DRAINAGE REPORT

BASELINE ROAD IMPROVEMENTS
LOOP 202 FREEWAY TO 57TH AVENUE

Prepared For:

BASELINE ROAD STAKEHOLDERS

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
PHOENIX, ARIZONA

CEC Project 182-001

KIVA: 06-2778

NOVEMBER 2018

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APPENDICES

1.0 INTRODUCTION

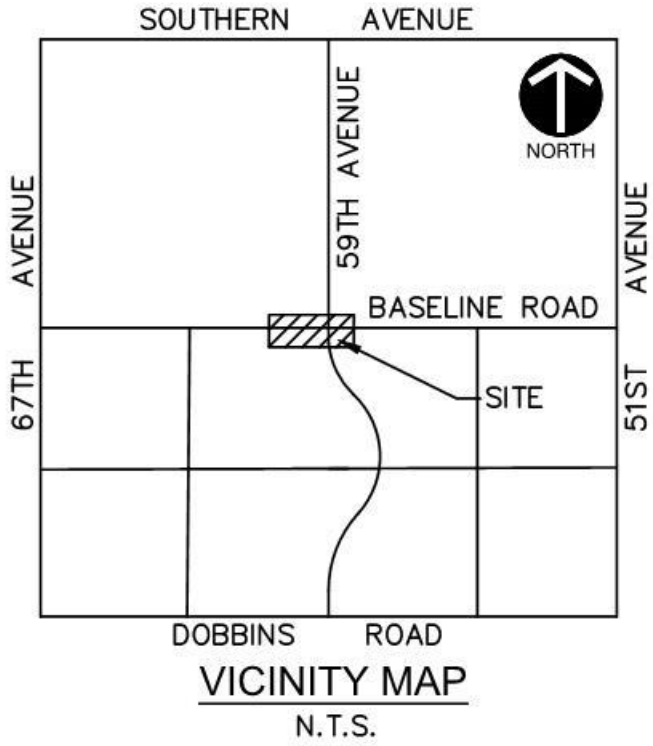
Baseline Road Improvements is a proposed arterial roadway improvement project located between the proposed Loop 202 Freeway and 57th Avenue in Phoenix, Arizona. The roadway improvements are 0.5 miles in length and will be in accordance with previously approved roadway geometry that the City of Phoenix has previously agreed upon. This is a joint venture project between the City of Phoenix and private land owners.

The site is further described as a portion of the southwest quarter Section 31, Township 2 North, Range 2 West and a very small portion of northeast quarter of Section 1, Township 1 North, Range 3 West of the Gila and Salt River Base and Meridian, Maricopa County, Arizona. Refer to the Vicinity Map on the following page.

This site is located within a shaded Zone X designation as identified on Flood Insurance Rate Map (FIRM) panel number 2195L of 4425 (Maricopa County) dated October 16, 2013 from the Federal Emergency Management Agency (FEMA). This area is defined as, "Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% chance annual flood." A copy of the FEMA FIRM Map is located in Appendix B at the back of this report.

This Drainage Report will document roadway retention requirements, offsite drainage, existing improvements, and anticipated improvements.

Vicinity Map



2.0 OFFSITE DRAINAGE AND EXISTING IMPROVEMENTS

There is no offsite drainage that affects this project. The property at the northwest corner of 59th Avenue and Baseline Road is currently an active farm field and is generally a couple of feet lower than the proposed Baseline Road improvements. This property also has an irrigation tail-water ditch that directs irrigation and storm water to an existing irrigation headwall and is piped under the proposed Loop 202 Freeway to the west. The property at the southwest corner of 59th Avenue and Baseline Road is currently under development by Laveen Baseline LLC. Drainage for this property is directed to the south and ultimately into the Laveen Area Conveyance Channel (LACC). The property at the southeast corner of 59th Avenue and Baseline Road is currently undeveloped. Drainage for this property ultimately goes south into the LACC. The properties at the northeast corner of 59th Avenue and Baseline Road currently an inactive driving range for a golf course. Immediately adjacent to Baseline Road there is a detention facility and drainage is directed to an existing headwall just west of 57th Avenue, which ultimately discharges into the LACC.

3.0 PROPOSED DRAINAGE AND INFRASTRUCTURE IMPROVEMENTS

Retention requirements for this project vary based on adjacent property. Coordination with the City of Phoenix it was decided by staff that each adjacent landowner will be required to account for their half street drainage. Scuppers will be constructed to capture roadway drainage and direct them to onsite retention/detention facilities.

The property at the northwest corner of 59th Avenue and Baseline Road will account for their half-street retention in a 1-foot temporary retention basin for the 100-year, 2-hour rainfall depth. A curb opening scupper will be constructed along with a concrete spillway to direct half street drainage into the temporary basin. This scupper is designed to handle the 10-year storm event per City of Phoenix drainage criteria. This scupper will be in a sag condition and the roadway spread is approximately 15.58 feet which will allow at least one dry travel lane within the roadway. 100-year peak flows will be contained within the right-of-way.

The property at the southwest corner of 59th Avenue and Baseline Road will account for their half-street retention in onsite retention facilities for the 5-year, 2-hour rainfall depth per a recorded development agreement with the City of Phoenix. Two scuppers will be constructed to direct half street drainage to the onsite drainage facilities. The onsite drainage facilities have been approved by the City of Phoenix as part of the Laveen Park Place – Phase 1 Grading & Drainage plans. The catch basins are designed to handle the 10-year storm event per City of Phoenix drainage criteria. The catch basins will be in sag conditions and the roadway spread is approximately 21.13 feet which will allow at least one dry travel lane within the roadway. 100-year peak flows will be contained within the right-of-way.

The property at the southeast corner of 59th Avenue and Baseline Road will account for their half street retention in a 1-foot temporary retention basin for the 100-year, 2-hour rainfall depth. A curb opening scupper will be constructed along with a concrete spillway to direct half street drainage into the temporary basin. This scupper is designed to handle the 10-year storm event per City of Phoenix drainage criteria. This scupper will be in a sag condition and the roadway spread is approximately 25.95 feet which will allow at least one dry travel land within the roadway. 100-year peak flows will be contained within the right-of-way.

The properties at the northeast corner of 59th Avenue and Baseline Road will account for their half street retention in an existing ponding area that serves as a detention facility. Drainage is ultimately directed to the LACC via headwall and storm drain. A scupper will direct half street drainage into the existing ponding area. The scupper is designed to handle the 10-year storm event per City of Phoenix drainage criteria. The scupper will be in a sag condition and the roadway spread is approximately 27.12 feet which will allow at least one dry travel land within the roadway. 100-year peak flows will be contained within the right-of-way.

Retentions Calculations

The following table presents calculations for required temporary retention for each sub-watershed for the project. Drainage sub-watersheds are shown on the Drainage Exhibit in Appendix D at the back of this report.

Retention Calculations							
RETENTION REQUIRED = (D/12*C * A)		(100-yr, 2-hr)	D=2.27 Inches				
RETENTION REQUIRED = (D/12*C * A)		(5-yr, 2-hr)	D=1.22 Inches				
C=.95							
A= Area, SF							
DRAINAGE AREA I.D.	**AREA** (Ac)	**AREA** (sf)	**VOLUME REQUIRED** (cf)	**VOLUME PROVIDED** (cf)	**EXCESS/ SHORT** (cf)	**STORM EVENT**	**"AS-BUILT" VOLUME PROVIDED**
1	1.05	45,697	8,212	8,263	51	100-YR, 2-HR	
2	1.08	46,993	4,539	4,539*	<---Laveen Park Place	5-YR, 2-HR	
3	1.52	66,138	6,388	6,388*		TO LACC	
4	1.43	62,215	11,181	11,184	3	100-YR, 2-HR	
5	0.42	18,176	1,755	1,755*		TO LACC	
6	0.44	19,231	1,857	1,857*		TO LACC	
Total	**5.93**	**258450**	**33932**	**29321**	**54**		

Retention Basin Volume Calculations

Retention Volume Calculations					
CONIC FRUSTUM METHOD					
RETENTION PROVIDED = h/3(B1+B2+ (B1*B2)**0.5)					
RETENTION BASIN ID	**ELEV.**	**AREA (SF)**	**DEPTH DIFF. (FT)**	**AVG VOLUME (CF)**	**CUMULATIVE VOLUME (CF)**
TEMP #1	997.00	7,598			
	998.00	8,947	1.00	8,263	**8,263**
TEMP #4	998.00	9,843			
	999.00	12,581	1.00	11,184	**11,184**

Dry-Up Calculations

The proposed temporary retention basins will be 1-foot in depth and will not require dual-chamber drywells. Dry-up calculations are shown below. The onsite drainage facilities for the property at the southwest corner will be de-watered in 36-hours or less based on approved Grading & Drainage Plans for the Laveen Park Place development. The onsite drainage facilities for the properties at the northeast corner are detention facilities and have a discharge pipe that will dewater them in 36-hour or less.

Dry-Up Calculations

CRITERIA USED: City of Phoenix

GIVEN: REQUIRED DRAIN TIME = 36 HRS

TEST RESULTS: DETERMINED PERC TIME = 80 (MIN/INCHES)

PERC RATE TEST = 0.0625 (FT^3/HR)/FT (safety factor applied)

ASSUMPTIONS: DRY WELL FLOW RATE = 0.1 CFS (safety factor applied)

SAFETY FACTOR = 2

DRYWELL CALCULATIONS

EQUATIONS:

$$\text{Perc Time (hr)} = \frac{\text{Volume to Drain (ft3)} \times \text{Saftey Factor}}{\text{Permeable Area (ft2)} \times \text{Perc Rate (ft/hr)}}$$

Volume Dis. Per Drywell = Drywell Q (cfs) x 3600 (sec/hr) x Time (hr)

Volume Disipation per Dry 12960 Ft3/Drywell

RETENTION BASIN	VOL. (FT^3)	PERMEABLE AREA (BOTTOM)	DRYWELL PERC RATE (CFS)	NATURAL PERC RATE (FT^3/HR)/FT^2		BASIN PERC TIME (HR)	DRY WELLS REQUIRED
TEMP #1	8,263	7,598	0.100	0.063		17.4	0
TEMP #4	11,184	9,843	0.100	0.063		18.2	0

Drainage Area Peak Flows

The Drainage Exhibit in Appendix B at the back of this report breaks down the overall drainage areas to perform hydrologic and hydraulic calculations to size the catch basins, scuppers and storm drain sizes for the 10-year storm event.

Full calculations for the proposed drainage structures are located at the back of this report in Appendix C & D. The following table summarizes the peak flows.

Baseline Road Improvements - 202 Freeway to 57th Avenue						
CEC JOB:		182-001				
PREPARED BY:		JG				
DATE:		9/10/2018				
Summary of Onsite Peak Discharges						
Rational Method (CxIxA) where:						
C=0.95, A=Sub Basin Area (AC)						
5-minute Time of Concentration						
i10=5.00						
i25=6.12						
i50=6.98						
i100=7.84						

Sub-Basin ID #	**AREA** (AC)	**AREA** (SF)	**10-YR PEAK FLOW** (cfs)	**25-YR PEAK FLOW** (cfs)	**50-YR PEAK FLOW** (cfs)	**100-YR PEAK FLOW** (cfs)
DA1	1.05	45697	**4.98**	6.10	6.96	7.81
DA2	1.08	46993	**5.12**	6.27	7.15	8.03
DA3	1.52	66138	**7.21**	8.83	10.07	11.31
DA4	1.43	62215	**6.78**	8.30	9.47	10.64
DA5	0.42	18176	**1.98**	2.43	2.77	3.11
DA6	0.44	19231	**2.10**	2.57	2.93	3.29

Scupper Calculations

Scuppers are sized based on the contributing drainage area flows and a 20% clogging factor was applied for inflows to account for debris. Refer to the Drainage Exhibit in Appendix B and to the Hydraulic calculations in Appendix D at the back of this report. The following table summarizes the scupper spread criteria.

Scupper Summary							
			Catch Basin Parameters				
ID	Sub-Basin ID	Area, Ac	10-Year Q, cfs	Width of Spread, ft	Gutter Depth, ft	Clogging Factor	
Scupper #1	DA1	1.05	4.98	15.58	0.36	20.00%	OK, Spread less than 30'
Scupper #2B	DA2	1.08	5.12	21.13	0.47	20.00%	OK, Spread less than 30'
Scupper #3	DA3	1.52	7.21	27.12	0.59	20.00%	OK, Spread less than 30'
Scupper #4	DA4	1.43	6.78	25.95	0.56	20.00%	OK, Spread less than 30'

Rip-Rap Calculations

Rip-rap has been sized for the peak contributing flows. Each scupper will have a 16-foot long by 24-feet long rip-rap apron as shown in the calculations. For full calculations refer to the Hydraulic Calculations located in Appendix D at the back of this report.

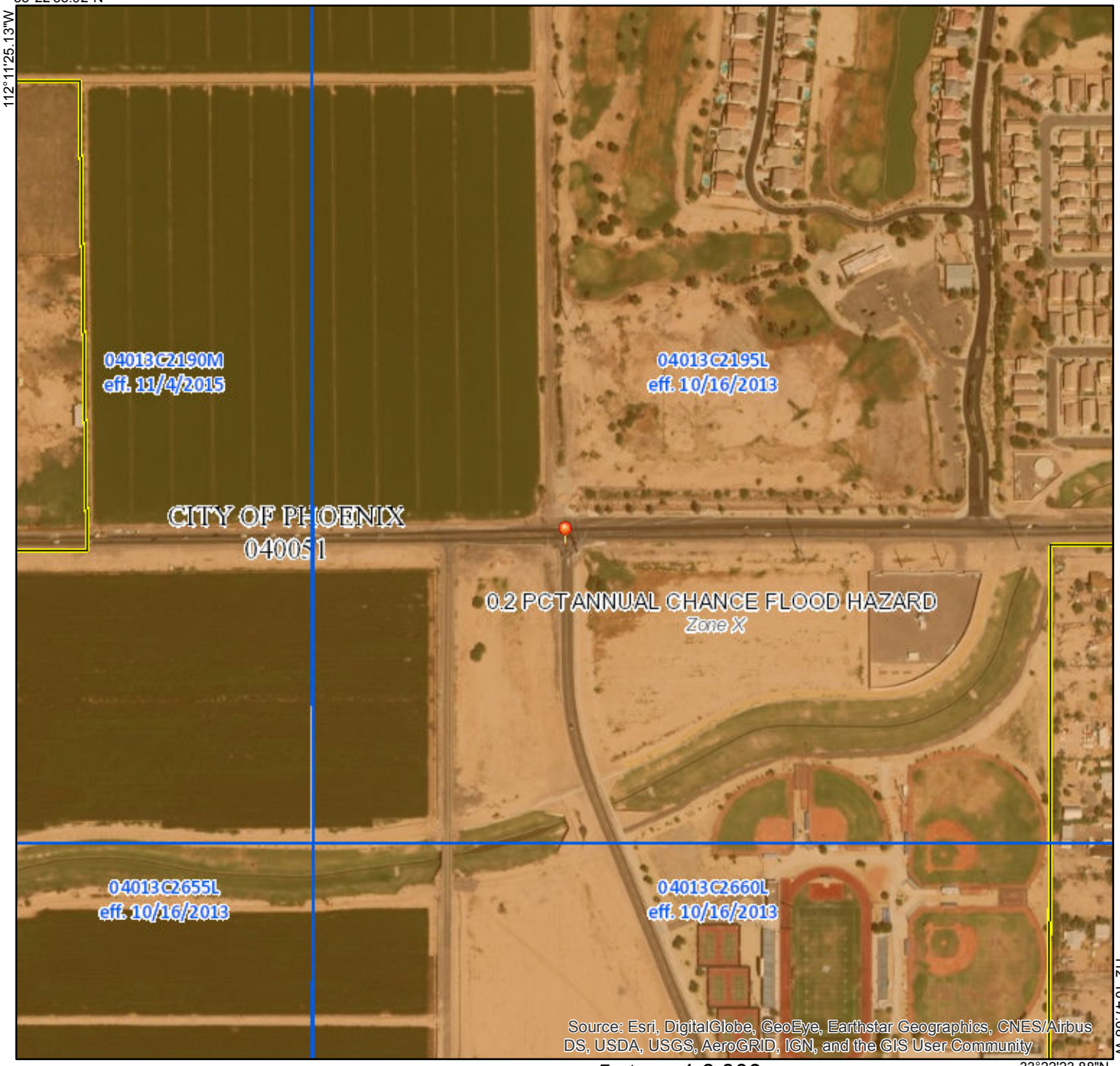
4.0 CONCLUSIONS

The proposed Baseline Road project will adhere to the City of Phoenix drainage criteria to retain half street drainage and temporary retention basins, onsite retention facilities, and detention facilities will be dewatered within the 36 hour time requirement. Roadway drainage structures are sized for the 10-year peak flows with spread criteria that will allow one dry travel lane within the roadway.

APPENDIX A – FEMA FIRM MAP

National Flood Hazard Layer FIRMette

FEMA



Feet

0 250 500 1,000 1,500 2,000

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth
- Regulatory Floodway *Zone AE, AO, AH, VE, AR*

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

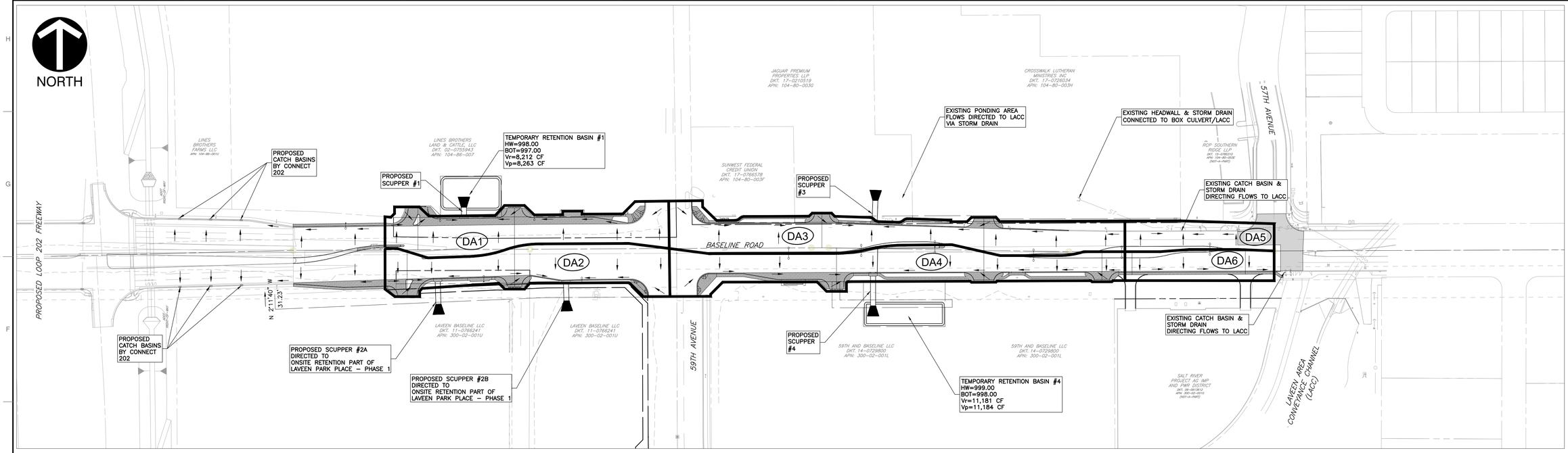
N

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/27/2018 at 5:38:09 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX B – DRAINAGE EXHIBIT



Retention Calculations

RETENTION REQUIRED = (D/12*C * A)	(100-yr, 2-hr)	D=2.27 Inches
RETENTION REQUIRED = (D/12*C * A)	(5-yr, 2-hr)	D=1.22 Inches

C=.95

A= Area, SF

DRAINAGE AREA I.D.	AREA (Ac)	AREA (sf)	VOLUME REQUIRED (cf)	VOLUME PROVIDED (cf)	EXCESS/ SHORT (cf)	STORM EVENT	"AS-BUILT" VOLUME PROVIDED
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2	1.08	46,993	4,539	4,539*	<---Laveen Park Place	5-YR, 2-HR	
3	1.52	66,138	6,388	6,388*		TO LACC	
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5	0.42	18,176	1,755	1,755*		TO LACC	
6	0.44	19,231	1,857	1,857*		TO LACC	
Total	**5.93**	**258450**	**33932**	**29321**	**54**		

Retention Volume Calculations

CONIC FRUSTUM METHOD

RETENTION PROVIDED = h/3(B1+B2+ (B1*B2)**0.5)

RETENTION BASIN ID	ELEV.	AREA (SF)	DEPTH DIFF. (FT)	AVG VOLUME (CF)	CUMULATIVE VOLUME (CF)
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TEMP #4	998.00	9,843			
	999.00	12,581	1.00	11,184	**11,184**

Scupper & Catch Basin Summary

			Catch Basin Parameters				
ID	Sub-Basin ID	Area, Ac	10-Year Q, cfs	Width of Spread, ft	Gutter Depth, ft	Clogging Factor	
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Scupper #3	DA3	1.52	7.21	27.12	0.59	20.00%	OK, Spread less than 30'
Scupper #4	DA4	1.43	6.78	25.95	0.56	20.00%	OK, Spread less than 30'

Dry-Up Calculations

CRITERIA USED:	City of Phoenix		
GIVEN:	REQUIRED DRAIN TIME =	36	HRS
TEST RESULTS:	DETERMINED PERC TIME =	80	(MIN/INCHES)
	PERC RATE TEST =	0.0625	(FT³/HR)/FT (safety factor applied)
ASSUMPTIONS:	DRY WELL FLOW RATE =	0.1	CFS (safety factor applied)
	SAFETY FACTOR =	2	

DRYWELL CALCULATIONS

EQUATIONS:

Perc Time (hr) = Volume to Drain (ft3) x Saftey Factor / Permeable Area (ft2) x Perc Rate (ft/hr)

Volume Dis. Per Drywell = Drywell Q (cfs) x 3600 (sec/hr) x Time (hr)

Volume Disipation per Dry: 12960 Ft3/Drywell

RETENTION BASIN	VOL. (FT³)	PERMEABLE AREA (BOTTOM)	DRYWELL PERC RATE (CFS)	NATURAL PERC RATE (FT³/HR)/FT²		BASIN PERC TIME (HR)	DRY WELLS REQUIRED
TEMP #1	8,263	7,598	0.100	0.063		17.4	0
TEMP #4	11,184	9,843	0.100	0.063		18.2	0

Baseline Road Improvements - 202 Freeway to 57th Avenue

CEC JOB:	182-001
PREPARED BY:	JG
DATE:	9/10/2018

Summary of Onsite Peak Discharges

Rational Method (CxIxA) where:

C=0.95, A=Sub Basin Area (AC)

5-minute Time of Concentration

i10=5.00

i25=6.12

i50=6.98

i100=7.84

Sub-Basin ID	AREA (AC)	AREA (SF)	10-YR PEAK FLOW (cfs)	25-YR PEAK FLOW (cfs)	50-YR PEAK FLOW (cfs)	100-YR PEAK FLOW (cfs)
DA1	1.05	45697	**4.98**	6.10	6.96	7.81
DA2	1.08	46993	**5.12**	6.27	7.15	8.03
DA3	1.52	66138	**7.21**	8.83	10.07	11.31
DA4	1.43	62215	**6.78**	8.30	9.47	10.64
DA5	0.42	18176	**1.98**	2.43	2.77	3.11
DA6	0.44	19231	**2.10**	2.57	2.93	3.29

SCALE IN FEET

0 100 200

REGISTERED PROFESSIONAL ENGINEER (CIVIL) CERTIFICATE NO. 23980 JEFFREY S. ERICKSON Date Signed 11/15/18 ARIZONA, U.S.A. Expires 09/30/20

REVISION RECORD

NO	DATE	DESCRIPTION

Civil & Environmental Consultants, Inc.
333 Baldwin Road · Pittsburgh, PA 15205
412-429-2324 · 800-365-2324
www.cecinc.com

BASELINE ROAD IMPROVEMENTS LOOP 202 TO 57TH AVENUE PHOENIX, ARIZONA CIVIL IMPROVEMENT PLANS

OFFSITE IMPROVEMENT PLANS DRAINAGE EXHIBIT

DATE: NOVEMBER 2018 | DRAWN BY: JG

DWG SCALE: 1"=100' | CHECKED BY: JG

PROJECT NO: 182-001

APPROVED BY: JE

DRAWING NO.: DX

SHEET 1 OF 1

P:\2018\182-001\--CAD\Dwg\CIVIL\Offsite Improvement\182001-CIV1-Drainage Exhibit.dwg[LAYOUT1] | LS:(11/15/2018 - jjowers) - LP: 11/15/2018 2:55 PM

APPENDIX C – HYDROLOGY CALCULATIONS

Baseline Road Improvements - 202 Freeway to 57th Avenue

CEC JOB: 182-001
PREPARED BY: JG
DATE: 9/10/2018

Summary of Onsite Peak Discharges

Rational Method (CxIxA) where:
C=0.95, A=Sub Basin Area (AC)
5-minute Time of Concentration
i10=5.00
i25=6.12
i50=6.98
i100=7.84

Sub-Basin ID #	**AREA** (AC)	**AREA** (SF)	**10-YR PEAK FLOW** (cfs)	**25-YR PEAK FLOW** (cfs)	**50-YR PEAK FLOW** (cfs)	**100-YR PEAK FLOW** (cfs)
DA1	1.05	45697	**4.98**	6.10	6.96	7.81
DA2	1.08	46993	**5.12**	6.27	7.15	8.03
DA3	1.52	66138	**7.21**	8.83	10.07	11.31
DA4	1.43	62215	**6.78**	8.30	9.47	10.64
DA5	0.42	18176	**1.98**	2.43	2.77	3.11
DA6	0.44	19231	**2.10**	2.57	2.93	3.29

APPENDIX D – HYDRAULIC CALCULATIONS

Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Monday, September 10, 2018

Project Units: U.S. Customary Units

Notes:

Curb and Gutter Analysis: Scupper #1

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0015 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0500 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 18.1793 ft

Gutter Result Parameters

Design Flow: 4.9800 cfs

Gutter Depression: 0.5400 in

Area of Flow: 3.3386 ft^2

Eo (Gutter Flow to Total Flow): 0.2233

Gutter Depth at Curb: 4.9030 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 20.0000 %

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Curb opening height: 6.0000 in

Local Depression: 2.0000 in

Inlet Result Parameters

Perimeter: 12.7000 ft

Effective Perimeter: 10.1600 ft

Area: 6.6667 ft^2

Effective Area: 5.3333 ft^2

Depth at curb face (upstream of local depression): 0.3568 ft

Computed Width of Spread at Sag: 15.5892 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Scupper #2B

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0015 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0500 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 18.3725 ft

Gutter Result Parameters

Design Flow: 5.1200 cfs

Gutter Depression: 0.5400 in

Area of Flow: 3.4092 ft^2

Eo (Gutter Flow to Total Flow): 0.2209

Gutter Depth at Curb: 4.9494 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 20.0000 %

Inlet Type: Curb Opening

Length of Inlet: 6.0000 ft

Curb opening height: 6.0000 in

Local Depression: 2.0000 in

Inlet Result Parameters

Perimeter: 8.7000 ft

Effective Perimeter: 6.9600 ft

Area: 4.0000 ft^2

Effective Area: 3.2000 ft^2

Depth at curb face (upstream of local depression): 0.4677 ft

Computed Width of Spread at Sag: 21.1343 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Scupper #3

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0015 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0500 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 20.9287 ft

Gutter Result Parameters

Design Flow: 7.2100 cfs

Gutter Depression: 0.5400 in

Area of Flow: 4.4139 ft^2

Eo (Gutter Flow to Total Flow): 0.1940

Gutter Depth at Curb: 5.5629 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 20.0000 %

Inlet Type: Curb Opening

Length of Inlet: 6.0000 ft

Curb opening height: 6.0000 in

Local Depression: 2.0000 in

Inlet Result Parameters

Perimeter: 8.7000 ft

Effective Perimeter: 6.9600 ft

Area: 4.0000 ft^2

Effective Area: 3.2000 ft^2

Depth at curb face (upstream of local depression): 0.5876 ft

Computed Width of Spread at Sag: 27.1289 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Scupper #4

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0015 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0500 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 20.4454 ft

Gutter Result Parameters

Design Flow: 6.7800 cfs

Gutter Depression: 0.5400 in

Area of Flow: 4.2139 ft^2

Eo (Gutter Flow to Total Flow): 0.1986

Gutter Depth at Curb: 5.4469 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 20.0000 %

Inlet Type: Curb Opening

Length of Inlet: 6.0000 ft

Curb opening height: 6.0000 in

Local Depression: 2.0000 in

Inlet Result Parameters

Perimeter: 8.7000 ft

Effective Perimeter: 6.9600 ft

Area: 4.0000 ft^2

Effective Area: 3.2000 ft^2

Depth at curb face (upstream of local depression): 0.5640 ft

Computed Width of Spread at Sag: 25.9489 ft

Flow type: Weir Flow

Efficiency: 1.0000

Riprap Analysis: Scupper #1

Notes:

Input Parameters

Riprap Type: Culvert Outlet Protection

Flow: 4.98 cfs

Culvert Diameter: 4 ft

Normal Depth in Culvert: 0.328477 ft

Tailwater Depth: 0.4 ft

If tailwater is unknown, use 0.4D

flow is sbcritical

Result Parameters

Tailwater Depth Used in Computations: 1.6 ft

Culvert Diameter Used in Computations: 4 ft

Computed D50: 0.198601 in

Riprap Class

Riprap shape should be angular

Riprap Class Name: CLASS I

Riprap Class Order: 1

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Layout Recommendations

Apron Length: 16 ft

Apron Depth: 1.89583 ft

Apron Width (at end): 22.6667 ft

Name of Selected Channel: Channel Analysis

Channel Analysis: Channel Analysis

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0150

Flow: 4.9800 cfs

Result Parameters

Depth: 0.3285 ft

Area of Flow: 1.7455 ft^2

Wetted Perimeter: 6.7087 ft

Hydraulic Radius: 0.2602 ft

Average Velocity: 2.8531 ft/s

Top Width: 6.6278 ft

Froude Number: 0.9797

Critical Depth: 0.3246 ft

Critical Velocity: 2.8953 ft/s

Critical Slope: 0.0052 ft/ft

Critical Top Width: 6.60 ft

Calculated Max Shear Stress: 0.1025 lb/ft^2

Calculated Avg Shear Stress: 0.0812 lb/ft^2

Riprap Analysis: Scupper #4

Notes:

Input Parameters

Riprap Type: Culvert Outlet Protection

Flow: 6.78 cfs

Culvert Diameter: 4 ft

Normal Depth in Culvert: 0.328477 ft

Tailwater Depth: 0.4 ft

If tailwater is unknown, use 0.4D

flow is sbcritical

Result Parameters

Tailwater Depth Used in Computations: 1.6 ft

Culvert Diameter Used in Computations: 4 ft

Computed D50: 0.299673 in

Riprap Class

Riprap shape should be angular

Riprap Class Name: CLASS I

Riprap Class Order: 1

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Layout Recommendations

Apron Length: 16 ft

Apron Depth: 1.89583 ft

Apron Width (at end): 22.6667 ft

Name of Selected Channel: Channel Analysis