

FINAL DRAINAGE REPORT ADDENDUM

Report 2

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ELLSWORTH ROAD
UNIVERSITY DRIVE TO MCLELLAN ROAD (PHASE II)

Maricopa County Project No. 68902

Earth Tech Project No. 78814

Prepared for:

Maricopa County Department of Transportation

Prepared by:

Earth Tech
3800 N. Central Avenue, Suite 1700
Phoenix, AZ 85012

January 2005



Final Drainage Report Addendum
Ellsworth Road – University Drive to McLellan Road
Maricopa County Project No. 68902
Earth Tech Project No. 78814

Introduction

These pages constitute an addendum to the Earth Tech drainage report issued June 8, 1999. This addendum is completed as part of design contract Change Order #6, effective September 24, 2004, and includes a description of the design changes and computer model output of the hydraulic analysis.

Design Changes

The former design included a concrete-lined open channel on the east side of Ellsworth Road between Adobe Road and the CAP canal, with a cross section including 7.5m top width and 1:1 side slopes. The new design includes a closed system of 2 – 1800mm x 900mm box culverts. The design flow given in Change Order #6 of 8.496 m³/sec (300 cfs) was used. The box culvert hydraulic design was completed using StormCAD v4.1.1. A Manning's equation was used with an n value of 0.016 (concrete, rough forms) taken from the Maricopa County Drainage Design Manual, Table 4.1. The box culvert slope follows the flow line profile of the existing channel and matches the existing elevation at the downstream outlet.

The box culvert inlet includes a drop with ADOT Standard B-04.30 inlet wings set 45 degrees to the construction centerline. Headwater elevations were calculated using the Maricopa County Drainage Design Manual, Volume II for the 50-year and 100-year events. The 50-year headwater elevation is 483.923 and the 100-year headwater elevation is 484.203. See attached Figure 5.27 for headwater depths.

The outlet structure includes ADOT Standard B-04.50 wings set 45 degrees to the box culvert centerline. The tailwater condition is assumed to be a free discharge. See attached printout for StormCAD output.

Headwater depths were completed using the Maricopa County Drainage Design Manual, Volume II for the elliptical culverts located at Sta. 6+384. The 50-year headwater elevation is 489.547 and the 100-year headwater elevation is 489.679. The 100-year event does not overtop the road. See attached Figure 5.31 for headwater depths.

Headwater depths were completed using the Maricopa County Drainage Design Manual, Volume II for the elliptical culverts located at Sta. 7+733. The 50-year headwater elevation is 513.947 and the 100-year headwater elevation is 514.594. Flow depth over the road during the 100-year event is 0.119m. See attached Figure 5.31 for headwater depths.

ELLSWORTH ROAD
 UNIVERSITY DRIVE TO MCLELLAN ROAD, PHASE II
 BOX CULVERT DRAINAGE ANALYSIS

Label	Number of Sections	Section Size	Section Shape	Length (m)	Total System Flow (m ³ /s)	Average Velocity (m/s)	Hydraulic Grade Upstream (m)	Hydraulic Grade Downstream (m)
5+639 to 5+634	2	1800 x 900 mm	Box	5.00	8.4960	2.79	479.87	479.78
5+793 to 5+639	2	1800 x 900 mm	Box	154.00	8.4960	2.70	480.74	479.86
5+819 to 5+793	2	1800 x 900 mm	Box	26.00	8.4960	2.95	480.99	480.62
5+984 to 5+819	2	1800 x 900 mm	Box	166.00	8.4960	3.16	483.14	480.80
6+012 to 5+984	2	1800 x 900 mm	Box	28.40	8.4960	2.90	483.38	483.04

50 yr $Q = 7.77 \text{ m}^3/\text{sec} = 274.5 \text{ cfs}$

Flow for graph = $137.25 \text{ cfs}/\text{barrel}$

Headwater Depth = $1.4 \times 3 = 4.2' = 1.28 \text{ m}$

1800 mm X 900 mm Box

Culverts and Bridges

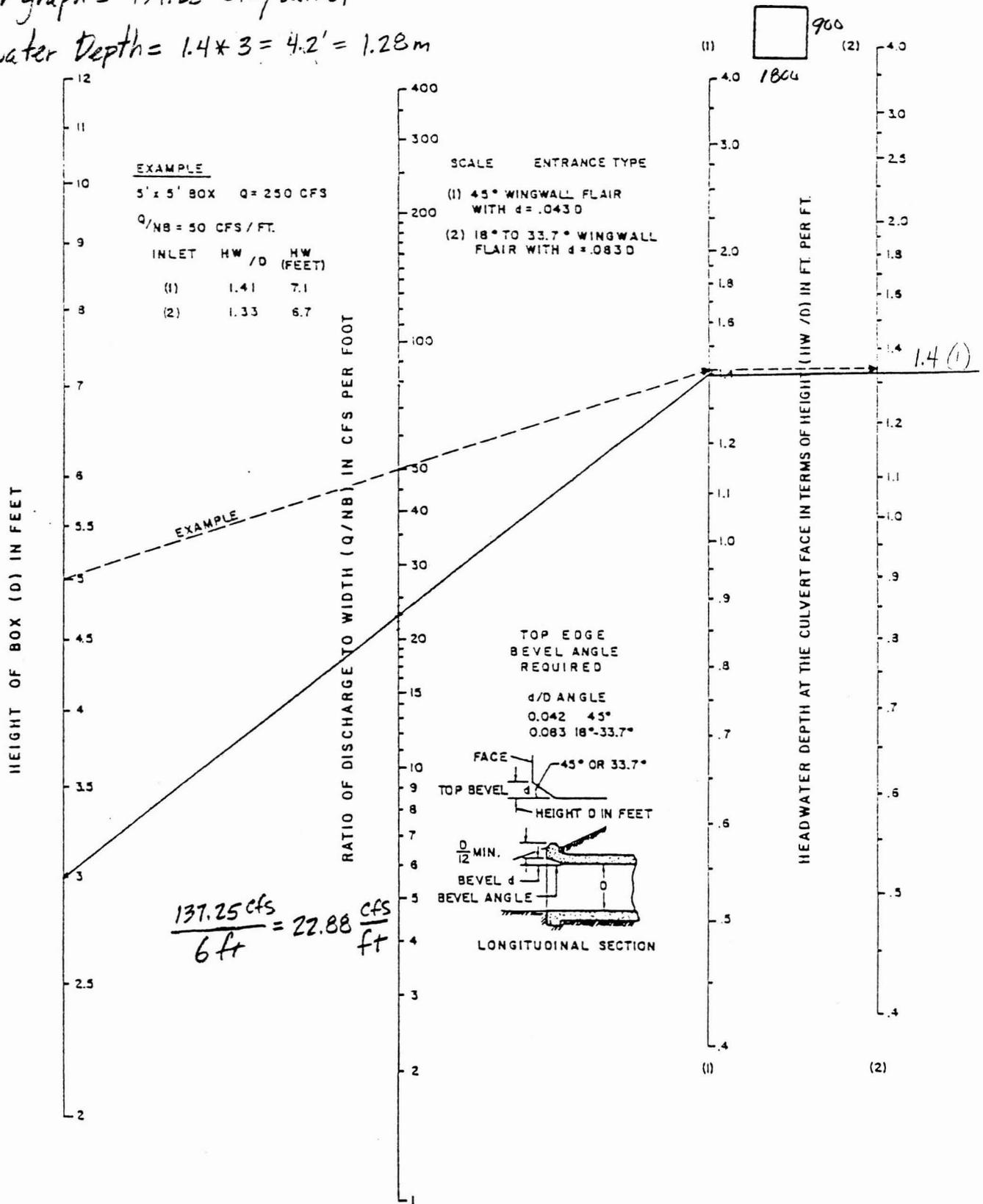


Figure 5.27

Headwater Depth for a Rectangular Box Culvert with Inlet Control, Flared Wingwalls (18° to 33.7°, and 45°), and Beveled Edge at the Top of the Inlet

(USDOT, FHWA, HDS-5, 1985)

$100\text{ yr } Q = 9.57 \text{ m}^3/\text{sec} = 338.1 \text{ cfs}$
 Flow for graph = $169.1 \text{ cfs}/\text{barrel}$
 Headwater Depth = $1.71 * 3 = 5.13' = 1.56\text{m}$

$1800 \text{ mm} \times 900 \text{ mm}$ BOX
 Culverts and Bridges

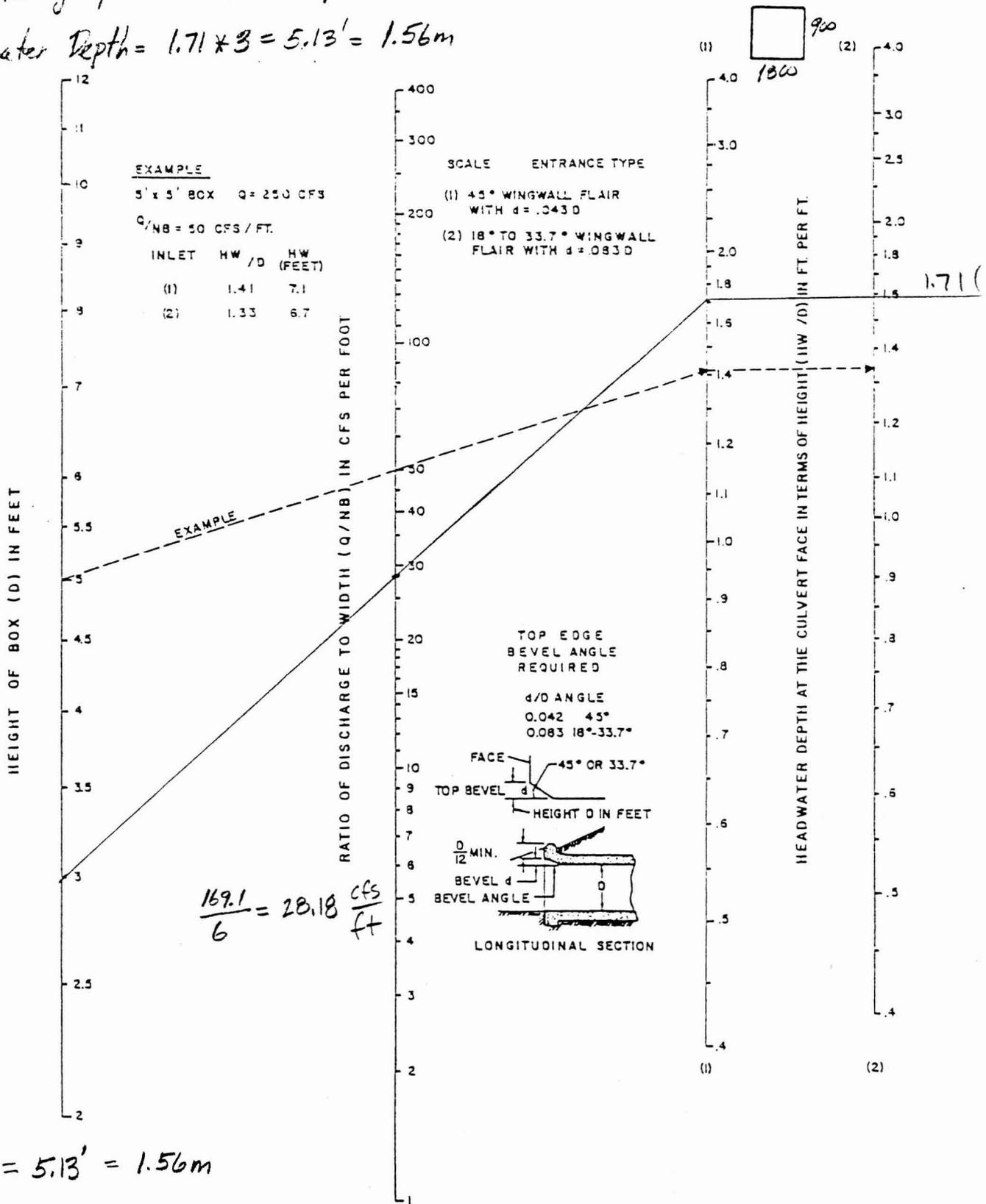


Figure 5.27

Headwater Depth for a Rectangular Box Culvert with Inlet Control, Flared Wingwalls (18° to 33.7°, and 45°), and Beveled Edge at the Top of the Inlet
 (USDOT, FHWA, HDS-5, 1985)

53 yr Q = 1.33 m³/sec = 47.0 cfs

Flow for graph = 23.5 cfs/barrel

Headwater Depth = 1.08 * $\frac{24}{12}$ = 2.16' = 0.658m

Sta 6+384
Culverts and Bridges

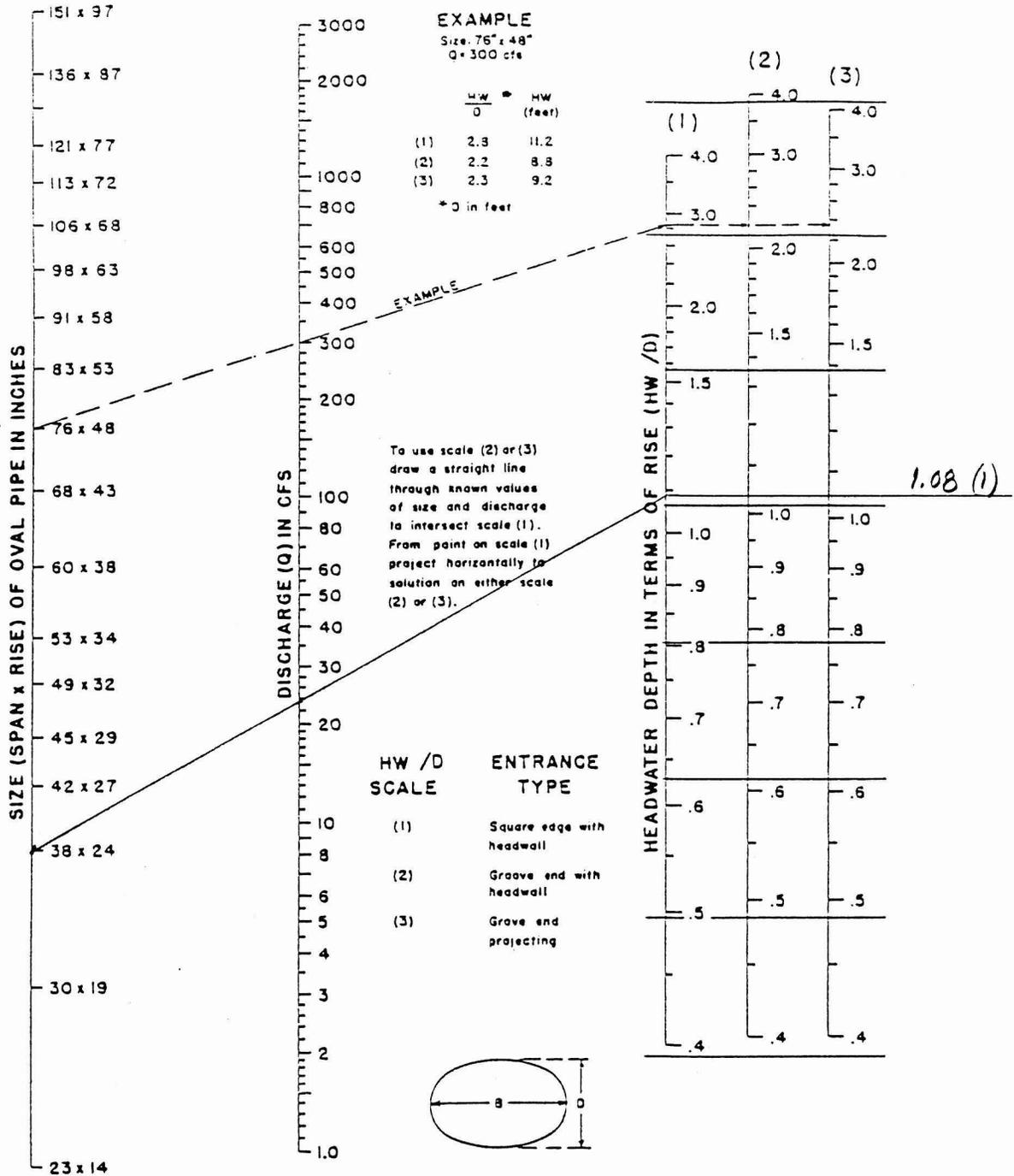


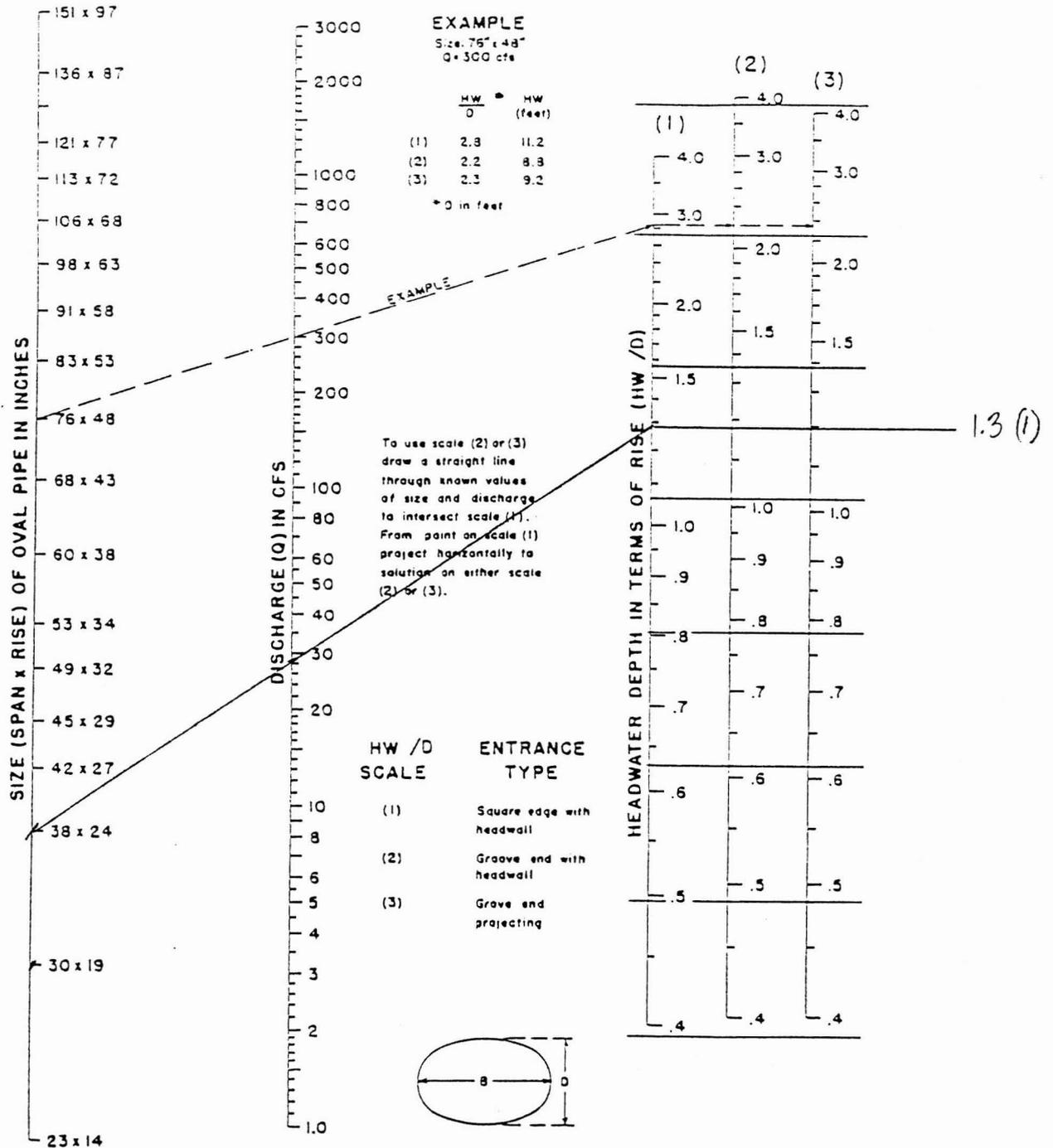
Figure 5.31
Headwater Depth for Oval Concrete Pipe Culverts
Long Axis Horizontal with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

100 yr $Q = 1.61 \text{ m}^3/\text{sec} = 56.88 \text{ cfs}$

Flow per graph = $28.44 \text{ cfs}/\text{barrel}$

Headwater Depth = $1.3 \times \frac{24}{12} = 2.6' = 0.79 \text{ m}$

Sta 6+384
Culverts and Bridges



$HW = 1.3 \times \frac{24}{12} = 2.6' = 0.79 \text{ m}$

Figure 5.31
Headwater Depth for Oval Concrete Pipe Culverts
Long Axis Horizontal with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

50 yr Q = 0.68 m³/sec = 24.02 cfs

Flow for graph = 12.01 cfs/barrel

Headwater Depth = $1 * \frac{19}{12} = 1.58' = 0.483 \text{ m}$

Sta 7+733
Culverts and Bridges

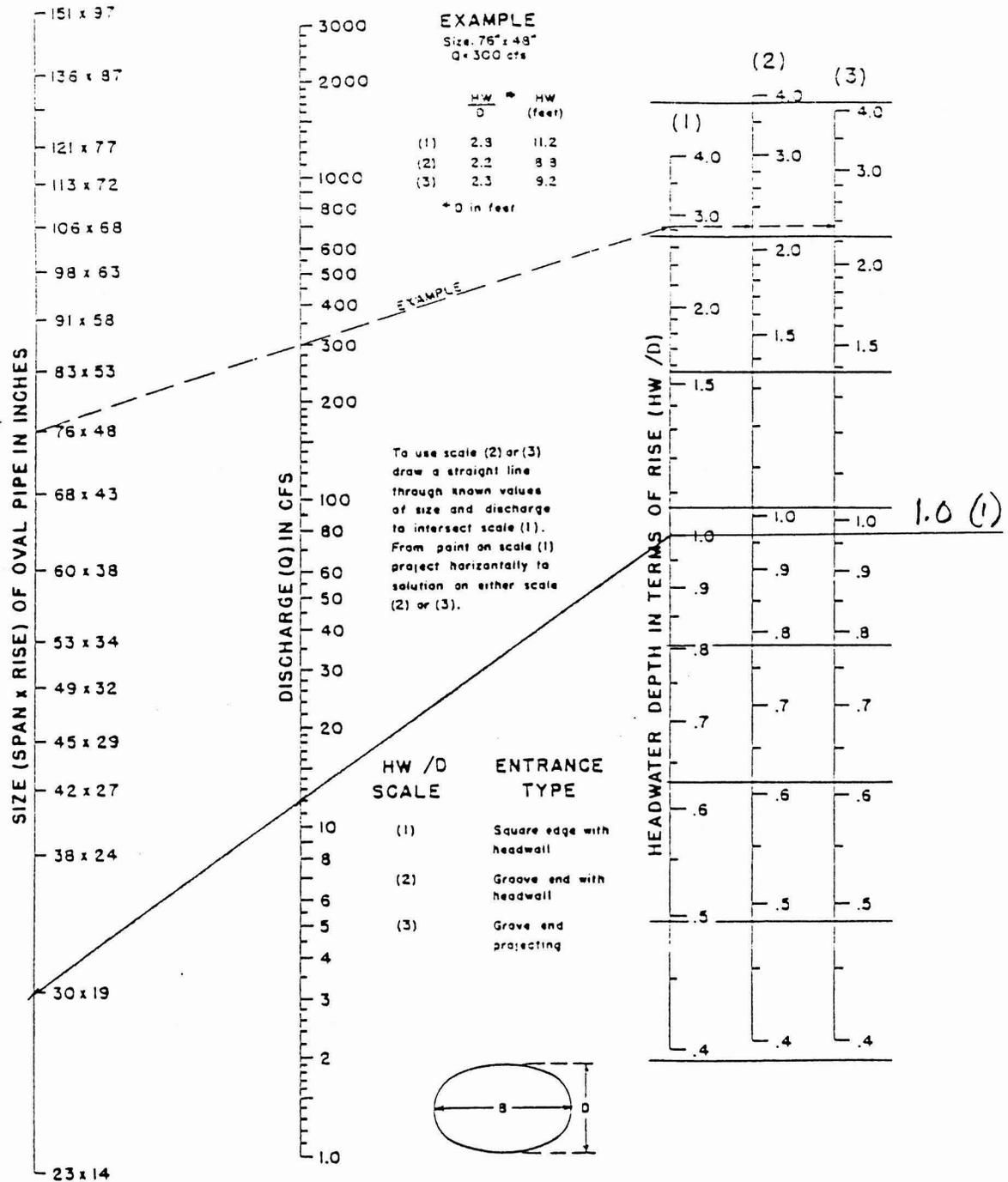


Figure 5.31
Headwater Depth for Oval Concrete Pipe Culverts
Long Axis Horizontal with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

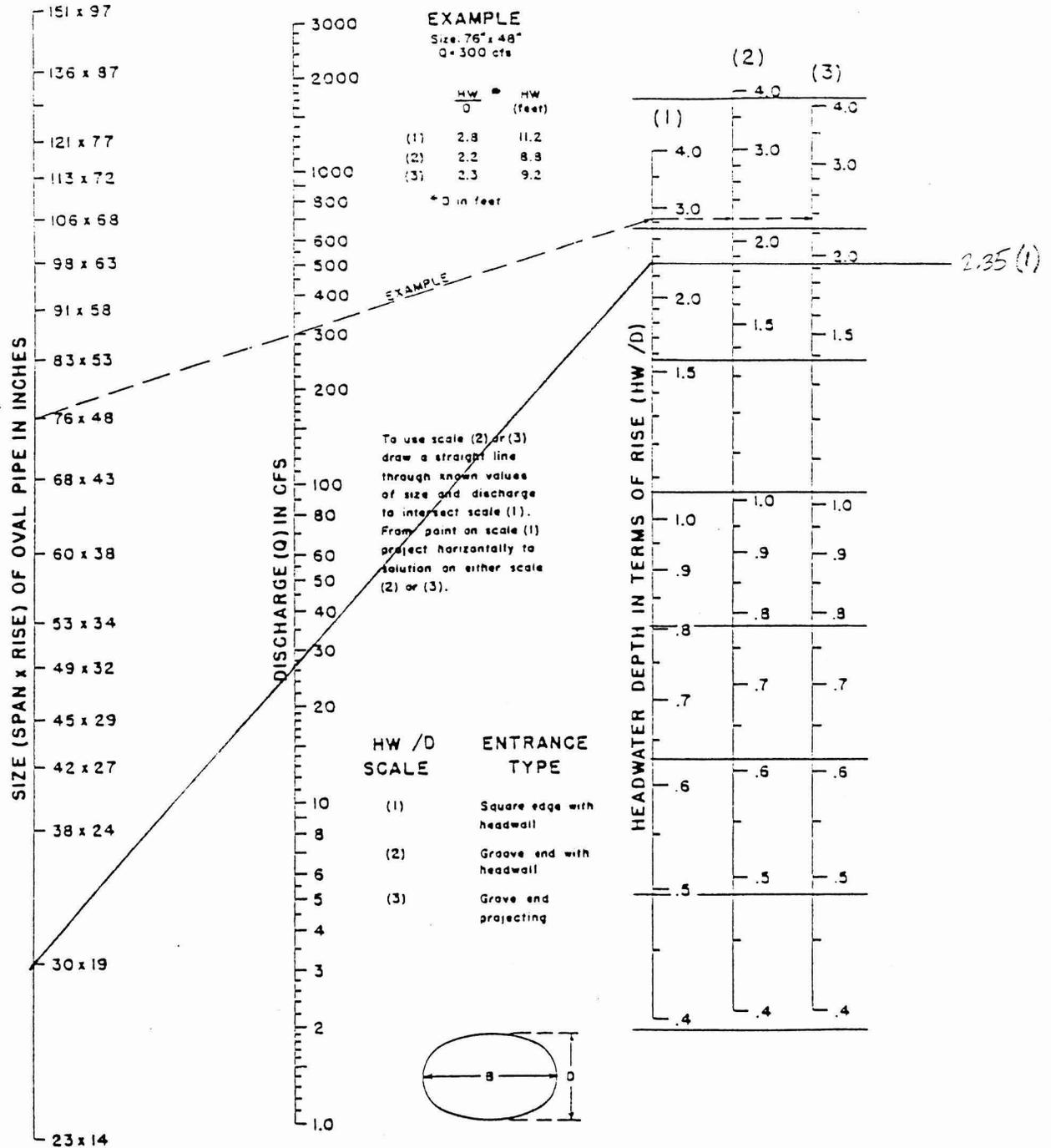
100 yr $Q = 1.50 \text{ m}^3/\text{sec} = 53 \text{ cfs}$

Sta 7+733
Culverts and Bridges



Flow for graph = $26.5 \text{ cfs}/\text{barrel}$

Headwater Depth = $2.35 \times \frac{19}{12} = 3.72' = 1.13 \text{ m}$



$hw = 2.35 \times \frac{19}{12} = 3.72' = 1.13 \text{ m}$

Figure 5.31
Headwater Depth for Oval Concrete Pipe Culverts
Long Axis Horizontal with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

DRAINAGE REPORT ADDENDUM

Report 1

ELLSWORTH ROAD
UNIVERSITY DRIVE TO MCLELLAN ROAD (PHASE II)

Maricopa County Project No. 68902

Earth Tech Project No. 78814

Prepared for:

Maricopa County Department of Transportation

Prepared by:

Earth Tech
3800 N. Central Avenue, Suite 1700
Phoenix, AZ 85012

November 2004



Drainage Report Addendum
Ellsworth Road – University Drive to McLellan Road
Maricopa County Project No. 68902
Earth Tech Project No. 78814

Introduction

The following is an addendum to the Earth Tech drainage report issued June 8, 1999. This addendum is completed as part of change order #6, issued August 13, 2004, and includes a description of the design changes and computer model of the hydraulic analysis.

Design Changes

The former design included a concrete-lined open channel on the east side of Ellsworth Road between Adobe Road and the CAP canal, with a cross section including 7.5m top width and 1:1 side slopes. The new design includes a closed system of 2 – 1800mm x 900mm box culverts. The design flow given in change order #6 of 8.496 m³/sec (300 cfs) was used. The box culvert hydraulic design was completed using StormCAD v4.1.1. A Manning's n value of 0.016 (concrete, rough forms) was taken from the Maricopa County Drainage Design Manual, Table 4.1. The box culvert slope follows the flow line profile of the existing channel and matches the existing grade at the downstream end. The upstream end utilizes a drop inlet to clear underneath Adobe Road. See attached sheet for hydraulic calculations.



ELLSWORTH ROAD
 UNIVERSITY DRIVE TO MCLELLAN ROAD, PHASE II
 BOX CULVERT DRAINAGE ANALYSIS

Label	Number of Sections	Section Size	Section Shape	Length (m)	Total System Flow (m ³ /s)	Average Velocity (m/s)	Hydraulic Grade Upstream (m)	Hydraulic Grade Downstream (m)
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5+984 to 5+819	2	1800 x 900 mm	Box	166.00	8.4960	3.16	483.14	480.80
6+012 to 5+984	2	1800 x 900 mm	Box	28.40	8.4960	2.90	483.38	483.04
INLET	1	1800 x 900 mm	Box	1.00	8.4960	5.63	484.71	483.22

Maricopa County Department of Transportation (MCDOT)

TRAFFIC ENGINEERING

REVIEW COMMENT SHEET

1 of 1

Project Name: Ellsworth Rd. – University to McLellan Rd., Phase II Location: Same – except Ellsworth and Brown Inter. Type: TIP	Date: February 7, 2005 Reviewer: Catherine Register
Consultant: Earth Tech (IGA with City of Mesa to annex) Phone: MCDOT Project: 68902- Ph2 (100%) Project Mgr: Sami Ayoub	Action Codes: A = Will Comply B = Deleted C = Consultant to Evaluate

Item #	Sheet #	<u>100% Phase II Plan Review</u>	Consultant Reply
1		I have completed my review of the subject plans and the responses to my previous comments. In my previous review, I had requested the complete input parameters used in the software for the design of the box culvert along the east side of Ellsworth. The consultant indicated that he would comply. However, the submitted data still lacks the culvert invert elevations and the selected 'n' value for the culvert.	A
2		The 300 cfs used for the design of the box culvert along the east side of Ellsworth Road should be substantiated. The East Mesa ADMP does not provide a concentration point and, therefore, a 100-yr Q at this location. Per the 1999 report, for concentration point #4, the discharge was "derived from previous study information developed as a part of the <i>Southeast Mesa Area Drainage Master Plan Study</i> ". It appears that the 300 cfs has also been "derived". An explanation regarding how the flow rate was determined, along with any appropriate back-up calculations (including the drainage area boundary map) should be included in the report.	B
3		Will water quality and/or 100-yr 2-hr retention be provided for the road improvements?	B
4		2/3/05 review: MCDOT explained that water quality will be addressed through Mesa's BMPs. However, it is not clear why the 50-yr storm was used for the basin design. Response: Basin is an attenuation basin to reduce the peak discharge to the box culvert.	B
5		I have not reviewed the 1999 Drainage Report and December 9, 1999 Addendum in great detail as I assume this has already been reviewed and approved by MCDOT but I have noted some items which I did not see addressed in the report and some additional comments:	
6		I did not see any back-up material for the determination of the inflow hydrographs used in the basin routing calculations.	B
7		The storm drain calculations have been performed using a circular section normal depth calculation. It appears that the tailwater for all of the calculations has been assumed as 0.00. Additionally, the pipe sizes, slopes, and reach breaks do not always match the current design. I recommend that the calculations be reviewed and updated as appropriate to match the current design and that the standard methodology for computing the hydraulic grade line in a storm drain system or a storm drain design software be used for the design. I also recommend that the hydraulic grade line be plotted on the storm drain plans.	B

Maricopa County Department of Transportation (MCDOT)

TRAFFIC ENGINEERING

REVIEW COMMENT SHEET

1 of 1

Project Name: Ellsworth Rd. – University to McLellan Rd., Phase II Location: Same – except Ellsworth and Brown Inter. Type: TIP	Date: January 28, 2005 Reviewer:
Consultant: Earth Tech (IGA with City of Mesa to annex) Phone: MCDOT Project: 68902- Ph2 (100%) Project Mgr: Sami Ayoub	Action Codes: A = Will Comply B = Deleted C = Consultant to Evaluate

Item #	Sheet #	<u>100% Phase II Plan Review</u>	Consultant Reply
8		Is the 100-yr HW elevation at the culverts contained within MCDOT's ROW or drainage easements? Per District criteria, flows up to and including the 100-yr frequency event should not cause increased flooding to adjacent property or buildings unless a drainage easement is acquired for those areas.	B
9		The December 9, 1999 Addendum states that the rip-rap lined spillway at the southwest corner of the Elmwood Road detention basin discharges into an existing wash. What is the existing watershed and 100-yr Q to this wash and how does that compare with the proposed? Per the drainage report, it appears that flows from both sub-basins 7 and 8 will be diverted into the detention basin	B

Maricopa County Department of Transportation (MCDOT)

TRAFFIC ENGINEERING

REVIEW COMMENT SHEET

1 of 2

Project Name: Ellsworth Rd. – University to McLellan Rd., Phase II Location: Same – except Ellsworth and Brown Inter. Type: TIP	Date: December 13, 2004 Reviewer: Catherine Register FCDMC
Consultant: Earth Tech (IGA with City of Mesa to annex) Phone: MCDOT Project: 68902- Ph2 (90%) Project Mgr: Sami Ayoub	Action Codes: A = Will Comply B = Deleted C = Consultant to Evaluate

Item #	Sheet #	<u>90% Phase II Plan Review</u>	Consultant Reply
1		<p>The 300 cfs used for the design of the box culvert along the east side of Ellsworth Road should be substantiated. The East Mesa ADMP does not provide a concentration point and, therefore, a 100-yr Q at this location. Per the 1999 report, for concentration point #4, the discharge was "derived from previous study information developed as a part of the <i>Southeast Mesa Area Drainage Master Plan Study</i>". It appears that the 300 cfs has also been "derived". An explanation regarding how the flow rate was determined, along with any appropriate back-up calculations (including the drainage area boundary map) should be included in the report. Response: Design flow given in change order.</p> <p style="color: green; text-align: center;">MCDOT TO CHECK</p>	B
2		<p>Will there be any flows south of Adobe which need to be captured by the proposed box culvert along the east side of Ellsworth? Response: The addition of manholes at 150m spacing on top of each barrel of the box culvert will allow covers to be open grates.</p>	A
3		<p>The complete input parameters used in the software for the design of the box culvert along the east side of Ellsworth have not been provided. Therefore, the design has not been checked.</p>	A
4		<p>Is the HW at the entrance to the box culvert along the east side of Ellsworth contained completely within MCDOT ROW or drainage easements? Response: Yes.</p>	A
5	BMP'S FOR MESA	<p>Will water quality and/or 100-yr 2-hr retention be provided for the road improvements? Response: Basins are sized for the 50-year event.</p>	B
6		<p>Sheet <i>Ellsworth Road, Storm Water Detention Area No. 1 (24 of 25)</i> needs a Construction Note for #17.</p>	A
7		<p>I have not reviewed the 1999 Drainage Report and December 9, 1999 Addendum in great detail as I assume this has already been reviewed and approved by MCDOT but I have noted some items which I did not see addressed in the report and some additional comments: Response: 1999 Drainage Report approved by MCDOT.</p> <ul style="list-style-type: none"> • I did not see any back-up material for the determination of the inflow hydrographs used in the basin routing calculations. • The storm drain calculations have been performed using a circular section normal depth calculation. It appears that the tailwater for all of the calculations has been assumed as 0.00. Additionally, the pipe sizes, slopes, and reach breaks do not always match the current design. I recommend that the calculations be reviewed and updated as appropriate to match the current design and that the standard methodology for computing the hydraulic grade line in a storm drain system or a storm drain design software be used for the design. I also recommend that the hydraulic grade line be plotted on the storm drain plans 	B

Maricopa County Department of Transportation (MCDOT)

TRAFFIC ENGINEERING

REVIEW COMMENT SHEET

1 of 1

Project Name: Ellsworth Rd. – University to McLellan Rd., Phase II Location: Same – except Ellsworth and Brown Inter. Type: TIP	Date: December 14, 2004 Reviewer: Joe Rumann FCDM
Consultant: Earth Tech (IGA with City of Mesa to annex) Phone: MCDOT Project: 68902- Ph2 (90%) Project Mgr: Sami Ayoub	Action Codes: A = Will Comply B = Deleted C = Consultant to Evaluate

Item #	Sheet #	<u>90% Phase II Plan Review</u>	Consultant Reply
1	General	<p><u>Review Comments:</u></p> <p>In addition to Cathy Regester's comments on the proposed improvements, I would like to add the following. The June, 1999 drainage report indicates that Maricopa County directed Earth Tech to exclude drainage improvements for offsite flows north of Brown Road based upon an assumption that future development along the east side of Ellsworth will direct flows into the Signal Butte floodway channel. This assumption and direction should be substantiated. To my knowledge no new right-of-way permits have been issued to directly connect to the floodway. Shelby Brown at 6-4583 can assist you with right-of-way information. The permit we issued to MCDOT for the storm drain you are now extending was based upon an H&H report dated April 2004. This report indicated that the storm drain was designed for a 10 year event. Impacts from the 100-year event have not been addressed.</p> <p>Response: There is an existing channel on the east side of Ellsworth Rd. beginning north of Hobart Dr. and continuing to Princess Dr. South of Princess Dr. the channel transitions to an existing 60" RCP pipe and presently connects to the Signal Butte Floodway.</p> <p>We are unaware of the H & H report dated April 2004.</p>	B