

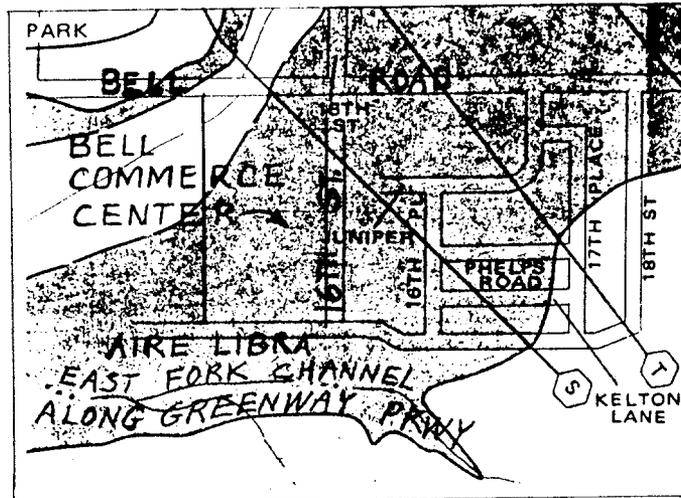
# AMWEST ENGINEERING COMPANY, INC.

CONSULTING ENGINEERS & LAND SURVEYORS  
CIVIL • PLANNING • SURVEYING  
Member ACEA • ASPE

David B. Hall, R.L.S., President  
Paul I. Rogers, Jr., P.E.  
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1710 East Indian School Road, Suite 100  
Phoenix, Arizona 85016  
Phone: (602) 264-1427

## DRAINAGE REPORT FOR BELL COMMERCE CENTER SW CORNER OF 16<sup>TH</sup> & BELL ROAD



Property of  
Flood Control District of MC Library  
Please Return to  
2001 W. Durango  
Phoenix, AZ 85009

PROJECT LOCATION ON 1984  
FLOODWAY MAP (PANEL 040051 0050C)

PREPARED: SEPTEMBER 17, 1987

AMWEST JOB NO: 82118





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Phone: (602) 264-1427

September 22, 1987

Mr. John Baldwin, Supervisor  
Engineering Plan Review  
City of Phoenix  
125 E. Washington Street  
Phoenix, Arizona 85004

Re: Bell Commerce Center  
Amwest Job No. 82118

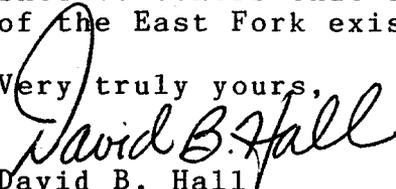
Dear Mr. Baldwin:

The site plan for this development was presented to DCO at a pre-ap meeting on 8/5/87. No site plan number was assigned because a second meeting to re-activate the 1986 plat processing was recommended. This property is identified by four separate City of Phoenix reference numbers ie, zoning 307-83, subdivision S-8511, abandonment V72-84, Folder 11687.

The decisions at the meeting on 9/8/87 on how to reactivate the plat and abandonment were inconclusive. However, several specific actions were listed as necessary to proceed with development. A grading plan and drainage report were scheduled to be submitted for engineering review on 9/21/87. The report is submitted herewith but the grading plan is not completed.

Please advise us of the name and telephone extension of the plan reviewer assigned to check the plans for this development. We will be available to meet at the City offices to discuss our drainage report at any time. Copies were furnished to others that also are interested in this analysis of the East Fork existing flood routing.

Very truly yours,

  
David B. Hall

DBH/ymb

Enclosure:

cc: Jon Wendt, City of Phoenix  
Mario Salamando, City of Phoenix  
Dwayne Williams, City of Phoenix  
Theresa Dominguez, County Flood Control  
John Levy, Owner  
Vince Carter, Owner  
Barry K. Moore, Payless Cashway

## INDEX

<u>Page</u>	<u>Description</u>
1	Introduction
2	Notes of 1/24/85 Drainage Appeals Board Meeting
3	Summary of Results

### SEPARATE SECTIONS

A	Information From Previous Reports on Flooding Conditions at Bell Commerce Center
B	Revisions To Previous Reports Needed to Determine Actual Flooding Conditions
C	Design for Control of Drainage at Bell Commerce Center
D	On-site Retention

## INTRODUCTION:

Amwest Engineering Company (AEC) has had so many occasions to address issues in flood prone areas that have been studied by the Federal Flood Insurance Program that we have developed a list of frequently used abbreviations. The list can be removed from the envelope at the end of this report and used for reference during the reading of this report.

Bell Commerce Center is located at the southwest corner of 16th Street and Bell Road. Part of the property is in the East Fork of the Cave Creek Wash SFHA defined on the current FIRM and part of the property is in the floodway limits drawn on the current FBFM. The information in this report is presented in four sections.

SECTION A: Information from previous reports related to determination of flooding conditions at Bell Commerce Center.

SECTION B: Revisions to other reports needed to to determine correct flooding conditions at Bell Commerce Center.

SECTION C: Design for control of drainage impacts at Bell Commerce Center.

SECTION D: On-site retention at Bell Commerce Center.

Section A contains much information that may seem extraneous to the purpose, ie drainage impacts at 16th Street and Bell Road. AEC feels it is necessary to explain why the previous information does not describe actual conditions at 16th Street and Bell Road because the City of Phoenix has taken the position that previously accepted reports establish the criteria for flooding conditions applicable to future developments throughout the area.

Some exceptions have been allowed when "new and better information can be introduced that shows reduced flows" (see notes from meeting at City of Phoenix 1/24/85 on next page.) After the previous reports are put in proper perspective, the AEC analysis in Section B will show what revisions to some previous reports are warranted and that the corrected flood flows are applicable to 16th Street and Bell Road, ie "better information introduced".

ENGINEERING DEPARTMENT  
SUMMARY OF MEETING

DATE: January 24, 1985 TIME: 9:30 A.M. FILE: Folder No. 11176

LOCATION: Room 100 CALLED BY Mr. Baldwin

SUBJECT/PURPOSE: GRADING & DRAINAGE APPEALS BOARD.

PRESENT: Messrs. Brünton/Counts/Korbitz/Baldwin/Siefert/Schumway/Herbert/Hoskins and Ms. White.

DISCUSSION:

1. Baldwin presents City position.
2. Discussion of error on Maps - Maps are Official Maps.
3. Agreement by Appeals Board that this meeting would be a fact finding meeting and the appeal hearing would take place at a later date.
4. Counts would like to see a more creative approach to the flooding problem.
5. Mr. Schumway knew the actual Selected Floodway went through his property.
6. Discussion of Floodplain issue.
7. New and better information can be introduced that shows reduced flows.

1/30/85

PLB OFFICE 8<sup>30</sup>  
SHUMWAY EVN BACKGROUND -- C2 E RECD DCO APPROVAL.  
PLB, HERBERT, KORBITZ, WENDT / MR SHUMWAY

RE - BUILD BOLT ON S 1/2; RESERVE PORTION OF N 1/2 FOR  
FUT. COP ACQUISITION.  
DON'T THINK THIS IS FLOODPLAIN APPEAL -- INTO GRADING & DRAINAGE / DCO. (will be avail. w/in 2 wks.)  
CELLA - BARR BELIEVES WILL CALC LESS THAN 4K/DFS

- OPTIONS -
- ① CITY BUY
  - ② " " 1/2 (RE-OPTION)
  - ③ DUPR WORK CHANNEL

CONCLUSION:

ACTION REQUIRED:

ACTION REFERRED TO:	COPIES SENT TO :	BY <u>J.F. Baldwin</u> JOHN F. BALDWIN
ATTENDEES -2-		122-243D Rev. 4-83

## SUMMARY OF RESULTS:

Section A contains sufficient reasons to support the position that the FEMA FIRM and FBFM for this area of the East Fork SFHA were not prepared to define actual flooding conditions. The City of Phoenix recognized the deficiencies in the FEMA FIS and contracted with Lowry and Associates to prepare a new hydrologic analysis of the East Fork in order to introduce better information on existing conditions. The Lowry Study has correctly predicted rain run-off patterns and 100 year storm flows for the East Fork Watershed except in the area where the storm water crosses 20th Street.

Section B contains information on the storm water flow routing in the East Fork watershed that reaches the 20th Street and Contention Mine Road intersection. Calculations using field survey data of the relative flow areas to the west and to the south at that intersection resulted in a determination that 1053 cfs will continue south in 20th Street and 598 cfs will turn west. Part of the westerly flow will cross Bell road east of 16th Street and the remaining 490 cfs will flow across the north end of the Bell Commercial Center.

Section C contains calculations and design drawings of the sag vertical curve for the dip on Bell road that will provide the area required for all the 100 year storm flow to cross the road at less than one foot deep. The county Highway department criteria for the future Bell Road transportation corridor is 7" deep 100 year flow across the road. This condition will be obtained when the recommended Lowry Study flood control improvements are constructed. The driveway entrance, depressed parking area and landscaped features have been designed at elevations low enough to contain the 100 year flow crossing this property in a narrow strip.

Section D contains drawings to show where the required on-site retention will be located and where the controlled flow outlet pipe will drain the basin into the new Greenway Parkway drainage channel.

## SECTION A

Item	Description
1	Results of 1980 and 1983 FIS
2	Revisions to FIS by Cella Barr Associates in 1985
3	Comparison of AEC East Fork Study to Cella Barr Report
4	Comments on 1986 Drainage Report for 1900 Bell Road
5	Comments on Lowry Study

### Item 1. Results of 1980 and 1983 FIS.

The FIS completed by Cella-Barr Associates for FEMA in 1980 was a HEC-2 computer coding assignment that did not account for any existing condition in the East Fork watershed. The hydrologic analysis predicted the quantity of the 100 year storm rainfall that will run-off the areas as floodwater. The route of that flow was defined by using contour maps to select "GROUND" EL along lines selected for coded sections. The ground points coded completely ignored existing buildings, walls, roads and filled areas that had been constructed throughout the area. Most of the flow area calculated by the HEC-2 program using ground contour EL is actually blocked by permanent obstructions at much higher EL, ie, 3' fills, 6' walls, 12' buildings. FEMA accepted the results for the SFHA limits on the FIRM with COP approval.

The development of the floodway limit lines on the FBFM is always a theoretical concept of how narrow the flow top width can be set by HEC-2 coded input data (encroachment points) in order to make the WS rise one foot higher than the unrestricted 100 year storm WS. FEMA regulations expect the encroachments for floodway boundaries to be moved in equally from each side of the SFHA. The East Fork FIS input the floodway limit line coded points 100'± on each side of the deepest area calculated by the HEC-2 program in the 100 year un-encroached output. The results do not conform to the FEMA criteria for equal conveyance reduction on each side.

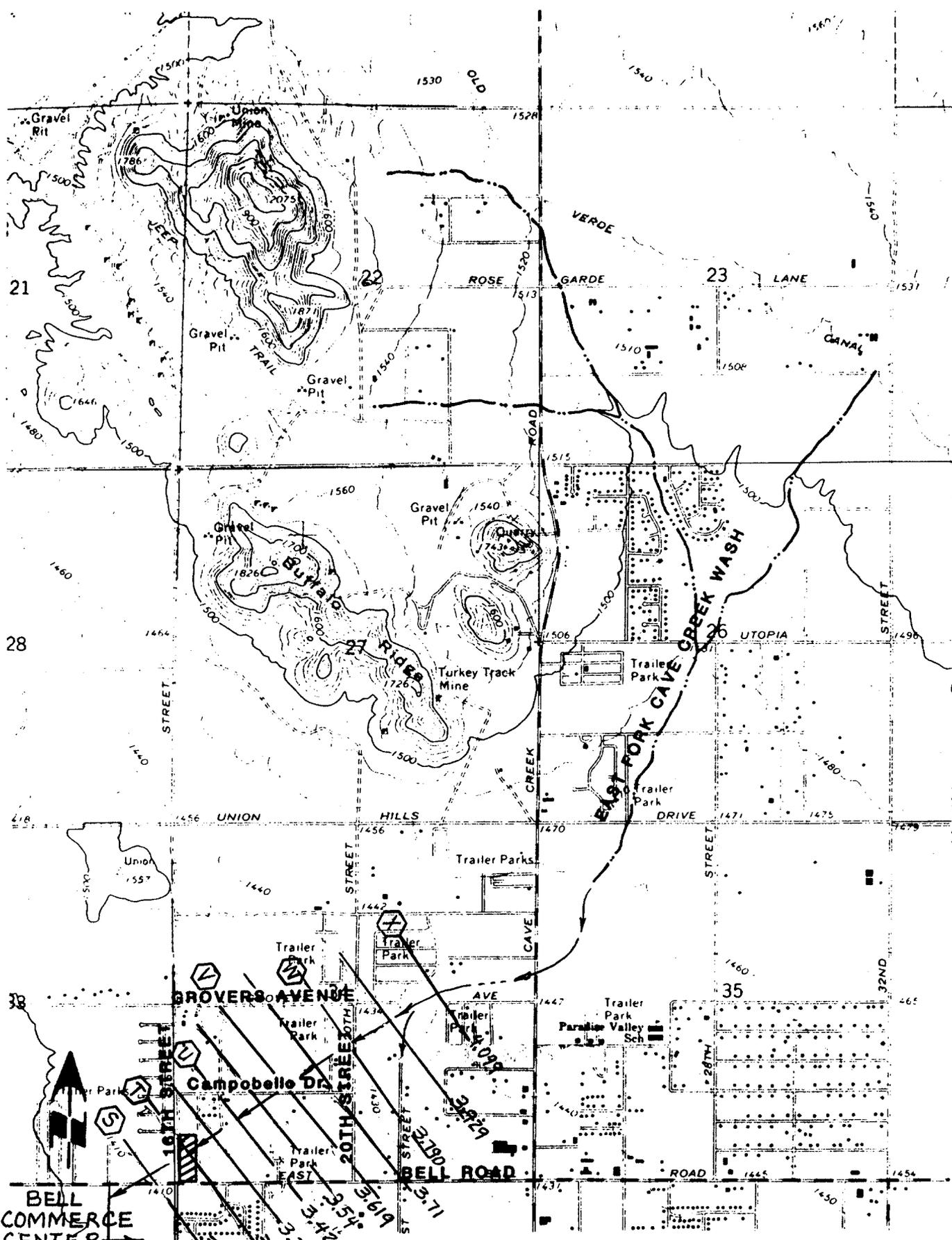
The Dewberry-Davis Engineering re-run of the East Fork FIS made no noticeable changes. The contour map ground EL points for the lines of coded data at each section was the same input used by Cella-Barr in 1980. No corrections were made to eliminate the area of flow along a coded section actually obstructed by walls, buildings, etc. The coding technique to set the floodway width was changed from encroachment points to restrictions on width of flow by use of high flow friction coefficients on each side of the SFHA. The 1983 FIRM and FBFM are no different than the 1980 maps and still do not show the route of East Fork storm flows for existing conditions.

Item 2. Revisions to FIS by Cella-Barr Associates in 1985.

Cella-Barr revised the FIS in 1985 when hired to define the Q in only a small width on a 3000' wide coded section line. SECNO. 3.23 on the FEMA FIS work map is marked T on the FBFM. This section crosses northeast of 16th Street and Bell Roads. (See Section Locator Map next page.) Cella-Barr could not define the Q crossing a 400' length of section T without going west to pick a coded section that closely modeled actual conditions. SECNO. 3.929 (near 21st) was the only line of coded ground EL that was correct for existing conditions because that line still crosses vacant fields where no wall or buildings obstruct the flow area.

Cella-Barr started at SECNO. 3.929 where storm water could spread out along the 3000' length of coded ground EL and determined the flow distribution along that line. Moving to the next downstream coded line at SECNO. 3.790, Cella-Barr calculated the Q split that has to happen to go around walls, buildings and fills. A page from the AEC Report inserted after the Section Locator Map (next page) describes the method used by Cella-Barr to split flood flows at each intersection. Cella Barr determined the Q west on Libby/south on 20th; west on Grovers/south on 20th; west on Contention Mine/south on 20th. The flow distribution on all sections east of SECNO. 3.929 calculated by the 1980 FIS HEC-2 program using unobstructed ground EL coded points was very different than the actual split flow combinations to account for existing obstruction in the area.

The Cella-Barr report was accepted by the City of Phoenix as a correct definition of Q crossing 16th Street 300' north of Bell Road. The flow distribution at SECNO. 3.23 determined only a small part of the total East Fork 100 year storm water crossed 16th north of Bell Road because most of the flood water went across Bell Road in dips at 21st Street, 20th Street and 18th Street. Most of the total 3900 cfs existing Q crosses 16th Street south of Aire Libre in the alignment of the future Greenway Parkway channel.



SCALE 1"=2000'  
 AIRE LIBRA  
 MOST FLOW IN  
 GREENWAY PKWY CHANNEL

**CBA** CELLA BARR ASSOCIATES

5062 N. 19th Avenue,  
 Phoenix, Arizona 85015  
 (602) 242-2999

### Analysis of The Haspro Drainage Report

The Haspro Report is a series of relative conveyance calculations at each intersection starting upstream where Section 3.929 crosses 20th at Grovers and 19th at Libby. The procedure used was to estimate the total Q reaching an intersection. The W.S. elevation was assumed, and using that depth, the cross section area of flow in the street heading west and the street heading south was calculated by Mannings equation for open channels. The flow to the west plus flow to the south was added and the sum should equal the total Q estimated at that intersection. If the sum of the two flows was less than the required total estimated Q, the W.S. depth was assumed to be higher and the Mannings formula calculated again. When the two flows calculated equaled the total Q estimated, the depth used in the formula was considered correct. The assumption that all the Q in a defined length of each cross section collects exactly at the street intersections is not substantiated. Therefore, the assumed W.S. needed to determine flows west and south that equal the estimated total is also not substantiated.

The Haspro Report area map shows a direction arrow and Q west and south at each intersection. The arrows indicate that the flow stays in the street right of way until reaching an overflow point across open space. This assumes that the flow divides as shown at intersections and remains divided until reaching the next calculation point. A Q of 725 or 885 will spread over a wide area rather than stay in a street right of way. Therefore, the results of analysis using all open passages in a wide part of the flow route more accurately calculates the correct water surface.

The map of cross section locations with Q split flows and pages from the Haspro Report are included in the supplemental materials at the end of this report.

The results of each relative conveyance calculation are summarized as follows:

#### Section 3.929

There is no logic to the  $n = .09$  outside the 1000 feet mean effective floodway unless the study is trying to simulate the selected floodway and Dewberry-Davis use of  $n = 10$ . The  $n = .09$  does not appear in any calculations so the reason for that value is moot. The decision on what Q goes west on Libby is based on a distance of half of 600 feet of Section 3.929 north of Grovers. The half division results in 330 cfs on Libby and 330 cfs on 20th. The W.S. in this report at Section 3.929 is 1436 and runs into Libby at a depth of 0.3 feet in the street. The HEC-2 W.S. at 3.929 is 0.05 feet lower than the 1980 flood study due to the split flow routing downstream. Possibly, most of the flow to the west crosses the lower yard elevations on the corner lot. The flow that reaches 20th and Grovers may be 1 foot deep near the intersection and 300 cfs, Q south is feasible.

### Item 3. Comparison of AEC East Fork Study to Cella-Barr Report

AEC realized the 1985 Cella-Barr report had more accurately defined existing flow routing for the whole area from Cave Creek Road to 16th Street than the FIS. AEC wanted to verify the flow routing using HEC-2 computed WS at each intersection to check the "assumed" depth of flow used by Cella-Barr for calculations of the split Q in each direction. The AEC model started at 12th street, coded high EL where walls, buildings and fills are located and divided the total flow into separate routes on the north and south side of a ridge of high ground along the middle of the SFHA. The AEC report submitted to the COP and FEMA in October 1985 determined a slightly higher Q at 16th Street and Bell Road than Cella-Barr but did substantiate the fact that most of the existing flood water crosses 16th Street south of Greenway Parkway alignment where the new channel will be built.

The COP was aware of the deficiencies of the FIRM and FBFM delineation of the East fork SFHA. Lowry and Associates were hired to analyze the East Fork again to correctly define existing flow patterns and recommend area wide drainage improvement projects. AEC was notified by the COP in December 1985 that our 1985 East Fork Report would not be reviewed because the Lowry Study will become the accepted FIS when completed in 6-12 months.

### Item 4. Comments on 1986 Drainage Report for 1900 Bell Road.

The Lowry Study was almost in the "Neighborhood Meeting" stage when the auto park south of Bell at 19th Street was being designed. AEC heard that the COP was not going to delay that project until the Lowry study was finished. AEC read the 1900 Bell Road drainage report with particular interest in any information that would support the findings of Cella-Barr and AEC in 1985, ie much existing Q south in 20th Street. AEC was disappointed to find that existing flow on 20th street was ignored.

The Drainage Report for 1900 Bell Road, Paradise Valley Auto Park, S-86109, ED12292, May 23, 1986 selected two previous drainage studies from the many that were reviewed as the basis for design. The 1980 FIS and the AEC report not reviewed by Phoenix were introduced as supporting documents. We see no reason to connect the 1980 FIS described by AEC as useless for determination of a specific existing Q at one location with the AEC 1985 study. Apparently, the credit was given only for the section location maps reproduced. The conclusion of the AEC report about the Q in 20th Street was not mentioned.

The 1900 Bell report did acknowledge that flows do go around the mini-storage building west of 20th Street on the north side of Bell Road. However, when the coded section west of the mini-storage is discussed in the report, only the open

areas and existing ground coded points are described as if no diversion of flow blocked by the mini-storage actually occurs. As Cella-Barr and AEC pointed out in 1985, flow distribution along a 1980 FIS HEC-2 coded section line does not reflect the Q diverted by obstructions upstream and actually crossing the section in a concentrated large Q at a different open area farther south. The 1900 Bell report looked only at the 1980 FIS unobstructed coded section crossing the auto park property, used the output flow distribution at the south end of the line and calculated (5% x 3900 cfs) 195 cfs as the 100 year storm Q through the dip in Bell Road and into a small channel designed to carry flood water around the auto park new car showroom. Even if other obstructions on the west side of 20th Street farther north than the mini-storage building were not considered to actually divert flood water to the south, the mini-storage building will block all flow from station 9400 to station 10300 on SECNO. 3.619 and cause (8.5 + 3.8 + 6.3 + 3.7 + 10.5 + 3.4 + 5.3) 41.5% of the 3900 cfs total Q to flow through the dip on Bell Road. Cella-Barr and AEC agreed that 1100 - 1200 cfs crossed Bell Road in the dip west of 20th Street.

Item 5. Comments on Lowry Study.

AEC got to look at the Lowry Study existing 100 year storm flow maps in February 1987. The main reason AEC was interested in the East Fork analysis was to read the determination of the existing Q intercepted in 20th Street because the flow south on 20th reduces the flow reaching 16th Street.

One obvious oversight was the direction arrow for the existing flow route shown on the map west of 16th Street. The map at the end of this Section A is the Lowry Study recommended improvement location plan with the flow routes marked as shown on their "Existing Conditions" overlay. The existing flow route west of 16th Street was shown to remain north of Bell Road. AEC is sure that the latest existing flow route has been revised to indicate what part of the existing flow crosses Bell Road in the dip at 400'± west of 16th Street.

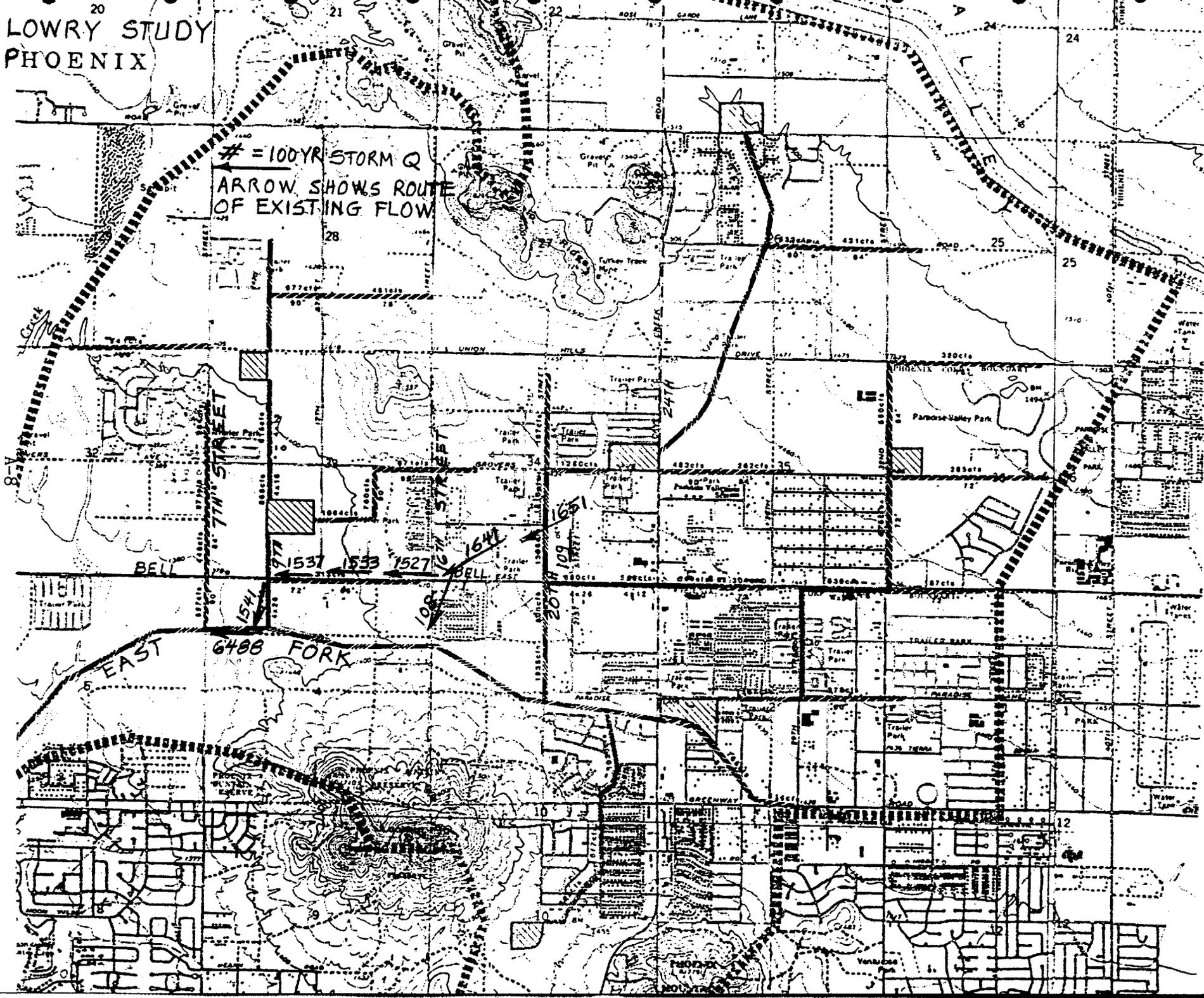
AEC was also disappointed to see that the existing flow route arrow crossing 20th Street does not show any diversion of Q to the south in the road right-of-way. A diversion arrow of 109 cfs is shown for the Q diverted into 21st Street and another diversion arrow of 108 cfs is shown for the Q crossing Bell east of 16th Street. AEC knows that the existing flow route arrow of 1651 cfs crossing 20th Street should have a diversion arrow pointing south for the large Q diverted into the road right-of-way.

AEC has made photographs of the obstructions along 20th Street, drawn a map to show where flow is diverted to the south, surveyed the flow area cross sections both to the west and to the south, and calculated the relative conveyance in each direction.

The resident on the corner of 20th Street and Contention Mine Road was amazed to hear that the Lowry Study does not report a large Q to the south on 20th Street. He confirms 1.5' deep flood water going south in storms much less than 100 year intensity. Section B contains the calculations of Q in 20th Street.

20  
LOWRY STUDY  
PHOENIX

# = 100YR STORM Q  
ARROW SHOWS ROUTE  
OF EXISTING FLOW



SECTION B

Calculations of the relative conveyance at the 20th Street/Contention Mine intersection show 38% (632 cfs) of the existing 100 year flow goes west and 62% (1019 cfs) goes south on 20th Street.

Please pull out the strip map at the end of this section. The important features on that map are:

- A. The open area coded on FIS SECNO. 4.099 for the existing flood flows. Photo at Location A is on Section B, page 2.
- B. The existing natural wash into 21st Street where the Lowry Study shows 109 cfs diverted to the south. Photos at Location B are on Section B, page 2.
- C. The 2.5' high fill on the west side of 20th Street from Grovers to Contention Mine Road that diverts existing flow to the south. Photo at Location C is on Section B, page 3. Cross sections and calculation of flow depth in 20th is on the same page.
- D. The flow area to the west on Contention Mine Road is now restricted to the distance between berm around the house on the south side and the 2.5' fill on the north side. Photo at Location D is on Section B, page 4. Cross section and calculation of flow depth in Contention Mine Road is on the same page.
- E. The flow area to the south on 20th Street is restricted by the berms along front yards on the west right-of-way line and higher ground elevations 150'± east of the road. Photo at location E is on Section B, page 5. Cross section and calculation of flow depth in 20th Street is on the same page.

The MANNING EQUATION was used to calculate Q at a specific depth in the existing flow areas on 20TH & Contention.

$$Q = \frac{1.49}{n} \times \text{Area (A)} \times \text{Hydraulic Radius (HR)}^{2/3} \times \text{Slope (S)}^{1/2}$$

$n = 0.02$  for friction factor in street

$$HR = \frac{\text{Area}}{\text{Wetted Perimeter}} = \frac{A}{WP}$$

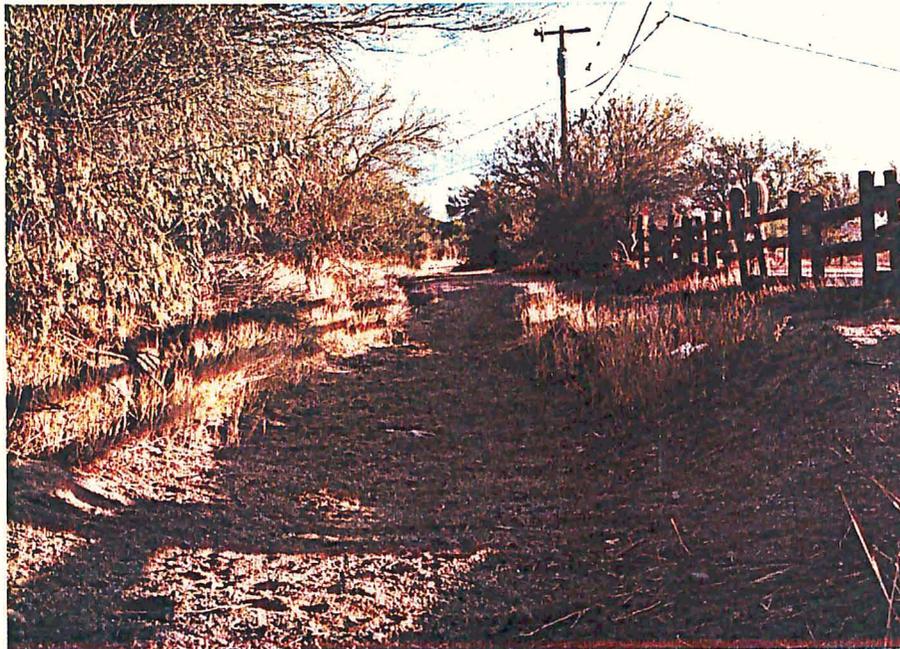
$S(\text{on } 20TH) = 100.0$  gutter north of Contention Mine Rd.  
 $\frac{99.72}{.28} \div 70' = 0.004$  gutter 70' south  
 $S^{1/2} = 0.063$

$S(\text{on Contention}) = 100.3$  C.L. at curb return  
 $\frac{100.0}{0.3} \div 90 = 0.0033$  C.L. 90' west  
 $S^{1/2} = 0.057$

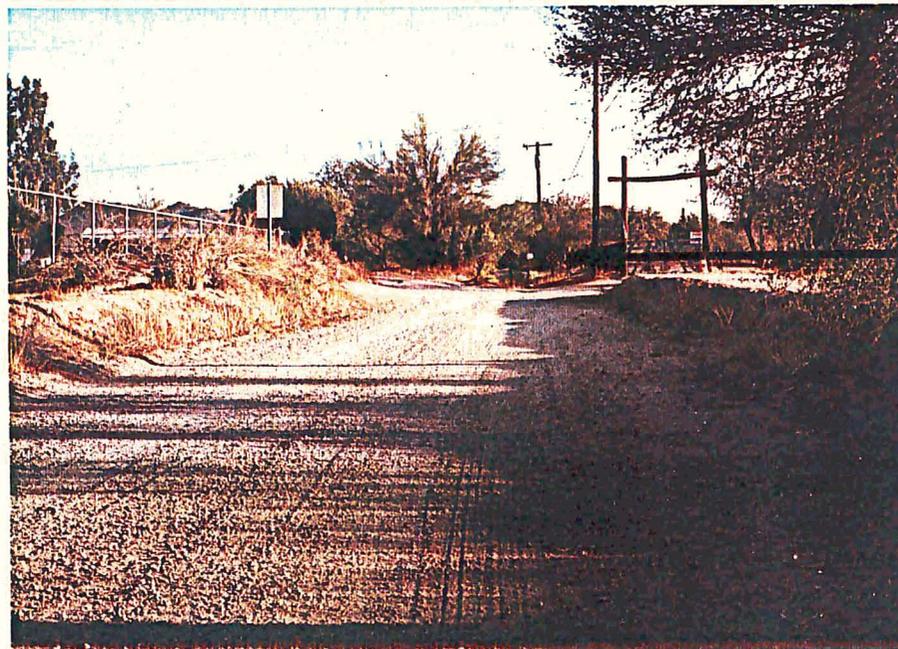
BM FOR SURVEY CROSS SECTIONS = TC 100'± SOUTH OF  
 CONTENTION MINE RD. ASSUMED EL. 100



LOCATION A  
OPEN AREA FOR  
EAST FORK FLOW  
NORTH OF GROVERS  
AT CEREUS DR.  
LOOKING WEST  
DOWNSTREAM

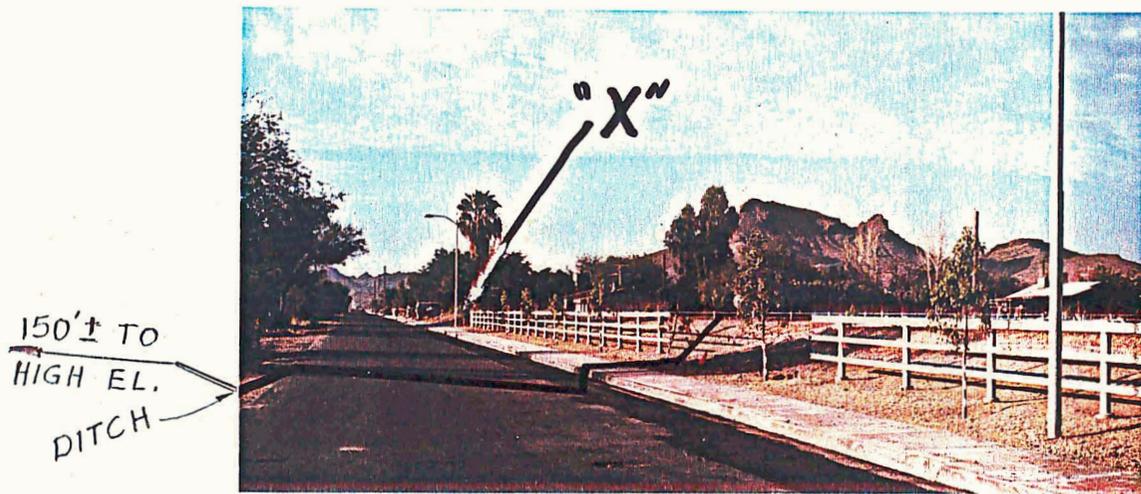


LOCATION B  
LOOKING NORTH  
UP THE NATURAL  
WASH AT THE  
NORTH DEAD END  
OF 21ST STREET  
NEAR CONTENTION  
MINE RD.  
ALIGNMENT

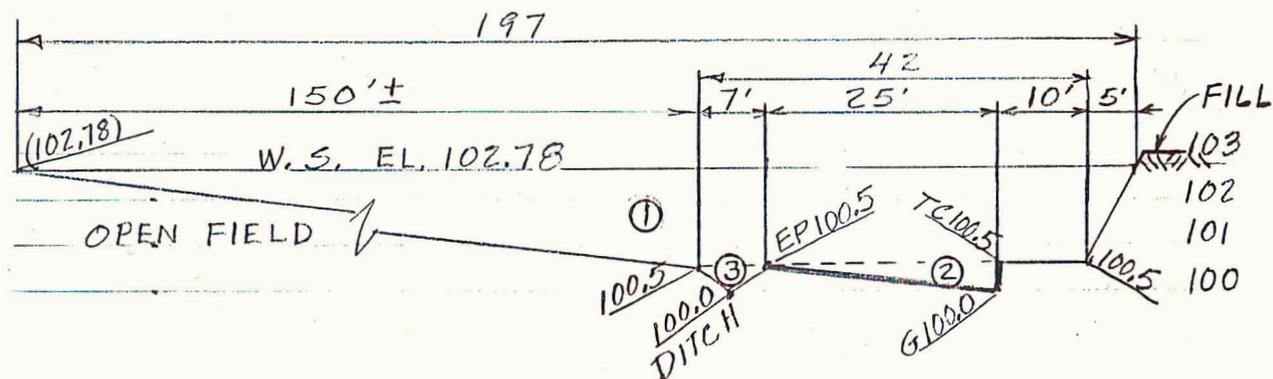


LOOKING NORTH UP  
21ST STREET AT  
DEAD END.

BARRICADE WARNING  
SIGNS MARK THE  
NATURAL WASH  
OUTLET INTO 21ST  
STREET



LOCATION C LOOKING SOUTH DOWN 20TH STREET  
 THE FILL ON THE WEST SIDE OF THE STREET BEHIND THE FENCE IS 2.5'±  
 HIGHER THAN THE SIDEWALK FROM GROVERS TO CONTENTION MINE ROAD.  
 POINT "X" IS ON TOP OF THE 2' HIGH BERM AROUND THE FRONT YARD OF  
 THE HOUSE ON THE SOUTHWEST CORNER OF THE 20TH STREET/CONTENTION  
 MINE RD. INTERSECTION. SURVEY EL ARE SHOWN ON CROSS SECTION BELOW  
 EXCEPT (EL).



AREAS:

$$\textcircled{1} \frac{197 + 42}{2} \times (102.78 - 100.5) =$$

$$119.5 \times 2.28 = 272 \text{ SF}$$

$$\textcircled{2} \frac{1}{2} \times 25 \times .5 = 6.25$$

$$\textcircled{3} \frac{1}{2} \times 7 \times .5 = 1.75$$

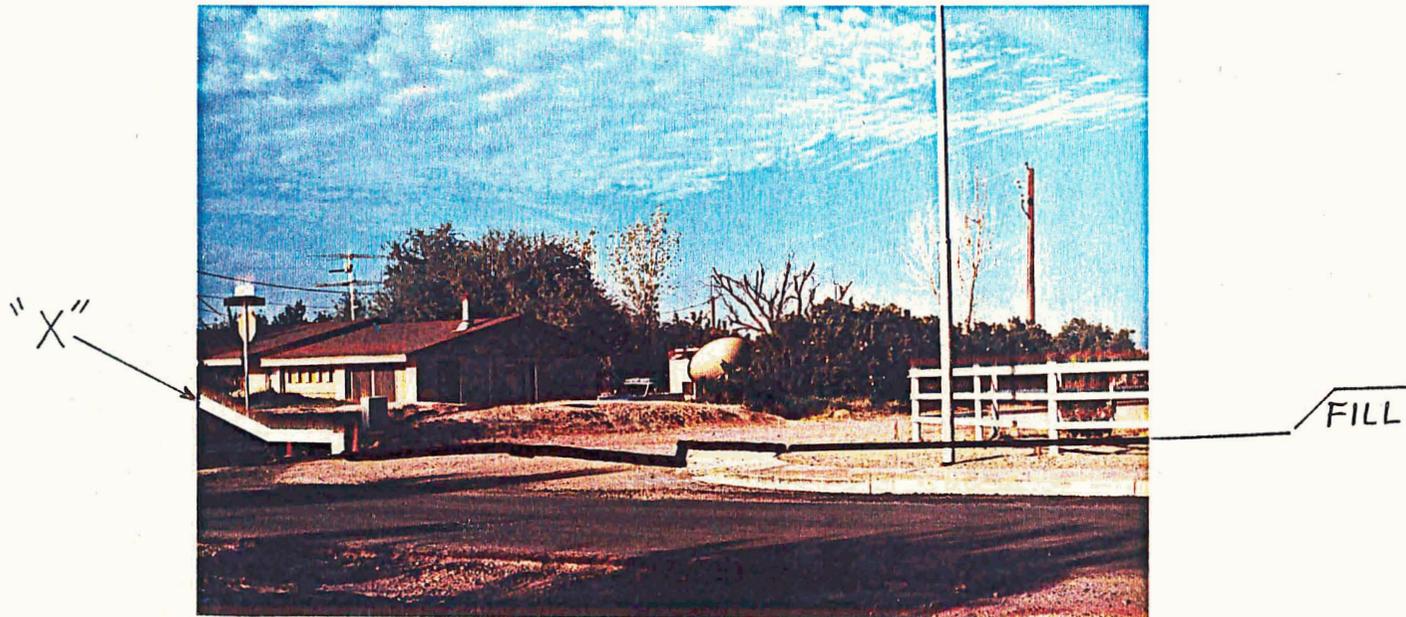
$$\frac{280 \text{ SF}}{197} = \frac{A}{WP} = 1.42 \text{ IR} \quad \text{IR}^{4/3} = 1.26$$

$$Q = \frac{1.49}{0.02} \times 280 \times 1.26 \times 0.063 = 1,651 \text{ cfs (LOWRY STUDY EXISTING FLOW)}$$

FACTORS FROM PAGE 1

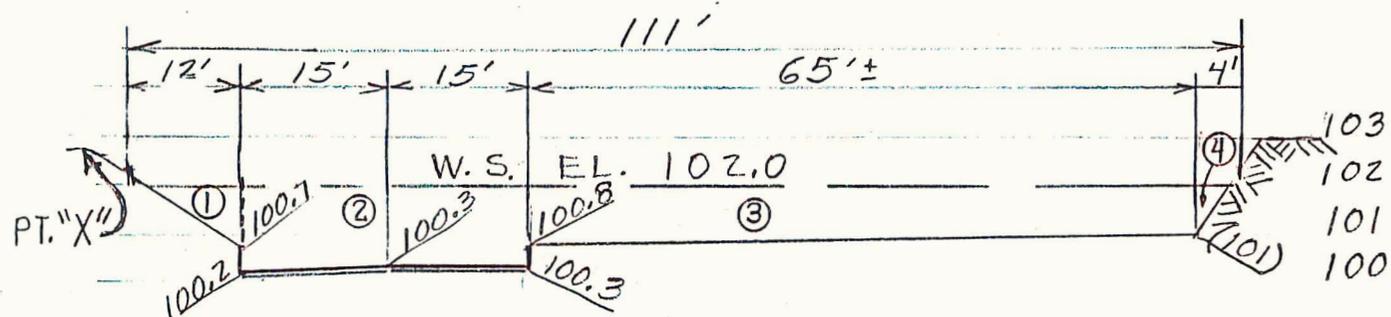
$$n = 0.02$$

$$S^{1/2} = 0.063$$



LOCATION D LOOKING WEST ACROSS 20TH STREET AT CONTENTION MINE ROAD INTERSECTION  
 HOUSE ON SOUTHWEST CORNER HAS 2' HIGH BERM AROUND THE FRONT YARD.  
 TOP OF BERM AT CORNER IS POINT "X", SURVEY EL ARE SHOWN ON CROSS SECTION BELOW EXCEPT (EL).

100 YR STORM FLOW SPREADS WEST AT SOUTH END OF FILL AND W.S. EL. DROPS 9" ± AT CONTENTION MINE (102.0)



AREAS:

$$\textcircled{1} \frac{1}{2} \times 12 \times (102.0 - 100.7)$$

$$\frac{1}{2} \times 12 \times 1.3 = 7.8 \text{ SF}$$

$$\textcircled{2} 30 \times (102.0 - 100.3) = 51$$

$$\textcircled{3} 65 \times (102.0 - 100.9) = 71.5$$

$$\textcircled{4} \frac{1}{2} \times 4 \times (102 - 101) = 2$$

$$\frac{132.3 \text{ SF}}{111} = \frac{A}{WP} = 1.19 \text{ IR} \quad \text{IR}^{2/3} = 1.125$$

$$Q = \frac{1.49}{.02} \times 132.3 \times 1.125 \times .057 = 632 \text{ cfs (38\% of LOWRY STUDY 1651)}$$

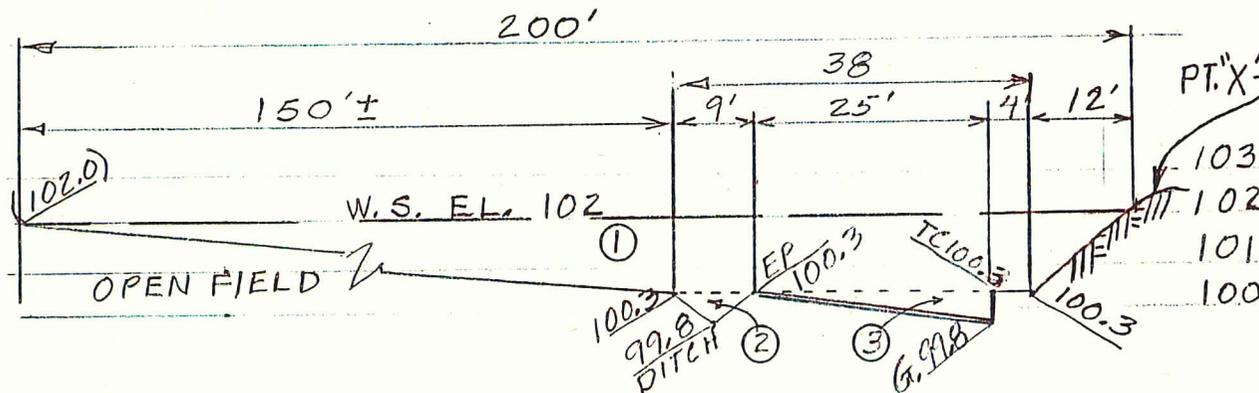
150'± TO  
HIGH EL.  
DITCH



LOCATION E LOOKING SOUTH DOWN 20TH STREET AT CONTENTION MINE ROAD INTERSECTION

HOUSE ON SOUTHWEST CORNER HAS 2' HIGH BERM AROUND THE FRONT YARD. TOP OF BERM AT CORNER IS POINT "X". SURVEY EL ARE SHOWN ON CROSS SECTION BELOW EXCEPT (EL).

100 YR STORM FLOW SPREADS WEST AT SOUTH END OF FILL AND W.S. EL. DROPS 9"± AT CONTENTION MINE (102.0)



AREAS:

$$\textcircled{1} \frac{200 + 38}{2} \times (102.0 - 100.3) =$$

$$119 \times 1.7 = 202 \text{ SF}$$

$$\textcircled{2} \frac{1}{2} \times 9 \times (100.3 - 99.8) = 2.25$$

$$\textcircled{3} \frac{1}{2} \times 25 \times (100.3 - 99.8) = 6.25$$

$$\frac{210.5 \text{ SF}}{200} = \frac{A}{WP} = 1.05 = HR \quad HR^{2/3} = 1.03$$

$$Q = \frac{1.49}{.02} \times 210.5 \times 1.03 \times .063 = 1,019 \text{ cfs (62\% of Lowry Q)}$$

$$Q \text{ west on Contention } \frac{632}{\text{TOTAL } 1,651 = \text{LOWRY}}$$

FACTORS FROM PAGE 1

$$n = 0.02$$

$$S^{1/2} = 0.063$$



GROVERS AVE

JOHN CABOT ROAD

SECTION NO 4099

LOCATION A PHOTO LOOKING WEST

EAST FORK FLOW  
CROSSES 24th ST

PEPPER RIDGE CHANNEL & RETENTION BASIN

JOHN CABOT ROAD

SCALE: 1" = 100'

LOCATION C PHOTO LOOKING SOUTH

20th ST

FLOW DIVERTED SOUTH IN WASH TO 21st ST AT LOCATION B

GROVERS AVE

CAVE CREEK RD (29th ST)

LOCATION D PHOTO LOOKING WEST

CEREUS DR

GROVERS AVE

CONTENTION MINE RD

PHOTO IN STREET LOOKING UP WASH

LOCATION E PHOTO SOUTH LOOKING

22nd PL

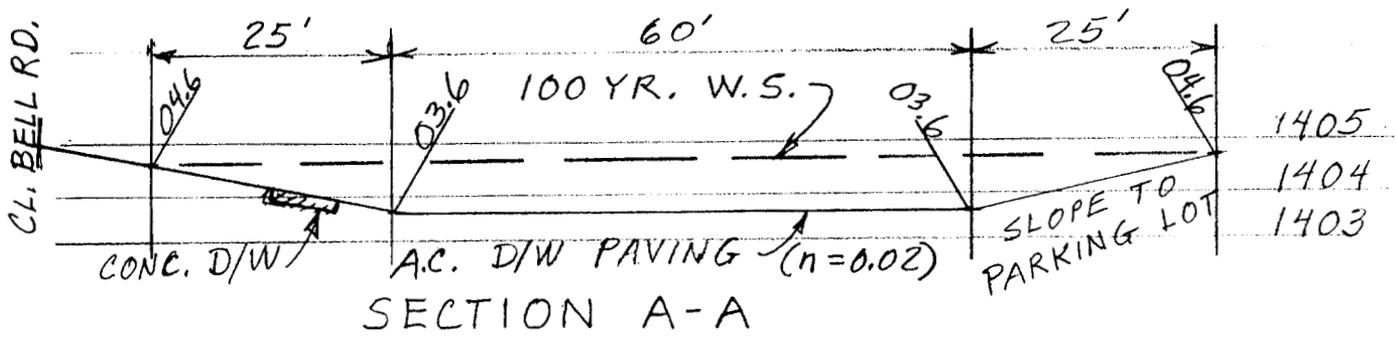
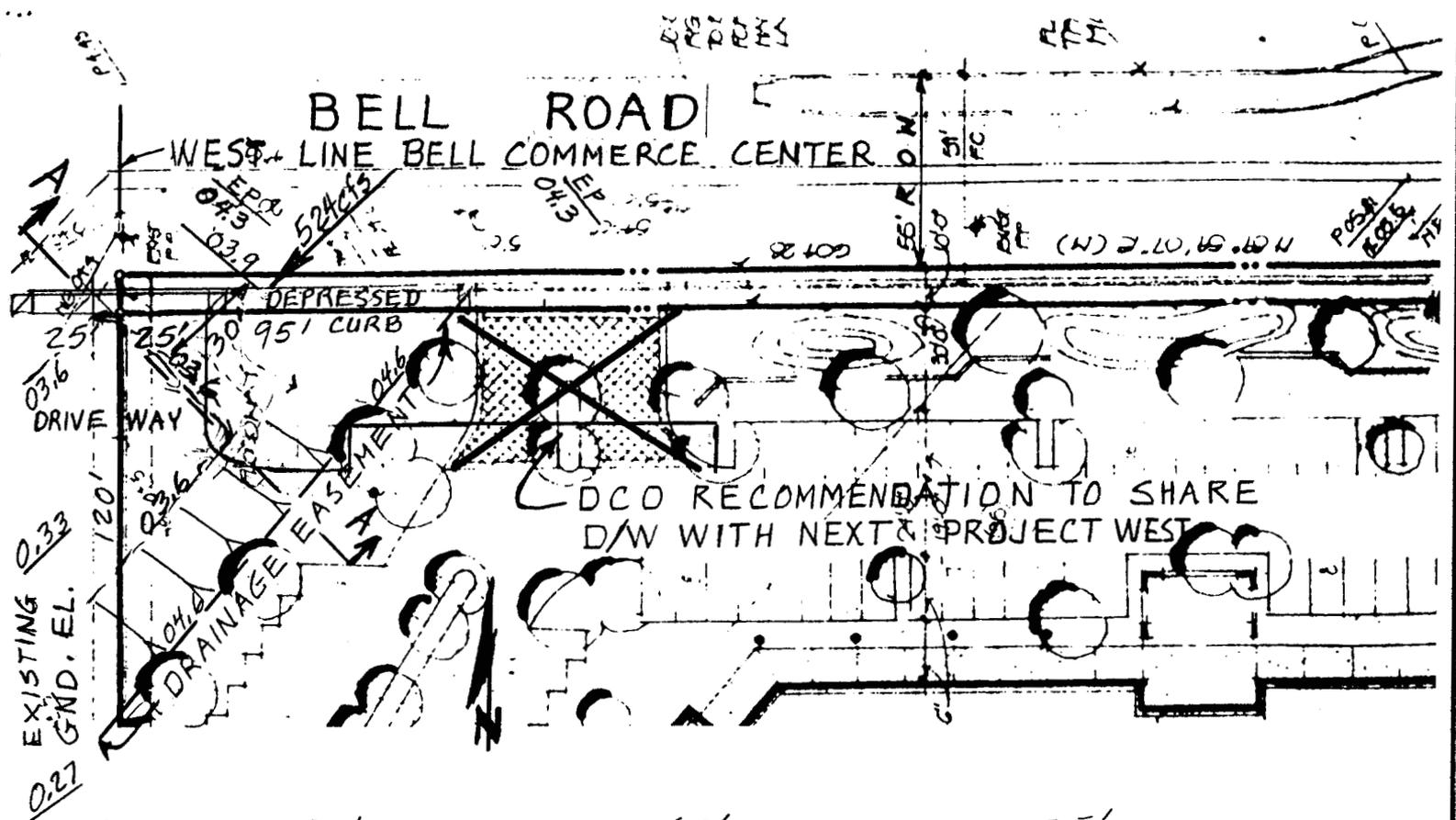
BLUEBIRD LN

23rd ST

## SECTION C

The existing 100 year storm 632 cfs crossing 20th Street to the west flows toward the northeast corner of 16th Street and Bell Road. The Lowry Study map shows 108 cfs is diverted to cross Bell Road east of 16th Street. The remaining 524 cfs (632-108) should pass through the shopping center on the east side of 16th Street about 300' north of Bell Road. The flow route continues across the northwest corner of the intersection and across Bell Road in the existing dip. (See contour map at end of this section.)

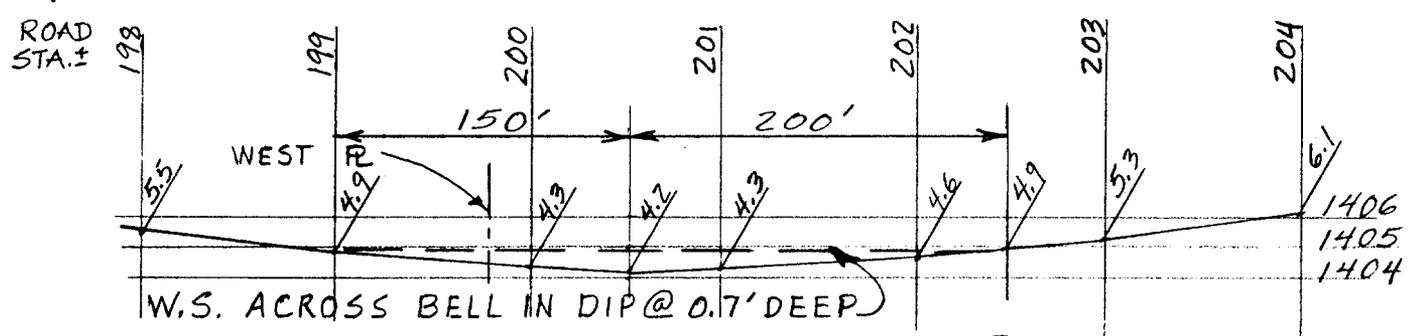
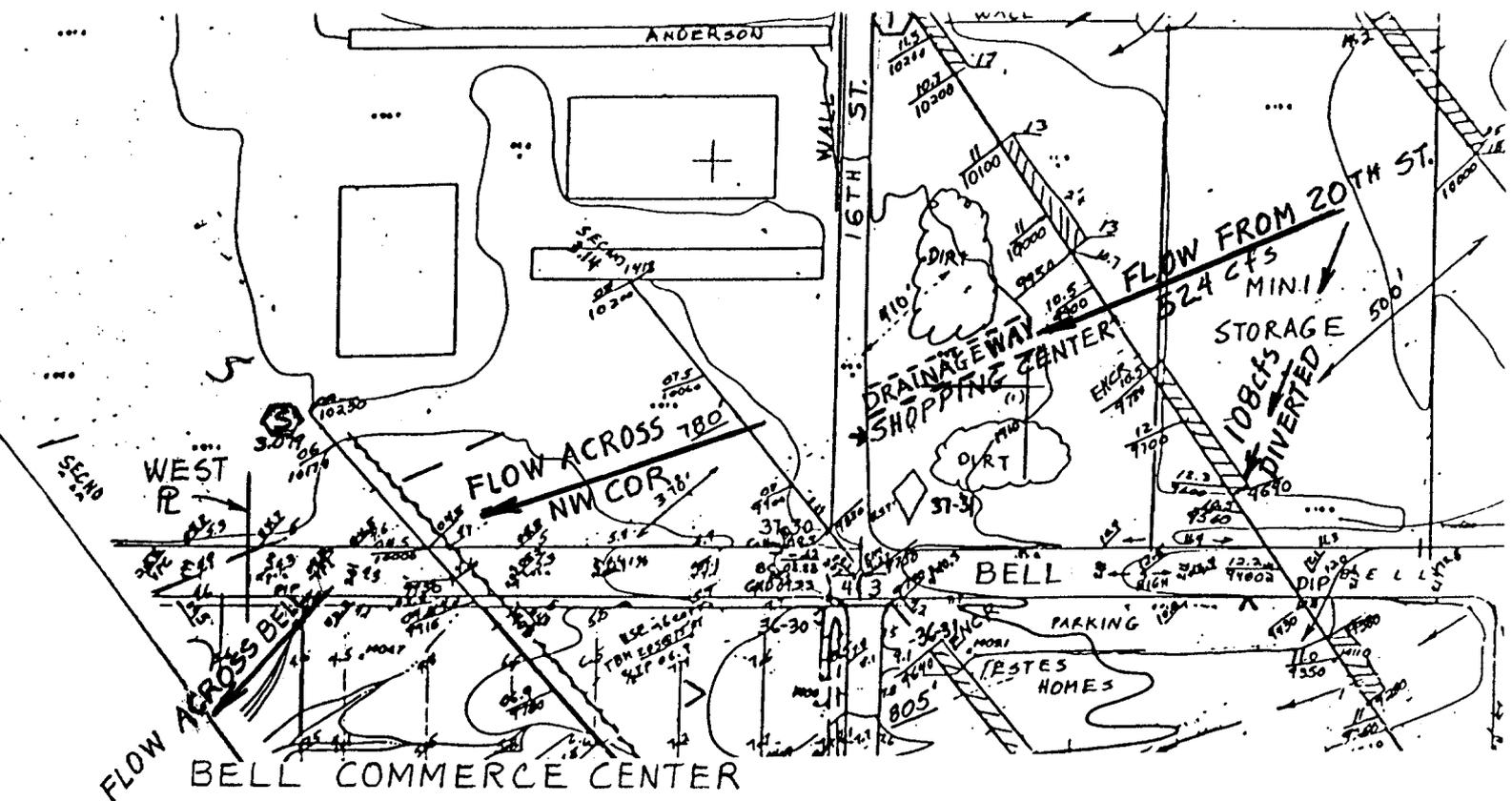
The EL on the road center line are taken from County Highway Department "as-built" plans of Bell Road. Calculations on the map show that the street cross slope is one way to the south at the dip. The road is approximately 33' wide and the EL change is 0.5'. The 524 cfs will cross the road at a depth of less than 0.7'. The Bell Road widening to comply with off-site requirements for Bell Commerce Center will match the grades of the dip vertical curve and the 0.015 cross slope. The flow will leave the south side of Bell Road and run into a driveway and depressed curb along the landscaped area as shown on a copy of the north part of the development site plan on the next page. Calculations on that drawing show that all the existing 100 year flow will cross the corner of the Bell Commerce Center confined in a 90' wide drainage easement. The flow leaves this property at the same location before and after development.



SLOPE GUTTER AT DEPRESSED CURB 03.9  
 TO D/W PAVEMENT SECT A-A - 03.6  
 $SLOPE(S) = (0.3 \div 30') = .01 \quad S^{1/2} = .1$

AREA:  $(\frac{110 + 60}{2}) \times 1' \text{ deep} = 85 \text{ SF}$   
 $\frac{85}{110} = 0.77 = HR \quad HR^{2/3} = 0.84$   
 WETTED PERIMETER = 110'

$Q = \frac{1.49}{.02} \times 85 \times 0.84 \times .1 = 532 \text{ cfs}$   
 $Q \text{ REQUIRED} = 524 \quad \text{FLOW IS } < 1' \text{ DEEP}$



W.S. ACROSS BELL IN DIP @ 0.7' DEEP  
 CO. HWY. DEPT. "AS-BUILT" EL. ON BELL RD.

CROSS SLOPE AT DIP. =  $0.015 \pm$   $S^{1/2} = 0.122$

$n = 0.02$  ON PAVEMENT

AREA APPROX. TRIANGLE

$A = \frac{1}{2} \times 0.7 \times 350 = 122.5 \text{ SF}$   
 $WP = \text{WETTED PERIMETER} = 350'$   $= 0.35 = HR$   $HR^{2/3} = 0.49$

$Q = \frac{1.49}{.02} \times 122.5 \times 0.49 \times 0.122 = 546 \text{ cfs}$

Q REQUIRED = 524 cfs

100YR EXISTING FLOW AT < 0.7'

W.S. SOUTH SIDE OF ROAD =  $1404.1 + 0.7 \approx 1404.8$

## SECTION D

A xerox copy of the south end of the Bell Commerce Center site plan is on the next page. Some of the alternatives discussed at the DCO meeting on 9/8/87 are noted on the drawing as if the actions will occur. For emphasis, the following notes are more clearly explained below.

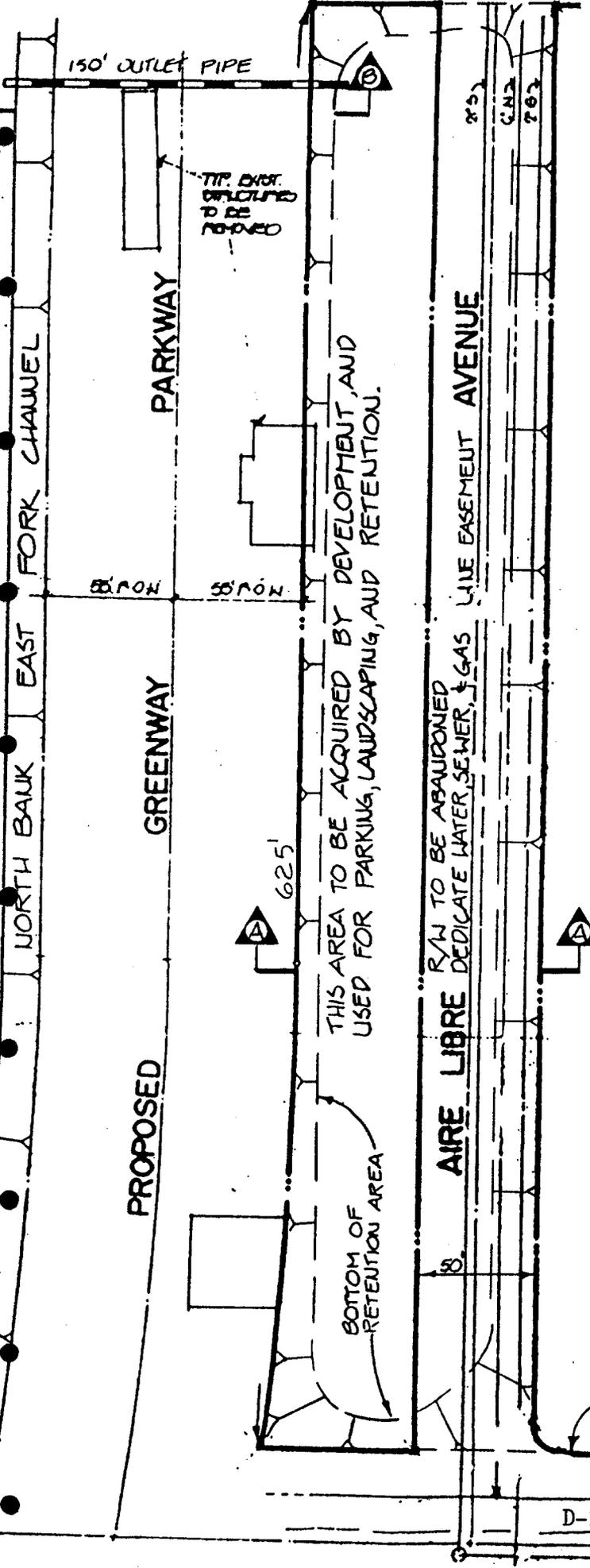
**THIS AREA TO BE ACQUIRED** - Property south of Aire Libre will be bought for Greenway Parkway right-of-way. The strip of land between that right-of-way and Aire Libre is not suited for any use and should become part of Bell Commerce Center as parking, landscaping and temporary retention and to meet set-back requirements.

**R/W TO BE ABANDONED & EASEMENT DEDICATED** - The note is clear that Aire Libre is no longer needed as a street with Greenway Parkway 60' farther south. The easement is needed to cover the existing utilities in the public R/W but the area can be used for parking, landscaping and temporary retention.

**150' OUTLET PIPE** - The retention area is called temporary because after the ACDC project provides a direct outlet to a major channel (New River) in 1989 for the East Fork, retention will no longer be required. The interim design for a controlled bleed-off of the retention pond and later discharge of flood water during a storm is drawn on the last page of this Section D.

**R/W FOR SHADOW MOUNTAIN IMPROVEMENT DISTRICT** - The City project will be out to bid in October. The owners of Bell Commerce Center will be assessed for the improvements on 16th Street. Payment will be required at time of development.

**RETENTION REQUIRED** - This property has a difference in EL of 5' (El at Bell 1406.5 - El at Aire Libre 1401.5). the average slope is  $5'/625' = 0.008$ . Site drainage will collect in on large retention area of 96' x 620' a maximum of 3' deep. Calculations of the required retention and volume provided are the xerox copy of the site plan. The retention area will not be needed after the ACDC project.



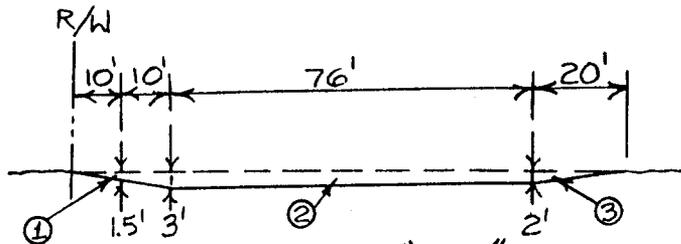
RETENTION REQUIRED

AREA =  $\frac{(1242 \times 625)}{43,560} = 17.8 \text{ AC}$

$C = 0.9$   
 $L_{100yr-2hr} = 1.25$

$Q = C \cdot I \cdot A \Rightarrow 0.9 \times 1.25 \times 17.8 = 20.0 \text{ cfs}$

Vol. =  $7200 Q = 144,216.0 \text{ cf.}$



SECTION "A-A"

AREAS: ①  $\frac{1}{2} \times 20 \times 3 = 30 \text{ sf.}$       LENGTH = 605 ft.

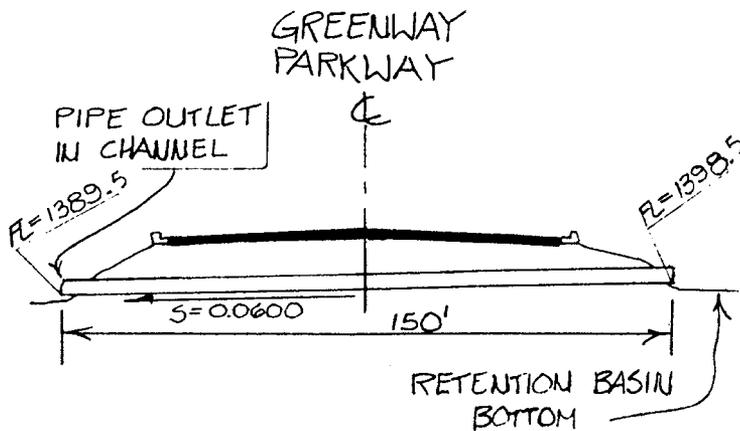
②  $\left(\frac{3+2}{2}\right) \times 76 = 190 \text{ sf.}$

③  $\frac{1}{2} \times 2 \times 20 = 20 \text{ sf.}$

240 sf.

RETENTION PROVIDED =  $240 \times 605$   
 = 145,200.0 cf.

BELL COMMERCE CENTER



SECTION "B-B"

R/W FOR SHADOW MOUNTAIN IMPROVEMENT DISTRICT

16th ST. WIDENING

D-2

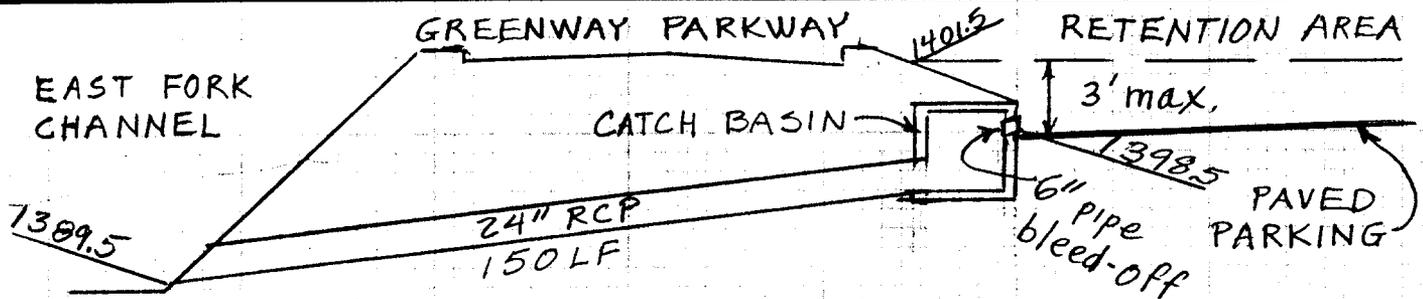
# AMWEST ENGINEERING COMPANY

## Computation Sheet

Project: BELL COMMERCE CENTER Job No.: 82118

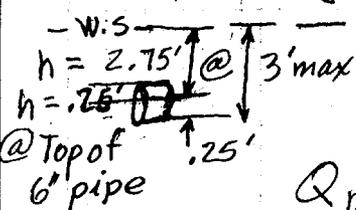
Item: RETENTION BASIN OUTLET PIPE

By: AR Date: 9/21/87 Revised: \_\_\_\_\_ Date: \_\_\_\_\_  
 Checked: \_\_\_\_\_ Date: \_\_\_\_\_ Checked: \_\_\_\_\_ Date: \_\_\_\_\_  
 Approved: \_\_\_\_\_ Date: \_\_\_\_\_ Approved: \_\_\_\_\_ Date: \_\_\_\_\_



**WHEN RETENTION REQ'D.**

Office flow thru 6" pipe into basin  
 $Q = C A (2gh)^{1/2} = [C A (2g)^{1/2}] (h)^{1/2}$  (C) sharp edge coefficient = .6  
 FACTOR

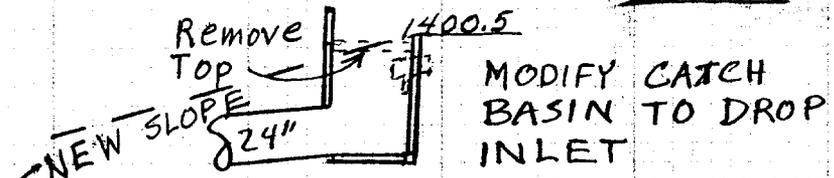


$A_{6"} = \pi \left(\frac{.5}{2}\right)^2 = .196 \text{ SF}$   
 $\text{FACTOR} = .6 \times .196 \times (64.4)^{1/2} = .94$

$Q_{\text{max}} = .94 (h)^{1/2} = .94 (2.75)^{1/2} = 1.55 \text{ cfs}$   
 $Q_{\text{@ Top of pipe}} = .94 (h)^{1/2} = .94 (.25)^{1/2} = .45$  (BLEED-OFF)  
 $2 \text{ cfs} \div 2 = 1 \text{ cfs ave.}$

**AFTER ACDC OUTLET**

Run-off  $Q_{\text{peak}} = C i A$   
 @  $T_c$  15 min,  $i = 4.7$   
 @  $T_c$  20 min,  $i = 4.2$



$Q_{15} = .9 \times 4.7 \times 17.8 = 76 \text{ cfs}$   
 $Q_{20} = .9 \times 4.2 \times 17.8 = 67 \text{ cfs}$

$S = \frac{(1400.5 - 1389.5)}{150 \text{ LF}} = 0.073$   
 $S^{1/2} = .27$   
 FROM CIRCULAR PIPE TABLE,  
 $Q = K S^{1/2}$

$K_{24"} \text{ pipe} = 258$   
 $Q = 258 (.27) = 70 \text{ cfs}$

Pipe capacity exceeded for a few minutes  
 Pipe has excess capacity after 18 min. ±

● ●

ABBREVIATIONS USED IN COMMUNICATION  
WITH NATIONAL FLOOD INSURANCE PROGRAM OFFICIALS

●

These abbreviations are used in the Amwest Engineering Company letter enclosed herewith:

- AEC - Amwest Engineering Company
- Autopark - Bell Road Autopark between Bell Road and Greenway Parkway from 7th Avenue to 11th Avenue.
- AZ Water Resources - The Arizona Water Resources office is designated coordinator for Federal flood insurance new studies and present flood map revisions.
- BFE - Base flood elevations of the 100 year frequency storm rainfall run-off water surface as determined by an authorized flood study. BFE remain the effective flood level criteria for protection of property until officially changed by map revision.
- cfs - Cubic feet per second units of flow (about 450 gallons per minute).
- COP - City of Phoenix
- EL - elevation in feet above mean sea level, usually written using only the tens and units digits ie, 53 is 1353 feet MSL.
- FEMA - Federal Emergency Management Agency, with headquarters in Washington DC, charged with responsibility to administer the federal flood insurance program and approve all flood map revisions.
- FBFM - Flood Boundary and Floodway Maps show the limits of 100 year storm flood area and the theoretical narrow width of the limits of flow that could be confined by fill on each side causing a water surface rise no more than 1' above the present 100 year water surface.
- FIRM - Flood Insurance Rate Map shows the area flooded by a 100 year storm flow shaded dark gray and marked zone A. The map also shows 100 year flood water surface elevation lines across zone A at selected locations and fringe flooding areas marked zone B.
- FIS - Flood Insurance Study authorized by the federal flood insurance program to delineate the 100 year flood area and floodways on local area maps. The original FIS is the effective flood criteria until revised.

- Floodway - The width of a theoretical route of the 100 year storm flow created by fill on the adjacent land. The selected reduced width will raise the water surface less than 1' higher than the normal 100 year storm water surface.
- Floodplain - The areas of the 100 year storm flow width and 500 year storm fringe flow areas designated zone A and B on flood insurance maps.
- FPS - Feet per second is the measure of flow velocity (about 0.7 mph.)
- HEC-2 - Hydraulic Engineering Center Computer Program 2 used to calculate storm flow water surface elevations. Program was developed by the Corps of Engineers at Davis, California.
- Input - (also coding) numbers entered into a computer to be used for calculation of water surface elevations. Data required are existing ground point elevations, distance between points, flow quantity, ground friction factor, etc.
- LOMA - Letter of Map Amendment, when issued by the federal flood insurance agency will list specific locations in an area of 100 year flooding as higher than the expected water surface and exempt from FHA requirements for flood insurance.
- LOMR - Letter of Map Revision, when issued by the federal flood insurance agency will revise the 100 year flooding limits on the present flood map and authorize that the changes be made the next time maps for the area are printed.
- MCFCDD - Maricopa County Flood Control District
- Model - The coded data entered in a computer for calculation of the storm flow water surface defines the conditions of the floodway and overbanks to closely model the actual flow conditions in the area.
- NFIP - National Flood Insurance Program
- Output - (Also printout) The computer printout of results of calculations executed in the Corps of Engineers water surface profile program. Output data includes flood water surface elevation, flow velocity, top width of flow area, depth, etc.
- Panel - The flood insurance maps are entitled by Community Panel index code numbers that identify State, County, City and area shown on each map.

Q - Quantity of storm flow expressed in cubic feet per second.

Reach - A specific length of a floodway, wash, channel or flow area that is described by upstream and downstream limits and subsequently referred to as "this reach".

Region IX- The FEMA office in San Francisco that monitors flood insurance program activities in Arizona.

SECNO - Coded data used in the computer program to calculate water surface elevations uses the abbreviation SECNO to identify the section numbered location on the flood map section numbered location on the flood map corresponding to the results printed for each computation.

SFHA - Special Flood Hazard area is the same dark gray color Zone A on flood insurance maps within the 100 year storm flood limits.

V - Velocity of flow expressed in feet per second.

WS - Water surface elevation of a specified quantity of storm flow through a study area either on the overbank surface or in an existing wash or new channel.