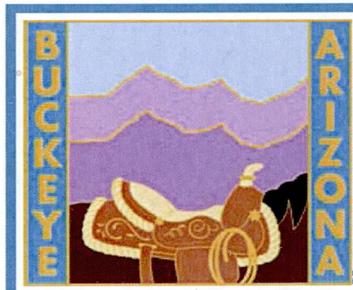


2011P025

# DRAINAGE REPORT FOR EAST BUCKEYE PARK AND RIDE BUCKEYE, ARIZONA

June 1, 2011

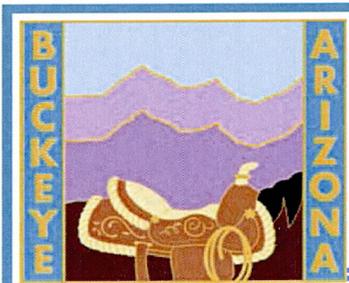


Prepared by:  
W.C. SCOUTTEN, INC.  
1626 N. Litchfield Road, Suite 310  
Goodyear, AZ 85395  
(623) 547-4661

A030.304

# DRAINAGE REPORT FOR EAST BUCKEYE PARK AND RIDE BUCKEYE, ARIZONA

June 1, 2011



Prepared by:  
W.C. SCOUTTEN, INC.  
1626 N. Litchfield Road, Suite 310  
Goodyear, AZ 85395  
(623) 547-4661

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## APPENDICES

Appendix A	Off-Site Drainage Calculations
Appendix B	Retention Calculations

## EXHIBITS

Exhibit 1	11"x 17" Site Drainage Map
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### 3. PROPOSED DEVELOPMENT

The overall development will be a Park and Ride with approximately 274 parking spaces. Palm Lane will be the only entrance into the Park and Ride for the buses, cars, and pedestrians. Palm Lane is designed to have two-lanes in each direction with a median. At the end of Palm Lane there will be a round-a-bout. At the entrance of Palm Lane from Jackrabbit Trail the Flood Control District is constructing a new outfall channel and 7' x 16' box culvert.

### 4. OFF-SITE DRAINAGE

An overall look at the regional contours surrounding the site show that the off-site runoff comes from the northwest, see **Appendix A** for Off-Site Drainage Exhibit with contours. From the contours, three off-site drainage basins were delineated. Since each basin was not greater than 160 acres, the Rational Method was used to determine the 100-year runoff from each basin. The calculations for each basin can be found in **Appendix A**. Basin BA3B which flows to the west property line was determined to have a magnitude of 8.68 cfs in the 100-year storm event.

To collect and manage the off-site flow from BA3B, openings were designed in the 6-foot high CMU wall running north to south along the west property line of the Park and Ride and a drainage swale was designed along the west property line of the Park and Ride. The collected runoff will be conveyed to a drop inlet structure. The inlet will capture the off-site runoff and convey it in an 18-inch storm drain to the proposed 7' x 16' box culvert at the White Tanks FRS 3 Outfall Channel. Storm drain calculations can be found in **Appendix A** in the back of the report.

### 5. ON-SITE RETENTION

The Park and Ride was designed to channel excess runoff water away from the parking areas to retention basins within the site. The runoff will be collected via catch basins, a scupper, and a spillway. The west half of the parking area and access road is directed to Retention Basin 1 (RB-1) and the east half of the parking area and Palm Lane is directed to Retention Basin 2 (RB-2). Both RB-1 and RB-2 are connected to underground StormTech retention systems by a weir structure. During large storm events the water will begin to fill the basins until it reaches a depth of three feet, at this point the water will begin to weir into the respective structure and be conveyed via a 24-inch pipe to the StormTech system. The Park and Ride retention system was designed to retain both the 100-year, 2-hour runoff from the Park and Ride site and the north half of Palm Lane.

The south half of Palm Lane will be retained in a temporary 1-foot deep retention basin (RB-3) located on Nevada Holding's property (Lot 1 of the JRM-NWC Subdivision). When Nevada Holding's develops their property in the future, they will

be required to build a permanent retention basin that collects their adjacent half street runoff during the 100-year, 2-hour storm event.

The Park and Ride site provides 37,262 cubic-feet of storage with an additional 11,872 cubic-feet of freeboard retention. The total 100-year, 2-hour retention required for the site is 37,707 cubic-feet.

All storm water will be dissipated by means of natural percolation into the sub soil. The weir structure in both RB-1 and RB-2 were designed with an orifice that will bleed-off the retained runoff into the underground StormTech system where it will percolate into the soil. All retained water on the site will be disposed of within 36 hours from the end of the storm event. The retention required and provided calculations along with percolation calculations for the Park and Ride can be found in **Appendix B.**

PERMIT ROUTING SLIP

Routed: 6-10-11

Project Name. East Buckeye Park & Ride

Location. Palm Lane @ White Licks Outlet Channel

Permit No. 2011P025

**(Please charge your review time to this PCN and Activity)**

PCN No. 001-02-60

Activity. RWP-P&W

To: KWG, MJI, Kenneth Rakestraw, Matt Ohler, Lynn Thomas

From: ALH

Please review and return comments and red-lined changes to my attention by:

Date. A.S.A.P.



## LETTER OF TRANSMITTAL

<b>To:</b> ATTN: Angie Hardesty Flood Control District of Maricopa County 2901 W. Durango Street Phoenix, AZ 85009	<b>Date:</b>	June 8, 2011
	<b>Subject:</b>	Jackrabbit Trail & Palm Lane Improvements
	<b>Project:</b>	EAST BUCKEYE PARK & RIDE
	<b>From:</b>	Robert E. Consoni, P.E., R.L.S.

**Method of Delivery:** \_\_\_\_\_ Courier/Delivery      \_\_\_\_\_ To be Picked Up       Hand Carried

**We Are Sending You as Follows:**

Attached      \_\_\_\_\_ Under Separate Cover

Plans/Reports      \_\_\_\_\_ Review Comments      \_\_\_\_\_ Letter / Memo

\_\_\_\_\_ Specifications      \_\_\_\_\_ For Reference Items      \_\_\_\_\_ Other

**Explain Other:** \_\_\_\_\_

Item #	Project #	Project Name:	Description:	Review Status:
1		East Buckeye Park & Ride	Jackrabbit Trail Improvement Plans 5 set of 24"x 36" Plans (24 Sheets), dated 06-03-2011	
2		East Buckeye Park & Ride	Palm Lane and Site Improvement Plans 5 set of 24"x 36" Plans (29 Sheets), dated 06-03-2011	
3		East Buckeye Park & Ride	Drainage Report, 2 copies, dated 06-03-2011	
4		East Buckeye Park & Ride	Review Comments and Responses, 2 copy, dated 05-26-2011	

**Notes:**

Attached are the revised East Buckeye Park & Ride Improvement Plans which includes the paving plans for Jackrabbit Trail and Palm Lane, along with the Water Line, Sewer line and Storm Drain Plans for your review and approval.

**The Above Transmitted as Follows:**

For Review      \_\_\_\_\_ Review Complete      \_\_\_\_\_ For Signature

\_\_\_\_\_ For Your Use       As Requested      \_\_\_\_\_ Other

**Explain Other:** \_\_\_\_\_

<b>Courier Company:</b> _____	<b>Date:</b> _____	<b>Time:</b> _____
<b>Signature:</b> _____	<b>Print:</b> _____	

**FLOOD CONTROL DISTRICT MARICOPA COUNTY - 1st REVIEW COMMENTS**  
**Permit 2011P025 - EAST BUCKEYE PARK & RIDE – WHITE TANKS OUTFALL CHANNEL**  
May 26, 2011

Gary Wesch – White Tanks Project Manager

1. I reviewed three different plans sets provided at different times. Still lacking one complete plan set with all sheets that are referred to in the drawings.

We agree the comment.

2. C2.2, P2.2: road profile for Palm lane is substantially different than approved FCD WT3O plan sheet 109 reflecting bid addendum 4. Checking the C2.2 design, on the north side the top of culvert concrete elevation will be 1091.85 on the upstream end. The bottom of vertical curb on the north side at sta 8+62.09 will be 1091.71, so this does not seem to work for 6" thick gutter. The structural section for Palm Lane is 17" so this may also be an issue. **The road profile design needs to be resolved quickly** because FCD's contractor will build this to subgrade per FCD's plans unless a design change to the plans is prepared and approved.

We agree with the comment concerning the road profile which is different from FCD WT3O Plan Sheet 109B. In checking C2.2 design, the north side top of box culvert located at the back of proposed curb is 1091.78. The bottom of the vertical curb & gutter (Sta. 8+71.09) located on the east edge of box culvert has a clearance 0.07 feet, which is what we intended. Your calculations were based on the upstream invert elevation at the centerline of box culvert of 1083.60 plus an 8.25 height which gives you an elevation of 1091.85. As for the 17-inch pavement structural section crossing the box culvert, the profile was designed with the top of the box culvert being placed into the 12-inch aggregate base coarse section and is not an issue since the box culvert has an H-20 loading. We also understand that when the FCD contractor constructs the subgrade that the top of the box culvert will be exposed until the TOB contractor starts construction.

Please refer to the Jackrabbit Trail Improvement Plans.

3. C2.2: the low point at Sta. 9+78 is 1091.51 versus 1091.00 on the FCD approved plan. There is a concern that the north curb return will not drain properly.

Correct, the profile cross-slope has been revised. The profile was adjusted to meet MCDOT requirements for the slope break over. As for the drainage, it was designed to flow south through a pavement swale (break over), and not north. The northwest asphalt pavement return has been design to direct the drainage flow east and south into the swale crossing from north to south.

Therefore, the drainage from the edge of the pavement tapers will be directed into a swale adjacent to the roadway, which flows south. Per the design on Sheet P 2.2 from Sta. 23+90.08, 21.20' Lt. with an elevation of 1092.00, the pavement slopes to the south at 0.50% and then to Sta. 23+50.08 with an elevation of 1091.80 and so on to 0.90% slope as it crosses through the intersection. Additionally, a concrete valley gutter is not warranted because there is sufficient grade. The plans have been revised to a 3" minus Rock Mulch at both ends of the curbs to handle the erosion before entering the roadway drainage ditch along Jackrabbit Trail.

Please refer to the Jackrabbit Trail Improvement Plans.

## FLOOD CONTROL DISTRICT MARICOPA COUNTY - 1st REVIEW COMMENTS

### Permit 2011P025 - EAST BUCKEYE PARK & RIDE – WHITE TANKS OUTFALL CHANNEL

May 26, 2011

4. W1.1: the profile does not match the sketch sent by Robert Consoni 5/25/11; sleeve invert elevations match FCD approved plans per bid addendum 4.

We agree with the comment. As discussed at the Pre-Construction Coordination Meeting for the East Buckeye Park & Ride, we have been required by Arizona Water Company to redesign the waterline crossing Jackrabbit Trail. The redesign does not affect the steel casing sleeve which matches FCD plans. Please refer to the revised Waterline Plans.

5. S1.0: sleeve invert elevations match FCD approved plans per bid addendum 4.

We agree with the comment.

6. LS1.6: FCD will install fence as noted. Does gabion basket sign monument interfere with fence & post installation?

As part of the WT30 Coordination Meetings, we had discussed the location of the proposed FCD fence in relationship to the Park & Ride proposed improvements. It was proposed that the 3-ft high gabion basket monument sign and 3-ft screen wall would act as the fence in lieu of the FCD four strand wire fence as a barrier. Therefore, the FCD would need to tie into the gabion basket monument sign at the deflection point just north of Palm Lane and at the north end of the 3-ft high masonry screen wall.

Please refer to the Landscape Plans.

#### Hoskin Ryan – Paul Hoskin – Consultant Project Engineer

John and I have reviewed the plans submitted by Scoutten's office and have some corrections to our plans as a result. We also have some comments for inclusion on their plan set. Notably, their work of adding tapers revises the location of access driveways from Jackrabbit and the new Palm Lane profile grade. John is revising these on our plans. The drainage from the edge of the pavement tapers will be directed into a swale adjacent to the roadway. Where it discharges is unclear. We think that they should add riprap along the edge of shoulder to protect the District's property from erosion.

The drainage runoff at the southwest corner of Jackrabbit Trail and Palm Lane will be handled by the White Tanks FRS 3 Outfall project, which will require relocation of the proposed rip-rap down drain (WT30 Plans) to match the pavement swale outlet at the edge of pavement on Jackrabbit Trail (TOB – Jackrabbit Trail Plans). Drainage runoff beyond this point will continue flowing south along the west side of Jackrabbit Trail in the relocated road ditch until it reaches the existing outfall into the White Tanks FRS 3 Outfall Channel.

Please refer to the revised Jackrabbit Trail Plans.

**FLOOD CONTROL DISTRICT MARICOPA COUNTY - 1st REVIEW COMMENTS**  
**Permit 2011P025 - EAST BUCKEYE PARK & RIDE – WHITE TANKS OUTFALL CHANNEL**  
May 26, 2011

**Angie Hardesty – Right-of-Way Specialist**

Add to notes that on the White Tanks project the plans show TCE on the Buckeye Park and Ride but your plans don't reflect that and I don't know the time frame of the phases and when the TCE will not apply or coordination of grading etc.

The Temporary Construction Easement (TCE) and Drainage Easement (DE) have been added to the Site Plan and Grading & Drainage Plan Sheets. Please refer to the On-Site Improvement Plans.

**Mike Jones – ROW Engineer**

1. Provide Drainage Report and missing drainage plans to justify connecting the storm sewer into the box culvert in Palm Lane.

Please refer to the submitted Drainage Report which addresses the 18-inch storm drain which carries the off-site drainage runoff from the west side of the park & ride site. Drainage runoff will be retained on-site in underground storage (StormTech) where it percolates into the ground, except for the on-site drainage swale along the west wall and north property line which collects and carries the off-site drainage runoff to the WT30 channel.

2. Demonstrate that storm water retention is provided on the property.

Please refer to the submitted Drainage Report which shows the site retaining the 100-year 2-hour storm event for the on-site drainage runoff according to the Town of Buckeye DM 500.

3. The District understands that Arizona Water is not going to allow the connection to the 16-inch waterline in Jackrabbit Trail. Please provide alternate plans for review.

Agreed, please refer to the submitted Waterline Plans which shows the new alignment connecting to the existing 12-inch waterline at Jackrabbit Trail and Monte Vista Road. The 12-inch waterline will then be extended south along the west side of Jackrabbit Trail to Palm Lane and then west along the original alignment into the site through the 24" steel casing being place by the FCDMC.

4. For water, sewer and storm trench details provide notes that require 1-sack slurry to the spring line of the pipe and either compaction at 95% of standard proctor or 1-sack slurry above the spring line. If compaction above the spring line is selected, compaction must be done in 6-inch lifts with compaction test run every other lift and at 100 foot intervals in the trench.

This requirement is not applicable, due to this project falling within Town of Buckeye right-of-way.

## FLOOD CONTROL DISTRICT MARICOPA COUNTY - 1st REVIEW COMMENTS

### Permit 2011P025 - EAST BUCKEYE PARK & RIDE – WHITE TANKS OUTFALL CHANNEL

May 26, 2011

5. Water and sewer lines within the District's right-of-way and/or easements must be constructed of ductile iron with restrained joints.

This requirement is not applicable, due to this project falling within Town of Buckeye right-of-way.

6. Provide missing site plans and landscaping plans. 11X17 size plans are preferred.

Please refer to On-Site Plans.

7. How will road drainage at the intersection of the Palm Lane and Jackrabbit Trail be handled. Provide details including erosion protection.

The drainage runoff from Encanto Blvd south to Palm Lane will flow within the west roadway ditch of Jackrabbit Trail as original designed under the FCDMC White Tanks FRS3 Outfall Channel and approved by MCDOT, and then sheet flows across Palm Lane within the swale (break over) on the west side of the intersection. The runoff then continues south along the west roadway ditch of Jackrabbit Trail until it then reaches the existing outfalls into the White Tanks RFS 3 Outfall Channel.

Rock Mulch (3" minus) 5-inches thick has been placed at the ends of both curbs on Palm Lane to control the erosion. No other erosion control is warranted within the roadway ditch.

Cross sections of Jackrabbit Trail will be provided for your review, if requested.

Please refer to the revised Jackrabbit Trail Plans.

8. Additional comments may be generated when requested information is provided.

Agreed

#### **Kenneth Rakestraw – Hydrologist**

- 1) Sheet S1.0 shows 7'x16' box culvert in new White Tanks 3 Outfall Channel (designed) as "Existing". The culvert has been included in Final Design but has not yet been constructed.

Even though the White Tanks 3 Outfall Channel box culvert hasn't been constructed, we still needed to show the drainage structure as existing, because by the time the TOB contractor starts construction on the Palm Lane roadway, there will be an existing FCD drainage structure in-place.

- 2) Sheet SD 1.0, Profile View- Shows 18" RGRCP pipe to Designed 16'x7' culvert to be constructed by FCDMS as 18" diameter. The FCDMC final plans show this pipe as 36" RGRCP.

The 36" RGRCP was changed to an 18" RGRCP, which was addressed under Addendum No. 4, of the White Tanks FRS 3 Outfall Channel, Sheet 109B.

## FLOOD CONTROL DISTRICT MARICOPA COUNTY - 1st REVIEW COMMENTS

### Permit 2011P025 - EAST BUCKEYE PARK & RIDE – WHITE TANKS OUTFALL CHANNEL

May 26, 2011

- 3) The above comment pertains also to Sheet C.2.2

The 36" RGRCP was changed to an 18" RGRCP, which was addressed under Addendum No. 4, of the White Tanks FRS 3 Outfall Channel, Sheet 109B.

- 4) Sheet C2.2 – Change spelling of “Flodd Control District” to “Flood Control District”, Note 15 and on profile in two locations.

The spelling has been revised to read “Flood” on Sheet C2.2. Please refer to the revised On-Site Plans.

Note: Many of the sheets listed on the Sheet Indexes on Sheets P1.0 and C1.0 were not included in the submittal.

#### *Drainage Report*

Rainfall intensity value of 0.4 inches per hour reported for the 10-yr frequency for all three sub-basins is clearly incorrect. These are most likely typos, as the resultant Q's are reasonable.

This is a typo, we will correct. Please refer to revised Drainage Report.

If the DDMSW by FCDMC was used for the Rational Equation analysis, then the project file( zip file) should be included in the next submittal.

The values shown on the spreadsheet were not determined using the DDMSW by the FCDMC. Therefore, we are unable to provide an electronic file.

Appendix B shows retention requirements for DA-1 through DA-9; however, areas DA-1 through DA-5 are not shown on Exhibit 1 with DA-6 through DA-9. Exhibit 1 should be expanded to show all of the drainage areas related to the Park and Ride.

These are for On-site Drainage Areas and were not part of the flow entering the White Tanks FRS 3 Outfall Channel. Please refer to revised Drainage Report for On-Site Drainage.

Retention Provided –Appendix B- Underground Retention, two sets of values are shown for System 1 and none for System 2, likely a typo.

This is a typo, we will correct. Please refer to revised Drainage Report.

**FLOOD CONTROL DISTRICT MARICOPA COUNTY - 1st REVIEW COMMENTS**  
**Permit 2011P025 - EAST BUCKEYE PARK & RIDE – WHITE TANKS OUTFALL CHANNEL**  
May 26, 2011

***Additional Comments***

1. WT30 Landscape Plans

The four (4) trees fronting the TOB Monument Sign will be relocated due to visibility.

2. Right-of-Way Cost versus Temporary Construction and Drainage Easement Costs

The FCDMC agreed that they should both be based on the Appraisal provided for the right-of-way.

3. Structural Loading of 7'x 16' Box Culvert

FCDMC provided structural calculations.

## 6. FLOOD ZONE INFORMATION

The Maricopa County, Arizona and Incorporated Areas Flood Insurance Rate Map (F.I.R.M.) panel number 04013C2055 G, dated September 30, 2005, (References 6) indicates that the project falls within Zone X shaded and Zone AE (Figure 2). Zone X shaded is defined by the Federal Emergency Management Agency (FEMA) 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 the 1% annual chance flood.*

Zone X is outside the delineated 100-year floodplain. Flood insurance is available, but not required by the Federal Insurance Administration, for buildings concerned with a federally insured loan. Flood insurance is optional at the discretion of the owner or lending institution.

Zone AE cross hatched is defined by the Federal Emergency Management Agency (FEMA) as:

*Base flood elevation determined.*

Zone AE will be redefined by the Flood Control District of Maricopa County (FCDMC) White Tanks FRS 3 Outfall Channel which crosses the site to the east, which falls within a 138-ft wide FCDMC easement. The FCDMC is currently in the process of a Letter of Map Revision (LOMR) which will be issued with the next FIRM map update.

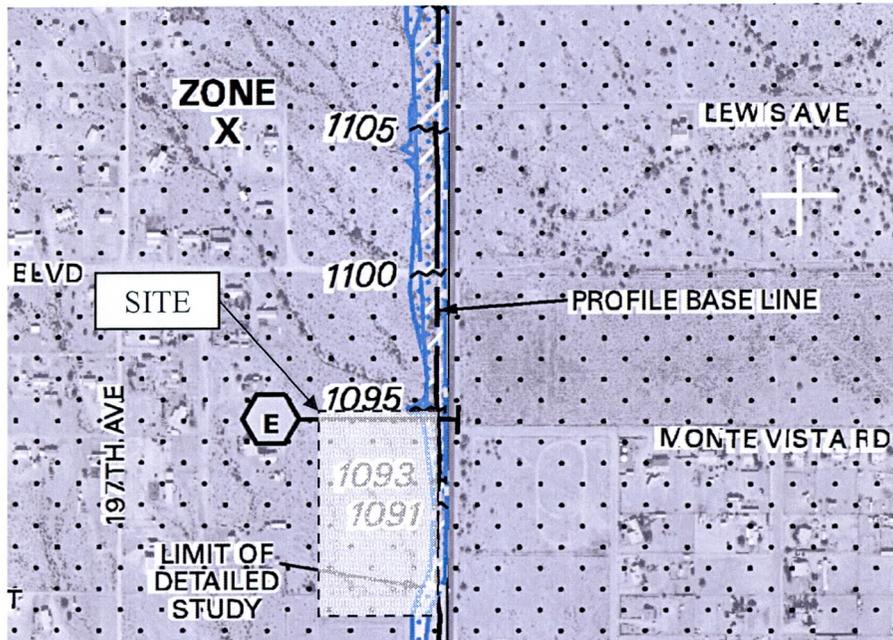


Figure 2 – FIRM Map

## 7. SUMMARY AND CONCLUSION

1. The site is situated in an area that is undeveloped desert land with residential developments to the north and northwest of the site.
2. The site will be developed into a Park and Ride with Palm Lane as the only access from Jackrabbit Trail.
3. The site will intercept the off-site flow from the northwest and convey the flow to the south by way of a channel. The off-site runoff will be collected in a drop inlet and conveyed via storm drain to the Flood Control Culvert.
4. The Park and Ride site and Palm Lane will retain the 100-year, 2-hour storm event utilizing above ground and below ground retention. The retention system will dissipate the collected runoff within 36-hours of the passing storm event.
5. The Park and Ride and Palm Lane meet first flush requirements.
6. The Park and Ride is located in a Zone X shaded flood zone.
7. Palm Lane will cross the Zone AE flood zone via a 7' x 16' box culvert constructed by the FCDMC as part of the FCDMC White Tanks FRS Outfall Channel which is currently under construction.

## 8. REFERENCES

1. Town of Buckeye Storm Water Drainage Design Manual (DM500)
2. Drainage Design Manual for Maricopa County, Arizona, Hydrology, June 14, 2010.
3. Drainage Design Manual for Maricopa County, Arizona, Hydraulics, June 2010 Draft.
4. Federal Emergency Management Agency Flood Insurance Rate Map (FIRM), Maricopa County, Arizona and Incorporated Areas, Panel Number 04013C2055G, dated September 30, 2005.
5. Loop 303/White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Flood Control District Maricopa County, Arizona, September 4, 2009.
6. Geotechnical Engineering Report – New Park & Ride Facility – Jackrabbit Trail & (Future) Palm Lane, Buckeye, Arizona by Ricker Atkinson McBee Morman & Associates, RAMM Project No. G18037, dated August 19, 2010.



**APPENDIX A**  
**EAST BUCKEYE PARK AND RIDE**  
*Off-Site Drainage Calculations*

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**HYDROLOGIC CALCULATION SUMMARY SHEET**  
**RATIONAL METHOD - OFF-SITE FLOW**  
W.C. Scoutten, Inc.

Project Name: East Buckeye Park & Ride  
Project No.:

Prepared by: REM  
Revised by:

Date: 06/01/11  
Date:

Complete calculations for each concentration point are presented in the attached hydrologic calculation sheets.

Sub-Basin & Concentration Point ID	C Runoff Coefficient Frequency				I Intensity Frequency				A Area [acres]	Q Peak Discharge Frequency			
	2-year	10-year	50-year	100-year	2-year	10-year	50-year	100-year		2-year	10-year	50-year	100-year
					[in/hr]					[cfs]			
BA1B	0.30	0.40	0.48	0.50	1.14	2.14	2.99	3.37	104.82	35.85	89.73	150.44	176.63
BA2B	0.30	0.40	0.48	0.50	1.52	2.83	4.25	4.89	6.98	3.18	7.90	14.24	17.06
BA3B	0.30	0.40	0.48	0.50	1.86	3.44	5.00	5.84	2.97	1.66	4.09	7.13	8.68

**HYDROLOGIC DESIGN DATA SHEET**  
**RATIONAL METHOD**  
W.C. Scoutten, Inc.

**Concentration Point ID: BA1B**

Project Name: East Buckeye Park & Ride  
Project No.:

Prepared by: REM  
Revised by:

Date: 06/01/11  
Date:

**Location Data**

State: Arizona

County: Maricopa

Jurisdiction: Town of Buckeye

**Design Data**

Design Frequency:	100	[yr]	Flow Path Length (L)=	8126.00	[ft]
Check Frequency:	50	[yr]	Elevation <sub>Max</sub> :	1193.00	[ft]
Check Frequency:	10	[yr]	Elevation <sub>Min</sub> :	1096.00	[ft]
Check Frequency:	2	[yr]	Elevation <sub>Difference</sub> :	97.00	[ft]
Drainage Area (A)=	104.82	[acres]	Flow Path Slope <sub>Average</sub> (S)=	0.01194	[ft/ft]

**Watershed Characteristics**

Hydrologic Soil Group: --  
Vegetation Cover: <25 [%]  
Classification Type: B (Reference, Table 3.1, Page 3-3)

**Rational Method Computations**

Time of Concentration, (T<sub>c</sub>)<sup>(2)</sup>:  
 $T_c = 11.4 * L^{0.5} * K_b^{0.52} * S^{-0.31} * i^{-0.38}$

L	[mi]	K <sub>b</sub> =m Log A + b
S	[ft/mi]	m= -0.01375
i	[in/hr]	b= 0.08
		A = Area [acres]

Frequency [yr]	m	b	K <sub>b</sub>	T <sub>c</sub> [min]	i [in/hr]
2	-0.01375	0.08	0.052219	48.0	1.14
10	-0.01375	0.08	0.052219	38.0	2.14
50	-0.01375	0.08	0.052219	33.0	2.99
100	-0.01375	0.08	0.052219	32.0	3.37

Peak Discharge (Q):  
 $Q = C \cdot i \cdot A$  [cfs]

A [acres]  
i [in/hr]  
C Runoff Coefficient

C<sub>10</sub><sup>(2)</sup> = 0.30  
C<sub>10</sub><sup>(2)</sup> = 0.40  
C<sub>50</sub><sup>(2)</sup> = 0.48  
C<sub>100</sub><sup>(2)</sup> = 0.50

Q<sub>10</sub> = 35.85 [cfs]  
Q<sub>10</sub> = 89.73 [cfs]  
Q<sub>50</sub> = 150.44 [cfs]  
Q<sub>100</sub> = 176.63 [cfs]

Reference: Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology. June 2010.

**HYDROLOGIC DESIGN DATA SHEET**  
**RATIONAL METHOD**  
**W.C. Scoutten, Inc.**

**Concentration Point ID: BA2B**

Project Name: East Buckeye Park & Ride  
 Project No.:

Prepared by: REM  
 Revised by:

Date: 06/01/11  
 Date:

**Location Data**

State: Arizona

County: Maricopa

Jurisdiction: Town of Buckeye

**Design Data**

Design Frequency:	100	[yr]	Flow Path Length (L)=	2018.00	[ft]
Check Frequency:	50	[yr]	Elevation <sub>Max</sub> :	1120.00	[ft]
Check Frequency:	10	[yr]	Elevation <sub>Min</sub> :	1098.00	[ft]
Check Frequency:	2	[yr]	Elevation <sub>Difference</sub> :	22.00	[ft]
Drainage Area (A)=	6.98	[acres]	Flow Path Slope <sub>Average</sub> (S)=	0.01090	[ft/ft]

**Watershed Characteristics**

Hydrologic Soil Group: --  
 Vegetation Cover: <25 [%]  
 Classification Type: B (Reference, Table 3.1, Page 3-3)

**Rational Method Computations**

Time of Concentration, (T<sub>c</sub>)<sup>(2)</sup>:  
 $T_c = 11.4 * L^{0.5} * K_b^{0.52} * S^{-0.31} * i^{-0.38}$

L	[mi]	K <sub>b</sub> =m Log A + b
S	[ft/mi]	m= -0.01375
i	[in/hr]	b= 0.08
		A = Area [acres]

Frequency [yr]	m	b	K <sub>b</sub>	T <sub>c</sub> [min]	i [in/hr]
2	-0.01375	0.08	0.068398	25.0	1.52
10	-0.01375	0.08	0.068398	20.0	2.83
50	-0.01375	0.08	0.068398	17.0	4.25
100	-0.01375	0.08	0.068398	16.0	4.89

Peak Discharge (Q):  
 $Q = C \cdot i \cdot A$

A [acres]  
 i [in/hr]  
 C Runoff Coefficient

C<sub>10</sub><sup>(2)</sup> = 0.30  
 C<sub>10</sub><sup>(2)</sup> = 0.40  
 C<sub>50</sub><sup>(2)</sup> = 0.48  
 C<sub>100</sub><sup>(2)</sup> = 0.50

Q<sub>10</sub> = 3.18 [cfs]  
 Q<sub>10</sub> = 7.90 [cfs]  
 Q<sub>50</sub> = 14.24 [cfs]  
 Q<sub>100</sub> = 17.06 [cfs]

Reference: Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology. June 2010.

**HYDROLOGIC DESIGN DATA SHEET**  
**RATIONAL METHOD**  
**W.C. Scoutten, Inc.**

**Concentration Point ID: BA3B**

Project Name: East Buckeye Park & Ride  
 Project No.:

Prepared by: REM  
 Revised by:

Date: 06/01/11  
 Date:

**Location Data**

State: Arizona

County: Maricopa

Jurisdiction: Town of Buckeye

**Design Data**

Design Frequency:	100	[yr]	Flow Path Length (L)=	951.00	[ft]
Check Frequency:	50	[yr]	Elevation <sub>Max</sub> :	1108.00	[ft]
Check Frequency:	10	[yr]	Elevation <sub>Min</sub> :	1098.00	[ft]
Check Frequency:	2	[yr]	Elevation <sub>Difference</sub> :	10.00	[ft]
Drainage Area (A)=	2.97	[acres]	Flow Path Slope <sub>Average</sub> (S)=	0.01052	[ft/ft]

**Watershed Characteristics**

Hydrologic Soil Group: --  
 Vegetation Cover: <25 [%]  
 Classification Type: B (Reference, Table 3.1, Page 3-3)

**Rational Method Computations**

Time of Concentration, (T<sub>c</sub>)<sup>(2)</sup>:  
 $T_c = 11.4 * L^{0.5} * K_b^{0.52} * S^{-0.31} * i^{-0.38}$

L	[mi]	K <sub>b</sub> =m Log A + b
S	[ft/mi]	m= -0.01375
i	[in/hr]	b= 0.08
		A = Area [acres]

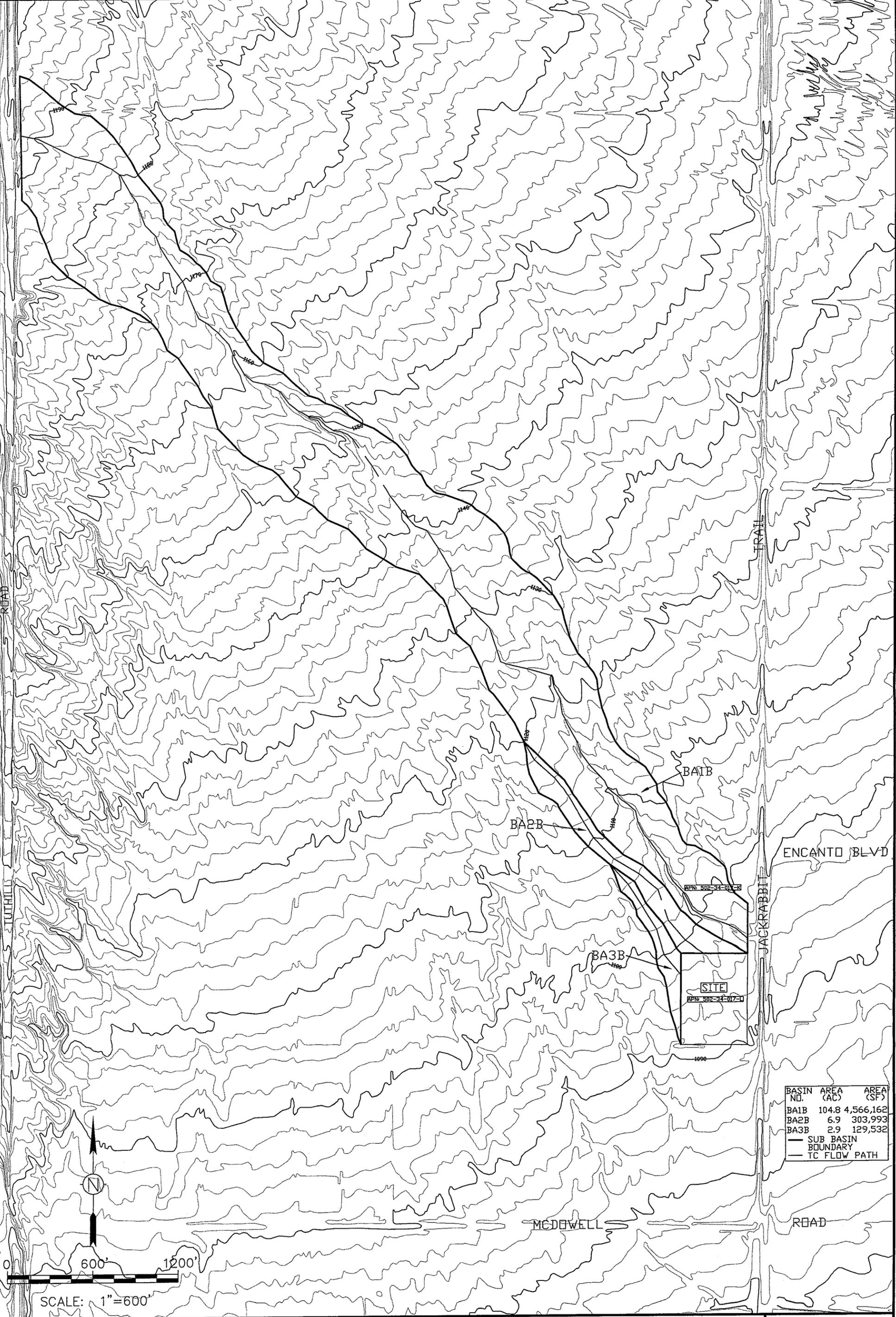
Frequency [yr]	m	b	K <sub>b</sub>	T <sub>c</sub> [min]	i [in/hr]
2	-0.01375	0.08	0.073494	17.0	1.86
10	-0.01375	0.08	0.073494	13.0	3.44
50	-0.01375	0.08	0.073494	12.0	5.00
100	-0.01375	0.08	0.073494	11.0	5.84

Peak Discharge (Q):  
 $Q = C * i * A$  [cfs]

A	[acres]
i	[in/hr]
C	Runoff Coefficient
	C <sub>10</sub> <sup>(2)</sup> = 0.30
	C <sub>10</sub> <sup>(2)</sup> = 0.40
	C <sub>50</sub> <sup>(2)</sup> = 0.48
	C <sub>100</sub> <sup>(2)</sup> = 0.50

Q<sub>10</sub> = 1.66 [cfs]  
 Q<sub>10</sub> = 4.09 [cfs]  
 Q<sub>50</sub> = 7.13 [cfs]  
 Q<sub>100</sub> = 8.68 [cfs]

Reference: Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology. June 2010.



BASIN NO.	AREA (AC)	AREA (SF)
BA1B	104.8	4,566,162
BA2B	6.9	303,993
BA3B	2.9	129,532

— SUB BASIN BOUNDARY  
 — TC FLOW PATH

**HYDRAULIC GRADE LINE CALCULATIONS**  
**STORM DRAIN A**  
**100-Year Storm Event**  
**W.C. Scoutten, Inc.**

**Project Name:** East Buckeye Park and Ride  
**Project No.:**

**Prepared By:** REM  
**Checked By:**

**Date:** 6/1/2011  
**Date:**

**Purpose:** Calculate the HGL and EGL for the 100-year storm event.

**Methodology:** The HGL was calculated starting from the downstream controlling surface water to the proceeding upstream point of interest. Headlosses were calculated from point of interest to point of interest and added to the HGL calculation.

**Assumptions:** 1. Full Flow Condition  
 3. Velocities of connector pipes at junctions obtained assuming full flow at designed connector pipe slope.

**Criteria:** Minimum catch basin freeboard 1' below gutter elevation  
 Main-Line Minimum Pipe Size 18-inches  
 Rubber Gasket Reinforced Concrete Pipe [RGRCP] Minimum Manning's "n" value of 0.013  
 Reinforced Concrete Box Minimum Manning's "n" value of 0.015

**References:** 1. Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology, November 2003.  
 2. Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics, September 2003.  
 3. Please enter "Jurisdictional City Design Manual" or any other reference that applies

**Calculations:**

**Manning's n:**  $n = 0.013$ , Concrete Pipe, [Reference 2, Table 4.1];

**Flow Area:**  $A = r^2 * \pi$ ;  $r$  = Pipe Radius

**Velocity:**  $V = Q/A$

**Velocity Head:** Velocity Head =  $V^2/2g$ ;  $g = 32.2 \text{ ft/s}^2$  [Reference 2]

**K:**  $K = 2 * g * n^2 / 2.21$  [Reference 2]

**Hydraulic Radius R:**  $R = A/P$ ;  $P$  = Wetted Perimeter =  $2 * \pi * r$

**Slope Friction:**  $S_f = K * [V^2/2 * g * R^{4/3}]$  [Reference 2]

**Pipe Outlet Headloss:**  $h_o = 1.0 * [V^2/2 * g]$  [Reference 2]

**Pipe Friction Headloss:**  $h_f = S_f * L$  [Reference 2]

**Junction Headloss:**  $h_j = [V_1^2/2 * g] - [V_2^2/2 * g] + [2 * [Q_2 * V_2 - Q_1 * V_1 - Q_3 * V_3 * \cos[\Theta]]] / [A_1 + A_2] * g$ ; [Reference 2]

$A_1 = r^2 * \pi$

$Q_1$ : Q upstream from pipe junction

$V_1 = V_1 = [Q_1 / A_1]$

$A_2 = r^2 * \pi$

$Q_2$ : Q downstream from pipe junction

$V_2 = V_2 = [Q_2 / A_2]$

$A_3 = r^2 * \pi$

$Q_3 = Q_2 - Q_1$

$V_3 = V_3 = [Q_3 / A_3]$

$V_1^2/2g$ :  $V_1^2/2 * g$ ,  $g = 32.2 \text{ ft/s}^2$

$V_2^2/2g$ :  $V_2^2/2 * g$ ,  $g = 32.2 \text{ ft/s}^2$

**Transition Headloss:**  $h_t = k_e * V^2/2 * g$ ,  $k_e$  = Coefficient for Sudden Enlargement [Reference 2, Page 4-17]

**Straight-Through Manhole Headloss:** Straight-Through Manhole Losses [no laterals]  $h_{stmh} = k_b * [V^2/2 * g]$

**Bend Manhole Headloss:** Bend Losses at Manholes  $h_{bnh} = k_b * [V^2/2 * g]$ ;  $k_b$  = Bend Loss Coefficient [Reference 2, Page 4-23]

**Total Headloss:** Summation of all the Head Losses =  $h_o + h_f + h_j + h_t + h_b + h_{stmh} + h_{bnh}$

**HGL:** Hydraulic Grade Line = Controlling Water Surface + Headloss in Pipe at that Point

**EGL:** EGL = Controlling Water Surface + Headloss in Pipe at that Point + Velocity Head

**HGL Elevation Below Gutter Elevation:** HGL at Inlet - Gutter at Inlet

**HYDRAULIC GRADE LINE CALCULATIONS**  
**STORM DRAIN MAIN LINE**  
**100-Year Storm Event**  
**W.C. Scoutten, Inc.**

Project Name: East Buckeye Park and Ride  
 Project No.:

Prepared By: REM  
 Checked By:

Date: 6/1/2011  
 Date:

Conveyance ID	Station [Inlet]	Station [Outlet]	Pipe Invert Elevation [ft]		Pipe Properties				Design Discharge			Friction Slope		
			Inlet	Outlet	Size [in]	Length [ft]	Manning's n	Flow Area [ft <sup>2</sup> ]	Design Discharge [cfs]	Velocity V [ft/s]	Velocity Head v <sup>2</sup> /2g [ft]	Friction Loss Coefficient K	Hydraulic Radius R [ft]	Friction Slope S <sub>f</sub> [ft/ft]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>Storm Drain A</b>														
P-2		00+00.00	1090.37	1087.49	18	195.49	0.013	1.77	8.68	4.90	0.37	0.0049	0.38	0.0066
P-1		Outlet	1087.39	1084.50	18	301.01	0.013	1.77	8.68	4.90	0.37	0.0049	0.38	0.0066
Outlet									8.68	4.90	0.37	0.0049	0.38	0.0066

Conveyance ID	Head Losses																		HGL		EGL		Gutter Elevation [ft]	HGL Elevation Below Gutter Elevation [ft]	Notes		
	Pipe Outlet h <sub>o</sub> [ft]	Pipe Friction h <sub>f</sub> [ft]	Lateral Angle into Main Line [degrees]	Junction														Manhole Bend Angle [degrees]	Manhole Loss h <sub>mh</sub> [ft]	Total Head Loss [ft]	Inlet [ft]	Outlet [ft]				Inlet [ft]	Outlet [ft]
				Lateral Size [in]	A <sub>1</sub> [ft <sup>2</sup> ]	Q <sub>1</sub> [cfs]	V <sub>1</sub> [ft/s]	A <sub>2</sub> [ft <sup>2</sup> ]	Q <sub>2</sub> [cfs]	V <sub>2</sub> [ft/s]	A <sub>3</sub> [ft <sup>2</sup> ]	Q <sub>3</sub> [cfs]	V <sub>3</sub> [ft/s]	V <sub>1</sub> <sup>2</sup> /2*g	V <sub>2</sub> <sup>2</sup> /2*g	Junction h <sub>j</sub> [ft]											
1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	
<b>Storm Drain A</b>																											
P-2		1.29																	1.29	1090.67	1089.38	1092.09	1089.75	1093.30	2.63	-	
P-1		1.99															0.00	0.02	2.01	1089.38	1087.37	1089.75	1087.74	1094.10	4.72	-	
Outlet	0.37																		0.37	1087.37	1087.00	1087.74	1087.00			-	

**Conclusion:** The HGL for storm drain A is at least 1-foot below the catch basin gutter elevation.  
 Manholes are spaced a maximum of 300-feet apart.  
 Storm drain main line is greater than the minimum of 18-inches.  
 Storm drain is sufficiently sized to convey the peak discharge

**Notes:** 1. The calculated HGL was lower than the actual pipe invert or the normal flow depth. This indicates that the storm drain is not flowing under a pressurized condition, but is instead flowing under open channel conditions. Therefore, the water surface elevation in the pipe is the normal depth of flow for the pipe as calculated by the Manning's equation.



**APPENDIX B**  
**EAST BUCKEYE PARK AND RIDE**  
*Retention Calculations*

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# HYDRAULIC CALCULATION SHEET

## Retention Calculations

W.C. Scoutten, Inc.

Project Name: East Buckeye Park & Ride  
Project No.:

Prepared by: REM  
Revised By:

Date: 06/01/11  
Date:

**Purpose:** Evaluate the required and provided retention volumes in order to assess conformance to project criteria.

**Methodology:** Calculate the volume of stormwater required to be retained using Town of Buckeye criteria. Calculate the estimated volume of stormwater retained using retention basin geometry.

**Criteria:** Retain the calculated stormwater run-off for the 100-Year, 2-Hour duration storm event.

**References:** 1. Drainage Design Manual for Maricopa County, Arizona, Volume I: Hydrology, November 2003.  
2. Drainage Design Manual for Maricopa County, Arizona, Volume II: Hydraulics, September 2003.

**Calculations:** Volume Required =  $C_{Composite} * P/12 * A$  [ft<sup>3</sup>] (Reference 1)

P = 2.3 [in] (Reference 1)

C = 0.95 (Pavement) (Reference 1)

C = 0.55 (Desert Landscape) (Reference 1)

C = 0.50 (Other)

$$\text{Composite } C = (C_1 * A_1 + C_2 * A_2 + C_3 * A_3) / A_{total}$$

$$\text{Volume Required} = \text{Composite } C * P/12 * A$$

**Results:**

Identifiers Contributory Area ID	CALCULATE RETENTION VOLUME REQUIRED					Volume Required	
	Total Area [acres]	Pavement Areas [acres]	Landscape Areas [acres]	Other Areas [acres]	Weighted C	[acre-ft]	[ft <sup>3</sup> ]
DA-1	0.22	0.00	0.22	0.00	0.55	0.02	995.16
DA-2	0.19	0.19	0.00	0.00	0.95	0.03	1,500.38
DA-3	1.32	1.32	0.00	0.00	0.95	0.24	10,470.89
DA-4	1.25	1.25	0.00	0.00	0.95	0.23	9,952.70
DA-5	0.04	0.00	0.04	0.00	0.55	0.00	194.65
DA-6	0.17	0.00	0.17	0.00	0.55	0.02	761.01
DA-7	0.16	0.00	0.16	0.00	0.55	0.02	730.56
DA-8	1.18	1.18	0.00	0.00	0.95	0.22	9,380.04
DA-9	0.47	0.47	0.00	0.00	0.95	0.09	3,721.63
<b>Total Area:</b>	<b>5.00</b>					<b>0.87</b>	<b>37,707.02</b>
					<b>TOTAL VOLUME REQUIRED:</b>		

# HYDRAULIC CALCULATION SHEET

Retention Provided

W.C. Scoutten, Inc.

Project Name: East Buckeye Park & Ride  
Project No.:

Prepared By: REM  
Revised By:

Date: 06/01/11  
Date:

$$\text{Retention Basin Volume Provided} = H/3 * (A_{H.W.} + A_{BOTTOM} + (A_{H.W.} * A_{BOTTOM})^{0.5})$$

ABOVE GROUND RETENTION					
Basin ID	HW Area ft <sup>2</sup>	Bottom ft <sup>2</sup>	H ft	Volume Provided ft <sup>3</sup>	Drainage Areas contributing to Basins
RB-1	2,445.48	140.09	3.00	3,170.88	DA-2, DA-3, DA-6
RB-2	2,927.69	563.77	3.00	4,776.19	DA-4, DA-5, DA-7, DA-8
RB-3	4,693.94	3,352.27	1.00	4,004.33	DA-9
RB-4	387.68	15.11	1.00	159.78	DA-1
Total ->				12,111.18	

UNDERGROUND RETENTION				
Pipe ID	Number of MC-4500 Chambers ea	Number of End Caps ea	Volume Provided ft <sup>3</sup>	Drainage Areas contributing to Basins
System 1	56	4	9,540.40	DA-2, DA-3, DA-6
System 2	92	6	15,611.40	DA-4, DA-5, DA-7, DA-8
Total ->			25,151.80	

MC-4500 Chamber Volume with Stone= 162.6 CF/Chamber  
MC-4500 Endcap Volume with Stone= 108.7 CF/Endcap

Basin ID	Retention Required ft <sup>3</sup>	Retention Provided* ft <sup>3</sup>	Excess/Deficiencies ft <sup>3</sup>	Freeboard ft <sup>3</sup>
RB-1 + System 1	12,732.28	12,711.28	-21.00	3,019.00
RB-2 + System 2	20,257.95	20,387.59	129.65	3,443.00
RB-3	3,721.63	4,004.33	282.70	5,410.00
RB-4	995.16	159.78	-835.39	0.00
Total->	37,707.02	37,262.98	-444.04	11,872.00

\*Retention Provided is a sum of the underground retention system and the above ground basins at a water depth noted in the above ground retention table above. Freeboard was calculated from the additional foot of volume found in basins RB-1, RB-2, and RB-3.

CALCULATED PERCOLATION TIME

Percolation Calculations

W.C. Scoutten Job: EAST BUCKEYE PARK AND RDIE  
 Prepared By: REM  
 Date: 6/2/2011

CRITERIA USED: Town of Buckeye Drainage Standards

GIVEN: REQUIRED DRAIN TIME = 36 HRS  
 TEST RESULTS: DETERMINED PERC TIME = 0.3336 (INCHES/MIN)  
 PERC RATE = 1.668 (FT<sup>3</sup>/HR)/FT<sup>2</sup>  
 ASSUMPTIONS: DRY WELL FLOW RATE = 0 CFS (safety factor applied)  
 SAFETY FACTOR = 2

RETENTION BASIN	VOL. (FT <sup>3</sup> )	AVG. PERMEABLE AREA (FT <sup>2</sup> )	PERC RATE (FT <sup>3</sup> /HR)/FT <sup>2</sup>	PERC RATE SF APPLIED (FT <sup>3</sup> /HR)/FT <sup>2</sup>	PERC TIME (HR)	Trench Drain Length	PERC TIME ADJUSTED (HR)
System 1	12,711	2,326	1.668	0.834	6.6		N/A
System 2	20,388	3,838	1.668	0.834	6.4		N/A



