DYS1

The WLB Group Inc.

Final

ADDENDUM

TO

DYSART DRAIN IMPROVEMENT PROJECT

Concept Design Study Selected Alternative

Prepared for:
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

November, 1993

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REGISTERED PROFESSIONAL ENGINEER (CIVIL)
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GAVAN
Date signed 12.8.93
ARIZONA, U.S.A.

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1.0 INTRODUCTORY SUMMARY

The purpose of this addendum is to respond to a question that the Flood Control District of Maricopa County has raised in regard to the flow capacity of Reems Road and its effect on the design flows for the Dysart Drain Improvement Project. The hydrologic model used for the Project (Concept Design Study Selected Alternative, dated August 4, 1993) predicts a flow of 2290 cfs in Reems Road which was assumed to be captured in the proposed detention basin. The concern is that, if Reems Road can not contain the 2290 cfs, flood flows could potentially breakout upstream and bypass the detention basin. If this were to occur, peak flows might enter the downstream channel without the attenuation effects of the detention basin, which may exceed the capacity of the channel. Hence, the District's question; Can flood flows breakout of Reems Road and, if so, will the breakout cause the downstream channel capacity to be exceeded while the detention basin is underutilized?

To answer this question, a supplemental hydrologic analysis was performed which includes breakout flows along Reems Road. This analysis, as described herein, results in a recommendation for a collector channel to extend upstream from the detention basin. The recommended channel has a capacity for 840 cfs and is 1/2 mile in length; parallel with and 1/2 mile east of Reems Road from the south side of Olive Avenue down to the basin.

It is important to understand that Reems Road collects a significant amount of stormwater. It is different from a typical County roadway in that it was constructed with an inverted crown to convey runoff. In addition, the farm fields are bermed up approximately 2 feet which adds to the roadway's conveyance capacity. The problem with relying on Reems Road to convey large floods is that the District has no control over the quality of construction or the height of the agricultural berms which help contain the flood flows. Therefore, this supplemental analysis is based on a more conservative estimate of what can be contained in Reems Road and also considers the case where the berms are breached and wash out altogether.

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2.0 SUPPLEMENTAL HYDROLOGIC ANALYSIS

A supplemental hydrologic analysis was developed for the Dysart Drain Improvement Project in order to determine the effects on the Project design in the event that flood flows split out of Reems Road. This modified HEC-1 model is referred to as the Reems Road Split Flow Model.

Reems Road was constructed with an inverted crown from Cactus Road to Northern Avenue. Currently, the roadway drains into the existing Dysart Drain channel on the north side of Northern Avenue. The hydrologic model for the Dysart Drain Improvement Project predicts a flow of 2290 cfs in Reems Road that will enter the basin. The model assumes that there is only one location between Cactus Road and Northern Avenue where flow will split out of Reems Road. This location is Olive Avenue. The split flow model incorporates breakout flows at Cactus Road, Peoria Avenue, and Olive Avenue in order to determine the effects on the project in the case where less flow is contained in Reems Road.

2.1 HEC-1 Model Modifications

The following paragraphs describe the modifications which were made to the Dysart Drain HEC-1 model.

<u>Diversion at Reems and Cactus</u>

A diversion was added at the intersection of Reems Road and Cactus Road. The Dysart Drain model assumed that all of the flow that reaches this point of concentration will flow south in Reems Road. The added diversion causes the first 240 cfs to flow south in Reems Road while the remainder flows southeasterly across the agricultural fields to the east. The basis of the 240 cfs is the approximate capacity of Reems Road just south of Cactus Road (refer to Appendix A for capacity calculations).

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Diversion at Reems and Peoria

A diversion was also added at Reems Road and Peoria Avenue. As was the case at Cactus Road, the Dysart Drain model assumed that all of the flow that reaches this point will flow south in Reems Road. The added diversion causes the first 1000 cfs to flow south and the remainder to flow southeasterly across the farm fields east of Reems Road. The approximate flow capacity of Reems Road is 1000 cfs at a depth of 2 feet which is about 1/2 foot below the top of the berm (refer to Appendix A for capacity calculations).

Diversion at Reems and Olive

The diversion at Reems Road and Olive Avenue was modified to reduce the flow conveyed in Reems Road as well as Olive Avenue. The Dysart Drain model predicts a split flow of 2290 cfs south in Reems Road and 1630 cfs east in Olive Avenue. The modification to this diversion causes the flow to split equally between Reems Road and Olive Avenue. Then another diversion is added which causes flows in excess of the capacity of each roadway to breakout and flow southeasterly. The approximate flow capacity of Reems Road and Olive Avenue is 1000 cfs and 240 cfs, respectively (refer to Appendix A for capacity calculations).

The stormwater that breaks out of the roadways and flows southeasterly is routed to the proposed detention basin. This routing assumption is based on the addition of a collector channel north of the detention basin which will collect and convey breakout flows to the basin (refer to section 3.0 of this addendum).

Subdivision of Sub-Basin 194

Sub-basin 194 was subdivided further into three sub-basins (194A, 194B, and 194C) to reflect the location of the proposed detention basin and the proposed collector channel (see the following exhibit).

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2.2 Results

The peak discharges from the Reems Road split flow model are presented on the following exhibit. A second exhibit is also included which presents the design flows for Dysart Drain. The HEC-1 split flow model (DYSMOD1A.24) is included in the back of this report on diskette.

The results of the split flow model indicate that 840 cfs will breakout and flow across the farm fields southeast of the intersection of Reems Road and Olive Avenue. In addition, significant breakouts occur along Reems Road at both Cactus Road and Peoria Avenue. The following paragraphs describe the effects that these split flows have on the proposed detention basin and the downstream channel improvement.

Effect on Detention Basin Volume

Inflow to the detention basin is reduced in the split flow model which results in a 13% lower storage requirement of 384 ac-ft compared with 440 ac-ft in the design model. The design storage at the spillway elevation is 600 ac-ft.

The 384 ac-ft requirement is based on the assumption that the 840 cfs breakout at Reems Road and Olive Avenue will be collected and conveyed to the basin. Refer to section 3.0 of this addendum for a description of the proposed collector channel required to ensure that these breakout flows reach the basin.

Although the split flow model results in a lower storage requirement, it is recommended that the concept design storage volume of 440 acre feet be maintained along with a freeboard capacity to the top of spillway of at least 25%. This would result in a storage volume of 550 acre-feet at the top of the spillway. The freeboard capacity is necessary to provide flood protection for the uncertainties in the direction of flow caused by diversions in the watershed, such as; Reems Road, the railroad, irrigation ditches, and other roadways. For example, farmers could raise the height of the berms along Reems Road which would significantly increase

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flood flows to the detention basin. The freeboard capacity provides protection against such events. The freeboard capacity also provides some flexibility in the design of future flood conveyance structures that may discharge to the basin. For instance, Reems Road conveys flood flows, therefore, any future improvement of the roadway would, most likely, include a flood control channel that would be designed to contain, at a minimum, the current capacity of Reems Road. The freeboard capacity would provide the flexibility to construct such future projects.

Effect on Detention Basin Inflow Peak Discharge

The split flow model results in a 28% reduction in the total combined peak inflow to the basin; 1700 cfs compared with the concept design inflow of 2350 cfs. This peak inflow, however, does not reach the basin at one location. The concept design calls for inflow spillways at the southwest corner, the northwest corner and the northeast corner of the basin. In addition, the concept study called for berms along the north side and west side in order to collect sheet flows and convey them to the inflow spillways. These proposed spillway locations, along with a means of collecting sheet flows, should be provided in the basin design.

The split flow model predicts peak inflow discharges of 840 cfs at the northeast corner of the basin, 1000 cfs at the northwest corner and 600 cfs at the southwest corner. Unfortunately, with the exception of the collection channel at the northeast corner, these peak discharges are not all well contained points of concentration. Instead, they are a combination of flow in Reems Road, flow along Northern Avenue, flow in the agricultural fields along the west side of Reems Road and sheet flow from the west. Consequently, there is a considerable amount of uncertainty as to the exact location where the runoff will reach the basin. Therefore, the basin design requires a means of collecting flows along its north and west sides. The following is the recommended inflow capacities for the basin:

- **Inflow Spillway at Northeast Corner**
  Inflow capacity should be equal to the capacity of the collector channel which is 840 cfs with one foot of freeboard.

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- **Inflow Spillway at Northwest Corner**
  This spillway should be designed for the capacity of Reems Road which is 1000 cfs. This flow includes approximately 700 cfs in Reems Road and 300 cfs in the agricultural field west of Reems Road. It is uncertain whether the 300 cfs will enter at this location or further downstream, therefore, inflow capacity for the 300 cfs should be provided at this location and further downstream along the west side of the basin.

- **Inflow Spillway at Southwest Corner**
  The inflow spillway at the southwest corner (Reems Road and Northern Avenue) should be designed to accept, at a minimum, the flow along Northern Avenue (approximately 120 cfs) plus half of the runoff from sub-basin 193 (approximately 275 cfs); for a total of 400 cfs.

- **Sheet Flow Along North Side of Basin**
  The collection system along the north side of the basin should be designed to accept 1000 cfs. This would provide adequate protection in the event that the berms on Reems Road entirely wash out and the capacity of the roadway (1000 cfs) flows southeasterly to the north side of the basin.

- **Sheet Flow Along West Side of Basin**
  The collection system along the west side of the basin should be designed to accept the 300 cfs described previously (refer to inflow spillway at northwest corner) plus one half of the runoff from sub-basin 193 (275 cfs). Total recommended capacity equals 600 cfs. It should be pointed out that the capacity of the inflow spillway at the southwest corner of the basin is based on the assumption that this 600 cfs is captured along the west side of the basin before it reaches Northern Avenue. If it isn't captured along the west side of the basin, the spillway at Northern Avenue (southwest corner) should be upsized from 400 cfs to 1000 cfs.

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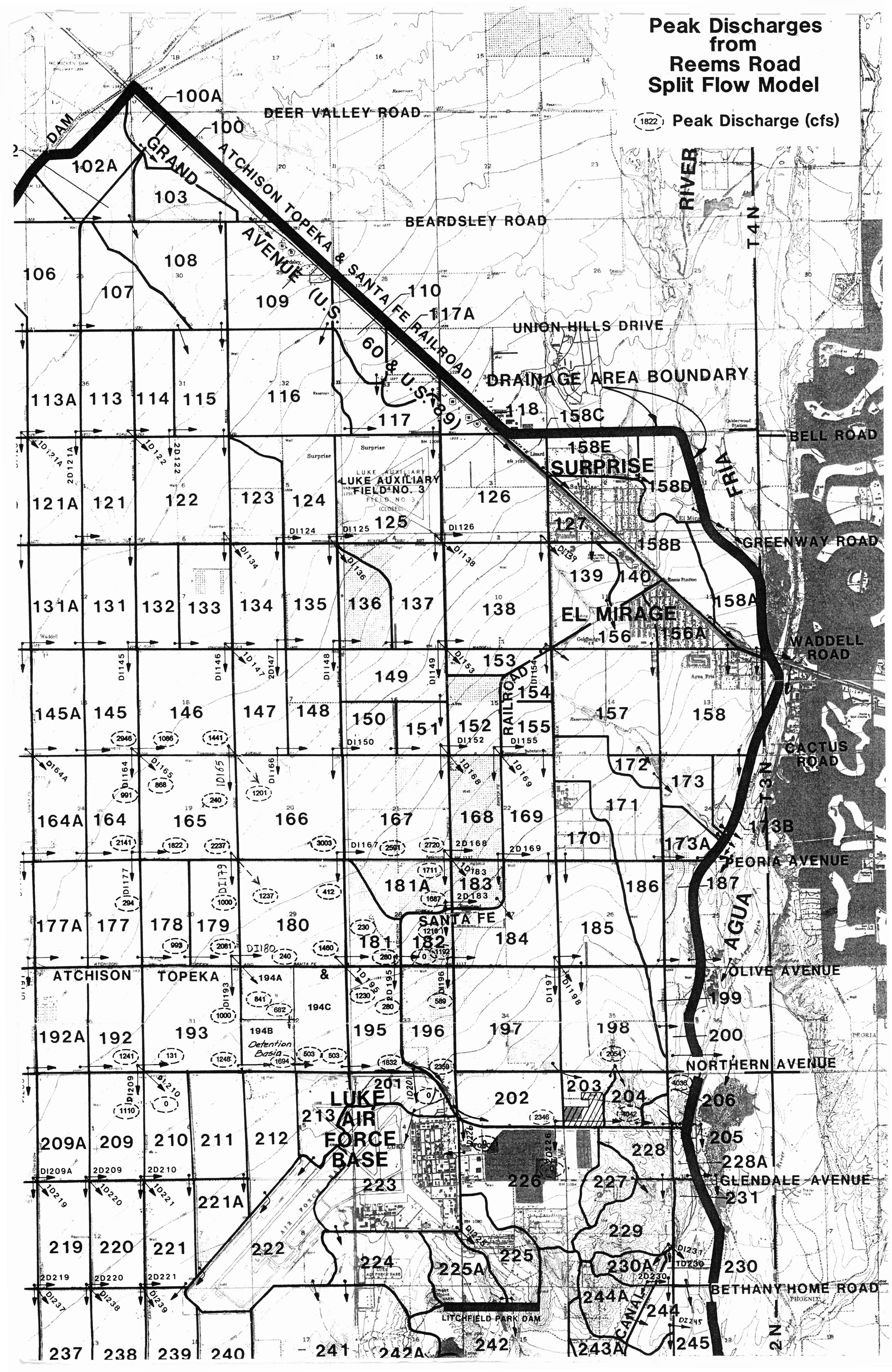
Effect on Dysart Drain Channel

The split flow model results in a reduction in the channel peak discharges for most of the length of the channel. From the basin outlet downstream to the inflow spillway, west of El Mirage Road, the peak discharges are 3% to 23% lower than the design flows. From the inflow spillway out to the Agua Fria River (about 1/2 mile), the flow is increased approximately 15%. This increase is due to the fact that most of the flow that splits out of Reems Road, at Cactus Road, will be collected in the natural channel that enters Dysart Drain at the inflow spillway.

A backwater computation was done to determine the effect of the increased flow downstream of the inflow spillway (refer to Appendix B). The results indicate that the water surface elevation rises a maximum of 0.70 feet. This rise in water surface elevation takes place at the downstream end of the channel where there is considerable freeboard. This reach of the channel is being excavated substantially which results in 5 to 10 feet of freeboard from the top of channel lining to the top of bank. Also, the 0.70 foot rise can be contained in the freeboard of the lined channel.

The results of the backwater computation also indicate that there is no increase in water surface elevation in the critical area downstream of Litchfield Road where there is limited freeboard.

No backwater analysis was performed for the reach upstream of Litchfield Road because the peak discharges are lower in the case of the split flow model. Therefore, the water surface elevations can be assumed to be lower.


Peak Discharges from Reems Road Split Flow Model
1822 Peak Discharge (cfs)
DEER VALLEY ROAD
BEARDSLEY ROAD
UNION HILLS DRIVE
DRAINAGE AREA BOUNDARY
BELL ROAD
GREENWAY ROAD
WADDELL ROAD
CACTUS ROAD
PEORIA AVENUE
OLIVE AVENUE
NORTHERN AVENUE
GLENDALE AVENUE
BETHANY HOME ROAD
ATCHISON TOPEKA & SANTA FE RAILROAD
GRAND AVENUE (U.S. 60 & U.S. 89)
SANTA FE RAILROAD
SURPRISE
EL MIRAGE
LUKE AUXILIARY FIELD NO. 3
LUKE AIR FORCE BASE
LITCHFIELD PARK DAM
AGUA FRIA RIVER
CANAL
T4N
T3N
T2N
100A
100
102A
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106
107
108
109
110
117A
113A
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118
158C
158E
158D
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158A
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131A
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Detention Basin
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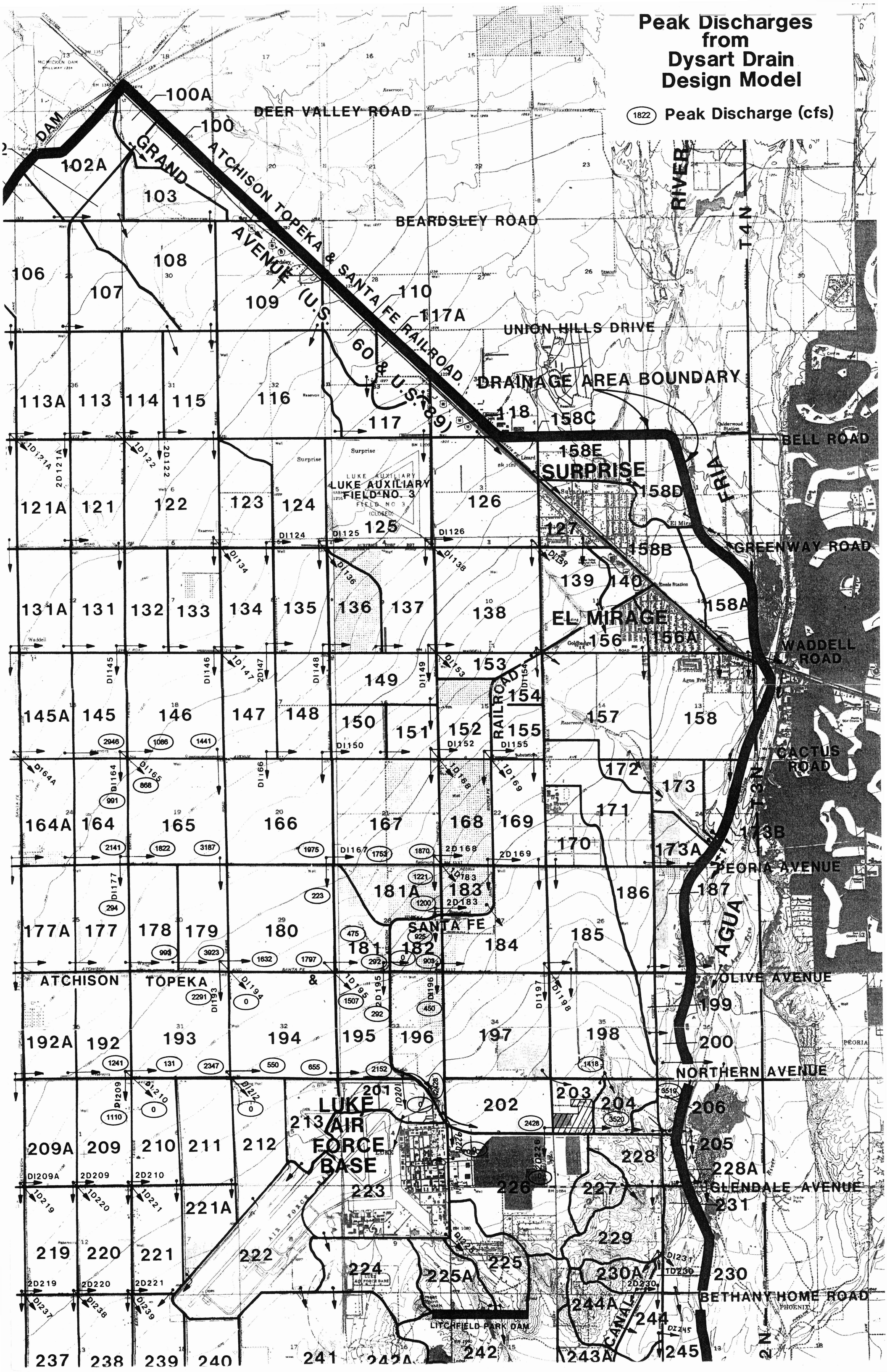
Peak Discharges from Dysart Drain Design Model

(1822) Peak Discharge (cfs)



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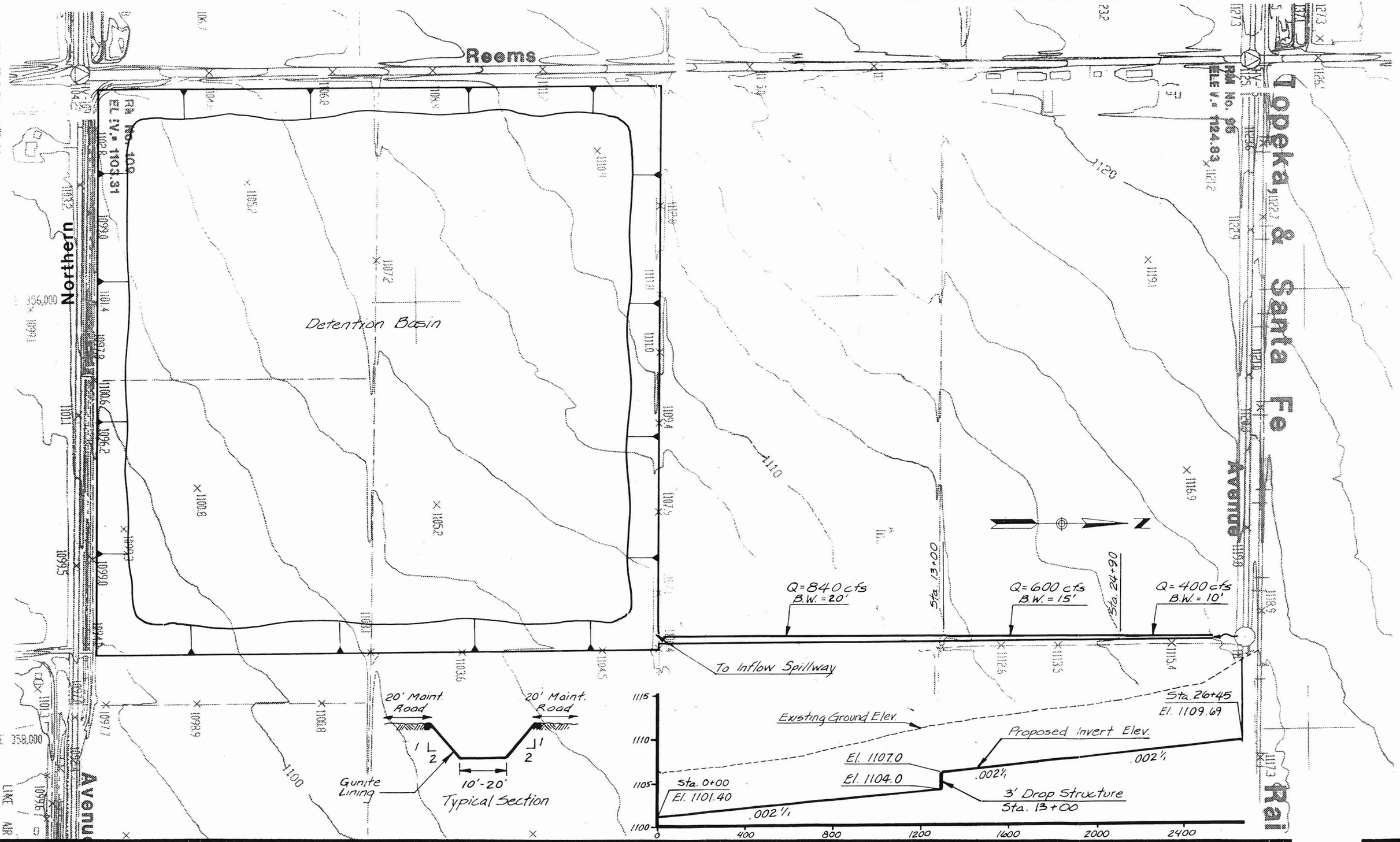
3.0 DETENTION BASIN COLLECTOR CHANNEL

A new collector channel feature is proposed to be added to the project. The following exhibit shows the location, size and profile of the new channel. It is located parallel with and 1/2 mile east of Reems Road from the detention basin upstream to Olive Avenue.

The purpose of the channel is to capture flows that breakout of Reems Road and convey them to the basin. The channel will ensure that all of the flood flows which concentrate at Reems Road and Olive Avenue will reach the basin (with the exception of the 240 cfs which will flow east in Olive Avenue).

The channel is designed to convey 840 cfs. This flow was identified in the split flow model as that runoff which would exceed the capacity of Reems Road and Olive Avenue and flow southeasterly across the farm fields. The breakout flows will result in wide, shallow sheet flooding and will enter the channel in several locations. Consequently, there is no need to design the entire channel for 840 cfs. Therefore, the channel design peak discharges were reduced upstream of the basin (refer to the following exhibit). Also refer to Appendix C for the channel backwater analysis.

The channel was designed with one foot of freeboard. Therefore, the channel full capacity is greater than 840 cfs. The extra conveyance provides added insurance of capturing flows in the event that the berms on Reems Road wash out and much greater flow breaks out to the southeast.



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Project: FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
Dysart Drain Improvement Project
Preliminary Design

Sheet Title: **Detention Basin Collector Channel**

No.	Date	Item

Revisions

Scale 1"=400'H., 1"=10'V.
Job No. 289036-4
Date
Drawn By JEB
Checked By MTG

Sheet 1
Of 1

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3.1 Cost Estimate

The following is the construction cost estimate for the proposed collector channel.

DETENTION BASIN COLLECTOR CHANNEL
COST ESTIMATE

DESCRIPTION	QUANTITY	UNIT COST	COST
Channel Excavation	15,300 C.Y.	$1.50/C.Y.	$23,000
Gunite Channel Lining	12,200 S.Y.	$12.00/S.Y.	$146,400
Crossings for Farm Roads and Irrigation Ditches	JOB	$50,000/Job	$50,000
Drop Structure	1 Ea.	$7,500	$7,500
		CONSTRUCTION COST	$226,900
Right of Way (100' x 2640')	264,000 S.F.	$0.15/S.F.	$39,600
		SUBTOTAL	$266,500
		20% Contingencies	$53,300
		TOTAL COST	$319,800

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4.0 RECOMMENDATIONS

A. A new collector channel feature should be added to the project that will collect and convey Reems Road breakout flows to the detention basin. The channel should extend approximately 1/2 mile from the detention basin upstream to the south side of Olive Avenue and should be constructed along the mid-section line, 1/2 mile east of Reems Road. This proposed alignment is parallel with the east edge of the basin which will maximize the runoff collected by capturing flows that might breakout of Reems Road upstream of Olive Avenue.

The capacity of the channel should be 840 cfs at the detention basin inflow structure. The capacity can decrease upstream of the basin since not all of the flow will be captured at the upstream end. Rather, the breakout flows will result in wide, shallow sheet flooding which will enter the channel in several locations. The recommended design flows decrease from 840 cfs at the basin to 400 cfs at Olive Avenue (refer to section 3.0).

The channel should be designed with one foot of freeboard. The freeboard will give the channel additional capacity to convey flows in excess of 840 cfs. This will provide extra capacity for the case where the berms on Reems Road wash out which would result in a breakout of more than 840 cfs.

B. There should be three major inflow spillways at the detention basin as shown in the concept design. In addition, as described in the concept design, there should be a means of collecting sheet flows that reach the north and west sides of the basin. The following is the recommended inflow capacity for each location.

Location	Inflow Capacity
NE Corner of Basin, 1/2 Mile East of Reems Rd., at Collector Channel	840 cfs
NW Corner of Basin at Reems Rd.	1000 cfs
SW Corner of Basin at Reems Rd. & Northern Ave.	400 cfs

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Sheet Flow Along North Side of Basin	1000 cfs
Sheet Flow Along West Side of Basin	600 cfs

The above inflow capacities are an estimate of the flows that might reach the basin and provide a certain amount of redundancy to account for the uncertainty in the capacity of Reems Road and the location and magnitude of sheet flows from the west. (Refer to Section 2)

C. It is recommended that the concept design storage of 440 ac-ft be maintained along with a freeboard capacity to the top of spillway of at least 25% which results in a design storage of 550 ac-ft to the top of spillway. The split flow model indicates that only 384 ac-ft is required. However, as explained in this addendum, there is considerable uncertainty in the amount of flow that Reems Road and other diversions in the watershed can contain. For example, farmers could raise the berm elevation along Reems Road another foot which would significantly increase flow to the detention basin. If this were to occur, the extra storage capacity would be available to contain the flood flows.

It is also important to maintain the design storage so that potential future flood conveyance facilities along Reems Road would have adequate outfall capacity. As part of the White Tanks/Agua Fria ADMS, The WLB Group has analyzed alternative drainage schemes for the study area. One of these alternatives includes a channel along Reems Road that would discharge to the detention basin. The preliminary analysis indicates that a storage volume of approximately 550 ac-ft would be required. Therefore, providing a basin with less than 550 ac-ft could put unnecessary constraints on future flood control projects.

D. The design peak discharges for the Dysart Drain channel should be maintained. The split flow model indicates that the 100-year flows in the channel may be 3% - 23% lower than the design flows for most of the length of the channel. It seems reasonable to maintain the additional capacity to provide extra conveyance for the uncertainty in flow direction described above. Only in the last 1/2 mile of channel does the split flow model predict higher flows than the design peak discharges. In this reach there is more than adequate freeboard to contain the increase in flow.

APPENDIX A

Capacity Calculations for Reems Road and Olive Avenue

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*  HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*          (916) 756-1104           *
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REEMS ROAD

Cactus Rd. to Peoria Ave.

Q - 240 cfs

```
X     X  XXXXXXX   XXXXX
X     X  X        X     X
X     X  X        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                   X
X     X  X        X     X             X
X     X  XXXXXXX   XXXXX              XXXXXXX
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15NOV93 11:30:43 PAGE 1

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HEC-2 WATER SURFACE PROFILES

Version   4.6.2;  May 1991
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146 → 165

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T4

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VARIABLE CODES FOR SUMMARY PRINTOUT

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42	5	26							

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15NOV93 11:30:43 PAGE 2

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Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV

TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

146 → 165

*PROF 1

CCHV= .100 CEHV= .300

*SECNO 1.000

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HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

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SUMMARY OF ERRORS AND SPECIAL NOTES

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 * U.S. ARMY CORPS OF ENGINEERS      *
 * HYDROLOGIC ENGINEERING CENTER     *
 * 609 SECOND STREET, SUITE D        *
 * DAVIS, CALIFORNIA 95616-4687      *
 *        (916) 756-1104             *
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165 → 179

REEMS ROAD

Peoria Ave. to Olive Ave.

Q - 1000 cfs

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X
XXXXXXX  XXXX     X          Y
X     X  X        X
X     X  X        X     X
X     X  XXXXXXX   XXXXX
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HEC-2 WATER SURFACE PROFILES

Version   4.6.2;  May 1991
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T1
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T3
T4

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15NOV93 09:59:19 PAGE 2

SECNO	DEPTH	CWSEL	CRIWS	WSELK	ES	HV	HL	OLOSS	L-BANK ELEV

Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

165 → 179

*PROF 1

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*SECNO 1.000

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.00	2.12	8.17	1.13	.035	.016	.070	.000	.00	9.71
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HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

SUMMARY PRINTOUT

SECNO	Q	CWSEL	SSTA	STCHL	STCHR	ENDST	DIFWSX	TOPWID	DEPTH	ELMIN	10*KS	VCH
1.000	1000.00	2.01	9.71	40.00	80.00	525.85	.00	501.57	2.01	.00	36.34	8.17

SUMMARY OF ERRORS AND SPECIAL NOTES

```
*                                          *
*  Version   4.6.2;  May 1991              *
*                                          *
*  RUN DATE    15NOV93    TIME   10:09:21  *
********************************************
```

```
*  HYDROLOGIC ENGINEERING CENTER      *
*  609 SECOND STREET, SUITE D         *
*  DAVIS, CALIFORNIA 95616-4687       *
*          (916) 756-1104             *
***************************************
```

REEMS ROAD

Olive Ave. to Det. Basin

Q - 1000 cfs

```
X     X  XXXXXXX   XXXXX
X     X  X        X     X
X     X  X        X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```


THIS RUN EXECUTED 15NOV93 10:09:21

```
************************************
HEC-2 WATER SURFACE PROFILES

Version   4.6.2;  May 1991
************************************
```

179 → 193

```
T1
T2
T3
T4

T1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

             2               1     .004                            2.0

T2  NPROF   IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

     1

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38      43      1       53      21      22      54      51      4       8
    42      5       26

NC    .035    .07     .016    .1      .3
NF      1     1000
NX1     1     10      15      55      0       0       0
NTR   2.5     0       .5      15      0       25      .5      55      2.5     60
NR    1.1     75      1.4     90      1.1     190     1.6     290     2.6     600
```



```
SECNO   DEPTH   CWSEL   CRIWS   WSELK   EG      HV      HL      OLOSS   L-BANK ELEV
```

Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

179 → 193

*PROF 1

CCHV= .100 CEHV= .300
*SECNO 1.000

3265 DIVIDED FLOW

1.000	2.18	2.18	2.43	2.00	3.08	.91	.00	.00	.50
1000.0	25.1	700.8	274.2	10.6	77.1	251.3	.0	.0	.50
.00	2.37	9.08	1.09	.035	.016	.070	.000	.00	2.41
.003987	0.	0.	0.	0	11	5	.00	462.71	469.37

THIS RUN EXECUTED 15NOV93 10:09:22

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

SUMMARY PRINTOUT

SECNO	Q	CWSEL	SSTA	STCHL	STCHR	ENDST	DIFWSX	TOPWID	DEPTH	ELMIN	10*KS	VCH
1.000	1000.00	2.18	2.41	15.00	55.00	469.37	.00	462.71	2.18	.00	39.87	9.08

SUMMARY OF ERRORS AND SPECIAL NOTES

```
* HEC-2 WATER SURFACE PROFILES          *
*                                       *
* Version   4.6.2;  May 1991            *
*                                       *
* RUN DATE    15NOV93    TIME   22:46:23 *
*****************************************
```

```
* U.S. ARMY CORPS OF ENGINEERS        *
* HYDROLOGIC ENGINEERING CENTER       *
* 609 SECOND STREET, SUITE D          *
* DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104             *
***************************************
```

OLIVE AVENUE

Reems Rd. to Bullard Ave.

Q - 240 cfs

```
X     X  XXXXXXX   XXXXX
X     X  X        X     X
X     X  X        X
XXXXXXX  XXXX     X
X     X  X        X
X     X  X        X     X
X     X  XXXXXXX   XXXXX
```

```
1
  15NOV93      22:46:23                                                    PAGE    1
```

THIS RUN EXECUTED 15NOV93 22:46:23

```
************************************
HEC-2 WATER SURFACE PROFILES

Version   4.6.2;  May 1991
************************************
```

179 → 180

```
T1
2
3
T4

1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

             2                        .0025                              2.0

2  NPROF    IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

   1

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

   38       43       1        53       21       22       54       51       4        8
   42       5        36

   .07      .03      .025     .1       .3
DT 1        240
V1 1        8        490      540      0        0        0
   4.5      0        2.5      375      1.2      435      1.7      490      0        510
SR 2.0      540      2.0      560      2.2      570

  15NOV93      22:46:23                                                    PAGE    2

  SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    L-BANK ELEV
```

179 → 180

Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CCHV= .100 CEHV= .300

*SECNO 1.000

1.000	2.12	2.12	.00	2.00	2.26	.14	.00	.00	1.70
240.0	42.5	195.8	1.6	56.7	59.1	2.8	.0	.0	2.00
.00	.75	3.31	.58	.070	.025	.030	.000	.00	392.40
.002489	0.	0.	0.	0	0	5	.00	173.75	566.15

THIS RUN EXECUTED 15NOV93 22:46:24

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

SUMMARY PRINTOUT

SECNO	Q	CWSEL	SSTA	STCHL	STCHR	ENDST	DIFWSX	TOPWID	DEPTH	ELMIN	10*KS	VCH
1.000	240.00	2.12	392.40	490.00	540.00	566.15	.00	173.75	2.12	.00	24.89	3.31

SUMMARY OF ERRORS AND SPECIAL NOTES

APPENDIX B
Revised Backwater Analysis for Dysart Drain

TRAPEZOIDAL CHANNEL ANALYSIS
STANDARD STEP WATER SURFACE PROFILE
December 7, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....	4040.0
Channel Bottom Slope (feet per foot).....	0.0008
Manning's Roughness Coefficient (n-value).....	0.0160
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).....	10.0
Channel Flow-Line Elevation at Starting Station (feet)..	1052.91
Water Surface Elevation at Starting Station (feet).....	1062.74
Starting Channel Station (feet).....	1040.00

==========

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....	12.47
Critical Depth (feet).....	9.85

Station (ft)	Flowline (ft)	WS Elev. (ft)	Depth (ft)	Flow Area (sq ft)	Vel (fps)	Velocity Head(ft)	EGL Slope (ft/ft)
1040.0	1052.91	1062.76	9.85	292.56	13.81	2.961	0.002326
1100.0	1052.96	1063.42	10.46	323.27	12.50	2.425	0.001782
1200.0	1053.04	1063.81	10.78	339.99	11.88	2.193	0.001556
1300.0	1053.12	1064.10	10.98	350.82	11.52	2.059	0.001430
1400.0	1053.20	1064.33	11.13	359.07	11.25	1.966	0.001344
1600.0	1053.36	1064.71	11.36	371.53	10.87	1.836	0.001227
1800.0	1053.52	1065.04	11.52	380.75	10.61	1.748	0.001149
2000.0	1053.68	1065.33	11.65	388.01	10.41	1.683	0.001092
2400.0	1054.00	1065.84	11.84	398.97	10.13	1.592	0.001014
2800.0	1054.32	1066.30	11.98	406.81	9.93	1.531	0.000962
3200.0	1054.64	1066.72	12.08	412.67	9.79	1.488	0.000926

==========

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

TRAPEZOIDAL CHANNEL ANALYSIS
STANDARD STEP WATER SURFACE PROFILE
December 7, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....	2360.0
Channel Bottom Slope (feet per foot).....	0.0004
Manning's Roughness Coefficient (n-value).....	0.0160
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).....	10.0
Channel Flow-Line Elevation at Starting Station (feet)..	1054.64
Water Surface Elevation at Starting Station (feet).....	1066.72
Starting Channel Station (feet).....	3200.00

==========

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....	11.47
Critical Depth (feet).....	7.59

Station (ft)	Flowline (ft)	WS Elev. (ft)	Depth (ft)	Flow Area (sq ft)	Vel (fps)	Velocity Head(ft)	EGL Slope (ft/ft)
3200.0	1054.64	1066.72	12.08	412.65	5.72	0.508	0.000316
3400.0	1054.72	1066.78	12.06	411.53	5.73	0.511	0.000318
3600.0	1054.80	1066.84	12.04	410.44	5.75	0.513	0.000321
3800.0	1054.88	1066.90	12.02	409.38	5.76	0.516	0.000323
4000.0	1054.96	1066.97	12.01	408.35	5.78	0.519	0.000325
4500.0	1055.16	1067.12	11.96	405.90	5.81	0.525	0.000330
5000.0	1055.36	1067.28	11.92	403.62	5.85	0.531	0.000335
5500.0	1055.56	1067.45	11.89	401.51	5.88	0.536	0.000340
6000.0	1055.76	1067.61	11.85	399.56	5.91	0.542	0.000345
6500.0	1055.96	1067.78	11.82	397.75	5.93	0.547	0.000349
7000.0	1056.16	1067.95	11.79	396.08	5.96	0.551	0.000353
7500.0	1056.36	1068.13	11.77	394.54	5.98	0.556	0.000356
8000.0	1056.56	1068.30	11.74	393.13	6.00	0.560	0.000360
8500.0	1056.76	1068.48	11.72	391.82	6.02	0.563	0.000363
9000.0	1056.96	1068.66	11.70	390.62	6.04	0.567	0.000366
9500.0	1057.16	1068.84	11.68	389.52	6.06	0.570	0.000369
10000.0	1057.36	1069.02	11.66	388.51	6.07	0.573	0.000371
10500.0	1057.56	1069.20	11.64	387.59	6.09	0.576	0.000374
11000.0	1057.76	1069.39	11.63	386.74	6.10	0.578	0.000376
11200.0	1057.84	1069.46	11.62	386.43	6.11	0.579	0.000377
11315.0	1057.89	1069.51	11.62	386.25	6.11	0.580	0.000377

==========

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

TRAPEZOIDAL CHANNEL ANALYSIS
STANDARD STEP WATER SURFACE PROFILE
December 7, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....	2360.0
Channel Bottom Slope (feet per foot).....	0.0011
Manning's Roughness Coefficient (n-value).....	0.0160
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).....	10.0
Channel Flow-Line Elevation at Starting Station (feet)..	1057.89
Water Surface Elevation at Starting Station (feet).....	1069.51
Starting Channel Station (feet).....	11315.00

==========

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....	9.15
Critical Depth (feet).....	7.59

Station (ft)	Flowline (ft)	WS Elev. (ft)	Depth (ft)	Flow Area (sq ft)	Vel (fps)	Velocity Head(ft)	EGL Slope (ft/ft)
11315.0	1057.89	1069.51	11.62	386.25	6.11	0.580	0.000377
11400.0	1057.98	1069.53	11.55	382.11	6.18	0.592	0.000388
11600.0	1058.20	1069.58	11.38	372.60	6.33	0.623	0.000415
12000.0	1058.64	1069.69	11.05	354.69	6.65	0.687	0.000474
12400.0	1059.08	1069.83	10.74	338.31	6.98	0.756	0.000538
12645.0	1059.35	1069.92	10.57	329.07	7.17	0.799	0.000579

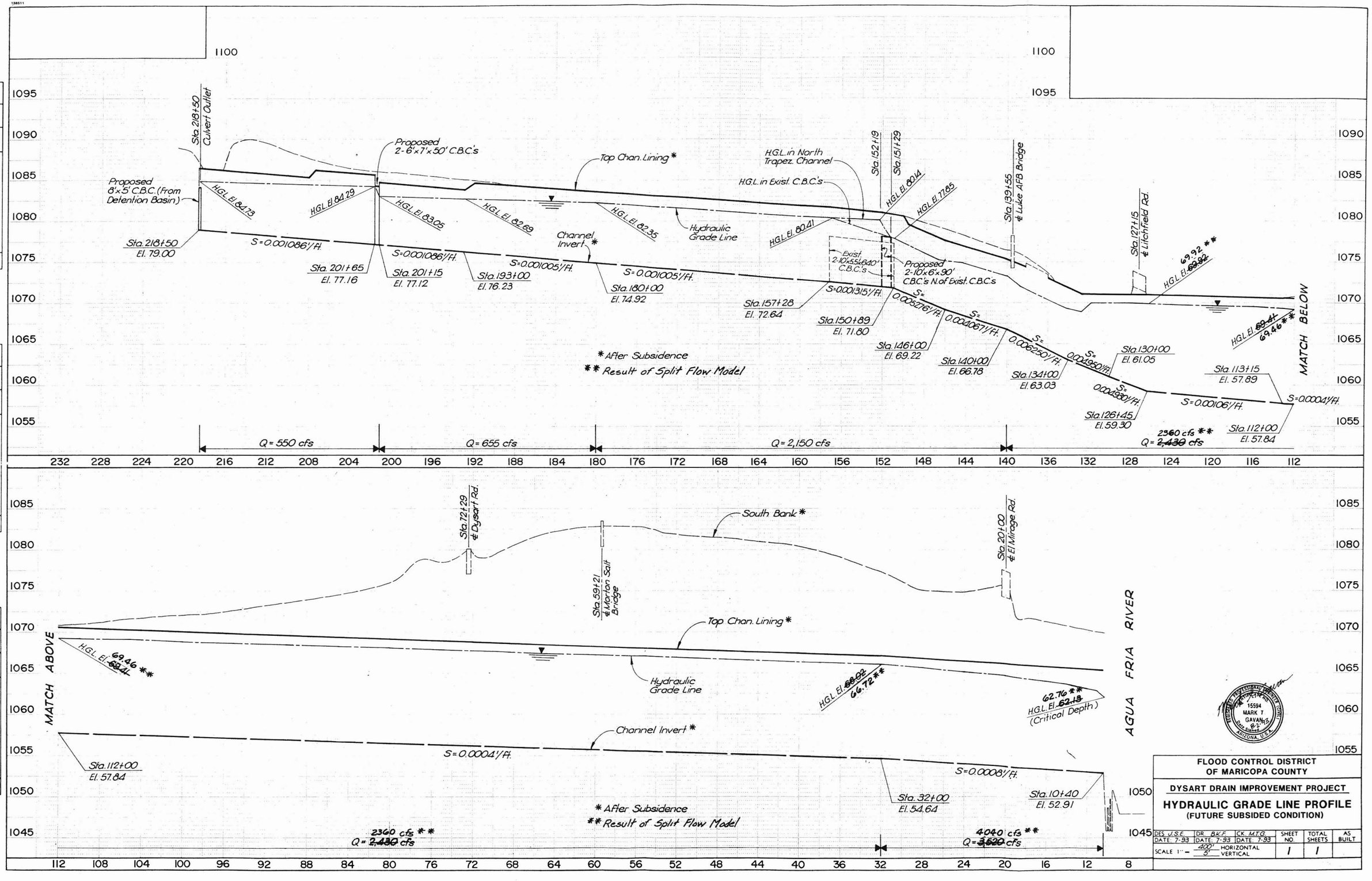
==========

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

REVISION BY CITY OF PHOENIX				
NO.	DESCRIPTION	REV. BY	CKD. BY	DATE

REVISION BY CITY OF PHOENIX				
NO.	DESCRIPTION	REV. BY	CKD. BY	DATE

REVISION BY CITY OF PHOENIX				
NO.	DESCRIPTION	REV. BY	CKD. BY	DATE



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

DYSART DRAIN IMPROVEMENT PROJECT

HYDRAULIC GRADE LINE PROFILE
(FUTURE SUBSIDED CONDITION)

DES. J.S.E.	DR. B.K.F.	CK. M.T.G.	SHEET NO.	TOTAL SHEETS	AS BUILT
DATE 7-93	DATE 7-93	DATE 7-93	1	1	

SCALE 1" = 400' HORIZONTAL, 5' VERTICAL

APPENDIX C
Backwater Analysis for Collector Channel

TRAPEZOIDAL CHANNEL ANALYSIS
STANDARD STEP WATER SURFACE PROFILE
November 29, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....	840.0
Channel Bottom Slope (feet per foot).....	0.0020
Manning's Roughness Coefficient (n-value).....	0.0160
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).....	20.0
Channel Flow-Line Elevation at Starting Station (feet)..	1101.40
Water Surface Elevation at Starting Station (feet).....	1102.00 (BASIN SPILLWAY ELEV.)
Starting Channel Station (feet).....	0.00

==========

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....	3.72
Critical Depth (feet).....	3.37

	Station (ft)	Flowline (ft)	WS Elev. (ft)	Depth (ft)	Flow Area (sq ft)	Vel (fps)	Velocity Head(ft)	EGL Slope (ft/ft)
—	0.0	1101.40	1104.77	3.37	90.20	9.31	1.347	0.002854
—	40.0	1101.48	1105.07	3.59	97.50	8.62	1.152	0.002285
	100.0	1101.60	1105.25	3.65	99.59	8.43	1.105	0.002149
	200.0	1101.80	1105.49	3.69	101.05	8.31	1.073	0.002061
	400.0	1102.20	1105.92	3.72	101.95	8.24	1.054	0.002010
—	630.0	1102.66	1106.38	3.72	102.10	8.23	1.051	0.002001
—	1020.0	1103.44	1107.16	3.72	102.12	8.23	1.051	0.002000
Drop struc. —	1300.0	1104.00	1107.72	3.72	102.12	8.23	1.051	0.002000

==========

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

TRAPEZOIDAL CHANNEL ANALYSIS
STANDARD STEP WATER SURFACE PROFILE
November 29, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....	600.0
Channel Bottom Slope (feet per foot).....	0.0020
Manning's Roughness Coefficient (n-value).....	0.0160
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).....	15.0
Channel Flow-Line Elevation at Starting Station (feet)..	1107.00
Water Surface Elevation at Starting Station (feet).....	1110.37
Starting Channel Station (feet).....	1300.00

==========

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....	3.53
Critical Depth (feet).....	3.17

Station (ft)	Flowline (ft)	WS Elev. (ft)	Depth (ft)	Flow Area (sq ft)	Vel (fps)	Velocity Head(ft)	EGL Slope (ft/ft)
1300.0	1107.00	1110.37	~~3.37~~	~~73.26~~	~~8.19~~	~~1.041~~	~~0.002372~~
— 1325.0	1107.05	1110.46	3.41	74.36	8.07	1.011	0.002275
— 1410.0	1107.22	1110.70	3.48	76.28	7.87	0.961	0.002116
1600.0	1107.60	1111.12	3.52	77.57	7.73	0.929	0.002019
1800.0	1108.00	1111.53	3.53	77.78	7.71	0.924	0.002004
— 2090.0	1108.58	1112.11	3.53	77.83	7.71	0.923	0.002000

==========

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

TRAPEZOIDAL CHANNEL ANALYSIS
STANDARD STEP WATER SURFACE PROFILE
November 29, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....	400.0
Channel Bottom Slope (feet per foot).....	0.0020
Manning's Roughness Coefficient (n-value).....	0.0160
Channel Side Slope - Left Side (horizontal/vertical)....	2.00
Channel Side Slope - Right Side (horizontal/vertical)...	2.00
Channel Bottom Width (feet).....	10.0
Channel Flow-Line Elevation at Starting Station (feet)..	1108.58
Water Surface Elevation at Starting Station (feet).....	1112.11
Starting Channel Station (feet).....	2090.00

==========

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....	3.36
Critical Depth (feet).....	2.99

Station (ft)	Flowline (ft)	WS Elev. (ft)	Depth (ft)	Flow Area (sq ft)	Vel (fps)	Velocity Head(ft)	EGL Slope (ft/ft)
2090.0	1108.58	1112.11	~~3.53~~	~~60.22~~	~~6.64~~	~~0.685~~	~~0.001651~~
— 2115.0	1108.63	1112.14	3.51	59.78	6.69	0.695	0.001685
2200.0	1108.80	1112.26	3.46	58.52	6.84	0.726	0.001787
— 2490.0	1109.38	1112.75	3.37	56.40	7.09	0.781	0.001978
— 2620.0	1109.64	1113.00	3.36	56.27	7.11	0.785	0.001991
— 2645.0	1109.69	1113.05	3.36	56.26	7.11	0.785	0.001992

==========

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
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(713) 895-8322. A manual with equations & flow chart is available.