

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT TECHNICAL POLICY

POLICY NO.: Technical Policy, TECH-014

EFFECTIVE DATE: August 31, 2009

REVISED DATE: 5/18/2021

POLICY NAME: Erosion Protection of Stem Wall Foundations in Regulatory Floodplains

PURPOSE: To clarify 16.20.020.C.4 of the Ordinance regarding the specifications for building construction and materials in order to establish consistent permitting requirements that are sufficiently protective of the structure elevated on stem walls for the flood and erosion hazards that have been identified without the need for site-specific engineering.

BACKGROUND:

The Floodplain Management Ordinance (Ordinance) provision 16.20.020.C.4 requires that an applicant submit specifications for building construction when requested by the Chief Engineer. Historically, this placed the burden on the District to identify when the foundation design considerations would be required, and when found necessary, this requirement was often objectionable to the applicant due to the unanticipated cost and time associated with the evaluation, design, and approval of the foundation.

In order to more consistently implement this provision, reduce engineering costs and review times, and sufficiently protect the structure from flood and erosion hazards, the District has developed this policy which establishes minimum toe-down depths for stem wall foundations. The toe-down depths have been developed using standard engineering practice including use of the following:

- 1) The City of Tucson Drainage Standards Manual, specifically Chapter 6, which provides methods to determine maximum anticipated erosion/scour depths. The scour equation in Chapter 6 includes the effects of local scour due to obstructions of flow, such as a structure. The applicable portions of the scour equation are used in estimating maximum anticipated scour. However, Equation 6-3 of the Manual is an additive equation that establishes maximum anticipated scour based on a variety of scour components. Since some of these components are not applicable for structures in broad floodplains, this policy may establish design criteria that is not as restrictive as the equation.
- 2) FLO-2D - The District commenced an evaluation of the flooding effects on stem wall foundation using FLO-2D modeling. This analysis provided significant insights regarding the flow of water around structures, demonstrating that an increased level of protection at the upstream corners should be provided.

In addition, in order to efficiently and effectively address the need for minimum erosion protection standards across a wide variety of flow regimes, the District has chosen to apply minimum standards categories using ranges of flow depths and flow velocities. The criteria from these publications and calculations are used as the basis for this policy.

In part to address the issue of constructing scour protection for existing foundations, and also to provide additional construction options for owners/applicants, the District created additional standard

details in 2019. These details cover the construction of concrete cut-off walls to protect existing foundations and the use of hardscaping adjacent to new or existing structures to protect the structure from scour.

POLICY:

Applicants may choose to use the standard details in lieu of providing a site-specific engineered foundation to address flood and scour hazards for structures, provided the floodplain conditions are within the foundation matrices that are a part of this policy. Deviation from the standard details and stipulations of this policy may require a site-specific engineering analysis and/or foundation design. This policy may be used to calculate stem wall foundation toe-down depths or establish specifications for other protective measures as detailed in Figures 014-A, 014-B and 014-C of this policy, as long as the following conditions are met:

- 1) The structure does not encroach into an Erosion Hazard Area, a study area that establishes a requirement for an engineering analysis or an area that the District has determined that, due to unusual conditions, engineering is required. If a structure is proposed in these areas, an engineering analysis to specify foundation construction characteristics will be required and will supersede this policy.
- 2) The obstructive width of the structure is 40 feet or less. Table 014 has been developed for a structure that is 40 feet wide and may be used for structures that are 40 feet wide or less. Structures wider than 40 feet will require an engineering analysis to determine the foundation construction characteristics.
- 3) The structure shall be oriented with the long axis parallel to the direction of flow. This will minimize the flow obstruction and reduce the potential scour depths.
- 4) Stem wall foundation scour protection shall be constructed in accordance with Table 014, which prescribes protection at specific locations:
 - a) When the structure is surrounded by floodwaters:
 - i) A toe-down depth is prescribed along the entire upstream edge of the structure and at least 10 feet along the sides of the structure extending from the upstream corners,
 - ii) A second toe-down depth is prescribed along the remaining perimeter of the structure.
 - b) When the structure is not surrounded by floodwaters:
 - i) A toe-down depth is prescribed along the upstream edge and at least 10 feet along the side(s) of the structure that are located within the 100-year floodplain,
 - ii) A second toe-down depth is prescribed along the remaining perimeter of the structure that is located within the 100-year floodplain,
 - iii) The portions of the structure that are not exposed to floodwaters do not require erosion protection.
- 5) Foundation scour protection for a stem wall foundation shall be accomplished by one of the following methods:
 - a) Extending the bottom of the foundation footer down to the toe-down depth specified by Table 014. Toe-down depth shall be referenced to natural grade beneath the perimeter of the foundation. This scour protection is detailed in Figure 014-A.

- b) Foundation scour protection from local (abutment) scour at the upstream end of an obstruction may be accomplished by the hardscaping option detailed in Figure 014-B. Protection of the remainder of the perimeter of the foundation from general scour shall utilize a foundation footer as detailed in Figure 014-A.
 - c) Existing structures built without consideration for foundation erosion protection may have foundations retrofitted for erosion protection as shown in Figure 014-C.
- 6) If the stem wall or cut-off wall, extended to the toe-down depth specified in Table 014, has the potential to retain more than 4 feet of fill under conditions of maximum scour, the applicant shall either:
- a) Demonstrate that the stem wall or cut-off wall is designed in accordance with the latest International Residential (IRC) code Tables R404.1.1(1) through (4). These tables establish minimum wall thickness and vertical reinforcement requirements (if any) for wall heights up to 9 feet. To apply these tables, the wall detail/plans must specify the type of soil being retained, since this determines the unit weight and lateral soil pressure it is necessary for the wall to resist. The IRC presents the properties of soils classified according to the Unified Soil Classification System in Table R405.1, or,
 - b) Provide a sealed construction detail, prepared by an Arizona registered structural engineer, adding appropriate retaining wall features to the wall foundation.

Pima County Building Codes will ensure that the structural design meets building code requirements.

- 7) Stem wall, hardscaping and/or retrofit details and specifications shall either be shown on the building plans, or the appropriate Figure(s) referenced on the building plans.

APPROVED BY:



Suzanne Shields, P.E.
Director and Chief Engineer

5/19/21

Date

Original Policy Approved: 8/31/2009

Date(s) Revised: Figure 014-A Revised 4/9/2015, 5/18/2021

TABLE 014 STEM WALLS

TOE-DOWN DEPTH REQUIREMENTS FOR EROSION PROTECTION OF STEM WALLS WITH A MAXIMUM WIDTH OF 40 FEET PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT TECHNICAL POLICY TECH-014

- ASSUMPTIONS:
1. Structure constructed/installed such that long dimension is generally aligned with the direction of flow;
 2. design scour depth at upstream corners applies over entire upstream edge and 10 feet along sides measured from upstream corners
 3. manning's roughness coefficient for overbank flow per Table 8.1, SMDDFM = 0.060;
 4. hydrodynamic forces negligible below flow velocity of 5 fps

TABLE 014-A - 100-YR NORMAL FLOW VELOCITY FOR BROAD, FLAT FLOODPLAINS USING MANNING'S EQUATION, fps															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.5	0.7	1.0	1.2	1.4	1.6	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7
1.0	1.1	1.6	1.9	2.2	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.8	4.0	4.1	4.3
1.5	1.4	2.0	2.5	2.9	3.2	3.5	3.8	4.1	4.3	4.6	4.8	5.0	5.2	5.4	5.6
2.0	1.8	2.5	3.0	3.5	3.9	4.3	4.6	5.0	5.3	5.5	5.8	6.1	6.3	6.5	6.8
2.5	2.0	2.9	3.5	4.1	4.5	5.0	5.4	5.7	6.1	6.4	6.7	7.0	7.3	7.6	7.9
3.0	2.3	3.2	4.0	4.6	5.1	5.6	6.1	6.5	6.9	7.2	7.6	7.9	8.2	8.6	8.9

TABLE 014-B - TOE-DOWN DEPTH REQUIREMENT FOR UPSTREAM EDGE AND AREA WITHIN 10 FEET OF UPSTREAM CORNERS OF A 40 FOOT WIDE (MAX) STEM WALL																
Flow Depth, ft	slope, ft/ft															
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030	
0.5																
1.0																
1.5																
2.0																
2.5																
3.0																

TABLE 014-C - TOE DOWN DEPTH FOR SIDES AND DOWNSTREAM EDGE OF STEM WALLS, EXCEPT FOR AREA WITHIN 10 FEET OF UPSTREAM CORNERS															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.5															
1.0															
1.5															
2.0															
2.5															
3.0															

DV² Greater than 18		= 18 inches deep		= 24 inches deep		= 36 inches deep		= 48 inches deep		= Engineered foundation required.
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NOTES

- VENT OPENINGS IN STEM WALL:
 - PROVIDE 1 SQUARE INCH OF NET OPEN VENT AREA FOR EACH SQUARE FOOT OF BUILDING FLOOR SPACE
 - PLACE BOTTOM OF VENTS 1 FOOT (MAX) ABOVE NATURAL GRADE.
 - ALL SCREENS AND LOUVERS MUST AUTOMATICALLY OPEN TO ALLOW UNOBSTRUCTED FLOW OF FLOOD WATERS, OR OTHERWISE MAY BE SCREENED WITH 1/2-INCH MIN SCREEN.
 - DISTRIBUTE REQUIRED VENTS UNIFORMLY ON AT LEAST TWO OPPOSING WALLS.
- FOOTER DEPTH FROM TABLE 014-B, SHALL APPLY ALONG ENTIRE UPSTREAM END, AND ALONG UPSTREAM-MOST 10 FEET OF BOTH SIDES OF STEM WALL. FOOTER DEPTH FOR REMAINING STEM WALL FROM TABLE 014-C.
- FOR MONOPOUR FOUNDATIONS, POUR FOUNDATION DOWN TO DEPTH FROM TABLE 014B-C AND 014-C.
- FOUNDATION ELEMENTS LOCATED WITHIN THE PERIMETER OF STEM WALL SHALL NOT BE REQUIRED TO BE PLACED BELOW MAXIMUM ANTICIPATED SCOUR DEPTH. LOCATION OF, AND STRUCTURAL CHARACTERISTICS OF INTERIOR FOUNDATION ELEMENTS SHALL BE DETERMINED BY OTHERS.
- STRUCTURAL FOOTER CHARACTERISTICS SUCH AS WIDTH, THICKNESS, REINFORCING, ETC. ARE MINIMUM ALLOWED AND ARE SUBJECT TO BUILDING CODE REVIEW.
- LONG DIMENSION OF STRUCTURE TO BE ORIENTED PARALLEL TO DIRECTION OF FLOW.
- MATERIALS: CONCRETE 3000 psi; MORTAR TYPE M, N, OR S PER ASTM C270; GROUT SHALL BE COARSE AGGREGATE PER ASTM VC476; REBAR 60 KSI; CMU ASTM C-90 TYPE I OR TYPE II.

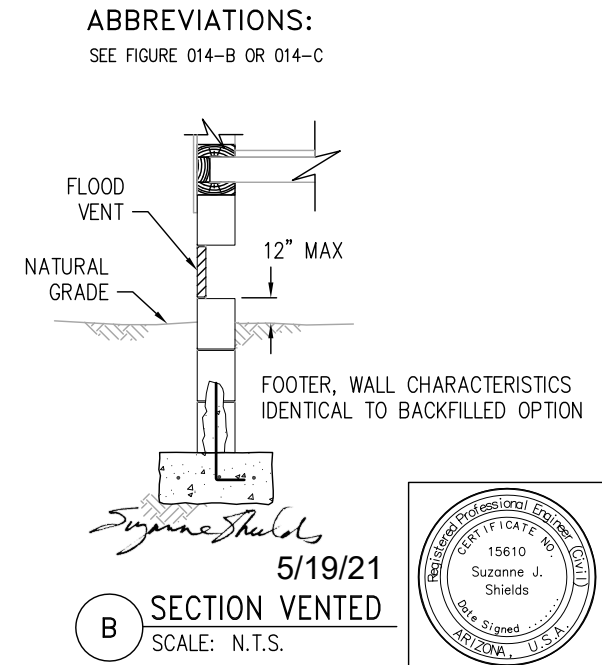
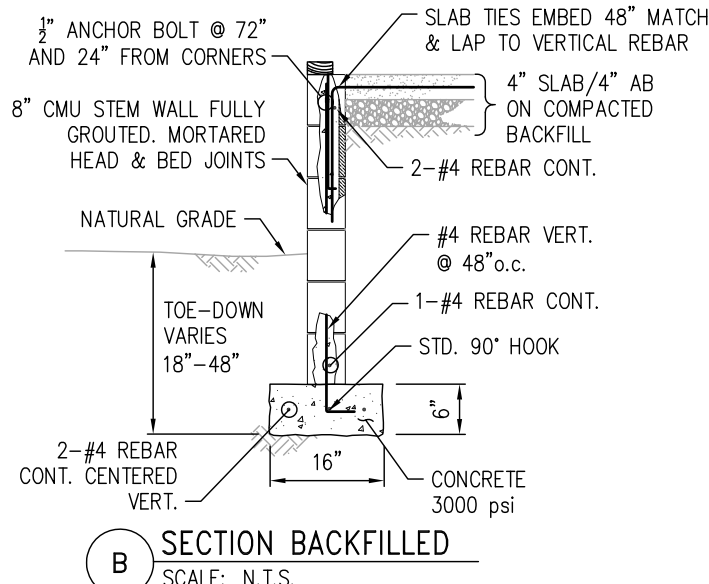
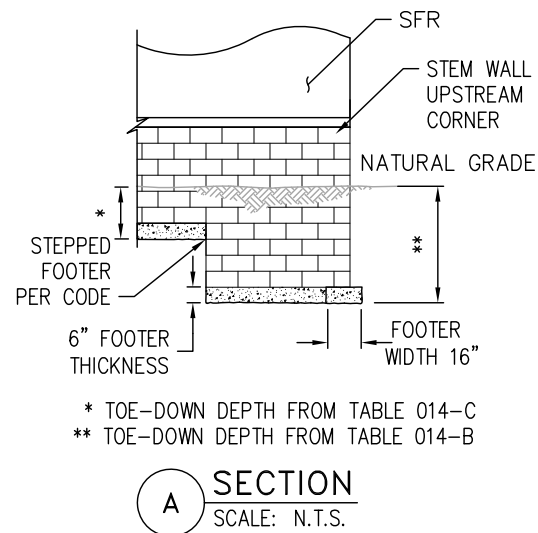
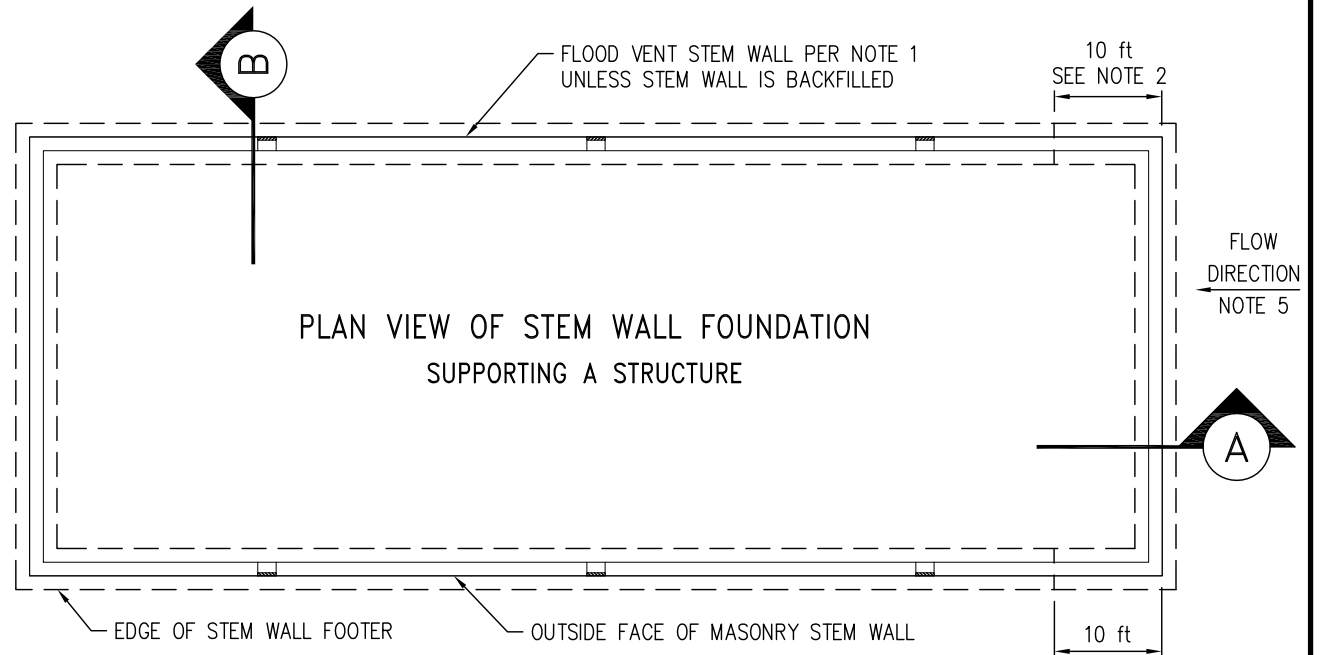


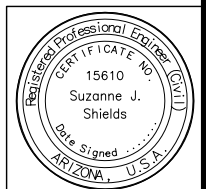
FIGURE 014-A
EROSION PROTECTION OF LOAD BEARING PERIMETER STEM WALL IN FLOODWAY FRINGE AREAS



SCALE: None

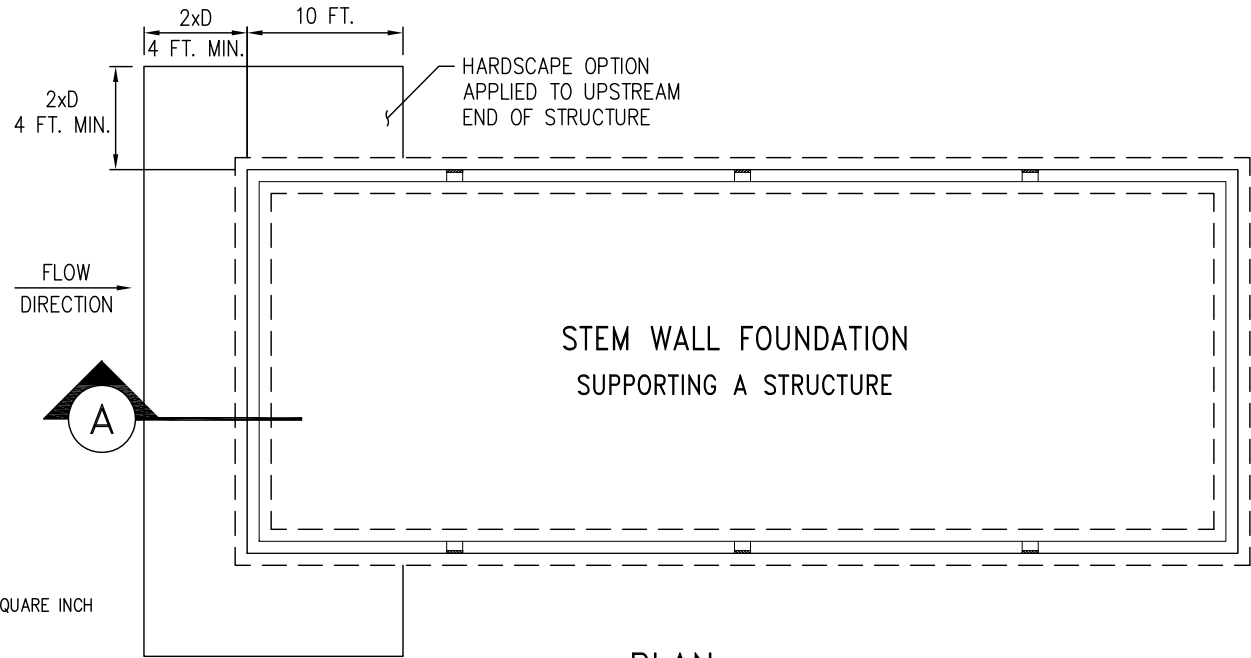
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DATE: Aug. 2019



NOTES

1. GRAVEL BASE AND SUBGRADE COMPACTED TO 95% STANDARD PROCTOR DENSITY.
2. VERIFY THAT HOLES FOR DOWEL BAR ARE CLEAN AND DRY PRIOR TO PLACING BONDING MATERIAL.
3. SHIFT DOWEL HOLE LOCATIONS IF EXISTING REINFORCING STEEL IS ENCOUNTERED.
4. PLACE SCORED EXPANSION JOINTS ¼ INCH DEEP EVERY 6 FEET OF LENGTH.
5. THIS OPTION FOR FOUNDATION EROSION PROTECTION MAY NOT BE USED WITH POST-STRESSED FOUNDATION DESIGN.
6. MATERIALS: CONCRETE 3000 PSI, REBAR 60 ksi, GRAVEL BASE PC/DOT SSPI SECTION 303.
7. TOE-DOWN FROM TABLE 014-B.
8. LONG DIMENSION OF STRUCTURE TO BE PARALLEL TO FLOW.
9. STRUCTURAL FOUNDATION CHARACTERISTICS (WIDTH, DEPTH, THICKNESS, REBAR) SUBJECT TO BUILDING CODE REVIEW.

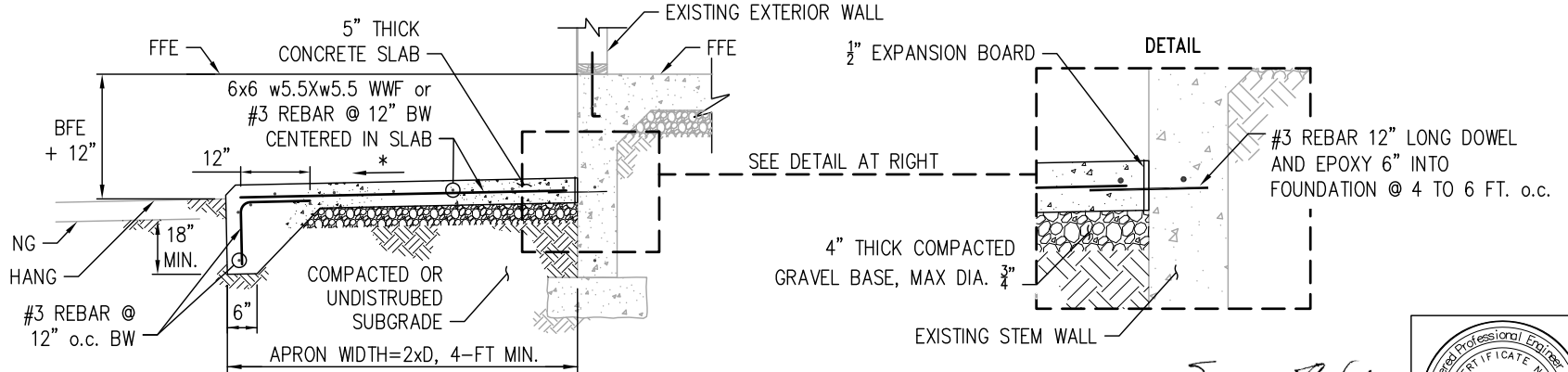


STEM WALL FOUNDATION
SUPPORTING A STRUCTURE

PLAN
SCALE: N.T.S.

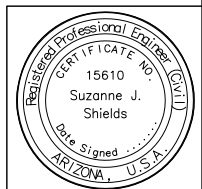
ABBREVIATIONS

- | | |
|---------------------------------------|---|
| BW = BOTH WAYS | ksi = KILOPOUND PER SQUARE INCH |
| BFE = BASE FLOOD ELEVATION | NG = NATURAL GROUND |
| CMU = CONCRETE MASONRY UNIT | N.T.S. = NOT TO SCALE |
| D = TOE-DOWN DEPTH | o.c. = ON CENTER |
| d = DEPTH OF EXISTING FOOTER | SSPI = PC/DOT STANDARD SPECIFICATIONS
for PUBLIC IMPROVEMENT |
| FFE = FINISH FLOOR ELEVATION | WWF = WELDED WIRE FABRIC |
| HANG = HIGHEST ADJACENT NATURAL GRADE | |



A HARDSCAPE OPTION
SCALE: N.T.S.

Suzanne Shields
5/19/21



* SLOPE: 1/8" TO 1/4" PER FT.



FIGURE 014-B
HARDSCAPE OPTION FOR EROSION PROTECTION FROM ABUTMENT SCOUR
OF LOAD BEARING PERIMETER STEM WALL IN FLOODWAY FRINGE AREAS

SCALE: None

DRAWN BY: sak

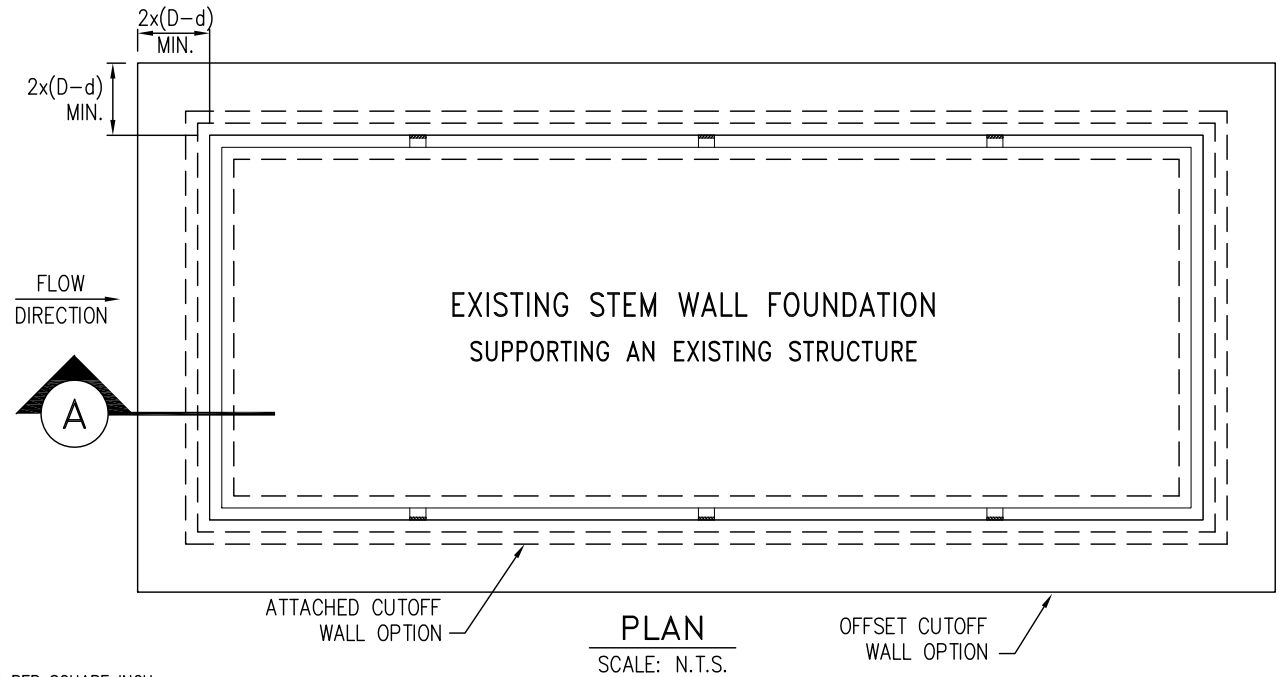
DATE: July 2019

NOTES

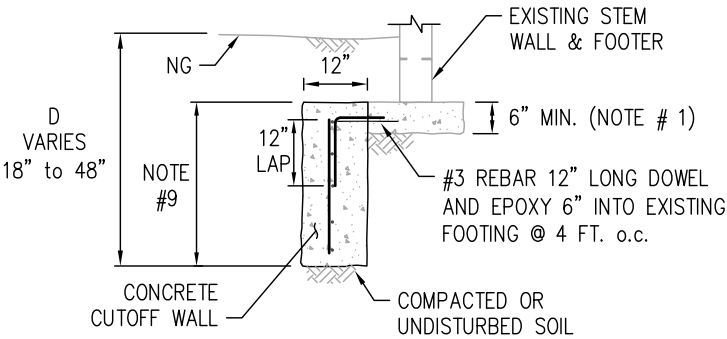
1. FOR ATTACHED CUTOFF WALL OPTION, THICKNESS OF EXISTING FOOTING MUST BE 6" MIN. AND TOP OF FOOTER MUST BE WITHIN 12" OF SURFACE.
2. VERIFY THAT HOLES FOR DOWEL BARS ARE CLEAN AND DRY PRIOR TO PLACING EPOXY.
3. SHIFT DOWEL HOLE LOCATIONS IF EXISTING REINFORCING STEEL IS ENCOUNTERED.
4. DRILL DOWEL HOLES IN EXISTING FOUNDATION PRIOR TO EXCAVATION OF TRENCH BELOW BOTTOM OF FOOTER.
5. MATERIALS: CONCRETE 3000 PSI, REBAR 60 ksi, GRAVEL BASE SSPI SECTION 303.
6. REBAR, WWF TO BE CENTERED IN SLAB AND/OR CUTOFF WALL.
7. 6x6 W5.5xW5.5 WWF OR #3 REBAR @ 12" o.c. BW.
8. #3 REBAR @ 6" o.c. OR #4 @ REBAR 12" o.c. BW, TYP.
9. CUTOFF WALL HEIGHT AS NECESSARY TO ACHIEVE SCOUR DEPTH.
10. TOE-DOWN FROM TABLES 014-B & 014-C.

ABBREVIATIONS

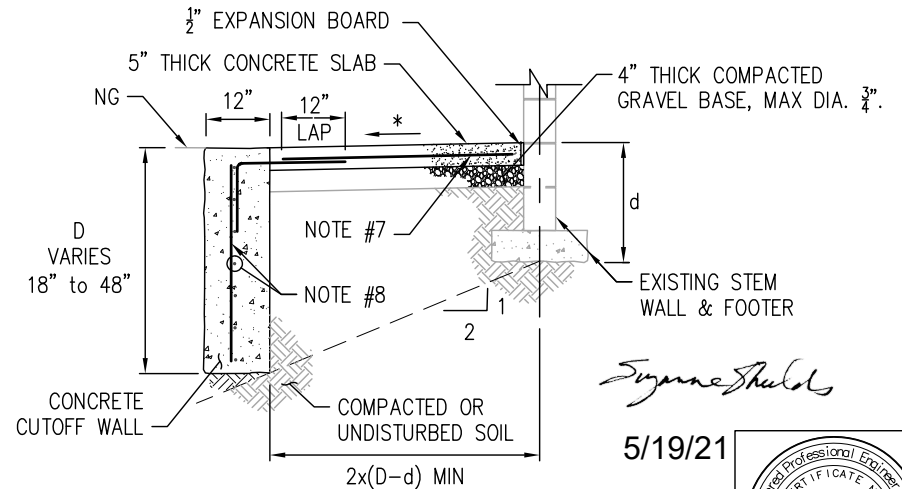
BW = BOTH WAYS	ksi = KILOPOUND PER SQUARE INCH
BFE = BASE FLOOD ELEVATION	NG = NATURAL GROUND
CMU = CONCRETE MASONRY UNIT	N.T.S. = NOT TO SCALE
D = TOE-DOWN DEPTH	o.c. = ON CENTER
d = DEPTH OF EXISTING FOOTER	SSPI = PC/COT STANDARD SPECIFICATIONS
FFE = FINISH FLOOR ELEVATION	for PUBLIC IMPROVEMENT
HANG = HIGHEST ADJACENT NATURAL GRADE	WWF = WELDED WIRE FABRIC



PLAN
SCALE: N.T.S.



A ATTACHED CUTOFF WALL OPTION
SCALE: N.T.S. APPLICATION LIMITED TO SITES WHERE TRENCH WALLS WILL STAND VERTICAL AND NOTE 1



A OFFSET CUTOFF WALL OPTION
SCALE: N.T.S.

* SLOPE: 1/8" TO 1/4" PER FT.

Suzanne Shields

5/19/21

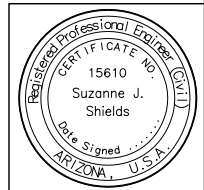


FIGURE 014-C
RETRO FIT OPTION FOR EROSION PROTECTION OF LOAD BEARING PERIMETER STEM WALL IN FLOODWAY FRINGE AREAS

SCALE: None

DRAWN BY: sak

DATE: July 2019