply conductors of over 300 V to 750 V [5] (ft)	Supply cables over 750 V meeting Rule 230C2 or 230C3; open supply conduc-tors, 0 to 750 V (ft) [15]	Unguarded rigid live parts, over 750 V to 22 kV; ungrounded equipment cases, 750 V to 22 kV; ungrounded guys exposed to over 750V to 22 kV [5] (ft)	Open supply conduct - ors, over 750 V to 22 kV (ft)
b. Vertical						
(1) Over or under catwalks and other surfaces upon which personnel walk	10.5	11.0	11.0	11.5	13.0	13.5
(2) Over or under other portions of such installations [4]	3.0	3.5	5.5	6.0 [1]	7.5	8.0

1. Where building, sign, chimney, antenna, tank, or other installation does not require maintenance such as painting, washing, changing of sign letters, or other operations that would require persons to work or pass between wires, conductors, cables or unguarded rigid live parts and structure, the clearance may be reduced by 2 ft.
2. Where available space will not permit this value, the clearance may be reduced by 2 ft provided the wires, conductors, or cables, including splices and taps, and unguarded rigid live parts have a covering that provides sufficient dielectric strength to limit the likelihood of a short circuit in case of momentary contact with a structure or building.
3. A roof, balcony, or area is considered readily accessible to pedestrians if it can be casually accessed through a doorway, ramp, window, stairway, or permanently mounted ladder by a person on foot who neither exerts extraordinary physical effort nor employs tools or devices to gain entry. A permanently mounted ladder is not considered a means of access if its bottom rung is 8 ft or more from the ground or other permanently installed accessible surface.
4. The required clearances shall be to the closest approach of motorized signs or moving portions of installations covered by Rule 234C.
5. Ungrounded guys and underground portion of guys between guy insulators shall have clearances based on the highest voltage to which they may be exposed to a slack conductor or guy.
6. For the purpose of this rule, trucks are defined as any vehicle exceeding 8 ft in height.
7. This clearance may be reduced to 3 in for the grounded portions of guys.
8. Windows not designed to open may have the clearances permitted for walls and projections.

9. The clearance at rest shall be not less than the value shown in this table. Also, when the conductor or cable is displaced by wind, the clearance shall be not less than 3.5 ft; see Rule 234C1b.
10. The clearance at rest shall be not less than the value shown in this table. Also, when the conductor or cable is displaced by wind, the clearance shall be not less than 4.5 ft; see Rule 234C1b.
11. Where available space will not permit this value, the clearance may be reduced to 7.0 ft for conductors limited to 8.7 kV to ground.
12. The clearance values shown in this table are computed by adding the applicable Mechanical and Electrical (M& E) value of Table A-1 to the applicable Reference Component of Table A-2b of Appendix A.
13. The anchor end of guys insulated in accordance with Rule 279 may have the same clearance as grounded guys.
14. For clearances above railings, walls, or parapets around balconies or roofs, use the clearances required for row 1b(1). For such clearances where an outside stairway exists, use the clearances required for row 2b(2).
15. Does not include neutral conductors meeting Rule 230E1.

CASE 2: Sponsor Owned Power Lines

Electrical lines owned by local sponsor shall be governed by latest version of NFPA 70 – National Electrical Code. Clearance requirements are separated per voltage levels and levee system components. Both horizontal and vertical clearances are required and have been provided below.

0 - 22kV Voltage Range: Levee Clearance Requirements

Levee clearances shall be determined by NFPA 70 Table 225.60 – Clearances over Roadways, Walkways, Rail, Water, and Open Land, shown below:

NFPA 70 – Table 225.60

Location	Clearance	
	m	ft
Open land subject to vehicles, cultivation, or grazing	5.6	18.5
Roadways, driveways, parking lots, and alleys – Levee with Road on Crown	5.6	18.5
Walkways	4.1	13.5
Rails – Rail on Levee	8.1	26.5
Spaces and ways for pedestrians and restricted traffic	4.4	14.5
Water areas not suitable for boating	5.2	17.0

The top of levees shall be considered as access roadways (utilized for maintenance personnel) when determining clearance distances for electrical lines. Clearances for "roadways, driveways, parking lots, and alleys" have a vertical clearance of 18.5 feet. If there is any other applicable criteria that would place the levee in question into another category, those clearances shall be utilized.

0 - 22kV Voltage Range: Pump Station and Floodwall Clearance Requirements

Pump station and floodwall clearances shall be determined by NFPA 70 Table 225.61 – Clearances over buildings and structures, shown below:

NFPA 70 – Table 225.61

Clearance from Conductors or Live Parts from:	Horizontal		Vertical	
	m	ft	m	ft
Building walls, projections, and windows	2.3	7.5	-	-
Balconies, catwalks, and similar areas	2.3	7.5	4.1	13.5
Over or under roofs or projections not readily accessible to people	-	-	3.8	12.5
Over roofs accessible to vehicles but not trucks	-	-	4.1	13.5
Over roofs accessible to trucks	-	-	5.6	18.5
Other structures	2.3	7.5	-	-

Floodwalls shall be considered a "projection not readily accessible to people". A clearance distance of 7.5 feet, as shown in category "Buildings walls, projections, and windows" is shown for horizontal distances of pump stations and floodwalls. Vertical distances shall be 12.5 ft, as shown in category "Over or under roofs or projections not readily accessible to people". If there is any other applicable criteria that would place the pump station or floodwall into question into another category, those clearances shall be utilized.

> 22kV Voltage Range

Clearances for the categories mentioned above shall be increased by 10mm (0.4 inches) per kV above 22,000 volts, in accordance with sections 225.60(B) of NFPA 70 – National Electrical Code.

Additional Notes

- Cables, conductors, and wires shall not be supported with vegetation, per NFPA 70 Section 225.26.

Note to Local Sponsor

NFPA 70 sections 225.60 and 225.61, and their associated tables provide clearance requirements and specific distances over buildings and structures that correlate with requirements in ANSI/IEEE C2 – National Electrical Safety Code. This indicates requirements are similar for both utility and sponsor owned equipment.

STANDARD OPERATING PRACTICE
FOR
SEALING FIBER OPTIC LINES INSIDE A CONDUIT THROUGH CONCRETE FLOODWALLS

2 December 2010

After final placement of conduit and cables, the entire length of conduit shall be filled with SEMCO PR-821 (or equivalent) two-part urethane foam which when mixed for a 15 second period will expand approximately 15 times in volume to form a dense, strong, tough foam with a density of 3 to 4 lbs. per cubic foot. PR-821 will reach about 60% of full strength in 8 to 10 minutes after application. It exhibits excellent mechanical adhesion to most surfaces without primers and has good resistance to alkalis, dilute acids, moisture, rot, and rodents.

STANDARD OPERATING PROCEDURE
FOR
SEALING FIBER OPTIC LINES INSIDE A CONDUIT UP AND OVER AN EXISTING LEVEE EMBANKMENT

2 December 2010

After final placement of conduit and cables, the entire length of conduit shall be filled with SEMCO PR-821 (or equivalent) two-part urethane foam which when mixed for a 15 second period will expand approximately 15 times in volume to form a dense, strong, tough foam with a density of 3 to 4 lbs. per cubic foot. PR-821 will reach about 60% of full strength in 8 to 10 minutes after application. It exhibits excellent mechanical adhesion to most surfaces without primers and has good resistance to alkalis, dilute acids, moisture, rot, and rodents.

LRL STANDARD OPERATING PROCEDURE FOR SLIP-LINING EXISTING PIPES THROUGH THE LEVEE/FLOODWALL TEMPLATE

19 August 2011

1. Slip-lining will be performed only where an existing pipe is determined to have a pipe condition grade of a 4 or 5 in accordance with the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) or as authorized by the USACE.

2. Acceptable slip-lining pipe materials fall into four categories: a composite system of flexible solid-wall high density polyethylene (HDPE) pipe with non-structural grout; a composite system of semi-rigid glass fiber reinforced plastic such as glass fiber reinforced pipe (GFRP) with non-structural grout; a composite system of man-entry spiral-wound PVC strip liner with non-structural grout; and a composite system of man-entry spiral-wound PVC strip liner and structural grout. Slip-lining using pipe-bursting methods is not acceptable. Other methods may be used where a special need exists and the alternate method is reviewed and approved by the Louisville District USACE. The following are a list of these methods: (a) Cured-in-Place Pipe (CIPP), (b) Fold-and-Form Pipe, (c) Spray-on-Lining. These methods of pipe rehabilitation will require the services of a qualified contractor with experience in the use of these methods.

3. Prior to slip-lining, the existing culvert must be surveyed to determine the maximum diameter of liner pipe that can be inserted through the entire length of the host pipe. The survey can be completed by pushing/pulling a mandrel (equal in pipe type and joint length to the proposed liner pipe segment length, where applicable) through the entire host pipe. Host pipes that are 36-inches inside diameter (I.D.) or larger may be verified through man-entry, mandrel or both. The outside diameter (O.D.) of the mandrel shall not be less than the O.D of the proposed slip-liner pipe plus 1-inch (annular grout space). A segment of the slip-liner pipe may be used as a mandrel, but this test segment shall not be used as a permanent slip-liner. Alternately the mandrel procedure can be performed virtually using 3D laser point cloud tools. Several pipe inspection companies now have the capability to provide a 3D BIM file that allows the engineer to determine the maximum pipe diameter of any given length that can be advanced through an existing pipe with a straight alignment, and through an existing pipe with a curvilinear alignment.

4. A levee system works permit application must signed by the local sponsor and submitted to the Louisville District USACE office for technical review and approval. Design submittals

shall be provided for review and approval prior to construction. At a minimum, the liner pipe I.D. shall not be less than 80% of the nominal I.D. of the host pipe and shall have a minimum design service life (in-place) of 50 years.

Current USACE approved methods are detailed in Specification Section 02830 (Methods A through D) as outlined below:

Method A (Non-Structural Grout) –	Slip-lining using solid-wall HDPE pipe.
Method B (Non-Structural Grout) –	Slip-lining using glass fiber-reinforced plastic pipe (GFRP)
Method C (Non-Structural Grout) –	Slip-lining using machine (exterior) spiral-wound PVC liner
Method D (Structural Grout) –	Slip-lining using machine (interior) spiral-wound PVC liner

5. The liner pipe shall provide the maximum conveyance capacity possible while maintaining a 1-inch minimum annular space between the host pipe and liner pipe for grouting. The Slip-lining contractor shall provide designs for the slip-lining system chosen/proposed. A determination must be made whether the slip-lined pipe is part of a composite system with structural grout or whether the pipe is self-supporting, and non-structural grout is acceptable. Structural and non-structural grout should conform to the following requirements where sampled at the inlet port:

Non-Structural Grout. Grout having a minimum 24-hour penetration resistance of 100 psi (ASTM C403) and a minimum 28-day compressive strength of 300 psi (ASTM C495). Where a foaming agent is incorporated into the grout mixture, the grout density shall be 45 pcf ±3 pcf (ASTM C138). To ensure that grout flows adequately through the annular space, a grout viscosity is 20 seconds or less (ASTM C939) is required. [Note: The reason that many of the slip-line contractors use the foam is for pump-ability of the grout (it flows better) and the overall grout mix becomes less dense and reduces the potential for liner pipe collapse. Where foam is not added, multiple lifts of grout will generally be required during placement. In addition, the ready mix supplier may need to add shrinkage reducing admixtures in order to meet the shrinkage by volume criteria (1% or less) listed in the specifications (Reference Section 02830, Paragraph 3.7, Methods A, B and C).

Structural Grout. Grout having a minimum 28-day compressive strength of 3,000 psi (ASTM C942). To ensure that grout flows adequately through the annular space, grout viscosity shall be 35 seconds or less (ASTM C939).

Immediately upon completion of grout placement, a minimum pressure of 5 psi shall be maintained within the closed system for a minimum period of 20 minutes.

6. Permit submittal shall include the proposed method of testing for 0% pipe leakage between the limits defined by the two points located 15 feet from the levee toe limits. A gravity line shall be pressure tested to no less than 1.5 times the maximum head pressure on the pipe during a flood event where water is loaded to the top of the levee system.

   This pressure test is subject to review and possible revision by the US Army Corps of Engineers (USACE) Mechanical Engineer during the permit review process, depending on the pipe material, joint type, etc.

7. Permit submittal shall include pipe loading calculations per EM 1110-2-2902 and the applicable section based on the liner pipe being installed if using Methods A, B or C.

8. It is the Contractor's responsibility to familiarize themselves with OSHA Standards and Regulations pertaining to all aspects of the work. Particular attention is directed to those safety requirements involving entry into confined spaces and mass excavations.

9. As part of the permit review process by USACE, Hydraulic Engineers will review the need for inlet or outlet control requirements due to the reduction in the I.D. and the potential increased velocities of water that will be discharged from the pipe.

STANDARD OPERATING PROCEDURE
FOR
TREE REMOVAL, ROOT BALLS AND SEEDING GUIDANCE

27 July 2011

Trees within levee embankments, within a minimum of 15 feet of the landside and riverside toes, or within a minimum of 15 feet of the face of a floodwall or 8 feet from the farthest floodwall structure (whichever is greater) shall be removed in accordance with this guidance. Trees with trunks less than four inches in diameter are cut flush to the ground surface. Trees four inches or greater in diameter (are cut down and the root balls removed entirely. The size of root balls varies with the size and variety of tree. Root balls are removed so that all roots one-half inch and larger in diameter are taken out. The resulting excavation is then backfilled as described below.

1. **Placing backfill *within the levee embankment* in the holes caused by the removal of a tree root ball will require the following:**

    a) The existing levee embankment where the root ball has been removed shall be over excavated in all directions by benching 1ft vertical and 1.5 ft horizontal into stiff undisturbed soil. A level bottom surface day-lighting toward the levee toe shall be provided from which the upward benching on the other three sides shall initiate. Benching will likely have to be performed by hand methods or small-scale excavation equipment.
    b) Backfill material must be low permeability soils - impermeable soils (e.g. SC, CL or CL-ML with an estimated hydraulic conductivity less than 1 $x10^{-5}$ cm/sec) in accordance with ASTM 2488 - USCS classification system.
    c) Backfill material shall be placed in loose lifts with thicknesses not to exceed 6-inches and compacted in the holes to a minimum 95 percent Standard Proctor density determined at optimum moisture content according to ASTM D-698. Moisture control limits are to be within -1% to +3% of optimum.
    d) The levee soil on which the backfill is to be placed should not be excavated until immediately before backfilling, and shall not be allowed to become overly wet or dry during the repair operation. The surface area of the benches shall be scarified as necessary to ensure a good bond between the existing soil and the backfill material.
    e) The finished riverside or landside slope of the levee shall be graded to match the existing levee slopes upstream and downstream of the hole where the tree/root ball was removed.

f) Once the hole has been completely filled, the disturbed areas shall be seeded and covered with a bio-degradable geotextile.

2. **Placing backfill materials *outside the projected levee slopes but within a minimum of 15 feet of the toe of the Levee or face of the Floodwall* in holes caused by the removal of a tree root ball will require the following:**

a) Backfill material must be low permeability soils - impermeable soils (e.g. SC, CL or CL-ML with an estimated hydraulic conductivity less than 1 $x10^{-5}$ cm/sec) in accordance with ASTM 2488 - USCS classification system.

b) Backfill shall be placed in loose lifts with thicknesses not to exceed 8-inches and compacted in the holes to a minimum 95 percent Standard Proctor density determined at optimum moisture content according to ASTM D-698, unless otherwise directed. Moisture control limits are to be within -1% to +3% of optimum.

c) Once the hole has been completely filled, the disturbed areas shall be seeded and covered with a bio-degradable geotextile.