PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY

POLICY NO.: Technical Policy, TECH-027 **EFFECTIVE DATE: May 25, 2011**

POLICY NAME: Protective measures for private vehicular access

PURPOSE: To clarify Section 16.20.040.B.10 of the Ordinance regarding protective measures when a private vehicular access in the form of a single family private driveway, a multi-family private driveway, or a driveway which serves as a common access for uses other than residential is proposed across the low-flow channel associated with a regulatory floodplain (private driveway crossing).

BACKGROUND: Section 16.20.040.B.10 allows the District to establish requirements for construction of channel modifications. When a private driveway crosses a low-flow channel associated with a regulatory floodplain, channel modifications may occur that have the potential to impact the floodplain and, as such, an engineering analysis is often required to ensure crossing stability and no adverse impact to adjacent parcels.

Currently, there are no standards for construction of private driveways across or through regulatory floodplains other than those found in Section 16.36.060 of the Ordinance. This Section establishes that lots within a subdivision or lots that are subject to development plan requirements shall have at least one paved permanent access over terrain that is traversable by a conventional motor vehicle at times of flooding. Paved permanent access is further described as having a base flood flow depth of 1 foot or less over the road surface and being constructed to remain stable during the base flood. This requirement is established in order to ensure that the lots may be accessed by the owner, visitors, emergency personnel, etc, regardless of the extent of flooding that may be occurring. This requirement is often referred to as "all-weather access" and applies up to the property line of lots within a subdivision. However, there may be regulatory floodplains <u>within</u> lots where the "all-weather access" requirement would not apply. Additionally, un-subdivided lots (i.e., "lot splits") are not required under the Ordinance to have "all-weather access" either up to, or within the lots.

Historically, under authority of Section 16.20.040.B.10 the District required improved private driveway crossings to be constructed to remain stable during the base flood. Improved in this policy means the driveway is paved and/or elevated across the channel. However, in many cases this requirement was cost prohibitive, which may have lead to improved crossings being constructed without the issuance of Floodplain Use Permits (FPUPs). Without FPUPs, there is no scrutiny as to the safety of the crossing, or the impact of the crossing on the natural wash system or on neighboring floodprone properties.

In addition, if "all-weather access" is not required or desired by the property owner, Section 16.44.030 allows for an alternative access provided the property owner acknowledges via an indemnification agreement (covenant) that the alternative access might not be passable during times of flooding and that users of the access will be notified of this condition. Even though the property owner will sign a covenant that the alternative access is not "all-weather access", the District maintains that some reasonable protective measures for private driveway crossings should be required. At a minimum, these protective measures reduce the frequency of failure of the crossing by erosion, reduce adverse impacts on neighboring properties and improvements, increase safety for passengers in the crossing vehicle(s), and help protect the natural processes associated with the wash system.

This policy establishes reasonable protective measures for private driveway crossings across the low-flow channel associated with a regulatory floodplain. Since the frequency of use of the crossing and the ability of the users to acknowledge any design limitations can vary, this policy considers private driveway crossings serving a single property separately from private driveway crossings which serve multiple properties or serve as a common access for uses other than residential. **Multiple property access shall include access that, in the future, is either anticipated or expected to serve more than a single property**.

In floodplain management, a low-flow channel is the geologic feature which generally conveys, at bank-full stage, the predominant discharge. Flows larger than the predominant discharge will overflow the low-flow channel banks, and begin to occupy the floodplain adjacent to the low-flow channel. In the arid southwest, the predominant discharge is considered to have a return period between 5 and 10 years.

POLICY FOR PROTECTIVE MEASURES FOR PRIVATE DRIVEWAY CROSSINGS:

I. Private driveways serving a single property: In all cases, design considerations shall include attempting to: 1) locate the crossing away from property lines to reduce the impact to neighboring properties; 2) maintain natural channel geometry to avoid creating a location where flow in the low-flow channel can break out and to encourage the conveyance of the incoming sediment load; and 3) locate the crossing to avoid or minimize disturbance of mapped riparian habitat. In all cases, if the District observes that unusual conditions exist, additional design constraints or an engineering analysis to verify stability & no adverse impact may be required.

A. At-grade unimproved crossing across a low-flow channel: This crossing generally maintains the natural geometry of the low-flow channel cross section but allows minor excavation of the low-flow channel banks to develop a drivable vertical curve across the channel. Driveway surface may include a layer of loose (i.e., uncemented) gravel or rock. In order to provide access for emergency vehicles, the District suggests that the roadway be 14-feet wide and have a maximum angle of approach and departure of 8 %. No engineering analysis of crossing stability or of adverse impacts is required. This crossing does not require a Floodplain Use Permit, but riparian habitat disturbance will be tracked. Refer to Figure 027-A for typical details of this crossing.

B. At-grade improved crossing across a low-flow channel: This crossing involves cutting back the channel banks as in I-A above, and constructing a paved driveway surface across the low-flow channel with upstream and downstream vertical concrete cutoff walls to protect the paved driveway surface from erosion damage. The roadway shall be 14-feet wide (minimum) and shall have a maximum angle of approach and departure of 8 %, as shown on Figure 027-B. When choosing this option the following specifications shall apply:

1. The upstream cut-off wall (minimum) shall be:
   a) In accordance with the table below for flows that are up to 2000 cfs:

	100 cfs <= Q_{100} < 500 cfs	**500 cfs <= Q_{100} < 1000 cfs**	**1000 cfs <= Q_{100} < 2000 cfs**
Upstream Cutoff Wall Depth	1 foot	2 feet	3 feet

   b) Designed by an Arizona-registered civil engineer when the base flood peak flow is 2000 cfs or more;
2. The downstream cutoff wall (minimum) shall be:
   a) In accordance with the table below for flows that are up to 2000 cfs:

	100 cfs <= Q_{100} < 500 cfs	**500 cfs <= Q_{100} < 1000 cfs**	**1000 cfs <= Q_{100} < 2000 cfs**
Downstream Cutoff Wall Depth	2 feet	3 feet	4 feet

   b) Designed by an Arizona-registered civil engineer when the base flood peak flow is 2000 cfs or more;
3. The Depth of upstream & downstream cutoff walls shall be measured from the paved driveway surface;
4. The driving surface shall be paved (concrete or asphalt), and this paved surface shall have a cross-slope of 4% minimum, except in sheet flow areas, alluvial fans or other areas with shallow channel depths (1 foot or less), then road cross-slope shall be 2% minimum. The purpose of the cross-slope is to minimize sediment deposition on the driving surface and shall be established by raising the upstream cutoff wall;
5. Cutoff walls (upstream and downstream) shall span the bottom of the low-flow channel, and continue beyond the toe of the banks until the driveway reaches one-half (minimum) of the bank height. Beyond reaching the full bank height, the driveway shall remain at-grade through the overbank;
6. Indemnification agreement (covenant) shall be signed by the owner(s) which contains statements holding Pima County harmless and acknowledging that the stability of the at-grade improved crossing during passage of the base flood has not been demonstrated, and therefore the crossing might not remain intact during flooding; and

7. When an engineering analysis is required due to unusual conditions, exceeding the discharge limit stated in I.B.1.b) or I.B.2.b), or unacceptability of the above configuration to the property owner, the engineering analysis shall demonstrate that the selected characteristics of the crossing shall survive the passage of the 10-year or larger flood event. If the engineering analysis does not address stability of the crossing during the base flood, indemnification agreement as described in I.B.6 shall be provided.

C. Elevated driveway with culvert crossing across a low-flow channel: This crossing consists of an earth embankment across the low-flow channel with a culvert(s) placed through the embankment at the channel invert (bottom) and aligned with the direction of flow in the channel. In general, the number and diameter of culverts may vary, as well as the height of the embankment relative to the natural channel bottom. The particular combination of culvert characteristics and embankment dimensions will determine how far the culvert headwater pool extends upstream, potentially producing adverse impacts to upstream properties, and the extent of downstream erosion, potentially producing adverse impacts on downstream properties. Due to the number of design parameters and the potential adverse impacts to the crossing, adjacent properties, and/or the natural wash system, an engineering analysis is frequently required to evaluate stability and adverse impacts. However, the District may accept certain crossing configurations without an engineering analysis when the protective measures described below are provided (refer to Figures 027-C1 and -C2):

1. The base flood peak discharge is between 100 cfs and 500 cfs;
2. The crossing location, channel geometry, and site topography clearly produce negligible off-property effects, and maximize stability of the crossing;
3. The minimum culvert diameter shall be 18 inches and the maximum diameter shall be 42 inches. The culvert shall be either unreinforced concrete sewer/culvert pipe (UCP, ASTM C-14), Reinforced Concrete Pipe (RCP, ASTM C-76) or Corrugated Metal Pipe (CMP, ASTM A-760). Other pipe materials may be allowed upon provision of manufacturer's specifications demonstrating the load carrying capacity (30,000 lb axle load) of the pipe as proposed to be installed and provision of manufacturer's recommended details for attaching the pipe to concrete headwalls (if appropriate);
4. The natural channel slope along the flow direction shall be no more than 0.030 ft/ft;
5. Slope of culvert barrel matches the natural longitudinal channel slope, but shall not be less than 0.01 ft/ft;
6. The invert of the culvert is placed no more than the smaller of 6 inches, or ¼ of the culvert inside diameter, below the natural bottom of the channel;
7. The culvert barrel orientation matches the natural channel alignment;
8. All embankment fill shall be compacted to 90% Proctor (minimum);
9. The embankment is located only within the low flow channel and the number and diameter of the culvert barrels shall be sufficient to fill the width and height of the channel, considering:
   a) The inter-barrel spacing shall allow for proper compaction of fill around the barrel haunches (spacing = ½ culvert diameter or 12 inches, whichever is greater, measured between outside walls of adjacent barrels at mid height of the culverts); and
   b) One foot (minimum) of soil cover shall be placed on top of the culverts;
10. Roadway is:
    a) Minimum of 14-feet wide;
    b) Paved or unpaved (check with local fire district for specific requirements);
    c) Constructed to provide a profile that is level or a vertical sag curve within the crossing. A vertical crest curve within the crossing shall not be allowed;
    d) Constructed to provide a maximum angle of approach and departure of 8 percent (check with local fire district for specific requirements);
    e) Able to support an axel load of 30,000 lbs (check with local fire district for specific requirements);
11. Culvert inlets are setback from the upstream property line such that the low point in the roadway profile or the top of headwall (if headwall extends above top of roadway) within the crossing is at or below the elevation of the natural channel bottom at the upstream property line; and either:
    a) Mitered or other form of inlet improvement to the match the fill slope, or
    b) Combined in a reinforced concrete headwall which extends 2 feet (minimum) below the natural bottom of the channel (refer to Figure 027-C3);

12. Culvert outlets are either:
    a) Unprotected and offset from the downstream property line by a distance equal to the natural bottom width of the channel or 10-feet, whichever is larger, and the downstream property owner covenants acceptance of downstream erosion;
    b) Combined in a reinforced concrete headwall which extends a minimum depth equal to the greater of the culvert barrel outside diameter or 2 feet, below the natural channel bottom. The culvert outlet must be offset from the downstream property line by a minimum of 20 culvert diameters, unless the downstream property owner covenants acceptance of downstream erosion (refer to Figure 027-C3);
    c) Directed to a plunge basin lined with dumped rock rip-rap having a D_{50} of 6" and a blanket thickness of 12". The riprap blanket shall be underlain with Mirafi 180-N or equivalent filter fabric. The plunge basin shall begin at the culvert outlet, and shall extend downstream a distance of six culvert diameters (minimum). The bottom of the plunge basin shall be depressed below the natural channel bottom by one-half of the culvert outside diameter at a minimum (refer to Figure 027-C4); or:
    d) Directed to a horizontal apron lined with dumped angular rock riprap. The apron shall begin at the culvert outlet and shall extend downstream a minimum distance equal to 1 foot of length for each inch of culvert diameter (i.e., if 18-inch diameter culverts are used, the apron shall extend 18 feet downstream from the culvert outlet). Within this length, the apron shall span the bottom width of the channel. The riprap shall have a D_{50} based on the longitudinal channel slope as presented in the table below, shall have a blanket thickness of twice the D_{50}, and shall be underlain with Mirafi 180-N or equivalent filter fabric. The riprap blanket will be dug into the channel bottom so that the top of the riprap blanket matches the natural channel bottom which it replaces (refer to Figure 027-C5);

CULVERT DIAMETER	**RIPRAP D_{50}**					
	S <= 0.005	**S <= 0.01**	**S <= 0.015**	**S <= 0.02**	**S <= 0.025**	**S <= 0.03**
18"	6"	6"	6"	6"	9"	9"
24"	6"	6"	9"	9"	9"	9"
30"	6"	9"	9"	9"	9"	9"
36"	6"	9"	9"	9"	9"	9"
42"	6"	9"	9"	9"	9"	9"

13. Indemnification agreement (covenant) shall be signed by owner(s) holding Pima County harmless and acknowledging that the stability of the crossing during passage of the base flood has not been demonstrated, that owner(s) shall maintain the culvert(s) in a clear and open condition, and that owner(s) shall modify the crossing at their expense if it is found to produce adverse impacts on adjacent properties.
14. When an engineering analysis is required due to unusual conditions, exceeding the discharge limit stated in I.C.1, or unacceptability of the above configuration to the property owner, the engineering analysis shall demonstrate that the selected characteristics of the crossing do not produce adverse impacts on adjacent properties during the base flood, assuming the structure remains intact, and shall survive the passage of the 10-year or larger flood event. If the engineering analysis does not address stability of the crossing during the base flood, indemnification agreement as described in I.C.13 shall be provided.

II. Private driveways serving more than one, but less than 6 properties:

A. At-grade unimproved crossing: Same requirements as I.A.

B. At-grade improved crossing:.

1. The upstream cutoff wall shall be :
    a) In accordance with the table below for flows from 100 cfs up to 500 cfs, and

100 cfs <= Q_{100} < 500 cfs	
Upstream Cutoff Wall Depth	2 feet

    b) Designed by an Arizona-registered civil engineer when the base flood peak flow is 500 cfs or more;

2. The downstream cutoff wall (minimum) shall be:
   a) In accordance with the table below for flow that are up to 500 cfs:

100 cfs <= Q_{100} < 500 cfs	
Downstream Cutoff Wall Depth	3 feet

   b) Designed by an Arizona-registered civil engineer when the base flood peak flow is 500 cfs or more;
3. The depth of cutoff walls (both upstream and downstream) shall be measured below the top of the paved driveway surface;
4. The driving surface shall be paved (concrete or asphalt) and this paved surface shall have a cross-slope of 4% minimum, except in sheet flow areas, alluvial fans or other areas with shallow channel depths (1 foot or less), then road cross-slope shall be 2% minimum. The purpose of the cross-slope is to minimize sediment deposition on the driving surface and shall be established by raising the upstream cutoff wall;
5. Cutoff walls (upstream and downstream) shall span the bottom of the low-flow channel, and continue beyond the toe of the banks until the driveway reaches one-half (minimum) of the bank height. Beyond reaching the bank height, the driveway shall remain at-grade through the overbank;
6. Indemnification agreement (covenant) shall be signed by the owner(s) which contain statements holding Pima County harmless and acknowledging that the stability of the improved at-grade crossing during passage of the base flood has not been demonstrated, and therefore the crossing might not remain intact during flooding; and
7. When an engineering analysis is required due to unusual conditions, due to exceedance of the discharge limit stated in II.B.1.b) or II.B.2.b), or unacceptability of the above configuration to the property owner, the engineering analysis shall demonstrate that the selected characteristics of the crossing shall survive the passage of the 10-year or larger flood event. If the engineering analysis does not address stability of the crossing during the base flood, indemnification agreement as described in II.B.6 shall be provided.

C. Elevated driveway with culvert crossing: Engineering analysis is required in order to demonstrate that the selected characteristics of the crossing do not produce adverse impacts on adjacent properties during the base flood, assuming the structure remains intact, and that the crossing will survive the passage of not less than the 10-year flood event. If the engineering analysis does not address stability of the crossing during the base flood, indemnification agreement as described in I.C.13 shall be provided.

III. Private driveways serving 6 or more properties, or for common access other than residential:

A. At-grade unimproved crossing: Same requirements as listed in I-A.

B. All other crossings: Usually, a driveway serving 6 or more properties or a business is required to provide all-weather access. However, if for some reason all-weather access is not required, then an engineering analysis is required to demonstrate that the selected characteristics of the crossing do not produce adverse impacts on adjacent properties during the base flood assuming the structure remains intact, and that the crossing will survive passage of the 10-year or larger event. In addition, signage is required indicating that the crossing may not be passable during flooding. If the engineering analysis does not address stability of the crossing during the base flood, an indemnification agreement as described in I.B.6 shall be provided.

APPROVED BY:

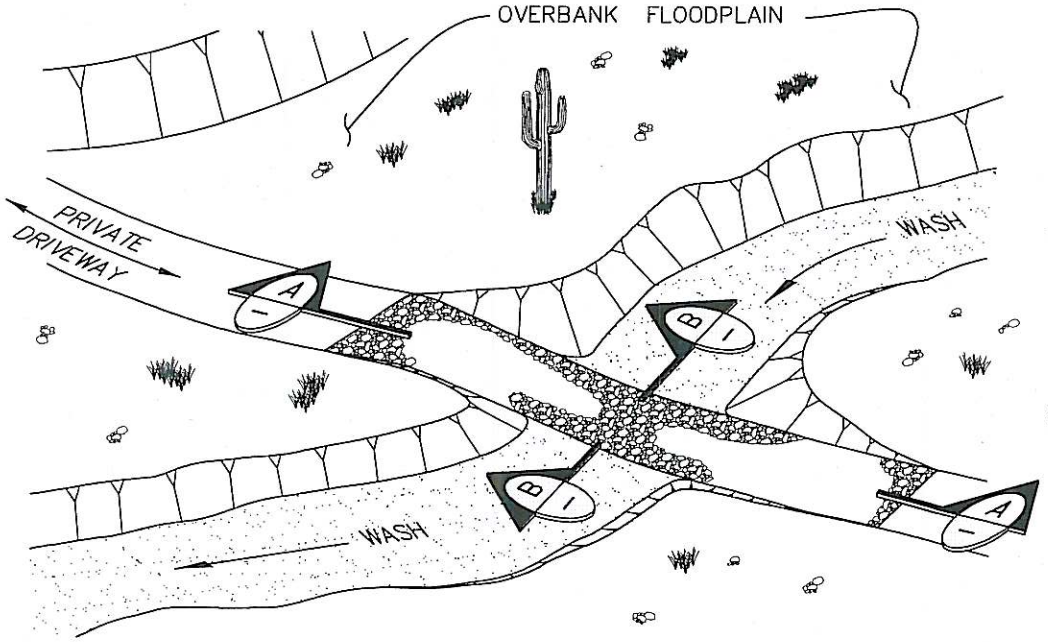
Registered Professional Engineer
CERTIFICATE NO.
15510
SUZANNE J.
SHIELDS
DATE SIGNED
ARIZONA U.S.A.

Suzanne Shields 5/25/2011

Suzanne Shields
Director

Date

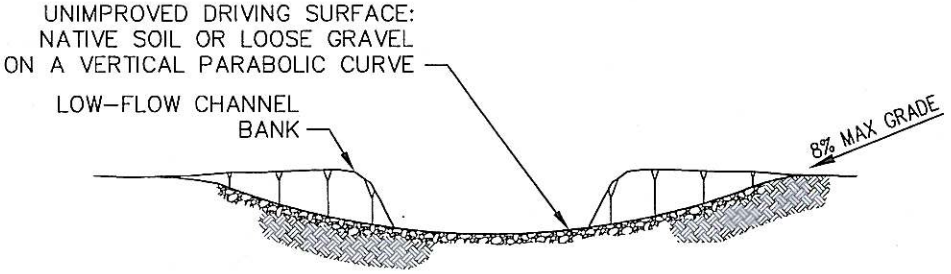
Original Policy Approved: June 30, 2013 approved
Date(s) Revised:



OBLIQUE VIEW

NOTES

1. CUT BACK LOW-FLOW CHANNEL BANKS AS NECESSARY TO FORM A DRIVEABLE VERTICAL CURVE ACROSS THE CHANNEL
2. CROSSING IS DESIGNED TO CROSS THE LOW-FLOW CHANNEL ONLY AND WILL BE OUTFLANKED BY INFREQUENT FLOOD EVENTS. OWNER IS ADVISED TO INSPECT CROSSING AFTER EACH FLOOD EVENT AND IMMEDIATELY REPAIR ALL DAMAGE.



A SECTION
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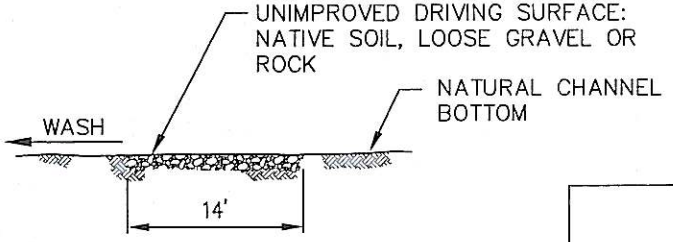


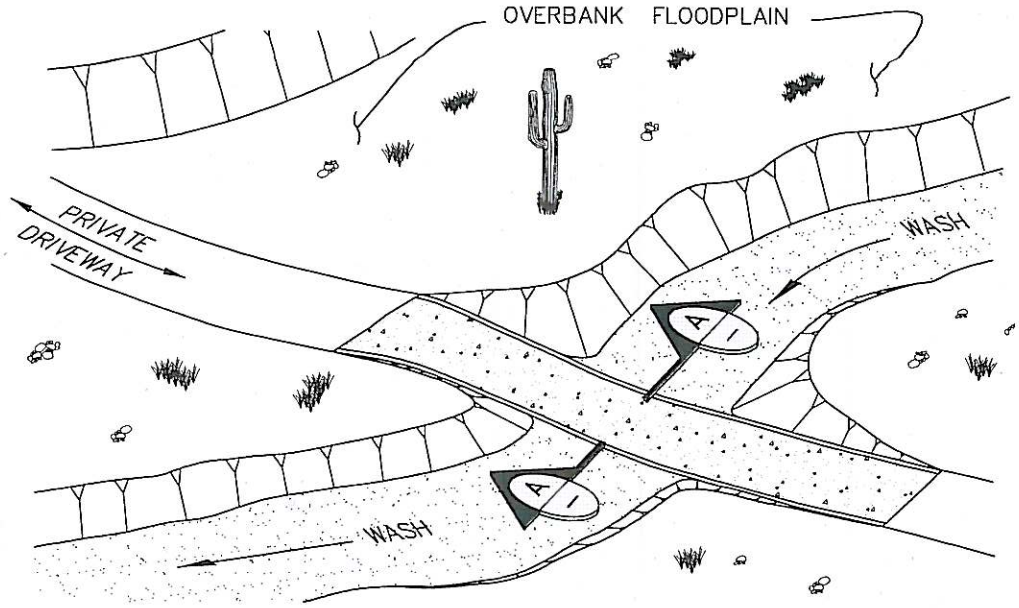
B SECTION
SCALE: N.T.S.

Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 - A
AT-GRADE UNIMPROVED CROSSING

SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

THE SEAL of PIMA COUNTY ARIZONA



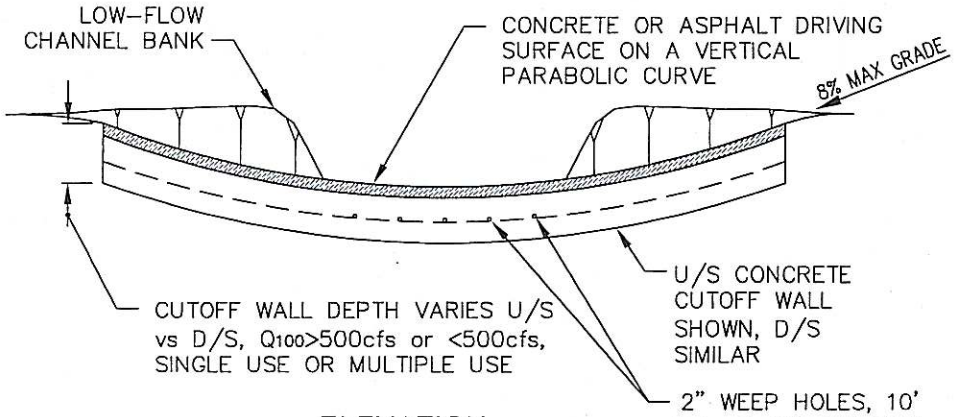
OBLIQUE VIEW

NOTES

1. CUT BACK LOW-FLOW CHANNEL BANKS TO FORM A DRIVEABLE VERTICAL CURVE ACROSS THE CHANNEL.
2. TO PRODUCE REQUIRED CROSS-SLOPE, ADD ADDITIONAL HEIGHT TO DRIVING SURFACE AT UPSTREAM EDGE.
3. SEE TECH-027 FOR CUTOFF WALL DEPTHS.
4. CROSSING IS DESIGNED TO CROSS LOW-FLOW CHANNEL ONLY AND WILL BE OUTFLANKED BY INFREQUENT FLOOD EVENTS. OWNER IS ADVISED TO INSPECT CROSSING AFTER EACH FLOOD EVENT AND IMMEDIATELY REPAIR ALL DAMAGE.

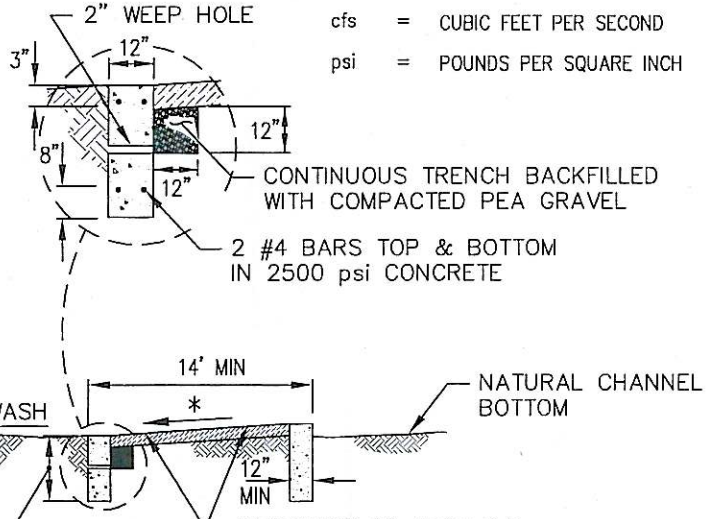
ABBREVIATIONS THIS PAGE:

D/S	=	DOWNSTREAM
U/S	=	UPSTREAM
bw	=	BOTH WAYS
cfs	=	CUBIC FEET PER SECOND
psi	=	POUNDS PER SQUARE INCH



ELEVATION

SCALE: N.T.S.
LOOKING U/S @ D/S CUTOFF WALL



A SECTION

SCALE: N.T.S.

FIGURE 027 - B
AT-GRADE IMPROVED CROSSING

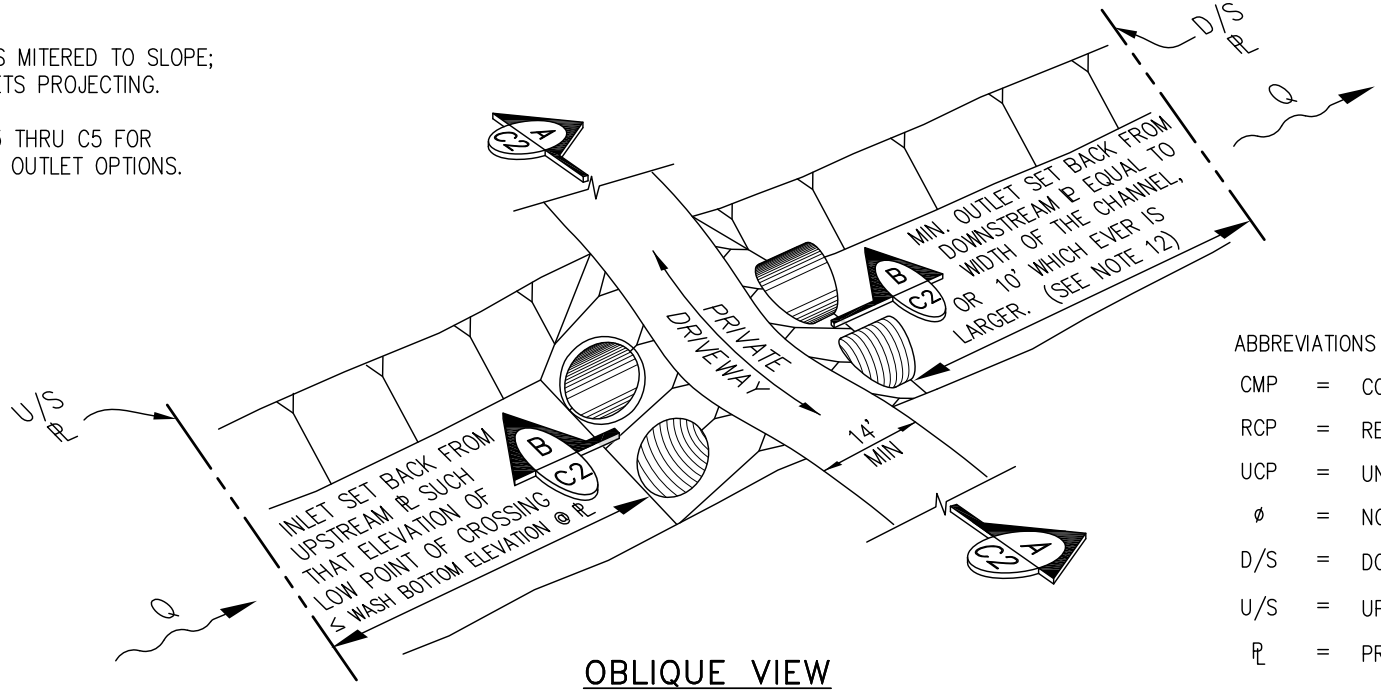
SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

Pima County Regional FLOOD CONTROL DISTRICT

THE SEAL of PIMA COUNTY ARIZONA

SHOWN:
CULVERT INLETS MITERED TO SLOPE;
CULVERT OUTLETS PROJECTING.

SEE SHEETS C3 THRU C5 FOR
OTHER INLET & OUTLET OPTIONS.



OBLIQUE VIEW

2–BARREL CROSSING SHOWN (SEE NOTE 4); CHOOSE CMP, RCP <u>OR</u> UCP;
<u>BOTH</u> CONCRETE PIPE & CMP SHOWN FOR ILLUSTRATION PURPOSES

ABBREVIATIONS THIS PAGE:

CMP	=	CORRUGATED METAL PIPE
RCP	=	REINFORCED CONCRETE PIPE
UCP	=	UNREINFORCED CONCRETE PIPE
ø	=	NOMINAL PIPE DIAMETER
D/S	=	DOWNSTREAM
U/S	=	UPSTREAM
℄	=	PROPERTY LINE

NOTES

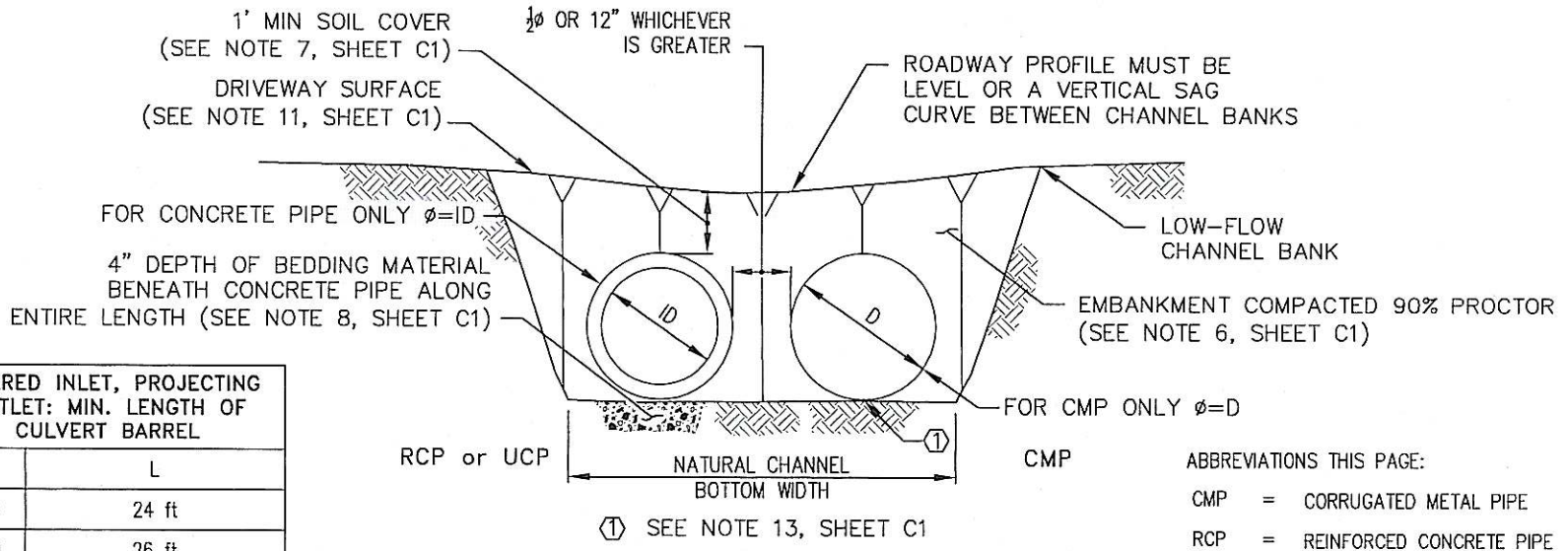
1. CORRUGATED METAL PIPE (CMP): GALVANIZED 16–GA MINIMUM 2 $\frac{2}{3}$" BY $\frac{1}{2}$" CORRUGATIONS HELICAL LOCK SEAM OR CONTINUOUSLY WELDED SEAM ONLY. 18" < ø < 42" INSTALLED PER ASTM A–798.
2. REINFORCED CONCRETE PIPE (RCP) SHALL BE: CLASS IV (18"), CLASS III (21", 24" or 27"), CLASS II (30") OR CLASS I (36" or 42"), ALL WALL A, B, OR C PER ASTM C–76 CLASS D BEDDING (SEE NOTE 8).
3. UNREINFORCED CONCRETE SEWER/CULVERT PIPE (UCP) PER ASTM C–14, CLASS 3 (18" or 21"), CLASS 2 (24", 27" or 30") OR CLASS 1 (36"), ALL WITH CLASS D BEDDING (SEE NOTE 8).
4. CULVERTS MUST OCCUPY ENTIRE BOTTOM WIDTH AND HEIGHT OF WASH, WITH ALLOWANCE FOR MINIMUM INTER–BARREL SPACING AND SOIL COVER. CULVERTS ALIGNED PARALLEL TO DIRECTION OF FLOW.
5. CHANNEL BOTTOM/BEDDING TO BE EXCAVATED TO ACCOMMODATE CONCRETE PIPE BELLS.
6. FILL UNDER HAUNCHES AND SURROUNDING THE PIPE TO BE PLACED ALTERNATELY ON BOTH SIDES OF THE PIPE IN 6" TO 8" COMPACTED LAYERS, 90% PROCTOR (MIN.) PER ASTM D–798 USING MECHANICAL OR HAND COMPACTION.
7. MINIMUM COVER REQUIREMENT MAY NOT BE ADEQUATE TO SUPPORT PASSAGE OF HEAVY CONSTRUCTION EQUIPMENT. IT IS OWNER'S RESPONSIBILITY TO COMPENSATE WITH ADDITIONAL TEMPORARY COVER.
8. MATERIAL FOR RCP OR UCP CLASS D BEDDING: CLEAN COURSE SAND (SEE NOTES 2 & 3).
9. MITER CULVERT INLET TO FILL SLOPE OR USE MANUFACTURED END SECTION OR OPTIONAL U/S HEADWALL (SHT C3).
10. CROSSING IS DESIGNED TO CROSS LOW–FLOW CHANNEL ONLY AND WILL BE OUTFLANKED BY INFREQUENT FLOOD EVENTS. OWNER IS ADVISED TO INSPECT CROSSING AFTER EACH FLOOD EVENT AND IMMEDIATELY REPAIR ALL DAMAGE.
11. DRIVEWAY SURFACE MAY BE UNIMPROVED OR IMPROVED. CHECK WITH LOCAL FIRE MARSHALL FOR SPECIFIC REQUIREMENTS.
12. CULVERT OUTLET TO INCORPORATE PLUNGE BASIN (SHT C4), CONCRETE HEADWALL WITH ℄ OFFSET (NOTE 3 ON SHT 3) OR RIPRAP APRON (SHT C5) UNLESS D/S PROPERTY OWNER COVENANTS ACCEPTANCE OF DOWNSTREAM EROSION.
13. CULVERT INVERT MAY BE PLACED NO MORE THAN THE SMALLER OF 6" OR $\frac{1}{4}$ø BELOW NATURAL WASH BOTTOM.
14. SEE SHEET C6 FOR TIRE RUBRAIL OPTION.

Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 – C1
ELEVATED DRIVEWAY WITH CULVERT CROSSING

SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

THE SEAL of PIMA COUNTY ARIZONA

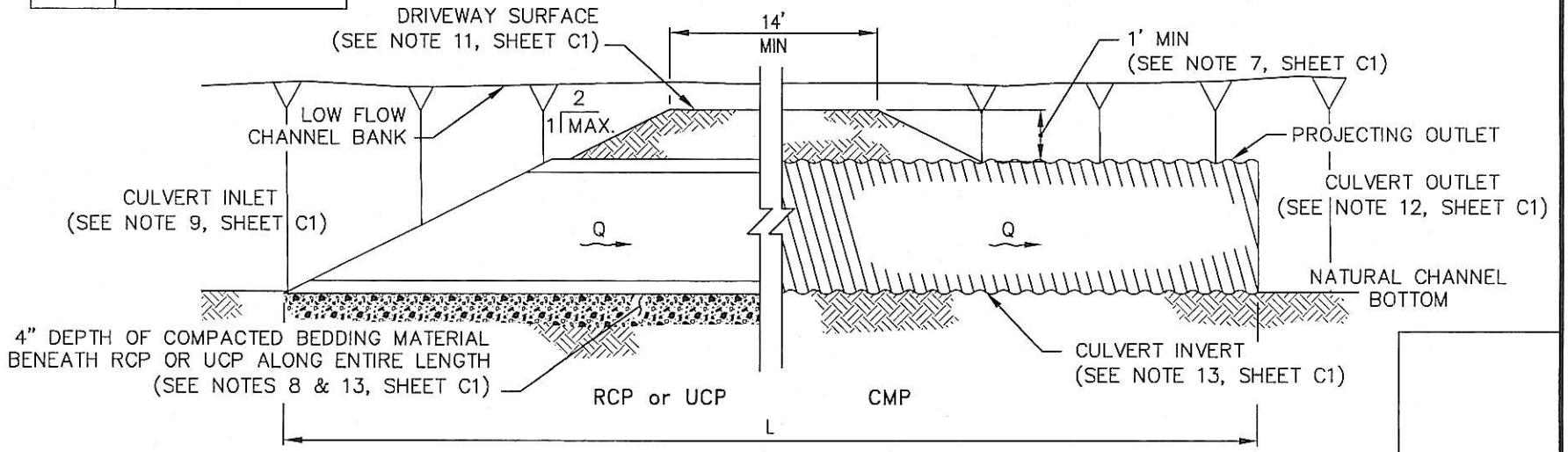


A SECTION
SCALE: N.T.S.

MITERED INLET, PROJECTING OUTLET: MIN. LENGTH OF CULVERT BARREL	
ø	L
18 in	24 ft
24 in	26 ft
30 in	28 ft
36 in	30 ft
42 in	32 ft

ABBREVIATIONS THIS PAGE:

CMP	=	CORRUGATED METAL PIPE
RCP	=	REINFORCED CONCRETE PIPE
UCP	=	UNREINFORCED CONCRETE PIPE
ø	=	NOMINAL PIPE DIAMETER
L	=	LENGTH OF CULVERT BARREL



B SECTION
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Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 – C2
ELEVATED DRIVEWAY WITH CULVERT CROSSING

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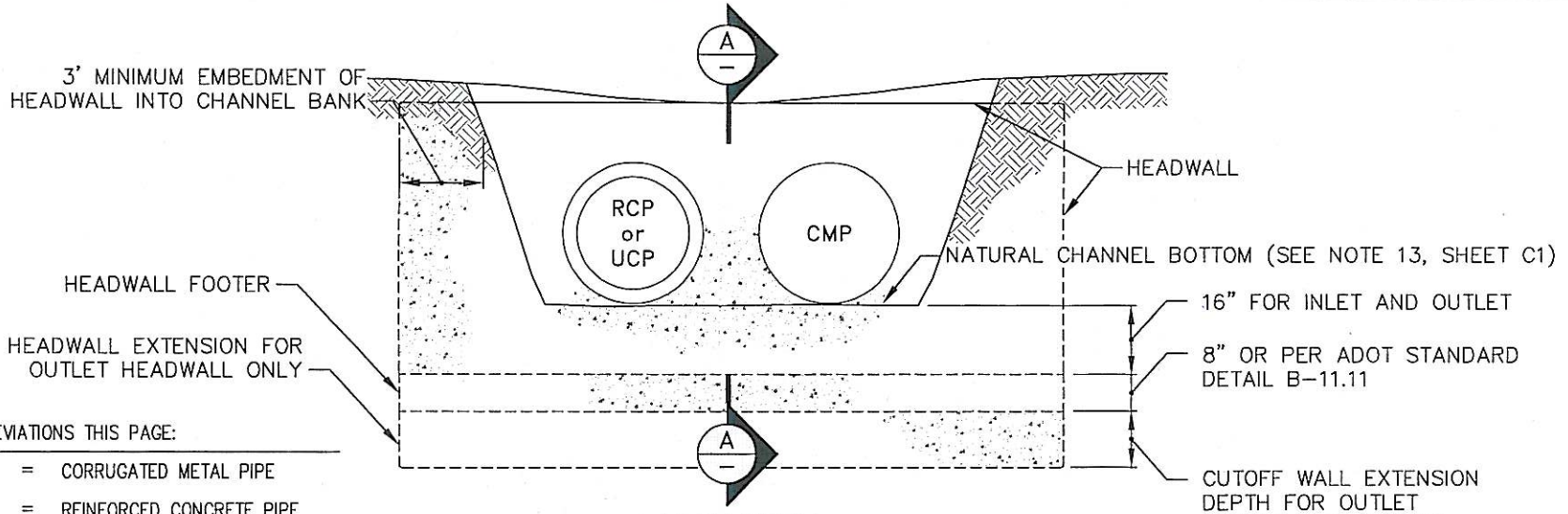
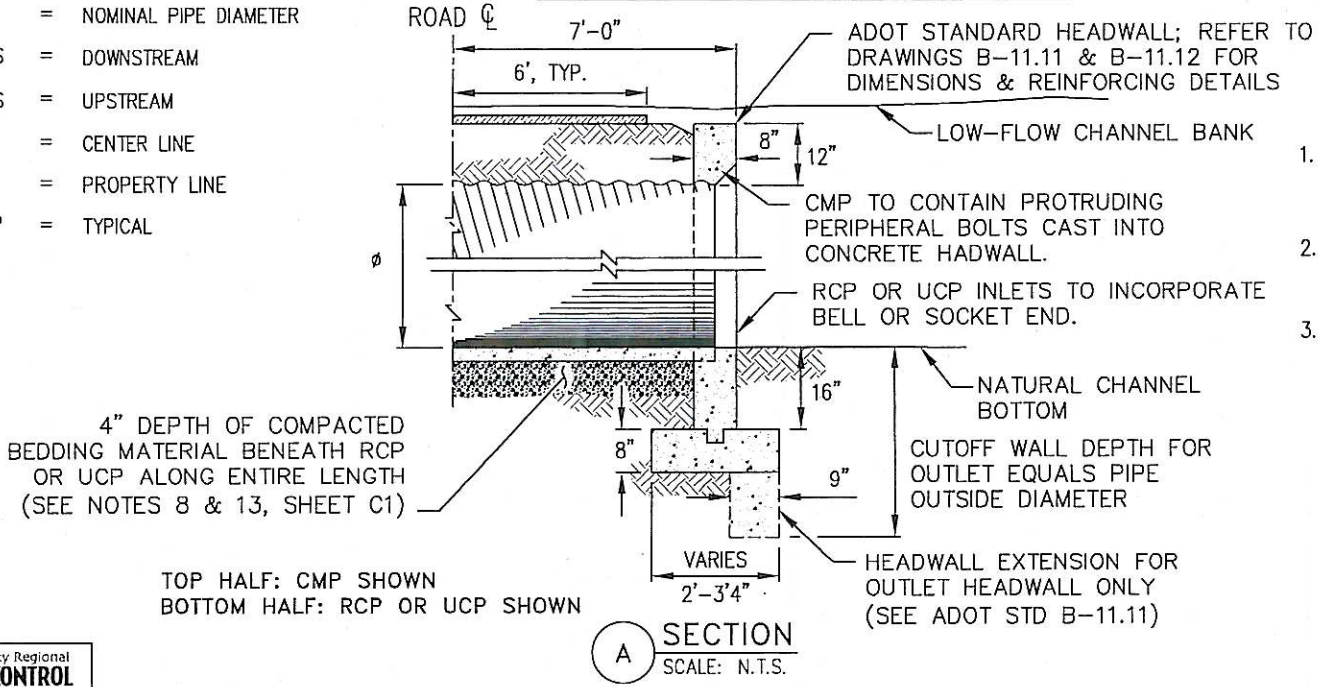


ELEVATION
FACE VIEW OF HEADWALL EMBEDMENT

ABBREVIATIONS THIS PAGE:

CMP	=	CORRUGATED METAL PIPE
RCP	=	REINFORCED CONCRETE PIPE
UCP	=	UNREINFORCED CONCRETE PIPE
ø	=	NOMINAL PIPE DIAMETER
D/S	=	DOWNSTREAM
U/S	=	UPSTREAM
℄	=	CENTER LINE
ℙ	=	PROPERTY LINE
TYP	=	TYPICAL



TOP HALF: CMP SHOWN
BOTTOM HALF: RCP OR UCP SHOWN

A SECTION
SCALE: N.T.S.

NOTE:

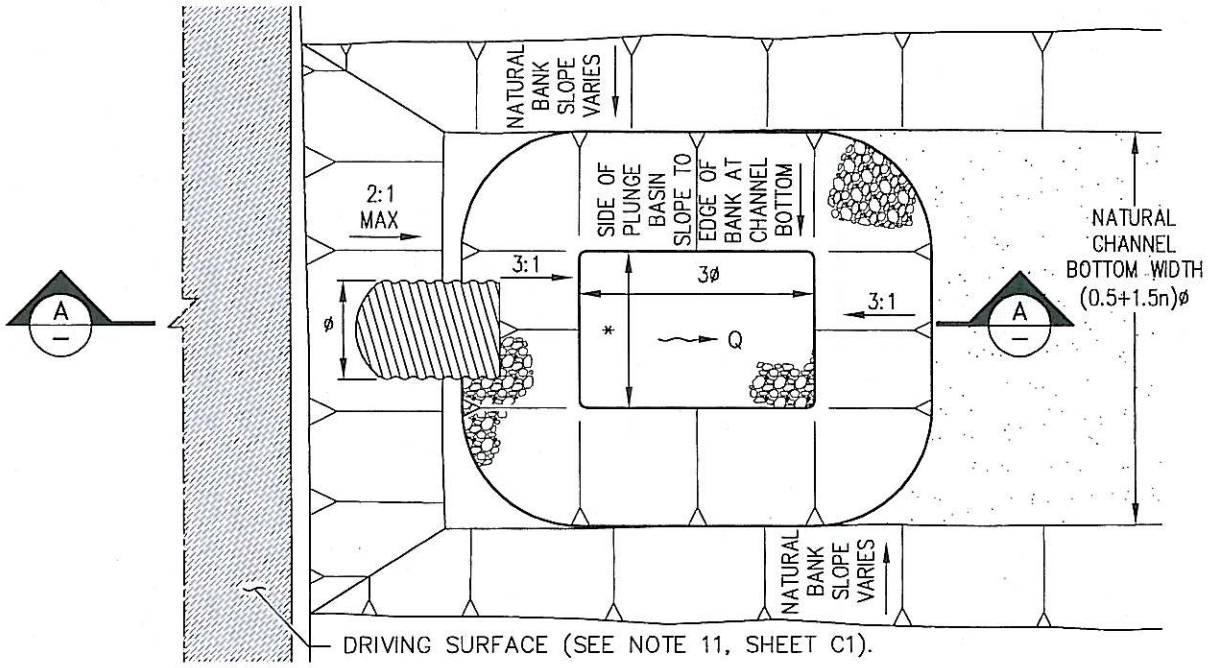
1. FOR CMP SEE NOTE 1, SHEET C-1; FOR RCP SEE NOTE 2, SHEET C-1. FOR UCP SEE NOTE 3, SHEET C-1.
2. ALL CONCRETE SHALL BE CLASS "B", f'c=2500 psi.
3. D/S HEADWALL TO BE OFFSET MIN 2ø FROM D/S ℙ UNLESS D/S OWNER COVENANTS ACCEPTANCE OF EROSION.

Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 – C3
ELEVATED DRIVEWAY WITH CULVERT CROSSING – HEADWALL INLET/OUTLET OPTION

SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

THE SEAL of PIMA COUNTY ARIZONA

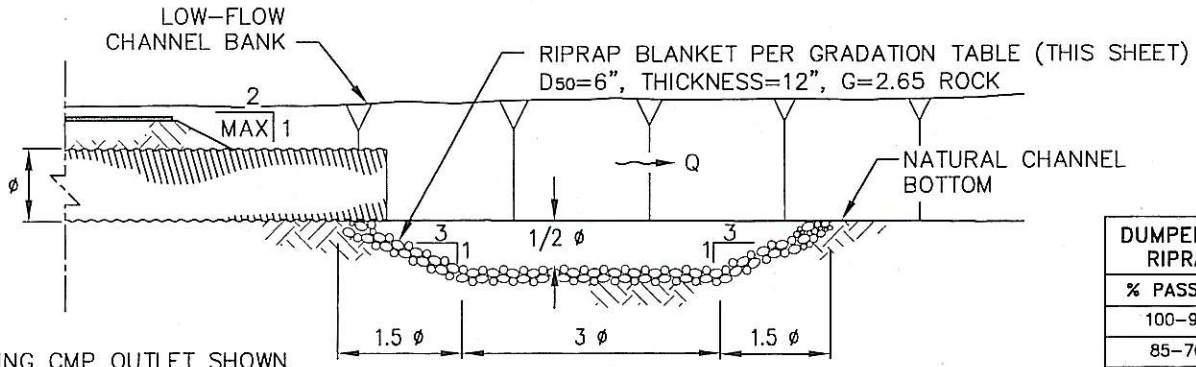


PLAN
OUTLET PLUNGE BASIN

* 2ø (SINGLE BARREL)
ø(n+1)+n-1 (n-BARREL n>1)

ABBREVIATIONS THIS PAGE:

CMP	=	CORRUGATED METAL PIPE
RCP	=	REINFORCED CONCRETE PIPE
UCP	=	UNREINFORCED CONCRETE PIPE
ø	=	NOMINAL PIPE DIAMETER
℄	=	CENTER LINE
n	=	NUMBER OF CULVERT BARRELS
BW	=	NATURAL CHANNEL BOTTOM WIDTH
D_{50}	=	MEDIAN ROCK DIAMETER, ft



PROJECTING CMP OUTLET SHOWN
PROJECTING RCP OR UCP OUTLET SIMILAR

A SECTION
SCALE: N.T.S.

NOTE:

FOR PLUNGE BASIN, RIPRAP MAY BE ANGULAR OR ROUNDED.

DUMPED/HAND-PLACED RIPRAP GRADATION	
% PASSING	SIZE
100-90	2.00 D_{50}
85-70	1.50 D_{50}
50-30	1.00 D_{50}
15-5	0.67 D_{50}
5-0	0.33 D_{50}

Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 - C4
ELEVATED DRIVEWAY WITH CULVERT CROSSING - PLUNGE BASIN OUTLET OPTION

SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

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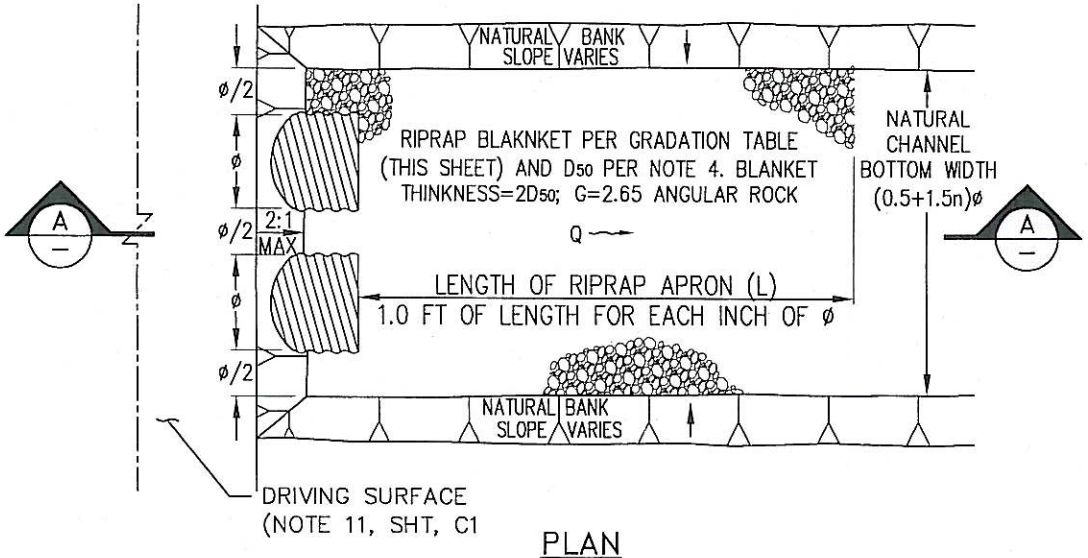
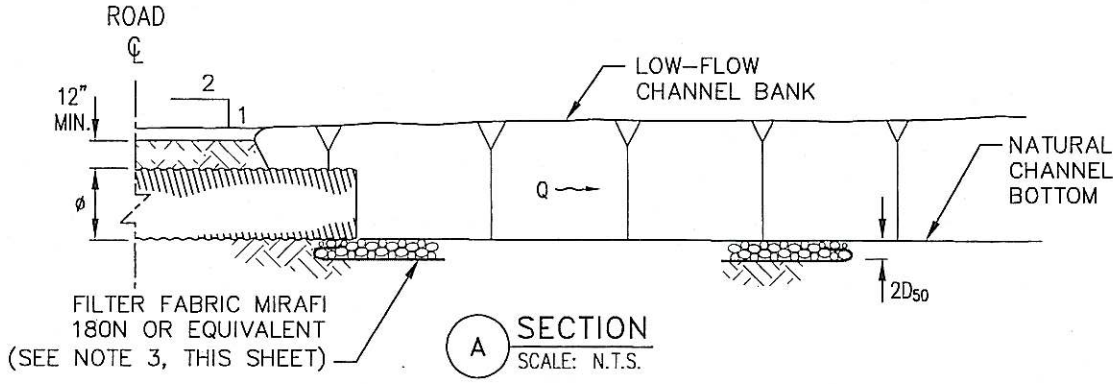


PLAN

RIPRAP SPREADING APRON

DUMPED RIPRAP GRADATION	
% PASSING	SIZE
100–90	2.00 D_{50}
85–70	1.50 D_{50}
50–30	1.00 D_{50}
15–5	0.67 D_{50}
5–0	0.33 D_{50}



ABBREVIATIONS THIS PAGE:

CMP	=	CORRUGATED METAL PIPE
RCP	=	REINFORCED CONCRETE PIPE
UCP	=	UNREINFORCED CONCRETE PIPE
ø	=	NOMINAL PIPE DIAMETER
℄	=	CENTER LINE
n	=	NUMBER OF BARRELS
S	=	NATURAL CHANNEL SLOPE ft/ft
D_{50}	=	MEDIAN ROCK DIAMETER, IN.
G	=	SPECIFIC GRAVITY OF RIPRAP

NOTES

1. RIPRAP APRON PROVIDES MINIMAL EROSION PROTECTION. OWNER MUST INSPECT OUTLET CHANNEL AFTER EACH STORM TO DETERMINE IF RIPRAP MUST BE REPLACED OR EXTENDED.
2. PROJECTIING CMP OUTLET SHOWN; PROJECTING RCP OR UCP ARE SIMILAR.
3. RIPRAP BLANKET IS TO BE DUG INTO CHANNEL BOTTOM; DIRECT PLACEMENT OF RIPRAP ON CHANNEL BOTTOM IS NOT ALLOWED
4. SEE TECH 027 POLICY FOR RIPRAP D_{50}

Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 – C5

ELEVATED DRIVEWAY WITH CULVERT CROSSING – RIPRAP APRON OUTLET OPTION

SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

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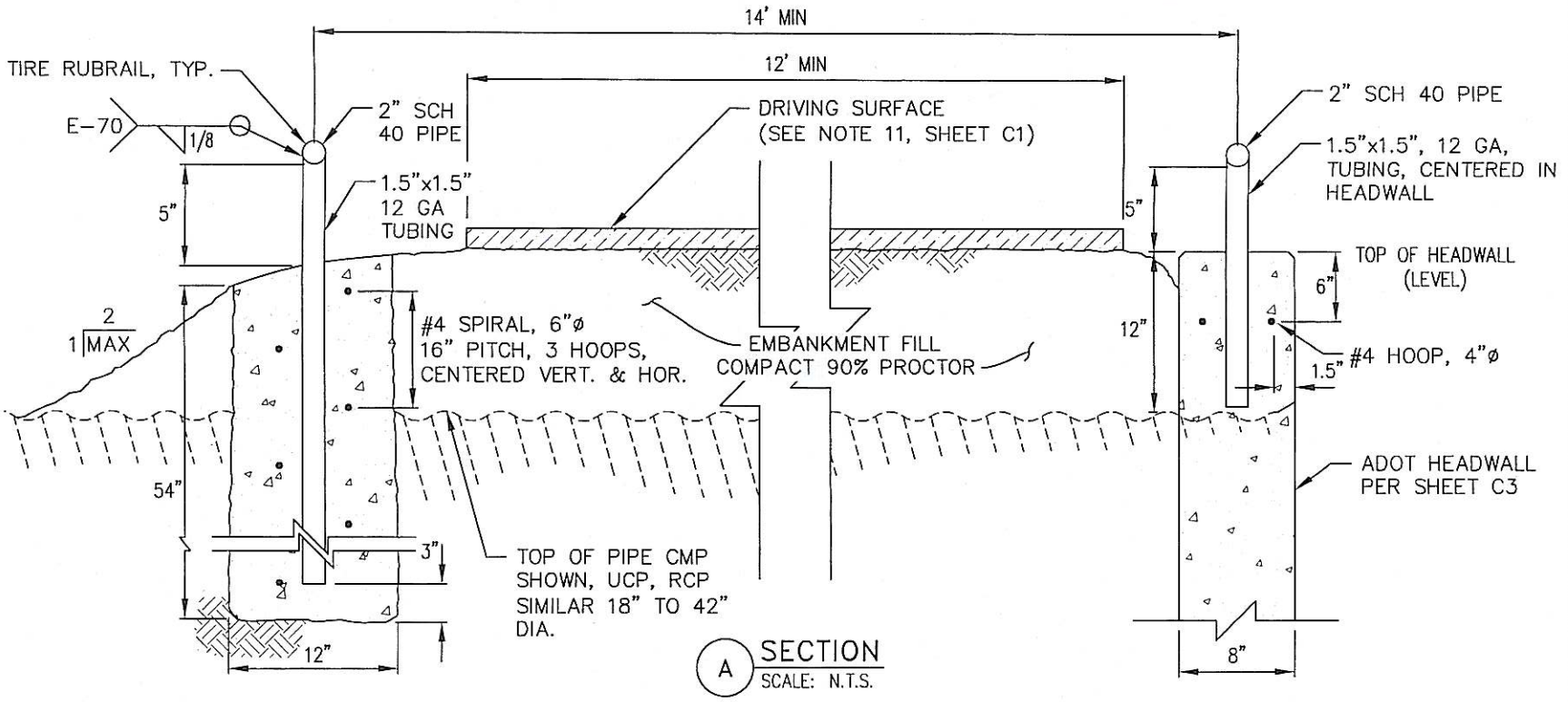

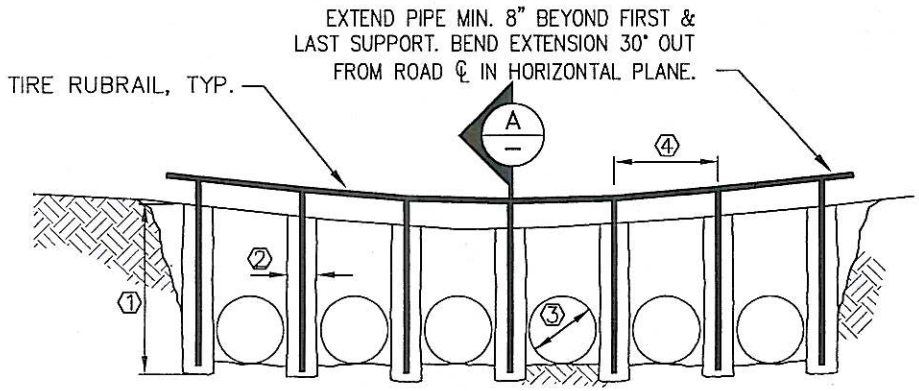

DIMENSION KEY
① 54"
② 12"
③ ø VARIES 18"–42"
④ CENTERED BETWEEN EACH PIPE

NOTES

1. DRAWING SHOWS TIRE RUBRAIL OPTION INCORPRATED INTO HEADWALL INLET, OUTLET OPTION (RIGHT HALF OF SECTION A) AND ALL OTHER INLET, OUTLET OPTIONS (LEFT HALF OF SECTION A)
2. ALL REBAR #4 SCH 40
3. CONCRETE f:=2500 psi TYPE B
4. PIPE ASTM A53 TUBE GRADE A
5. DESIGN BASED ON 4000 lb. VEHICLE AT 5 MPH IMPACTING RAIL AT 15° ANGLE.
6. CROSSING TO BE POSTED 5 MPH

ELEVATION
INLET, OUTLET OPTIONS OTHER THAN HEADWALL SHOWN

Pima County Regional FLOOD CONTROL DISTRICT

FIGURE 027 – C6
ELEVATED DRIVEWAY WITH CULVERT CROSSING – TIRE RUBRAIL OPTION

SCALE: N.T.S. DRAWN BY: sak DATE: Apr 2011

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