

**PAPIO NRD CHANNEL AND LEVEE PROJECTS**  
**SECTION 408 AND TECHNICAL REVIEW - SUBMITTAL CHECKLIST**

**PAPIO NRD-REQUIRED SUBMITTAL FOR PROPOSED CONSTRUCTION WITHIN  
PAPIO NRD FLOOD REDUCTION (CHANNEL and/or LEVEE) PROJECT**

Papio NRD Project Name: \_\_\_\_\_ Project ID: \_\_\_\_\_  
(Assigned by Papio NRD)

Papio NRD Project Station: \_\_\_\_\_  
(Assigned by Papio NRD)

Requester/Owner: \_\_\_\_\_

Engineer/Architect: \_\_\_\_\_

**Papio NRD**  
**8901 S. 154<sup>th</sup> St.**  
**Omaha, NE 68138**

	Submitted	Not Submitted	Not Needed
1. Written Request	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Cover Letter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Project Location and Description (with Aerial Photo)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Technical Analysis – Levee Impact (e.g., Geotechnical, Hydraulic, Structural, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Real Estate Interest Required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Operation and Maintenance Needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Project Schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Engineering Plans and Specifications: Status ____%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Profiles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Plan Sheets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Contours	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Cross Sections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Surface Drainage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Critical Area Limits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Levee (Federal Project) ROW	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Specifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. No Adverse Impact Certification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Two Sets of Documents and Electronic Copy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. GIS or CADD Data for proposed project (on electronic media)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Submittal date to Papio NRD, 8901 S. 154<sup>th</sup> St., Omaha, NE 68138: \_\_\_\_\_

Requester/Owner or Engineer of Record Signature: \_\_\_\_\_

Requester/Owner or Engineer of Record Printed Name \_\_\_\_\_

*By signing this document, the signer affirms the completeness of this submittal and agrees to prepare and submit all required post construction documentation, including as built plans and preparation of a levee Operation and Maintenance Manual Addendum, per USACE guidance.*

**PAPIO NRD CHANNEL AND LEVEE SYSTEM**  
**SUBMITTAL INFORMATION**

**PAPIO NRD-REQUIRED SUBMITTAL FOR  
PROPOSED CONSTRUCTION WITHIN THE CHANNEL and/or LEVEE CRITICAL AREA**

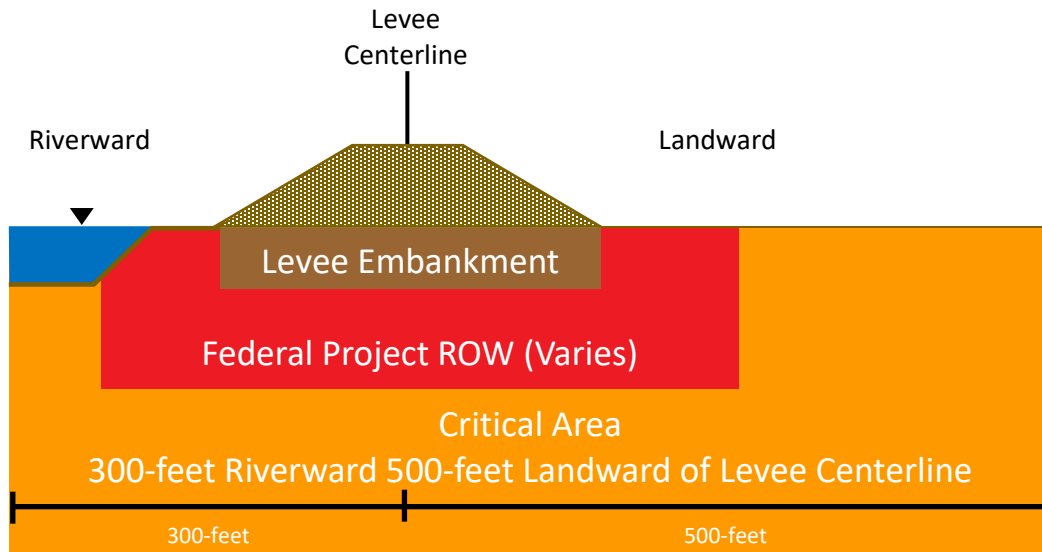
Submittal requirements for construction activities within the Channel or Levee system “critical area” are listed below. The critical area is generally defined as 300 feet riverward or 500 feet landward of a Channel or Levee centerline. Construction activities generally include any and all activities including, but not be limited to, excavation, fill, installing utilities, drainage structures, pressure relief or dewatering or monitoring wells, stormwater detention ponds, and directional drilling. Submittals shall adhere to U.S. Army Corps of Engineers (USACE) policy and guidance including EC 1165-2-220, “Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 USC 408”, where applicable.

1. A detailed request shall be submitted to the Papio NRD by the “Engineer of Record” for proposed construction.
2. Supplied information must include engineering drawings that fully illustrate existing conditions, alterations due to the proposed construction, the associated changes to the ROW of the Channel or Levee system, a list of all real property interests required for the proposed alteration, and the proposed schedule for construction.
3. Engineering drawings of the work must include the plans that show profiles, a contour map (2-foot or more detailed) of the area, cross sections, drainage, structural details, the critical area, and the location of the work in reference to the location of the Channel or Levee system ROW. For all proposed excavations, underground utilities, drainage structures, wells, and directional drilling the plans must be accompanied by a technical analysis that describes the proposed construction and the impact to the Channel or Levee system and any proposed mitigation measures. The technical analysis must include supporting geotechnical analysis (e.g., soil borings), engineering analysis, data, specifications, and other information as appropriate. Potential impacts that need to be considered include, but are not limited to, erosion protection, slope stability, through- and under-seepage, drainage, hydraulic conveyance, and floodplain.
4. **Two complete paper sets and one electronic set of the submitted documents and the completed Submittal Checklist shall be provided to the Papio NRD; the Papio NRD shall forward copies to the U.S. Army Corps of Engineers – Omaha District (USACE) and will coordinate their review (see first page for minimum Submittal Checklist requirements).** Incomplete submittals will be returned. The Papio NRD will determine if minor activities may not require USACE review.
5. The “Engineer of Record” should be familiar with the existing Operations and Maintenance Manual for the affected area and any design documents.
6. The “Engineer of Record” must certify in writing that the proposed construction activities will not adversely impact the operation or the integrity of the Channel or Levee system.
7. The “Engineer of Record” agrees to provide as-built plans and certify in writing to the Papio NRD upon completion of the approved work that the work was done in conformance with the approved plan for the construction activities.
8. The “Engineer of Record” agrees to provide the Papio NRD with sufficient information to update the Operation and Maintenance Manual, as required.
9. Papio NRD Channel & Levee Projects are shown on Papio NRD Project Maps available upon request.
10. Federal levee and channel projects will require a Section 408 review by USACE, and non-federal levee and channel projects will require a technical review by USACE, instead of Section 408 review.
11. The Project Plans and Specifications must adhere to Papio NRD minimum specifications for construction activities as shown on Attachment A.
12. A Permit for Occupation of Levee Right-of-Way (ROW) will need to be acquired from Papio NRD for any construction activity in Papio NRD ROW. *(ROW permit is included in Attachment A.)*
13. Any questions should be directed to Martin P. Cleveland, P.E., Papio NRD Construction Engineer, 402-315-1707 or [mcleveland@papionrd.org](mailto:mcleveland@papionrd.org)

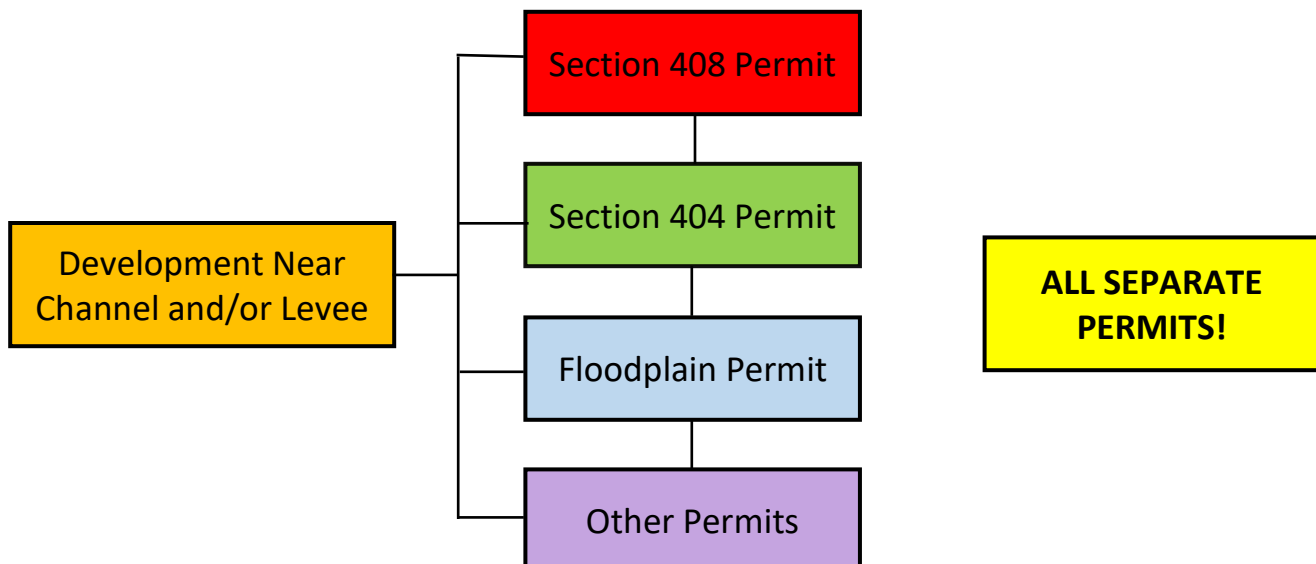
**PAPIO NRD CHANNEL AND LEVEE SYSTEM**  
**ADDITIONAL INFORMATION FOR SUBMITTALS FOR**  
**PROPOSED CONSTRUCTION WITHIN THE CHANNEL and/or LEVEE CRITICAL AREA**

**Review Time:** A District level U.S. Army Corps of Engineer's review is anticipated to take a minimum of 6-8 weeks. Papio NRD will provide a written response to the request. Additional time may be necessary for other Papio NRD/local permit reviews.

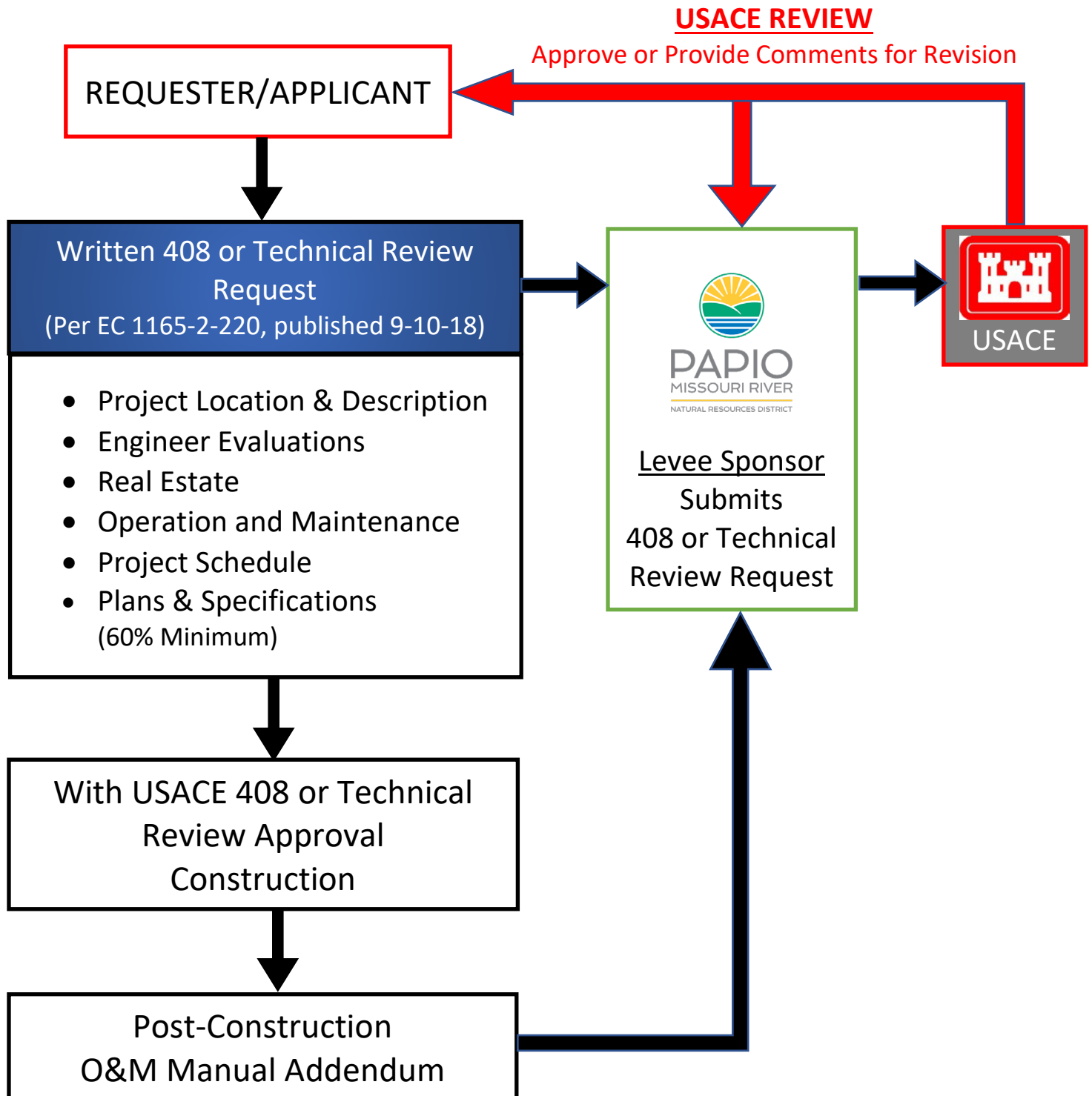
**Typical Levee Section**  
**(NTS)**



**Potential Permits Required for Development Near Papio NRD Channel or Levees**



# SECTION 408 and/or TECHNICAL REVIEW PROCESS DIAGRAM



PAPIO NRD REQUIREMENTS FOR PROPOSED CONSTRUCTION/PIPE INSTALLATIONS  
WITHIN THE CHANNEL and/or LEVEE CRITICAL AREA

Missouri River Levee System Units R-613 and R-616,  
Big Papio and West Branch Papio Creek Levees, Little Papio Channel,  
Union Dike, No-Name Dike, and Western Sarpy Levee

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Papio NRD's standard requirements for pipe installations in the referenced projects is as follows:  
*(plans and specifications need to include)*

- a) Pipe outlets should be installed so that they are angled downstream  $10^{\circ}$  to  $15^{\circ}$  off perpendicular ( $90^{\circ}$ ) with respect to channel flowline in the channel. This will help prevent trash and debris from collecting on the pipe.
- b) The slope of the pipe should be kept to a minimum to limit the velocity of the water as it enters the channel and to help prevent scouring of the channel bottom. It is recommended that the outlet end section of pipe (e.g., 20 to 30 feet) be installed at a flat ( $0^{\circ}$ ) grade. If the pipe outlet velocity exceeds 6 feet per second, then mitigation via channel stabilization or energy dissipation is required.
- c) Riprap should be installed around the outlet of the pipe. The riprap should be graded riprap rock with 18" maximum size stone and placed on a properly sized bedding stone, in a two foot thick layer within 25 feet either side of the outlet.
- d) Backfill material used for installation of the project shall be impervious material, placed in 6 inch lifts and compacted to 95% of the maximum density of the Standard Proctor Test (ASTM D 698). Trench side slopes shall be 3:1 (horizontal/vertical) or more gradual in grade.
- e) Pipe outlet should be located about 2 feet above normal water level and horizontally near the stream edge (do not project the pipe outlet into the stream). Pipe supports (e.g. timber piles) should be placed at the pipe outlet if the pipe is 24" diameter or larger.
- f) Pipe sections should be connected via secure, watertight bands (rod and lugs [four sets per band] are required for corrugated metal pipes). Please be aware that your agency or company will be responsible for the storm sewer that is installed and future maintenance/repair of it.
- g) Any area disturbed within the channel levee right-of-way needs to be reseeded to a grass mixture as follows: 20 lbs. PLS per acre Smooth Brome, 20 lbs. PLS per acre Tall Fescue (K31), 4 lbs. PLS (pure live seed) per acre Switchgrass, and 50/lbs per acre oats. If smooth brome is prohibited by a project Corps of Engineers Section 404 Permit, then the following grass mixture should be used: 2.5 lbs/acre little blue stem, 3.3 lbs./acre side oats grama, 0.08 lbs./acre blue grama, 4.0 lbs/acre Western wheatgrass, 1.7 lbs/acre Virginia wild rye, 5.7 lbs/acre Canada wild rye, 1.5 lbs/acre switchgrass, 20 lbs/acre tall fescue, 50 lbs/acre oats; all seed quantities in PLS lb/acre. This seed mixture should be planted at the proper seeding times (e.g., August 15 to September 15 or April 15 to May 15 of a given calendar year). Seed needs to be incorporated into the soil via grass drill. All disturbed areas shall be mulched with hay or straw that is crimped into soil or covered with biodegradable erosion control mat. It will be the responsibility of your company to re-establish channel vegetation.

- h) The Papio NRD will need to be notified 24 hours prior to construction start-up and after completion. Papio NRD will notify the U.S. Army Corps of Engineers and both entities may conduct site visits during construction.
- i) An easement or permit needs to be executed for any activity that is planned within the levee right-of-way. A metes and bounds legal description needs to be provided for easements. Easements must be recorded at the County Court House and provided to Papio NRD prior to commencement of the work.
- j) Floodgates (e.g., Hanson Type "A") will be required on any pipe outlet when the pipe is through a leveed segment of the project.
- k) For pressure pipes (e.g., natural gas, water) the pipes must be placed in the upper 2 ft. (freeboard) layer of the levee and be provided with shut-off valves near the landside slope top edge, on both sides of the levee.
- l) Flood protection must be maintained at all times throughout the construction, such as via an equal elevation ring levee around the excavated trench through the levee.
- m) On the R-613 and R-616 levees and at Union Dike it is important to properly stockpile soil and then backfill in pervious and impervious layers, as per the original design.
- n) Levee sections must be overbuilt (raise height over existing) at cut sections to provide for expected settlement. Increase levee top height one foot at pipe centerline and taper to zero feet at edges of excavation (maximum slope = 20:1 [horizontal: vertical]).
- o) Concrete trail sections disturbed by construction must be rebuilt to original grade and dimensions (usually six inches thick by ten feet wide). Trail sections at overbuilt levee segments will require a two year warranty or phased construction techniques, to reduce trail cracking. A separate trail specification (attached) must be adhered, where trail (pavement) is impacted.
- p) Sewer manholes in levee ROW must be below the ground surface or flush with the surface to permit mowing over the manhole.

**PERMIT FOR OCCUPATION OF  
LEVEE/CHANNEL RIGHT-OF-WAY**

This agreement is entered between: the **PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT**, a governmental subdivision of the State of Nebraska, with offices at 8901 South 154<sup>th</sup> Street, Omaha, Nebraska, hereinafter called "*the District*" and \_\_\_\_\_, hereinafter called "*the Permittee*", witnesseth that,

**WHEREAS**, the Permittee desires to \_\_\_\_\_ (hereafter called "the Construction") in the District's \_\_\_\_\_ (ROW) in \_\_\_\_\_ Section \_\_\_\_\_, T \_\_\_\_\_, R \_\_\_\_\_ E, \_\_\_\_\_ County, Nebraska.

**WHEREAS**, the District is agreeable to permit the Construction in the aforesaid structure right-of-way in accordance with the terms and conditions hereinafter set forth.

**NOW THEREFORE**, in consideration of their mutual covenants herein expressed, it is agreed between the District and the Permittee that approval to construct, operate and maintain the Construction, in accordance with the plans and specifications for \_\_\_\_\_, as per plans prepared by \_\_\_\_\_, dated \_\_\_\_\_ contained herein by reference is hereby granted to the Permittee subject to the following conditions:

1. Levee and channel facilities and appurtenances thereof damaged as a result of the installation, operation and maintenance of the Construction are properly and immediately restored to their "as built" condition. This shall include but not be limited to the following:
  - (a) all excavations shall be backfilled with same or comparable material and compacted to a density at least equal to that of the adjacent Levee,
  - (b) all seeded areas which are disturbed shall be re-seeded and an acceptable cover established,
  - (c) all materials, pipe, debris and other material shall be removed from the site following completion of the Construction,
  - (d) a new six inch (6") thick by ten foot (10') wide crushed limestone (1-1/2 inch crusher run) surfacing will be placed on all traveled unpaved portions of levee roadway, unless District waives this requirement at the project final inspection and
  - (e) all concrete or asphalt trails shall be rebuilt to original constructed thickness and width.
  
2. The Permittee agrees to pay for all damages occasioned to the levee system arising out of the Construction and/or the use of the levee system by the Permittee and/or its contractors. In the event of any damage to the levee system caused by the installation, operation or maintenance of the Construction, the District shall notify the Permittee, who shall promptly cause such damage to be properly repaired to the satisfaction of the District. In the event that such damaged portions of the levee are not promptly or properly repaired by the

Permittee, the District shall make the repairs and, following demand, shall have an action against the Permittee for the actual cost of such repairs, and for a reasonable fee for associated administration costs and for attorney fees.

3. The Permittee agrees to hold the District harmless from and against any and all liability, causes of action and claims occasioned by the use of said levee system by the Permittee and/or its contractors, including liability for any injury to any personnel employed by the Permittee, and personnel employed by contractors or subcontractors of the Permittee, or personnel of the District, except for the negligence of the District, its agents and employees.
4. Use of the levee for vehicular traffic shall be limited to the area designated in the preceding paragraphs and shall be limited to one ton rated pickups and automobiles, except in the immediate work area.
5. The Permittee agrees to reimburse the District for any costs associated with inspection of the work permitted under this agreement, which costs should be itemized and forwarded by the District within ninety days after their accrual.
6. The Permittee agrees to notify the District 24 hours prior to beginning the Construction on said levee system.
7. Upon completion of installation of the Construction or any modifications thereto, the Permittee shall furnish to the District two copies of "as built" plans for the Construction or modification, if it differs from the approved plans.
8. In the event the Corps of Engineers or the District shall determine that it shall be necessary to re-shape or re-build the levee, and in the event such work shall necessitate the removal, reinstallation, replacement, relocation and/or alteration of the Permittee's Construction, Permittee agrees to have done or reimburse the District upon demand, for that part of the cost of such work that shall be determined by the District to be attributable to such removal, installation, replacement, relocation and/or alteration of the Permittee's Construction.
9. The Permittee shall maintain the Construction in a manner which will not interfere with the continued operation and maintenance of the levee and channel facilities. The level of flood protection afforded by the levee system must be maintained at all times.
10. Permittee assumes the entire risk of loss or damage to its Construction, from all causes whatsoever, including flood or other natural disaster or act of God, and excluding only the sole negligence of the District or its officers and employees.
11. It is understood that this agreement does not include a warranty by the District of its title to the right-of-way or to the interest herein conveyed. It shall be the responsibility of the Permittee to secure such other approvals as shall be necessary for its Construction.



**IN WITNESS WHEREOF**, the parties hereto have executed this agreement on the respective dates shown:

**PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT**

By \_\_\_\_\_  
P-MRNRD General Manager

Dated \_\_\_\_\_

\_\_\_\_\_  
Printed Name

**ATTEST:**

By \_\_\_\_\_  
P-MRNRD Assistant General Manager

Dated \_\_\_\_\_

\_\_\_\_\_  
Printed Name

-----

\_\_\_\_\_  
Permittee Name

By \_\_\_\_\_  
Name

Dated \_\_\_\_\_

\_\_\_\_\_  
Printed Name

Title \_\_\_\_\_

**ATTEST:**

By \_\_\_\_\_  
Name

Dated \_\_\_\_\_

\_\_\_\_\_  
Printed Name

Title \_\_\_\_\_

DATE:	10/6/2021	PROJECT NO.:	
TO:	PAPIO MISSOURI RIVER NRD	LOCATION:	NRD LEVEES & DAMS
FROM:	Dan Strey	CONTRACTOR:	TBD
	UNITED SEEDS INC.	SEED TYPE:	SEED MIX A - BROME
RE:	SEED CERTIFICATION FORM	ACRES:	1
		LOT NUMBER:	TBD



UNITED SEEDS INC  
DES MOINES  
OMAHA

KIND*	VARIETY	PLS# / AC	AC (X)	(=) TOTAL PLS#	PLS FACTOR	TOTAL BULK LBS
SMOOTH BROMEGRASS	LINCOLN	20	1.00	20.000	1.306	26.121
TALL FESCUE	FAWN	20	1.00	20.000	1.138	22.764
SWITCHGRASS	DAKOTAH	4	1.00	4.000	1.078	4.310
SEED OATS	JERRY	50	1.00	50.000	BULK	50.000

COMMON NAME	GENETIC ORIGIN	LOT NUMBER	TEST DATE					TOTAL PURE	TOTAL GERM.		PLS %	PLS FACTOR	
				PURITY	CROP	INERT	WEED		GERM	DORMANT			
SMOOTH BROMEGRASS	KS	2101	8/16/2021	91.15%	0.16%	8.66%	0.03%	100.00%	84%	0%	84%	76.566%	1.306
FAWN TALL FESCUE	OR	L4-21-B8F	7/30/2021	97.62%	0.00%	2.58%	0.00%	100.00%	90%	0%	90%	87.858%	1.138
SWITCHGRASS	MN	H86041	7/27/2021	99.79%	0.17%	0.04%	0.00%	100.00%	93%	0%	93%	92.805%	1.078
OATS	SD	01	4/1/2021	99.65%	0.01%	0.54%	0.00%	100.00%	98%	0%	98%	97.657%	1.024

**PAPIO NRD**  
**SEED MIX A - BROME**  
**NRD LEVEES & DAMS**  
**(2)-51.6 LB BAGS = 0.5 ACRES EACH**

NOTES: (1). ALL SEED IN THIS PERMENANT SEED MIXTURE HAVE BEEN GROWN WITHIN THE UNITED STATES. (2) SPECIES LOTS AND VARIETIES ARE SUBJECT TO CHANGE WHEN THE MIXTURE IS ORDERED, MIXED AND BAGGED.

Approved by:  
Dan Strey

ACRES / BAG:	0.500		TOTAL BULK LBS	103.20
LBS / BAG:	51.60	2.00	# of Bags	1
NEED:	2	0.50	AC. TAGS	1

DATE:	5/23/2013	PROJECT NO:	VARIOUS LEVEE SITES
TO:	PAPIO MISSOURI NRD	LOCATION:	PAPIO MISSOURI NRD_DISTRICT
		CONTRACTOR:	PAPIO MISSOURI NRD
FROM:	Andre Hoyt	SEED TYPE:	NRD NATIVE GRASS MIX
	UNITED SEEDS INC.	ACRES:	1
	SEED CERTIFICATION FORM	LOT NUMBER:	



UNITED SEEDS INC  
7500 BURLINGTON  
OMAHA, NE 68127  
800-456-9901  
DES MOINES, IA 50316  
800-366-6674



UNITED SEEDS INC  
DES MOINES  
OMAHA

KIND*	VARIETY	PLS # / AC	AC (X)	(=) TOTAL PLS #	PLS FACTOR	TOTAL BULK LBS
LITTLE BLUESTEM		2.5	1	2.50	1.318	3.30
SIDEOATS GRAMA		3.3	1	3.30	1.079	3.56
BLUE GRAMA		0.8	1	0.80	1.154	0.92
WESTERN WHEATGRASS		4	1	4.00	1.139	4.56
VIRGINIA WILDRYE		1.7	1	1.70	1.063	1.81
CANADA WILDRYE		5.7	1	5.70	1.046	5.96
SWITCHGRASS		1.5	1	1.50	1.054	1.58
TALL FESCUE		20	1	20.00	1.061	21.22
OATS		50	1	50.00	BULK	50.00

COMMON NAME	VARIETY NAME	ORIGIN	LOT NUMBER	TEST DATE	TEST				TOTAL PURE	TOTAL		TOTAL GERM	PLS %	PLS FACTOR
					PURITY	CROP	INERT	WEED		GERM	DORMANT			
LITTLE BLUESTEM	CAMPER	NE	EFC-12	2/12/2013	85.25%	0.02%	14.66%	0.07%	100.00%	89%	0%	89%	75.87%	1.318
SIDEOATS GRAMA	BUTTE	NE	KS-12	11/1/2012	97.56%	0.17%	2.26%	0.01%	100.00%	95%	0%	95%	92.68%	1.079
BLUE GRAMA	BAD RIVER	MN	A3507	12/28/2012	93.17%	0.13%	6.66%	0.04%	100.00%	93%	0%	93%	86.65%	1.154
WESTERN WHEATGRASS	BARTON	SD	24763.436	1/15/2013	96.44%	0.00%	3.52%	0.04%	100.00%	91%	0%	91%	87.76%	1.139
VIRGINIA WILDRYE	IA NATIVE	IA	2011.A.3760R2	2/1/2013	99.07%	0.00%	0.93%	0.00%	100.00%	95%	0%	95%	94.12%	1.063
CANADA WILDRYE	MANDAN	MN	A3504	3/1/2013	99.61%	0.01%	0.38%	0.00%	100.00%	96%	0%	96%	95.63%	1.046
SWITCHGRASS	NE28	IA	491	12/20/2012	99.87%	0.00%	0.13%	0.00%	100.00%	95%	0%	95%	94.88%	1.054
TALL FESCUE	FAWN	OR	L65-11-SK2	12/1/2012	99.24%	0.00%	0.76%	0.00%	100.00%	95%	0%	95%	94.28%	1.061
OATS	JERRY	SD	7016	1/15/2013	99.30%	0.10%	0.59%	0.01%	100.00%	96%	0%	96%	95.33%	1.049

Written By: Andre Hoyt *Andre Hoyt*  
Vice President/Submittal Writer

Species analysis tags represented on this submittal represent inventory on hand at the time this submittal was originated. Analysis information can change from the time this submittal was generated until the point the actual mixture was prepared.

ACRES / BAG:	2.500	TOTAL BULK LBS	92.91
LBS / BAG:	46.45	# of Bags	2
NEED:	2	AC. TAGS	0.500
NEED:		AC. TAGS	

# MEMORANDUM

**TO:** File

**FROM:** Martin P. Cleveland

**SUBJECT:** Dam, Levee and Channel Native Grass Mixture

**DATE:** December 20, 2006

In response to US Army Corps of Engineers Regulatory Section requirement that replacement grass mixture used in disturbed areas adjacent to Section 404 Permit areas not include smooth brome, the NRD hereby adopts the following native grass mixture as an alternative to brome-fescue-switchgrass-oats grass mixture used elsewhere on NRD project areas:

## NRD Native Grass Mixture, for Dams, Levees and Channels

SPECIES	PLS Lbs/Acre
1. Little bluestem	2.50
2. Sideoats grama	3.30
3. Blue grama	0.80
4. Western wheatgrass	4.00
5. Virginia wildrye	1.70
6. Canada wildrye	5.70
7. Switch grass	1.50
8. Tall Fescue	20
9. Oats (cover crop)	50 (not PLS)

\*PLS = pure live seed

## SECTION 32 13 00

### CONCRETE PAVEMENT

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

##### 1.02 DESCRIPTION OF WORK:

- A. Work under this section shall consist of the preparation and placement of exterior portland cement concrete for all concrete site improvements including, but not limited to concrete walk pavement, concrete trail pavement; roadways, parking lots, curbing, combination curb and gutter, basketball court concrete pavement, handicapped curb ramps, concrete pavement under playground surfacing, concrete shelter pavement, heavy duty concrete pavement on the prepared subgrade, etc. where located and as detailed on the plans.

##### 1.03 RELATED WORK:

- A. Other specification sections which directly relate to the work of this section include, but are not limited to, the following:
  - 1. Division 31, Section 31 20 00, "Site Earthwork".
  - 2. Division 32, Section 32 17 23, "Painted Pavement Markings".
  - 3. City of Omaha Standard Specifications for Public Works Construction 2020 (a.k.a. Standard Specifications).

##### 1.04 SUBMITTALS:

- A. The Contractor shall submit the following samples, certifications or test results prior to use on the project.
  - 1. Concrete mix design, including type of cement and cement to water ratio.
  - 2. Product data on Expansion Joint Material and Elastomeric Sealing Compound.
  - 3. Product data on Fiber mesh.
  - 4. Product data on Smooth Steel Dowels.
  - 5. Product data on welded wire fabric (W.W.F.).
  - 6. Product data on steel reinforcement.
  - 7. Sieve analysis for Crushed Aggregate Base Course.

8. Product data on Detectable Warning Panels for ADA Concrete Curb Ramps.

#### 1.05 QUALITY ASSURANCE:

- A. Pre-Installation Conference: Before installing concrete paving the Contractor shall meet on the Project Site with representatives of the authorities having jurisdiction, the Owner, the Park Planner, the Architect-Landscape Architect-Engineer, consultants, the independent testing agency, and other concerned entities to review the requirements for concrete paving. All participants shall be notified at least three (3) working days prior to Pre-Installation Conference.
- B. Concrete Testing Service: Owner shall employ the services of a qualified independent testing agency to perform all construction material evaluation tests and design concrete mixes.
  1. Refer to Specification Section 32 13 00, "Concrete Pavement", Part 3.12, "Field Quality Control Testing" for additional information on testing.

#### 1.06 PROJECT CONDITIONS:

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Environmental Requirements:
  1. Cold Weather Requirements: Conform to ACI 306R, "Recommended Practice for Cold Weather Concreting".
  2. Hot Weather Requirements: Conform to ACI 305R, "Recommended Practice for Hot Weather Concreting".
  3. Avoid placing concrete when stormy or inclement weather is eminent or prevents good workmanship.
  4. Apply anti-spalling compound to concrete pavement when placed after August 1st and opened to traffic prior to March 1st of the following year.

## PART 2 - PRODUCTS

#### 2.01 CONCRETE MATERIALS:

- A. Portland Cement: Portland cement shall conform to the requirements for Cement Type 1, Cement Type 1L or Cement Type 2 in accordance with ASTM C150, Specifications for Portland Cement including Table 2 (Maximum Equivalent Alkalis requirements only) and Table 3. All cements shall be on the Nebraska Department of Transportation (NDOT) Approved Project List (APL).
- B. Aggregate for Portland Cement Concrete: Coarse aggregate shall conform to all material property requirements in accordance with ASTM C33, Specification for Concrete Aggregates and shall conform to the gradation requirements of Table 500.01, Section 500 – Rigid Pavement dated September 2019 of the "Draft 2018 - Standard Specifications for Public Works Construction" (Standard Specifications" except as noted below:

- C. Water: All water used in Portland Cement Concrete mixture shall be potable in accordance with AASHTO T26, Quality of Water to be used in Concrete.

## 2.02 CONCRETE MIX:

- A. Mix and deliver concrete in accordance with ASTM C 94, Alternative No. 3.
1. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 90 minutes (1-1/2 hours) to 75 minutes.
  2. When air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes (1 hour).
- B. Select proportions for normal weight concrete in accordance with ACI 301, Method 3.
- C. Provide concrete to the following criteria:
1. Minimum Compressive strength at 7 days: 3,000 psi.
  2. Minimum Compressive strength at 28 days: 4,000 psi.
  3. Slump: Not less than 2 inches and not more than 4 inches.
  4. Mix: Cement to water ratio shall comply with one of the following two requirements.
    - a. 611 pounds of Type 1 or Type 2 cement per cubic yard minimum, and a maximum water to cement ratio of 0.42.
    - b. 672 pounds of Type 1L Type 1C cement per cubic yard, and a maximum water to cement ratio of 0.38
  5. Provide synthetic fiber reinforcement as per Part 2.03, "Reinforcement", Item A, unless noted otherwise.
- D. Fly ash shall not be used in the concrete mix without first receiving written permission of the Park Planner.
- E. Use of accelerating admixtures in cold weather only when approved in writing by the Park Planner. Use of admixtures will not relax cold weather placement requirements.
- F. Use of Calcium chloride will not be allowed.
- G. Use set retarding admixtures during hot weather only when approved in writing by the Park Planner.
- H. Add air entraining agent to all concrete. Provide between five and seven percent (5% to 7%).

## 2.03 REINFORCEMENT:

- A. Synthetic Fiber Reinforcement: One hundred percent (100%) virgin homopolymer polypropylene fibrillated fibers containing no reprocesses olefin materials. Fibers shall be specifically engineered and

manufactured in an ISO 9001:2000 certified facility to an optimum gradation for use as concrete secondary reinforcement at a minimum of 0.1% by volume (1.5 lbs/cubic yard).

1. Conform to the following requirements:

- a. ASTM C 1116, Type III.
- b. Fire Classifications:
  1. UL Report File No. R8534-11.
  2. Southwest Certification Services (SWCS), Omega point Laboratories No. 8662-1.
- c. Fiber Length: Graded
- d. Alkali Resistance: Alkali Proof.
- e. Absorbption: Nil.
- f. Specific Gravity: 0.91.
- g. Melt Point: 324 degrees F (162 degrees C).

2. Approved Product/Manufacturer:

- a. Propex Fibermesh Fibermesh 300, as manufactured by Propex Operating Company, LLC, PO Box 22788, 6025 Lee Highway, Suite 425, Chattanooga, TN 37421; phone: 800-621-1273 or 423-892-8080; fax: 423-892-0157; website: [www.fibermesh.com](http://www.fibermesh.com); e-mail: [fibermesh@propexglobal.com](mailto:fibermesh@propexglobal.com)
- b. MasterFiber F70 as manufactured by BASF Corporation, Admixtures Systems, 23700 Chagrin Boulevard, Cleveland, Ohio 44122; phone: 216-839-7500.
- c. Or Approved Equivalent.

B. Smooth Steel Dowels: Smooth steel dowels, where noted on plans, shall be smooth, round bars and conform to Section 501.02.J, "Reinforcement for PCC" of the Standard Specifications except that they shall not be deformed bars. Before delivery to the project, approximately three-fifths the length of each dowel bar may be coated with a suitable paint such as red lead or zinc chromate-iron oxide primer.

C. Welded Wire Fabric (W.W.F.): Welded wire fabric, where noted on plans, shall conform to the requirements of ASTM A185, "Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement".

1. Welded Wire Fabric shall be provided in flat sheet. Rolled welded wire fabric will not be accepted for use on the project.

D. Steel Reinforcement: Steel bars for concrete reinforcement shall conform to ASTM A 615, Grade 60, deformed.

E. Supports for Reinforcement: Chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

1. Use supports with sand plates or horizontal runners where base material will not support chair legs.



## 2.04 EXPANSION JOINT MATERIAL:

- A. Expansion joint material shall be one-half inch (1/2") non-extruding, expansion joint filler material. It shall conform to Section 501.02.G, "Pre-molded Joint Filler" of the Standard Specifications and shall conform to the requirements of either:
1. ASTM D 1751, "Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)" or;
  2. ASTM D 1752 (Type 1), "Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction", with the additional requirements that thicknesses up to one inch (1") shall be homogenous and show no evidence of lamination.
- B. Joint Sealer: Joint Sealer shall conform to Section 501.02.I, "Joint Sealant of the Standard Specifications and meet the following requirements:
1. Expansion Joint Sealer: Vulkem 116 or approved equivalent.
  2. Control Joint Sealer: Vulkem 116 or approved equivalent.

## 2.05 CURING COMPOUNDS, ADMIXTURES AND ANTISPALLING COMPOUND:

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per square yard and complying with AASHTO M 182, Class 2.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171. Where required by local or state environmental regulation, provide materials with a maximum volatile organic compound (VOC) rating of 350 g/L per liter.
1. Polyethylene film.
  2. White burlap-polyethylene sheet.
- C. Clear Waterborne Membrane-Forming Curing Compound: Comply with ASTM C 309, Type 1, Class B.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
    - a. AH Curing Compound #2 DR WB; Anti-Hydro International, Inc.
    - b. Aqua Resin Cure; Burke Group, LLC (The).
    - c. Safe-Cure Clear; ChemMasters.
    - d. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
    - e. Day Chem Rez Cure (J-11-W); Dayton Superior Corporation.
    - f. Nitocure S; Fosroc.
    - g. Aqua Kure-Clear; Lambert Corporation.
    - h. L&M Cure R; L&M Construction Chemicals, Inc.
    - i. 1100 Clear; W.R. Meadows, Inc.
    - j. Resin Cure E; Nox-Crete Products Group, Kinsman Corporation
    - k. Rich Cure E; Richmond Screw Anchor Co.
    - l. Resi-Chem Clear Cure; Symons Corporation

- m. Horncure 100; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
  - n. Hydro Cure; Unitex.
  - o. Cert-Vex Enviocure; Vexcon Chemicals, Inc.
- D. Evaporation Retarder: Waterborne monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
    - a. Cimfilm; Axim Concrete Technologies.
    - b. Finishing Aid Concentrate; Burke Group, LLC (The).
    - c. Spray-Film; ChemMasters.
    - d. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
    - e. Sure Film; Dayton Superior Corporation.
    - f. Eucobar; Euclid Chemical Co.
    - g. Vapor Aid; Kaufman Products, Inc.
    - h. Lambco Skin; Lambert Corporation.
    - i. E-Con; L&M Construction Chemicals, Inc.
    - j. Confilm; Master Builders, Inc.
    - k. Waterhold; Metalcrete Industries.
    - l. Rich Film; Richmond Screw Anchor Co.
    - m. SikaFilm; Sika Corporation.
    - n. Finishing Aid; Symons Corporation.
    - o. Cert-Vex EnvioAssist; Vexcon Chemicals, Inc.
- E. Admixtures shall conform to Section 501.02.D, "Admixtures for PCC" of the Standard Specifications.
- F. Antispalling Compound: Combination of 50 percent boiled linseed oil conforming to ASTM D 260, Type II, and 50 percent petroleum spirits conforming to ASTM D 235 mixed to conform to AASHTO M233.

## 2.06 FORM MATERIAL:

- A. Wood or steel form material, profiled to suit conditions.
- B. Forms: All forms shall be of the same height as the specified thickness of the concrete as shown on the drawings.
  - 1. Forms that are less than the thickness of the concrete as detailed are unacceptable.
  - 2. Forms for all curbed walks and for curbing having less than 100-foot radius shall be wood or curved metal. Wood shall be of sufficient thickness to permit bending to the required radius and yet provide rigidity required to resist deformation during concrete placement.
  - 3. Form Materials: Metal, 10-foot minimum in length and depth equal to thickness of concrete. At integral curbs, additional height required for curb height may be obtained by bolting extra forms to top of main form. Where indicated on the Drawings, face of form shall have a keyway. Form shall be of such dimension and strength required to resist deformation caused by concrete

placement or weight of equipment riding atop form. Forms shall have at least three-stake pocket per section. Each section shall have devices to maintain alignment between sections.

- C. Form Release Agent: Provide commercial formulation form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

**2.07 CRUSHED AGGREGATE BASE COURSE:**

- A. Crushed aggregate base course shall conform to Section 300, "Aggregate Sub-base/Base Course", be in accordance with ASTM D2940, "Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways and Airports" and comply with the following Gradation Limits.

- 1. Gradation Limits:

<u>Sieve Size</u>	<u>Allowable Percent Passing</u>
1-1/2 inch	100%
3/4 inch	65-95%
3/8 inch	36-70%
No. 10	10-30%
No. 200	0-10%

**2.08 DETECTABLE WARNING PANELS FOR ADA CONCRETE CURB RAMPS:**

- A. Detectable Warning Panels shall be natural unfinished cast iron detectable warning panels for ADA concrete curb ramps.
- B. The following products are approved for use within the City of Omaha and its three mile extraterritorial jurisdiction:
  - 1. Iron Dome as manufactured by ADA Solutions, Inc., 323 Andover Street, Suite 3, Wilmington, MA 01887; voice: 800-372-0519; fax: 978-262-9125; website: <https://adatile.com>
  - 2. Detectable Warning Plate 4984 as manufactured by Deeter Foundry, Inc., a Neenah Foundry Company, 5945 North 70th Street, P.O. Box 29708, Lincoln, Nebraska 68529; voice: 402-464-7466 or 800-234-7466; fax: 402-464-8533; web site: <http://www.deeter.com>; e-mail: [sales@deeter.com](mailto:sales@deeter.com).
  - 3. Duralast Detectable Warning Plate as manufactured by EJ, 301 Spring Street, P.O. Box 439, East Jordan, MI 49727; voice: 800-626-4653 or 231-536-2261; email: [us.sales@ejco.com](mailto:us.sales@ejco.com).
  - 4. TufTile Cast Iron ADA Tactile Tiles as manufactured by TufTile, Inc., 1200 Flex Court, Lake Zurich, IL 60047; voice: 888-960-8897; fax: 847-0550-8004; website: [www.tuftile.com](http://www.tuftile.com)

**PART 3 - EXECUTION**

**3.01 GENERAL:**

- A. The installation shall conform to the requirements of Section 500, "Rigid Pavement" of the Standard Specifications.

1. Concrete shall be spread, consolidated, screeded, bull-floated, and finished in accordance with Section 7.2 of ACI Standard 302, "Recommended Practice for Concrete Floor and Slab Construction".
- B. Verify site conditions are ready for the installation of concrete.
- C. Verify requirements for concrete cover over reinforcement.
- D. Verify that the items to be cast into concrete are accurately placed, positioned securely and will not cause hardship in the placing of concrete.
- E. Concrete shall be placed only on a moist base. Concrete shall not be placed on a soft, muddy or frozen base.

### **3.02 PREPARATION:**

- A. Prepare the subgrades for concrete as detailed on the plans, parallel to finish grade after compaction. Placement of Base Course shall not take place until compaction tests (minimum of two) have been taken and the required compaction has been achieved.
  1. Proof-roll prepared subgrade surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
  2. Remove loose material from compacted subgrade surface immediately before placing concrete.
  3. Owner shall review the sub grade preparation for elevation and compaction prior to placement of concrete and/or aggregate base course.
- B. Subgrades shall be parallel to finished grade, to depth specified on the plans.
- C. Aggregate Base Course: If required, on prepared subgrade compacted to maximum density, place aggregate base course to depths shown on the plans and as detailed. Compact to ninety-five percent (95%) maximum density.
- D. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

### **3.03 LAYOUT:**

- A. Layout of the pavement shall be as per the plans. Layout shall be done by someone experienced in the layout of such items.
- B. Concrete pavement shall be of the width, depth and extent shown on the plans.

### **3.04 REINFORCEMENT:**

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

- B. Place, support and secure reinforcement against displacement by concrete placement. Do not deviate from required position.
  - 1. Place tie bars in the edge of slabs and center in slab. Insert bars through holes in forms. Do not insert bars in unsupported edges of freshly placed concrete.
- C. Accommodate placement of formed openings.
- D. All reinforcement at the time of concrete placement shall be free of loose, flaky rust and other coatings or films that could interfere with bonding to the concrete.
  - 1. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- E. All reinforcement shall be placed and inspected by the owner prior to placement of concrete.

### 3.05 FORMS AND SCREEDS:

- A. Forms and screeds shall be accurately set to the lines and grades indicated on drawings and be securely staked to prevent settlement or movement during placing of concrete.
- B. Forms shall remain in place until concrete has taken its final set.
- C. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement. Neatly join and secure form sections together. Rest forms on grade completely along length of form.
- D. Check completed formwork and screeds for grade and alignment to following tolerances:
  - 1. Top of forms: Not more than 1/8 inch in 10 feet.
  - 2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.
- E. Clean forms after each use and coat with form release agent as required, to ensure separation from concrete without damage.

### 3.06 JOINTS:

- A. General: Construct control (contraction), construction, and expansion joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.
  - 1. When adjoining existing paving, locate transverse joints to align with existing joints, unless indicated otherwise.
- B. Install expansion joints where noted on the plans.
- C. Edges of joints shall be tooled with an edging tool having a radius of one-quarter inch (1/4").
- D. After the concrete has cured and the tack strips over the joints removed, the joints shall be sealed with an elastomeric sealing compound to within one eighth inch (1/8") of the surface of the concrete slab.

- E. Control (Contraction) Joints: Provide weakened-lane contraction joints, sectioning concrete into area as shown on Drawings. Construct contraction joints for a depth equal to at least  $\frac{1}{4}$  of the concrete thickness, as follows:
1. Tooled Walk Joints and Edges: Form control (contraction) joints in fresh concrete by grooving and finishing each edge of joint with a (1/4-inch) radiused jointer tool. Precut joints when large aggregates are used in order to reposition aggregates away from joint to allow straight, uniform, smooth jointing. Tool the joints prior to brooming.
  2. Tool edge of pavement slabs to produce a rounded corner of  $\frac{1}{4}$ -inch radius. Tool edges prior to finishing.
- F. Sawed Joints: Form control (contraction) joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into hardened concrete when cutting action will not tear, abrade, or otherwise damage surface and before development of random control (contraction) cracks. Next, re-saw the joint to create a reservoir for sealant that is  $\frac{1}{4}$  inch wide by 1 inch deep. Discontinue sawing if a crack develops ahead of saw or immediately adjacent to joint alignment. Rout cracks which develop to a depth of 1 inch and  $\frac{3}{8}$  inch wide. Hand tool joint where walls or other obstructions prevent saw cutting to slab edge.
- G. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than  $\frac{1}{2}$  hour, unless paving terminates at isolation joints.
1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete.
  2. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
  3. Provide tie bars at sides of paving strips where indicated.
- H. Expansion Joints: Form expansion joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated on the drawings.
1. Locate expansion joints at locations shown on the drawings. Locate in curb and gutters at point of radius curvature and where expansion joint occurs in abutting concrete slab.
  2. Provide  $\frac{1}{2}$  inch expansion joints with pre-molded asphaltic expansion joint filler, cut to the shape of the cross-section, at seventy-five foot (75') maximum intervals, where shown on the plans and where new concrete meets existing concrete. Trim preformed expansion joint filler with sharp chisel  $\frac{1}{4}$  inch below top of concrete curbing.
  3. Place expansion joint fillers vertically and in true alignment. Place bottom of filler completely through concrete into subgrade at a minimum of  $\frac{1}{2}$  inch to totally isolate slabs. Provide a removable metal, plastic, or wood cap strip atop filler to create a 1-inch deep sealant reservoir after cap removal.
  4. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.

5. Provide one half inch (1/2") diameter, two foot (2'-0") long smooth, steel dowels, at all expansion joints as noted on the plans. Wrap in tar paper or provide metal cap for "Free End" of dowel to prevent adhesion to concrete. Provide 1/2 inch asphaltic type preformed expansion joint filler as described in item 2.02 above.
- I. Clean sealant reservoirs at expansion and pavement contraction joints by re-sawing and blowing clean. Install sealant as specified in the project's specifications.

### 3.07 PLACING AND FINISHING CONCRETE SLAB:

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
  1. Avoid placing concrete when stormy or inclement weather is eminent or prevents good workmanship.
- B. Notify the Park Planner at least twenty-four (24) hours prior to commencement of the placement of concrete.
- C. Remove snow, ice, or frost from sub-base surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.
- D. Moisten subgrade to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- E. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.
- F. Addition of water to the concrete mixture on site is strictly prohibited.
- G. Ensure reinforcement and formed expansion joints are not disturbed during concrete placement.
- H. On prepared base course or sub-base course compacted to maximum density, place concrete to depths shown on the drawings and as detailed.
- I. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place. Consolidate and smooth concrete to produce a dense pavement free from honeycomb, pockets, or segregated aggregates.
  1. Halt concreting operations at expansion or contraction joints whenever concrete placing must be delayed for more than ½ hour. Place a construction joint in place of contraction joint.
- J. Do not interrupt successive placement. Do not permit cold joints to occur.
- K. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use the equipment and procedures to consolidate concrete complying with ACI 309R.
  1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only

square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing and joint devices.

- L. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- M. Curbs and Gutters: Spade and tamp concrete curb to produce a dense concrete with mortar worked into surface. Strike off concrete to desired cross section and smooth exposed surface with a wood float. Edge exposed corners to produce a sandy gritty texture.
1. When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.
- N. Slip-Form Pavers: When automatic machine placement is used for paving, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish, and jointing as required for formed paving.
1. Compact and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
  2. Design slipforming equipment to spread, consolidate, screed, place keyway, and float finish concrete in one complete pass. Control alignment of paver utilizing lasers or securely placed guide wires and automatic sensing devices.
- O. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- P. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement
  2. Do not use frozen materials or materials containing ice or snow.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- Q. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.



2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
  3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
- R. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

### 3.08 CONCRETE FINISHING:

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. When concrete is sufficiently set to withstand foot pressure with only a one-quarter inch (1/4") indentation and the water sheen has left the surface, the slab shall be uniformly finished by floating and troweling.
- C. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Cut down high spots and fill low spots while concrete is plastic. Refloat surface immediately to a uniform granular texture.
1. Burlap Finish For Concrete Pavements: Drag a seamless strip of damp burlap across concrete pavement, perpendicular to line of traffic, to provide a uniform gritty texture finish. Rinse or wash drags every four hours. Discard drags that cannot be cleaned.
  2. Medium-to-Fine Textured Broom Finish For Sidewalks Less Than Five Percent (5%) Slope:
    - a. Draw a soft nylon broom across concrete walk surface perpendicular to line of traffic to provide a uniform fine line texture finish.
  3. Medium-to-Coarse-Textured Broom Finish For Sidewalks and Ramps Steeper Than Five Percent (5%) Slope:
    - a. Provide a coarse finish by striating surface 1/16 inch to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

### 3.09 PAVEMENT TOLERANCES:

- A. The concrete surface shall be finished so that the tolerance is one-eighth inch (1/8") measured as the departure from the testing edge of a ten foot (10') straightedge held parallel to and in contact with the surface.
- B. Comply with tolerances of ACI 117 and as follows:
1. Thickness: Plus 3/8 inch (9mm), minus 0 inch (6mm).
  2. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/4 inch (6 mm).

3. Lateral Alignment and Spacing of Tie Bars: 1 inch (25 mm).
4. Vertical Alignment of Tie Bars: ¼ inch (6mm).
5. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: ½ inch (13 mm).
6. Joint Spacing: 3 inches (75 mm).
7. Contraction Joint Depth: Plus ¼ inch (6 mm), no minus.
8. Joint width: Plus 1/8 inch (3 mm), no minus.

### 3.10 CURING OF THE CONCRETE:

- A. Immediately after placement, cover and protect concrete from premature drying, excessively hot or cold temperatures, rain, rapid temperature change, flowing water and mechanical injury for a period of at least 72 hours immediately after finishing.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Curing method shall be approved by the Park Planner.
- D. The use of a covering material which contains sugar, or becomes contaminated with sugar in any form, tannic acid, or any other substance considered detrimental to portland cement is not permitted. The initial curing medium shall be effective and applied to prevent checking, cracking, and the appearance of dry spots on surface of concrete. Immediately protect sides of concrete slabs, exposed by the removal of forms, to provide continuance of curing and to prevent injury of slab edges and underlying subgrade. If the temperature is expected to fall below 35F, cover concrete with straw, hay, or other material maintained on the site and approved by the Park Planner, protecting surfaces and edges from freezing until concrete is at least ten days old.
- E. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- F. Curing Methods: Cure concrete as follows:
  1. Mat Curing: When applying mats or burlap, cotton, or other fibrous material having similar water absorptive properties, thoroughly wet material and keep continuously wet and in intimate contact with covered surface for duration of curing period. Mats shall be uniform in thickness, shall weigh not less than 20 ounces per square yard when dry, and shall be capable of absorbing at least one and one-half times their weight of water. If used, burlap shall be in multiple layers, not single. Mats shall be approved by the Park Planner.
  2. Membrane Curing Compound: No compound shall be used until it has been approved by the Park Planner. Thoroughly agitate curing compounds during use and spray uniformly on concrete surfaces, in a single coat, with approved spraying equipment, at a rate recommended by the manufacturer, and based on moisture retention tests. Apply immediately following the final finishing operation. Keep concrete surface, to which membrane compounds have been applied, free from foot and vehicular traffic and all other sources of abrasion for a minimum of 72 hours.

- G. Anti-spalling Treatment: Apply treatment only when concrete pavement is placed after August 1st and when the pavement will be subject to contamination by deicing chemicals. Apply boiled linseed oil mixture no sooner than 28 days after placement to clean dry concrete pavements free of oil, dirt, or other foreign material. Apply when temperature of concrete and air are at least 40F and rising. Apply in 2 sprayed applications at rate of 40 sq. yd. per gallon for the first application and 60 sq. yd. per gallon for the second application. Allow complete drying between applications. Avoid spraying bituminous surfaces and sidewalks. Avoid overheating compound due to low flash point.
1. Close treated areas to traffic until slipperiness caused by compound application is lessened.

### 3.11 PROTECTION OF CONCRETE:

- A. Contractor shall protect the finished concrete work against damage while it is curing and from other work of the project.
- B. Protect concrete from damage. Exclude traffic from paving for at least fourteen (14) calendar days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion Inspections

### 3.12 FIELD QUALITY CONTROL TESTING:

- A. Testing of concrete shall be done by a qualified testing laboratory employed and paid for by the Owner. Only tests that pass will be paid for by the Owner
- B. Field Quality control tests to be performed by the testing lab employed by the Owner shall include but may not be limited to compression slump and air entrainment tests.
- C. Every seventy-five cubic yards (75 CY) of concrete or fraction thereof delivered to the site shall be tested. All tests shall be taken at the truck prior to the concrete being placed.
  1. Three concrete cylinders shall be taken for every seventy-five cubic yards (75 CY) of concrete or fraction thereof.
  2. One slump test will be taken for each set of test cylinders taken.
- D. Perform smoothness test(s) while concrete is still plastic. Tolerance shall be within 1/8 inch when measured with a 10-foot straightedge placed anywhere on the slab in any direction.
- E. Perform thickness testing in accord with ASTM C 174. If directed by the Owner, take one core per 500 square yards at random, evenly divided areas. Cores found to be longer than required thickness shall be considered as required thickness. Remove and replace areas found to less than required thickness less tolerance. Take additional cores for determining limits of deficient thickness. The entire pavement will be considered defective and subject to removal and replacement if the average thickness of all cores exceeds three percent deficient in thickness.

### 3.13 PATCHING:

- A. Allow the Park Planner to inspect concrete surfaces immediately upon removal of forms.

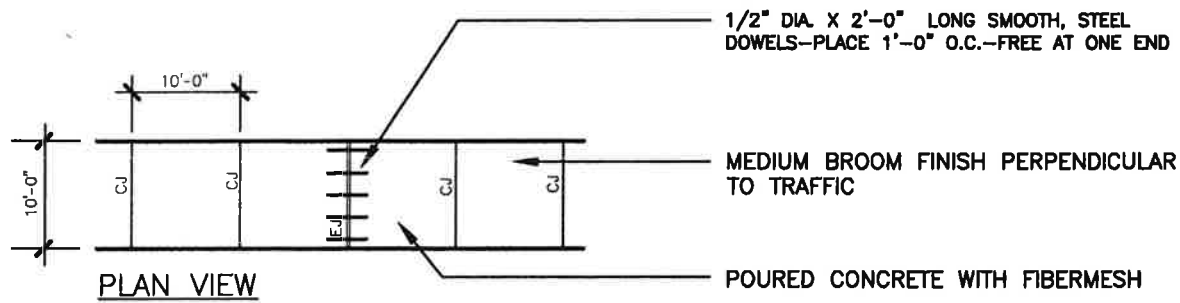
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify the Park Planner immediately upon discovery.
- C. Patch imperfections in accordance with ACI 301.

**3.14 DEFECTIVE CONCRETE:**

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Park Planner.
- C. Do not patch, fill, touch-up, repair or replace exposed concrete except upon express direction of the Park Planner for each individual area.
- D. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.
- E. Drill Test cores where directed by Owner when necessary to determine magnitude of cracks or defective areas. Fill test core holes in satisfactory pavement areas with portland cement concrete.

**END OF SECTION**

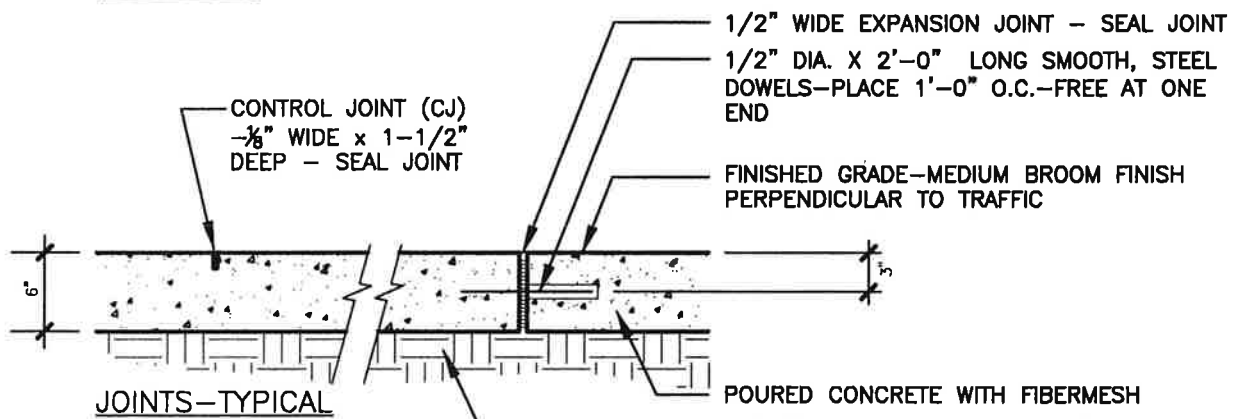
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1/2" DIA. X 2'-0" LONG SMOOTH, STEEL DOWELS—PLACE 1'-0" O.C.—FREE AT ONE END

MEDIUM BROOM FINISH PERPENDICULAR TO TRAFFIC

POURED CONCRETE WITH FIBERMESH



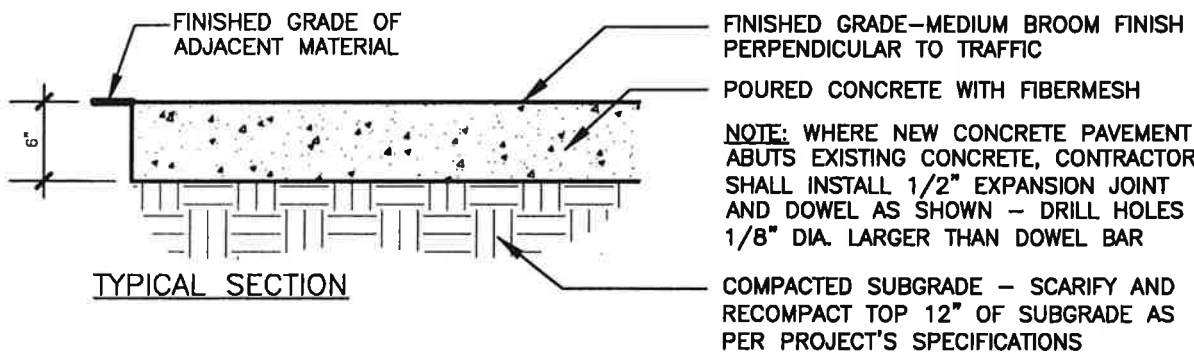
1/2" WIDE EXPANSION JOINT - SEAL JOINT

1/2" DIA. X 2'-0" LONG SMOOTH, STEEL DOWELS—PLACE 1'-0" O.C.—FREE AT ONE END

FINISHED GRADE—MEDIUM BROOM FINISH PERPENDICULAR TO TRAFFIC

POURED CONCRETE WITH FIBERMESH

COMPACTED SUBGRADE - SCARIFY AND RECOMPACT TOP 12" OF SUBGRADE AS PER PROJECT'S SPECIFICATIONS



FINISHED GRADE—MEDIUM BROOM FINISH PERPENDICULAR TO TRAFFIC

POURED CONCRETE WITH FIBERMESH

NOTE: WHERE NEW CONCRETE PAVEMENT ABUTS EXISTING CONCRETE, CONTRACTOR SHALL INSTALL 1/2" EXPANSION JOINT AND DOWEL AS SHOWN - DRILL HOLES 1/8" DIA. LARGER THAN DOWEL BAR

COMPACTED SUBGRADE - SCARIFY AND RECOMPACT TOP 12" OF SUBGRADE AS PER PROJECT'S SPECIFICATIONS

**NOTES**

1. EXPANSION JOINTS (EJ) AND CONTROL JOINTS (CJ) SHALL BE PLACED TO MATCH EXISTING OR AS DIRECTED BY THE PARK PLANNER.

2. ALL EXPANSION (EJ) AND CONTROL (CJ) JOINTS SHALL BE SEALED WITH A CURED SINGLE OR MULTICOMPONENT COLD APPLIED ELASTOMERIC JOINT SEALER. COLOR OF JOINT SEALER SHALL BE GRAY.

3. WHERE NEW CONCRETE PAVEMENT MEETS EXISTING CONCRETE, CONTRACTOR SHALL INSTALL 1/2" EXPANSION JOINT AND SMOOTH STEEL DOWELS AS SHOWN - DRILL HOLES 1/8" DIAMETER LARGER THAN DOWEL BAR.



**CONCRETE TRAIL PAVEMENT**

NOT TO SCALE

**USACE - Omaha District**

**Levee Safety Program**

**Requirements for  
Horizontal Directional Drill Requests**

**September 2014**

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## **A Partial List of Requirements for Pipeline Installation Using HDD Techniques.**

a. Identification of the intent of the directional drilling process – to create an open hole or to modify the soils along a design drill path.

b. Detailed drawings showing the plan location of the entrance and exit pits with respect to the levee embankments.

c. Detailed drawings showing the drill path alignment (plan and profile) of the proposed pipeline. This alignment shall include all curve geometry of the borehole pilot hole including, but not limited to, its length, radius of curvature, points of curvature and tangency, depth of cover and elevations at all points along the alignment. The plan should identify the location, elevations and proposed clearance between the drill path and all existent underground and above ground utilities. The depth of soil cover over the drill path shall always be great enough to prevent hydrofracture. The profile shall provide the proposed location of every drill stem joint anticipated by the driller. The plans shall identify the diameter of the pilot hole and the final reamed hole. The plan shall identify how many reaming passes would be made if there are to be more than one.

d. Description of the drill rig that would install the conduit and proof that it has the capability to install the proposed pipeline showing that its capacity is at least twice that of the loads anticipated during construction. The plan shall identify the proposed location of the drill rig, support vehicles, working areas, pipe fabrication and layout areas and means of access to the entrance and exit pits.

e. Description of the drilling mud system that would be used on this drill rig. The plan shall describe the composition (density, viscosity, etc) of the drill mud and how it would be used - continuously for removal of cuttings, or continuously for mixing cuttings into slurry, or intermittently for lubrication purposes. The plan shall state the proposed operating pressures and flow rates of the drilling mud system and how the drilling contractor would prevent hydrofracture from occurring. The plan shall also address how the drilling contractor would repair the foundation if a hydrofracture does occur.

f. A drilling fluids management plan describing how cuttings and all drilling mud would be contained, collected, recycled (if applicable) and transported off site and disposed of. This plan should also describe the planned response should there be a hydrofracture or inadvertent return that introduces drilling mud into a nearby body of water or onto the adjacent ground surfaces. The plan shall include a drilling mud engineer who would monitor and maintain the required drilling mud properties.

g. Description of the drill crew's experience with a list of completed water crossing projects including location, product diameter and length of installation. The plan should describe the measures the driller would take to prevent the drill bit from getting stuck and what methods would be undertaken to retrieve a drill bit should it become stuck.

h. Description of the pipeline material including product material, length, diameter and wall thickness. The plan shall show how the conduit would be laid-out on site prior to its pullback into the borehole. The plan shall show how the conduit would be assembled and that the completed product has the strength to withstand the installation loads and long term normal and extreme operating loads.

i. Description of the tracking system that the driller would use to track the progress of the pilot hole. There shall be no blind sections – even when the bit is under the waters in an adjacent canal or river. The plan shall describe how the driller would regain the desired line and grade if the drill bit veers off the design alignment. The plan shall describe the accuracy and resolution of the tracking system and how it would be calibrated at the beginning of the work. At a minimum, this calibration should include readings at the 3, 6, 9 and 12-o'clock positions with the locator in the housing that it would be installed in during the drilling and on a level surface. The calibration should also be performed with the sonde set at a 15-degree pitch.

j. Description of any hand-holes or manholes and how the ends of the conduit would be sealed against water flow that may enter the conduit interior should the conduit develop a crack somewhere along its length. This seal shall prevent water entering the conduit anywhere along its length from flowing into the conduit, then into the manhole, and flooding the protected area landside of the flood protection system.

k. The borehole diameter will be larger than the conduit diameter, leaving an open, annular space between the conduits' exterior and the borehole wall. This annular space must be completely grouted shut for a distance of 50-feet along the completed conduit from the end of the conduit at the entrance and exit pits. Cementitious grout shall be injected into the annular space at multiple points around the circumference of the pipeline throughout this 50-foot length. Necessary baskets or other devices shall be installed on the pipeline just beyond the 50-foot length to ensure that the injected grout does not flow more deeply into the hole, but completely fills the annular space between the basket and the ground surface.

l. Results of geotechnical, site-specific, investigation by a qualified geotechnical engineer along the proposed borehole alignment. This exploration shall determine the foundation conditions that would be encountered along the

designed drill path. The exploration should extend to 20-feet below the deepest part of the design drill path and should include:

- The vertical and horizontal extents of subsurface strata, fill, debris.
- Standard penetration rates.
- The particle size distribution of coarse-grained soils.
- The plastic and liquid limits of fine-grained soils
- Water table levels.
- Areas of suspected and known contamination should be noted and characterized.

These borings shall be backfilled after completion by tremie grouting, from the bottom up, with a neat cement grout. The grout shall consist of a mixture of 94 pounds of Type 1 Portland cement to no more than 6 gallons of water. Bentonite shall be added in proportion of 1% to 10% by weight of cement.

m. Backfill procedures for the entry and exit pit excavations. The backfill must consist of cohesive material containing a minimum of 30% clay size fraction. These soils must be compacted to a minimum of 95% Standard Proctor maximum dry density with moisture contents within 3% of the Standard Proctor optimum moisture content. In-place backfill shall have an in-place permeability equal to or less than the natural blanket.

n. The exit and entrance pits at the ends of the design drill path shall be at least 300-feet landside of any landside levee toe and at least 50-feet riverside of any riverside levee toe. Where the design drill path is within 100-feet of either levee toe, the drill path shall be in rock or a minimum of 30-feet below the base of the flood protection system.

o. Assessment of the maximum allowable residual mud pressures that the borehole wall can tolerate without hydrofracturing. The maximum allowable mud pressures can be estimated using the Delft equation and shall account for overburden pressure, soil type, shear strength and other geotechnical parameters.

p. During drilling, the actual residual pressure in the return mud flow shall be measured at a point behind the drill bit, but no further than 15 or 20-feet behind the drill bit. The pressure shall be measured continuously while drilling and there is a positive return mud flow. The pressure shall also be measured while drilling is paused and there is no return mud flow. The measured mud pressures shall be no more than one-half of the calculated maximum.

q. The contractor shall provide proof that all measurement system (sensors, readout devices, etc) related to the horizontal/vertical control system and the drilling fluid pumping and pressure measurement system have been calibrated against appropriate national standards within the last 6-months.

r. Any misdirected or unsuccessful bores must be completely grouted shut with a cement-bentonite grout.

## **Example of a Procedure for Monitoring and Management of Down Hole Pressure during HDD installation under Federal Projects**

APPLICANT would be using Horizontal Directional Drilling (HDD) to install its 42" diameter pipeline beneath the FEATURE. During the HDD process drill fluid is pumped under pressure into the borehole. The Corps of Engineers (COE) has a requirement that drill fluid pressures be monitored and kept below certain maximum allowable limits to ensure that the formations beneath FEATURE are not damaged by hydro fracturing. (Hydro fracturing occurs when formations are subjected to excessive pressures that cause voids or fissures to be created in the formations.)

Down hole pressure monitoring and management is a technique for ensuring that drill fluid is contained within the borehole during pilot hole drilling for a HDD installation. When used in conjunction with an annular pressure curve it can also be used to ensure that the surrounding formations are not damaged by hydro fracturing

APPLICANT would monitor down hole pressure over the entire length of the pilot hole. For the portion of the pilot hole that lies within an area 100 feet either side of the FEATURE, APPLICANT would manage down hole pressures to ensure that the allowable limits are not exceeded.

### Factors affecting drill fluid pressure

Drill fluid pressures are affected by several factors. A description of some of these factors and how they can be managed follows.

- *Drill fluid density.* Greater drill fluid densities result in greater down hole pressures. A large component of drill fluid density is the concentration of cuttings in the fluid. By controlling drilling and hole opening penetration rates and maximizing the effectiveness of drill fluid recycling equipment drill fluid densities can be kept below acceptable limits.
- *Drill fluid viscosity.* Greater drill fluid viscosities result in greater down hole pressures. However, greater viscosities also help seal off fissures and other escape paths into the surrounding formation from the HDD borehole. Similarly increased viscosity improves the cuttings carrying capability of the drill fluid. Drill fluid viscosity must be carefully managed to obtain a balance between these conflicting requirements.
- *Borehole cleanliness.* Cuttings tend to settle out of the flow of drill fluid in the annular space around the drill pipe string. Accumulations of cuttings or cutting beds restrict the flow of drill fluid through the annular space. This would result in an increase in the pressure required to maintain flow. Careful management of drill fluid properties and the regular use of borehole swabbing techniques would keep the borehole free of cuttings beds and their associated pressure increases.

The drill fluid pressures in the borehole would vary throughout the installation processes. They would change with the depth of cover, the distance drilled, and the borehole

diameter. However, changes in pressure should be gradual and can to large extent be predicted. Rapid or unexpected changes in pressure are indicators of potential problems down hole. It is critical that drill fluid pressures be monitored and recorded throughout the pilot hole process, when pressures are the highest.

#### Downhole pressure monitoring and management

Down hole pressure monitoring can be used during the pilot hole operation only. This is a sophisticated technique that involves the use of a pressure transducer incorporated into the down hole survey probe immediately behind the drilling assembly. The transducer measures the drill fluid pressure in the annular space around the probe. Data from the transducer is transmitted to the drill rig at the surface via the same electrical wire line used to transmit survey data.

APPLICANT has developed an annular pressure diagram for the crossing. This diagram show, for every point along the length of the planned profile, the maximum annular pressure that can safely be resisted by the formations. This pressure is known as the confining pressure. The curve would also show the predicted drill fluid pressure that would be required to push the cuttings laden drill fluid back to the surface via the annular space.

Throughout the pilot hole drilling operation the annular drill fluid pressure measured at the bottom hole assembly would be continuously monitored. The contractor would use the data obtained to assist in his management of the drilling operation.

In the area that is defined by boundaries set 100 feet either side of the FEATURE, the measured pressure would be compared with the predicted and confining pressures shown on the annular pressure curve. At no point in this area is the measured pressured allowed to rise above the confining pressure. The predicted pressure is lower than the confining pressure in this area and would be used as the benchmark against which the measured pressure would be compared. The following three scenarios are possible:

- 1) Measured pressure approximately equal to predicted pressure

This is an indication that conditions are normal and the driller would be allowed to proceed with the pilot hole drilling.

- 2) Measured pressure greater than predicted pressure

This is an indication that the annular space behind the drill bit is becoming plugged with cuttings or that the concentration of cuttings in the drill fluid returns is too high resulting in excess drill fluid density. The driller would be required to implement measures to clean the annular space and or reduce the concentration of cuttings. This typically involves “swabbing” the borehole by slowly retracting the drilling assembly while pumping clean drill fluid into the bore to flush out cuttings and replace the cuttings laden fluid with clean, less dense fluid. The composition of the drill fluid pumped into the bore may also be modified to improve its cuttings carrying capacity.

3) Measured pressure less than predicted pressure.

If the measured pressure is significantly less than the predicted pressure this is normally an indication that some of the drill fluid is escaping from the borehole. If the pressure drop is gradual and occurs over a significant length of the pilot hole it is an indication that the fluid is escaping from multiple points along the pilot hole. This type of release is due to the formation being too porous to allow the drill fluid to be contained rather than being due to hydro fracture.

If this is the result of a sudden drop in pressure it is an indication that fluid is escaping from the borehole in the immediate vicinity of the drilling assembly and that hydro fracturing may be occurring. In this event, the contractor would be required to implement measures to reduce or eliminate the loss of drill fluid from the borehole. One measure that may be implemented is the use of Lost Circulation Materials (LCM) to plug a fissure in the formation. The use of additives to improve the sealing properties of the drill fluid.

## **Example of a horizontal drilling frac out plan**

### SECTION 1 - INTRODUCTION

In the HDD industry the term frac out is used to describe an inadvertent release of drill fluid resulting from the fluid escaping from an underground HDD borehole and rising to the surface above the borehole. The purpose of this document is to establish procedures for addressing potential impacts associated with a frac out of drilling fluid during the horizontal directional drill (HDD) process. In addition, this document establishes the criteria by which APPLICANT and appropriate agencies will determine when a proposed HDD is unsuccessful. The procedures and criteria described will generally apply to all HDD crossings on the project. Site-specific variations for crossings with more specific requirements will be described elsewhere. APPLICANT selected the HDD construction method to satisfy certain site-specific conditions for certain crossings.

The APPLICANT will provide on-site environmental and construction inspection during the HDD process to keep adequate documentation, daily progress reports, as-built information, etc.

### SECTION 2 - HDD PROCESS

Installation of an HDD crossing involves drilling an open borehole under an obstacle and the pulling a pipeline section into the borehole. There are three basic steps, or processes, that are executed in sequence: pilot hole, hole opening, and pullback. During all three processes drilling fluid is pumped into the borehole under pressure. This section addresses the HDD process.

#### Pilot Hole Process

The pilot hole is the first step in the HDD process. The pilot hole is drilled along a predetermined alignment and profile. The entry and exit points are located using traditional survey methods. The trajectory of the pilot hole is surveyed by two separate methods both of which employ a down hole survey tool referred to as a probe. The first method uses the earth's natural magnetic field as a reference while the second method uses a system known as TruTracker that uses a wire coil on the surface that creates a magnetic field. After each section of the drill pipe has been drilled (approximately 30 feet), both methods of survey are used to calculate the pilot hole location.

The pilot hole process consists of drilling a small diameter hole along the pre-determined alignment and profile. The pilot hole is drilled using either a jetting assembly or a down hole mud motor connected to a tri-cone rotary bit. Drilling fluid is pumped downhole via the string of drill pipe. The flow of drilling fluid powers the mud motor or jetting assembly that cuts the rock strata or soil. The fluid then flows back to the surface along the annular space between the drill pipe and the inside of the pilot hole. As it does so, the fluid also lubricates the drill stem, suspends and carries the drilled cuttings to the surface, and forms a wall cake to keep the hole open.



Data obtained during the pilot hole process will aid the contractor in planning the details of subsequent phases of the installation. These data include the rate of penetration and the friction forces acting upon the drill string. More subjective data on the behavior of the drill string during the process is equally valuable.

### Hole Opening Process

Once the pilot hole is complete the borehole diameter must be increased to allow it to accommodate the pipeline. Typically, the final borehole diameter is approximately 1-1/2 times the pipe diameter. The final borehole diameter is determined by the contractor and is dependent to a large degree on the length of the crossing and the types of geological formations through which the borehole passes.

The borehole diameter is typically increased in several increments or passes. There are two types of downhole tools that are used: fly cutters, used for most soil formations, and rock hole opening tools, used for very dense soil or rock formations. Typically, the fly cutter or hole opening tool is attached to the drill pipe string that drilled the pilot hole and is then rotated and pulled back towards the drill rig from the entry point. A second drill rig or a track hoe is typically used to handle the drill pipe at the exit point.

For each hole opening pass, as the fly cutter or hole opening tool progresses along the crossing profile, drill pipe is added to the string behind it while drill pipe is removed from the string ahead of it. Doing so maintains a continuous string of drill pipe in the borehole over its entire length.

In soil formations, typically there will only be two or three hole opening passes. The first pass may be between a 24-inch- and a 30-inch-diameter fly cutter. Subsequent fly cutter passes will enlarge the hole to the desired diameter. Depending on the stability of the hole, the HDD contractor may use a barrel reamer, typically several inches smaller than the outside diameter of the final hole opening tool, and pull it through the hole immediately prior to pullback. This is typically referred to as a swab pass. The purpose of the swab pass is to ensure the establishment of a good drilling fluid wall cake, a clean hole, and a hole full of drilling fluid with the proper density.

In rock formations, there will be several passes starting typically with a 22-inch-diameter hole opening tool and increasing in steps of 6-inch to 12-inch increments until the desired diameter is achieved. The diameter of each reaming pass is typically determined by the contractor based on field conditions. The drilling fluid serves continues to serve as a lubricant, facilitates the removal of cuttings, and stabilizes the borehole.

### Pullback Process

The last step to complete a successful installation is the pullback of the prefabricated pipeline into the enlarged hole. A reinforced pull head is attached to the leading end of

the pipe and to a swivel that is connected to a hole opener or fly cutter and the drill pipe. On the surface, the pipeline is supported with rollers as it is guided into the borehole. Once in the borehole the large diameter pipeline will be very buoyant in the drill fluid that occupies the borehole. The buoyancy will push the pipeline to the top of the borehole with considerable force. This will result in the following:

- A dramatic increase in the friction between the side of the borehole and the pipe.
- The possibility that the leading edge of the pull head could dislodge a cobble or rock fragment, binding the pipeline and making it possible to move the pipeline in either direction.
- The possibility that the external coating could be damaged by sharp and/or protruding material and highly abrasive material (coarse sands).

The buoyant force will be counteracted by adding water to the pipeline to increase its weight. The amount of water will be controlled to make the pipe as close to neutrally buoyant, or weightless, as possible.

#### Drilling fluid

The drilling fluid (also referred to as drilling mud) is made up primarily of water and bentonite. The concentration of bentonite typically varies between 0.24lb/gal and 0.36 lb/gal. Bentonite is a naturally occurring, non-toxic, inert clay that meets NSF/ANSI 60 NSF Drinking Water Additives Standards and is frequently used for drilling potable water wells.

The environmental impact of a release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or is settles to the bottom. In the immediate vicinity of a release, benthic organisms may be smothered if sufficient quantities of bentonite settle upon them.

Drill fluid is easily contained by standard erosion and sedimentation control measures such as straw bales and silt fence. Drill fluid would be contained on entry and exit worksites by hay bales and silt fence installed and maintained around the perimeter of each site. Within the boundaries of the worksites drill fluid would be controlled through the use of pits at the crossing entry and exit points and typical fluid handling equipment such as trash pumps. Drill fluid is released regularly on the drill rigs as part of normal operations when sections of drill pipe are separated. The worksite will be graded such that fluid released on the rig will flow into the fluid pit in front of the rig.

#### Operating hours

Due to issues associated with borehole stability for the large diameter boreholes required, it will be necessary for all HDD installation operations to be performed on a 24 hour per day, 7 day per week basis.

### SECTION 3 – FRAC OUT OF DRILLING FLUID

Throughout the HDD process there is a loss of drilling fluid into the geologic formation through which the drill passes. In some cases, the drilling fluid may be forced to the surface resulting in what is commonly referred to as a frac out. Therefore, while the intent of the HDD method is to avoid surface disturbance, surface disturbance may occur when there is a frac out of drilling fluid.

It is extremely important to note that a loss of drilling fluid into the formation is not necessarily an indication that a frac out has occurred or is about to occur. It is normal to lose a significant amount of fluid into the formation without ever having a frac out. In fact, in very soft ground formations or in highly fractured formations it is normal to lose all of the drill fluid pumped into the borehole without a frac out occurring.

A frac out cannot occur unless drill fluid escapes from the borehole into the formation. Hence preventing and managing such escapes will in turn prevent and manage frac outs. Drilling fluid releases are typically caused by pressurization of the drill hole beyond the containment capability of the overburden soil material. In some cases, a frac out of drilling fluid can be caused by existing conditions in the geologic materials (e.g., fractures) even if the down hole pressures are low.

Drill fluid pressures are generally the highest during the pilot hole process and hence it is this process that presents the greatest risk for a frac out. If a frac out occurs during the pilot hole it opens a path through the ground formation for drill fluid to escape during the subsequent processes. Hence frac outs are likely, at the same location during the hole opening and pullback process. Similarly, if the pilot hole process can be completed without a frac out, then it is likely that the entire installation can also be completed without a frac out.

Considerations for preventing and managing frac outs are described below.

#### Frac out prevention

The risk of a frac out in a sensitive area can be mitigated through profile design and through implementation of specific measures throughout the installation process.

#### Profile design

The HDD profile is designed to minimize the potential for the release of drilling fluid in sensitive areas. The type of subsurface material and the depth of cover material are factors considered in developing the profile of an HDD crossing. Cohesive soils, such as clays, dense sands, and competent rock are considered ideal materials for containment of drill fluid. An industry recommended minimum depth of cover of 25 feet in cohesive soils should be maintained to provide a margin of safety against drilling fluid loss in sensitive areas. In non-cohesive soils, a greater depth of cover will be used. In the

designs of all the HDD crossings, APPLICANT has used depths of cover well in excess of the recommended minimum.

In the vicinity of the entry and exit points of the crossing the depth of cover will be minimal. It is probable and expected that frac outs will occur in these segments of the crossing. The crossings are designed such that these segments will be in upland areas. Preventative measures implemented during installation

Key preventative measures implemented during installation are geared toward keeping the drill fluid contained in the borehole and preventing its escape to surrounding ground formations. This is accomplished through monitoring and management of drill fluid pressures and drill fluid volumes.

#### Drill fluid pressure monitoring and management

The APPLICANT will implement a down hole pressure monitoring and management program. This program is described in a separate document.

#### Drill fluid volume monitoring and management

It is intuitive that if drill fluid is not allowed to escape from the borehole then the entire volume of fluid pumped downhole should return to the surface via the annular space. However, as described above, it is normal that a portion or all of the drill fluid will be lost to the surrounding formation. Nevertheless a program for monitoring and managing the volumes of drill fluid used will be beneficial in identifying sudden increases in the volume of fluid lost which could signal a potential frac out.

Throughout the HDD processes the contractor will keep a running balance of the total volume of fluid pumped downhole and the total volume recovered from the return pits. The difference between these volumes will be the volume lost from the borehole. If the rate of loss of fluid is greater than expected or if it suddenly increases this could be an indication of a problem downhole. Measures to reduce the loss of fluid from the borehole would be implemented as described in previous paragraphs.

#### Frac out management

Management of frac outs is key to minimizing the environmental impact of an HDD crossing and ensuring its successful completion. Managing frac outs requires that appropriate equipment is available, that the frac outs are detected in a timely manner, and that appropriate procedures are used to minimize the volume of fluid released and its environmental impact. A discussion of these issues follows.

#### Response Equipment

Equipment for containing, controlling and cleaning up any drill fluid released during a frac out will be kept on site throughout the installation process. Heavy equipment not

specifically designated for control and clean up of drill fluid such as backhoes will also be available on site.

The following list identifies some materials and equipment that will be maintained at each HDD site in sufficient quantities to help ensure containment of frac outs of drilling fluid:

- Weed free straw or hay bales.
- Sand bags
- Stakes to secure bales.
- Silt fence.
- Shovels, rakes, brooms and buckets
- Trash pumps and flexible hose
- Light tower(s), so that cleanup work could continue after dark.
- A boat with appropriate personal safety equipment at major water body crossings.

#### Monitoring and detection

An obvious key to the timely detection of a frac out is monitoring of the surface above the HDD crossing for drill fluid. This is relatively easy to accomplish in upland areas during daylight hours. However, for large diameter pipelines such as the one proposed by the APPLICANT, the HDD process must be done on a 24 hour per day, 7-day per week basis.

Visually detecting a frac out in a large waterbody or marshy area will be difficult, especially at night. Unfortunately the areas where the potential environmental impact of a frac out are greatest are wetlands and waterbodies. These areas will present the greatest challenge visual monitoring.

The APPLICANT will employ a program of visually monitoring the ground above the HDD crossing for frac outs. However, this program will be supplemented by data from the downhole monitoring measures described above, namely pressure monitoring and volume monitoring.

The downhole pressure is greatest in the vicinity of the downhole tool in all three of the HDD processes described above. If a frac out occurs it will initiate from the borehole in the immediate vicinity of the downhole tool. Hence, visual monitoring on the surface will be concentrated on the area above the downhole tool. Survey stakes will have been placed and labeled on the surface at 100-foot intervals along the HDD centerline.

The monitors will be constant radio contact with the driller who will keep them apprised of the position of the downhole tool. The survey stakes will provide the monitors with the necessary reference to allow them to concentrate their efforts above the downhole tool.

The driller will also keep the monitors apprised of the drill fluid pressures and mud volume balance and will provide his professional opinion of level of risk of a frac out occurring at any given time.

Armed with this data the monitors will be able to decide if monitoring a difficult area, such as a deep swift river at night is warranted. It will also allow them to allocate their resources in the most effective manner.

The identification of a potential frac out prior to it actually occurring is dependent upon the skill and experience of the people involved. For this reason, the APPLICANT will be using a contractor that specializes in HDD to perform the proposed crossings. Similarly the environmental inspector who will supervise monitoring and mitigation efforts will also be experienced in this type of work.

#### Corrective Action for Frac outs

If a frac out occurs the chief inspector and the environmental inspector will be immediately notified. The following describes the sequence of events that will then take place.

#### Minimization of volume released.

The first action required when a frac out is detected is to minimize the volume of drill fluid that is released. This will be done by immediately halting pumping of drill fluid downhole. Pumping will not resume until the situation is assessed and, if possible, the fluid release is contained and controlled. As it is probable that the frac out will resume as soon as fluid pumping starts again containment and control measures will have to be able to contend with a further release of fluid. Normally the frac out stops of its own accord when the drilling assembly progresses a short distance ahead of the release point. The risk of failure of the HDD installation increases dramatically as the duration over which pumping is halted increases. Hence, actions will be taken quickly in order that pumping may resume as quickly as possible.

#### Containment and control of drill fluid released

The types of measures implemented to contain the fluid released will depend on the type of area in which the release occurs.

*Upland areas* - Frac outs in upland areas are most common as the drill profiles are designed such that the portions that have minimal depth of cover are beneath upland areas. Containment measures in these areas are easily implemented and consist of using hay bales, and or silt fence to contain the fluid within the immediate vicinity of the release. If the rate of release is large, a collection pit will be dug at the point of release and a trash pump will be set up to draw fluid from the pit and pump it back to the drill rig via a flexible hose. Once the containment measures are in place drilling operations will resume.

*Wetlands* - Frac outs in wetlands are quite rare as the depth of cover provided in these areas is normally sufficient to prevent frac outs. If a frac out occurs the containment and control measures will be similar to those used in upland areas with the exception that the

use of heavy equipment will be severely restricted. Once the containment measures are in place drilling operations will resume. Depending of the flow rate of fluid released, drilling procedures may be modified to reduce that rate. These modifications include introduction of LCM's (Lost Circulation Material) into the drill fluid, increasing drill fluid viscosity and the temporary reduction of drill fluid pumping rates. Drill penetration rates may also be temporarily increased in an effort to move the drilling assembly away from the release point as quickly as possible in order that the release stops quickly.

*Waterbodies* - Frac outs in waterbodies are also rare due to the provision of adequate depth of cover. Implementation of containment and control measures is most difficult in waterbodies and is only practicable when the depth of water is less than two feet and the water is slow moving. In these cases only, the drill fluid will be contained by hand carrying sand bags into the waterbody. A containment barrier that extends above the water surface will be built by hand placing the sand bags around the release point. If practicable, a trash pump will be placed on the shore and a suction hose extended from the pump to the release point. The drill fluid will then be pumped through a flexible hose back to the drill rig. Once the containment measures are in place drilling operations will resume.

If a frac out occurs in a water body that is more than two feet in depth or has significant flow there is nothing that can be done to contain or control the drill fluid that has been released. Drilling operations will resume immediately and measures will be implemented to limit the further release of fluid into the waterbody. These include introduction of LCM's into the drill fluid, increasing drill fluid viscosity and the temporary reduction of drill fluid pumping rates. Drill penetration rates will also be temporarily increased in an effort to move the drilling assembly away from the release point as quickly as possible in order that the release stops quickly.

The effectiveness of the measures implemented to limit the release of drill fluid will be closely monitored. If the measures are not effective and if the environmental impact of the release is deemed unacceptable the HDD installation will be abandoned. Another attempt using a modified profile or at an alternate location may be made. The APPLICANT will notify appropriate downstream water intake authorities of the existence and location of any drill fluid plume that extends more than 1,000 yards from the HDD crossing site.

#### Additional control measures

A determination will be made of the cause of the frac out. If it is determined that downhole pressures are excessive then measures to reduce them will be implemented. These measures are described above and include swabbing the hole and or modifying the drill fluid properties.

### Drill fluid clean up

Measures to clean up drill fluid released by a frac out will be determined on a case-by-case basis in consultation with the environmental inspector. Often, if the features affected are not sensitive and the volumes released are small minimal or no clean up will be required. Similarly, it is often determined that clean up measures will do more harm than good to sensitive features and that it is best to let the drill fluid dissipate naturally. Drill fluid can be cleaned up by collecting it by hand with shovels, brooms and buckets. Larger volumes can be cleaned up by means of pits and pumps or mechanized equipment. In wetland and upland areas drill fluid can be diluted by washing the affected area down with water.

### Agency Notification Procedures

If a frac out occurs within a stream, wetland or wetland buffer, or other sensitive resources, or poses a threat to public safety, the Environmental Inspector will immediately notify Senior Environmental Specialist for the project.

The Environmental Inspector will provide the following:

- The location of the frac out;
- A description of the area affected; and
- The containment measures implemented.

As soon as possible, a report, containing the following information, will be prepared and emailed to the appropriate agencies.

- The cause of the release;
- Photographs of the release site;
- The area affected;
- The location and size of the resulting work area; and
- The location of any drainage, streams or wetlands in the area and the distance to them from the failure site.

Upon completion of HDD activities, the APPLICANT will prepare a report that summarizes:

- The events leading up to the frac out;
- The measures taken to minimize the impacts following the release;
- Any impacts from the release;
- Mitigation for the impacts from the release; and
- Agency

contacts.



## **Geotechnical Report Example**

The following report is an example of the analysis that should be undertaken following the acquisition of geotechnical data. This should be submitted early in the process to U.S. Army Corps of Engineers geotechnical staff at the Omaha District office.

*\*This is included as a .pdf in appendices folder.*

## PIPING SYSTEMS

1. General. In general, piping should not penetrate a levee embankment or foundation. The recommended placement is in a levee crest within the freeboard zone. Construction of a piping system through a levee embankment or its foundation must be justified based on technical criteria and merits. A minimum diameter pipe of 48 inches on major urban levees and 36 inches on rural levees should be used to facilitate installation, maintenance and inspection. Reinforced concrete pipe should be used for gravity drainage through urban levees. Pressurized pipes should be concrete, cast in place concrete, ductile iron or welded steel.

2. Pipes placed over or within the freeboard zone of a levee embankment.

2.1. The recommended placement of a pipe within a levee freeboard zone is shown in Figure 1.

2.2. The backfill on a levee crest and levee slopes covered with grass should be sloped on 1V on 10H to allow for traffic on the levee crest and mowing equipment on the levee slope.

2.3. The backfill should provide a minimum of 1 foot of coverage above the top of the pipe on a levee slopes and at least 2 feet on a levee crest, and should consist of compacted impervious material on a levee crest and riverside slope. Random material can be used on the landside slope if the soil will support grass growth.

2.4. The pipe should not be buried more than 1 foot in a levee embankment on the riverside slope.

2.5. Pipes passing over or within the freeboard zone of a levee should be limited to metal pipes, preferably ductile iron or coated steel, suitable for use with flexible couplings. Pipes over the levee require an air release and a siphon breaker at the crest. If installation of a siphon breaker is not feasible provisions shall be made for closure on the waterside of the levee accessible from the levee crest. If the pipe cannot act as a siphon, a permanent vent opening can be used. Pipes within the freeboard zone should have provisions for closure on the waterside of the levee accessible from the levee crest.

3. Pipes placed within a levee embankment, or in the critical area of a flood control structure.

3.1. Pressurized pumping station discharge piping under a levee or through a floodwall or levee should be avoided.

3.2. If it is not feasible to place a discharge pipe over a levee, the pipe must have adequate strength and be provided with water tight joints that accommodate differential movements while limiting axial movement.

3.3. For pipes passing through a levee embankment or flood protection structure foundation, either a gate valve or a sluice gate should be provided and housed in a gatewell. The gatewell should be located so as to provide personnel access to the gate from the top of the levee.

3.4. Pipes located within or beneath a levee embankment or in the critical area must have watertight joints. RCP with either steel or concrete bell- and spigot surfaces and solid "O-ring" rubber gaskets having a circular cross sectional should be used.

3.5. At pipe connections to concrete structures, articulated joints must be provided in the pipes at the exterior wall face of the structure. Two half-lengths of pipe should be used at each structure connection to provide flexibility.

3.6. Cast-in-place manholes should be used on major levees. Precast manholes may be used on less critical levees. All joints must be watertight.

3.7. If precast concrete manholes or curb inlets are used, the bottom wall ring should project at least 3 inches into the base slab to insure water tightness in these structures. The structures must utilize "O-ring" rubber gaskets in each wall joint. Joint mating surfaces must be parallel to the walls (modified tongue and groove joint), not sloped. Gasket spaces between the tongue and groove should provide containment grooves to accept and prevent the gasket from disengaging from the compression surface or being blown out by hydrostatic pressure.

3.8. All manhole and other structures related to the piping system should be designed and constructed to conform to the topic STRUCTURES.

3.9. All pipes and structures related to the piping system should be analyzed for uplift based on hydraulic gradients determined in accordance with the topic UNDERSEEPAGE. The uplift calculations should conform to the topic UPLIFT.

#### 4. Use of Plastic, Fiberglass, and Other Flexible Pipes.

4.1. Corrugated Metal Pipes (CMP). CMP is not allowed in the levee embankment or foundation of urban levees. Coated CMP with 1 inch bituminous coating inside and outside of the pipe can be used on agricultural levees where levee embankments are no more than 12 feet above the pipe invert. Corrugated metal pipes should be minimum 36 inches in diameter.

4.2. Plastic Pipes and Fiberglass Pipes: Plastic and fiberglass pipes are designed to work in tandem with granular bedding and backfill material in the pipe envelope (sometimes referred to as embedment). The cohesive soils used in the levee critical area can result in excessive deflection of plastic pipes, which will usually preclude the use of these pipes in impervious zones of the levee critical areas. EM 1110-2-2902 prohibits the use of plastic pipes through levees. The following guidance is applicable if plastic, fiberglass or flexible pipes are to be used in other locations within the critical area.

4.2.1. Plastic pipe should only be used with granular backfill materials such as those listed in ASTM D 2321 as Class I and II. Class I and II materials are usually not acceptable in the levee critical area unless they replace similar existing fill.

4.2.2. Installation shall be in accordance with ASTM D 2321, except when flowable backfill is

used. In either case pipe embedment should be as shown in ASTM D 2321. Concrete cradles should not be used.

4.2.3. Details on the type of bedding and backfill that will be used for the plastic pipes, and calculations demonstrating that the backfill provides sufficient structural support for the pipe must be provided. See paragraph 5. for excavation and backfill requirements.

4.2.4. A flotation check is required.

5. Excavation and backfill for installation of piping system should conform to the topic EXCAVATION AND BACKFILL. All pipe backfill material in the critical area of the flood control project must be impervious material. No granular bedding is accepted in this area. The minimum compaction requirements are as required in EXCAVATION AND BACKFILL. The use of flowable backfill to replace the pipe embedment materials is an option. The material should be easily removed in case the pipe needs to be replaced in the future. Flowable backfill should have a maximum compressive strength of 500 pounds per square inch. Design of the pipe/flowable backfill system must be presented for review and acceptance. Rationale must be provided for the design input values, such as the horizontal soil modulus equivalent of the flowable backfill to be used. Flowable concrete does not adhere to plastics and will require rubber waterstops (gaskets) to prevent seepage along the pipeline. Design of the pipe/flowable backfill system must be provided.

6. Pipes located in corrosive environment should conform to Section: STRUCTURES.

7. Abandonment of piping system.

7.1. Removal of piping system. The preferred method of piping system abandonment within the critical area is complete removal. The excavation and backfill for removal of the piping system should comply with the topic EXCAVATION AND BACKFILL. Details of abandonment of the piping system, including plans and profiles showing the limits and elevations of pipes to be removed relative to the levee embankment or floodwall, excavation and backfill details (such as backfill material and compaction), and existing soil stratum at the pipe abandonment location should be provided to the Corps for review.

7.2. Grouting of existing pipes. If removal of the pipes and other structures related to the piping system is not feasible, the pipes and the other structures should be grouted full with a grout based on cement-bentonite, or flowable fill (CLSM). The grout or flowable fill mix should be approved by the Corps of Engineers. The grout shall be fluid enough, and pumped in the "up-slope" direction, so that the pipe will be completely filled leaving no voids. Points of access need to be made into the pipe at sufficient intervals to accomplish the grouting. Details of abandonment of the piping system, including plans and profiles showing the limits and elevations of pipes to be grouted relative to the levee embankment or floodwall, existing soil stratum at the pipe abandonment location, and grout mix should be provided to the Corps for review.

8. Recommended references. The following references contain details regarding COE requirements for the design and construction of a piping system within the critical area of a flood control project constructed by the COE.

8.1. EM 1110-2-2902, CONDUITS, CULVERTS AND PIPES, includes the following information.

- a. Details regarding reinforced concrete pipes (RCP) materials, methods of analysis, installation, joints, and camber.
- b. Details regarding corrugated metal pipes (CMP) materials, methods of analysis, installation, joints, and camber.
- c. Details for design and construction for concrete culverts.
- d. Details for design and construction for plastic, ductile iron and steel pipes.

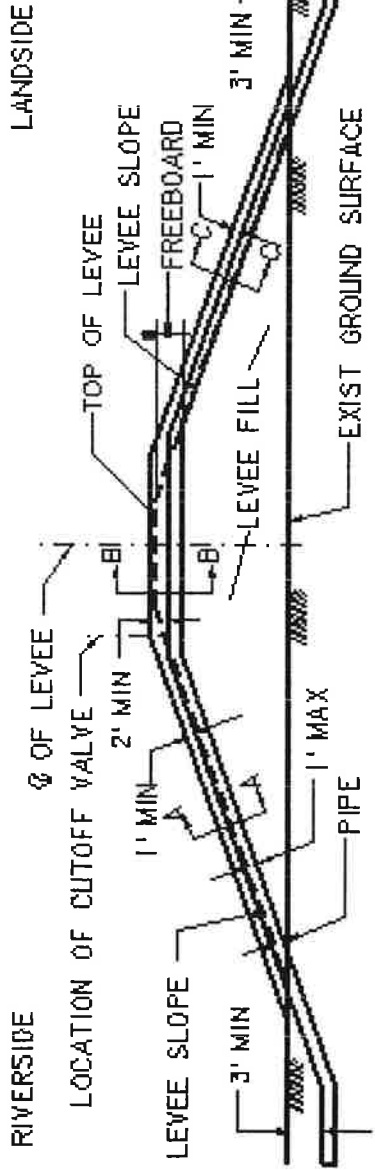
8.2. EM 1110-2-3102, GENERAL PRINCIPLES OF PUMPING STATION DESIGN AND LAYOUT, defines the criteria for Pumping Station discharge lines.

8.3. EM 1110-2-3104, STRUCTURAL AND ARCHITECTURAL DESIGN OF PUMPING STATIONS, addresses design criteria for pressurized discharge systems.

8.4. EM 1110-2-3105, MECHANICAL AND ELECTRICAL DESIGN OF PUMPING STATIONS, addresses discharge systems requirements through flood protection projects or over a levee.

8.5. EM 1110-2-1813, DESIGN & CONSTRUCTION OF LEVEES, addresses requirements for pipelines and other utility lines crossing levees.

Figure 1 – PIPELINE CROSSING A LEVEE



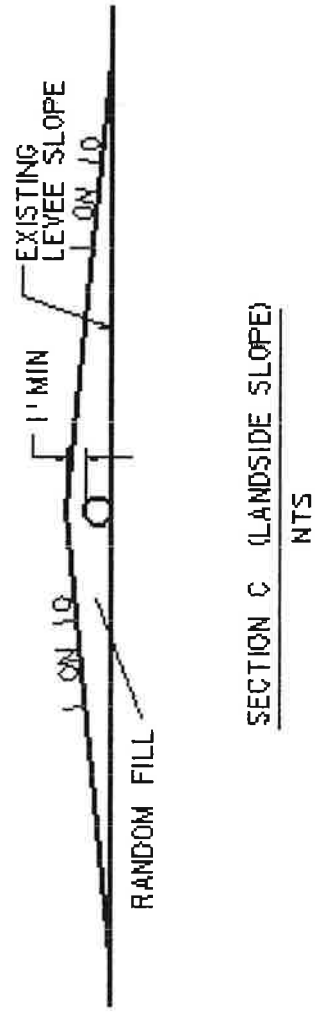
PROFILE OF PIPELINE CROSSING

NTS



SECTION A (RIVERSIDE SLOPE)

NTS

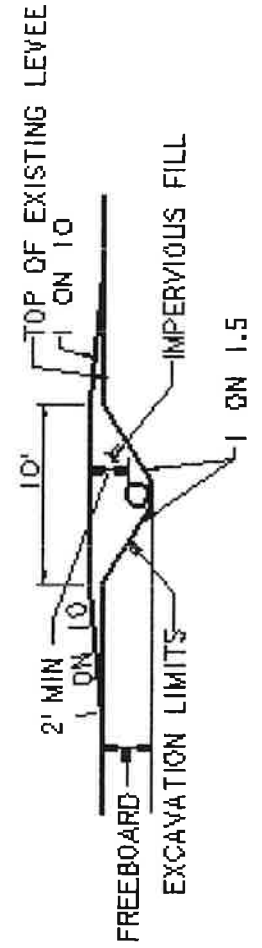


SECTION C (LANDSIDE SLOPE)

NTS

**NOTE:**

IF PERMISSION IS GRANTED FOR A PIPELINE OR UTILITY TO CROSS THE LEVEE BELOW THE FREEBOARD, A POSITIVE CUTOFF VALVE OR CLOSURE GATE WILL BE INSTALLED AT THE RIVERSIDE SHOULDER OF THE LEVEE. POSITIVE CUTOFF MAY BE REQUIRED EVEN THOUGH THE CROSSING IS WITHIN THE FREEBOARD IF IT IS DETERMINED TO BE NECESSARY BY THE CORPS OF ENGINEERS



SECTION B (LEVEE CREST)

NTS

**PIPELINE CROSSING A LEVEE**

## **INTERIM FLOOD PROTECTION AND CONTINGENCY PLANS**

1. General. High water conditions may occur while construction is in progress. Plans and specifications for the proposed work must address measures to maintain the integrity of the levee during these periods. Common measures include dewatering, construction of ring levees, and emergency backfilling of open excavations. Sandbags and pumping can also be used to supplement the effort. Driven sheet piling should not be used for temporary flood control purposes. Preferably, work within the critical area of the flood protection project should be scheduled during dry periods of the year. Excavation in the critical area is to be avoided between April 1 and August 1 of any year. However, waivers to this restriction may be obtained from the Corps of Engineers for periods not to exceed 30 days, provided antecedent conditions and potential river stages are favorable. A waiver request will require a contingency plan addressing high water conditions.

### 2. Temporary Flood Control Methods.

2.1. Dewatering. The dewatering option is more typically used on larger projects, on excavations within a levee embankment, or where construction access is limited landside of the flood control project. When excavation proceeds during high water, the dewatering system should be capable of maintaining the piezometric levels to minimum depth of 2 feet below the bottom of the excavation during a 100-year river stage event. At least one piezometer must be installed near the excavation to monitor the piezometric level. If this level cannot be maintained, provision must be made in the plans to backfill the open excavation to the original ground surface. Additional guidance on dewatering is discussed in the topic DEWATERING.

2.2 Ring Levee. A ring levee should be used when excavation within the levee embankment will lower the level of protection below the design level of protection. This option is commonly used if satisfactory impervious material and construction access is available to build an embankment.

2.2.1. The ring levee should be constructed riverward or landward of the flood protection structure to a height equal to the 100-year river stage event, in urban areas where the design level of protection is 500 year. If the design level of protection of the levee is below 100 year, the ring levee should be constructed to the height of the existing levee.

2.2.2. The crest width of the ring levee should be 8 to 10 feet and side slopes should be constructed at 1V on 2.5H. A 5 feet wide impervious zone should be constructed on the riverside slope. The levee crown should be surfaced with 5 inches of compacted crushed rock surfacing to facilitate continuous access on the levee crown in emergency situation.

2.2.3. Stability analysis should be performed for the ring levee embankments. Procedures to analyze

slope stability of a temporary ring levee should conform to the topic SLOPE STABILITY.

2.2.4. The toe of the ring levee should be offset from the open excavation a distance equal to the depth of the excavation. The alignment transition between the ring levee and original levee should not exceed a rate more severe than 1 foot offset to 3 feet of length.

2.2.5. Materials and compaction requirements for construction of the ring levee are the same as those discussed in the topic EXCAVATION AND BACKFILLING.

2.3. Backfilling. Provision to backfill the excavation during high water periods may be an adequate measure for excavations on the landside or riverside of the flood control project, especially if the work is planned during low river flow periods. Plans and specifications should include a contingency plan that addresses emergency backfill capabilities such as availability of adequate impervious fill material, type and availability of backfill equipment, and when emergency backfilling operations would be initiated during a flood period. The stockpile of the emergency fill should be shown on the construction drawings. No stockpile material is allowed on the levee slopes or crown. Typically, it is recommended that excavation work should cease and backfilling start when the river level reaches a point 3 feet below the bottom of the excavation. The contingency plan should state that the rate of emergency backfill exceeds the rate of the rising river level.

3. Contingency Plan. A contingency plan should include all necessary data related to actions to be taken in case of river exceeding the flood stage. The contingency plan should include all proposed measures to protect the area with a reduced level of protection due to construction activities.

3.1. The river stage should be monitored and the river elevation at which the contingency plan will be activated should be determined.

3.2. The contingency plan should include all material and equipment to be used to activate the plan, and the location of the stockpiled materials.



12/29/14

**U.S. Army Corps of Engineers, Omaha District**

**Guidance on  
OPERATION & MAINTENANCE MANUAL ADDENDUMS  
for Flood Risk Reduction Projects**

*Updated January 2013*

1. **PURPOSE.** This information has been compiled to provide general guidance regarding developing an Addendum to a Flood Risk Reduction Project's (FRRP) Operations and Maintenance (O&M) Manual to reflect additions or modifications to the FRRP.
  
2. **RESPONSIBILITIES.** Local sponsors are the owners of the FRRP and are responsible for controlling all modifications to the FRRP and ensuring that the Addendum to the O&M Manual is complete and distributed to the appropriate parties. The engineer-of-record or design engineer (EOR) for the proposed modification should complete the O&M Manual Addendum. The EOR is ultimately responsible to ensure that the modification does not adversely affect the operation or integrity of the FRRP. The U.S. Army Corps of Engineers (USACE) provides review and approval of the O&M Plan Addendums for Federally constructed FRRPs. USACE will also review addendums for non-federally constructed O&M Plans that are in the USACE PL 84-99 Rehabilitation and Inspection Program (RIP) to ensure that the changes do not adversely affect the operation or integrity of FRRP.
  
3. **ADMINISTRATION.**
  - a. **Copies.** As a general rule, **three (3) complete printed sets and a PDF digital version** of all draft and final addendums should be provided to USACE. If additional copies are necessary, the EOR will be notified.
  
  - b. **Transmittal for Review.** The O&M Manual Addendum needs to be coordinated with, and processed through, the appropriate local sponsor of the FRRP. The local sponsor should review the Addendum to ensure that it is complete and that they have no objections prior to forwarding the submittal to USACE.

Submittals may be sent to:

**USACE, Omaha District  
CENWO-OD-E  
1616 Capitol Ave.  
Omaha, NE 68102**

A copy of the submittal must be provided to the local sponsor. No reviews will proceed without permission of the local sponsor. If needed, a point of contact with a local sponsor may be obtained from the USACE at 402-995-2448.

**U.S. Army Corps of Engineers, Omaha District**

**Guidance on  
OPERATION & MAINTENANCE MANUAL ADDENDUMS  
for Flood Risk Reduction Projects**

*Updated January 2013*

- c. **Review Schedule.** The sponsor and EOR should allow six (6) to eight (8) weeks for USACE coordination, scheduling, comment development and consolidation, and mailing of comments to the sponsor for each submittal review.
  - d. **Final Addendum.** After all comments have been resolved, the final version of the O&M Manual Addendum must be provided to USACE for the record.
4. **TEMPLATE.** Provided, on the following pages, is a template for an O&M Manual Addendum that illustrates the types of information that should be provided and offers other guidance on developing an addendum. The scope and complexity of the addendum can vary significantly depending on the nature of the added feature or modification and needs to be considered on a case-by case basis. However, in all cases, sufficient information must be provided in the addendum to fully document what the addition or modification consists of, what the associated operation and maintenance requirements are for the added or modified feature, and any changes to the operation and maintenance requirements for the system.

--- END ---

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**ADDENDUM NO. XX**

**OPERATIONS AND  
MAINTENANCE MANUAL**

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**PROJECT NAME:**

**River/Creek Name**

**Locations/City/Jurisdiction**

**Date**

**Organization**

**PROJECT NAME**  
**LOCATION**  
**ADDENDUM NO. XX**  
**OPERATION AND MAINTENANCE MANUAL**

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## SECTION I - INTRODUCTION

**1.1 Purpose of the Addendum.** The purpose of this addendum to provide an update to the project's Operations and Maintenance (O&M) Manual to reflect added or modified features. It is not the intent of this addendum to replace the current O&M Manual, but only to supplement the current document. This addendum is a separate document to be added to the front of the current O&M Manual, until which time the entire manual is updated to incorporate any changes or modifications to the project.

The current O&M Manual and any existing addendums have been marked-up as necessary to direct readers to this addendum where there are conflicts or changes. A copy of each such marked-up page is provided in Appendix A. Each holder of an O&M Manual should insert these marked-up pages into the appropriate place in their copy of the document.

**1.2 Scope of the Addendum.** This addendum is intended to cover all pertinent inspections, operations and maintenance procedures for the added or modified features and for other portions of the project that are impacted by these added or modified features. Details of the added or modified features are summarized below and described in detail in Section 2. Procedures or other information given in this addendum supersede any conflict with the current O&M manual.

**1.3 Summary of Added/Modified Project Features.** *\*\*\*Provide a brief description of each added features or modifications and any associated impacts to other portions of the project. Include project stationing, etc.\*\*\**

**1.4 Summary of Changes to the Current O&M Manual.** *\*\*\*\*Provide a summary of what sections, checklists, appendices of the O&M Manual are impacted by the added feature or modification. Also discuss any significant changes in O&M procedures\*\*\*\**

**1.5 References.** *\*\*\*\*Provide all appropriate references\*\*\*\**

## SECTION II - PROJECT DESCRIPTION

**2.1 Description of Added/Modified Features.** *\*\*\*\*Provide a detailed description of each added or modified project features and impacts to the project..\*\*\*\**

**2.2 Ownership of Added/Modified Features.** *\*\*\*\*Provide a discussion of what entity has ownership, operation and maintenance, and rehabilitation responsibility for the added feature or modification..\*\*\*\**

**2.3 Construction History of Added/Modified Features.** *\*\*\*\*Provide a summary of the construction of each added feature or modification to include dates, contractor, design firm, construction QC/QA, and any construction issues.\*\*\*\**

**2.4 Approval of Added/Modified Features.** *\*\*\*\*Provide a brief review of approvals granted for the implementation of the added feature or modification.\*\*\*\**

## SECTION III – through XXX

*\*\*\*\*These sections will consist of necessary descriptions, instructions, checklists, etc. required to conduct proper O&M on the added feature or modification and should follow the general format of the O&M manual. Each Section of the current O&M Plan will be listed. If the added feature or modification does not result in any changes to the section, that should be so stated.\*\*\**

**APPENDIX A - MARKED-UP PAGES FROM CURRENT O&M MANUAL OR ADDENDUMS**

*\*\*\* Insert pages from the existing O&M Manual or other addendums that have been marked-up to direct readers to this addendum due to conflicts or changes. Each holder of an O&M manual should insert these pages into their copy of the document. \*\*\**

**APPENDIX B - AS-BUILT DRAWINGS**

*\*\*\* Insert 11" x 17" or other appropriately sized drawing showing as-built conditions of the added feature or modifications. \*\*\**

**APPENDIX C - CATALOG CUT-OUTS/OTHER PERTINENT DATA**

*\*\*\* Insert catalog cut-outs, manufacturer instructions, and/or any other pertinent data of the added feature or modifications. \*\*\**

**APPENDIX D - TECHNICAL SPECIFICATIONS**

*\*\*\* Insert technical construction specifications/instructions of the added feature or modifications. \*\*\**

**APPENDIX E - OTHER APPENDICES AS NEEDED**

*\*\*\* Provide information in other appendices as needed\*\*\**

**APPENDIX F - ELECTRONIC VERSION**

*\*\*\* Insert a CD/DVD or other appropriate storage medium that contains this addendum in its entirety. The addendum should be provided in a PDF format and in the format in which it was created in (e.g., Microsoft Word). As-Built Drawings should similarly be provided in a PDF format and in the format in which they were created in (e.g., AutoCAD)\*\*\**