

ELOY
BRALU Property
(National Gypsum Company) - EXPEDITED
Area Drainage Plan

3R



eps group, Inc.
Engineers, Planners & Surveyors

RECEIVED

JAN 27 2009

W.C. SCOUTTEN, INC.

BRALU Property Area Drainage Plan

City of Eloy,
Pinal County, Arizona



APPROVED

CITY OF ELOY ENGINEER

DATE

THE CITY APPROVES THIS REPORT FOR CONCEPT ONLY AND ACCEPTS NO
LIABILITY FOR ERRORS OR OMISSIONS.

Project No. 06-031

Date December 2008
Revised: (December 2008)
Revised: January 2009

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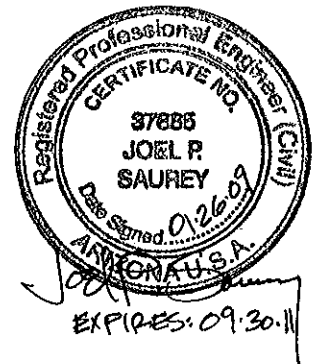
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1.0 Introduction

The BRALU property is a proposed industrial and retail development comprising most of the area between Sunshine Boulevard and La Palma, and Interstate 10 and Highway 84 (Frontier Street) in the City of Eloy, Arizona. The total area of the BRALU property is approximately 270 Acres. The BRALU property is neighbored by the existing Pilot Truck Stop, and by the National Gypsum Wallboard facility (NGC) currently under construction. The legal description of the property is a portion of Section 8 of Township 8 South, Range 8 East of the Gila and Salt River Meridian in the City of Eloy, Arizona. See the vicinity map in **Appendix A**.

The BRALU property is aligned in planning for mostly industrial use on the 270 Acre property area. Other minor retail/commercial uses are slated for the property, but these uses will be limited to smaller acreages primarily along Sunshine Boulevard. At this stage of development, only conceptual site plans have been produced for marketing and budgeting purposes; no formal submittals have been made to the City of Eloy for specific site plan review. Potential buyers/users of the BRALU site may change as site planning proceeds and market forces dictate.

In order to maintain maximum flexibility in the property's site planning (given the likely life of site use and build-out) and to establish a recognizable plan for the area drainage impacting this site, this report is prepared. The purpose of this report is to evaluate the impacts that offsite drainage has on this area, quantify methods for management of the offsite drainage, provide approximate quantities for management of on-site drainage, and provide a plan that can act as a general guide in seeing through the planning and permitting of future site parcels. More immediately, this report serves to supplement permitting of new drainage facilities in Date Street which need to be installed now for future needs when development of the BRALU property is realized.

2.0 Area Offsite Drainage

An examination of offsite drainage characteristics affecting the BRALU property is found within the Final Drainage Report for the National Gypsum Wallboard Facility (City Approval October 2007). Refer to the Final Drainage Report for the National Gypsum Facility for a specific analysis and full calculations supporting the offsite drainage impacting the site. The BRALU property is one among several property components affected by the regional offsite drainage in the area. Due to their proximity to one another, the analysis performed for the National Gypsum Facility necessarily relates to the impact by the offsite drainage to the BRALU property. Conclusions in this report benefit from similar conclusions reached in the National Gypsum Facility analysis. As a study previously approved by the City of Eloy, the drainage analysis of the area is agreeably accepted. Refer to **Appendix C**. Contained therein are excerpts of the offsite drainage as evaluated for the National Gypsum Site. Refer also to **Appendix D**. In Appendix D, a sketch of the overall drainage patterns as they exist today in the area is shown. This sketch in Appendix D breaks the regional drainage into components which offer an understanding of how the BRALU property relates to the other area properties on a larger scale and best defines the BRALU property offsite drainage boundaries. For

simplicity, all naming conventions of culverts, washes, or other drainage features established with the studies for the National Gypsum Facility are carried through to this report for the BRALU property. The sketch in Appendix D is simply an understanding of the area drainage of which EPS Group may or may not have involvement with the projects affected by the behavior of the regional drainage or design behind its management. The conclusions in this report are limited to those findings for projects in which EPS Group was a part.

2.1 Area Offsite Drainage Summary

An offsite drainage area of several square miles contributes to runoff that concentrates in the vicinity of Interstate 10 and La Palma. The flow is carried by the Picacho Wash, a natural watercourse paralleling the Santa Cruz Wash which is approximately 2 miles west of the Picacho Wash. The Picacho Wash discharges nearly 5,000 cfs and is directed toward the Interstate 10 and La Palma intersection (**Appendix C**). The resulting flow ponds on the south side of Interstate 10. The collected storm water hydraulically divides near the intersection of Interstate 10 and La Palma in three (3) primary directions.

The first component of which (350 cfs) goes beneath I-10 through a bridge at La Palma north until Date Street and crosses Date Street in a box culvert adequately sized to convey the total of the flow without overtopping Date Street. This flow then travels along the east, then north sides of the National Gypsum Facility and against the Union Pacific Railroad on the south side of Highway 84 (Frontier Street). This flow then discharges toward the north through a group of culverts under the railroad and Highway 84. This flow represents the regional offsite flow component affecting the National Gypsum Facility.

The second of the three discharges reacting to the ponded storm water on the south side of Interstate 10 is a weir overflow of a main irrigation lateral which runs north and is situated between Sunshine Blvd. and La Palma Road. The ponded storm water weirs over this lateral and discharges what is the distinct majority of the nearly 5,000 cfs to the west. This discharge is a diversion which eventually meets up with the flows from the Santa Cruz wash and contributes to the vast floodplain area of the Santa Cruz. It is estimated that more than 4,200 cfs is diverted over the lateral and toward the west.

Affecting the BRALU property is the third portion of this large regional offsite flow which discharges in five (5) culverts under Interstate 10 west of La Palma. As storm water builds on the south side of I-10 and while the other various discharges simultaneously occur, these I-10 culverts are discharging flow beneath I-10 dissipating the cumulated headwater. The invert elevations of each of the I-10 culverts are slightly higher than the grade of the BRALU site just downstream. It is approximated that 219 cfs total flow (peak discharge during the 100-year event) is passing through this culvert system and impacting the BRALU property. It is this flow that will be analyzed in remaining sections of this report.

Area Drainage Maps, calculations, and a summary for the regional drainage impacting the BRALU site are located in Appendix C. A sketch is located in Appendix D. For a complete analysis of this drainage, refer to the Final Drainage Report for National Gypsum Facility.

2.2 FEMA (F.I.R.M.) Assessment

The BRALU property is situated in Zone 'X' of the Flood Insurance Rate Map (Map Number 04021C1975E). Zone 'X' is described as:

“Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood.”

Previous sections of this report describe the drainage which can be seen resulting in the Flood Insurance Rate Map. Although not in an administrative floodplain, the BRALU property is affected by the previously described offsite drainage. Refer to **Appendix B** for FEMA (F.I.R.M.) Assessment information.

2.3 Proposed Offsite Drainage Management Plan

As analyzed in the previously approved Final Drainage Report for the National Gypsum Facility and reviewed in previous sections of this report, an approximate discharge of 219 cfs impacts the BRALU property.

In **Appendix E**, a sketch further detailing the findings from the National Gypsum Facility Final Drainage Report displays the existing drainage conditions as the offsite runoff affects the site. The discharge from the five (5) culverts discharging the 219 cfs total crosses under I-10 and flows across the site toward the northwest corner of the property. The flow likely behaves as sheet flow or shallow concentrated flow in its course over the site. The ultimate outfall for the offsite drainage impacting the BRALU property is the northwest corner of the site and discharging through the culvert tandem identified as RR #6 (Railroad Culvert number 6 under the UPRR) and the corresponding 84 #6 (Culvert number 6 under Highway 84), each of these culvert conventions were established with the National Gypsum Final Drainage Report. For the purposes of this report, this culvert system (RR #6 & 84 #6) will simply be referred to as “Culvert #6”. Back near Date Street, there is a potential for a very small portion of the 219 cfs to divert west toward Sunshine Boulevard, however, this is negligible and for this analysis it is given that the entirety of the offsite runoff, 219 cfs, reaches and discharges through Culvert #6. After discharge through Culvert #6, which is aligned with Santa Cruz Avenue, the flow continues in combination with other regional flows to an ultimate regional outfall location downstream.

Refer to the **Drainage Exhibit** in the Pocket of this report. The Drainage Exhibit displays proposed methods for the management of the property's offsite drainage. In order to create a compatibility with developed conditions of the property, capturing this offsite runoff and routing it through the site to its location of historic outfall (Culvert #6), a channel or other similar open space drainage facility will be required. This report does not firmly assert that a traditional channel will be required to convey the offsite storm water, rather, any combination of courses viable to transfer the drainage across the site and to the proposed culvert must be left available to the project for site planning flexibility.

Drainage planning for the property requires leaving maximum flexibility in place for the site design of the future parcels/users as limited information on site design versus acknowledgement of the area drainage is contemplated. To do this, it has been suggested that this channel, or other open space drainage facility have the latitude of a varying alignment across the site given it has sufficient geometric character to properly convey the offsite drainage. The best corridor for the drainage channel (or open space) is left to the site planners to best determine how to maximize developable area while complying with requirements of the offsite drainage conveyance.

In the Drainage Exhibit, three areas are highlighted. Point 'A', Point 'B', and Point 'C'. Each of these areas establishes locations where a channel or other similarly meandering open space for conveyance of the offsite runoff must all have in common regardless of their final determined corridor.

Point 'A' will be approximately 2,000' of channel, reaching from the irrigation lateral between Sunshine Boulevard and La Palma Road east to the I-10 Culvert identified as CUL#5 (Named in the Final Report for the National Gypsum Facility). This channel will be sectioned approximately at 4:1 (max) side-slopes, 3' to 4' in depth and a minimum of 75' in top width. The purpose of this channel within Point 'A' will be to capture the discharge from each of the I-10 culverts and excess discharge from the irrigation lateral which, in the existing condition, impacts the BRALU property and flows to Culvert #6. This same behavior will be preserved in the post-developed condition.

Point 'B' shall be configured similarly to that shown in the Drainage Exhibit with sufficient area, side-slope, and depth to intercept and discharge the flow through the proposed culvert to be installed near Date Street STA 18+00±.

Point 'C' is a proposed outfall basin 8' in depth with 8:1 (max) side slopes which will act to both retain on-site runoff (see following sections of this report) and as detention of the offsite runoff. It is very difficult to quantify the volume of the discharge from offsite drainage reaching the BRALU site. With several upstream diversions before arriving at the BRALU property, the runoff volume is undetermined. However, the outfall basin (Basin 'A') identified at Point 'C', will have reserved 40% of its volume strictly for offsite runoff. This excess volume is intended as an abatement of the first-arriving discharge from the 100-year offsite flow. A weir structure with a crest elevation at approximately 60.0 will likely need to be constructed between the basin's discharge and the UPRR right-of-way to direct the runoff to Culvert #6.

The final routes of the offsite drainage channel (or optional meandering open space corridor) will vary according to the proposed specific site plans for the BRALU property between the set points of Point 'A' and Point 'B' and Point 'B' and Point 'C'. In **Appendix F**, a HEC-RAS evaluation demonstrates the hydraulics resulting from the minimum required corridor cross-sections for the offsite storm water conveyance and the resulting hydraulics. To account for freeboard (and grading transitions) it is recommended that no location along the length of the channel/open space corridor be less than 75' in width.

Appendix F is also the location for the culvert evaluation for the proposed culvert to be installed near Date Street STA 18+00±.

2.3.1 Offsite Drainage Interim Condition

It is proposed that the culvert to be installed near Date Street STA 18+00± be “dry installed” exposed at its entry and outlet ends only after development of the parcels on the BRALU property begin that will establish the channel/open space corridors. Otherwise, this culvert will be plugged on each end until development occurs. In **Appendix G**, calculations are provided that will establish the interim plan for management of the offsite drainage. Along with the culvert near Date Street STA 18+00±, a new pipe will be installed between the catch basins near STA 15+70. Coupled with this new 12” pipe and weir overflow over Date Street, the approximate 219 cfs is conveyed. See Appendix G.

As a temporary measure, this interim condition of weir overflow is suggested to maintain the historic drainage pattern over the site. Currently, the offsite flow will pond south of Date Street, overtop, and arrive on the north side of Date Street and discharge in a relief channel, constructed with the NGC facility, to its outfall at Culvert #6. This is designed only as a safeguard from keeping offsite flows from Sunshine Boulevard which does not expect to see this flow under any storm event. Because of the infrequency of the event which would see the overtopping of Date Street, it is recommended as a temporary, cost-effective means of controlling the offsite drainage in an interim condition.

Once development begins on the BRALU site, and more fixed, ultimate conditions are realized on the property, it is fully expected that this temporary means of flow transfer be abandoned in favor of the proposed culvert at STA 18+00± “dry installed” for the time being. The culvert will then be exposed; headwalls and other appurtenances constructed, and the transfer of offsite flow will ultimately be handled by the culvert. The culvert design is located in Appendix F.

3.0 Area Onsite Drainage

The BRALU property has been divided into four (4) drainage areas. None of these areas represent actual known parcel subdivisions of the property. These areas have been created simply to delineate areas of known acreage to best describe the proposed plan for onsite drainage.

3.1 Proposed Site Retention

Pinal County design standards specify that retention basins must contain the 100-year, 2-hour storm event (2.80”). The maximum allowable side slope on any retention basin is 4:1. The following equation is used to determine the required retention volumes:

$$V = D \times A \times C_w \quad (\text{MCFCD Drainage Design Manual, Vol. I, pp. 3-7, eq. 3.3})$$

Where:

V = Volume (ac-ft)

D = Rainfall depth from 100-year, 2-hour storm (2.80 in)

A = Drainage area (ac)

C_w = Weighted runoff coefficient

Refer to **Appendix H** for detailed calculations of runoff volumes for each catchment area and basin volumes based on the Drainage Exhibit.

It is proposed that a given percentage of each of the delineated drainage areas be allowed to discharge its runoff directly to the channel/open space corridor meant for outfall to Basin 'A'. The remaining portion of the volume of runoff will be required to be retained on-site, within the bounds of the developed parcel. As previously stated, Basin 'A' will have no more than 60% of its volume consumed by onsite retention from the developed property. Any parcel discharging its runoff to the channel/open space corridor will ultimately end in Basin 'A'. Table I follows summarizing the runoff/retention conditions of the proposed developed condition of the BRALU property. Refer to Appendix H for complete runoff and retention calculations.

Table I
-BRALU Property Developed Condition Runoff/Retention Summary-

Parcel ID	Area (Ac)	Area Runoff (Ac-ft)	Parcel Retention Provided (Ac-ft)	Parcel Retention Percentage	Excess Volume to Channel/Basin A (Ac-ft)
A	66.6	13.99	10.77	77%	3.22
B	13.6	2.86	0.40	14%	2.46
C	159.8	33.56	25.84	77%	7.72
D	10.0	2.10	0	0%	2.10

BASIN 'A' Volume = 26.24 Ac-ft

On-site Runoff Volume to BASIN 'A' = 15.50 Ac-ft

BASIN 'A' Volume Remainder for Offsite = 10.74 Ac-ft (41%)

Drywells will be used when needed to aid in runoff percolation. Pinal County standards require all retention basins to drain their volume from the 100-year, 2-hour storm event within a 36-hour period. Where drywells may have to be utilized, unless valid as-built drywell percolation rates for other drywells in the immediate area are available, design percolation rates for drywells is limited to no more than 0.10 cfs.

Other onsite drainage elements of design, such as street capacities, inlets, storm drain, and specific retention designs will be produced along with the development of each individual parcel and submitted for approval and permitting when users proceed with production of the BRALU property.

4.0 Conclusions

- Drainage conditions in the developed state of the BRALU property will follow the existing conditions without increasing downstream discharge or volume.
- Future Parcels will have a percentage allowance of direct discharge to the site's channel/open space corridor, while leaving available volume in the outfall basin for offsite runoff
- Future Retention basins will be properly sized to retain the street runoff from the 100-year, 2-hour storm.
- Interim drainage conditions for the BRALU property are addressed and follow or exceed minimum guidelines for roadway overtopping.

5.0 References

Maricopa County Drainage Policies and Standards, dated January 2007

Pinal County Drainage Manual, dated August 2004

Final Drainage Report for Date Street, dated September 2007

Final Drainage Report for National Gypsum Facility, dated September 2007

APPENDIX A

VICINITY MAP

PINAL COUNTY STREET & ROAD ATLAS 2007 T8S R8E

194

195

MAP
288

60S

E1000N

BATTAGLIA

DRIVE

P1670E

P3270F

P4870E

5

4

N
NTS

ALSDORF

ROAD

E-0

VARIOUS

1. A PALM

PROGRESS

CALLE KEYVA RD

LETZRING AVE

SAINT

ROAD

PACIFIC
EXIST. NGC

TRUCK
STOP

THIS
SITE

~~F10AAS~~

144

~~R.R.~~



16

SINSHINE
E-0

17

E1000F

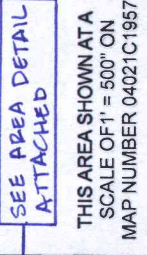
BRALU PROPERTY	VICINITY
NOT TO SCALE	

State Route 84
Interchange

211

APPENDIX B

FEMA (F.I.R.M.) ASSESSMENT

[illegible][illegible][illegible][illegible]

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AV, AR, VE, and V. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A
No base flood elevations determined.

ZONE AE
Base flood elevations determined.

ZONE AH
Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR
Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently declassified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE AV
Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no base flood elevations determined.

ZONE VE
Coastal flood zone with velocity hazard (wave action); no base flood elevations determined.

ZONE V
Coastal flood zone with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE
The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increase in flood heights.

OTHER FLOOD AREAS
Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by areas from 1% annual chance flood.

OTHER AREAS
Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

CONATAL BARRIER RESOURCES SYSTEM (CBRS) AREAS
Areas determined to be outside the 0.2% annual chance floodplain.

OTHERWISE PROTECTED AREAS (OPAs)
CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone boundary

CBRS and OPA boundary

Base Flood Elevation line and value; elevation in feet*

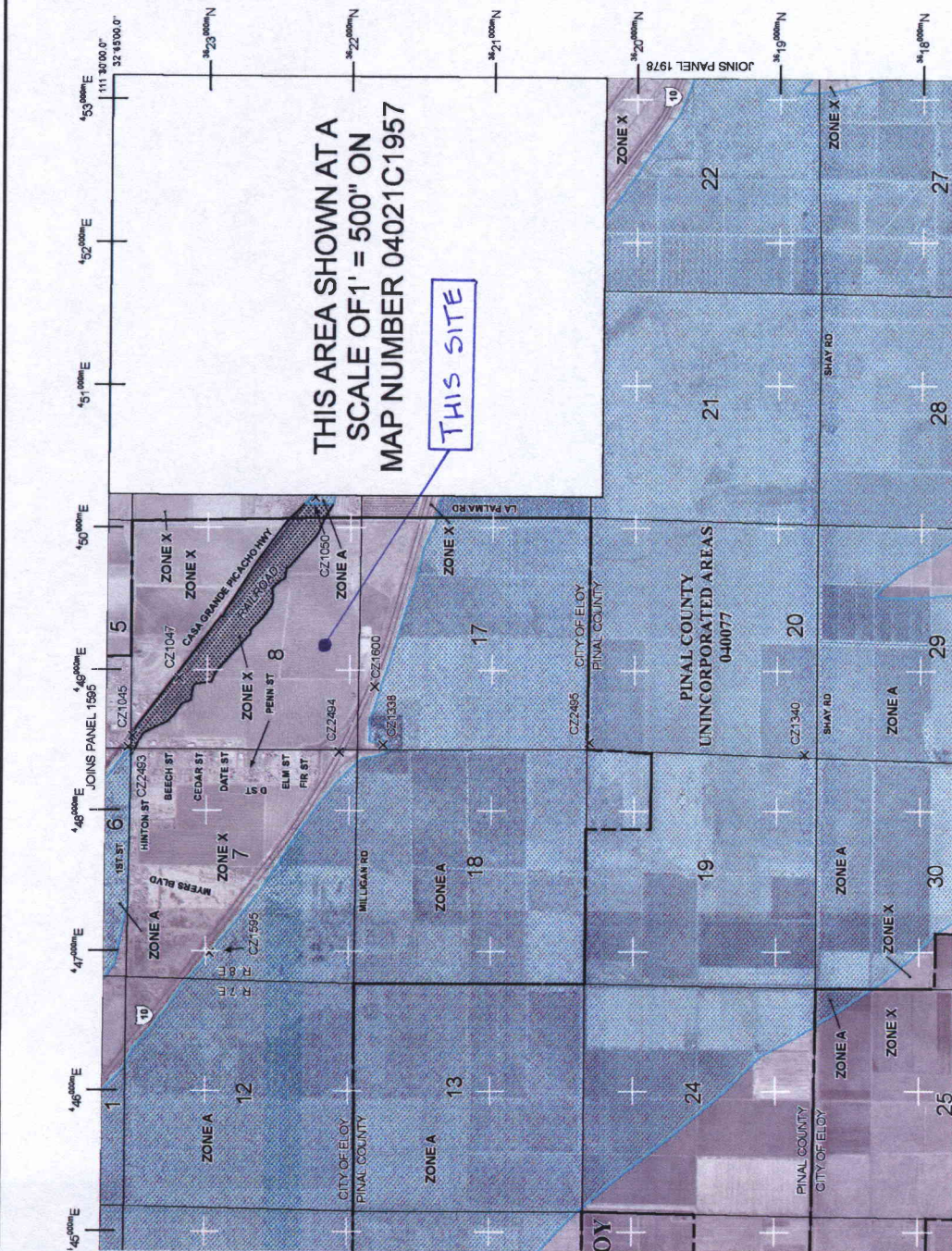
Base Flood Elevation value where uniform within zone; elevation in feet*

(EL 967)

*Referenced to the North American Vertical Datum of 1989

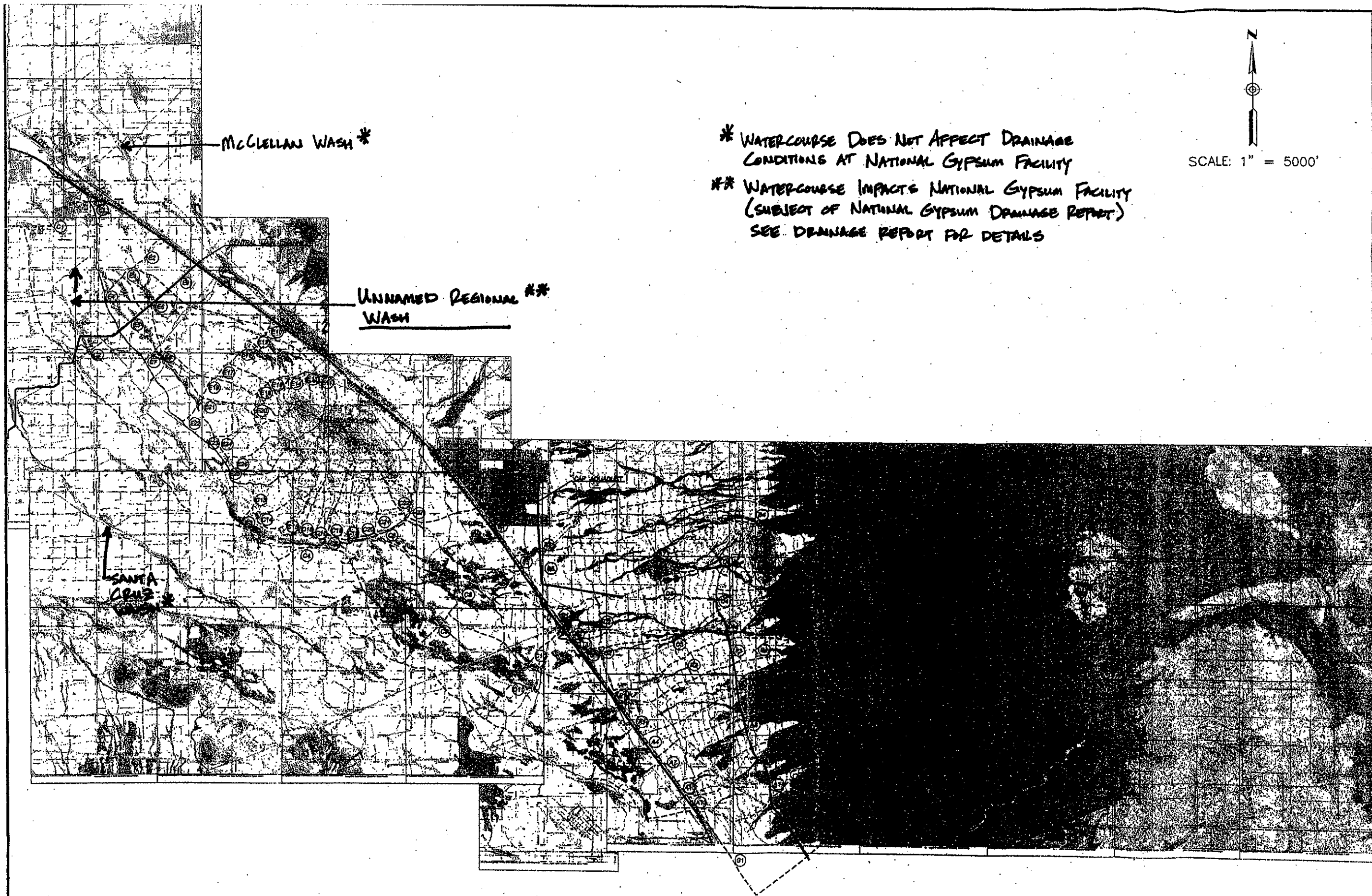
THIS AREA SHOWN AT A SCALE OF 1" = 500' ON MAP NUMBER 04021C1957

THIS SITE



APPENDIX C

NGC HYDROLOGY DESIGN SUMMARY



* WATERCOURSE DOES NOT AFFECT DRAINAGE
CONDITIONS AT NATIONAL GYPSUM FACILITY

** WATERCOURSE IMPACTS NATIONAL GYPSUM FACILITY
(SUBJECT OF NATIONAL GYPSUM DRAINAGE REPORT)
SEE DRAINAGE REPORT FOR DETAILS



SCALE: 1" = 5000'

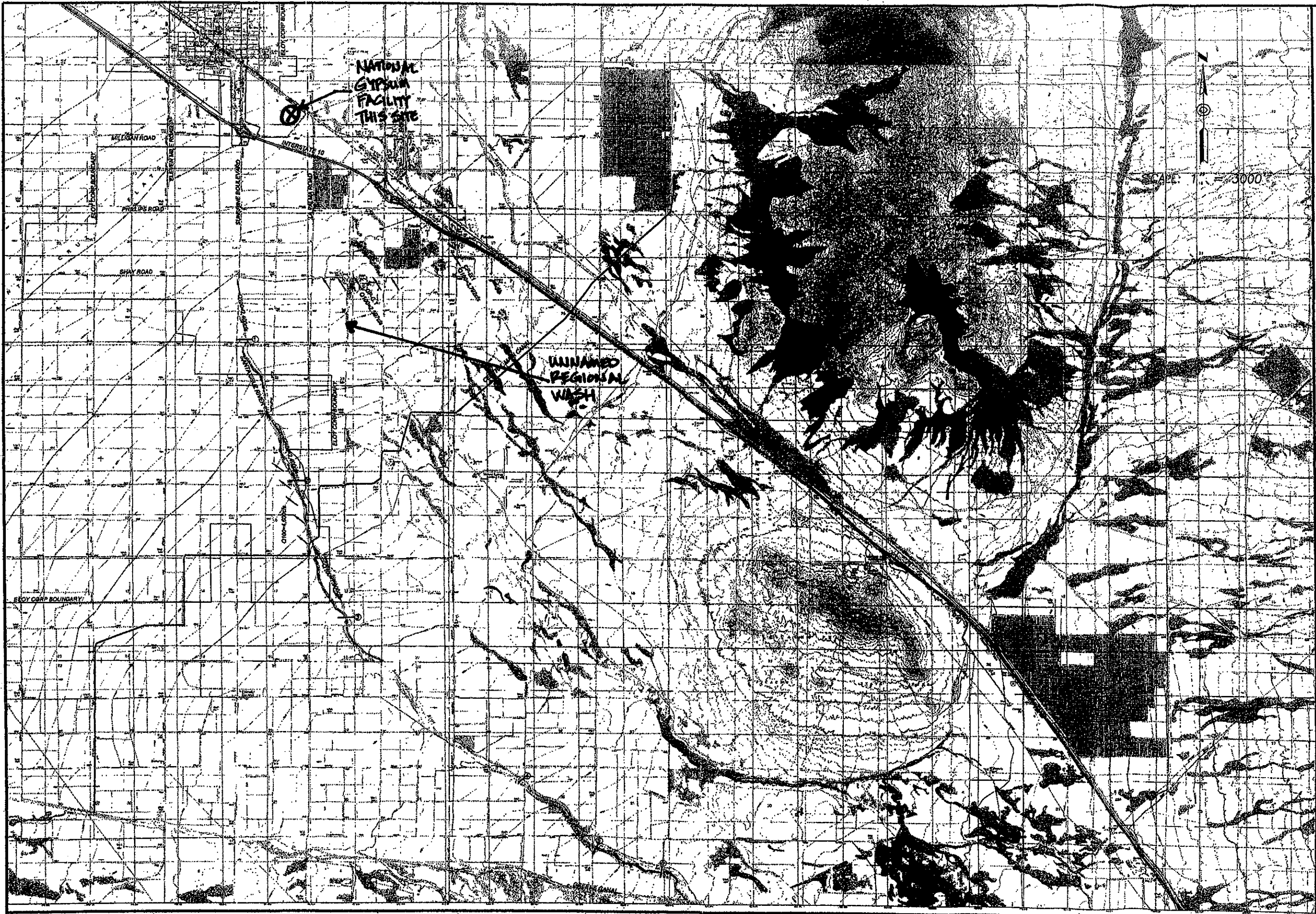
FIGURE 2
WATERSHED MAP
Pinal County, Arizona

CMG DRAINAGE
ENGINEERING, INC.
4574 N. 1st AVE. Tucson, Arizona 85718
Phone (520) 882-4284 Fax (520) 882-3008

PROJECT NO.	20118
DATE	04-15-2004
FILE	-
DESIGNER	RLB
CHECKER	RLB
APPROVER	FLS

SHEET NAME:

SHEET NUMBER:



REVISION	DATE

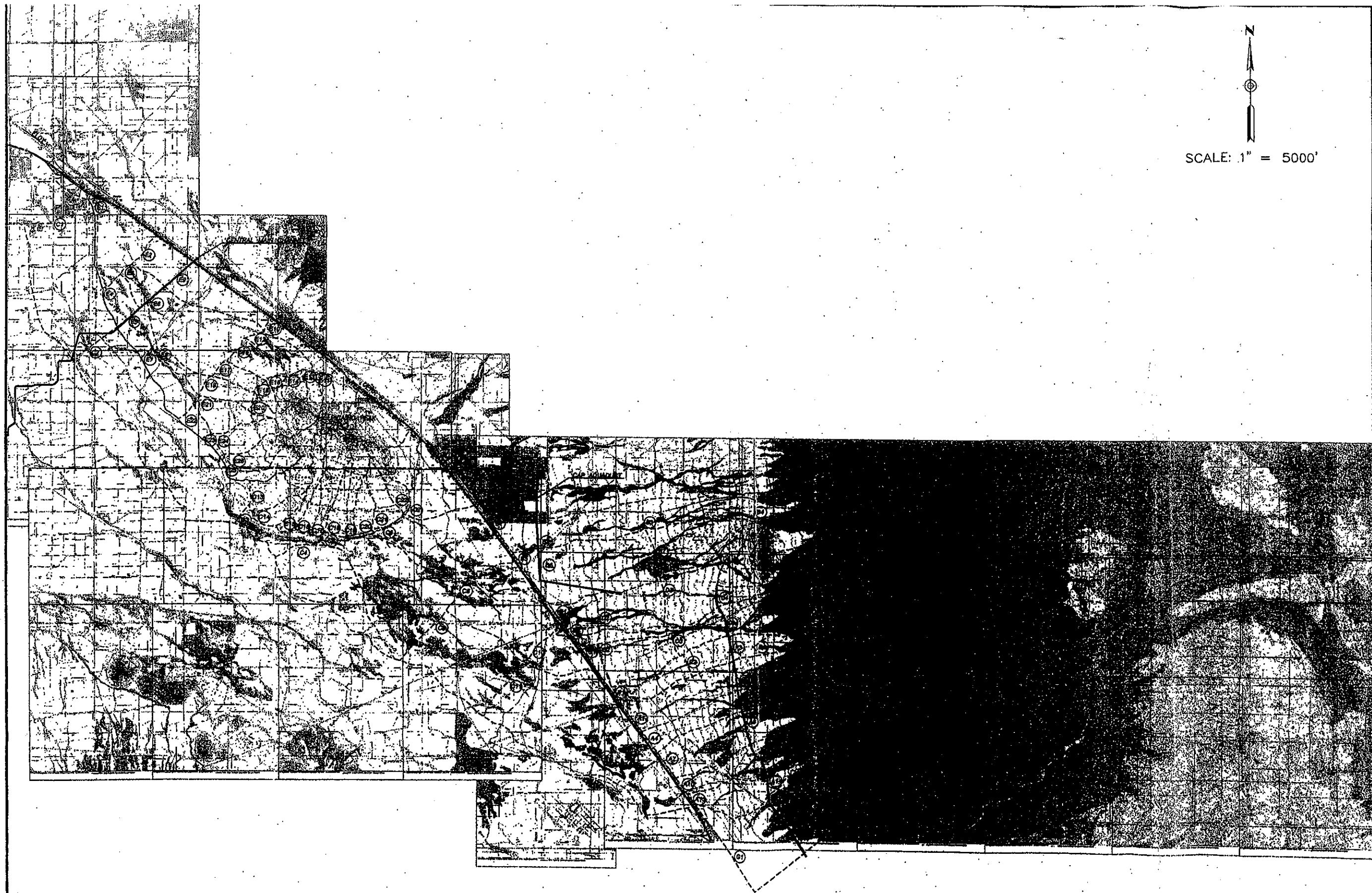
FIGURE 3
CONCENTRATION POINTS
NEAR ELOY, ARIZONA
Pinal County, Arizona

CMG DRAINAGE
ENGINEERING, INC.
4574 N. 1st AVE. Tucson, Arizona 85718
Phone (520) 882-4244 Fax (520) 882-3068

PROJECT NO.	23118
DATE	04-13-2004
FILE	-
DESIGN	RLB
CHECKED	RLB
DRAWN	RAS

SHEET NAME

SHEET NUMBER



SCALE: 1" = 5000'

REVISION:	DATE:

FIGURE 2 WATERSHED MAP

Pinal County, Arizona

**CMC DRAINAGE
ENGINEERING, INC.**
4574 N. 1st AVE. Tucson, Arizona 85718
Phone: (520) 882-4244 Fax: (520) 882-3006

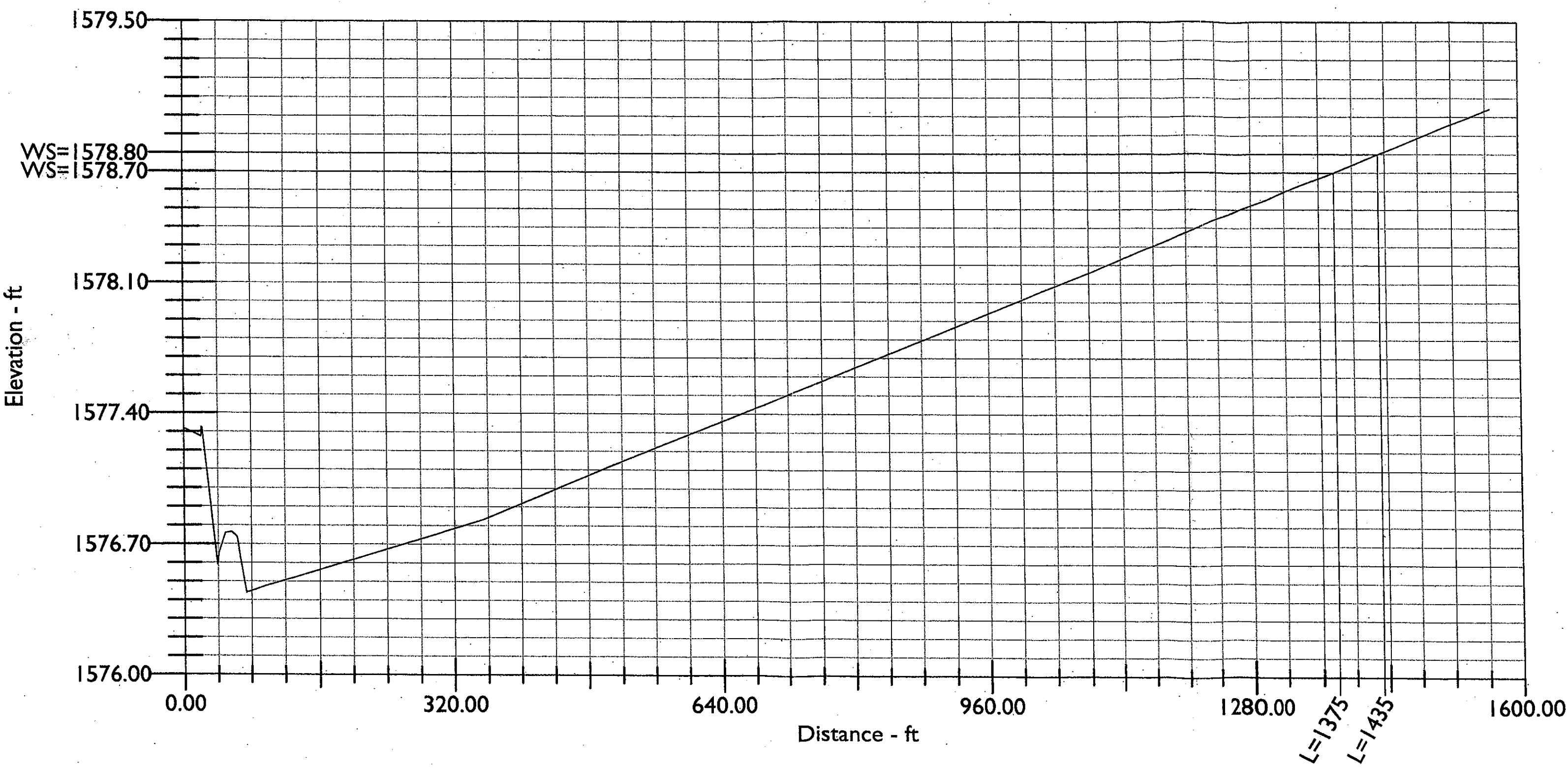
PROJECT NO.: 23118
DATE: 04-15-2004
FILE: -
DESIGNER: RLB
CHECKER: RLB
DRAWN: RAS

SHEET NAME:

SHEET NUMBER:

1

Broadcrested Weir Cross-Section



III STUDY RESULTS

The results of the HEC-1 model for the study watersheds are summarized by subbasin in Table 1. Runoff emanating from the Tortolita tributary is conveyed via sheetflow to the southeast property corner (Figure 3). Runoff emanating from the Picacho tributary is conveyed via sheetflow east of the project site, but is directed toward the project site near the northeast property boundary. HEC-1 model output is included in Appendix G of this report.

Table 1: 100-year Runoff at Watershed Outlet

Watershed	Area (sq. mi)	Subbasin Runoff (cfs)	Time of Peak (hrs)
C-1 (Tortolita Trib.)	130.5	2,597	16.58
E-1 (Picacho Trib.)	17.2	3,792	10.67
Combined	147.7	4,991	9.08

↑
ACCEPTED AREA
HYDROLOGY FOR
NATIONAL GYPSUM
FACILITY

IMPACT TO
DATE STREET (*)

Elevation Based Offsite Runoff Calculations

Flow over broad-crested weir (South of I-10) Q=CLH ^{3/2} (3/2)		Flow through the 43"x27" culverts under I-10 (D=2.25')										Flow Under Bridge (From HEC-RAS)	Total System Flow
Weir Coefficient (C)= 2.6		Culvert #1 Invert = 1574.31	Culvert #2 Invert = 1574.88	Culvert #3 Invert = 1575	Culvert #4 Invert = 1575.26	Culvert #5 Invert = 1575.76	Culverts Total		Flow Under Bridge (From HEC-RAS)			Total System Flow	
Water Surface Elevation	L-Length of Weir (ft)	H-Head (ft)	Q-Flow (cfs)	Flow* (cfs)	HW/D	Flow* (cfs)	HW/D	Flow* (cfs)	Flow* (cfs)	HW/D	Flow* (cfs)	Flow (cfs)	Flow (cfs)
1579.0	1540	1.27	5731	54	2.08	49	1.83	48	1.66	45	1.44	395	6362
1578.8	1435	1.17	4722	52	2.00	47	1.74	46	1.57	42	1.35	370	5315
1578.7	1375	1.12	4237	50	1.95	47	1.70	45	1.53	41	1.31	350	4806
1578.5	1265	1.02	3388	49	1.86	44	1.61	42	1.44	39	1.22	305	3900
1578.0	990	0.77	1739	45	1.64	38	1.39	36	1.22	33	1.00	230	2149
1577.8	890	0.67	1269	42	1.55	36	1.30	34	1.13	30	0.91	205	1638
1577.6	775	0.57	867	40	1.46	33	1.21	32	1.04	29	0.82	180	1201
1577.4	665	0.47	557	37	1.37	30	1.12	29	0.95	25	0.73	160	855
1577.2	525	0.37	307	35	1.28	29	1.03	28	0.86	22	0.64	140	576
1577.0	415	0.27	151	33	1.20	24	0.94	21	0.77	19	0.55	120	379
1576.5	50	0.02	0	26	0.97	17	0.72	16	0.55	11	0.33	80	150
1576.0	0	0	0	18	0.75	9.7	0.50	8	0.33	0	0.11	50	86
1575.5	0	0	0	10.5	0.53	0	0.28	0	0.11	0	0	26	37

* Flows derived from Chart 34B of Hydraulic Design of Highway Culverts (USDOT)

THIS
Flow

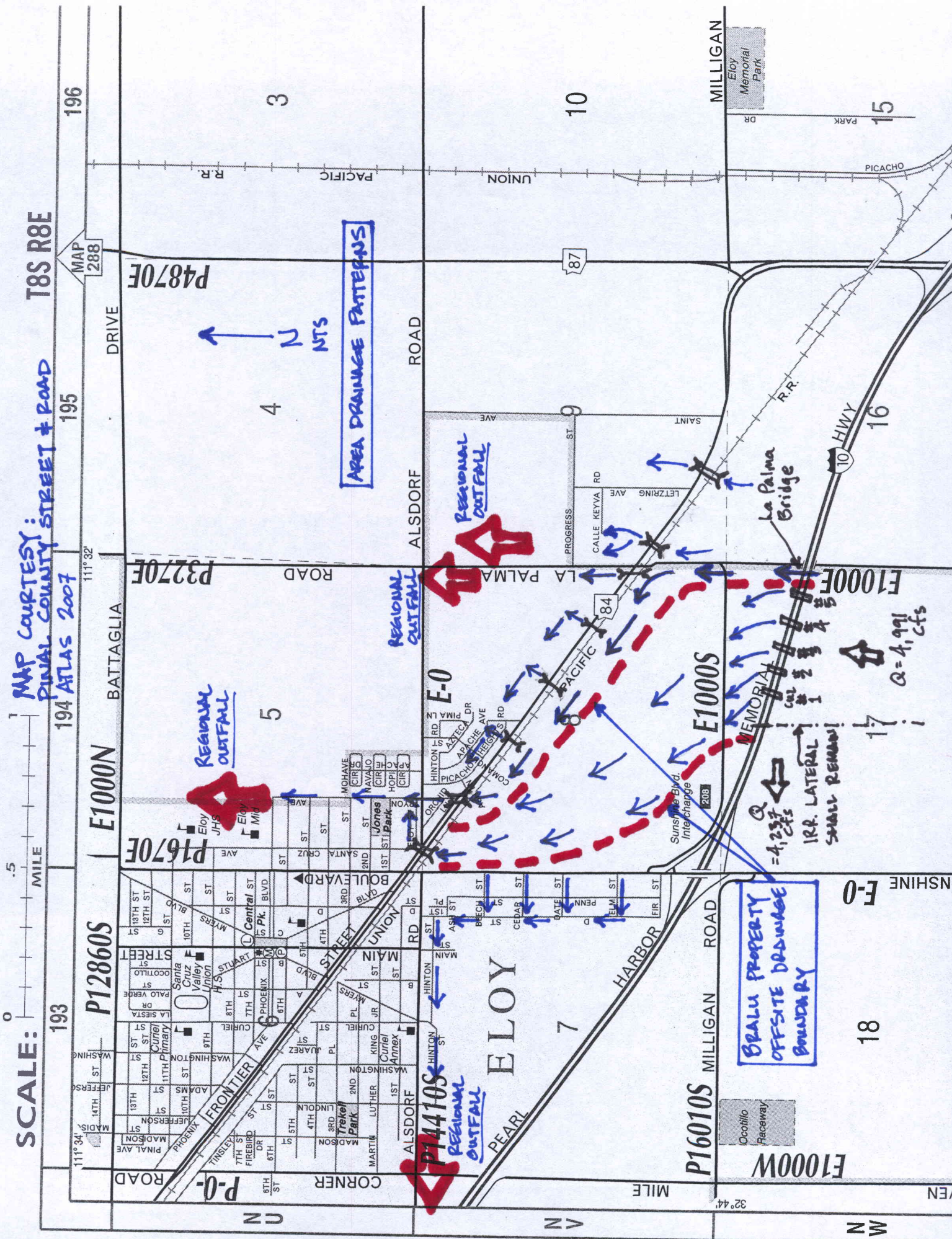
IMPACT TO

BRALL PROPERTY

(*) DATE STREET EAST NEAR STA 71+00
CROSSING IN R.C.B.C. IMPACTS NGC
SITE SEPARATE FROM BRALL

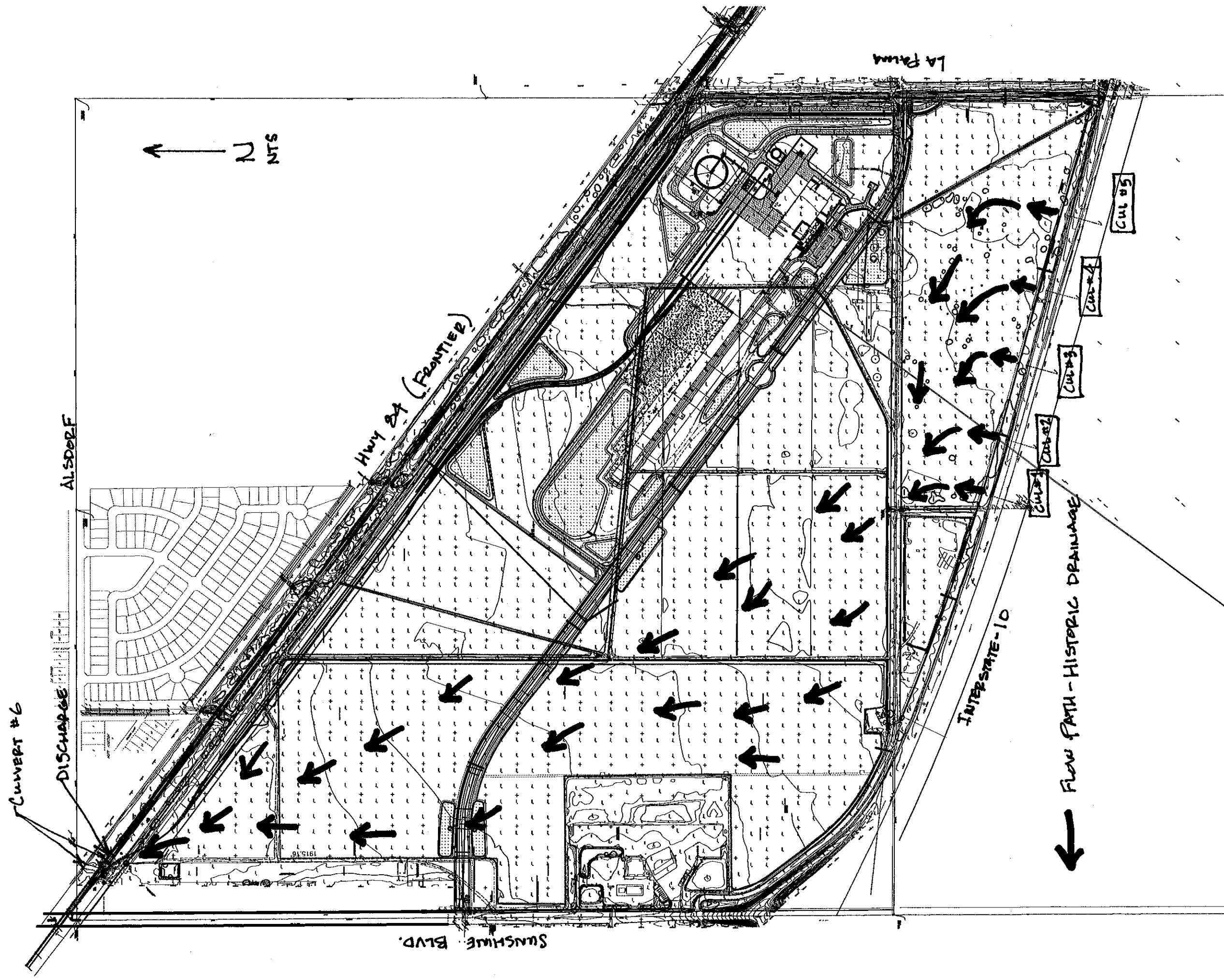
APPENDIX D

AREA DRAINAGE SUMMARY



APPENDIX E

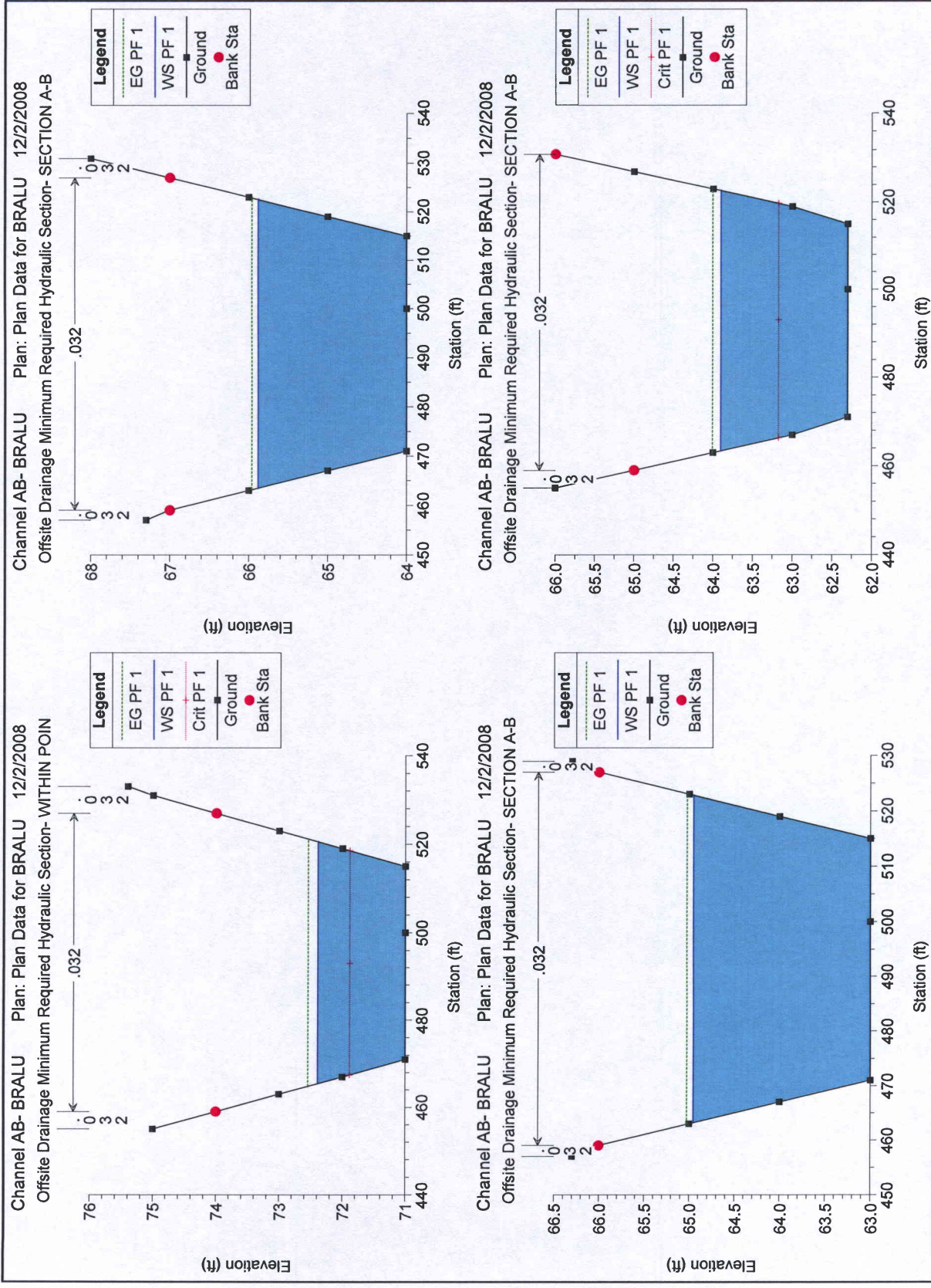
BRALU PROPERTY HISTORIC DRAINAGE PATTERNS



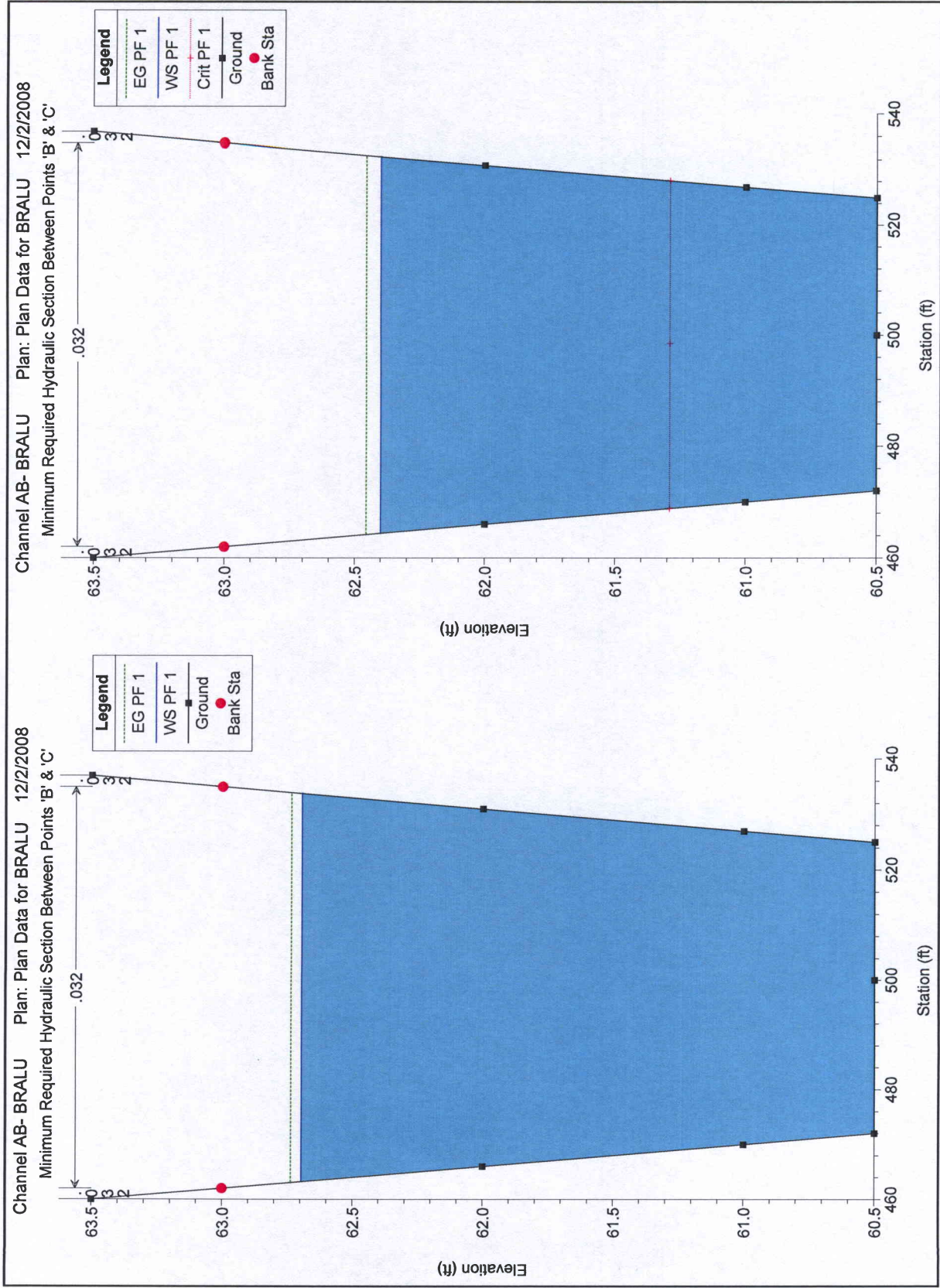
BRAU PROPERTY HISTORIC OFFSITE DRAINAGE PATTERN

APPENDIX F

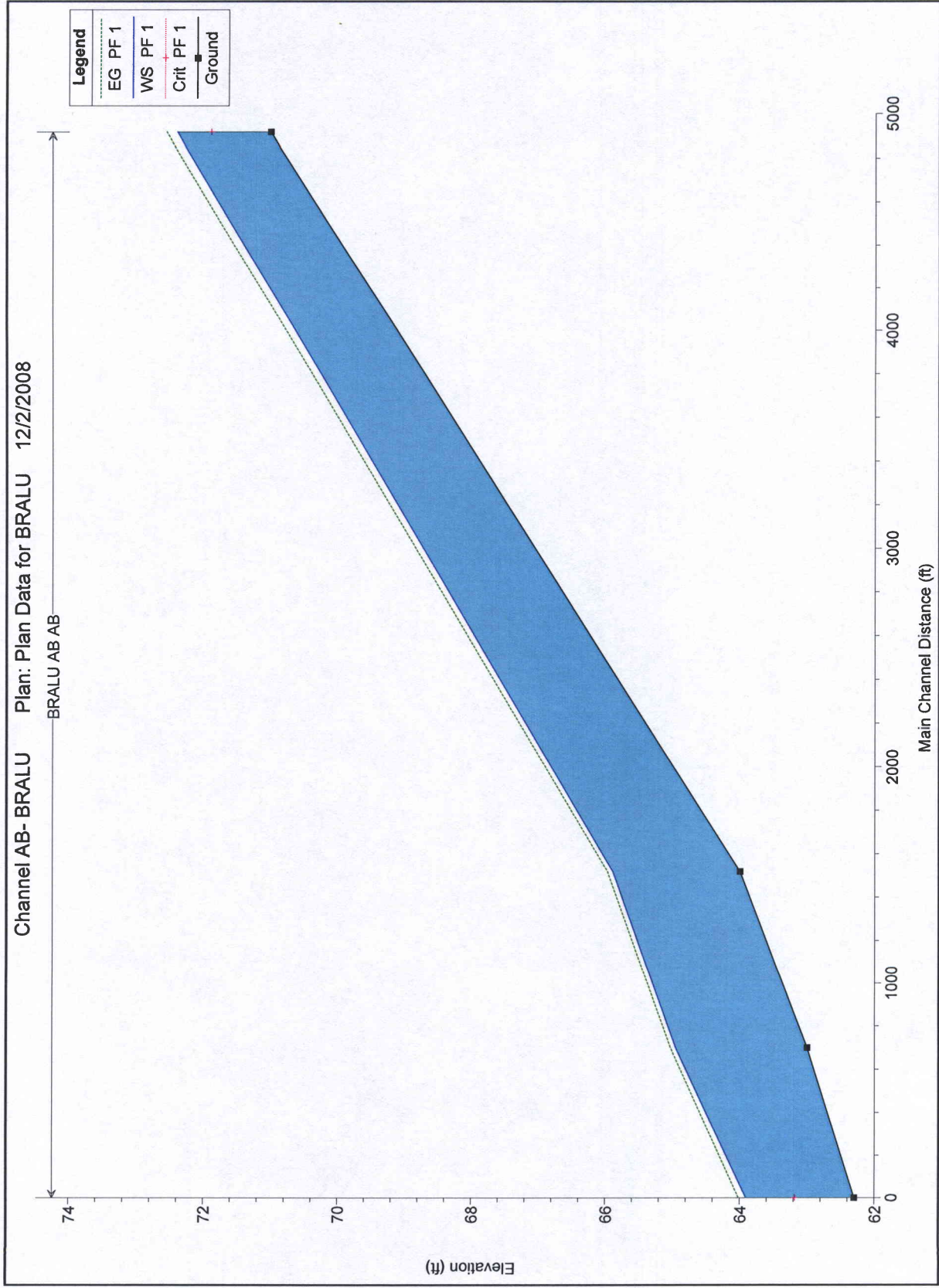
HEC-RAS SECTIONS- OFFSITE DISCHARGE HYDRAULICS



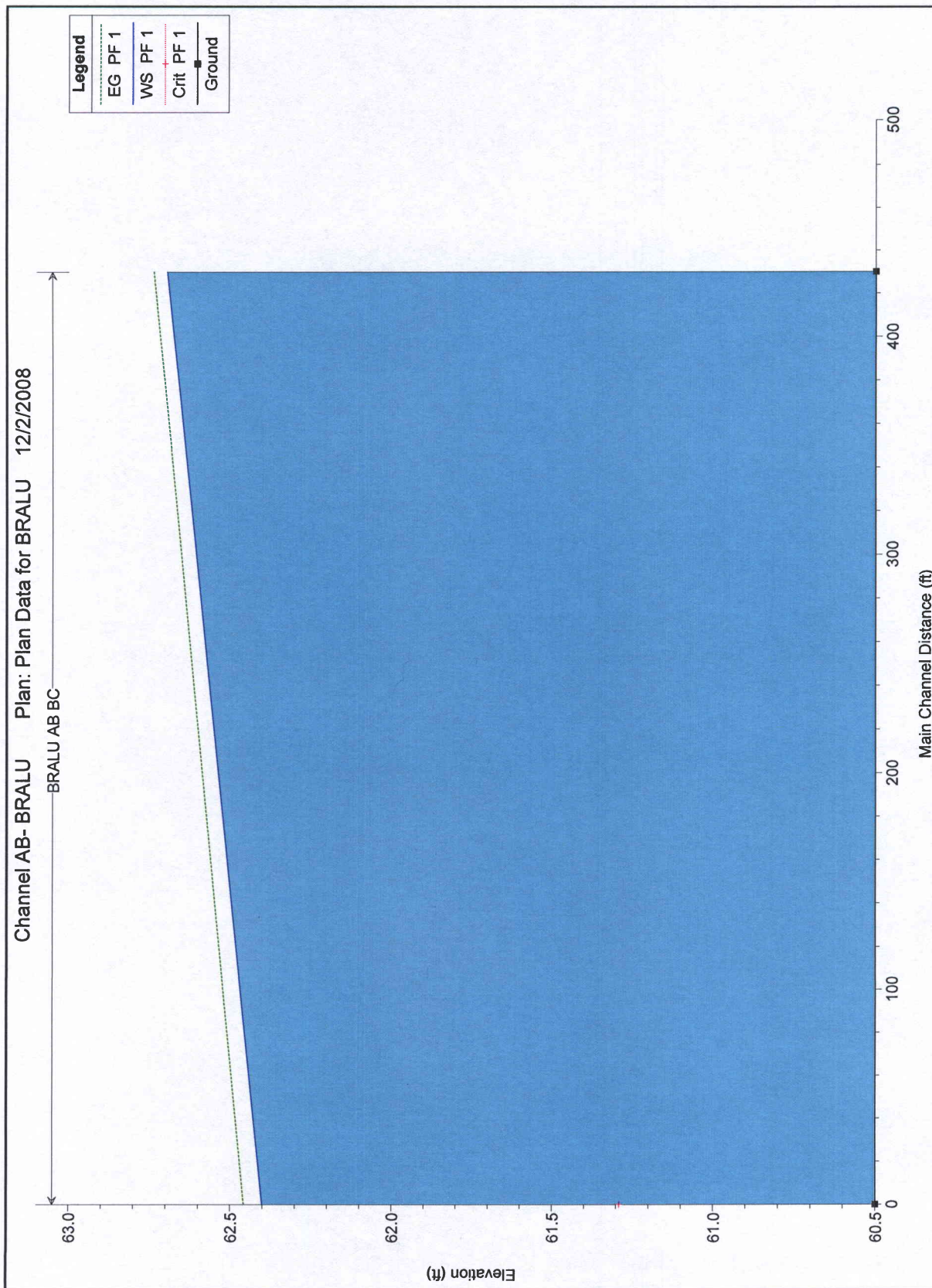
-MODELED ONLY TO DEMONSTRATE HYDRAULIC CHARACTERISTICS--
EQUIVALENT SYSTEM IN FINAL DESIGN ALSO ACCEPTABLE



-MODELED ONLY TO DEMONSTRATE HYDRAULIC CHARACTERISTICS-
EQUIVALENT SYSTEM IN FINAL DESIGN ALSO ACCEPTABLE



-MODELED ONLY TO DEMONSTRATE HYDRAULIC CHARACTERISTICS -
EQUIVALENT SYSTEM IN FINAL DESIGN ALSO ACCEPTABLE

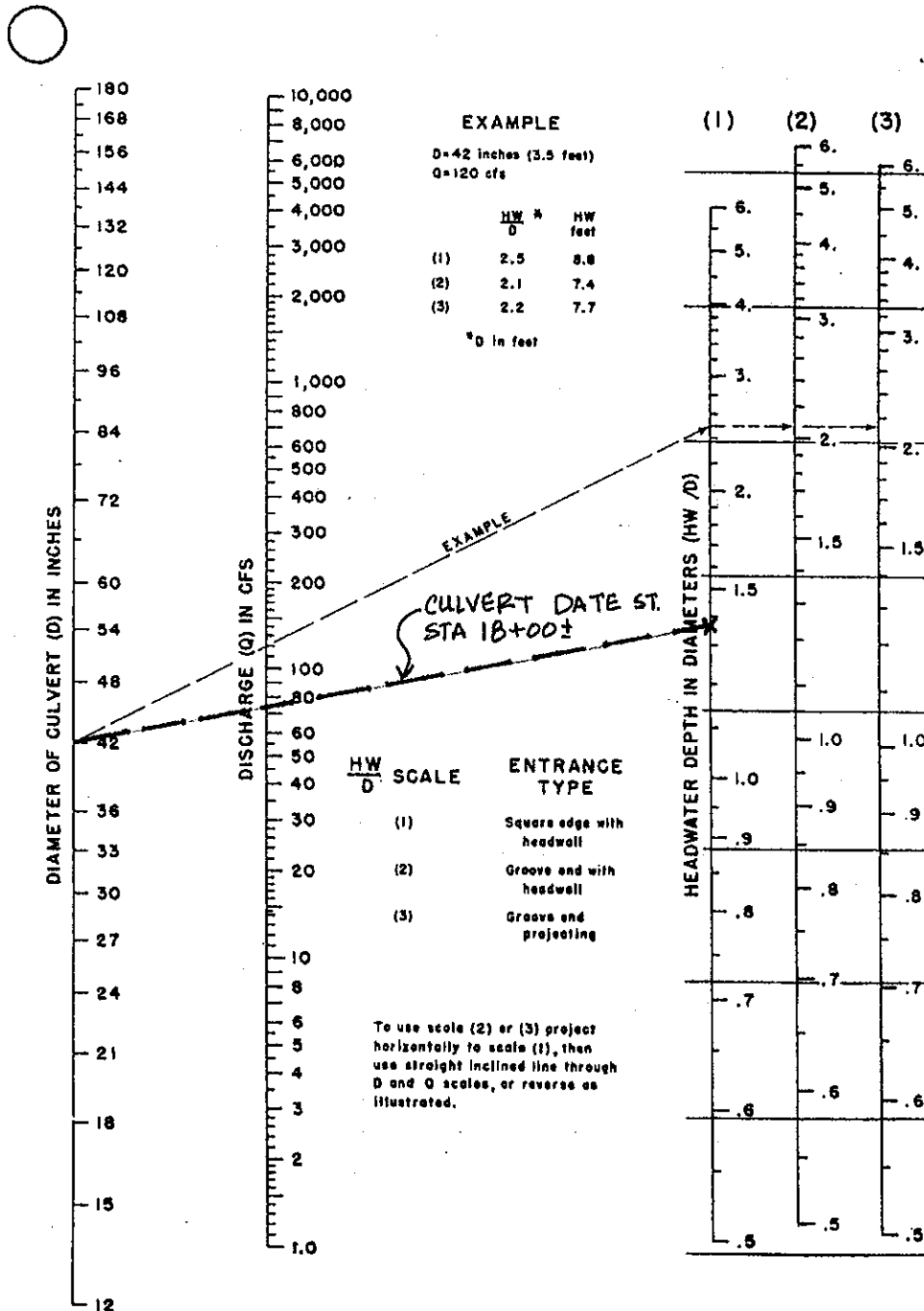


-MODELED ONLY TO DEMONSTRATE HYDRAULIC CHARACTERISTICS -
EQUIVALENT SYSTEM IN FINAL DESIGN ALSO ACCEPTABLE

HEC-RAS Plan: BRALU PLAN Profile: PF 1

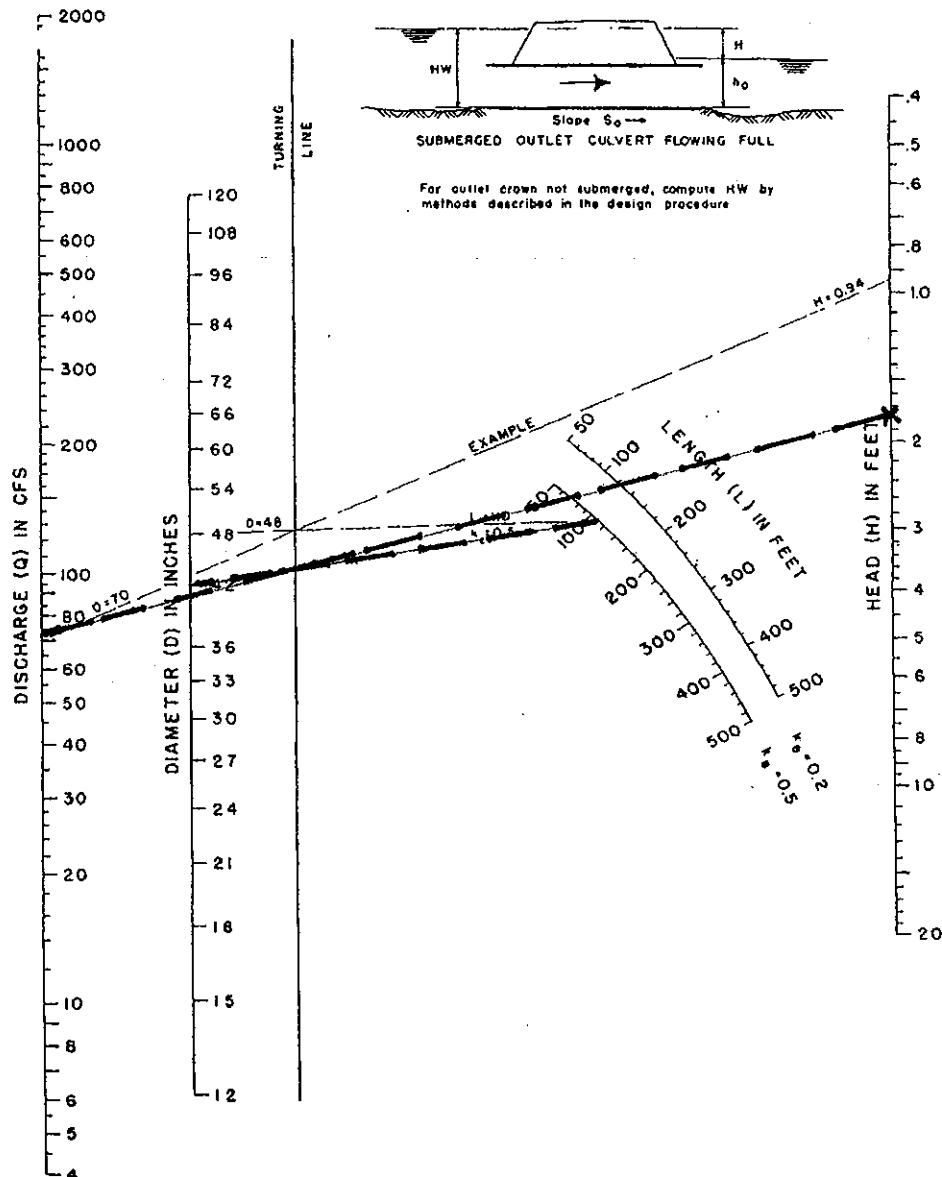
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
BC	530	PF 1	219.00	60.50	62.70		62.74	0.000511	1.61	135.65	70.57	0.21
BC	100	PF 1	219.00	60.50	62.40	61.29	62.46	0.000842	1.90	115.14	68.20	0.26
AB	4720	PF 1	219.00	71.00	72.39	71.89	72.55	0.003499	3.18	68.96	55.13	0.50
AB	1320	PF 1	219.00	64.00	65.89		65.97	0.001220	2.25	97.33	59.10	0.31
AB	800	PF 1	219.00	63.00	64.95		65.02	0.001088	2.17	101.09	59.61	0.29
AB	100	PF 1	219.00	62.30	63.90	63.18	64.01	0.002002	2.61	83.90	59.24	0.39

FIGURE 5.20
INLET CONTROL HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS
 (USDOT, FHWA, HDS-5, 1985)

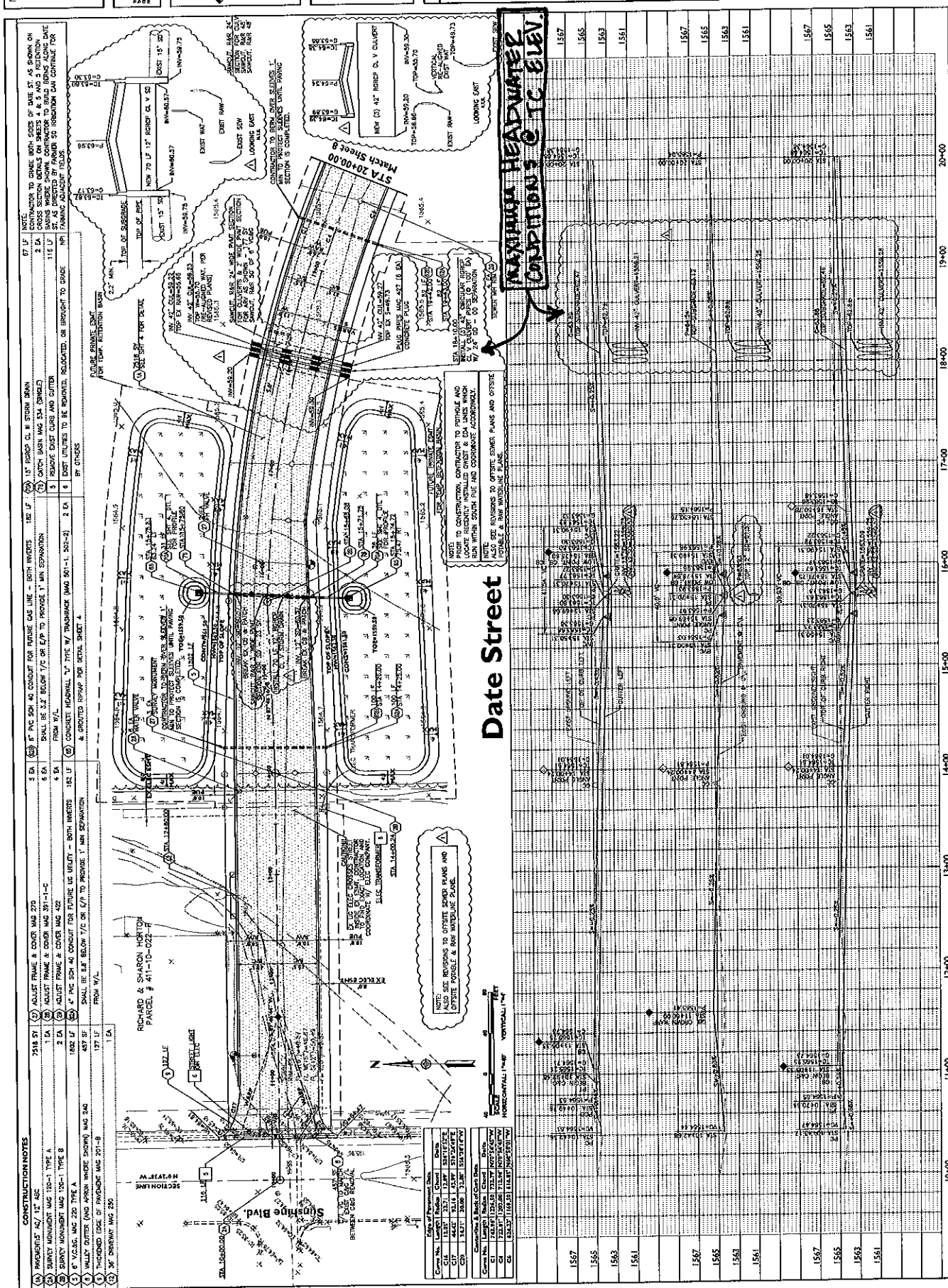


PROPOSED CULVERT: 3X 42" RARCP CI V PIPE
 I.C. HW d = 4.83' ±

FIGURE 5.24
HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL
 $n = 0.012$
 (USDOT, FHWA, HDS-5, 1985)



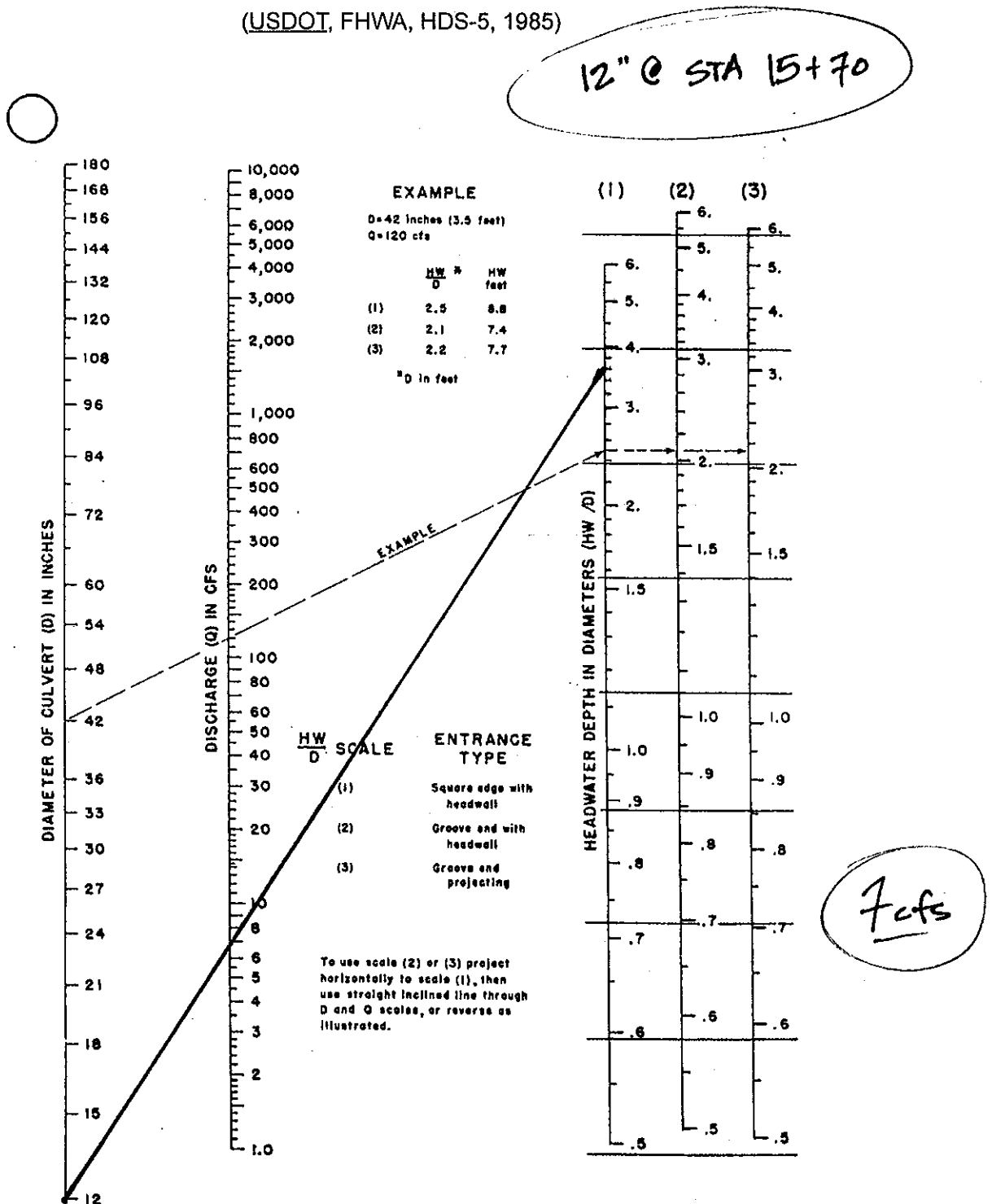
PROPOSED CULVERT: 3X 42" PERCP CI V PIPE
 OC HW d = 5.30' ±
 GOVERNING CONDITION: OUTLET CONTROL



APPENDIX G

INTERIM CONDITIONS- OFFSITE RUNOFF

FIGURE 5.20
INLET CONTROL HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS
 (USDOT, FHWA, HDS-5, 1985)



HW @ 6" WEIR OVER DATE STREET = 3.6'

DATE STREET

INTERIM CONDITION 100-YR. WEIR OVERTOP @ 8" MAX.

MAX. WEIR ELEV. = 64.34

STA 1 = 13+03

STA 2 = 18+19

$$L = (1819 - 1303) = 516'$$

$$Q = CLH^{1.5}$$

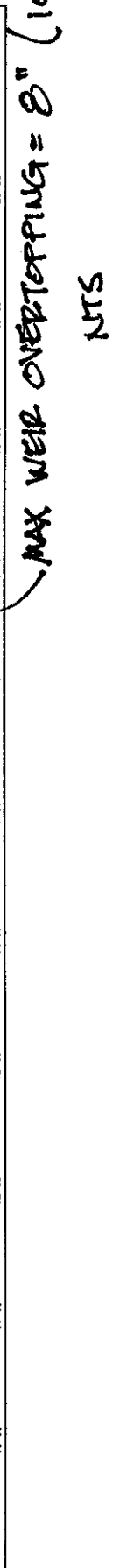
$$Q = 2.8 * 516 * (0.67/2)^{1.5} =$$

$$Q = 280 \text{ cfs (CAPACITY @ 8")}$$

$$\text{REQUIRED} = 212 \text{ cfs}$$

∴ ROAD WEIR WILL OPERATE AT A DEPTH LESS THAN 8" TO CONVEY 212 cfs.

WHERE: $C = 2.8$
 $L = 516'$
 $H = 8"/2$ (TRIANGULAR WEIR)



APPENDIX H

ON-SITE DRAINAGE: RUNOFF& RETENTION

RETENTION REQUIRED

Bralu Property

*Runoff volume calculations based on 100-year, 2-hour storm.

*100-year, 2-hour rainfall depth = 2.80 in

Drainage Area 'A'

Catchment Area	Runoff Coeff. (C_w)	Rainfall Depth (ft)	Area (ac)	Volume (ac-ft)
Composite Site Area	0.90	0.23	66.6	13.99
Total Retention Required				13.99

Drainage Area 'B'

Catchment Area	Runoff Coeff. (C_w)	Rainfall Depth (ft)	Area (ac)	Volume (ac-ft)
Composite Site Area	0.90	0.23	13.6	2.86
Total Retention Required				2.86

Drainage Area 'C'

Catchment Area	Runoff Coeff. (C_w)	Rainfall Depth (ft)	Area (ac)	Volume (ac-ft)
Composite Site Area	0.90	0.23	159.8	33.56
Total Retention Required				33.56

Drainage Area 'D'

Catchment Area	Runoff Coeff. (C_w)	Rainfall Depth (ft)	Area (ac)	Volume (ac-ft)
Composite Site Area	0.90	0.23	10.0	2.10
Total Retention Required				2.10

Refer to The Drainage Exhibit



RETENTION PROVIDED

Bralu Property

BASIN A

	Area (ft²)	Area (ac)	Avg Area (ac)	Depth (ft)	Volume (ac-ft)
HW	201456	4.62			
TOE	84305	1.94	3.28	8	26.24

BASIN B

	Area (ft²)	Area (ac)	Avg Area (ac)	Depth (ft)	Volume (ac-ft)
HW	7716	0.18			
TOE	3817	0.09	0.13	3	0.40

Refer to The Drainage Exhibit

TOTAL = 15.50

