PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
DISTRICT STANDARD

PROCEDURE NO: District Standard DS-304 **EFFECTIVE DATE: October 24, 2011**

PROCEDURE NAME: Specification for Repair of Existing Soil-Cement Erosion Protection

PURPOSE: To provide guidelines for the removal, repair, placement, and/or replacement of soil-cement bank protection and utility scour cap related to utility or storm drain installation or to other substantial disturbances to the soil-cement bank protection. Guidelines include:

- Material and Construction Specifications for work related to the removal, repair, placement and/or replacement of existing soil-cement bank protection and scour cap.
- Standard details for the removal, repair, placement and/or replacement of soil-cement bank protection and scour cap.

DEFINITIONS: For the purpose of this Standard, a ***protected watercourse*** is a surface flow conveyance, the banks of which have been stabilized against lateral erosional movement by placement of soil-cement bank protection. The ***thalweg*** of the watercourse is the line of maximum depth. ***Maximum Anticipated Scour Depth*** (MASD) is the depth below the thalweg of the protected watercourse to which the soil-cement bank protection is extended in order to avoid scour failure of the bank protection; this depth is also referred to as the toe-down, and is evaluated by various scour equations given the hydraulic characteristics of the 100-year discharge along the watercourse. A ***utility*** is a pipeline or conduit, such as a sewer or waterline, which crosses the protected watercourse beneath its thalweg; the utility might cross beneath the bottom of the soil-cement bank protection, or may cross by penetrating the soil cement bank protection. A ***storm drain*** is a conveyance structure which only penetrates the soil-cement bank protection with the purpose of discharging into the protected watercourse.

BACKGROUND: Soil-cement bank protection has been installed by the Pima County Regional Flood Control District (District) along selected major watercourses throughout eastern Pima County since the late 1970's. The District has pursued the use of soil-cement for several reasons, including its aesthetic (i.e., non-industrial) appearance, its demonstrated resistance to the erosive stresses of flood flows and to normal weathering, and its low cost when applied on a regional scale. Soil-cement bank protection is typically constructed by excavating for toe-down and shaping the bank, then laying lifts of soil-cement against the shaped bank, and compacting the lifts as they are laid. A lift is typically 8 feet wide by eight inches deep and is several thousand feet long. The soil-cement is a relatively stiff mixture which when placed, compacted, and cured will exhibit an ultimate 7-day compressive strength between 700 and 1,000 psi. As applied as bank protection along a major watercourse, the soil-cement bank protection is typically extended to MASD, typically at a depth of some 8 to 10 feet below the bed of the watercourse, in order to insure it extends below maximum anticipated scour depth.

Underground utilities shall either be installed below this maximum anticipated scour depth if they cross the protected watercourse, or shall be protected against loss of their integrity due to this scour. This protection typically involves capping the utility within the channel with a layer of soil-cement or concrete, and extending the upstream and downstream legs of this cap at least one foot below the

maximum anticipated scour depth. Upstream and downstream maximum anticipated scour depths are evaluated separately, with the downstream depth typically being the greater of the two.

Although both contain Portland cement, soil-cement is significantly different from the usual concrete found in construction. These differences involve both composition and placement of the product. Construction concrete has a compressive strength much higher than soil-cement, and is formed into structural elements much thinner than those formed using soil-cement. Steel tension reinforcement is standard in construction concrete, but is used infrequently in soil-cement. Most contractors are familiar with methods for placing and finishing construction concrete, but some have much less or no experience working with soil-cement. For this reason, the District is frequently contacted by consulting engineers and other agencies as a source for details and specifications for removal and replacement of existing soil-cement in order for the developer or another agency to install new, or modify existing facilities. Proper removal and replacement of the soil-cement, as well as proper interface of the new/modified facility with remaining soil-cement, is essential to insure the structural integrity of the soil-cement bank protection.

SCOPE: Soil cement repair and replacement may require different material and equipment than the utility or storm drain project. When projects are subject to this Standard, the project manager shall also furnish all the materials, equipment and labor needed to repair or replace the soil-cement bank protection and/or utility scour cap. Project work may include boring trenches, toe-trench excavation, removal of soil-cement, foundation backfill and compaction, dewatering, placement of new soil-cement or accepted alternatives, and other items related to the soil-cement bank protection, including but not limited to safety rail, paved and decomposed granite pathways, survey monuments, irrigation lines, irrigation control lines, trees and natural vegetation and any and all permits required from the District, County, State, or Federal agencies (e.g. ADEQ, CWA 404, etc).

A. SPECIFICATIONS FOR UTILITY INSTALLATIONS:

1. **Installation beneath the soil-cement bank protection -** When feasible, disturbance of the existing soil-cement bank protection shall be avoided by installing a utility a minimum of 2 feet below the toe of the existing soil-cement bank protection, using a boring trench to minimize the impact to the continuity and integrity of the existing soil-cement bank protection. Note that toe-downs for the soil-cement bank protection are typically 8 to 10 feet in depth on a major watercourse and that the top of the soil-cement bank protection above the thalweg can be 10 to 12 feet high or more. This results in the need for substantial trench boxes to protect workers during installation of the utility.

   When the utility is installed beneath the toe of the existing soil-cement bank protection, as described above, the District anticipates that the utility will continue across the protected watercourse (channel) at this depth. When the utility is constructed below the toe of the soil cement bank protection across the channel, the District will not require additional scour protection of the utility. Any additional protection of the utility proposed by the engineering consultant, such as structural protection to account for passage of construction equipment over the utility (see A.2.a below), is subject to review and approval by the District.

2. **Installation through the soil-cement bank protection** – In the event that a boring trench is not feasible due to extenuating circumstances such as a requirement for gravity flow for a sewer line, a cut in the existing soil-cement bank protection may be allowed for the installation of a utility. In

order to maintain the integrity of the soil-cement bank protection, this cut must be filled with a replacement wedge of soil-cement immediately after installation of the utility (Refer to Standard Detail DS-304 Sht 1 Detail 1 and Section A).

a. **Scour Protection -** When installing a utility by a cut in the soil-cement bank protection, the District anticipates that the utility will continue across the protected watercourse at a depth which is above the channel's maximum anticipated scour depth, and therefore the utility must be protected against loss of foundation soil due to scour within the channel. This protection typically consists of capping the utility within the channel with soil-cement. The soil-cement cap must extend at least one foot below maximum anticipated scour depth along the length of the utility within the channel. (Refer to Standard Detail DS-304 Sht 1 Section C). When a utility proposes to cut through the soils cement but remain below the MASD, the soil cement cap is not required.

b. **Structural Protection -** Prior to replacement of the soil-cement bank protection and the scour cap on top of the utility, it may be necessary to protect the utility from the weight of the replacement soil-cement wedge, the scour cap, and/or construction equipment bearing on the top of the utility. Excessive vertical force on the top of the utility may crush the pipe, or may deflect the pipe downward into the foundation material, jeopardizing the integrity of the pipe joints or failing the pipe barrel. The following specifications are applicable to the structural protection of a utility installed through the soil-cement bank protection:

   The method of structural protection for the utility will depend on several factors, some of which are listed below. Due to the various possible combinations of these factors, it is impossible to propose a single standard construction detail, or even a group of construction details, for structural protection of the utility. Therefore, an analysis of these factors must be performed by the consulting engineer, and this analysis must support a proposed protection method. This analysis and protection method, in the form of appropriate construction details, must be presented to the District for review and approval prior to incorporation of the details and specifications into the construction package and commencement of the project. Factors to address in the analysis include, but may not be limited to, the following:

   i. Weight and height of the replacement soil-cement wedge above the top of the utility within the soil-cement bank protection;
   ii. Weight and height of the soil-cement cap on top of the utility within the channel;
   iii. Weight of construction equipment which must pass over the utility during reconstruction of the soil-cement wedge and placement of the soil-cement cap;
   iv. Anticipated need to access the exterior of utility in the future (i.e., if it leaks or must be replaced);
   v. Ability of the utility to resist vertical loads and deflections; and
   vi. Diameter, wall thickness, age and composition of the utility pipe.

c. **Soil-Cement Removal and Repair -** For utility installation through the soil-cement bank protection, the following Specifications shall be followed in the removal and replacement of the soil-cement.

i. The existing soil-cement bank protection and/or scour cap may be removed by a hoe ram or by cutting with a concrete saw. The area removed shall be for the full width of the soil-cement bank protection (typically 8 feet) to the approved bottom elevation of the utility or its structural protection. In the case of installing a utility beneath an existing scour cap, the full thickness of the scour cap shall be removed along the length of the utility and for a minimum width at the bottom of the utility scour cap equal to the diameter of the utility plus 2 feet. For removal by hoe ram, the exposed cut surface of the soil-cement shall form a 2:1 (H:V) slope, or flatter, in order to facilitate replacement of a repair wedge. A soil-cement scour cap 2 feet thick or less shall be removed by the concrete saw method. For this method, the exposed cut surface may be vertical.

ii. For soil-cement removal 6 feet deep or less, the replacement wedge shall be anchored to the remaining soil-cement using grade 40 (min) #8 reinforcing bar (rebar) dowels. These dowels shall each be 3 feet in length and shall be installed on 18-inch centers in a grid pattern over the cut face of the soil-cement. Dowels shall extend a minimum of 18 inches into the existing soil-cement bank protection, using a 1.25 inch diameter drilled hole, and shall be secured using a two-part epoxy specifically designed for rebar embedment, per Section 1015-2 of the publication titled: *Standard Specifications for Public Improvements (PC/COT SSPI), current edition*, except the pull-out resistance requirement shall not apply. (Ref: Standard Detail DS-304 Sht 1 Sections A & B).

- Rebar shall be located such that all dowels are located at least 18 inches from an exposed or potentially exposed surface of the repaired soil-cement bank protection or scour cap.

- For repair wedges greater than six feet deep, no rebar reinforcement is required at the interface with the existing soil-cement bank protection or scour cap.

iii. The exposed cut surface of the soil-cement bank protection and/or scour cap shall be power-washed using clean (potable) water and broom cleaned to remove all loose or friable pieces or fragments of the soil-cement. The exposed cut surface shall then be pre-moistened before placing new soil-cement or other acceptable repair material.

iv. Replacement soil-cement shall meet or exceed the minimum material and construction specifications as described in Section 920 of the *PC/COT SSPI*.

- If soil-cement is not being manufactured onsite, a chemical delaying agent may be used for travel time up to 1 hour of delay from time of manufacture to completion of compaction, if approved in advance by the District.

- Alternatives methods of on-site manufacturing of soil-cement, other than a batch plant as described in Section 920 of the *PC/COT SSPI* , maybe used if approved in advanced by the District.

v. As it may be difficult to place and properly compact soil-cement in a confined space associated with a minor repair of the soil-cement bank protection or scour cap, an alternate material or method such as a two-sack concrete mix may be used. Difficulty in

placing and compacting soil-cement economically in a minor repair project is the main reason sighted for going to a two-sack concrete mix design, as it can be formed and poured. Compaction is key to obtaining a good quality soil-cement product.

- A two-sack concrete mix means a concrete mix containing 2 94-lb sacks of Portland Cement per cubic yard (CY) of final concrete volume. This two-sack concrete mix may be poured in place, vibrated to remove voids, and allowed to cure without compacting. If a two-sack mix is to be used, it shall meet the material and testing specifications presented in Section 1006 of the *PC/COT SSPI*, with the exception that the maximum aggregate size shall be 2 inches, 28-day compressive strength shall be 1,000 psi, and hydraulic cement shall be 190 lbs / CY (minimum).

- Two-sack concrete mix shall be placed along the full width, thickness, and height of the replacement wedge in the soil-cement bank protection or scour cap, and finish form work shall extend and conform to adjacent geometry of existing structure. Concrete mix shall be colored to match the existing soil-cement color and shade.

B. SPECIFICATIONS FOR STORM DRAIN INSTALLATION:

1. **Installation through the soil-cement bank protection** - Storm drains passing through soil-cement bank protection shall consist of reinforced concrete pipe or reinforced, cast in place concrete culverts, unless an alternative is approved in advance by the District. Metal pipes tend to rust and plastic pipes may not have sufficient strength to resist applied loads. In addition, plastic pipes have been observed to be damaged by fire. It is assumed that the storm drain will discharge through the soil-cement bank protection and into the receiving watercourse, and therefore the storm drain will not continue across the watercourse. Removal or placement of a soil-cement scour cap is not anticipated for this installation (Standard Detail DS-304 Sht 2 Detail 1).

2. **Hydraulic Design -** Storm drain design shall be supported by an engineering analysis which shall be submitted to the District for review and approval. The analysis shall demonstrate that:

   a. The storm drain is properly sized to convey its design discharge;
   b. The storm drain will not adversely increase flow depths in the receiving watercourse due to the increased discharge from the storm drain;
   c. The storm drain will have a sufficient longitudinal slope to provide a minimum 3 ft per second flow velocity during the 10-year event, in order to limit sedimentation within the storm drain, unless otherwise approved by the District; and
   d. The resulting scour hole at the outlet of the storm drain will not exceed the existing toe of the soil-cement bank protection or, if the scour hole does exceed the toe, then additional toe-down of the soil-cement bank protection or other erosion protection will be required at the drain outlet.

3. **Outlet Design -** In order to minimize pipe blockage due to channel migration, the invert of the storm drain shall be placed a minimum of 2 feet above the channel thalweg, above the adjacent top of existing long-term sandbars, or above the 10-year water surface elevation of the receiving watercourse, which ever is greater, unless otherwise approved by the District.

Flapgates shall be provided at the storm drain outlet if hydraulic calculations show that the 100-year hydraulic grade line of the storm drain will create flooding at the storm drain inlet when the watercourse has a 10-year event; or if the 100-year water surface elevation for the watercourse would allow backflow through the storm drain, resulting in flooding at the storm drain inlet.

a. If flapgates are required, they shall be attached to a vertical concrete headwall with horizontal apron. The headwall shall be recessed into the soil-cement bank protection such that the flapgate does not project beyond the soil-cement bank protection.
b. If flapgates are not required, then no headwall or apron are required. Outlet of the storm drain shall be mitered to closely match the slope of the soil-cement bank protection, and shall not be allowed to project into the watercourse.

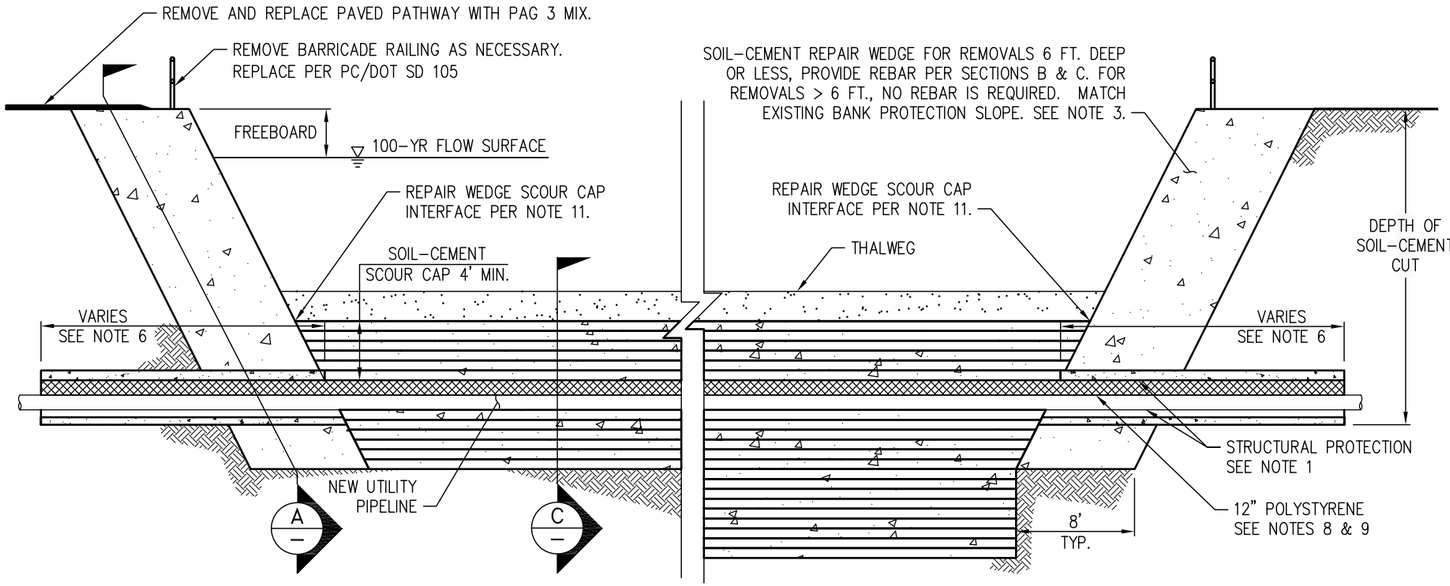
4. **Soil-cement Removal and Repair** – For storm drain installation through the soil-cement bank protection, guidelines for removal and replacement of the soil-cement are identical to those presented in A.2.a thru A.2.c above, with the following three exceptions:
   a. All references in the above guidelines and referenced figures to a soil-cement scour cap do not apply;
   b. All figure references shall refer to the appropriate details presented on Sheet 2 instead of Sheet 1 of the Standard Details; and
   c. Where the guidelines refer to a utility, refer instead to a storm drain.

PLAN SUBMITTAL: Construction drawings must be submitted for review and approval by all governmental entities having jurisdiction. In general, the construction drawings must demonstrate that the project will not adversely affect adjacent properties, will protect native and riparian habitat, will be executed in a safe manner, and will maintain the integrity of the existing bank/invert protection. The District will review the construction plans to ensure incorporation of this Standards detail(s) and specifications into the construction drawings.

INSPECTION: Inspection of the repair by District personnel will be required. When authorizing the soil-cement repair/replacement, inspection milestones will be established as conditions for approval.

APPROVED BY:

Suzanne Shields 10/24/11
Suzanne Shields Date
Director and Chief Engineer



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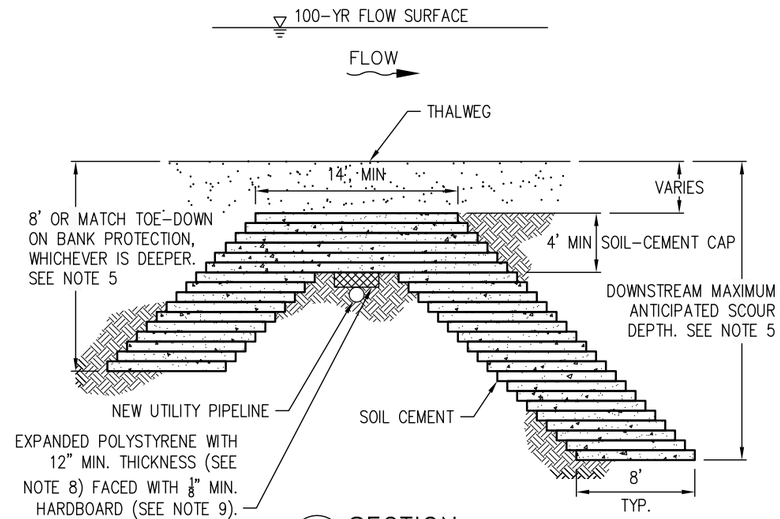

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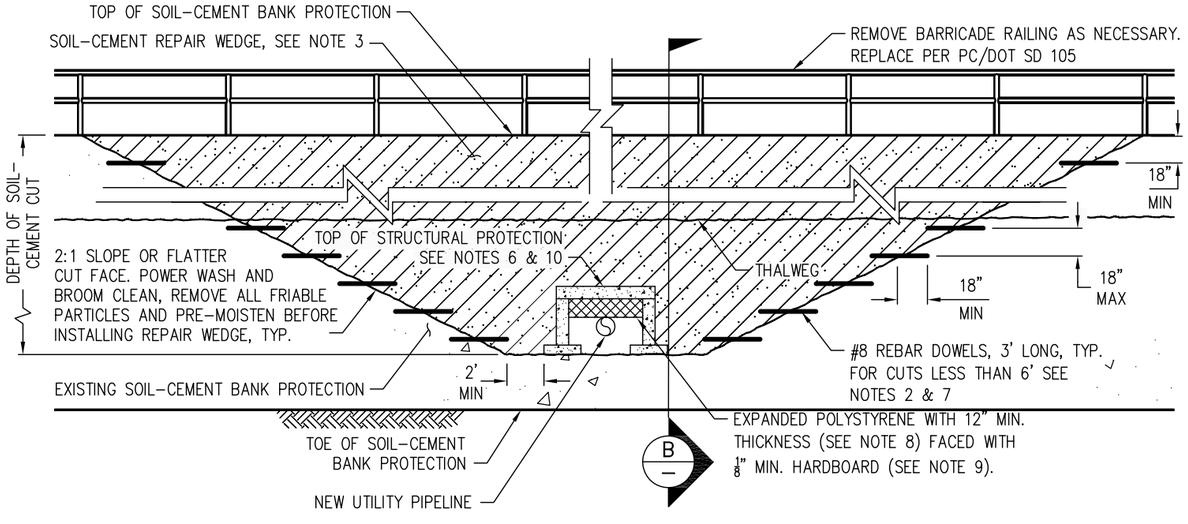

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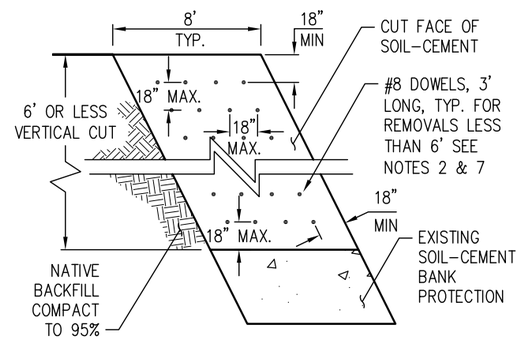

B SECTION
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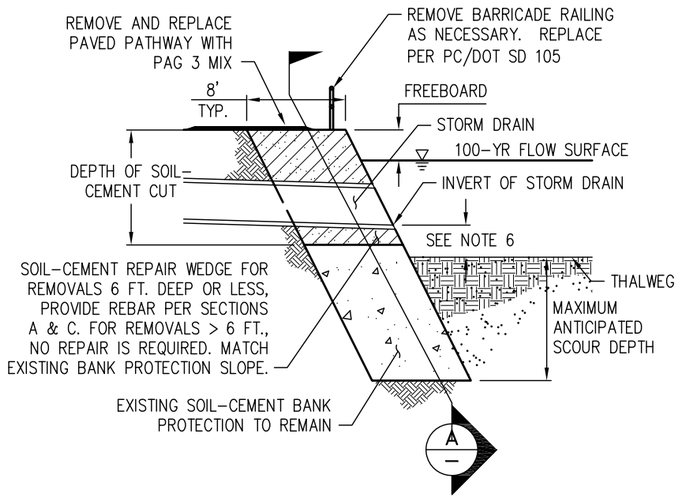
NOTES

1. ALL CONSTRUCTION AND TEST METHODS SHALL CONFORM TO THE PC/COT STANDARD SPECS & DETAILS FOR PUBLIC IMPROVEMENTS, CURRENT EDITION.
2. ANCHOR DOWELS INTO SOIL CEMENT PER SEC 1015-2, (IGNORE PULLOUT RESISTANCE)
3. SOIL CEMENT PER MIN SPECS SEC 920 OR THE TWO CONCRETE MIX PER THIS STANDARD.
4. TO BE USED ONLY WITH DISTRICT APPROVAL & IF JACK & BORE IS NOT FEASIBLE.
5. ENGINEERING CONSULTANT TO PROVIDE SCOUR ANALYSIS.
6. STRUCTURAL PROTECTION TO BE PROPOSED AND JUSTIFIED BY ENGINEERING CONSULTANT.
7. REINFORCING STEEL SHALL CONFORM TO ASTM C-203.
8. POLYSTYRENE SHALL BE COMMERCIALLY AVAILABLE BOARD WITH 35 PSI MIN FLEXURAL STRENGTH (ASTM C-203) & 16-40 PSI COMPRESSIVE STRENGTH AT 5% COMPRESSION.
9. HARDBOARD SHALL BE 1/8" MINIMUM THICKNESS. BOARDS SHALL BE SECURED BY NAILS, WATERPROOF ADHESIVE OR OTHER APPROVED MEANS.
10. TRAFFIC, BACKFILL & SOIL-CEMENT PROHIBITED ON STRUCTURAL PROTECTION UNTIL 10 DAYS MIN AFTER THE TOP SLAB HAS CURED, & UNTIL PLACED CONCRETE REACHES 28-DAY COMPRESSIVE STRENGTH.
11. WHERE SOIL-CEMENT LIFTS IN REPLACEMENT WEDGE & THE SCOUR CAP ARE AT THE SAME LEVEL, LIFTS ARE TO BE PLACED & COMPACTED IN A SINGLE OPERATION.

Pima County Regional FLOOD CONTROL DISTRICT

STANDARD DETAIL DS-304
NEW UTILITY PIPELINE THROUGH EXISTING SOIL-CEMENT BANK PROTECTION

SCALE: NONE | DRAWN BY: sak | DATE: AUG. 2011



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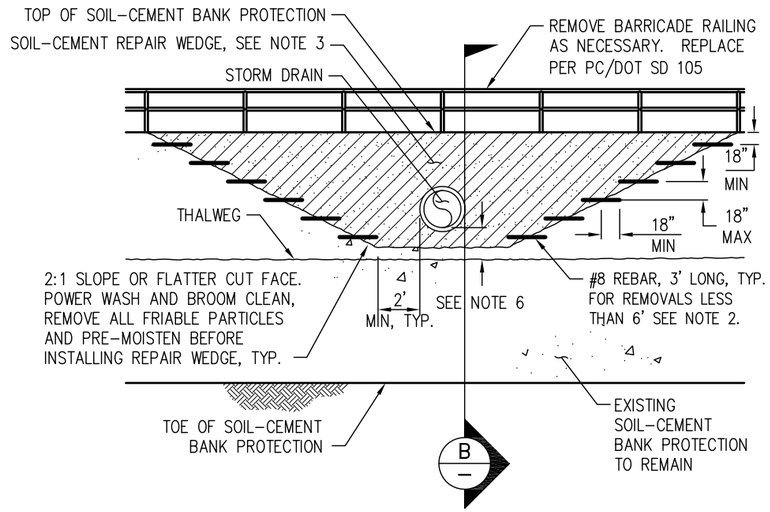

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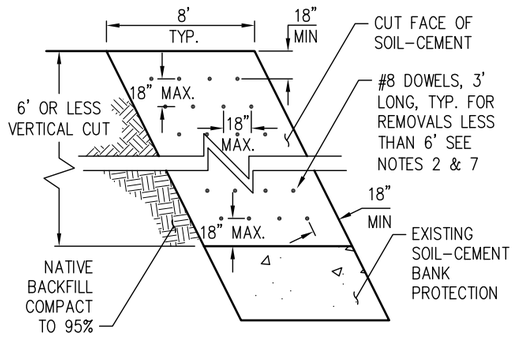

B SECTION
SCALE: N.T.S.

NOTES

1. ALL CONSTRUCTION AND TEST METHODS SHALL CONFORM TO THE PIMA COUNTY/CITY OF TUCSON STANDARD SPECIFICATIONS AND DETAILS FOR PUBLIC IMPROVEMENTS, CURRENT EDITION.
2. ANCHOR DOWELS INTO SOIL CEMENT PER SECTION 10115-2, EXCEPT PULLOUT RESISTANCE DOES NOT APPLY.
3. SOIL CEMENT SHALL MEET OR EXCEED THE MINIMUM SPECIFICATIONS DESCRIBED IN SECTION 920 OR THE TWO SACK CONCRETE MIX SPECIFIED IN THIS STANDARD.
4. ENGINEERING CONSULTANT TO PROVIDE HYDROLOGIC AND HYDRAULIC ANALYSIS.
5. ENGINEERING CONSULTANT TO PROVIDE SCOUR ANALYSIS.
6. GREATER OF 2' OR HEIGHT OF EXISTING SANDBAR OR 10-YR FLOW DEPTH.
7. REINFORCING STEEL SHALL CONFORM TO ASTM C-203.

Pima County Regional FLOOD CONTROL DISTRICT

STANDARD DETAIL DS-304
STORM DRAIN INSTALLATION THROUGH EXISTING SOIL-CEMENT BANK PROTECTION

SCALE: NONE | DRAWN BY: sak | DATE: AUG. 2011

THE SEAL OF PIMA COUNTY ARIZONA