Final Drainage Report
100% Submittal

Skyline Regional Park Phase I
Watson Road
Buckeye, Arizona

Prepared for:
City of Buckeye
530 E. Monroe Ave.
Buckeye, Arizona 85326

Registered Professional Engineer (Civil)
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Melanie A.
Wadsworth
DATE SIGNED 02/05/15
ARIZONA U.S.A.
Exp. 03-31-2016

Prepared by:
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February 2015
091131022

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APPROVAL

DISCLAIMER:
THE CITY APPROVES THIS REPORT FOR CONCEPT ONLY AND ACCEPTS NO LIABILITY FOR ERRORS AND OMMISIONS.

BY_____
CITY OF BUCKEYE ENGINEER DATE

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Site Location 1
1.2 Project Description 1
2.0 EXISTING DRAINAGE CONDITIONS AND CHARACTERISTICS 3
2.1 Existing Drainage Conditions 3
2.2 FEMA FIRM Designation 3
3.0 PROPOSED DRAINAGE PLAN 5
3.1 Proposed On-Site Drainage Plan 5
3.1.1 404 Permit/Jurisdictional Waters 5
3.1.2 Floodplain Use Permit 5
3.2 Proposed Off-Site Drainage Plan 5
3.2.1 Low Flow Crossing 5
3.2.2 Culvert Crossings 6
4.0 DATA ANALYSIS METHODS 8
4.1 Procedures, Parameter selection, and Assumptions 8
5.0 EMERGENCY ACCESS 9
6.0 SUMMARY AND CONCLUSIONS 10
7.0 REFERENCES 11

TABLE OF FIGURES

FIGURE 1: LOCATION MAP 2
FIGURE 2: FEMA FIRM 4
FIGURE 3: ON-SITE DRAINAGE MAP 7

APPENDICES

APPENDIX A – HYDROLOGY DOCUMENTATION
APPENDIX B – FLOODPLAIN USE PERMIT
APPENDIX C – RATIONAL METHOD CALCULATIONS
APPENDIX D – LOW FLOW CROSSING CALCULATIONS
APPENDIX E – CULVERT CALCULATIONS
APPENDIX F – SCOUR AND RIPRAP CALCULATIONS

1.0 INTRODUCTION

This is the Final Drainage Report to accompany the 100% plan submittal for the proposed Skyline Regional Park Phase I improvements. These improvements were identified in the Skyline Regional Park Master Plan, and further defined according to Task Order #1 of On-Call Engineering Services Contract 2011-120. The improvements also include the new Skyline Park Access Road (extension of Watson Road).

The drainage improvements outlined in this report comply with the drainage criteria from the City of Buckeye Storm Water Drainage System Design Manual #500, August 2007 and the Street Planning and Design Criteria Manual Section 6-3, December 2012.

1.1 Site Location

The park is located west of Verrado, east of the future Tartesso Development, and south of the Maricopa County Parks and Recreation Department's White Tanks Mountain Regional Park. Phase I park improvements are concentrated within 27 acres in the NW ¼ of Section 34 and the SW ¼ of Section 27, T2N R3W as well as the NE ¼ of Section 3 and the NW ¼ of Section 4, T1N R3W. Access road improvements are located within Sections 3, 4 and 34, along the extension of Watson Road, from McDowell Road north to the park boundary. A location map is included as **Figure 1**.

1.2 Project Description

The project consists of paving of a 2-lane, uncurbed access road across a new alignment; a 2-lane, uncurbed park road; and paved appurtenances such as parking spaces and a widened section for a future gatehouse. Designated camping and other recreation areas will be graded within the park site. No inhabited buildings or finished floor elevations are established within this project. The general slope of the land ranges from 3% to 5%.

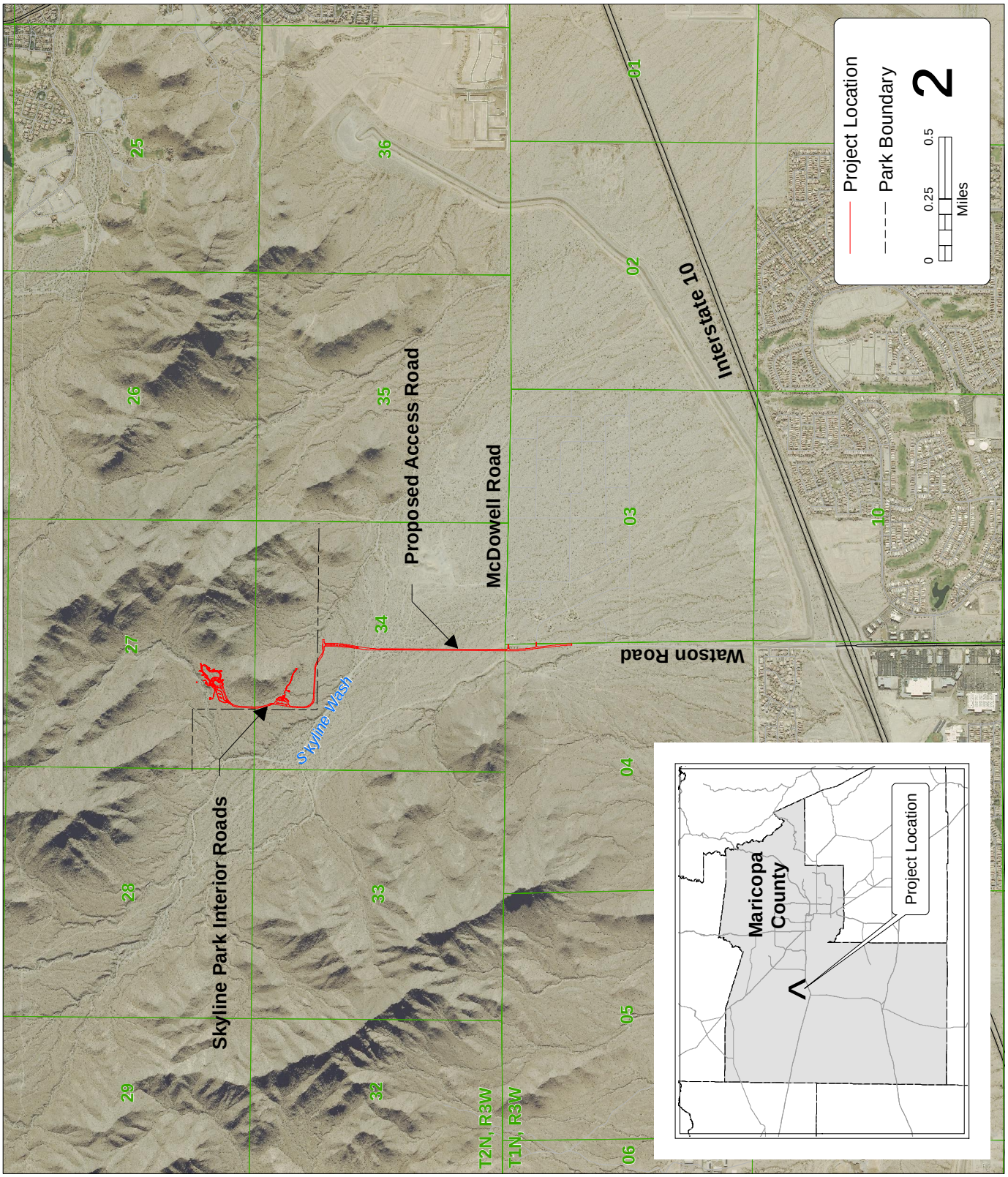


Figure 1: Location Map

2.0 EXISTING DRAINAGE CONDITIONS AND CHARACTERISTICS

2.1 Existing Drainage Conditions

In existing conditions, runoff is conveyed through the project site in small, distributary washes as sheet flow. In the southern portion of the site along the proposed Watson Road alignment, runoff flows southeast in the Skyline Wash alluvial floodplain. More information on the floodplain is provided in **Section 2.2**. North of the proposed Watson Road alignment, the runoff will sheet flow south and west from the mountains. Runoff from the mountains east of the project site is conveyed south in a natural wash.

2.2 FEMA FIRM Designation

The Federal Emergency Management Agency (FEMA) effective FIRM panel for this area is map number 04013C2110L, dated October 16, 2013. A FIRMette copy of the map panel showing the disturbed area of Phase I improvements and access road is attached as **Figure 2**. The significant drainage feature crossing the access road is Skyline Wash. At this location, Skyline Wash is designated as Zone A, (active alluvial fan flooding). It is further denoted as an administrative floodway (subject to local regulations).

Zone "A" is defined by FEMA as:

> Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.

The limit of the detailed study for Skyline Wash is located at the apex of the Skyline Wash alluvial fan, approximately 700 feet upstream of the road crossing. The 100-year flow at that location is 4346 cfs. The depth of flow at the floodplain study limits for the 100-year flood is approximately 2.7 feet and the flow velocity is approximately 9.7 fps. See **Appendix A** for documentation.

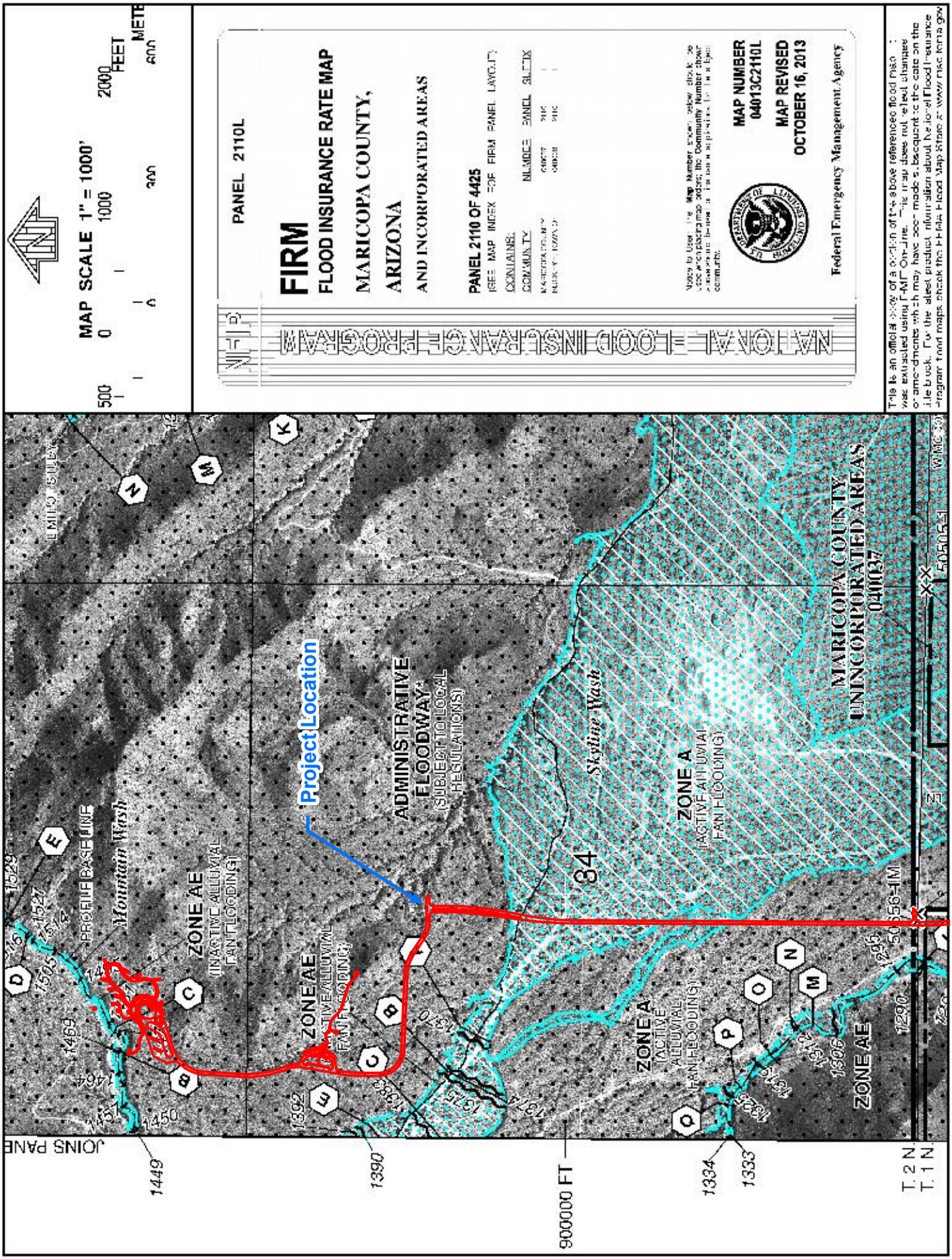


Figure 2: FEMA FIRM

3.0 PROPOSED DRAINAGE PLAN

3.1 Proposed On-Site Drainage Plan

Watson Road and the Skyline Park interior roads will not have curb or gutter, allowing runoff to sheet flow off the roads. The proposed Watson Road cross section will be graded to slope to the east (one-way cross slope) in the location of the Skyline Wash floodplain to maintain existing drainage patterns. There are no proposed or existing retention or detention basins or drywells located within the project limits.

3.1.1 404 Permit/Jurisdictional Waters

The original Section 404 Nationwide Permit for the project has expired, therefore a new Nationwide Permit Application, preliminary jurisdictional delineation, and pre-construction notification will be prepared. A Preliminary Jurisdictional Delineation was prepared by Kimley-Horn and there are 1.94 acres of potentially jurisdictional waters of the U.S. (WOUS) in the project area. Based on impact calculations, it appears that impacts to WOUS will only be from road improvements and each crossing (viewed as a single project) will be less than 0.10 acres. Therefore, the project will qualify for a non-notify Nationwide Permit (NWP) No. 14 Linear Transportation Projects. The total impact to WOUS will be 0.31 acres. Compliance documentation will be prepared to document compliance with the conditions of NWP 14.

3.1.2 Floodplain Use Permit

Because Watson Road crosses over an administrative floodplain, a floodplain use permit was applied for and granted by the Flood Control District of Maricopa County on May 2, 2014. The floodplain use permit may be declared null and void if "substantial progress of development" does not occur within one year of approval. See **Appendix B** for a copy of the floodplain use permit.

3.2 Proposed Off-Site Drainage Plan

Off-site runoff is conveyed across the proposed roadways either with low flow crossings or culvert crossings. These conditions are described below. A summary of the proposed culverts is provided in **Table 3.1** and an Onsite Drainage Map is provided as **Figure 3**.

3.2.1 Low Flow Crossing

The Skyline Wash alluvial fan is defined as a long area of shallow or distributary flow. The construction of culverts to pass the flow is impractical, so 100-year flows will be allowed to pass over the roadway. The low water crossing will have AC pavement erosion protection.

The Skyline Wash alluvial fan crosses the access road at a skew angle of approximately 32 degrees. The elevation of the road over the fan surface will vary, being higher on the north end and lower on the south end. Maximum depth of flow for the 100-year flood is limited to 6 inches over the roadway. Maximum velocity of the flow over the roadway is estimated to be between 5

and 6 fps, which is in the low danger zone according to Maricopa County Drainage Standard 6.2.2, Figure 6.1. An asphalt cut-off wall is provided for scour protection.

Due to the length of the access road crossing of the Skyline Wash alluvial fan, 24-inch RGRCP culverts are provided in several locations to pass nuisance flow. This will allow for a smoother roadway profile.

3.2.2 Culvert Crossings

Within the park, runoff from the mountain is captured in an adjacent wash that crosses the proposed Stargazing Trail and the Skyline Park Interior Road. This wash will be conveyed under the trail through a 6-foot x 6-foot concrete box culvert and under the road through a 10-foot x 9-foot concrete box culvert. The wash is very deeply incised, and the box culvert crossing the park road has been oversized to facilitate future trail use. The wash is a potential WOUS and must comply with NWP 14. See **Section 3.1.1** for more details on WOUS.

Table 3.1 – Summary of Proposed Culverts

Culvert ID	Culvert Size	Culvert Type	Roadway Station	Q_{10} (cfs)
1	18”	RGRCP	Watson 93+46	NF
2	24”	RGRCP	Watson 100+70	NF
3	24”	RGRCP	Watson 115+84	NF
4	24”	RGRCP	Watson 116+20	NF
5	2-24”	RGRCP	Watson 118+00	NF
6	2-24”	RGRCP	Watson 121+26	NF
7	24”	RGRCP	Watson 131+71	NF
8	24”	RGRCP	Watson 132+18	NF
9	24”	RGRCP	Watson 132+83	NF
10	24”	RGRCP	Watson 133+50	NF
11	10’×9’	RCBC	Skyline Park 20+96	66
12	2-24”	RGRCP	Skyline Park 23+34	4
13	6’×6’	RCBC	Stargazing Trail 10+82	64
14	24”	RGRCP	Skyline Park 43+64	7

Note:
NF represents nuisance flows. Q_{10} was not determined for culverts in the Skyline Wash alluvial fan area.

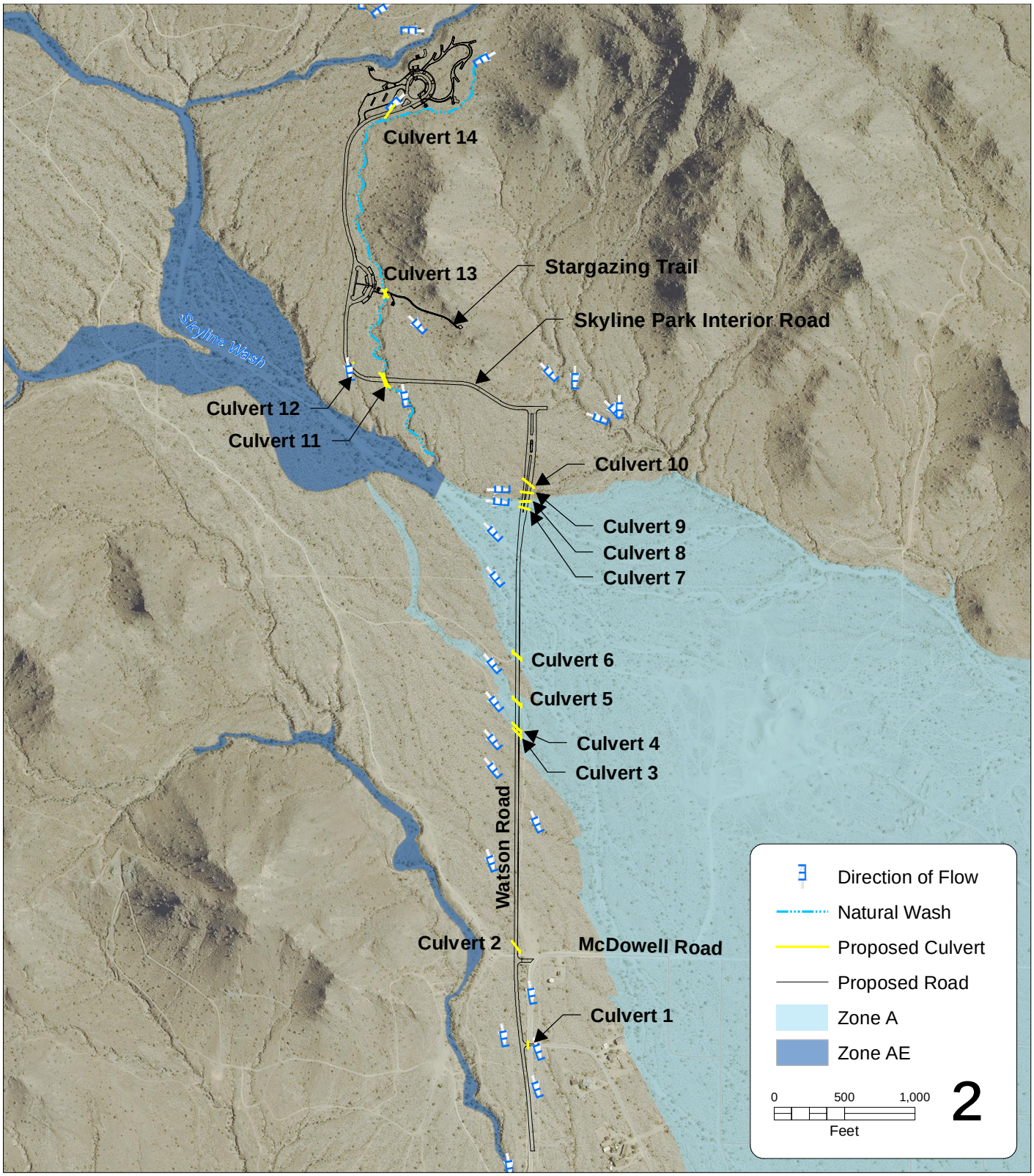


Figure 3: On-Site Drainage Map

4.0 DATA ANALYSIS METHODS

4.1 Procedures, Parameter selection, and Assumptions

Drainage design standards for the project are governed by;

- City of Buckeye Engineering Design Standards
- Maricopa County Drainage Policies and Standards, 2007
- Drainage Design Manual for Maricopa County, Arizona, Hydrology 2013
- Drainage Design Manual for Maricopa County, Arizona, Hydraulics 2013

A detailed analysis was not conducted for Culverts 1 through 10. Culverts 2 through 10 are used to convey nuisance flow across Watson Road and were not sized for a specific storm event. Culvert 1 crosses a driveway adjacent to Watson Road. All Watson Road crossings are 24-inch RGRCP culverts and the driveway crossing is an 18-inch RGRCP culvert.

Existing 10-year runoff contributing to culverts 11 through 14 were calculated using the Rational Method. Drainage areas and time of concentration flow paths were delineated using one-foot project topography, supplemented with topography from the US Geologic Society Quadrangle Maps. The land was classified as Passive Open Space (includes mountain preserves and washes), which uses an associated runoff coefficient of 0.55 for a 10-year storm event. The Flood Control District of Maricopa County's DDMSW software was used to perform the rational calculations. Rational method calculations are provided in **Appendix C**.

To analyze the flow depths across the skewed roadway section, three different flow sections were analyzed using FlowMaster normal depth calculations. Each flow section was drawn perpendicular to the flow with the full 100-year discharge. The roadway is at an elevation in each cross section that shows the depth of flow over the road is approximately 6 inches or less. See **Appendix D** for FlowMaster cross sections with the roadway location indicated on each cross section. Note that there was not enough project topography to extend Cross Section C across the entire floodplain so the depth of flow is conservative.

Culverts 11 to 14 were analyzed for the existing 10-year runoff using HY-8. Culvert 13 was sized with a minimum height of 6 ft for ease of maintenance. Culvert 11 has been oversized to facilitate future trail use. See **Appendix E** for HY-8 results.

Since a detailed analysis was not conducted for culverts 1 through 10, riprap protection was selected with a D_{50} of 12-in based upon engineering judgment. Grouted riprap protection for culverts 11 through 14 were sized for the 10-year storm event using FCDMC standards, including protection to the 10-year scour depth. The depth of the asphalt cut-off wall for the low flow crossing was compared to 100-year scour depths based on FCDMC scour calculations for general and bedform scour conditions. The draft geotechnical report was used to obtain information on D_{50} in the vicinity of the low flow crossing. See **Appendix F** for scour and riprap sizing calculations. See **Appendix G** for 100% design plans.

5.0 EMERGENCY ACCESS

The park access road, which is an extension of Watson Road, crosses the Skyline Wash FEMA floodplain with low-flow crossings, allowing the 100-year storm event to flow over the roadway (see **Section 4.1** for details on the low flow crossing calculations). The following measures should be taken to prevent motorists from crossing the roadway during flooding events.

Appropriate signage should be posted to warn drivers of the danger of crossing the road when flooding is occurring, stating "Do Not Cross When Flooded". Additionally, permanently mounted signs with "Flooded – Turn Around, Do Not Drown" should also be posted with hinges and latches. When flooding occurs staff can unlatch the sign to display the warning. When the flooding is over or mitigated, the signs will be latched in the closed position.

Additionally, park regulations should also warn campers to have sufficient water in case flooding causes an extended stay in the park. For example, the park camping brochure can state, "Campers, please ensure that your water tanks are completely full when utilizing the campground, so in the unlikely event of a rain storm that closes the roadways due to flooding, you will have enough fresh water to extend your stay."

6.0 SUMMARY AND CONCLUSIONS

Based on the analysis presented in this drainage report, the following summary is presented:

- Watson Road and the Skyline Park interior roads will not have curb or gutter, allowing runoff to sheet flow off the roads. The proposed Watson Road cross section will be graded to slope to the east (one-way cross slope) in the location of the Skyline Wash floodplain to maintain existing drainage patterns.
- A preliminary jurisdictional delineation has been prepared. The project will qualify for a non-notify Nationwide Permit (NWP) No. 14 Linear Transportation Projects.
- Watson Road crosses the Skyline Wash floodplain, which has been designated by FEMA as Zone A. A floodplain use permit was granted by the Flood Control District of Maricopa County on May 2, 2014 for the Skyline Wash low flow crossing.
- The maximum depth of flow across Watson Road at the low flow crossing during the 100-year event is 6 inches. Culverts are provided across Watson Road to help convey nuisance flows under the road.
- Four culvert crossings within the park were sized to convey the 10-year storm event under interior roads. The 10-year flows were calculated using the Rational Method.
- Riprap protection was provided at each culvert. Riprap at culverts crossing Watson Road was selected based on engineering judgment and riprap at culverts within the park was sized for the 10-year storm event.
- All drainage design calculations conform to the City of Buckeye and Maricopa standards.
- A flood warning plan is outlined for the low flow crossing of Watson Road, including warning signs and other steps to notify campers of the potential flood dangers.

7.0 REFERENCES

1. City of Buckeye. *DM 500 City of Buckeye Storm Water Drainage System Manual*, August 2007.
2. Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Arizona – Hydrology*, August 2013.
3. Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Arizona – Hydraulics*, August 2013.
4. Flood Control District of Maricopa County, *Technical Data Notebook for Skyline Wash and Tributaries, Floodplain Delineation Study*, prepared by DEI Professional Services, revised July 2000.
5. Federal Emergency Management Agency, *Flood Insurance Rate Map of Maricopa County, Arizona and Incorporated Areas*, Map Number 04013C2110L, October 16, 2013.
6. Federal Emergency Management Agency, *Flood Insurance Study of Maricopa County, Arizona and Incorporated Areas*, October 16, 2013.
7. Speedie and Associates, *Report on Geotechnical Investigation*, July 25, 2015
8. U.S. Department of Transportation Federal Highway Administration, *Hydraulic Design of Highway Culverts Hydraulic Design Series No. 5*. September, 1985.

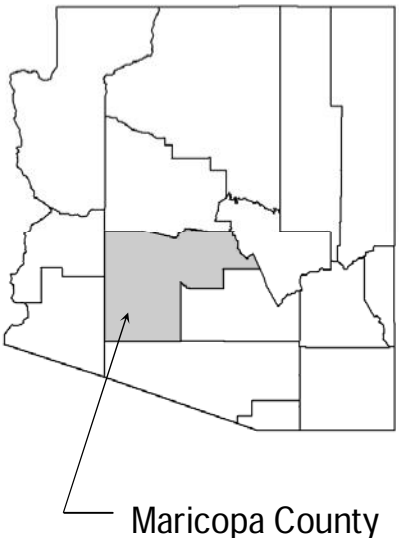
APPENDIX A – HYDROLOGY DOCUMENTATION

FLOOD INSURANCE STUDY

VOLUME 1 OF 23

MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
AVONDALE, CITY OF	040038
BUCKEYE, TOWN OF	040039
CAREFREE, TOWN OF	040126
CAVE CREEK, TOWN OF	040129
CHANDLER, CITY OF	040040
EL MIRAGE, CITY OF	040041
FOUNTAIN HILLS, TOWN OF	040135
GILA BEND, TOWN OF	040043
GILBERT, TOWN OF	040044
GLENDALE, CITY OF	040045
GOODYEAR, CITY OF	040046
GUADALUPE, TOWN OF	040111
LITCHFIELD PARK, CITY OF	040128
MARICOPA COUNTY (UNINCORPORATED AREAS)	040037
MESA, CITY OF	040048
PARADISE VALLEY, TOWN OF	040049
PEORIA, CITY OF	040050
PHOENIX, CITY OF	040051
QUEEN CREEK, TOWN OF	040132
SCOTTSDALE, CITY OF	045012
SURPRISE, CITY OF	040053
TEMPE, CITY OF	040054
TOLLESON, CITY OF	040055
WICKENBURG, TOWN OF	040056
YOUNGTOWN, TOWN OF	040057



REVISED: OCTOBER 16, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
04013CV001B

Table 3. Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (Sq. Miles)	PEAK DISCHARGES (cfs) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
Skunk Creek Tributary 27.161					
At confluence with Skunk Creek	N/A	--[1]	--[1]	2,255	--[1]
Skunk Tank Wash					
At confluence with Skunk Creek	4.8	--[1]	--[1]	5,260	--[1]
At Irvine Road	1.4	--[1]	--[1]	1,880	--[1]
At Desert Hills Drive	1	--[1]	--[1]	1,420	--[1]
Skyline Wash					
At apex of Skyline Wash Alluvial Fan	3.93	--[1]	--[1]	4,346	--[1]
Upstream of confluence with Pyrite Wash	2.75	--[1]	--[1]	3,344	--[1]
Upstream of confluence with Mountain Wash	1.92	--[1]	--[1]	2,502	--[1]
At a point approximately 4,450 feet upstream of the confluence with Pyrite Wash	1.79	--[1]	--[1]	2,410	--[1]
Upstream of confluence with Granite Falls Wash	0.73	--[1]	--[1]	1,443	--[1]
Sols Wash					
At confluence with Hassayampa River	147.2	7,019	12,453	15,045	20,836
Upstream of confluence of Casandro Wash	145.5	6,758	11,964	14,459	20,005
Upstream of confluence of Hospital Wash	145.1	6,725	11,927	14,413	19,986
Upstream of confluence of Flying E Wash	134.8	5,784	10,433	12,945	18,691
At railroad bridge at Railroad Milepost 36	119.3	4,795	9,767	12,244	17,749
At Maricopa - Yavapai County Boundary	86.7	3,696	7,504	9,419	13,760
Sols Wash Tributary AH2					
At Sols Wash	10.27	--[1]	--[1]	6,031	--[1]

--[1] Data Not Computed
--[2] Data Not Available

TECHNICAL DATA NOTEBOOK
for
SKYLINE WASH AND TRIBUTARIES FLOODPLAIN DELINEATION STUDY
FCD 96-08

NOTEBOOK 1 of 2

November 4, 1997
Revised July 24, 2000

Prepared for:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Prepared by:

DEI PROFESSIONAL SERVICES
6225 N. 24th Street, Suite 200 Phoenix, AZ 85016 (602) 954-0038

In Association with:

HOSKIN ENGINEERING CONSULTANTS, INC.
323 W. Roosevelt Street, Suite 200 Phoenix, AZ 85003 (602) 252-8384

cross section identifier as well as the peak 100-year, 6-hour or 100-year, 24-hour discharge as applicable.

Reaches for the riverine portion of Skyline Wash are broken out based on changes in discharge and new river names are given to junctions of washes with Skyline Wash. The detailed delineation portion of Skyline Wash begins at the apex of the Skyline Wash at river mile 1.80 above the fan confluence with the ponding area behind Buckeye F.R.S. #3.

Tributary washes to Skyline Wash are as follows:

Wagon Wash,
Pyrite Wash,
Granite Falls Wash,
and Mountain Wash.

Prospect Wash is a separate delineation that ends in the ponding area of Buckeye F.R.S. #3 and the Rattler Wash delineation ends at the confluence with the alluvial fan portion of Skyline Wash. Refer to the overall site map on the following page for the location of these washes and to the half size work maps for detailed information.

RAS Plan: SkylineRiver	Reach	River Sta	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Top Width	Hydr Depth C	Froude # XS	Sta W.S. Lft	Sta W.S. Rgt
Skyline	s3	2.17	3344.00	1395.79	1395.79	8.91	620.55	2.62	0.62	9397.44	10017.99
Skyline	s3	2.17	3344.00	1395.81	1395.81	8.78	620.55	2.64	0.61	9397.44	10017.99
Skyline	s4	2.12	4346.00	1390.58	1390.58	9.68	507.47	2.61	0.72	9685.70	10193.17
Skyline	s4	2.12	4346.00	1390.61	1390.61	9.54	506.83	2.63	0.71	9686.30	10193.13
Skyline	s4	2.08	4346.00	1386.41	1386.41	9.20	559.17	1.37	0.92	9678.75	10237.91
Skyline	s4	2.08	4346.00	1386.41	1386.41	9.18	559.16	1.38	0.92	9678.75	10237.91
Skyline	s4	2.01	4346.00	1380.21	1380.21	10.17	429.77	2.88	0.73	9977.59	10407.35
Skyline	s4	2.01	4346.00	1380.24	1380.24	9.96	429.76	2.92	0.71	9977.59	10407.35
Skyline	s4	1.94	4346.00	1372.03	1372.03	9.15	537.69	1.84	0.83	9934.93	10472.62
Skyline	s4	1.94	4346.00	1372.03	1372.03	9.14	537.69	1.84	0.83	9934.93	10472.62
Skyline	s4	1.87	4346.00	1367.38	1367.38	10.54	224.08	3.58	0.80	9878.21	10102.29
Skyline	s4	1.87	4346.00	1367.40	1367.40	10.44	224.08	3.61	0.79	9878.21	10102.29
Skyline	s4	1.80	4346.00	1360.81	1360.81	9.69	183.11	2.96	0.96	9908.93	10092.04
Skyline	s4	1.80	4346.00	1360.83	1360.83	9.63	183.11	2.98	0.95	9908.93	10092.04
Granite Falls	g1	0.39	1138.00	1606.68	1606.68	9.05	123.88	2.41	0.80	9893.31	10017.19
Granite Falls	g1	0.39	1138.00	1606.68	1606.68	8.99	123.88	2.41	0.79	9893.31	10017.19
Granite Falls	g1	0.30	1138.00	1594.69	1594.69	11.66	62.11	4.29	0.78	9965.49	10027.60
Granite Falls	g1	0.30	1138.00	1594.81	1594.81	11.12	62.11	4.40	0.73	9965.49	10027.60
Granite Falls	g1	0.28	1138.00	1573.22	1573.22	10.92	43.83	4.37	0.88	9966.96	10010.79
Granite Falls	g1	0.28	1138.00	1573.28	1573.28	10.72	43.83	4.43	0.85	9966.96	10010.79
Granite Falls	g1	0.24	1138.00	1566.35	1566.35	9.24	61.77	2.89	0.94	9980.00	10041.77
Granite Falls	g1	0.24	1138.00	1566.40	1566.40	9.07	61.77	2.94	0.92	9980.00	10041.77
Granite Falls	g1	0.19	1138.00	1560.01	1560.01	6.88	97.05	3.80	0.48	9914.96	10012.01
Granite Falls	g1	0.19	1138.00	1560.01	1560.01	6.88	97.05	3.80	0.48	9914.96	10012.01

APPENDIX B – FLOODPLAIN USE PERMIT

Flood Control District
of Maricopa County

Board of Directors
Denny Barney, District 1
Steve Chucri, District 2
Andrew Kunasek, District 3
Clint L. Hickman, District 4
Mary Rose Wilcox, District 5

www.fcd.maricopa.gov

2801 West Durango Street
Phoenix, Arizona 85009
Phone: 602-506-1501
Fax: 602-506-4601
TT: 602-505-5897

May 6, 2014

Mr. Stephen Cleveland
Town Manager
City of Buckeye
530 East Monroe Avenue
Buckeye, AZ 85326

SUBJECT: FCP2014033 (Floodplain Use Permit for Skyline Regional Park Phase I)

Dear Mr. Cleveland:

Enclosed is a copy of the Floodplain Use Permit that was granted for the subject request. We appreciate your continued cooperation in maintaining both the City's and the District's good standing as participants in the NFIP.

Please feel free to contact me at (602) 506-4779 with any questions or if I can be of any further assistance.

Sincerely,

Lynn M. Thomas

Lynn M. Thomas, P.E., CFM
Technical Review Branch Manager, Floodplain Management & Services Division

Enclosures

Copy to: Scott Zipprich, P.E., City of Buckeye City Engineer
Melanie A. Wadsworth, P.E., Kimley-Horn and Associates, Inc.
Robert Wisener, Conservation & Project Manager, City of Buckeye Parks Dept.

Flood Control District of Maricopa County

2801 West Durango Street, Phoenix AZ 85009

Office 602-506-2419 Fax 602-372-6232

Floodplain Use Permit: FCP2014033

Reference Number/s:

Granted: 4/29/2014

Property Address: Not Assigned Buckeye, AZ 85396

Owner: Robert Wisener 530 E. Monroe Ave. Buckeye, AZ 85326

Applicant: Melanie Wadsworth, P.E. 7740 N. 16th St., STE 300 Phoenix, AZ 85020

Parcel: **Lot/SpaceNumber:** **Block:**

Subdivision/Mobile Home Park:

Section: 34 **Township:** T2N **Range:** R3W **Quarter Section:**

Description of Construction and Intended Use:

Watson Rd. Culvert crossing Skyline Wash

Documentation Required		Floodplain Information	
Elevation Certificate:	No	**Community (Number):**	City of Buckeye (040039)
Warning and Disclaimer:	Yes	**Flood Zone:**	AE
Property Owner Authorization:	Yes	**Floodplain:**	Skyline Wash Alluvial Fan
404:	No	**FIRM:**	2110L
ADEQ:	No	**Map Date:**	10/16/2013
		Base Flood Elev:	
		Reg. Flood Elev:	

Print: MELANIE WADSWORTH Signature: Melanie Wadsworth Date: 4/30/14

Floodplain Administrator: Kelly A Serrick Date: 5/2/2014

Flood Control District of Maricopa County
2801 West Durango Street, Phoenix AZ 85009
Office 602-506-2419 Fax 602-372-6232
Floodplain Use Permit: FCP2014033

Applicant's Responsibilities

Standard

1. Development to be in compliance with the Floodplain Regulations for Maricopa County and Construction Plans for Skyline Regional Park Phase 1 stamped approved by the Flood Control District on 04/29/2014. Approval is only for work noted in "Description of Construction and Intended Use" on this permit.
2. The owner/applicant shall submit a Warning and Disclaimer of Liability Notice.
3. The owner/applicant must secure all property rights needed prior to start of construction.
4. The owner/applicant shall obtain separate drainage approval from the City of Buckeye before any construction can begin. Flood Control District approval is for Floodplain purposes only, based upon how the proposed development affects the effective floodplain.
5. The owner/applicant shall obtain all approvals necessary prior to any development.
6. The owner/applicant understands that while the structure is designed to be free from inundation during the 100-year peak discharge if developed in accordance with the approved plan, other locations on the property may be inundated during the 100-year peak discharge event.
7. This permit may be declared null and void if substantial progress of development does not occur within one (1) year of approval or for any substantial deviation from the approved plan referenced in Condition 1, or for any violation of the Floodplain Regulation, or any condition, or other terms or agreement in connection with approval of this Floodplain Use Permit.
8. Approval of this permit does not convey any property rights, either real estate or material, and is not to be construed as consent, approval or authorization to cause any injury to property or invasion of rights or the infringement of any Federal, State or other local laws, rules or regulations nor does it obviate the requirement to obtain other permits. Furthermore, the plan review by the District has been solely for the purpose of determining that your application conforms with the written requirements of the Floodplain Regulation for Maricopa County and is not to be taken as a warranty that structural plans and specifications meet engineering requirements or standards or are free from failure to perform as described or designed in the application, reports or plans as submitted. Approval does not imply that the total drainage concept for the site has been reviewed or approved by our office.

Development

1. In accordance with A.R.S. §48-3613(B) written authorization, established in the Floodplain Regulations as a Floodplain Use Permit, is not required for nor shall the Board of Directors of the Flood Control District prohibit construction of streams, waterways, lakes, and other auxiliary facilities in conjunction with development of public parks and recreation facilities by a public agency or political subdivision as referenced in §48-3613(B). Except that before any construction may begin, the person must submit plans for construction to the Board for review and comment. Floodplain Management staff has reviewed the submitted plans on behalf of the Board. This Floodplain Use Permit paperwork serves as a record that the plans were submitted for the required review and comment.

Inspections

1. The owner/applicant shall be responsible for contacting the City of Buckeye for all required inspections.

Print: MELANIE WADSWORTH Signature: Melanie Wadsworth Date: 4/30/14

Floodplain Administrator: Kellie Serfid Date: 5/2/2014

Flood Control District
of Maricopa County

WARNING AND DISCLAIMER OF LIABILITY

A Floodplain Regulation for Maricopa County has been in force since February 25, 1974. The current version of the Floodplain Regulation for Maricopa County, Arizona was adopted on August 4, 1986, and amended March 23, 1987, April 6, 1988, September 18, 1989, September 3, 1991, December 15, 1993, November 1, 2000, December 20, 2006, and November 30, 2011. The intent of the Regulations is to prevent the dangerous and expensive misuse of floodplains in Maricopa County.

A Floodplain as defined in the Regulations is the areas adjoining the channel of a watercourse susceptible to inundation by a base flood including areas where drainage is or may be restricted by man-made structures that have been or may be covered partially or wholly by flood water from the 100-year flood.

Depending on the location of your property it could possibly be inundated by greater frequency flood events (those occurring more often). A flood greater in magnitude than the 100-year flood could also occur.

The review your development has undergone is solely for the purpose of determining if your application conforms with the written requirements of the Floodplain Regulation for Maricopa County. It is not to be taken as a warranty. Compliance with this Regulation does not insure complete protection from flooding. The Floodplain Regulation meets established standards for floodplain management, but neither this review nor the Regulation take into account such flood related problems as natural erosion, streambed meander or man-made obstructions and diversions all of which may have an adverse affect in the event of a flood. You are advised to consult your own engineer or other expert regarding these considerations.

In consideration for the issuance of the requested permit the applicant, owner, agent, engineer and their successors agree to hold the District harmless from any onsite or offsite damages of any kind arising from the development of the subject property in accordance with their submittals as outlined in the attached permit

I have read and understand the above WARNING AND DISCLAIMER OF LIABILITY.

FCP2014033	[illegible]	3/18/14
Permit Number	Owner or Agent	Date

FCDMC Rev. 12/13/2011

2801 West Durango Street Phoenix, Arizona 85009 Phone: 602-506-2419 Fax: 602-506-4601

Flood Control District
of Maricopa County

FLOODPLAIN USE PERMIT APPLICATION – PROPERTY OWNER AUTHORIZATION FORM

FORM MUST BE COMPLETED IF THE APPLICANT IS NOT THE PROPERTY OWNER

I hereby authorize:

Name: Melanie Wadsworth - Kimley-Horn and Associates, Inc.

Address: 7740 N. 16th Street, Suite 300

City, State, Zip: Phoenix, Arizona, 85020

E-mail address: melanie.wadsworth@kimley-horn.com

to file this application for a floodplain use permit for development, as described in the application and supporting materials, for my property at Watson Road north of McDowell in Buckeye, AZ, and to take all action required related to the requested development on my property including documentation and submittal of technical information required by the Flood Control District of Maricopa County ("District").

Property Owner Signature: Robert Wisener Conservation & Project Manager

Property Owner Printed Name: City of Buckeye

Property Owner Address: 530 E. Monroe Ave.

City, State, Zip: Buckeye, AZ 85326

Property Owner Phone: 623-349-6621

Property Owner e-mail: rwisener@buckeyeaz.gov

Date: 3/13/2014

Property is owned by the AZ State Land Department. The City of Buckeye submitted an application for right of way which is under review by the State Land Department.

STATE OF ARIZONA)
)ss.
COUNTY OF MARICOPA)

SUBSCRIBED AND SWORN TO before me this 18 day of MARCH, 2014

NISVETA DIXON
NOTARY PUBLIC
MARICOPA COUNTY, ARIZONA
My Commission Expires 07-26-17

Nisveta Dixon
Notary Public

My Commission Expires: 7-26-17

NOTE: This form is for all Floodplain Use Permits except for extraction of sand and gravel or other materials.

DISTRICT USE ONLY

Tracking Number: _____ Project Name: _____

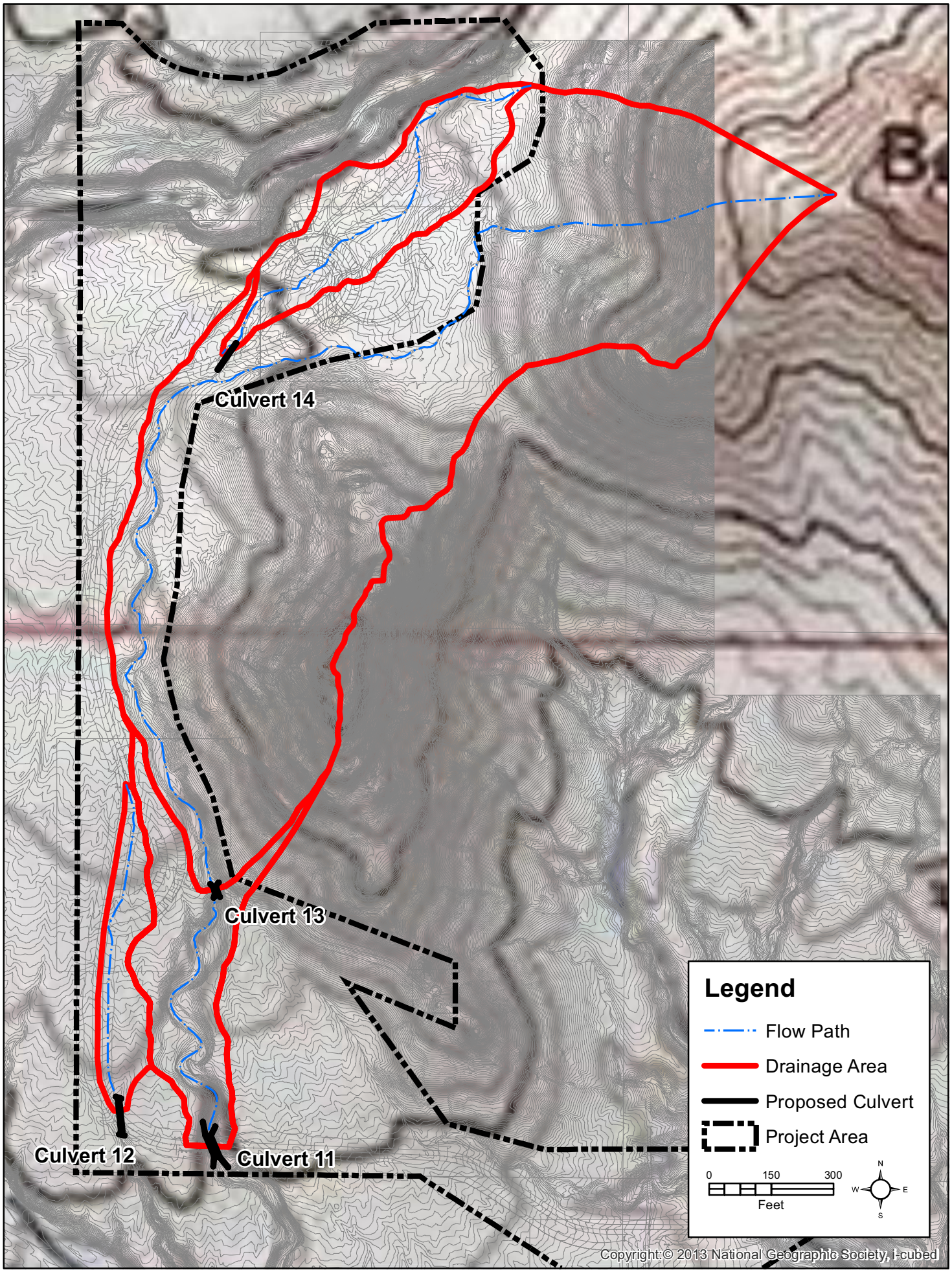
APPENDIX C – RATIONAL METHOD CALCULATIONS

Flood Control District of Maricopa County
Drainage Design Management System
SUB BASINS
Project Reference: SKYLINE PARK

ID	Sub Basin Data							Sub Basin Hydrology Summary					
	Area (acres)	Length (ft)	USGE	DSGE	Slope (ft/mi)	Kb		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Major Basin ID: 01													
C-14	3.5	1,132	1,531.00	1,488.00	200.6	0.136	Q (cfs)	4.1	6.0	7.5	10.6	13.4	16.0
							C	0.55	0.55	0.55	0.61	0.66	0.69
							CA (ac)	1.93	1.93	1.93	2.14	2.32	2.42
							Tc (min)	16	14	13	12	11	11
							i (in/hr)	2.14	3.10	3.88	4.96	5.77	6.63
C-13	32.1	3,215	1,790.00	1,450.00	558.4	0.112	Q (cfs)	35.6	51.3	63.9	91.4	115.4	139.3
							C	0.55	0.55	0.55	0.61	0.66	0.69
							CA (ac)	17.64	17.64	17.64	19.57	21.17	22.14
							Tc (min)	18	16	15	13	13	12
							i (in/hr)	2.02	2.91	3.62	4.67	5.45	6.29
C-12	1.5	778	1,445.50	1,408.00	254.5	0.145	Q (cfs)	2.1	3.0	3.7	5.3	6.7	8.0
							C	0.55	0.55	0.55	0.61	0.66	0.69
							CA (ac)	0.85	0.85	0.85	0.94	1.02	1.06
							Tc (min)	12	11	10	9	8	8
							i (in/hr)	2.45	3.54	4.38	5.62	6.57	7.58
C-11	35.4	3,970	1,790.00	1,392.00	529.3	0.111	Q (cfs)	36.4	53.2	66.3	93.6	118.5	143.5
							C	0.55	0.55	0.55	0.61	0.66	0.69
							CA (ac)	19.49	19.49	19.49	21.61	23.38	24.45
							Tc (min)	21	18	17	15	15	14
							i (in/hr)	1.87	2.73	3.40	4.33	5.07	5.87

* Non default value

Sub Basin	Land Use Code	Area (acres)	Area (%)	Kb	Runoff Coefficient C					
					2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Major Basin ID: 01										
C-11	730	35.43	100.0	0.111	0.55	0.55	0.55	0.61	0.66	0.69
		35.430	**100.0**							
C-12	730	1.54	100.0	0.145	0.55	0.55	0.55	0.61	0.66	0.69
		1.540	**100.0**							
C-13	730	32.08	100.0	0.112	0.55	0.55	0.55	0.61	0.66	0.69
		32.080	**100.0**							
C-14	730	3.51	100.0	0.136	0.55	0.55	0.55	0.61	0.66	0.69
		3.510	**100.0**							


Culvert 14
Culvert 13
Culvert 12
Culvert 11
Legend
Flow Path
Drainage Area
Proposed Culvert
Project Area
0
150
300
Feet
N
W
E
S
Copyright:© 2013 National Geographic Society, i-cubed

ID	Method	Duration	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
DEFAULT	NOAA14	5 MIN	0.268	0.364	0.437	0.535	0.610	0.686
	NOAA14	10 MIN	0.408	0.555	0.666	0.815	0.928	1.044
	NOAA14	15 MIN	0.506	0.688	0.825	1.010	1.150	1.294
	NOAA14	30 MIN	0.681	0.926	1.111	1.360	1.549	1.742
	NOAA14	1 HOUR	0.843	1.146	1.375	1.683	1.917	2.156
	NOAA14	2 HOUR	0.955	1.281	1.529	1.867	2.124	2.393
	NOAA14	3 HOUR	1.006	1.327	1.582	1.935	2.217	2.515
	NOAA14	6 HOUR	1.172	1.509	1.776	2.145	2.435	2.737
	NOAA14	12 HOUR	1.321	1.680	1.965	2.350	2.644	2.950
	NOAA14	24 HOUR	1.612	2.099	2.483	3.017	3.439	3.884

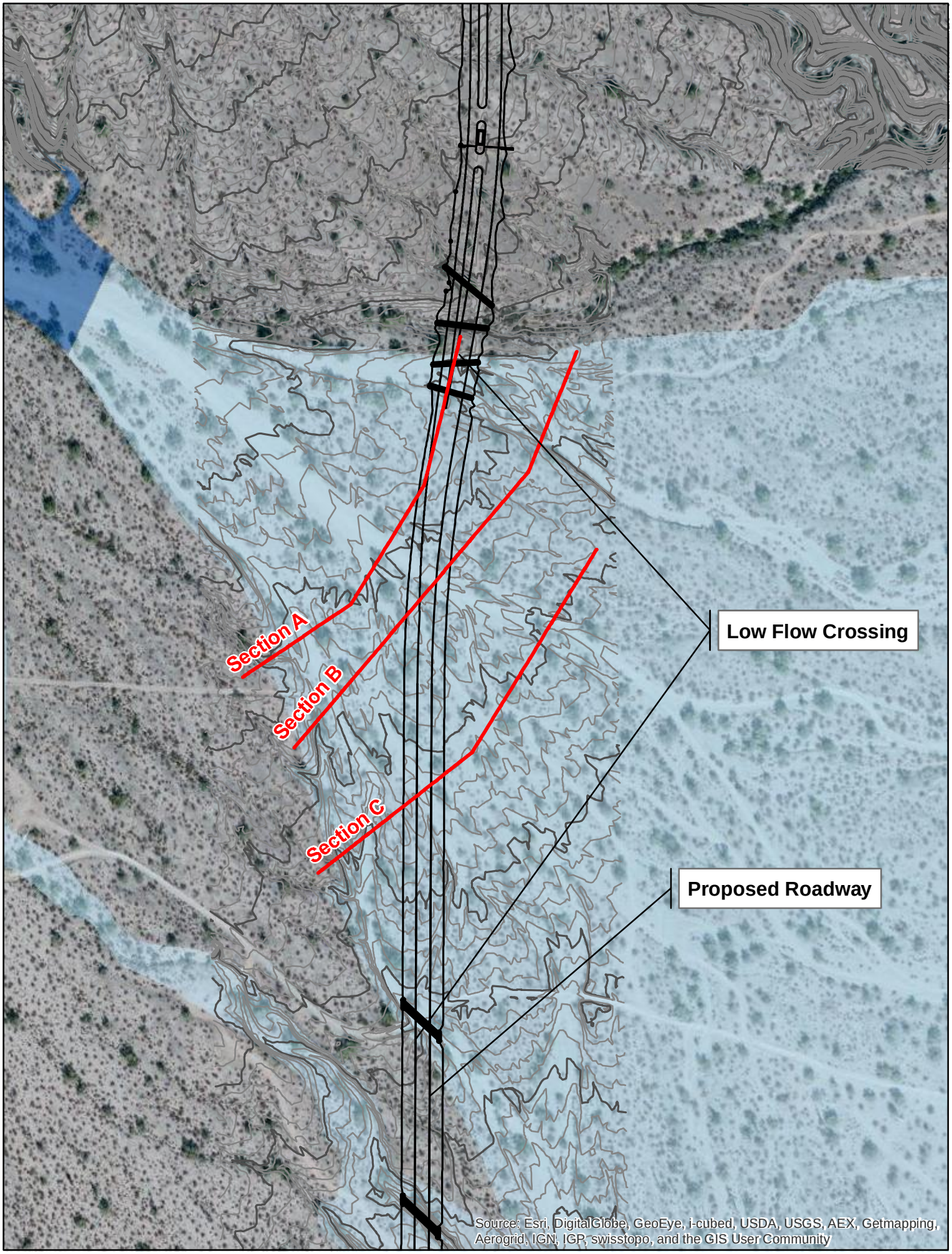
Sub Basin	Land Use Code	Area (acres)	Area (%)	Kb	Runoff Coefficient C					
					2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Major Basin ID: 01										
C-11	730	35.43	100.0	0.111	0.55	0.55	0.55	0.61	0.66	0.69
		35.430	**100.0**							
C-12	730	1.54	100.0	0.145	0.55	0.55	0.55	0.61	0.66	0.69
		1.540	**100.0**							
C-13	730	32.08	100.0	0.112	0.55	0.55	0.55	0.61	0.66	0.69
		32.080	**100.0**							
C-14	730	3.51	100.0	0.136	0.55	0.55	0.55	0.61	0.66	0.69
		3.510	**100.0**							

Flood Control District of Maricopa County
Drainage Design Management System
Agency: FCDMC - LAND USE DEFAULTS
Project Reference: SKYLINE PARK

Code	Description	Rational Method C						Resistance Coefficient Kb
		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr	
Agriculture								
750	Agriculture	0.20	0.20	0.20	0.22	0.24	0.25	LOW
Commercial								
200	General Commercial (Commercial where no detail available)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
220	Neighborhood Commercial (50,000 to 100,000 sq. ft.)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
230	Community Commercial (100,000 to 500,000 sq. ft.)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
240	Regional Commercial (500,000 to 1,000,000 sq. ft.)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
250	Super-Regional Commercial (>= 1,000,000 sq. ft.)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
210	Specialty Commercial (<=50,000 sq. ft.)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
Industrial								
300	General Industrial (Industrial where no detail available)	0.80	0.80	0.80	0.88	0.95	0.95	MIN
310	Warehouse/Distribution Centers	0.85	0.85	0.85	0.94	0.95	0.95	MIN
320	Industrial	0.80	0.80	0.80	0.88	0.95	0.95	MIN
Institutional								
520	Educational (Schools and universities)	0.75	0.75	0.75	0.83	0.90	0.94	MIN
530	Institutional (Includes hospitals and churches)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
550	Public Facilities (comm centers, libraries, sub-stations)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
Office								
400	Office General (Office where no detail available)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
420	Office Mid Rise (5-12 stories)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
430	Office High Rise (13 stories or more)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
810	Business Park (enclosed industrial, office or retail)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
410	Office Low Rise (1-4 stories)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
Open Space								
540	Cemeteries	0.25	0.25	0.25	0.28	0.30	0.31	LOW
700	General Open Space (Open space where no detail available)	0.40	0.40	0.40	0.44	0.48	0.50	LOW
710	Active Open Space (Includes parks)	0.25	0.25	0.25	0.28	0.30	0.31	MIN
730	Passive Open Space (Includes mountain preserves and washes)	0.55	0.55	0.55	0.61	0.66	0.69	HI
740	Water	1.00	1.00	1.00	1.00	1.00	1.00	MIN
900	Vacant (Existing land use database only)	0.40	0.40	0.40	0.44	0.48	0.50	LOW
720	Golf courses	0.25	0.25	0.25	0.28	0.30	0.31	MIN
Other								
560	Special Events (stadiums, sports complexes and fairgrounds)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
Other Employment								
570	Other Employment - low (Proving grounds and land fills)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
580	Other Employment - medium	0.85	0.85	0.85	0.94	0.95	0.95	MIN
590	Other Employment - high	0.85	0.85	0.85	0.94	0.95	0.95	MIN
Residential								
120	Estate Residential (1/5 du per acre to 1 du per acre)	0.42	0.42	0.42	0.46	0.50	0.53	MIN
140	Medium Lot Residential - Single Family (2-4 du per acre)	0.48	0.48	0.48	0.53	0.58	0.60	MIN
150	Small Lot Residential - Single Family (4-6 du per acre)	0.65	0.65	0.65	0.72	0.78	0.82	MIN
170	Medium Density Residential - Muli Family (5-10 du per acre)	0.75	0.75	0.75	0.83	0.90	0.94	MIN
180	High Density Residential - Multi Family (10-15 du per acre)	0.75	0.75	0.75	0.83	0.90	0.94	MIN
190	Very High Density Residential - Multi Family (>15 du per ac)	0.75	0.75	0.75	0.83	0.90	0.94	MIN
110	Rural Residential (<= 1/5 du per acre)	0.42	0.42	0.42	0.46	0.50	0.53	MIN
130	Large Lot Residential - Single Family (1-2 du per acre)	0.48	0.48	0.48	0.53	0.58	0.60	MIN
160	Very Small Lot Residential - Single Family (>6 du per acre)	0.75	0.75	0.75	0.83	0.90	0.94	MIN
Tourist								
510	Tourist and Visitor Accommodations (Hotels, motels, resorts)	0.85	0.85	0.85	0.94	0.95	0.95	MIN

Code	Description	Rational Method C						Resistance Coefficient Kb
		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr	
Transportation								
600	General Transportation (where no detail available)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
610	Transportation (railways, transit centers, freeways)	0.85	0.85	0.85	0.94	0.95	0.95	MIN
620	Airports (Includes public use airports)	0.80	0.80	0.80	0.88	0.95	0.95	MIN
630	General Transportation	0.85	0.85	0.85	0.94	0.95	0.95	MIN

APPENDIX D – LOW FLOW CROSSING CALCULATIONS


Section A
Section B
Section C
Low Flow Crossing
Proposed Roadway
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Cross Section for Section A

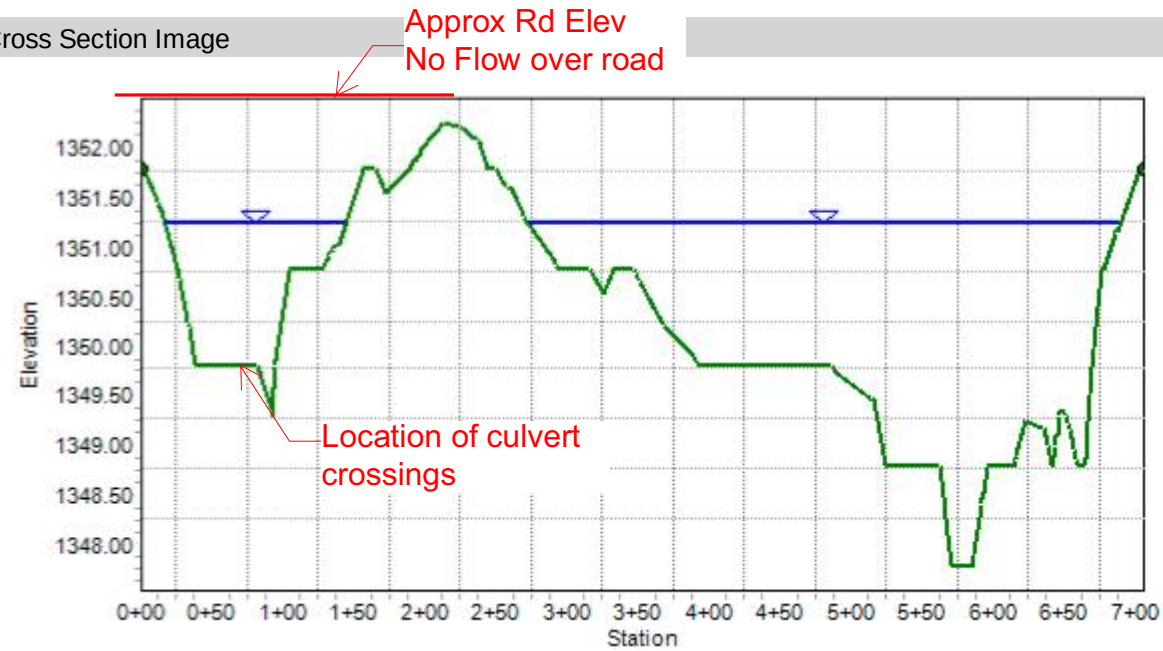
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01250	ft/ft
Normal Depth	3.44	ft
Discharge	4346.00	ft³/s

Cross Section Image



Cross Section for Section B

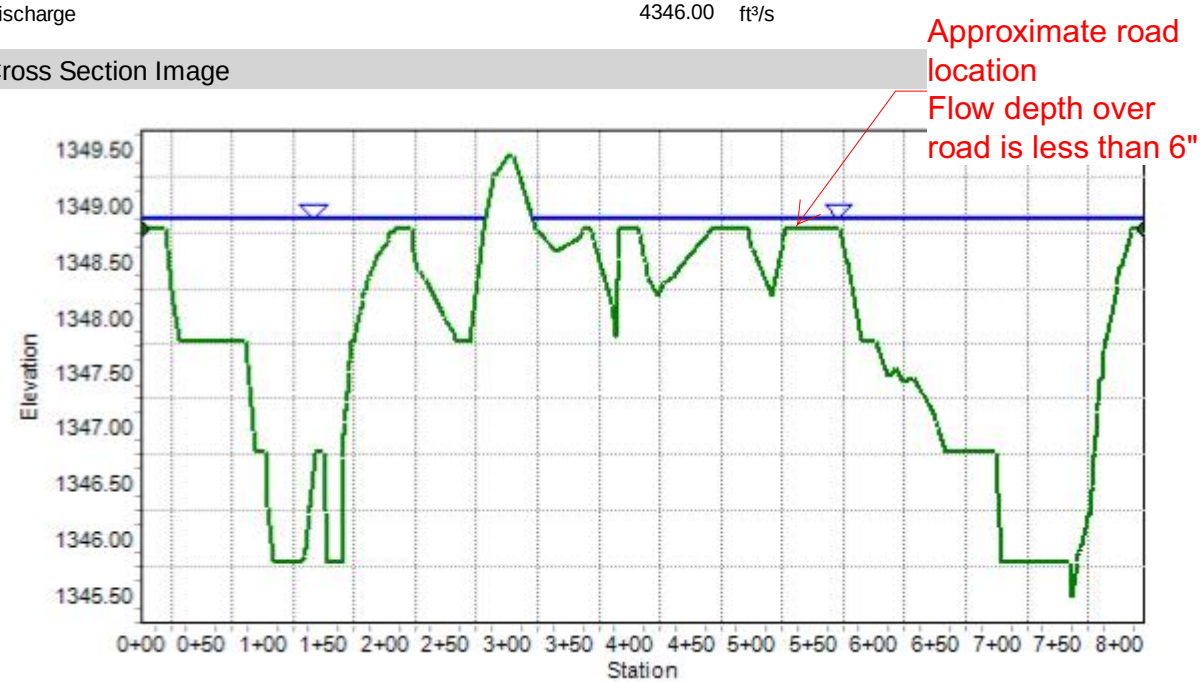
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01250	ft/ft
Normal Depth	3.39	ft
Discharge	4346.00	ft³/s

Cross Section Image



Cross Section for Section C

Project Description

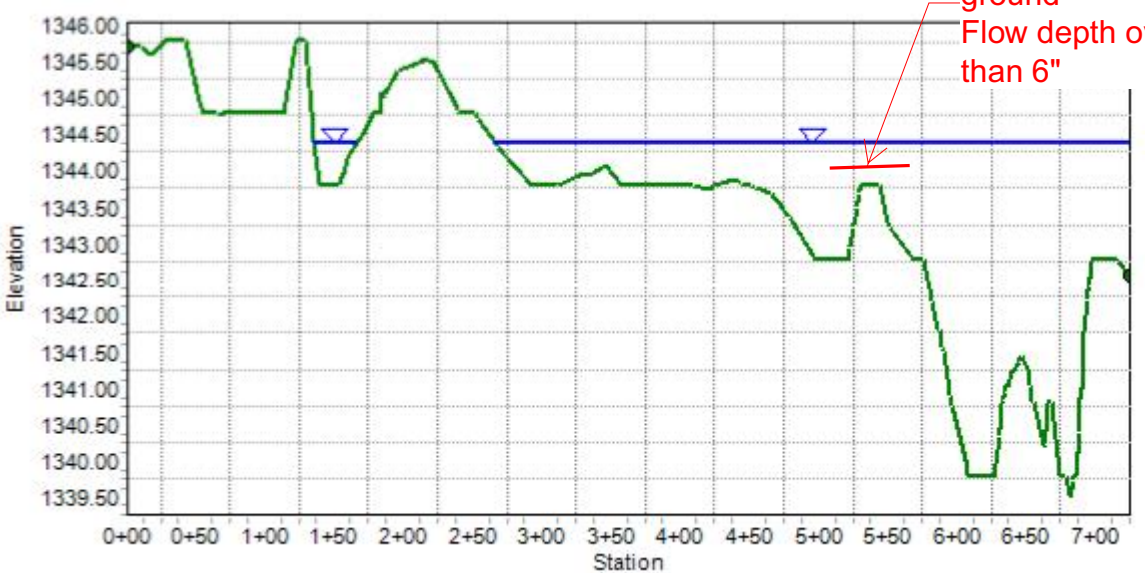
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01250	ft/ft
Normal Depth	4.87	ft
Discharge	4346.00	ft³/s

Cross Section Image

Approximate location of road
Road is higher then existing ground
Flow depth over road is less than 6"



APPENDIX E – CULVERT CALCULATIONS

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 8 cfs

Maximum Flow: 16 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 14

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 14 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1488.96	0.00	0.00	0.00	1
1489.54	1.60	1.60	0.00	1
1489.79	3.20	3.20	0.00	1
1490.00	4.80	4.80	0.00	1
1490.20	6.40	6.40	0.00	1
1490.37	8.00	8.00	0.00	1
1490.53	9.60	9.60	0.00	1
1490.68	11.20	11.20	0.00	1
1490.83	12.80	12.80	0.00	1
1490.98	14.40	14.40	0.00	1
1491.14	16.00	16.00	0.00	1
1491.80	21.56	21.56	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 14

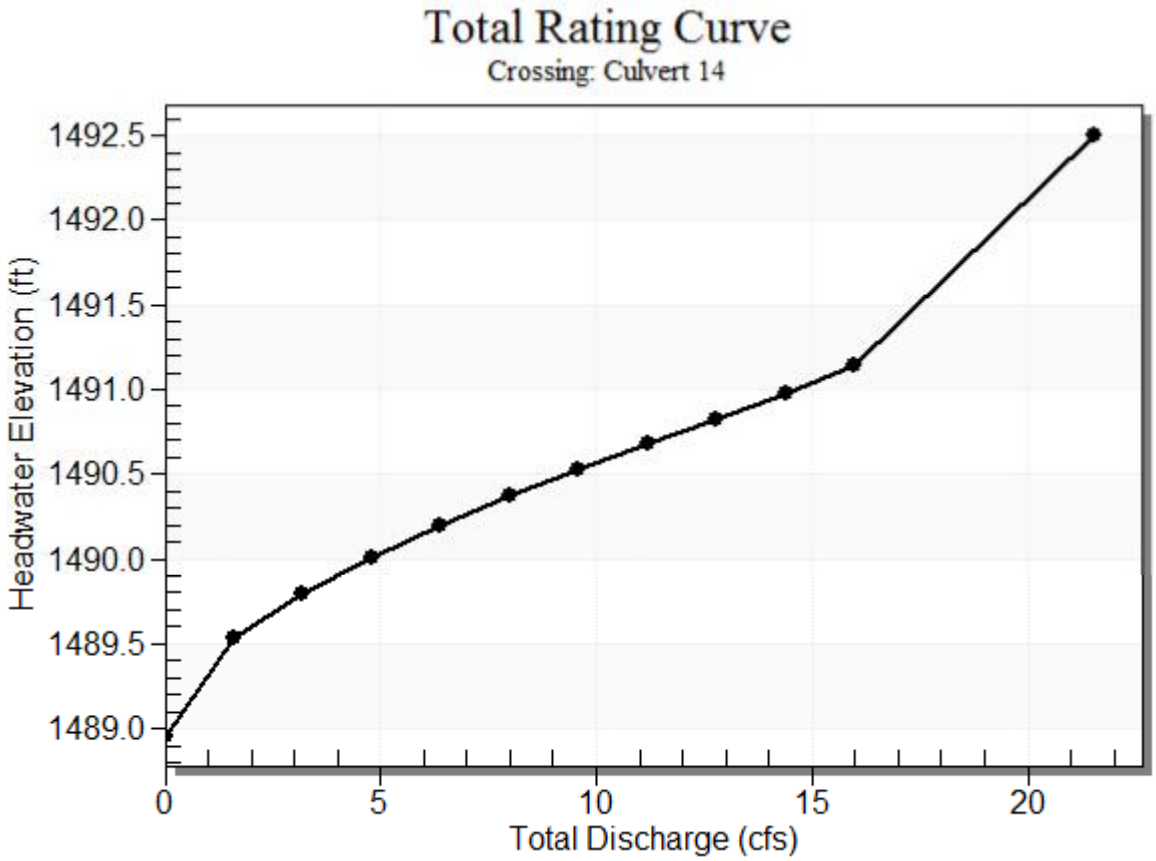


Table 2 - Culvert Summary Table: Culvert 14

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1488.96	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
1.60	1.60	1489.54	0.577	0.0*	1-S2n	0.254	0.435	0.254	0.158	6.651	1.800
3.20	3.20	1489.79	0.832	0.0*	1-S2n	0.375	0.622	0.375	0.236	7.885	2.286
4.80	4.80	1490.00	1.042	0.0*	1-S2n	0.453	0.765	0.453	0.297	8.886	2.613
6.40	6.40	1490.20	1.240	0.0*	1-S2n	0.532	0.896	0.532	0.349	9.539	2.867
8.00	8.00	1490.37	1.413	0.0*	1-S2n	0.594	1.006	0.594	0.395	10.318	3.075
9.60	9.60	1490.53	1.571	0.0*	1-S2n	0.653	1.104	0.671	0.437	10.343	3.254
11.20	11.20	1490.68	1.720	0.0*	1-S2n	0.712	1.197	0.741	0.476	10.592	3.412
12.80	12.80	1490.83	1.868	0.0*	1-S2n	0.765	1.284	0.765	0.511	11.621	3.554
14.40	14.40	1490.98	2.019	0.0*	5-S2n	0.815	1.363	0.846	0.545	11.376	3.681
16.00	16.00	1491.14	2.179	0.0*	5-S2n	0.865	1.437	0.865	0.577	12.290	3.797

* Full Flow Headwater elevation is below inlet invert.

****

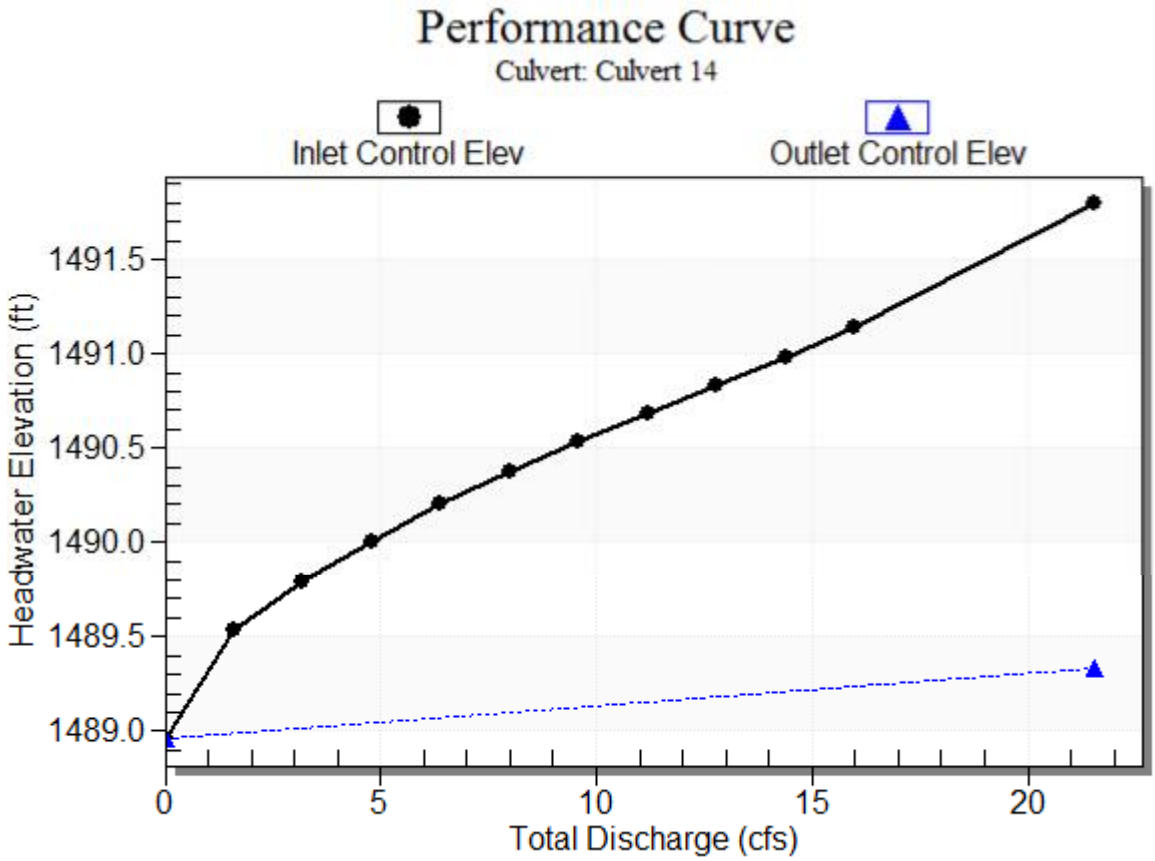
Straight Culvert

Inlet Elevation (invert): 1488.96 ft, Outlet Elevation (invert): 1485.74 ft

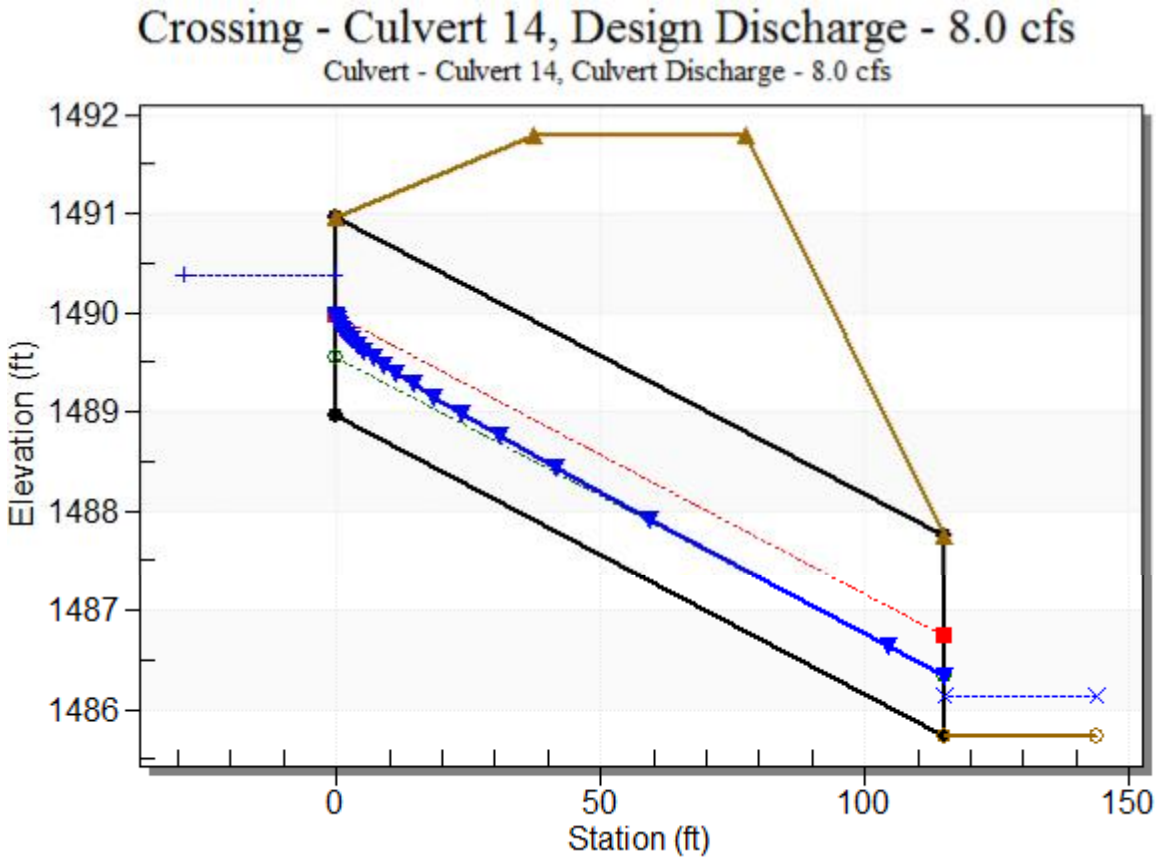
Culvert Length: 115.05 ft, Culvert Slope: 0.0280

****

Culvert Performance Curve Plot: Culvert 14



Water Surface Profile Plot for Culvert: Culvert 14



Site Data - Culvert 14

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1488.96 ft

Outlet Station: 115.00 ft

Outlet Elevation: 1485.74 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 14

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 14)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1485.74	0.00	0.00	0.00	0.00
1.60	1485.90	0.16	1.80	0.49	0.84
3.20	1485.98	0.24	2.29	0.73	0.89
4.80	1486.04	0.30	2.61	0.93	0.92
6.40	1486.09	0.35	2.87	1.09	0.94
8.00	1486.14	0.40	3.08	1.23	0.96
9.60	1486.18	0.44	3.25	1.36	0.97
11.20	1486.22	0.48	3.41	1.48	0.98
12.80	1486.25	0.51	3.55	1.60	0.99
14.40	1486.28	0.54	3.68	1.70	1.00
16.00	1486.32	0.58	3.80	1.80	1.01

Tailwater Channel Data - Culvert 14

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0500

Channel Invert Elevation: 1485.74 ft

Roadway Data for Crossing: Culvert 14

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 1491.80 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 64 cfs

Maximum Flow: 139 cfs

Table 4 - Summary of Culvert Flows at Crossing: Culvert 13

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 13 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1424.90	0.00	0.00	0.00	1
1425.80	13.90	13.90	0.00	1
1426.33	27.80	27.80	0.00	1
1426.77	41.70	41.70	0.00	1
1427.17	55.60	55.60	0.00	1
1427.39	64.00	64.00	0.00	1
1427.88	83.40	83.40	0.00	1
1428.20	97.30	97.30	0.00	1
1428.51	111.20	111.20	0.00	1
1428.81	125.10	125.10	0.00	1
1429.09	139.00	139.00	0.00	1
1434.50	403.70	403.70	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 13

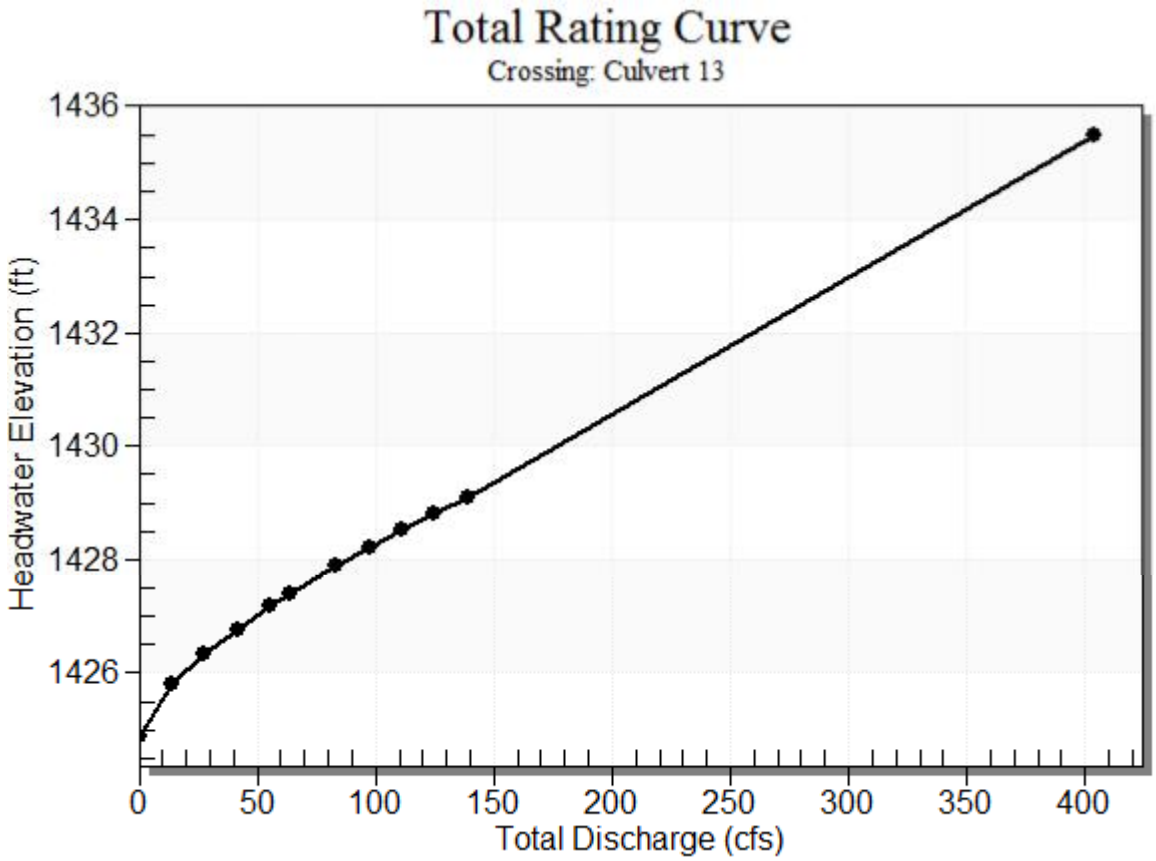


Table 5 - Culvert Summary Table: Culvert 13

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1424.90	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
13.90	13.90	1425.80	0.901	0.0*	1-S2n	0.144	0.550	0.256	0.387	9.049	3.334
27.80	27.80	1426.33	1.430	0.0*	1-S2n	0.288	0.874	0.432	0.583	10.713	4.274
41.70	41.70	1426.77	1.874	0.0*	1-S2n	0.432	1.145	0.593	0.738	11.720	4.921
55.60	55.60	1427.17	2.270	0.0*	1-S2n	0.562	1.387	0.747	0.873	12.402	5.424
64.00	64.00	1427.39	2.494	0.140	1-S2n	0.608	1.523	0.837	0.947	12.750	5.684
83.40	83.40	1427.88	2.975	0.488	1-S2n	0.715	1.817	1.035	1.102	13.433	6.200
97.30	97.30	1428.20	3.300	0.733	1-S2n	0.791	2.014	1.170	1.204	13.855	6.516
111.20	111.20	1428.51	3.610	0.975	1-S2n	0.867	2.201	1.303	1.298	14.228	6.799
125.10	125.10	1428.81	3.907	1.217	1-S2n	0.944	2.381	1.432	1.388	14.564	7.056
139.00	139.00	1429.09	4.193	1.459	1-S2n	1.020	2.554	1.558	1.473	14.869	7.291

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 1424.90 ft, Outlet Elevation (invert): 1423.44 ft

Culvert Length: 31.03 ft, Culvert Slope: 0.0471

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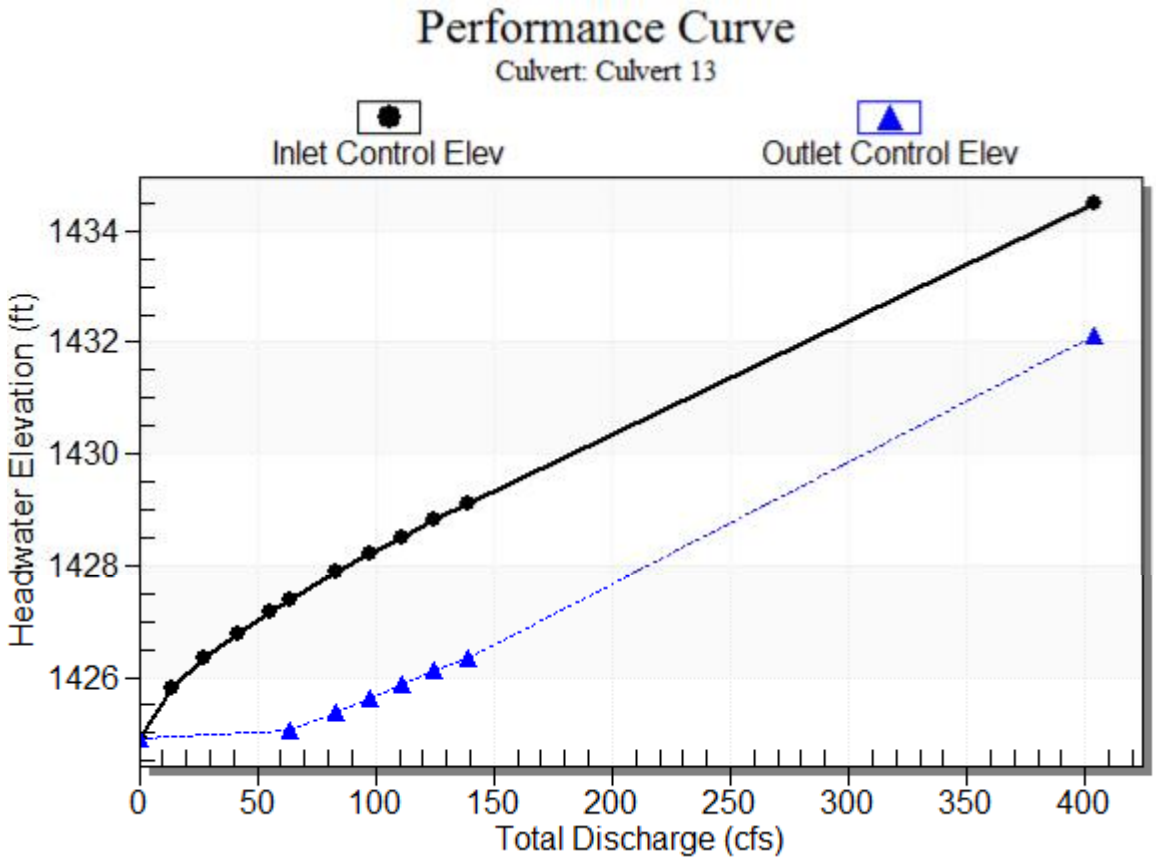
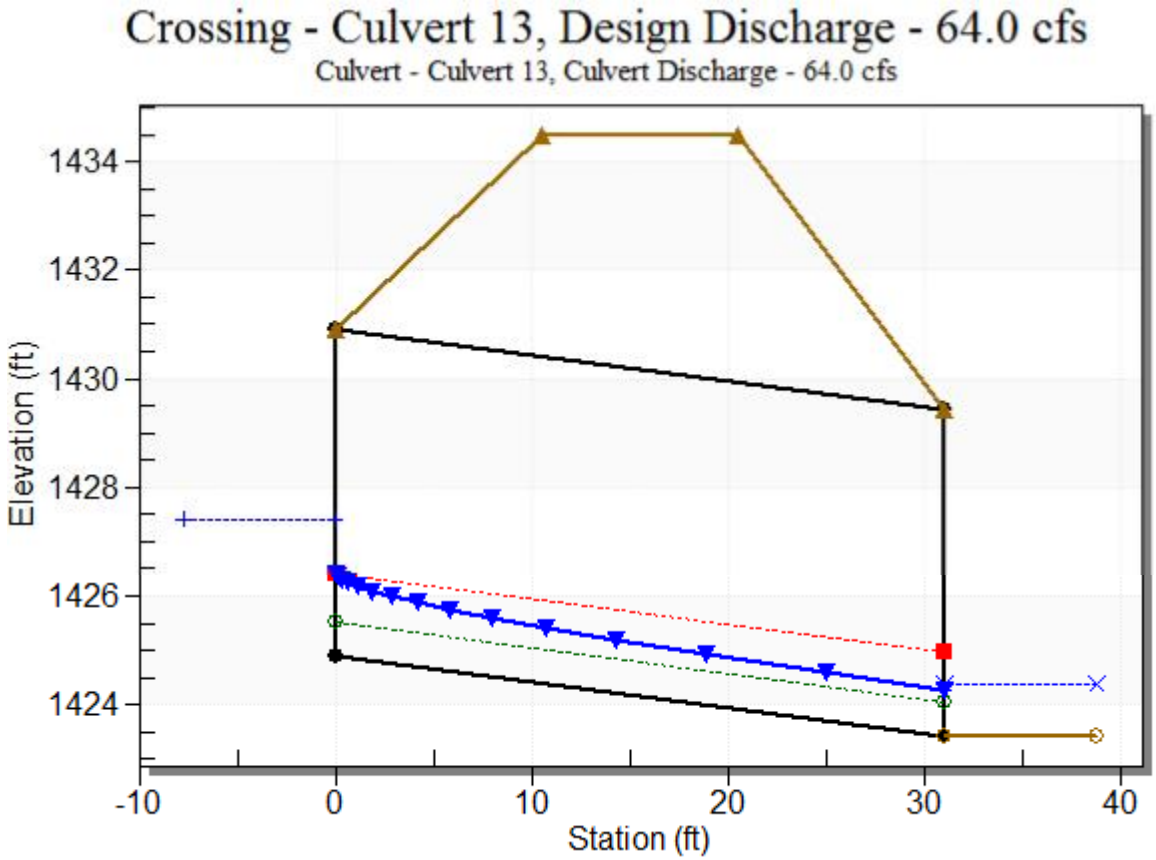
Culvert Performance Curve Plot: Culvert 13



Water Surface Profile Plot for Culvert: Culvert 13



Site Data - Culvert 13

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1424.90 ft

Outlet Station: 31.00 ft

Outlet Elevation: 1423.44 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 13

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 6 - Downstream Channel Rating Curve (Crossing: Culvert 13)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1423.44	0.00	0.00	0.00	0.00
13.90	1423.83	0.39	3.33	1.21	0.98
27.80	1424.02	0.58	4.27	1.82	1.04
41.70	1424.18	0.74	4.92	2.30	1.07
55.60	1424.31	0.87	5.42	2.72	1.10
64.00	1424.39	0.95	5.68	2.95	1.11
83.40	1424.54	1.10	6.20	3.44	1.13
97.30	1424.64	1.20	6.52	3.76	1.14
111.20	1424.74	1.30	6.80	4.05	1.15
125.10	1424.83	1.39	7.06	4.33	1.16
139.00	1424.91	1.47	7.29	4.59	1.17

Tailwater Channel Data - Culvert 13

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0500

Channel Invert Elevation: 1423.44 ft

Roadway Data for Crossing: Culvert 13

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 45.00 ft

Crest Elevation: 1434.50 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 4 cfs

Maximum Flow: 8 cfs

Table 7 - Summary of Culvert Flows at Crossing: Culvert 12

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 12 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1408.13	0.00	0.00	0.00	1
1408.45	0.80	0.80	0.00	1
1408.52	1.60	1.60	0.00	1
1408.62	2.40	2.40	0.00	1
1408.69	3.20	3.20	0.00	1
1408.76	4.00	4.00	0.00	1
1408.83	4.80	4.80	0.00	1
1408.89	5.60	5.60	0.00	1
1408.94	6.40	6.40	0.00	1
1408.99	7.20	7.20	0.00	1
1409.04	8.00	8.00	0.00	1
1409.20	10.49	10.49	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 12

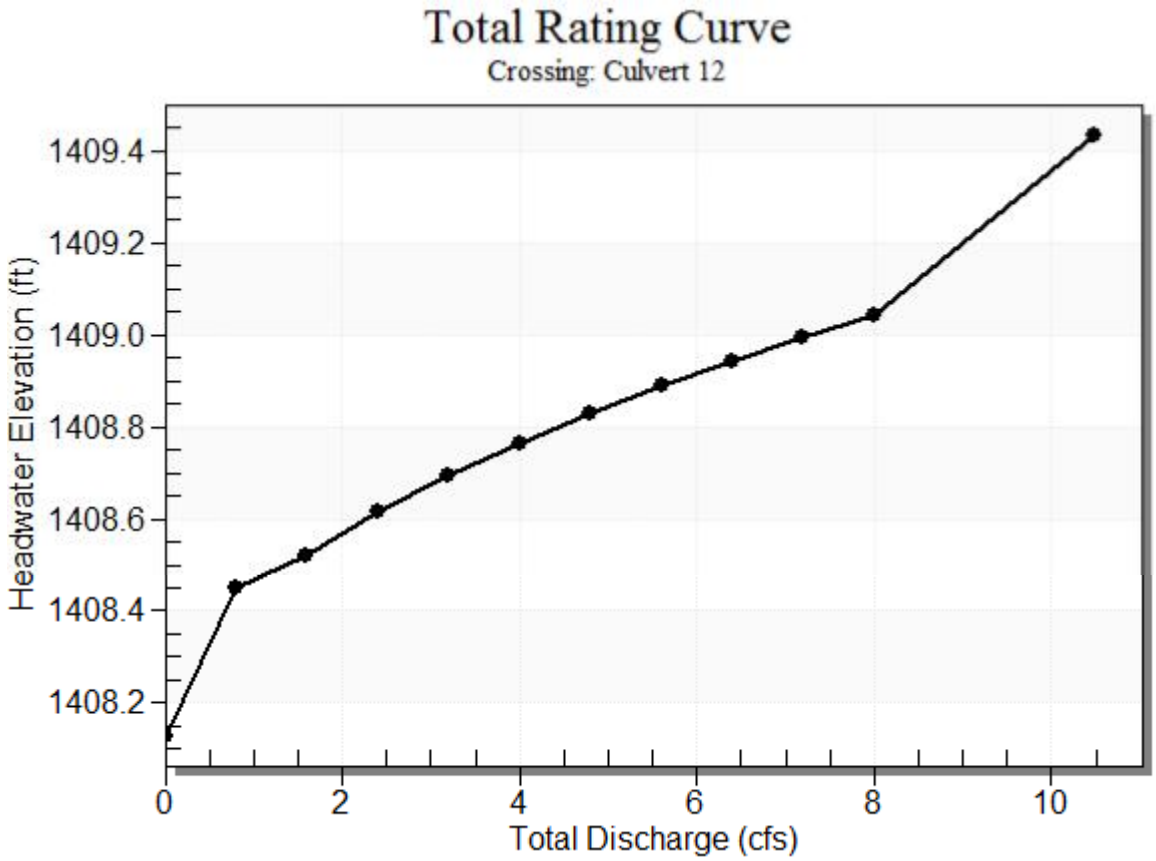


Table 8 - Culvert Summary Table: Culvert 12

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1408.13	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.80	1408.45	0.321	0.0*	1-S2n	0.072	0.213	0.072	0.087	4.452	1.482
1.60	1.60	1408.52	0.390	0.0*	1-S2n	0.143	0.302	0.143	0.132	5.896	1.929
2.40	2.40	1408.62	0.488	0.0*	1-S2n	0.192	0.374	0.192	0.168	8.469	2.250
3.20	3.20	1408.69	0.562	0.0*	1-S2n	0.214	0.435	0.214	0.200	11.626	2.502
4.00	4.00	1408.76	0.632	0.0*	1-S2n	0.236	0.485	0.253	0.228	8.338	2.717
4.80	4.80	1408.83	0.697	0.0*	1-S2n	0.259	0.534	0.259	0.254	9.723	2.902
5.60	5.60	1408.89	0.759	0.0*	1-S2n	0.281	0.580	0.281	0.278	10.104	3.068
6.40	6.40	1408.94	0.811	0.0*	1-S2n	0.303	0.622	0.314	0.301	9.931	3.219
7.20	7.20	1408.99	0.863	0.0*	1-S2n	0.325	0.659	0.325	0.323	10.661	3.357
8.00	8.00	1409.04	0.913	0.0*	1-S2n	0.347	0.697	0.347	0.343	10.871	3.484

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 1408.13 ft, Outlet Elevation (invert): 1401.26 ft

Culvert Length: 117.20 ft, Culvert Slope: 0.0587

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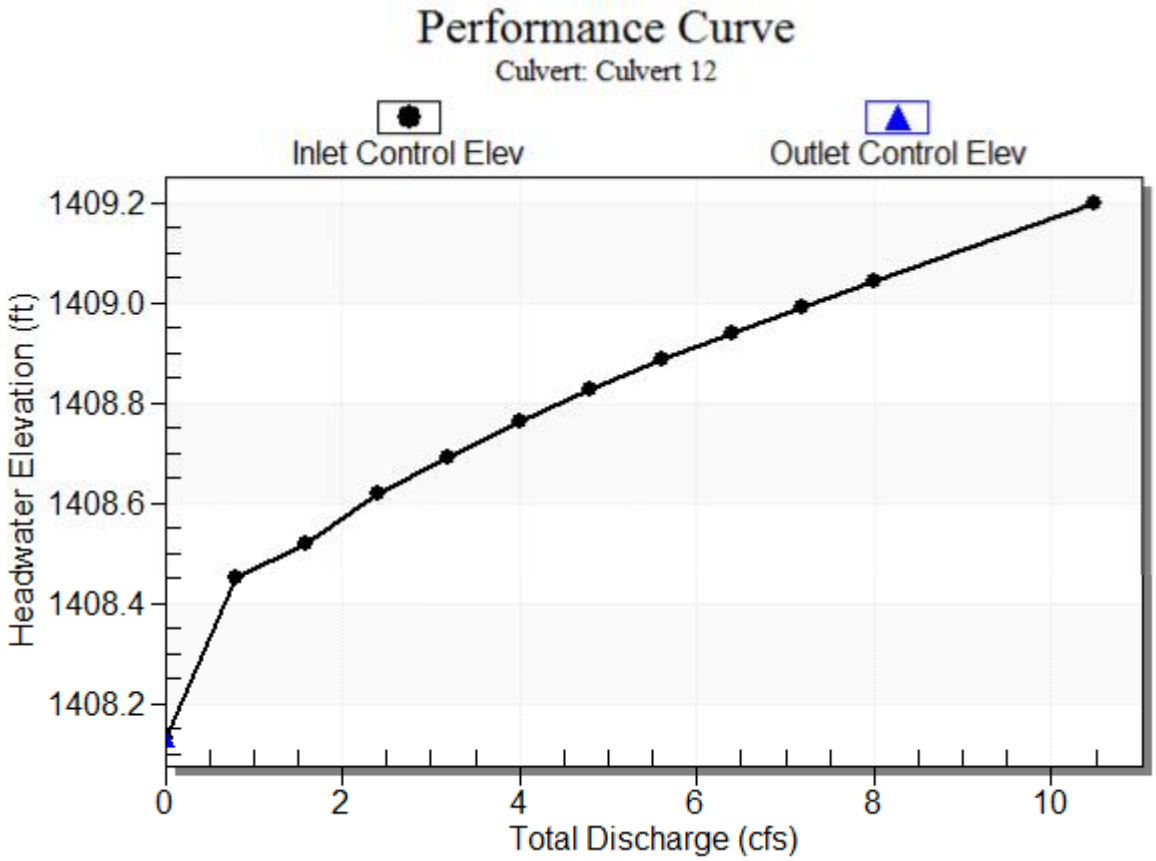
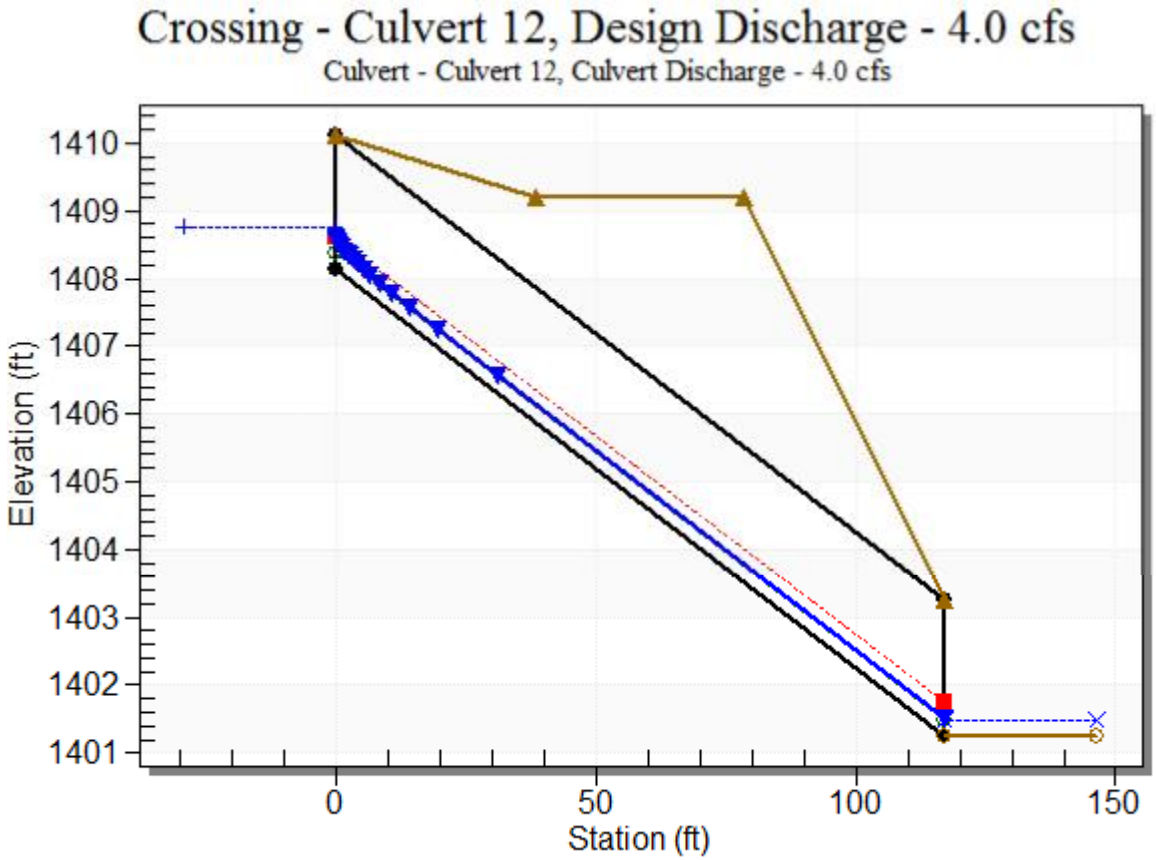
Culvert Performance Curve Plot: Culvert 12



Water Surface Profile Plot for Culvert: Culvert 12



Site Data - Culvert 12

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1408.13 ft

Outlet Station: 117.00 ft

Outlet Elevation: 1401.26 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 12

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 9 - Downstream Channel Rating Curve (Crossing: Culvert 12)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1401.26	0.00	0.00	0.00	0.00
0.80	1401.35	0.09	1.48	0.37	0.90
1.60	1401.39	0.13	1.93	0.55	0.95
2.40	1401.43	0.17	2.25	0.70	0.99
3.20	1401.46	0.20	2.50	0.84	1.02
4.00	1401.49	0.23	2.72	0.95	1.04
4.80	1401.51	0.25	2.90	1.06	1.05
5.60	1401.54	0.28	3.07	1.16	1.07
6.40	1401.56	0.30	3.22	1.26	1.08
7.20	1401.58	0.32	3.36	1.35	1.09
8.00	1401.60	0.34	3.48	1.44	1.10

Tailwater Channel Data - Culvert 12

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0670

Channel Manning's n: 0.0500

Channel Invert Elevation: 1401.26 ft

Roadway Data for Crossing: Culvert 12

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 30.00 ft

Crest Elevation: 1409.20 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 66 cfs

Maximum Flow: 144 cfs

Table 10 - Summary of Culvert Flows at Crossing: Culvert 11

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1392.27	0.00	0.00	0.00	1
1392.93	14.40	14.40	0.00	1
1393.32	28.80	28.80	0.00	1
1393.65	43.20	43.20	0.00	1
1393.94	57.60	57.60	0.00	1
1394.10	66.00	66.00	0.00	1
1394.46	86.40	86.40	0.00	1
1394.69	100.80	100.80	0.00	1
1394.92	115.20	115.20	0.00	1
1395.14	129.60	129.60	0.00	1
1395.34	144.00	144.00	0.00	1
1405.60	1142.51	1142.51	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 11

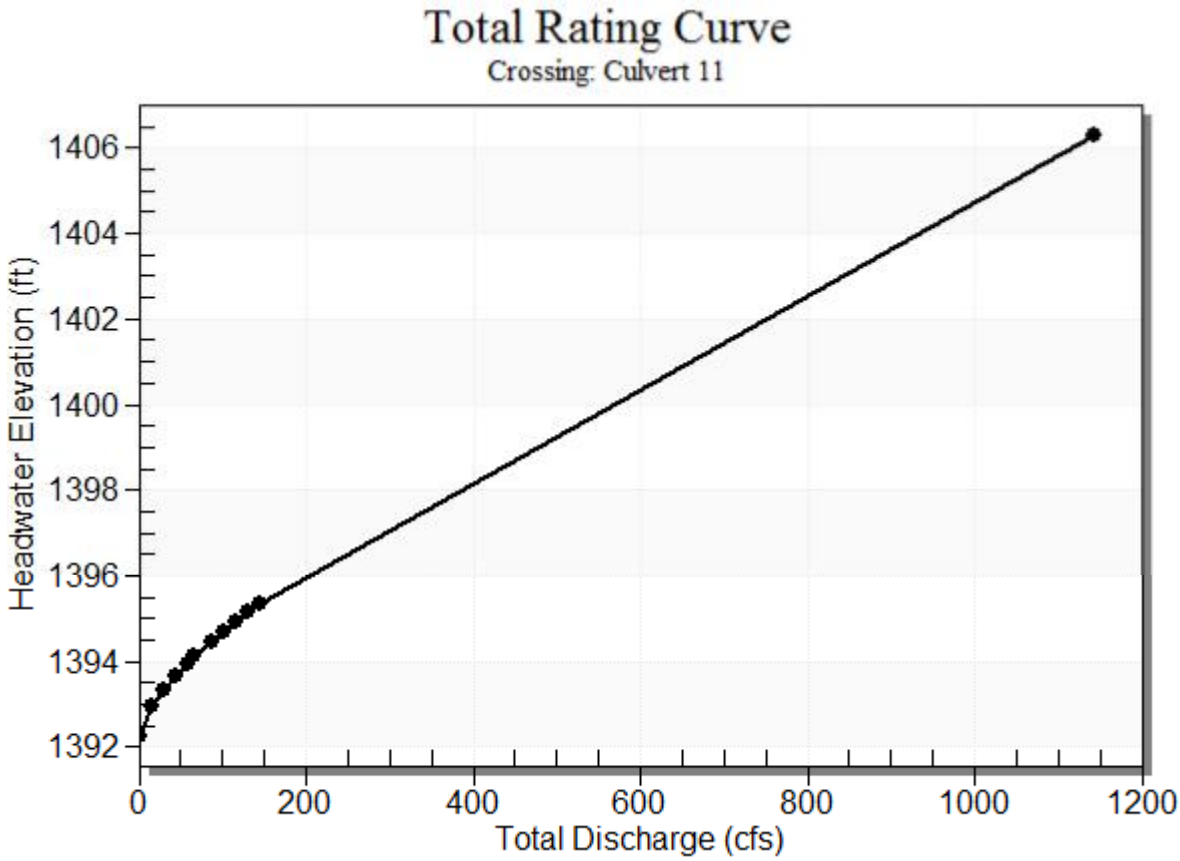


Table 11 - Culvert Summary Table: Culvert 11

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1392.27	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
14.40	14.40	1392.93	0.662	0.0*	1-S2n	0.076	0.401	0.181	0.395	7.942	3.377
28.80	28.80	1393.32	1.051	0.0*	1-S2n	0.151	0.636	0.292	0.595	9.851	4.329
43.20	43.20	1393.65	1.378	0.0*	1-S2n	0.227	0.834	0.384	0.754	11.236	4.980
57.60	57.60	1393.94	1.669	0.0*	1-S2n	0.302	1.010	0.468	0.891	12.299	5.488
66.00	66.00	1394.10	1.828	0.0*	1-S2n	0.346	1.106	0.518	0.964	12.745	5.742
86.40	86.40	1394.46	2.187	0.0*	1-S2n	0.453	1.323	0.630	1.125	13.712	6.271
100.80	100.80	1394.69	2.424	0.0*	1-S2n	0.529	1.467	0.709	1.228	14.207	6.590
115.20	115.20	1394.92	2.650	0.0*	1-S2n	0.604	1.603	0.787	1.325	14.643	6.875
129.60	129.60	1395.14	2.866	0.0*	1-S2n	0.680	1.734	0.862	1.416	15.042	7.134
144.00	144.00	1395.34	3.075	0.0*	1-S2n	0.755	1.860	0.935	1.502	15.399	7.372

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 1392.27 ft, Outlet Elevation (invert): 1389.40 ft

Culvert Length: 76.05 ft, Culvert Slope: 0.0378

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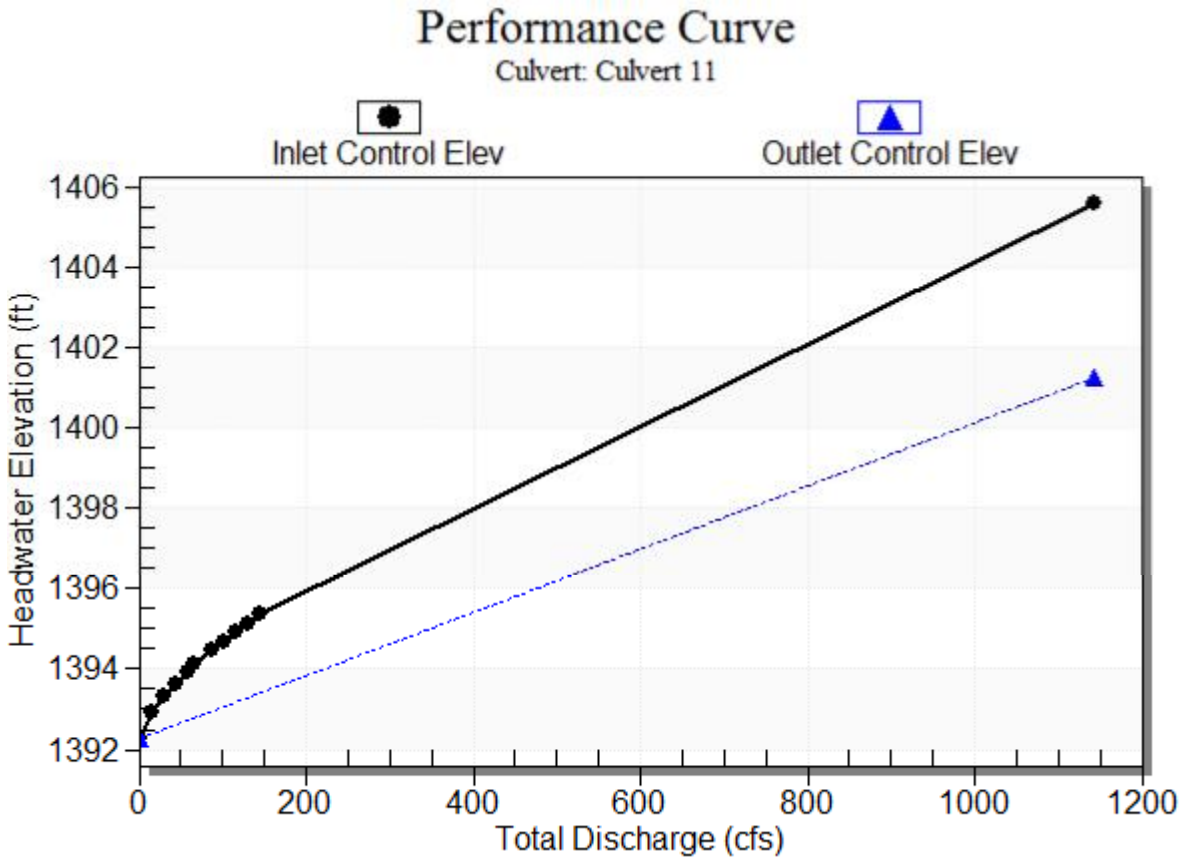
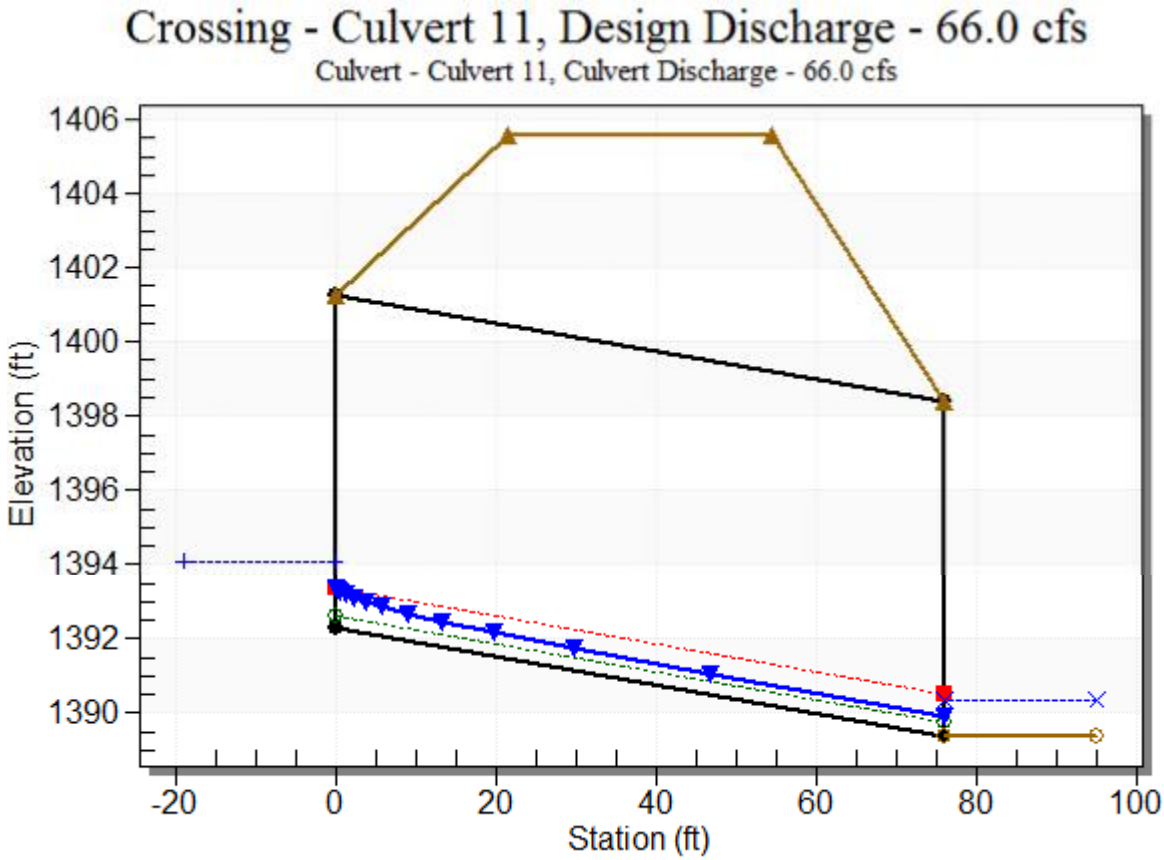
Culvert Performance Curve Plot: Culvert 11



Water Surface Profile Plot for Culvert: Culvert 11



Site Data - Culvert 11

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1392.27 ft

Outlet Station: 76.00 ft

Outlet Elevation: 1389.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 11

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 9.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 12 - Downstream Channel Rating Curve (Crossing: Culvert 11)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1389.40	0.00	0.00	0.00	0.00
14.40	1389.80	0.40	3.38	1.23	0.98
28.80	1389.99	0.59	4.33	1.86	1.04
43.20	1390.15	0.75	4.98	2.35	1.07
57.60	1390.29	0.89	5.49	2.78	1.10
66.00	1390.36	0.96	5.74	3.01	1.11
86.40	1390.52	1.12	6.27	3.51	1.13
100.80	1390.63	1.23	6.59	3.83	1.15
115.20	1390.72	1.32	6.88	4.13	1.16
129.60	1390.82	1.42	7.13	4.42	1.17
144.00	1390.90	1.50	7.37	4.69	1.18

Tailwater Channel Data - Culvert 11

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0500

Channel Invert Elevation: 1389.40 ft

Roadway Data for Crossing: Culvert 11

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 1405.60 ft

Roadway Surface: Paved

Roadway Top Width: 33.00 ft

APPENDIX F – SCOUR AND RIPRAP CALCULATIONS

Dumped Riprap Calculations

Project Name **Skyline Regional Park Phase I**

Subject *Dumped Riprap Apron Dimension Calculations for Nuisance Flow Culverts (Culverts 1-10)*

By MAW Date 7/15/2014 Project No. 191342007

Dumped Riprap Aprons

Culvert ID	Diameter (ft)	Used D_{50} (in)	Apron Length (ft)	Apron Thickness [1] (ft)	Upstream Width [1] (ft)	Downstream Width [1] (ft)
Culvert 1	1.5	12	8	2.3	5	10
Culverts 2-10	2.0	12	11	2.3	6	13

Notes:

[1] *Apron dimensions from FCDMC Hydraulics Manual, Section 8.4.2*

At locations with headwalls, the upstream width will match the headwall length

Grouted Riprap Calculations

Project Name **Skyline Regional Park Phase I**

Subject *Grouted Riprap Apron Dimension Calculations for 10-year Culverts (Culverts 12-14)*

By MAW Date 7/15/2014 Project No. 191342007

Grouted Riprap Aprons

Culvert ID	Diameter (ft)	Velocity (ft/s)	Apron Thickness [1] (ft)	Not to Exceed D_{50} [2] (ft)	Used D_{50} [2] (in)	Apron Length [3] (ft)	Upstream Width [3] (ft)	Downstream Width [3] (ft)
Culvert 12	2.0	11.6	1.4	0.9	9	16	14.5	17
Culvert 14	2.0	10.3	1.3	0.9	9	16	6	17

Grouted Riprap Protection

Culvert ID	Span (ft)	Height (ft)	Equivalent Diameter (ft)	Velocity (ft/s)	Thickness [1] (ft)	Not to Exceed D_{50} [2] (ft)	Used D_{50} [2] (in)	Length [4] (ft)
Culvert 11	10.0	9.0	10.7	12.8	1.4	0.9	9	54
Culvert 13	6.0	6.0	6.8	12.8	1.4	0.9	9	54

Notes:

[1] *Required thickness of grouted riprap obtained from FCDMC Hydraulics Manual, Figure 6.16*

[2] *Grouted riprap dimensions from FCDMC Hydraulics Manual, Section 6.5.6*

[3] *Apron dimensions from FCDMC Hydraulics Manual, Section 8.4.2; upstream width for culvert 12 is the headwall length*

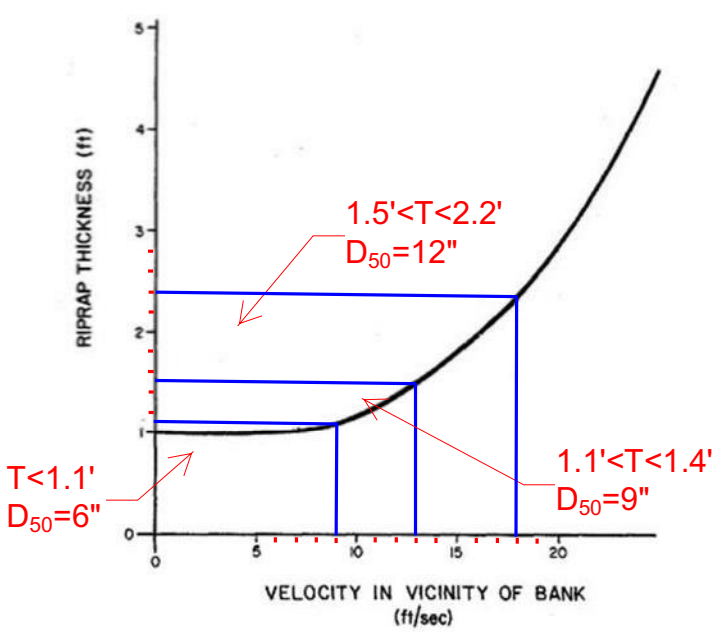
[4] *Length of riprap protection for culvert 11 was set to match length for culvert 13 since culvert 11 was oversized*

riprap failure resulting from toe scour, and failures of frequently overtopped drainways and drainage ditches.

Materials - Riprap quality should conform to the property requirements described in Section 6.6.3. Figure 6.16 gives the required blanket thickness of grouted rock for a given design channel velocity. The median rock size d_{50} shall not exceed 0.67 times the blanket thickness and the largest rock used should not exceed the blanket thickness. d_{50} and d_{100} can be 0.67 and 1.0 times the blanket thickness, respectively. It is required that rocks smaller than the d_{50} size be removed. The other gradation limits should conform to those described in Section 6.6.3.

The grout mix should be specified to provide the strength and durability required to meet the specific application. The minimum 28-day compressive strength shall be 2,000 psi and the slump shall be within a range of 4 to 7 inches. The stone aggregate should conform to the gradation requirements of Size Number 8 coarse aggregate (3/8 inch to No. 8) as specified in ASTM C-33. A maximum of 30 percent of the cementitious material may be fly ash (ASTM C-618, Type C or F). Fiber reinforcement is recommended to be added to the grout to provide additional control of shrinkage and cracking.

FIGURE 6.16
REQUIRED BLANKET THICKNESS OF GROUTED ROCK
(USDOT, 1989)



Major Basin: 01

ID: CULV11

Type	Calc (ft)	FS	Value (ft)	Method
Long Term		1.30		
General	.60	1.30	.78	Lacey
Local	3.65	1.30	4.75	Culvert Outlet
Bedform	.44	1.30	.57	**Comments**
Low Flow		1.30		
Total			**6.10**	

ID: CULV12

Type	Calc (ft)	FS	Value (ft)	Method
Long Term		1.30		
General	.19	1.30	.25	Lacey
Local	.93	1.30	1.21	Culvert Outlet
Bedform	.10	1.30	.13	**Comments**
Low Flow		1.30		
Total			**1.59**	

ID: CULV13

Type	Calc (ft)	FS	Value (ft)	Method
Long Term		1.30		
General	.60	1.30	.78	Lacey
Local	3.66	1.30	4.76	Culvert Outlet
Bedform	.44	1.30	.57	**Comments**
Low Flow		1.30		
Total			**6.11**	

ID: CULV14

Type	Calc (ft)	FS	Value (ft)	Method
Long Term		1.30		
General	.30	1.30	.39	Lacey
Local	1.54	1.30	2.00	Culvert Outlet
Bedform	.13	1.30	.17	**Comments**
Low Flow		1.30		
Total			**2.56**	

ID: LOWFLOW

Type	Calc (ft)	FS	Value (ft)	Method
Long Term		1.30		
General	2.43	1.30	3.16	Lacey
Local		1.30		
Bedform	.44	1.30	.57	**Comments**
Low Flow		1.30		Velocity values for Bedform scour calculations were taken from FlowMaster normal depth calculations, assuming 6" maximum overtopping of the roadway.
Total			**3.73**	

Design FlowRate (cfs)	D50 (mm)	Bend Factor, Z	Scour Depth Including Bend (ft)
Maior Basin ID: 01			
ID: CULV11		**Cross Section ID: Manual**	
66	0.078	0.25	0.60
ID: CULV12		**Cross Section ID: Manual**	
2	0.078	0.25	0.19
ID: CULV13		**Cross Section ID: Manual**	
64	0.078	0.25	0.60
ID: CULV14		**Cross Section ID: Manual**	
8	0.078	0.25	0.30
ID: LOWFLOW		**Cross Section ID: Manual**	
4,346	0.078	0.25	2.43

Culvert Discharge (cfs)	Full Flow Culvert Hydraulic Radius, Rc (ft)	Culvert Slope (ft/ft)	Time of Scour, t (min)	Drop Height, Dh (diam)	D84 (mm)	D16 (mm)			Cs	Ch
Maior Basin ID: 01										
ID: CULV11										
66	2.37	0.033700	30	-	4.750	0.400	**Depth of Scour (ft)**	3.65	1.05	1.00
							Width of Scour (ft)	13.51	1.28	1.00
							Length of Scour (ft)	28.52	1.17	1.00
							Volume of Scour (cu ft)	1,376	1.30	1.00
ID: CULV12										
2	0.50	0.055500	30	-	4.750	0.400	**Depth of Scour (ft)**	0.93	1.09	1.00
							Width of Scour (ft)	3.51	1.28	1.00
							Length of Scour (ft)	7.24	1.17	1.00
							Volume of Scour (cu ft)	21	1.30	1.00
ID: CULV13										
64	1.50	0.048800	30	-	4.750	0.400	**Depth of Scour (ft)**	3.66	1.08	1.00
							Width of Scour (ft)	15.42	1.28	1.00
							Length of Scour (ft)	30.45	1.17	1.00
							Volume of Scour (cu ft)	1,387	1.30	1.00
ID: CULV14										
8	0.50	0.033700	30	-	4.750	0.400	**Depth of Scour (ft)**	1.54	1.05	1.00
							Width of Scour (ft)	7.32	1.28	1.00
							Length of Scour (ft)	13.89	1.17	1.00
							Volume of Scour (cu ft)	117	1.30	1.00
ID: LOWFLOW										
-	-	-	-	-	-	-	**Depth of Scour (ft)**	-	-	-
							Width of Scour (ft)	-	-	-
							Length of Scour (ft)	-	-	-
							Volume of Scour (cu ft)	-	-	-

Main Channel Hydraulic Depth (ft)	Main Channel Average Velocity (ft/s)	Main Channel Froude Number	Dune Height/Depth	Dune Scour Depth (ft)	Anti Dune Scour Depth (ft)	Final Scour Depth (ft)
Maior Basin ID: 01						
ID: CULV11		**Cross Section ID: Manual**				
0.30	5.70	1.83	0.20	-	0.44	0.44
ID: CULV12		**Cross Section ID: Manual**				
0.20	2.70	1.06	0.20	-	0.10	0.10
ID: CULV13		**Cross Section ID: Manual**				
0.60	5.70	1.30	0.20	-	0.44	0.44
ID: CULV14		**Cross Section ID: Manual**				
0.60	3.10	0.71	0.20	0.06	0.13	0.13
ID: LOWFLOW		**Cross Section ID: Manual**				
0.50	5.70	1.42	0.20	-	0.44	0.44

SPEEDIE AND ASSOCIATES
Geotechnical ▪ Environmental ▪ Materials Engineers

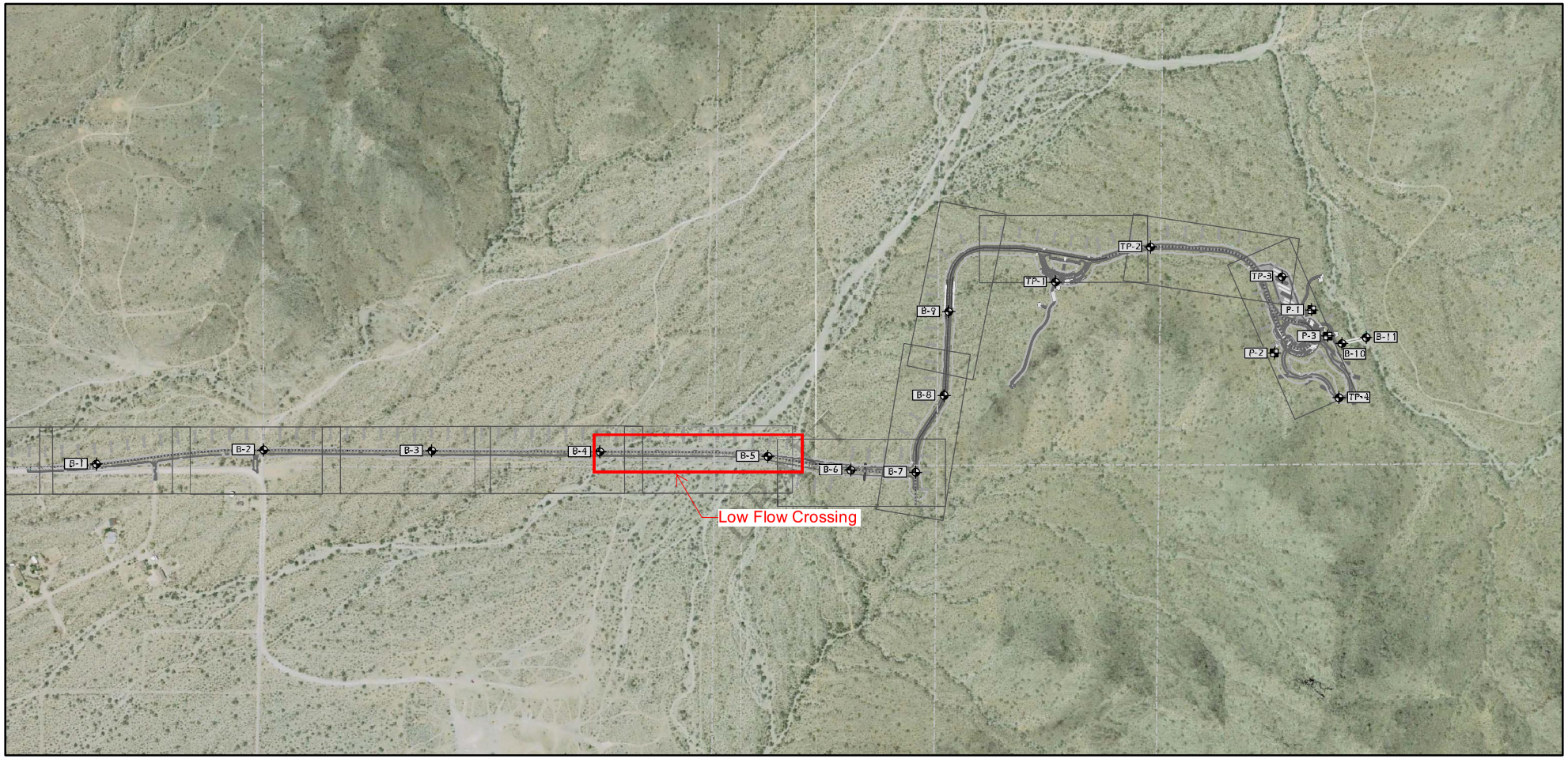
www.speedie.net

REPORT ON GEOTECHNICAL INVESTIGATION

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14388
GREGG ALAN
CREASER
Date Signed 7/25/14
ARIZONA, U.S.A.
Expires 06/30/17

DESIGNATION:	Skyline Regional Park - Phase I
LOCATION:	Watson Road and McDowell Road Buckeye, Arizona
CLIENT:	Kimley-Horn and Associates, Inc.
PROJECT NO:	130624SA
DATE:	July 25, 2014

3331 East Wood Street ▪ Phoenix, AZ 85040 ▪ Phone (602) 997-6391 ▪ Fax (602) 943-5508
4025 East Huntington Drive, Suite 140 ▪ Flagstaff, AZ 86004 ▪ Phone (928) 526-6681 ▪ Fax (928) 526-6685
3125 E. 47th Street ▪ Tucson, AZ 85713 ▪ Phone (520) 514-9411 ▪ Fax (520) 514-9474



- APPROXIMATE SOIL BORING / TEST PIT LOCATIONS

- APPROXIMATE PERCOLATION TEST LOCATIONS

N

0' 200' 500' 1000'
SCALE

IMAGE COURTESY OF: MARICOPA COUNTY ASSESSOR

PROJECT LOCATION PLAN					
SHEET: 1 OF 1	DR: TSW	CHK: XXX	REV: XXX	DATE: 07/03/2014	PROJECT NO. 1306745A

SKYLINE REGIONAL PARK PHASE I
WATSON ROAD & MCDOWELL ROAD
BUCKEYE, ARIZONA

SPEEDIE AND ASSOCIATES
GEOTECHNICAL/ENVIRONMENTAL/MATERIALS ENGINEERS
3331 E. WOOD ST. PHOENIX, ARIZONA 85040 (602) 997-6391

TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
B- 1	BS-2	BULK	0.0 - 5.0	NT	NT	15	36	72	87	100	NP	NP	NP	SM	SILTY SAND
B- 3	BS-2	BULK	0.0 - 5.0	NT	NT	10	31	72	85	100	NP	NP	NP	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
B- 5	RS-1	RING	1.0 - 2.0	NT	NT	7	21	49	63	100	NP	NP	NP	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
B- 7	BS-2	BULK	0.0 - 5.0	NT	NT	18	39	67	79	100	NP	NP	NP	SM	SILTY SAND with GRAVEL
B- 8	RS-1	RING	1.0 - 2.0	NT	NT	19	38	79	95	100	27	17	10	SC	CLAYEY SAND
B-10	BS-2	BULK	0.0 - 5.0	NT	NT	21	43	73	85	100	NP	NP	NP	SM	SILTY SAND
B-10	RS-3	RING	5.0 - 6.0	1.5	117.8	NT	NT	NT	NT	NT	NT	NT	NT		
B-10	RS-5	RING	15.0 - 16.0	2.2	114.5	13	40	74	84	100	NP	NP	NP	SM	SILTY SAND with GRAVEL
B-11	RS-1	RING	1.0 - 2.0	1.8	118.7	14	33	67	84	100	24	20	4	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-1	BS-1	BULK	0.0 - 5.0	NT	NT	13	29	52	61	100	NP	NP	NP	SM	SILTY SAND with GRAVEL
TP-3	BS-1	BULK	0.0 - 5.0	NT	NT	20	38	63	74	100	NP	NP	NP	SM	SILTY SAND with GRAVEL

Sieve analysis results do not include material greater than 3". Refer to the actual boring logs for the possibility of cobble and boulder sized materials.

NT=Not Tested

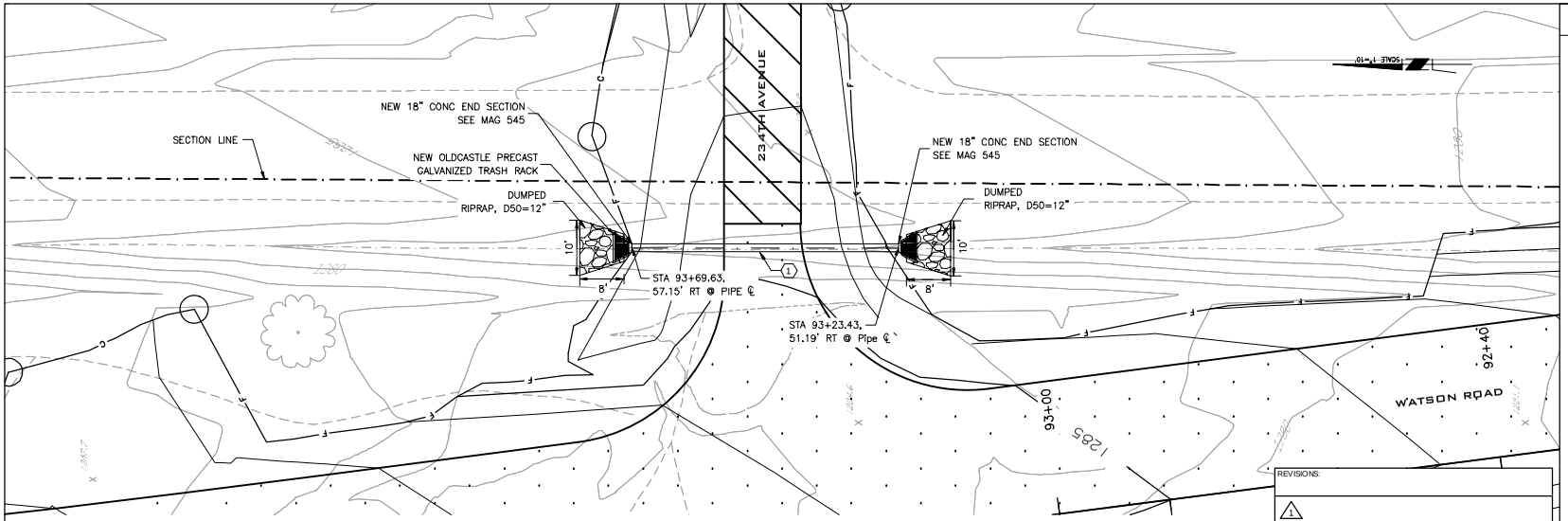
Sheet 1 of 1

Skyline Regional Park Phase I
Watson Road & McDowell Road
Buckeye, Arizona
Project No. 130624SA

SPEEDIE AND ASSOCIATES

TABULATION OF TEST DATA 130624SA.GPJ GENGEO.GDT 7/24/14

APPENDIX G – 100% PLANS

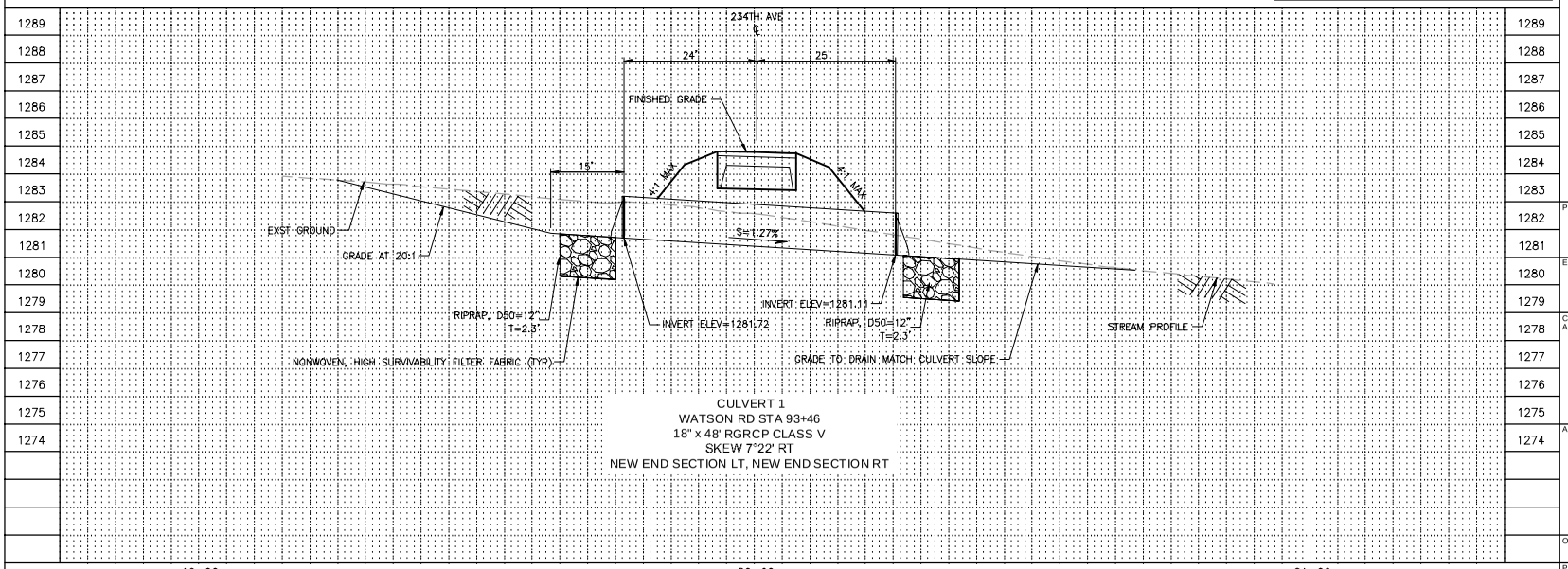


REVISIONS:

1	
2	
3	

GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.



CULVERT 1
WATSON RD STA 93+46
18" x 48' RGRCP CLASS V
SKEW 7°22' RT
NEW END SECTION LT, NEW END SECTION RT

10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D01
STA 93+46

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL

AS-BUILT SEAL
DESIGN SEAL
Registered Professional Engineer (Civil)
CHRISTIAN E. SALSBURY
21673
Date Signed 02/05/15
ARIZONA, U.S.A.
Expires 06/30/15

ORIGINAL PLAN DATE
LATEST REVISION DATE
PROJECT No.
SHEET ID. D01
SHEET No. 24 OF 125
COB PLAN TRACKING #
COB PERMIT #
ENG-13-00317

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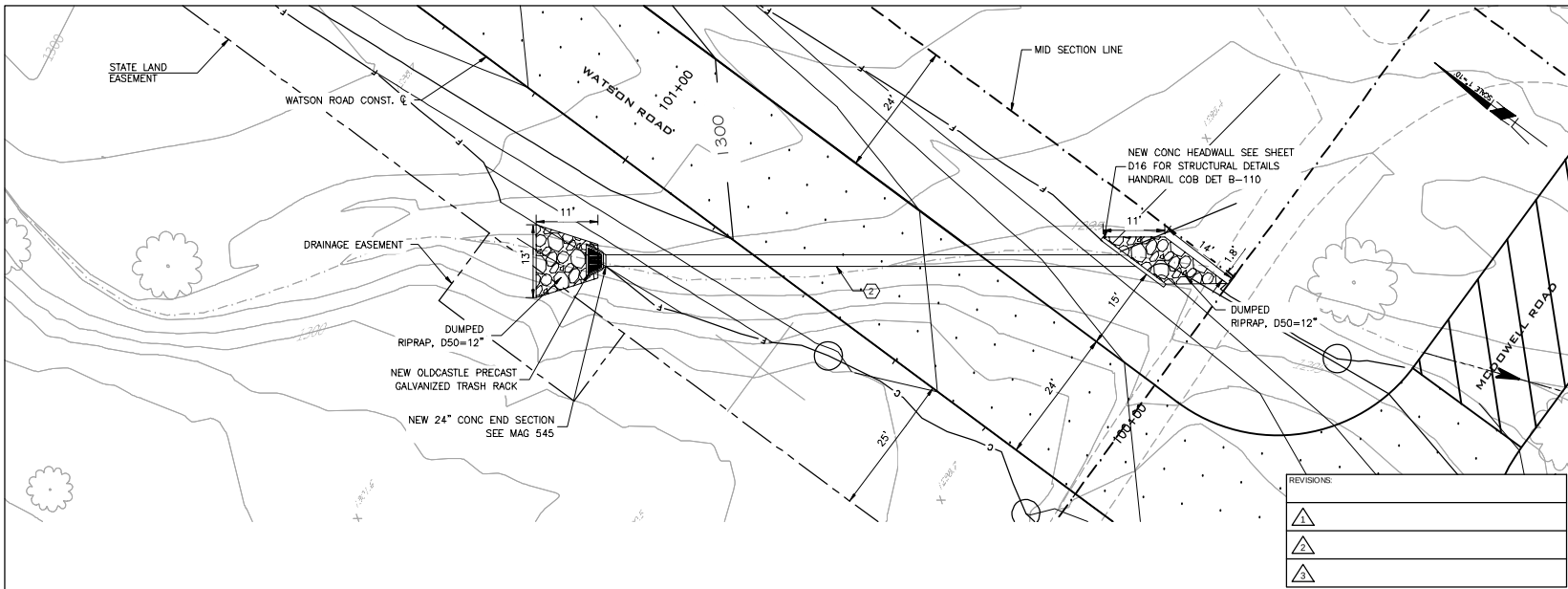

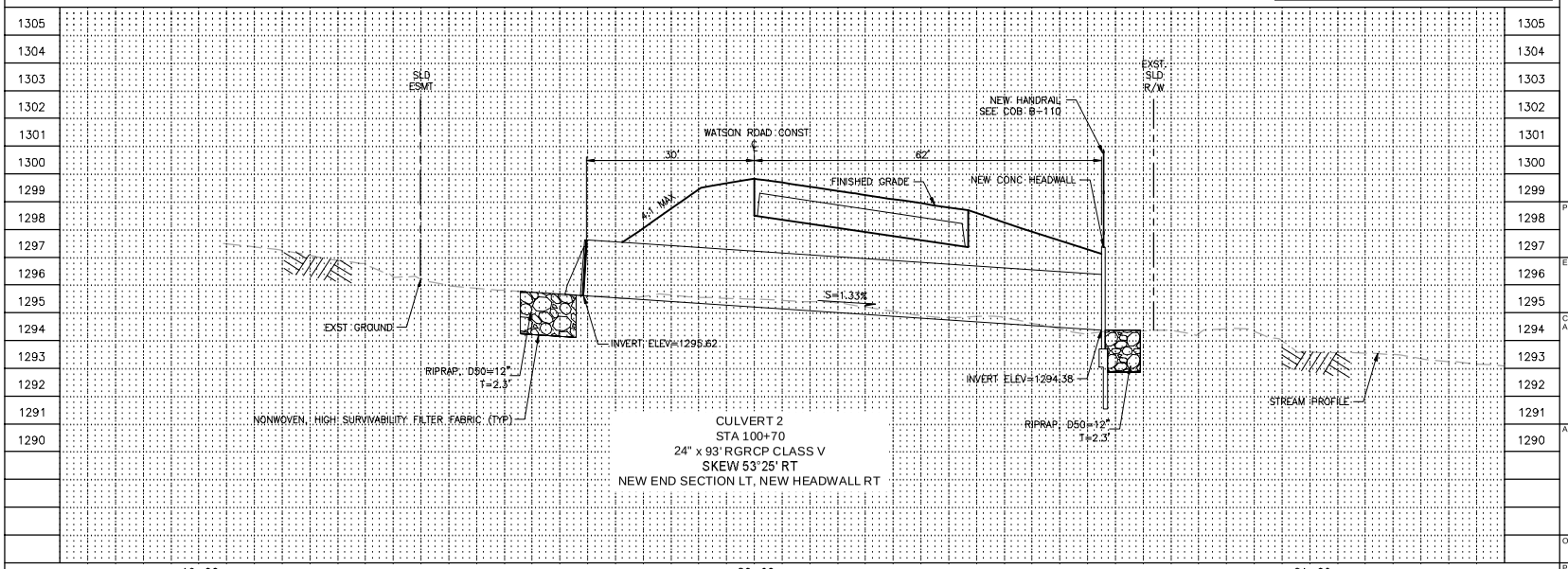

GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.

10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D02
STA 100+70

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
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COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL:

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 21673
RAJESH S. CHRISTIAN
Date Signed 09/04/13
ARIZONA, U.S.A.
Expires 09/30/15

ORIGINAL PLAN DATE

LATEST REVISION DATE

PROJECT No.

SHEET ID. D02

SHEET No. 25 OF 125

COB PLAN TRACKING #

COB PERMIT # ENG-13-00317

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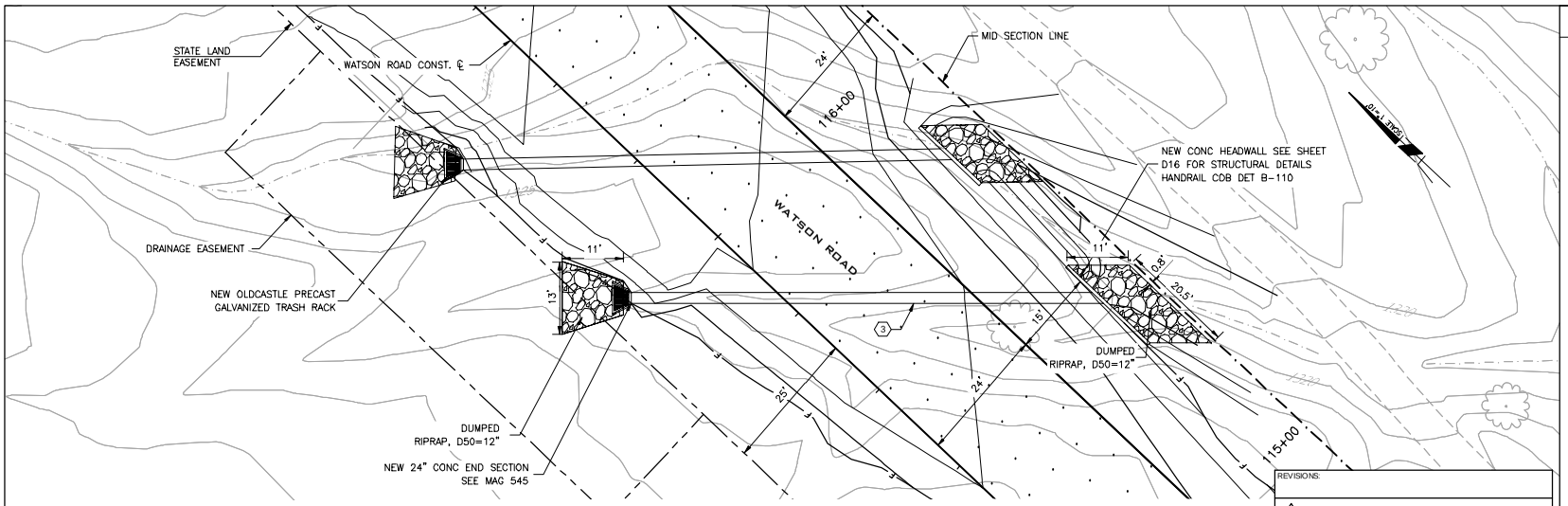

GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

1
2
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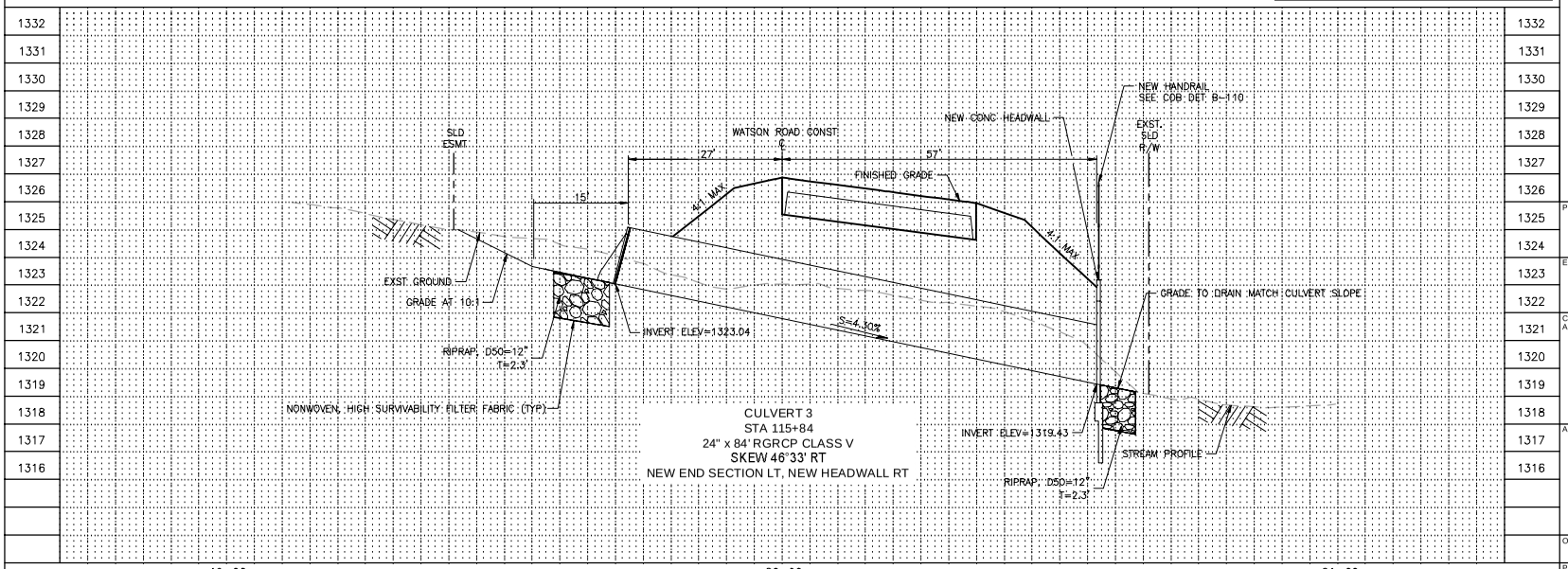

10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D03
STA 115+84

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
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COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL

AS-BUILT SEAL
DESIGN SEAL
Registered Professional Engineer (Civil) CERTIFICATE NO. 21673 RAJESH G. CHRISTIAN Date Signed 02/05/15 ARIZONA, U.S.A.
Expires 06/30/15

ORIGINAL PLAN DATE
LATEST REVISION DATE
PROJECT No.
SHEET ID. D03
SHEET No. 26 OF 125
COB PLAN TRACKING #
COB PERMIT # ENG-13-00317

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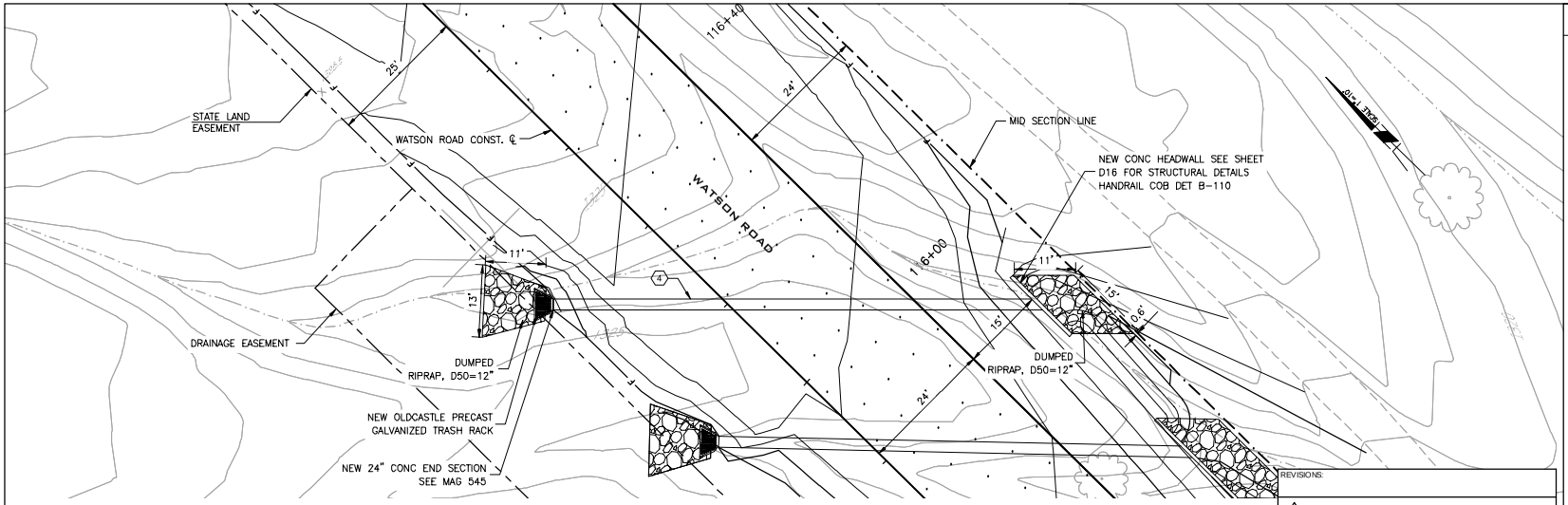
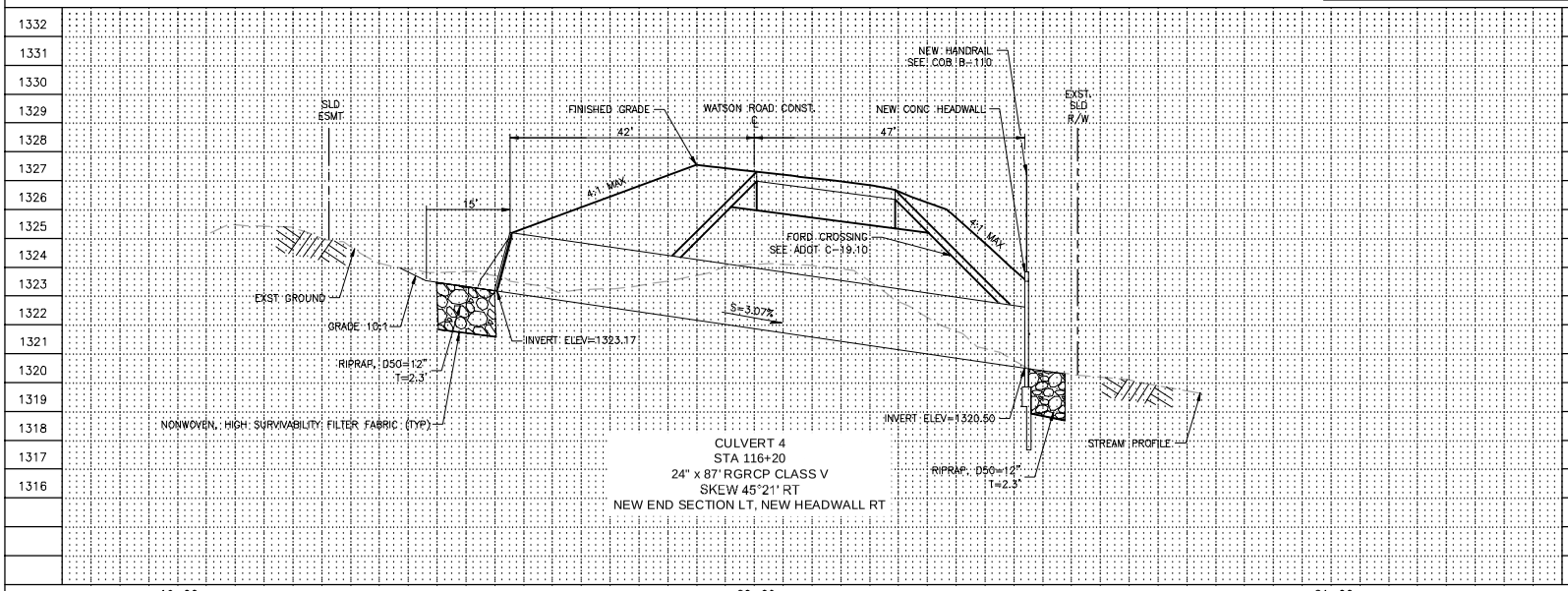


GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.



10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D04
STA 116+20

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
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PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL

AS-BUILT SEAL
DESIGN SEAL
Registered Professional Engineer (Civil) CHRISTOPHER A. KUNSMAN 21673 Date Signed 5/29/15 ARIZONA, U.S.A. Expires 3/30/16

ORIGINAL PLAN DATE
LATEST REVISION DATE
PROJECT No.
SHEET ID. D04
SHEET No. 27 OF 125
COB PLAN TRACKING #
COB PERMIT # ENG-13-00317

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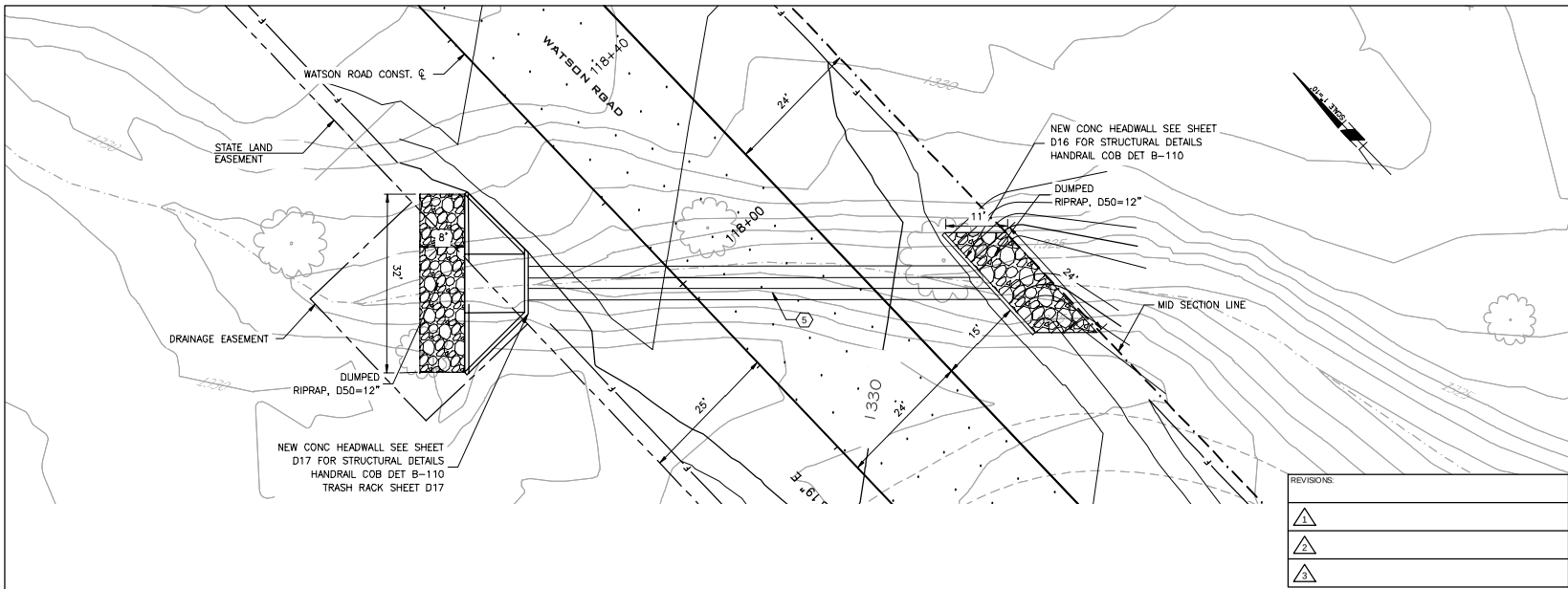

REVISIONS:

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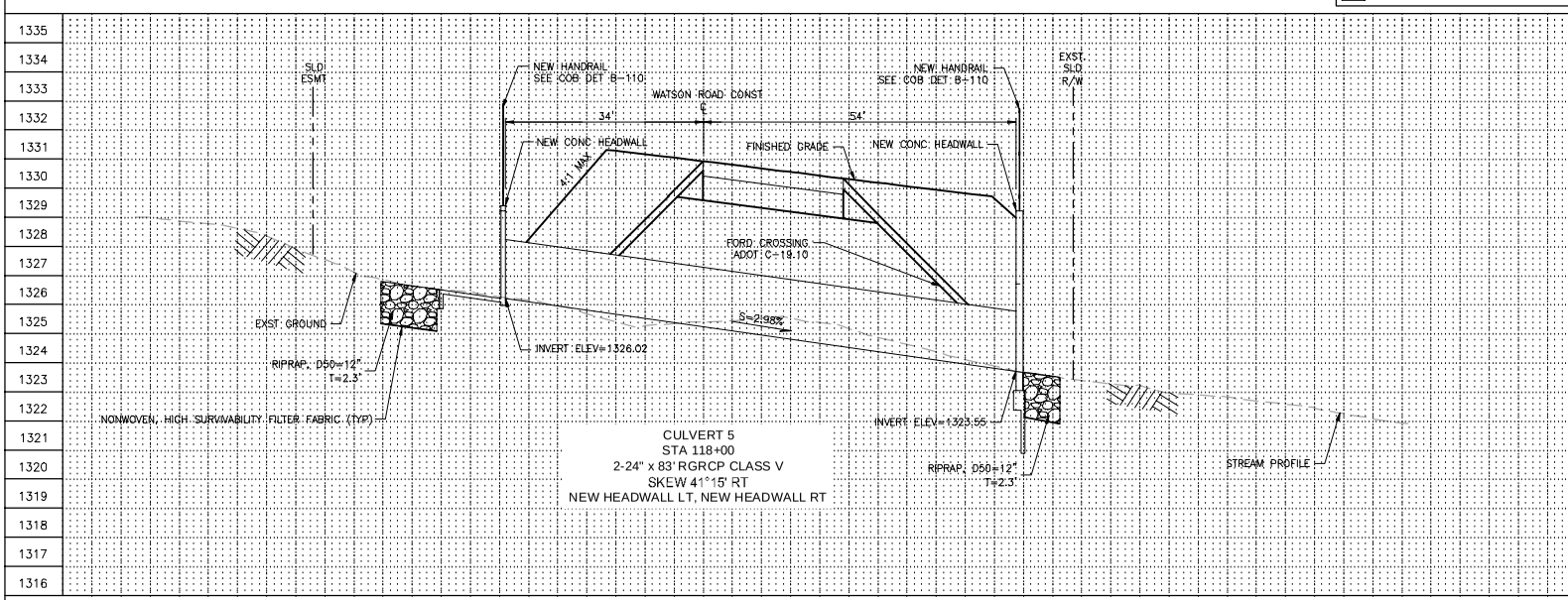

GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.

10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D05
STA 118+00

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
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COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL:

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 31673
RAJESH S. CHRISTIAN
Date Signed 5/29/15
ARIZONA, USA
Expires 3/30/15

ORIGINAL PLAN DATE

LATEST REVISION DATE

PROJECT No.

SHEET ID. D05

SHEET No. 28 OF 125

COB PLAN TRACKING #

COB PERMIT # ENG-13-00317

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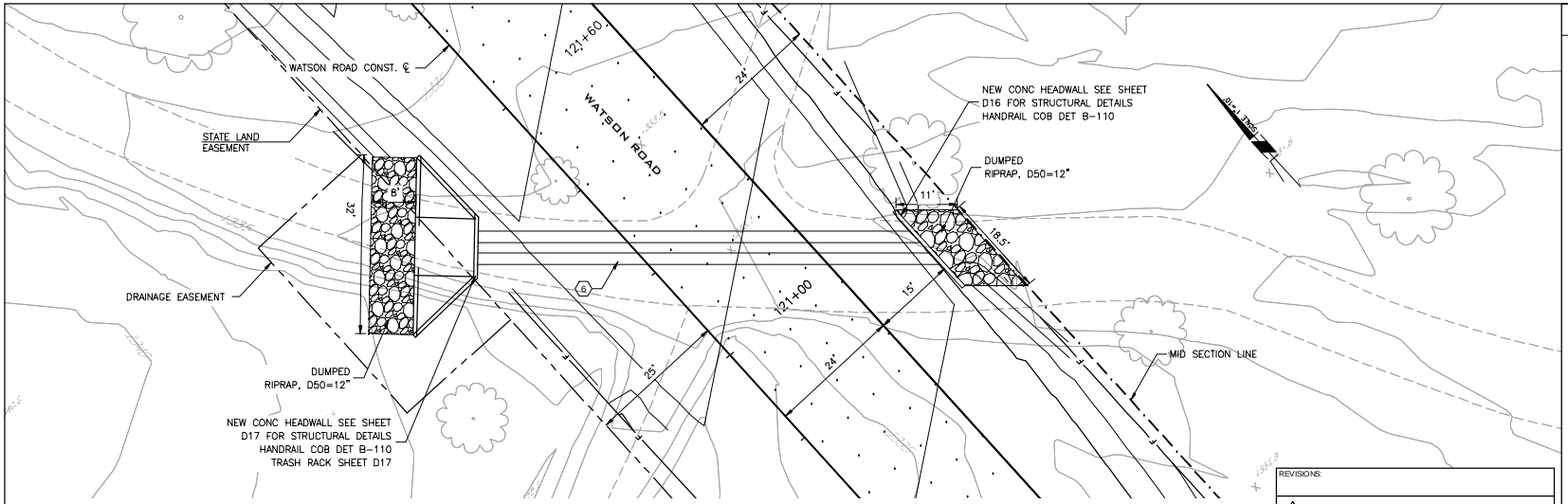
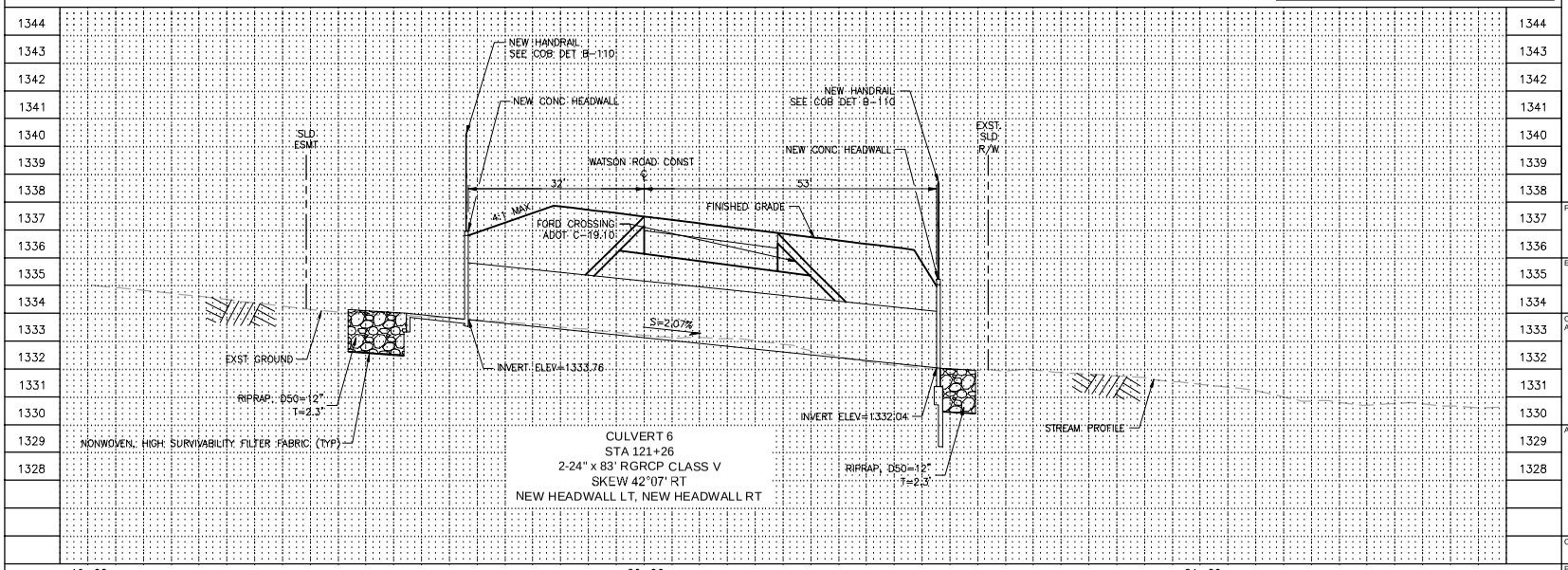


GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

1
2
3



CULVERT 6
STA 121+26
2-24" x 83' RGRCP CLASS V
SKEW 42°07' RT
NEW HEADWALL LT, NEW HEADWALL RT

10' 5' 0 10'
SCALE HORIZ: 1" = 10'
SCALE VERT: 1" = 2'

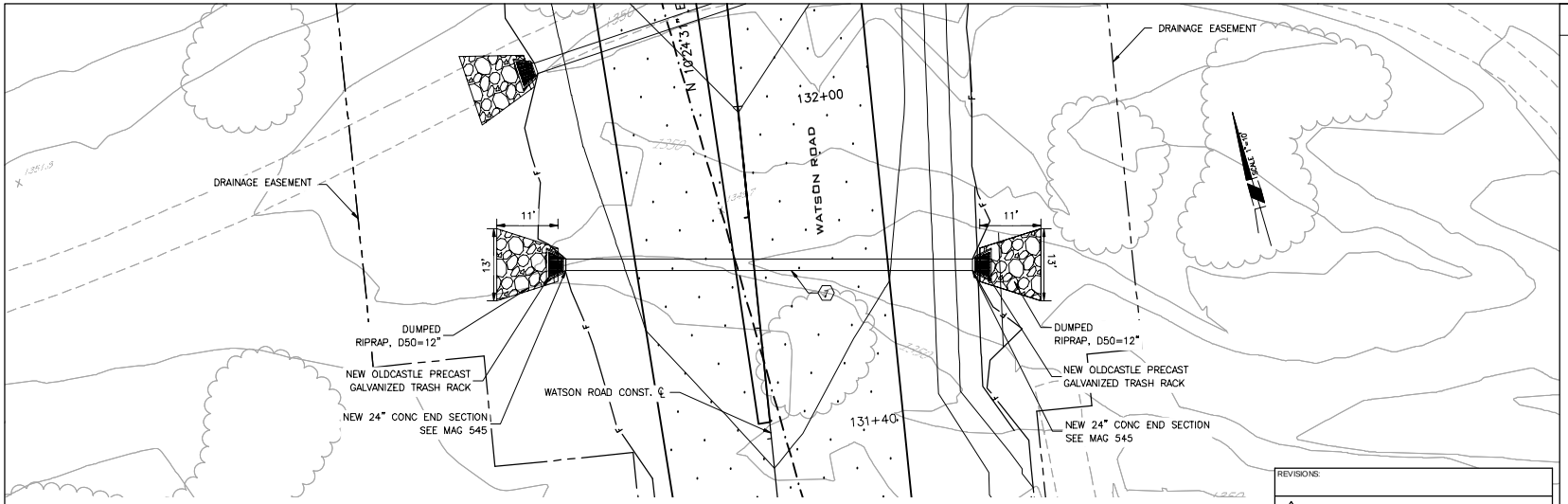
CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D06
STA 121+26

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL
AS-BUILT SEAL
DESIGN SEAL
Expires 09/30/15
ORIGINAL PLAN DATE
LATEST REVISION DATE
PROJECT No.
SHEET ID. D06
SHEET No. 29 OF 125
COB PLAN TRACKING #
COB PERMIT #
ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT06.dwg February 5, 2015 Hall, Joseph

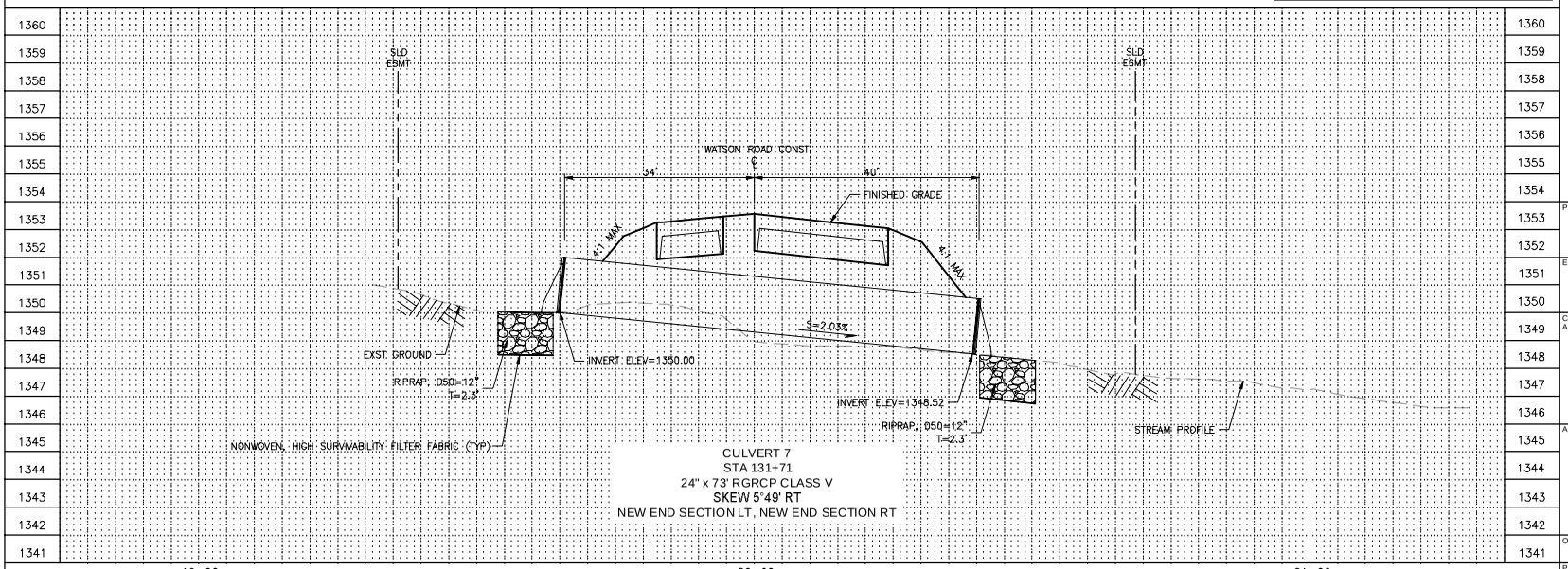


REVISIONS:

1
2
3

GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.



10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D07
STA 131+71

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL

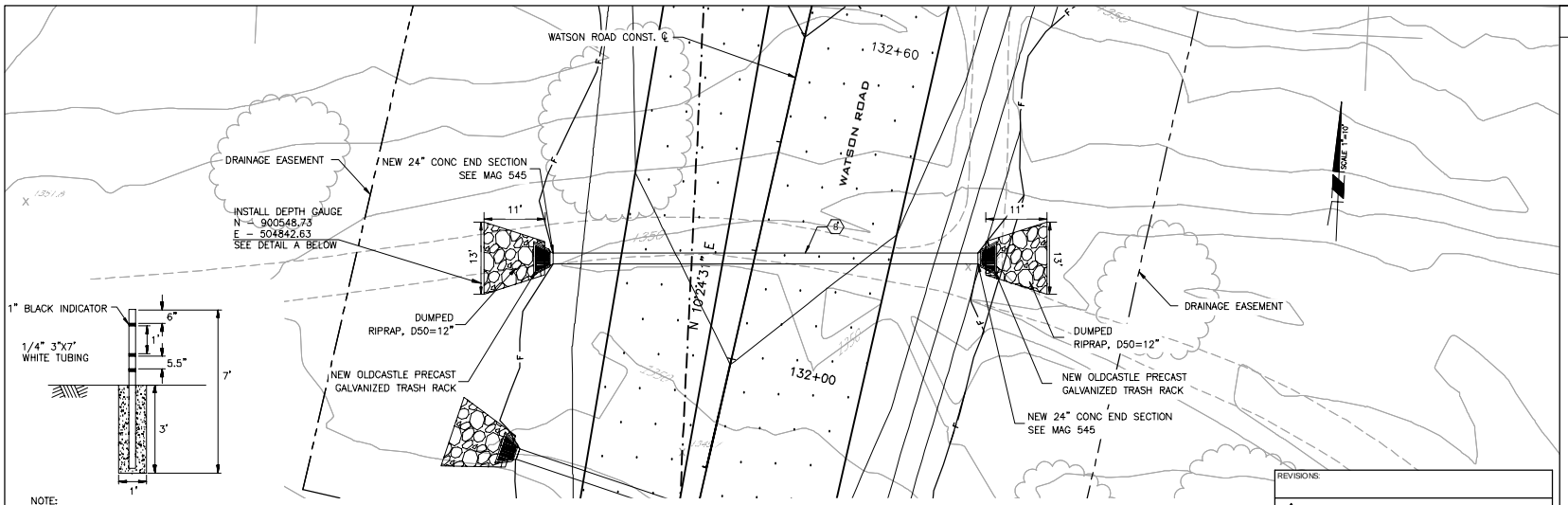
AS-BUILT SEAL
DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 31673
RAJESH G. CHRISTIAN
Date Signed 02/05/15
ARIZONA, U.S.A.
Expires 06/30/15

ORIGINAL PLAN DATE
LATEST REVISION DATE

PROJECT No.
SHEET ID. D07
SHEET No. 30 OF 125

COB PLAN TRACKING #
COB PERMIT #
ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Filee\2011-120-PH1-DDT07.dwg February 5, 2015 Hall, Joseph



NOTE:
BOTTOM LEVEL WITH PROFILE GRADE LINE
EMBED 3' INTO GROUND AND SET IN CONCRETE.
SET IN GROUT OR CAP.

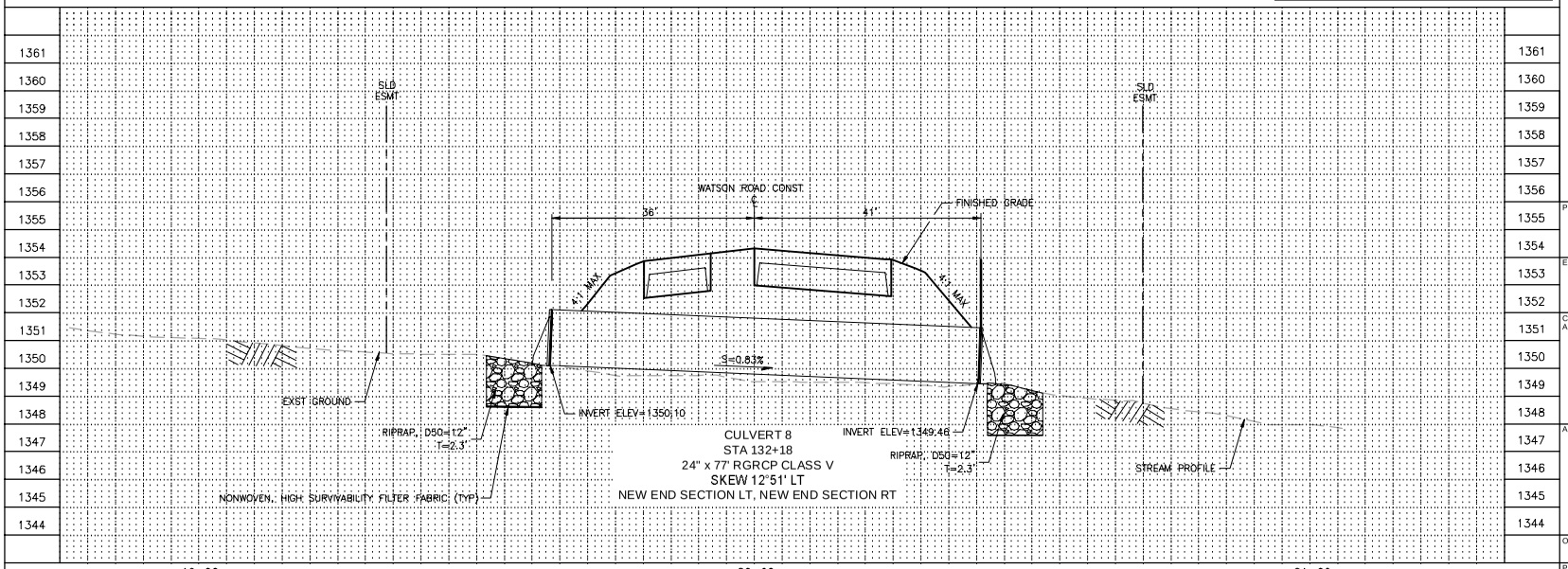
DETAIL A

GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

1
2
3



10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D08
STA 132+18

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL

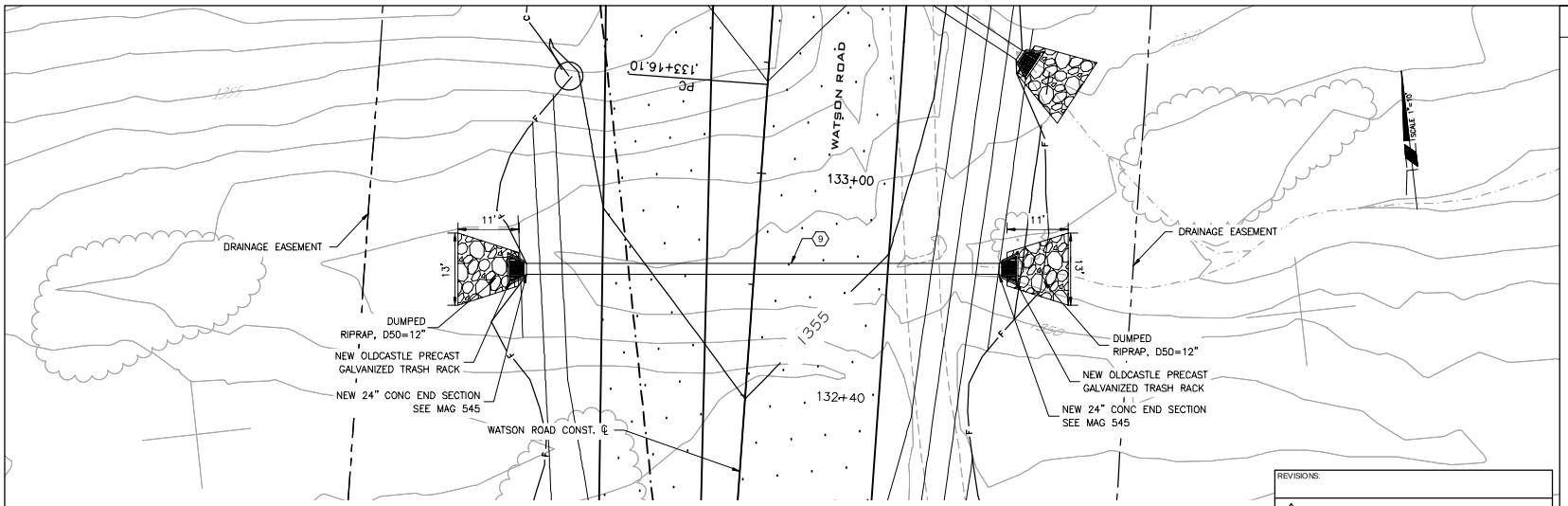
AS-BUILT SEAL
DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 21673
RAJESH G. CHRISTIAN
Date Signed 02/05/15
ARIZONA, U.S.A.
Expires 06/30/15

ORIGINAL PLAN DATE
LATEST REVISION DATE

PROJECT No.
SHEET ID. D08
SHEET No. 31 OF 125

COB PLAN TRACKING #
COB PERMIT #
ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT08.dwg February 5, 2015 Hall, Joseph



REVISIONS:

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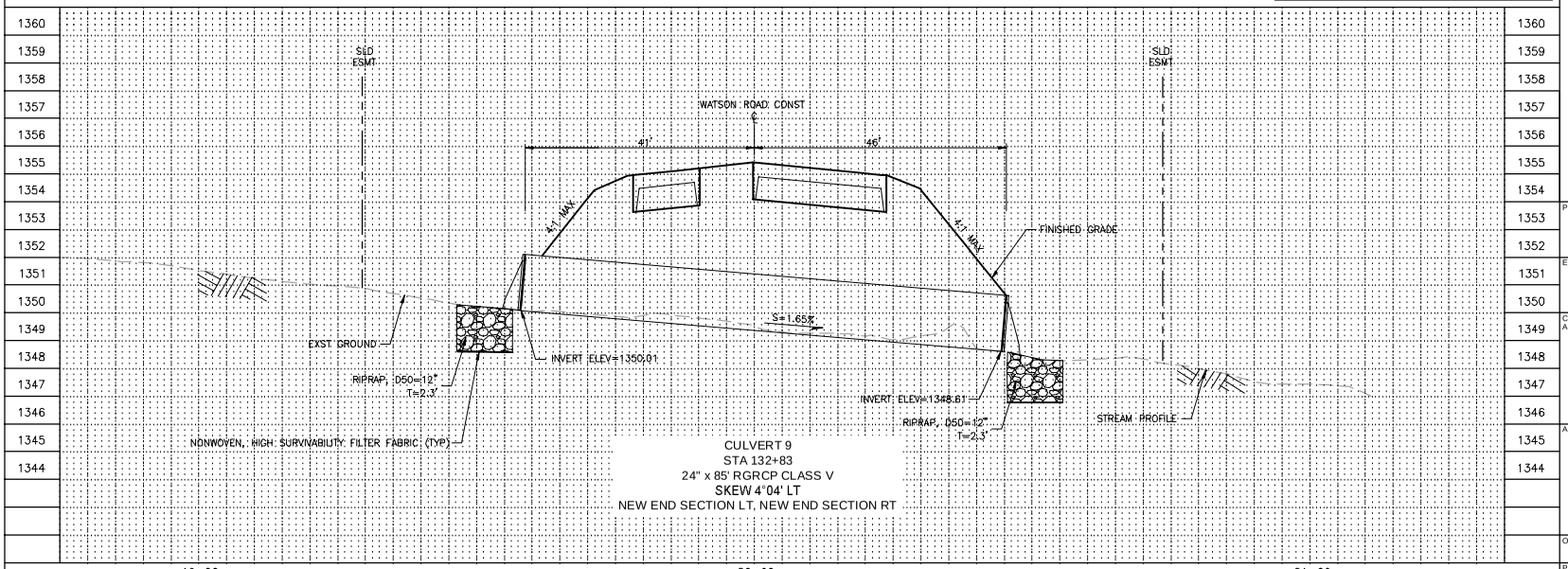

GENERAL NOTES

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2. SEE SHEET D16 FOR RIPRAP GRADATION.

10' 5' 0 10'
SCALE HORIZ: 1"= 10'
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CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D09
STA 132+83

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL:

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 31673
RAJESH S. CHRISTIAN
Date Signed 03/04/15
ARIZONA, U.S.A.
Expires 09/30/15

ORIGINAL PLAN DATE

LATEST REVISION DATE

PROJECT No.

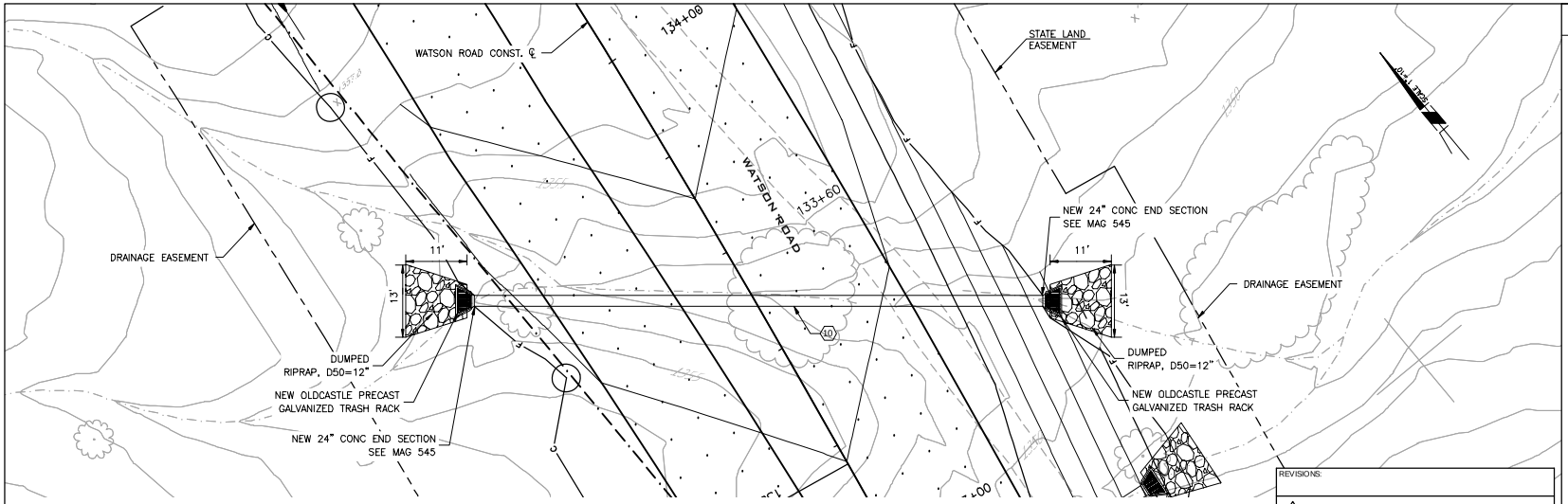
SHEET ID. D09

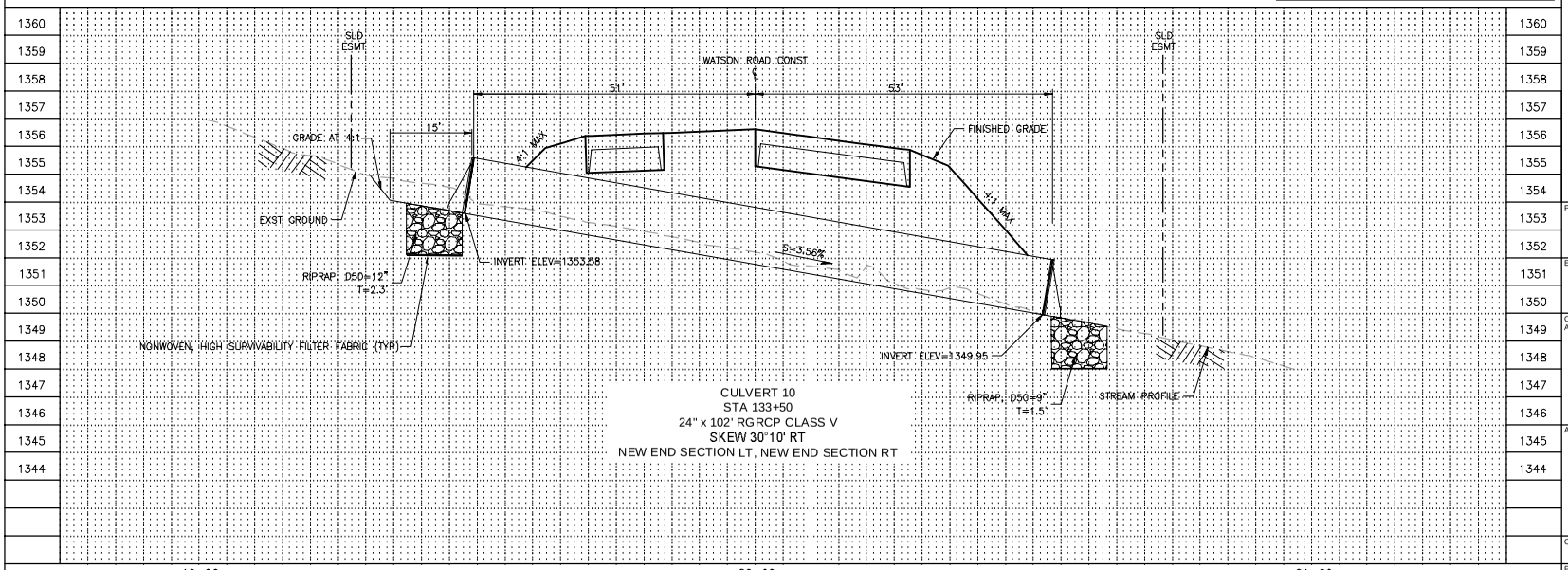
SHEET No. 32 OF 125

COB PLAN TRACKING #

COB PERMIT # ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT09.dwg February 5, 2015 Hall, Joseph





GENERAL NOTES

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2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

1	
2	
3	

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CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D10
STA 133+50

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL:

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 31673
RAJESH S. CHRISTIAN
Date Signed 09/04/13
ARIZONA, U.S.A.
Expires 09/30/15

ORIGINAL PLAN DATE

LATEST REVISION DATE

PROJECT No.

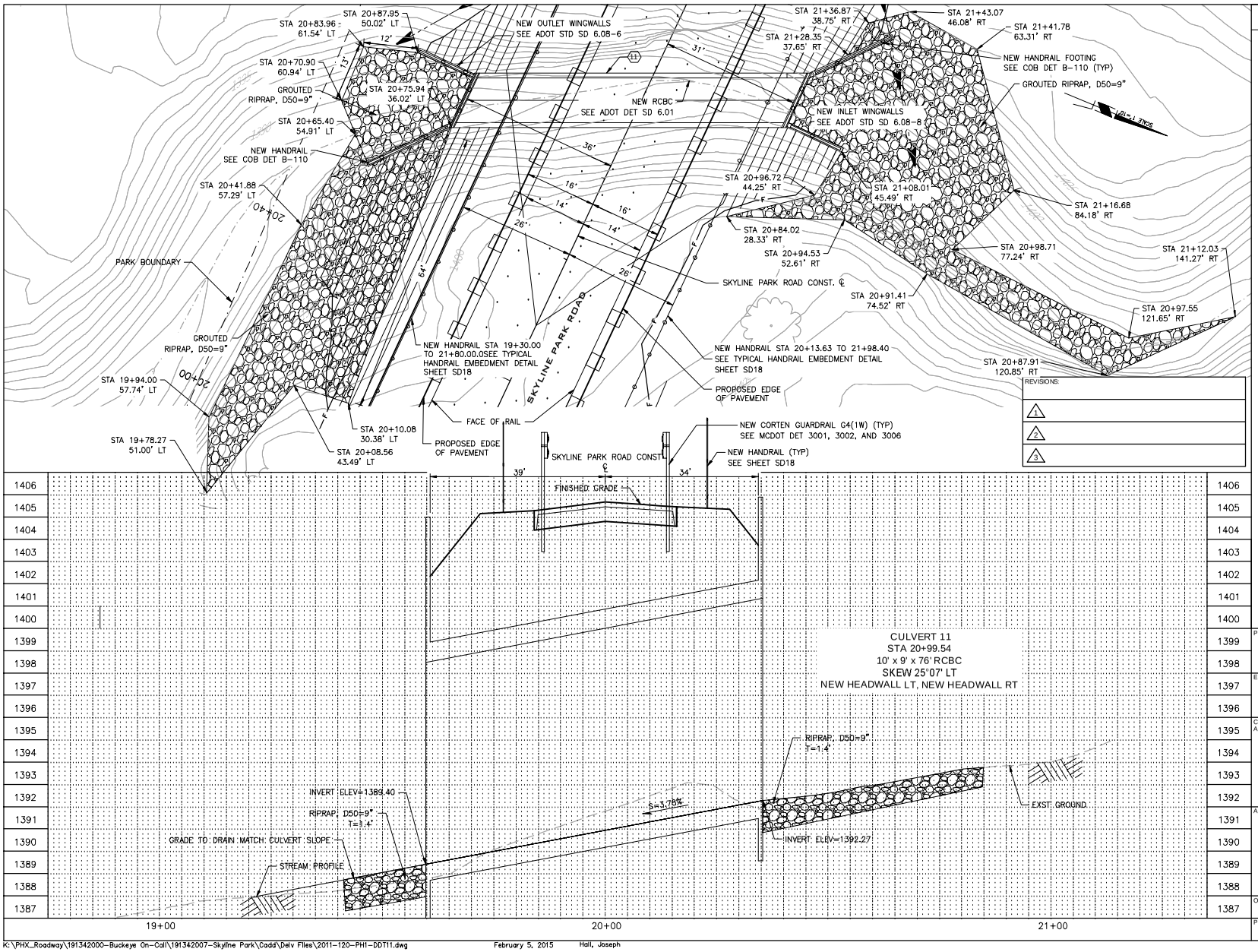
SHEET ID. D10

SHEET No. 33 OF 125

COB PLAN TRACKING #

COB PERMIT # ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT10.dwg February 5, 2015 Hall, Joseph



GENERAL NOTES

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2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

1	
2	
3	

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SCALE VERT: 1" = 2'

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602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D11
STA 20+96

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL

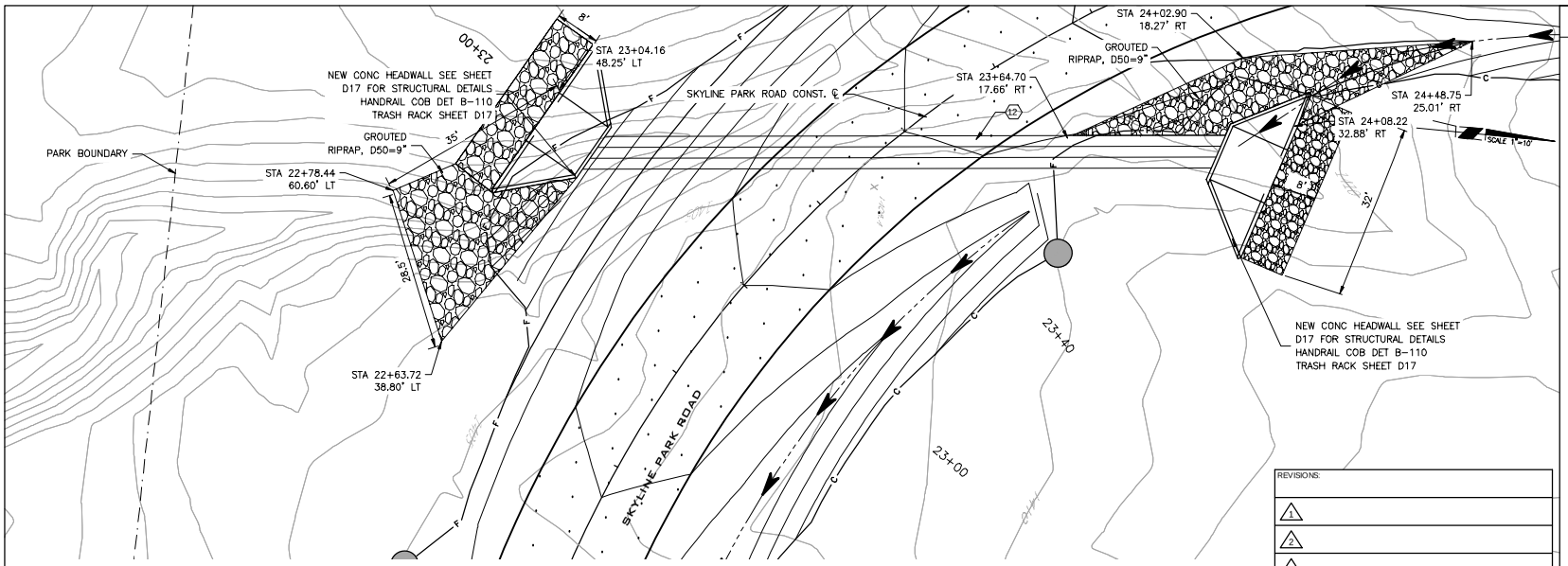
AS-BUILT SEAL
DESIGN SEAL
Expires 09/30/15

ORIGINAL PLAN DATE
LATEST REVISION DATE

PROJECT No.
SHEET ID. D11
SHEET No. 34 OF 125

COB PLAN TRACKING #
COB PERMIT #
ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT11.dwg February 5, 2015 Hall, Joseph



REVISIONS:

1

2

3

GENERAL NOTES

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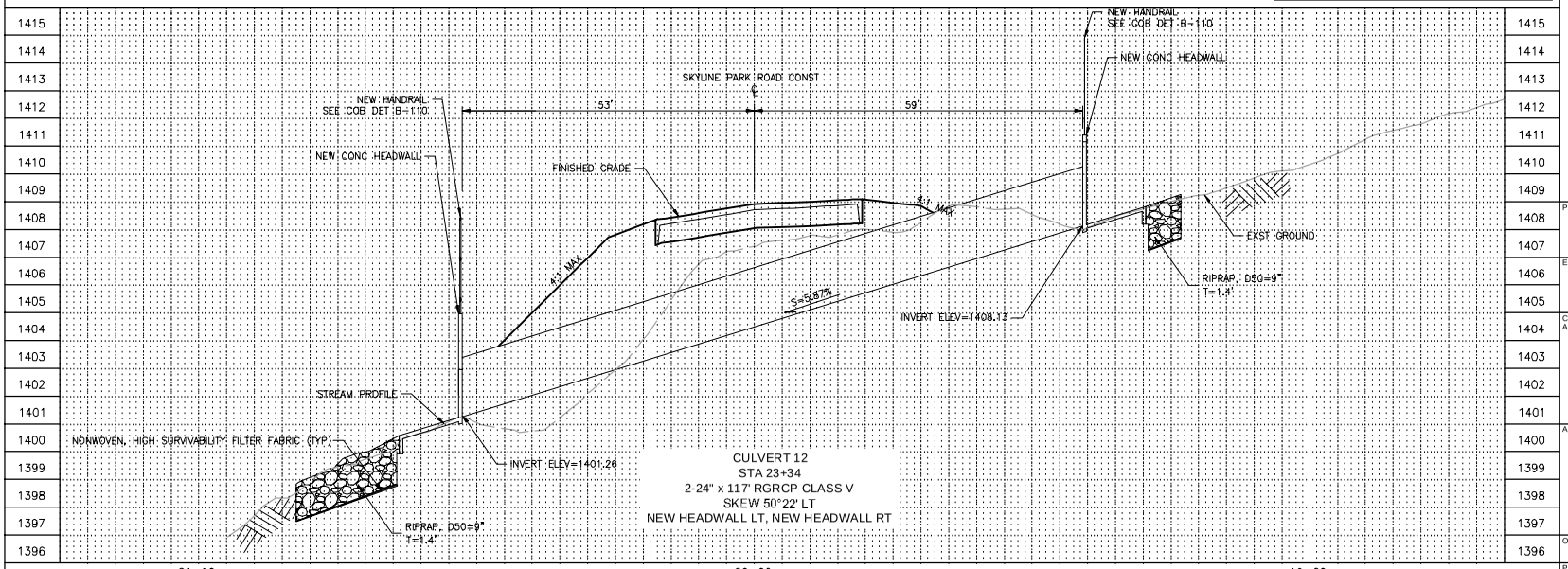

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602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D12
STA 23+34

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL:

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 21673
RAJESH S. CHRISTIAN
Date Signed 09/04/17
ARIZONA, U.S.A.
Expires 09/30/18

ORIGINAL PLAN DATE

LATEST REVISION DATE

COB PLAN TRACKING #

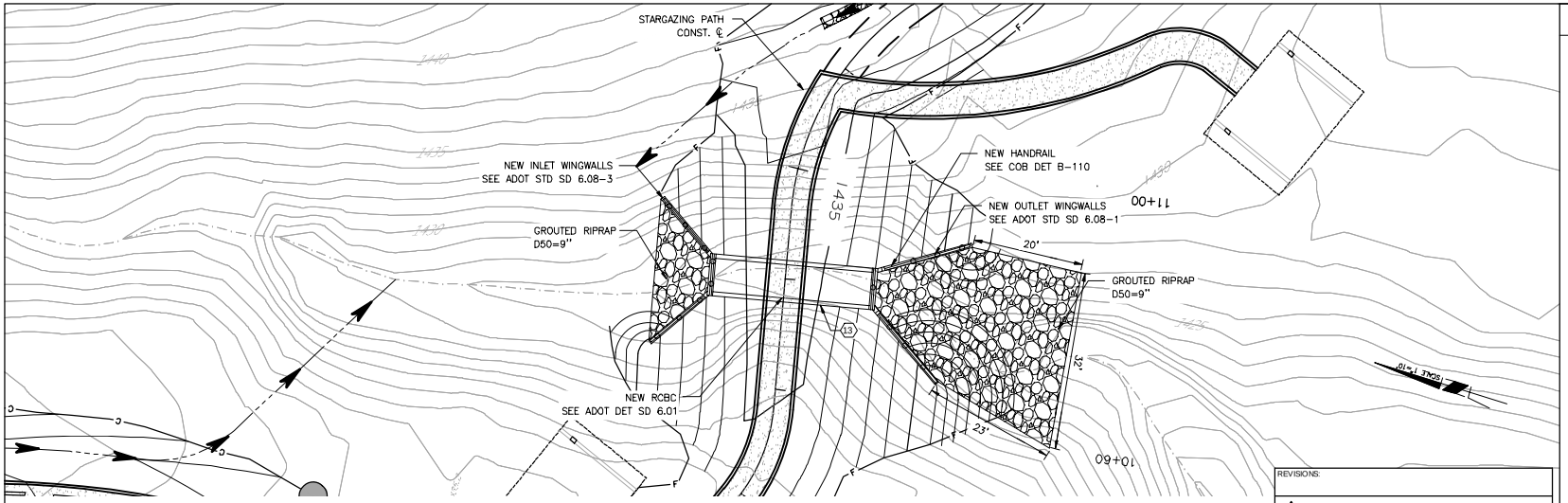
COB PERMIT #
ENG-13-00317

PROJECT No.

SHEET ID. D12

SHEET No. 35 OF 125

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT12.dwg February 5, 2015 Hall, Joseph



GENERAL NOTES

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2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

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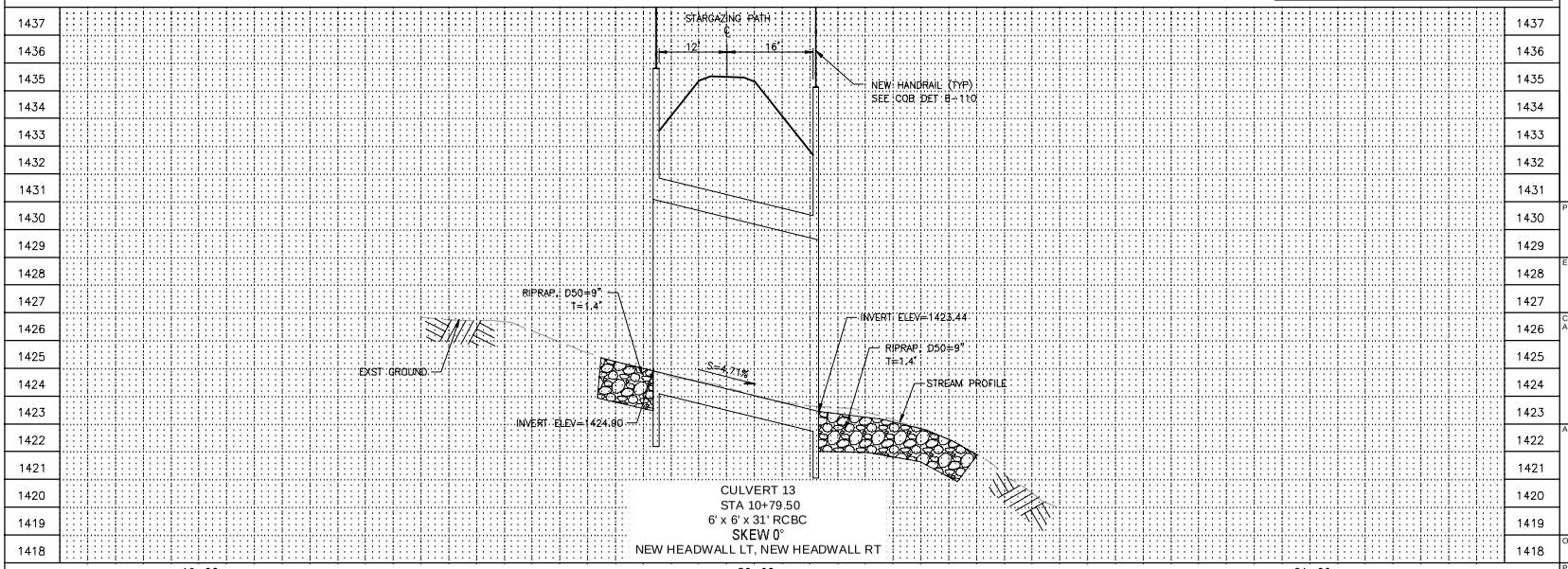

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SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D13
STA 10+82

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 21673
RAJESH G. CHRISTIAN
Date Signed 02/05/15
ARIZONA, U.S.A.
Expires 06/30/15

ORIGINAL PLAN DATE

LATEST REVISION DATE

PROJECT No.

SHEET ID. D13

SHEET No. 36 OF 125

COB PLAN TRACKING #

COB PERMIT #
ENG-13-00317

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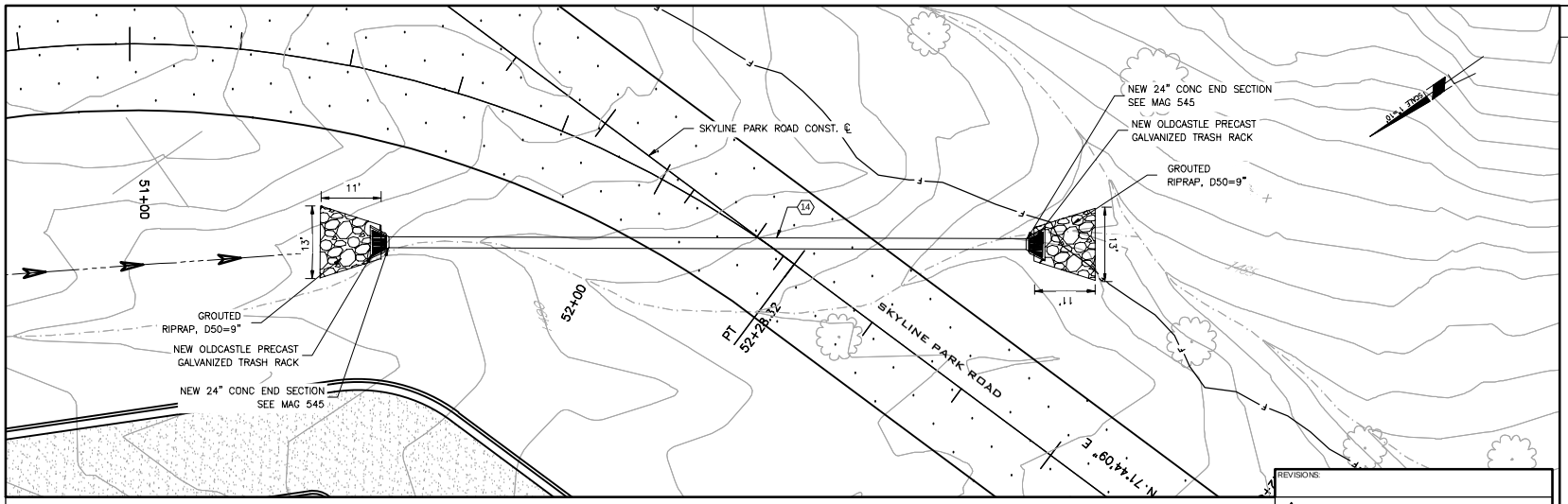
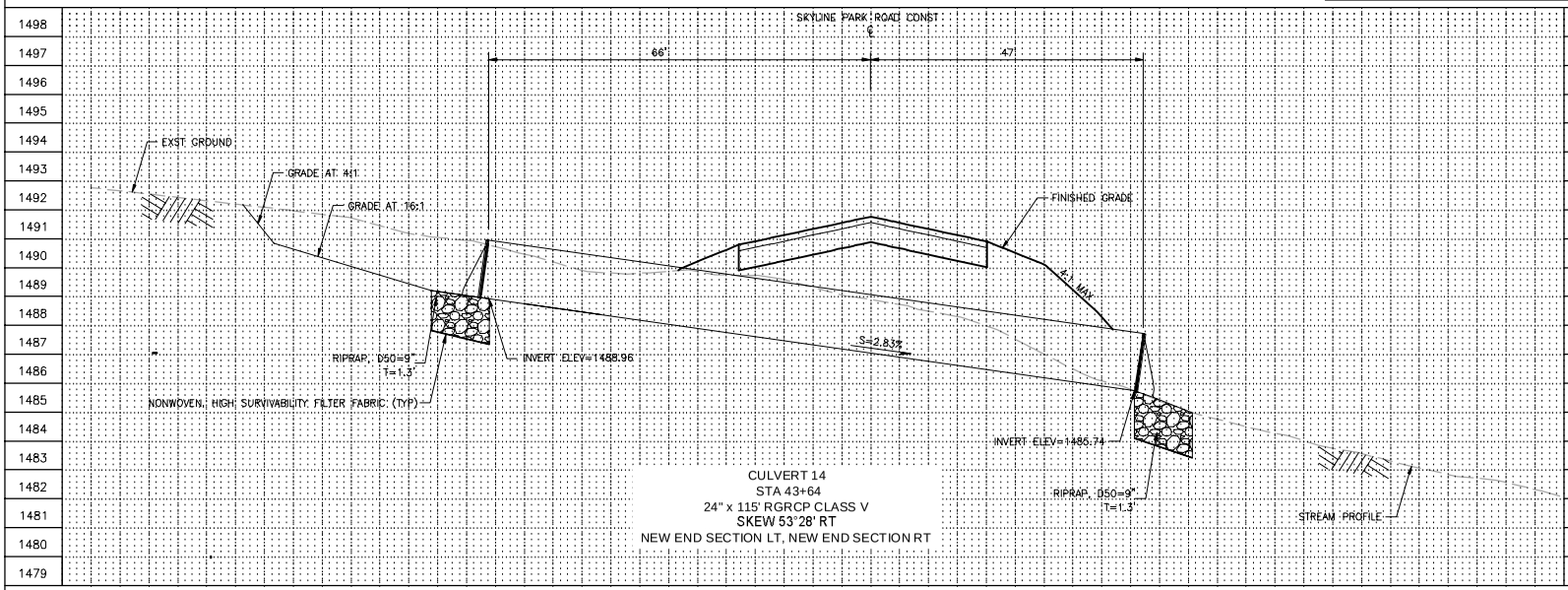


GENERAL NOTES

1. SEE PAVEMENT SHEETS AND SHEET D15 FOR CULVERT QUANTITIES BY CULVERT ID NUMBER (#)
2. SEE SHEET D16 FOR RIPRAP GRADATION.

REVISIONS:

1	
2	
3	



10' 5' 0 10'
SCALE HORIZ: 1"= 10'
SCALE VERT: 1"= 2'

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
CULVERT DETAIL SHEET
DETAIL D14
STA 23+34

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL

COB ENGINEERING APPROVED SEAL

SUBMITTAL:

AS-BUILT SEAL

DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 21673
RAJESH S. CHRISTIAN
Date Signed 09/30/15
ARIZONA, U.S.A.
Expires 09/30/15

ORIGINAL PLAN DATE

LATEST REVISION DATE

PROJECT No.

SHEET ID. D14

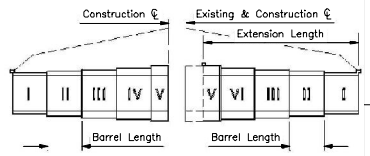
SHEET No. 37 OF 125

COB PLAN TRACKING #

COB PERMIT # ENG-13-00317

K:\PHX_Roadway\191342000-Buckeye On-Call\191342007-Skyline Park\Cadd\Delv Files\2011-120-PH1-DDT14.dwg February 5, 2015 Hall, Joseph

CULVERT SUMMARY



	DESCRIPTION												END TREATMENT									LENGTH OF BARREL & BARREL EXTENSIONS										APPROXIMATE QUANTITIES									
	Plan Reference Number ⬡ &		New	Extend	Number of Barrels	Barrel Span (0.0)	Barrel Height (0.0)	Culvert Length (0.0)	Skew (Degree) (0)	B-01.10 Misc Details	B-01.11 Ext Details	Standard or Detail	Location	WINGS: Inlet Wings	WINGS: Outlet Wings	WINGS: Standard or Detail	APRON: Apron	APRON: Standard or Detail	MISCELLANEOUS: Scour/Bank Protection	MISCELLANEOUS: Standard or Detail	MISCELLANEOUS: Energy Dissipaters	MISCELLANEOUS: Detail - "place a letter or dash here"	Linear Feet (0.0) Left of Centerline I	Left of Centerline II	Left of Centerline III	Left of Centerline IV	Left of Centerline V	Right of Centerline V	Right of Centerline IV	Right of Centerline III	Right of Centerline II	Right of Centerline I	lbs. Reinforcing Steel (0)	Ea Place Dowels	Cubic Yards Class S Concrete f'c=3,000 psi	Remove Str. Concrete (0)	Structural Excavation (0)	Structure Backfill (0)	Berm Embankment (0)	Dike Embankment (0)	Drainage Excavation (0)	REMARKS
	11		X		1	10	9.0	75.6	25.1 Lt				Left		X	SD 6.08-6							40.3										10,469		87		35	120				DETAIL D11
			20+99.54										Right	X		SD 6.08-8																35.3	9,130		76		32	108				
SKYLINE PARK RD			1 - 10'x9'x75.6' CBC Sk 25.1 Lt																										Box Culvert Total				19,600		163		67	228				
	13		X		1	6	6.0	30.6	0				Left	X		SD 6.09-3							13.6										2,458		23			50				DETAIL D13
			10+79.50										Right		X	SD 6.08-1																17.0	3,256		32			56				
			1 - 6'x6'x30.6' CBC Sk 0																										Box Culvert Total				5,715		55			108				

	DESCRIPTION								CSP						CAP				RCP		NRCP	NRCPCP	CHDPE/PP		END TREATMENT																						
	Station		Plan Ref No. ⬡	Controlling Fill Height Range	Size, Corrugated (in.)	Size, Smooth (in.)	Length (ft.)	Skew (Degree)	Corrugation	Wall Thickness (in.)	Coating: Zinc	Coating: Bit. Coated Zinc	Coating: Aluminum	Coating: Bit. Coated Aluminum	Corrugation	Wall Thickness (in.)	Uncoated	Bit. Coated	Class - Non Trench	Class - Trench	Class	Min Wall Thickness (in.)	AASHTO M-294 Type C	AASHTO M-294 Type S	Each: MAG Det. 545	Each: End Sec/ Headwall: Concrete Headwall	Each: End Sec/ Headwall: Detail	Tresh Rack	Catch basin, Manhole & Junction Structure: Ea	Standard Detail	S-Single / D-Double	Location	H (0.0) (ft.)	L Wing (0.0)	L 18" Slotted Drain (0)	L 24" Slotted Drain (0)	Type	Elev. (0.00) (ft.)	Inlet Depression: Depth (in.)	Inlet Depression: L (0.0) (ft.)	Pipe Exc (0)	Pipe Bdl (0)	Dim Exc (0)	Berm/Dike Emb (0)	REMARKS
WATSON RD	93+46		1	1		18	48	7.4 Rt											IV	IV	5				2			2													23	10	59	33	Detail D01
	100+70		2	1		24	93	53.4 Rt											V	V	5				1	1	D16	1													11	23	44	30	Detail D02
	115+84		3	2		24	84	46.5 Rt											V	V	5				1	1	D16	1													18	21	12	50	Detail D03
	116+20		4	2		24	87	45.4 Rt											V	V	5				1	1	D16	1													23	21	10	30	Detail D04
	118+00		5	1		2 - 24	83	41.2 Rt											V	V	5					2	D16	2													14	28		14	Detail D05
	121+26		6	1		2 - 24	83	42.1 Rt											V	V	5					2	D16	2													8	28		30	Detail D06
	131+71		7	1		24	73	5.82 Rt											V	V	5				2			2													9	18		14	Detail D07
	132+18		8	1		24	77	12.85 Lt											V	V	5				2			2													6	18		30	Detail D08
	132+83		9	2		24	85	4.1 Lt											V	V	5				2			2													11	20		14	Detail D09
	133+50		10	2		24	102	30.2 Rt											V	V	5				2			2													15	24		30	Detail D10
SKYLINE PARK RD	23+34		12	2		2 - 24	117	50.4 Lt											V	V	5					2	D16	2													1.19	40		30	Detail D12
	43+64		14	2		24	115	53.5 Lt											V	V	5				2			2													87	28		30	Detail D14

FILL HEIGHT RANGE												
RANGE NO.		1	2	3	4	5	6	7	8	9	10	11	12
FILL	>	1	3	5	8	11	15	20	25	30	40	55	70
HEIGHT (FT.)	≤	3	5	8	11	15	20	25	30	40	55	70	90

SHOULD FIELD CONDITIONS VARY FROM THE RANGE INDICATED, CONTACT DESIGN FOR RE-EVALUATION OF PIPE DESIGN REQUIREMENTS.

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

REVISIONS:
1
2
3

PLAN NAME
CULVERT SUMMARY SHEET

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

COB PERMITTING APPROVED SEAL
COB ENGINEERING APPROVED SEAL
SUBMITTAL:
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DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 21073
RUSS A. CHRISTIAN
Date Signed 03/30/15
ARIZONA, U.S.A.
Expires 03/30/15
ORIGINAL PLAN DATE
LATEST REVISION DATE
PROJECT No.
SHEET ID. D15
SHEET No. 38 OF 125
COB PLAN TRACKING #
COB PERMIT # ENG13-00317

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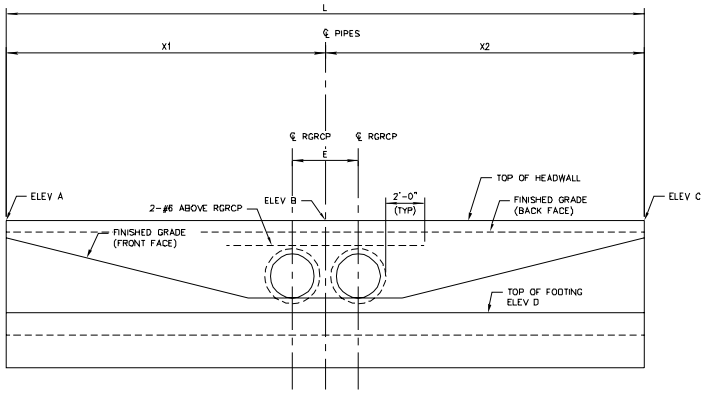
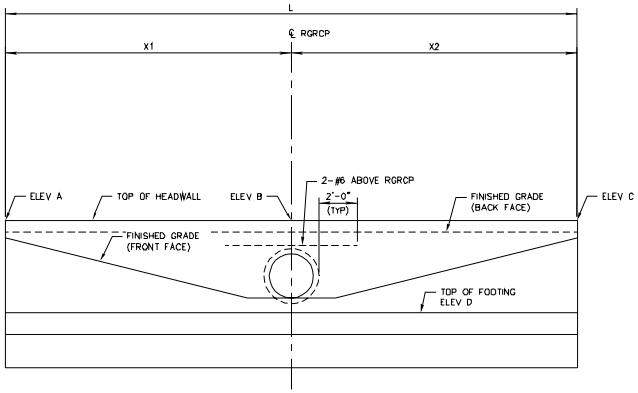
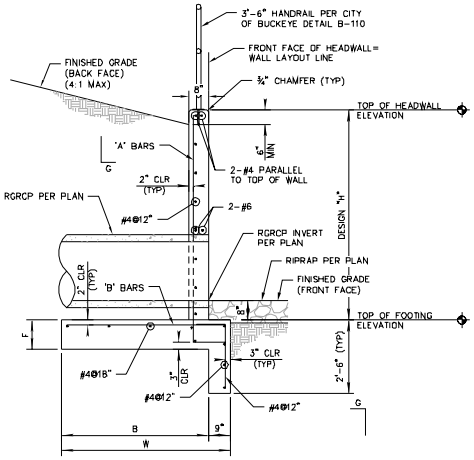


TYPICAL DOUBLE PIPE HEADWALL ELEVATION
SCALE: 3/8" = 1'-0"



TYPICAL SINGLE PIPE HEADWALL ELEVATION
SCALE: 3/8" = 1'-0"



TYPICAL SECTION
SCALE: 1/2" = 1'-0"

HEADWALL NOTES:

1. ALL CONCRETE SHALL BE CLASS 'A' PER MAG SECTION 725, f'c = 3000 PSI.
2. DESIGN CRITERIA:
   2.1. SOIL UNIT WEIGHT: 120 PCF
   2.2. ACTIVE SOIL PRESSURE: 35 PCF
   2.3. ALLOWABLE BEARING CAPACITY: 1500 PSF
   2.4. COEFFICIENT OF FRICTION: 0.35 (WITH PASSIVE PRESSURE)
   0.45 (W/OUT PASSIVE PRESSURE)
3. REINFORCING STEEL SHALL CONFORM TO ASTM SPECIFICTAION A615. ALL REINFORCING SHALL BE FURNISHED AS GRADE 60.
4. ALL BENDS AND HOOKS SHALL MEET THE REQUIREMENTS OF AASHTO LRFD ARTICLE 5.10. ALL BEND DIMENSIONS FOR REINFORCING STEEL SHALL BE OUT-TO-OUT OF BARS. ALL PLACEMENT DIMENSIONS FOR REINFORCING STEEL SHALL BE TO CENTER OF BARS UNLESS NOTED OTHERWISE.
5. ALL REINFORCING STEEL SHALL HAVE 2" CLEAR COVER UNLESS NOTED OTHERWISE.
6. COMPACT BACKFILL FOR FOOTING AND HEADWALL MINIMUM 95 PERCENT OF ASTM D698 MAXIMUM DRY DENSITY.
7. SEE CULVERT DETAIL SHEETS FOR CULVERT LAYOUTS AND ADDITIONAL DETAILS.

PIPE HEADWALL DIMENSIONS AND REINFORCING

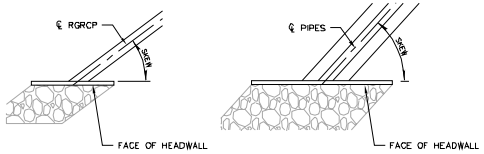
HEADWALL LOCATION					DIMENSIONS												REINFORCING STEEL LIST						MAX TOE PRESSURE (LBS/SQ. FT)
																	"A" BARS			"B" BARS			
HEADWALL INDENTIFICATION	CULVERT NUMBER	STATION	SKEW	TYPE	DESIGN "H"	W	B	F	L	E	X1	X2	ELEV A	ELEV B	ELEV C	ELEV D	BAR SIZE	SPACING	LENGTH	BAR SIZE	SPACING	LENGTH	
H1	2 (RIGHT)	100+70	36.6°	SINGLE PIPE	4'	3'-3"	2'-6"	1'-0"	14'-0"	N/A	7'-0"	7'-0"	1297.88	1297.88	1297.88	1293.71	#4	12"	SEE NOTE 1	#4	12"	2'-11"	1400
H2	3 (RIGHT)	115+84	43.5°	SINGLE PIPE	5'	4'-3"	3'-6"	1'-0"	20'-4"	N/A	11'-8"	8'-8"	1323.50	1323.50	1323.50	1318.76	#4	12"	SEE NOTE 1	#4	12"	3'-11"	1450
H3	4 (RIGHT)	116+20	44.6°	SINGLE PIPE	4'	3'-3"	2'-6"	1'-0"	15'-0"	N/A	7'-6"	7'-6"	1324.00	1324.00	1324.00	1319.83	#4	12"	SEE NOTE 1	#4	12"	2'-11"	1400
H4	5A (RIGHT)	118+00	47.9°	DOUBLE PIPE	7'	6'-6"	5'-9"	1'-0"	24'-0"	3'-11"	12'-0"	12'-0"	1329.50	1329.50	1329.50	1322.89	#5	12"	SEE NOTE 1	#5	12"	6'-2"	1475
H5	5B (LEFT)	118+00	90.0°	MODIFIED MAG STD. DET. 501-3 PER DETAILS ON SHEET D17																			
H6	6A (RIGHT)	121+26	47.9°	DOUBLE PIPE	4'	3'-3"	2'-6"	1'-0"	18'-6"	3'-11"	9'-6"	9'-6"	1335.54	1335.54	1335.54	1331.37	#4	12"	SEE NOTE 1	#4	12"	2'-11"	1400
H7	6B (LEFT)	121+26	90.0°	MODIFIED MAG STD. DET. 501-3 PER DETAILS ON SHEET D17																			
H8	12A (RIGHT)	23+34	67.0°	MODIFIED MAG STD. DET. 501-3 PER DETAILS ON SHEET D17																			
H9	12B (LEFT)	23+34	55.0°	MODIFIED MAG STD. DET. 501-3 PER DETAILS ON SHEET D17																			

REINFORCING NOTES:

1. "A" BAR LENGTH SHALL BE AS REQUIRED TO PLACE BAR TO TOP OF HEADWALL

LAP SPLICE AND HOOK LENGTH TABLE-REINFORCED CONCRETE

BAR SIZE	LAP LENGTH SPLICE	G
#4	1'-8"	0'-8"
#5	2'-1"	0'-10"
#6	2'-6"	1'-0"
#7	2'-11"	1'-2"
#8	3'-4"	1'-4"



TYPICAL HEADWALL SKEW DETAIL
SCALE: N.T.S.

RIPRAP GRADATION	
Percent Passing	D_{50}=9 Inch
100	13.50-15.30 Inch
85	10.80-12.60 Inch
50	9.00-10.35 Inch
15	3.60-5.40 Inch

RIPRAP GRADATION	
Percent Passing	D_{50}=12 Inch
100	18.00-20.4 Inch
85	14.40-16.80 Inch
50	12.00-13.8 Inch
15	4.80-7.20 Inch

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

PLAN NAME
PIPE CULVERT HEADWALL DETAILS
1 OF 2

ENGINEER INFORMATION
KIMLEY-HORN AND ASSOCIATES
7740 N 16TH ST, STE 300, PHOENIX, AZ 85020
PHONE:(602)944-5500, FAX:(602)944-7423

TOB PERMITTING APPROVED SEAL
TOB ENGINEERING APPROVED SEAL
SUBMITTAL

AS-BUILT SEAL
DESIGN SEAL
Registered Professional Engineer (Civil)
CERTIFICATE NO. 43920
KEVIN R. KAMM
Date Signed 12/13/19
ARIZONA, U.S.A.

ORIGINAL PLAN DATE
LATEST REVISION DATE

PROJECT No.
SHEET ID. D16
SHEET No. 39 OF 125

TOB PLAN TRACKING #
TOB PERMIT # ENG-13-00317

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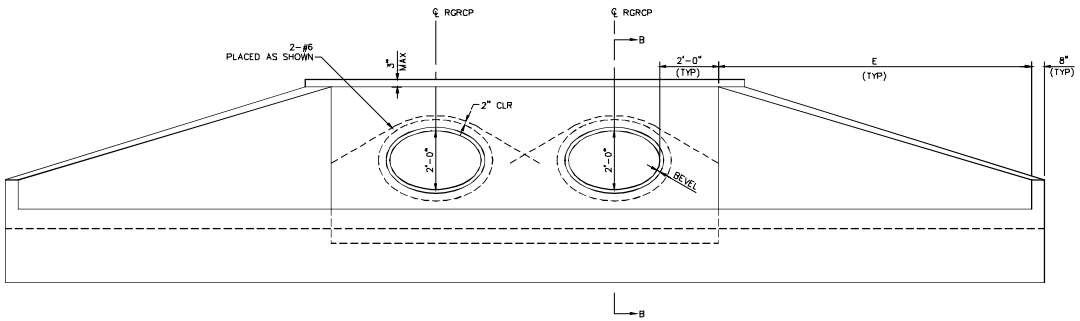
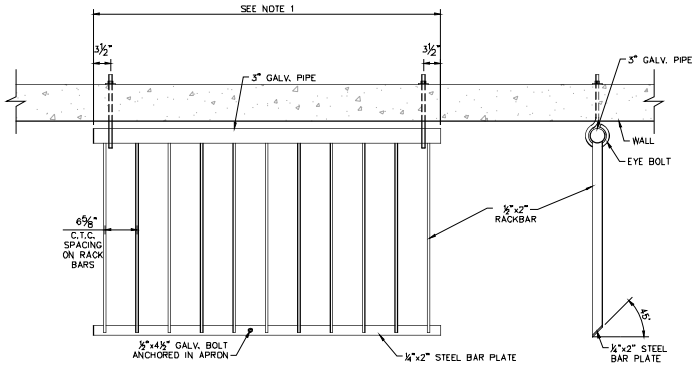


MODIFIED MAG STD. DET. 501-3 HEADWALL ELEVATION
SCALE: ½" = 1'-0"
(INLET SHOWN, OUTLET SIMILAR)
(TRASH RACK NOT SHOWN FOR CLARITY)

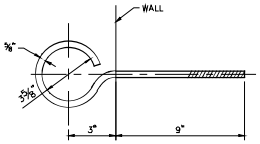


TRASH RACK- BAR RACK DETAIL
SCALE: 1" = 1'-0"

TRASH RACK NOTES:

1. CONTRACTOR TO VERIFY CLEARANCE @ EACH WINGWALL LOCATION

CULVERT	DIMENSION
5B (LEFT)	3'-6"
6B (LEFT)	3'-6"
12A (LEFT)	3'-10"

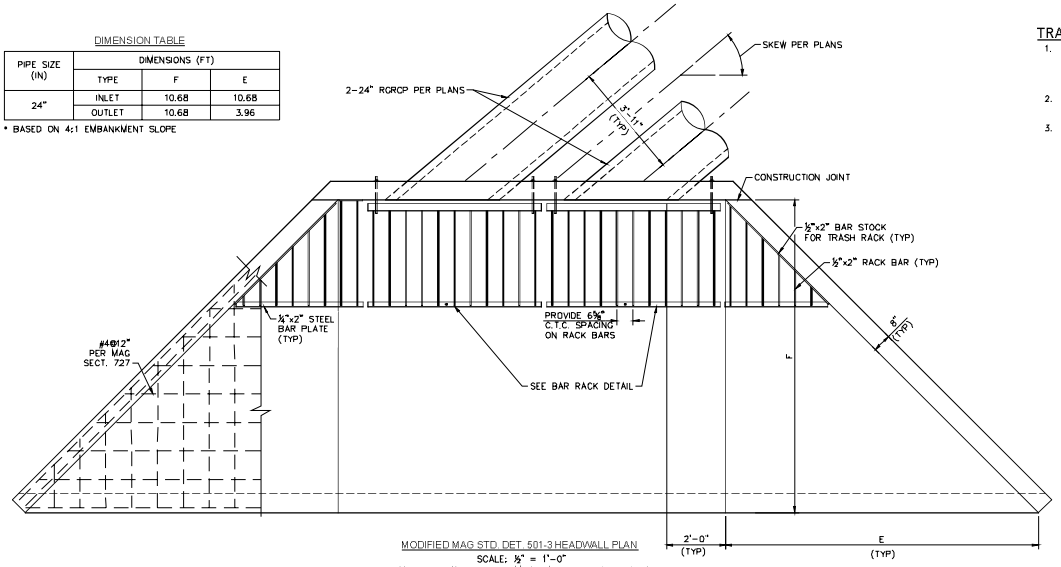


EYE BOLT DETAIL
SCALE: 3" = 1'-0"

DIMENSION TABLE

PIPE SIZE (IN)	DIMENSIONS (FT)		
	TYPE	F	E
24"	INLET	10.68	10.68
	OUTLET	10.68	3.96

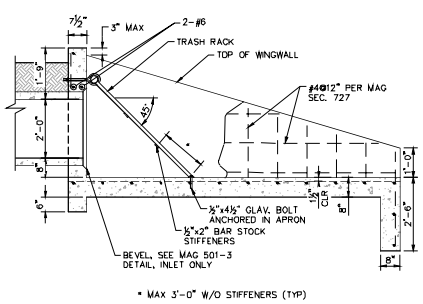
* BASED ON 4:1 EMBANKMENT SLOPE



MODIFIED MAG STD. DET. 501-3 HEADWALL PLAN
SCALE: ½" = 1'-0"
(INLET SHOWN, OUTLET SIMILAR WITHOUT TRASH RACK)

TRASH RACK NOTES:

1. REMOVE ALL SCALE FROM RACK BARS. METAL SPRAY OR SPRAY PAINT ONE COAT ZINC CHROMATE OR RED LEAD PRIMER (INDUSTRIAL QUALITY), OVERCOAT WITH GREY INDUSTRIAL ENAMEL, MAG SECTION 790.
2. STEEL BARS, PLATES, AND BOLTS SHALL CONFORM TO MAG SPECIFICATION SECTION 770.
3. BOLT MATERIAL SHALL CONFORM TO ASTM A307. BOLTS SHALL BE GALVANIZED TO CONFORM TO ASTM A153.



* MAX 3'-0" W/O STIFFENERS (TYP)

SECTION B-B
SCALE: ½" = 1'-0"

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

REVISIONS:

1

2

3

PLAN NAME
PIPE CULVERT HEADWALL DETAILS 2 OF 2

ENGINEER INFORMATION
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PHONE: (602)944-5500, FAX: (602)944-7423

COB PERMITTING APPROVED SEAL | COB ENGINEERING APPROVED SEAL

SUBMITTAL

AS-BUILT SEAL | DESIGN SEAL

Registered Professional Engineer (Civil)
CERTIFICATE NO. 37873
RUSSELL G. CHRISTIAN
Date Signed 10/30/14
ARIZONA, U.S.A.
Expires 30/30/15

ORIGINAL PLAN DATE | LATEST REVISION DATE

PROJECT No. | SHEET ID. D17 | SHEET No. 40 OF 125

COB PLAN TRACKING #

COB PERMIT # ENG-13-00317