P-15/D2

Bohannan ▲ Huston INC.

Courtyard I
7500 Jefferson St. NE
Albuquerque, NM
87109-4335
www.bhinc.com
voice: 505.823.1000
facsimile: 505.798.7988
toll free: 800.877.5332

CLIENT/COURIER TRANSMITTAL

File
P15/D2

To: Brad Bingham
PO Box 1293
Albuquerque, NM 87103

Requested by: Scott Armstrong

Date: August 4, 2004

Time Due:
- ☒ This A.M.
- ☐ This P.M.
- ☐ Rush _____
- ☐ By Tomorrow

Phone: (505) 924-3986

Job No.: 050019

Job Name: University Blvd.

DELIVERY VIA

- ☐ Courier
- ☐ Federal Express
- ☒ Mail
- ☐ UPS
- ☐ Other ____

PICK UP

Item:

Item No.	Quantity	Description
1	1	Meeting Minutes from Tijeras Arroyo Floodplain Meeting

COMMENTS / INSTRUCTIONS

Brad,

Attached are some meeting minutes from our meeting in early summer regarding the Tijeras Arroyo as it relates to the University Blvd. Extension Project.

Please review and if you have any questions, please call me at 798-7832.

Thanks
Scott

REC'D BY: _____ ***DATE:*** _____ ***TIME:*** _____

P:\050019\Hydro\corres\Transmittals\trans-BradB.doc

ENGINEERING ▲
SPATIAL DATA ▲
ADVANCED TECHNOLOGIES ▲

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MEETING MEMORANDUM

TO: BRIAN KENT – BERNALILLO COUNTY FLOODPLAIN MANAGER
BRAD BINGHAM - CITY OF ALBUQUERQUE FLOODPLAIN MANAGER

FROM: SCOTT ARMSTRONG, P.E.
BOHANNAN HUSTON, INC.

RE: MISCELLANOUS FLOODPLAIN / CLOMR ISSUES
UNIVERSITY BLVD/RIO BRAVO BLVD EXTENSION
COA PROJECT NO. 732502
BHI PROJECT NO. 050019

The following memo summarizes the discussions that occurred during our May 26, 2004 meeting at the City offices. The meeting was attended by:

Brian Kent	Bernalillo County Floodplain Manager
Brad Bingham	City of Albuquerque Floodplain Manager
Craig Hoover	Bohannan Huston, Inc. - V.P.
Scott Armstrong	Bohannan Huston Inc. - Project Manager

The purpose of the meeting was to discuss issues related to the Tijeras Arroyo bridge crossing and resulting floodplain revisions that will be required as part of this project. Following is a brief summary of the comments and discussions:

1. Discussed / overview of design approach – see attached handouts
   a. Earth transitions to existing geometry downstream and on south bank, upstream of bridge
   b. Hardened Bank u/s on north bank
   c. Guide Bank upstream on south bank
   d. Concrete lined channel (50' u/s of bridge deck, 30' d/s of bridge deck)
   e. Brad suggested that the City will maintain the bridge and earth transitions
   f. Therefore wants design maintenance free - Need to harden / wrap d/s embankments around abutments

2. BHI noted the HEC RAS model still require some revision – may affect BFE, freeboard, etc. discussed below

3. Discussed proposed Base Flood Elevation (water surface) changes based on current HEC RAS model
   a. Quantification
      i. 50' U/s roadway CL – Q500 WSE is 3.7' above existing conditions, Q100 is 2.7' above existing
      ii. 100' D/s of roadway CL –Q500 WSE is 3.57' above existing, Q100 is 2.94' above existing
   b. Potential Issues
      i. Craig mentioned that we have had recent comments from FEMA on other projects stating that we needed justification for raising the BFE > 1' and that the justification can NOT be cost savings.
      ii. FEMA may require that we identify and dismiss other options: e.g. a) COA won't allow dip section, and b) Los Picaros under serves the area. Therefore, University is required.
      iii. Brad seemed to think we can get approval from FEMA even though we would be raising the BFE >1'.
         1. Brad suggested we get letters of Endorsement from the City and Co. prior to submitting to FEMA.
         2. Brad suggested that we contact FEMA to get the appropriate text for the CLOMR submittal.

3. We can present it as good for community – public infrastructure (vs. private developer).
4. Potentially get letter from adjacent landowners agreeing to increase in BFE.
5. Obviously cost savings to community can be toted as well.

iv. Brian noted that Bern. Co. would accept the increase in BFE as long as FEMA approved the CLOMR. He noted that the increase would have to return to the original BFE at some point downstream.

4. Discussed Proposed Freeboard – based on current HEC RAS model
   a. Proposed Conditions – 50' u/s Q500 = 7.23' FB; 100' u/s Q500 = 7.29' FB
   b. Future Conditions - Mussetter's Draft report anticipates the d/s limiting area will aggrade ~ 12'
      i. Therefore, the resulting Q500 WSE at the bridge would increase ~ 1.5'
      ii. W/ anticipated aggradation – 50' u/s Q500 = 5.69' FB

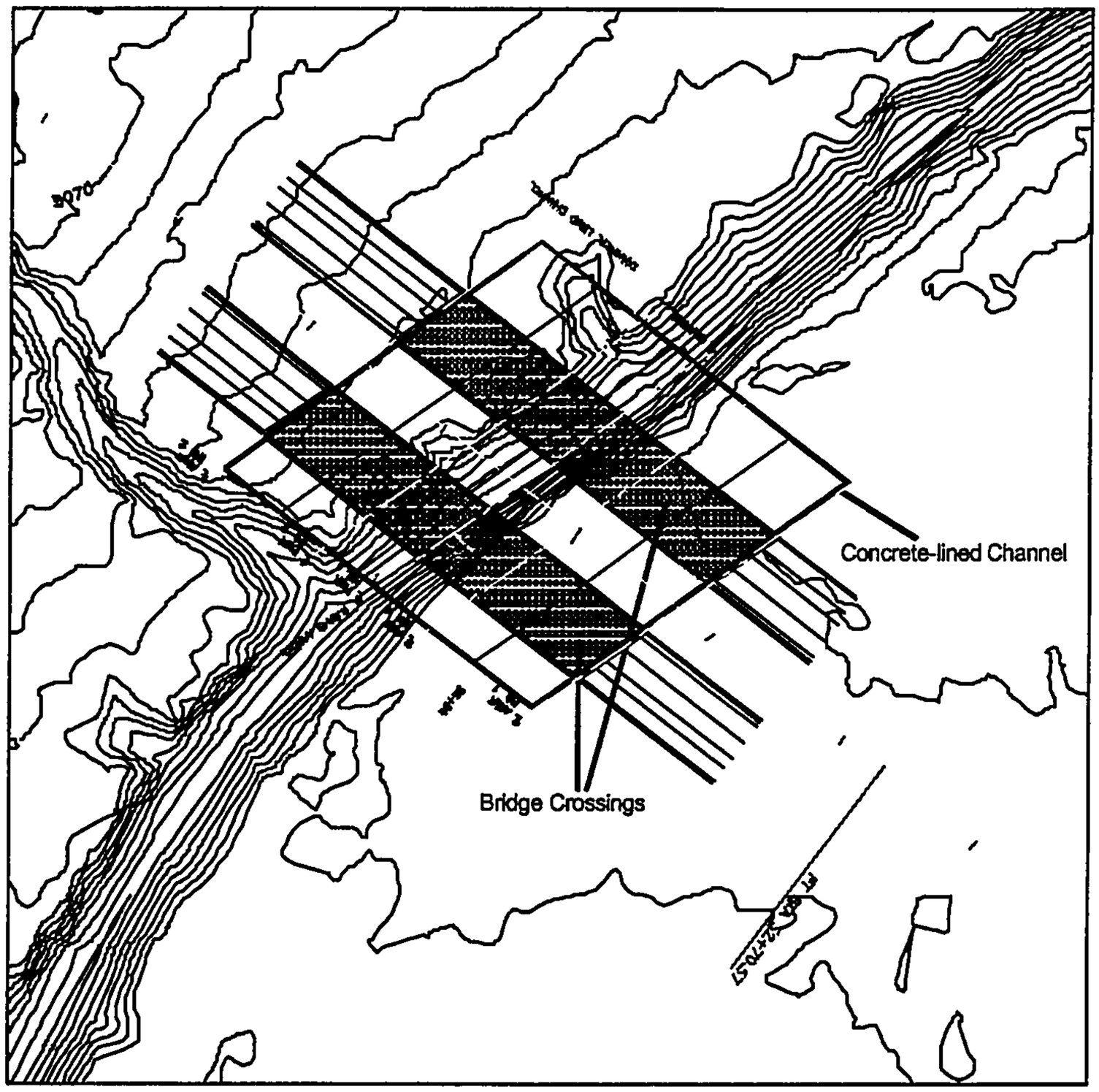
5. Discussed potential scour from Mussetter report
   a. U/s end of concrete = 3' D/s end of concrete = 5'
   b. Hardened north bank u/s = 9.5' Guide bank u/s = 9.0'
   c. If the sediment supply decreases 50%, Mussetter stated that you could get 14' of scour d/s of the bridge

6. Discussed and reviewed floodplain limits
   a. Existing floodplain - Arroyo has moved significantly since last FEMA study (1983?)
   b. Proposed floodplain - New floodplain d/s bridge greatly expanded from existing
      i. Approx. 3000' d/s before it ties back into existing
   c. Brad mentioned that URS is contracted w/ FEMA to revise the FIS in October 2004. He suggested that we check to see if the Tijeras is on the list of areas being revised.
   d. Brad suggested that we verify we are matching the FIS flow rates.
   e. Brad mentioned that the CLOMR submittal will require a two distinct parts
      i. Address floodplain revisions to existing conditions, and
      ii. Address proposed floodplain revisions

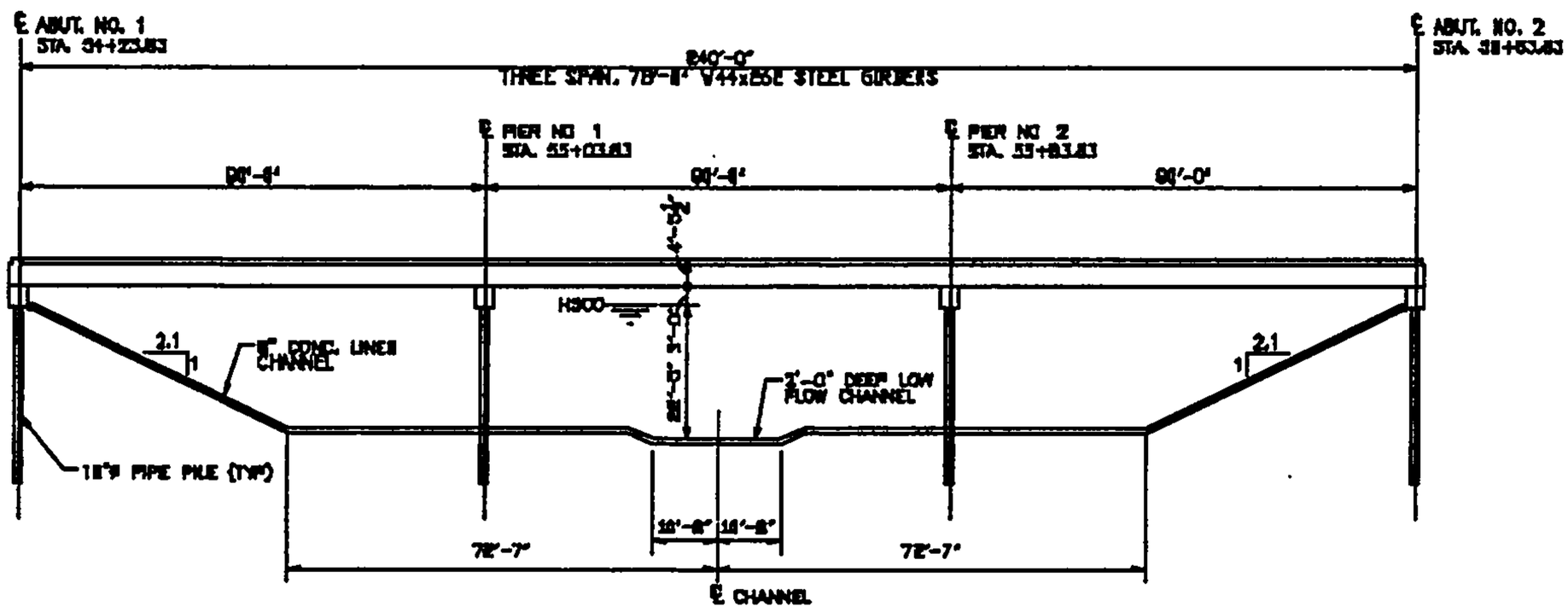
7. Discussed strategy to get CLOMR approved by FEMA
   a. Officially Bern Co. (Brian Kent) is the contact person. Brad will act in a review capacity.
   b. Need to define / verify FEMA criteria
   c. Get Brad B. and Brian Kent's input and suggestions prior to FEMA submittal to avoid potential problems
   d. CLOMR may require notification of adjacent landowner
      i. Need to be proactive w/ Valle del Sol property owner – get Raymond Hensley involved upfront
      ii. Need to send registered letter notifying them of proposed changes

8. Discussed risk of designing / building w/ known potential problems w/ FEMA BFE increases
   a. Brad stated that he fully supports the plan and acknowledge the potential risk.
   b. It was discussed that FEMA can't stop construction, although they could deny CLOMR
   c. It was discussed that we need to get input from Suzzane B.

cc: Attendees
Jerry Parker – BHI (w/ attachments)
Suzanne Busch – COA (w/ attachments)
SMA/



Plan



Profile

Figure 1.12. Plan and profile views of proposed University Boulevard bridge crossing of Tijeras Arroyo.

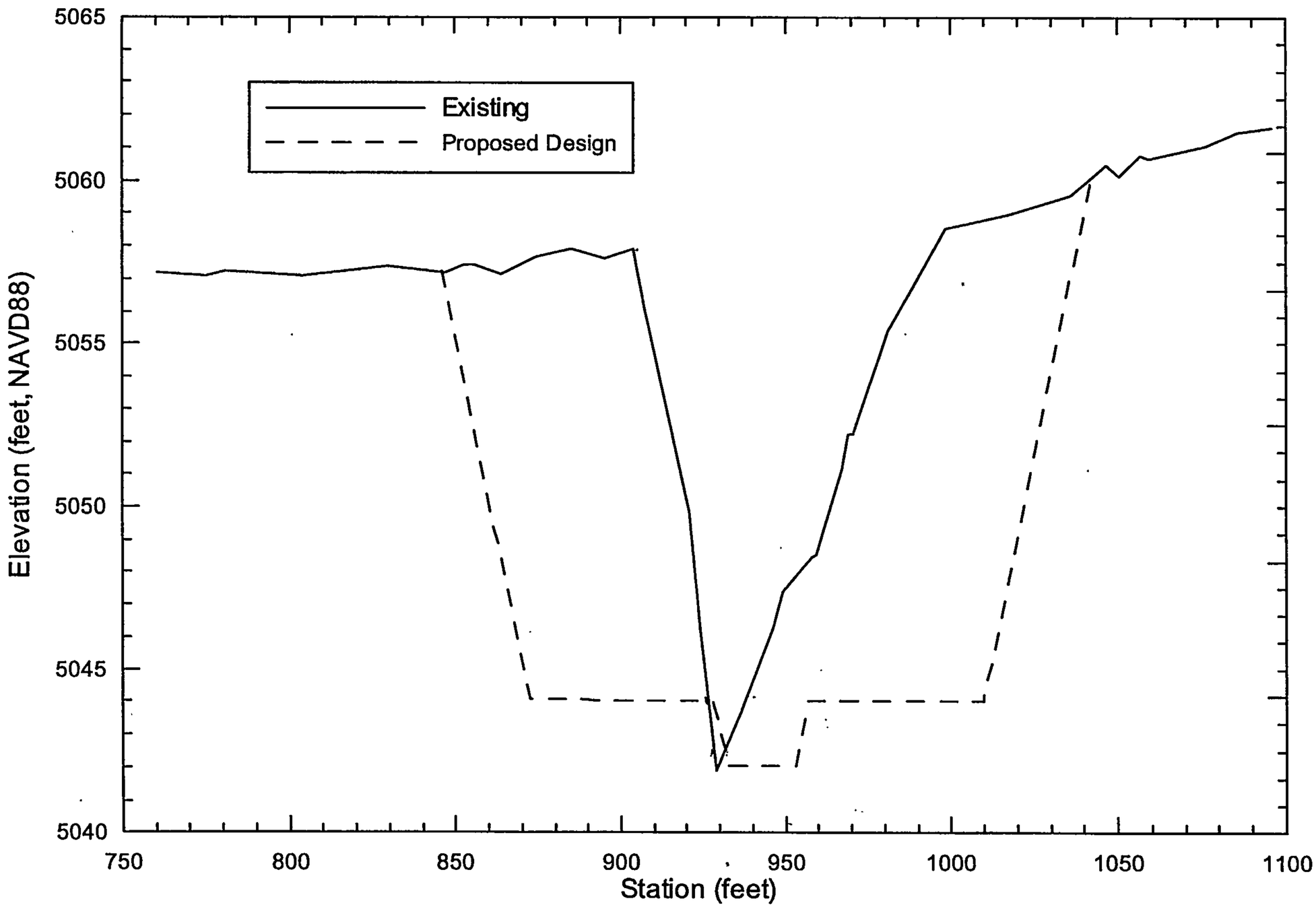


Figure 1.13. Proposed widening of Tijeras Arroyo at the proposed University Boulevard bridge crossing.

Figure 5.1. Proposed scour countermeasures and unlined channel transitions in the vicinity of the bridge.

CITY OF
Albuquerque

October 11, 1996

Martin J. Chávez, Mayor

Joe Kelley
Chavez-Grieves
5639 Jefferson NE
Albuquerque, NM 87109

RE: ETHICON STERILIZATION BUILDING (P15-D1). ENGINEER'S CERTIFICATION FOR CERTIFICATE OF OCCUPANCY. ENGINEER'S CERTIFICATION DATED SEPTEMER 26, 1996.

Dear Mr. Kelley:

Based on the information provided on your September 27, 1996 submittal, please address the following comments:

1. A drawing with an Engineer's stamp date of July 2, 1996 was approved for Building Permit. The Engineer's stamp date on this drawing is September 26, 1996. This is not the same plan that the Hydrology Division approved. Coincedentaly, you Engineer's Certification date is September 26, 1996.

2. The Engineer's Certification must include your stamp (dated and signed).

3. I need some indication that the finish floor elevation was "shot."

4. Who did the as-built survey on this project?

If I can be of further assistance, please feel free to contact me at 768-3622.

Sincerely,

Lisa Ann Manwill
Engineering Assoc./Hyd.

c: Andrew Garcia
File

CITY OF
Albuquerque

Martin J. Chávez, Mayor

October 30, 1996

Joe Kelley
Chavez-Grieves
5639 Jefferson NE
Albuquerque, NM 87109

RE: ETHICON STERILIZATION BUILDING (P15-D1). ENGINEER'S CERTIFICATION FOR CERTIFICATE OF OCCUPANCY. ENGINEER'S CERTIFICATION DATED 9-26-96.

Dear Mr. Kelley:

Based on the information provided on your October 24, 1996, the above referenced project is approved for Certificate of Occupancy.

If I can be of further assistance, please feel free to contact me at 768-3622.

Sincerely,

Lisa Ann Manwill
Engineering Assoc./Hyd.

c: Andrew Garcia
File

CHAVEZ · GRIEVES
CONSULTING ENGINEERS, INC.
THE ENGINEERING FIRM OF CHOICE
5639 JEFFERSON STREET NE · ALBUQUERQUE, NEW MEXICO 87109 · PHONE (505) 344-4080 · FAX (505) 343 8759

GRADING AND DRAINAGE PLAN

FOR

ETHICON ENDO-SURGERY

GAMMA IRRADIATION ADDITION

ALBUQUERQUE, NEW MEXICO

NOVEMBER, 1995

CHAVEZ · GRIEVES
CONSULTING ENGINEERS, INC.
THE ENGINEERING FIRM OF CHOICE

5639 JEFFERSON STREET NE · ALBUQUERQUE, NEW MEXICO 87109 · PHONE (505) 344·4080 · FAX (505) 343·8759

GRADING AND DRAINAGE PLAN

ETHICON ENDO-SURGERY

GAMMA IRRADIATION ADDITION

November 1995

RECEIVED
NOV 16 1995

ENGINEER'S STATEMENT

I certify that I am a Registered Professional Engineer in the State of New Mexico and that this report was prepared by me or under my supervision. I have personally inspected this land, and it appears that no grading, filling, or excavation has occurred thereon since the existing contour map was prepared.

Joe P. Kelley 11/13/95

JOE P. KELLEY
NEW MEXICO
9996
REGISTERED PROFESSIONAL ENGINEER

LOCATION

This site is located in South Albuquerque between I-25 and University Blvd. It is the site of an existing manufacturing facility.

LEGAL DESCRIPTION

Tract B, Lands of UNM.

ZONING AND SURROUNDING DEVELOPMENT

The site is zoned M-2, and has been developed in accordance with this designation. The site is the site of the Ethicon manufacturing facility. The University South golf course abuts the site on the north, I-25 abuts the site on the west, and University Blvd abuts the site on the east and south.

FLOOD HAZARD ZONES

As shown by Panel 3500020041 of the National Flood Insurance Rate Maps for the City of Albuquerque, dated October 14, 1983, the site is not in a designated flood hazard zone.

RELATED REPORTS

Drainage reports for this site are on record at City Hydrology. The original report for the Ethicon site was dated 10/18/79 by Jeryl D. Hart, Jr. Subsequent reports have been submitted that cover the entirety of the Ethicon site as it has developed through the years. The latest City submittal for Ethicon was the Engineers Certification for the new storage facility addition by Mark Holstad, dated 5/12/94.

EXISTING SITE CONDITIONS AND DRAINAGE PATTERN

The site is an existing manufacturing facility in an area of town that is primarily undeveloped. The Ethicon site has been developed as a large manufacturing building with large paved parking areas. The parking lots and roofs collect the runoff, and then discharge it to underground storm drains, which collect the runoff and discharge it to surface channels that discharge the runoff off-site. Visual inspection of these facilities shows that they are behaving in an acceptable manner. There has been some erosion at the outlets of some of the drainage facilities, but not to a degree that renders them useless

or endangers downstream properties. This erosion is on Ethicon property, and it is Ethicon's responsibility to maintain these outlets.

PROPOSED SITE CONDITIONS AND DRAINAGE PATTERN

The proposed drainage pattern is the same as the existing pattern. The only difference between existing and developed conditions will be that a building will be constructed in an existing asphalt parking lot in developed Basin B, as shown on the master drainage plan for Ethicon (at City Hydrology). This new building will not result in an increase in the amount of runoff, so no measures will be taken to control runoff downstream.

HYDROLOGY

The drainage design has been done in accordance with Section 22.2 of the Development Process Manual of the City of Albuquerque, January 1993. The new building addition makes no change in the amount of runoff from the site.

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

September 16, 1999

Mark Holstad, P.E.
URS Griener Woodward Clyde
5971 Jefferson Blvd. NE, Suite 101
Albuquerque, New Mexico 87109

RE: ETHICON ENDO-SURGERY (P15-D1). GRADING AND DRAINAGE PLAN FOR PARKING LOT EXPANSION FOR BUILDING PERMIT APPROVAL. ENGINEER'S STAMP DATED JULY 20, 1999. ORIGINALLY STAMPED OCTOBER 18, 1979.

Dear Mr. Holstad:

Based on the information provided on your July 21, 1999 submittal, the above referenced project is approved for Building Permit. As noted by the Original Stamp Date, this is a long established commercial site. The parking lot expansion does not appreciably alter runoff patterns/volumes.

Please attach a copy of this approved plan to the construction sets prior to sign-off by Hydrology.

Prior to Certificate of Occupancy approval, an Engineer's Certification per the DPM will be required.

Enclosed is a copy of the City Consultant's comments. No specific response to them is required for project approval.

If I can be of further assistance, please feel free to contact me at (505) 924-3984.

Sincerely,

John P.Murray, P.E.
Hydrology

c: File
WR

Mark H. Burak, P.E.

1512 Sagebrush Trail SE Albuquerque, NM 87123 (505) 296-0461 235-2256 cell 296-0467 fax

August 16, 1999

Fred J. Aguirre, P.E., City Engineer
City of Albuquerque
600 2nd Street NW
Albuquerque, NM 87102

- ***Case No:*** P15 / D001
- ***Submittal dated:*** July 21, 1999 by Mark Holstad, URS-Greiner
- ***Project Title:*** Ethicon Endo-Surgery
- ***Address:*** 3801 University Blvd. SE
- ***Location:*** East of Rio Bravo, I-25 intersection
- ***Approval Type:*** drainage requirements

- ***Note:*** *This submittal concerns the parking lot expansion for an existing commercial development of a 12-ac site. The site utilizes a number of downstream detention basins based on an approved master plan dated 1979.*

Dear Mr. Aguirre:

Based on the submittal dated July 21, 1999, the proposed drainage plan can be approved for drainage requirements. Assuming that the calculations associated with the 1979 submittal are adequate when compared to the current DPM 22.2 standards, very few improvements to the plan may be necessary.

The following clarifications are requested for subsequent submittals:

- Topography is not clear. It appears that the subbasin boundaries for areas A1 and A2 do not follow the topography and may be larger than shown on the plan. Offsite OS-A and OS-D subbasins must be fully delineated and shown on the plan.

- The OS-D3 runoff appears to be diverted southwest in University Boulevard. Does University have adequate capacity? How does this runoff enter the roadway?

- The points where the storm drainage pipes release runoff may experience erosive outlet velocities. Are there any measures being taken to minimize scour in these areas?

- Each of the detention dam sites must be assessed and volume capacity calculations must be included in the plan.

- Additional hydrologic calculations need to be included to update the overall peak flow rates associated with each subbasin. Fully developed conditions must be addressed.

- An overall site plan with grading and topography shown would be very helpful in understanding the drainage patterns. Sheet 2 of 5 would be easier to understand if grading and topo were shown.

If you have any questions regarding this letter or need any clarification concerning the above project, please feel free to call me at 296-0461.

Sincerely,

Mark Burak

Mark H. Burak, P.E.
Hydrology Consultant

DRAINAGE INFORMATION SHEET

APPLICANT'S NAME: ETHICON ZONE ATLAS/DRNG. FILE #: P 15/D001

DRB #: NA EPC #: NA WORK ORDER #: NA

LEGAL DESCRIPTION: SEC 9, T9N, R 3E ALBUQUERQUE, NM

CITY ADDRESS: 3801 UNIVERSITY BLVD SE 87125

ENGINEERING FIRM: URS GREINER WOODWARD CLYDE CONTACT: MARK HOLSTAD / SHEILA JOHNSON

ADDRESS: 5971 JEFFERSON BLVD NE PHONE: (505) 345-3977

OWNER: ETHICON ENDO-SURGERY CONTACT: ED BAYLIS

ADDRESS: 3801 UNIVERSITY BLVD SE 87125 PHONE: 768-5222 ✓

ARCHITECT: NA CONTACT:

ADDRESS: PHONE:

SURVEYOR: URS GREINER W. C. CONTACT: SEE ABOVE

ADDRESS: SEE ABOVE PHONE: "

CONTRACTOR: UNKNOWN CONTACT:

ADDRESS: PHONE:

TYPE OF SUBMITTAL:

- ___ DRAINAGE REPORT
- X DRAINAGE PLAN
- ___ CONCEPTUAL GRADING & DRAINAGE PLAN
- ___ GRADING PLAN
- ___ EROSION CONTROL PLAN
- ___ ENGINEER'S CERTIFICATION
- ___ OTHER ___

PRE-DESIGN MEETING:

- ___ YES
- X NO
- ___ COPY PROVIDED

CHECK TYPE OF APPROVAL SOUGHT:

- ___ SKETCH PLAT APPROVAL
- ___ PRELIMINARY PLAT APPROVAL
- ___ S. DEV. PLAN FOR SUB'D APPROVAL
- ___ S. DEV PLAN FOR BLDG. PERMIT APPROVAL
- ___ SECTOR PLAN APPROVAL
- ___ FINAL PLAT APPROVAL
- ___ FOUNDATION PERMIT APPROVAL
- X BUILDING PERMIT APPROVAL
- ___ CERTIFICATE OF OCCUPANCY APPROVAL
- ___ GRADING PERMIT APPROVAL
- ___ PAVING PERMIT APPROVAL
- ___ S.A.D. DRAINAGE REPORT
- X DRAINAGE REQUIREMENTS
- ___ SUBDIVISION CERTIFICATION
- ___ OTHER ___ (SPECIFY)

DATE SUBMITTED: 21 July 1999

BY: MARK HOLSTAD, PE

ised 02/98

RECEIVED
JUL 21 1999
HYDROLOGY SECTION

URS Greiner Woodward Clyde

DRAINAGE SUMMARY & CALCULATIONS FOR ETHICON ENDO-SURGERY PARKING LOT EXPANSION

Ethicon Endo-Surgery wishes to expand their parking lot as shown on the attached plans. A Vicinity Map is shown on Figure 2. The site drainage was initially studied in a master plan titled "Drainage Report Ethicon/Johnson & Johnson, Property in Albuquerque, New Mexico" and dated October, 1979. This new expansion is in compliance with the master plan. The proposed parking lot drainage calculations are per City of Albuquerque DPM, Section 22.2 Hydrology.

The new parking lot is to the east of an existing parking area within Basin A6. Currently Basin A6 consists of some existing parking, grass landscaping and trees. The original drainage calculations were done using Rational Equation and per City criteria at the time. The "c" coefficient used then was 0.714 indicating some development was planned for the future, The original plan also called for Phase II parking in this area. See Report pages 1through 3 and Figure 2.

The new parking layout is shown in the construction plans included with these calculations.

The original report calculated 15.1 cfs for the 100 year storm in Basin A6. This was somewhat conceptual as no parking lot was designed at that time. As shown on Calculation Sheets 1 through 4, the actual areas of differing land treatments were measured and the intensity and "c" values were assigned per the City DPM. The end result was a Q100 of 15.2 cfs and a Q10 of 9.4 cfs.

Runoff from the new parking area will drain north through a concrete rundown to the driveway and west to an existing City Standard double "C " inlet. Flow drains into the inlet and through an existing storm drain line that will carry the flow to an existing arroyo on the north side of the site. Runoff in the arroyo drains west and is detained at a small detention dam built with the original Ethicon construction.

In the event that flow overtops the existing double C inlet, it will drain to the north through an existing parking lot with another drop inlet and, assuming this line is also full, flow will continue northward to the existing arroyo.

Attachments
Calculation Sheets 1-7
Copies from Original Report 1-3
Figure 2 from Original Report – Drainage Plan
Plan sheets 1-5

URS Greiner

Job ETHICON PKG. LOT | Project No. E30000032864 | Sheet 1 of 1

Description DRAINAGE | Computed By S Johnson | Date 25 June 1999

Per DPM, section 22.2 | Checked By H. Buckner | Date 13 July 1999

PROJECT IN ZONE ATLAS PAGE P-15

PRECIPITATION ZONE (2)

DESIGN STORM 100 YR - 6 HOUR
- RAINFALL DEPTH = 2.35" - Table A-2

NEW PARKING AREA S WITHIN BASIN A6 - 3.92 ac.

BASIN A6 WAS PLANNED FOR FUTURE PARKING
C USED WAS 0.714

CHECK ACTUAL DEVELOPMENT WITH PLANNED

IMPERVIOUS AREA

NEW - 0.8006 Ac.	→	0.8006
EXIST. LEVEL 3 - 61 x 427 = 26,047.00 □	=	0.5980 AC
EXIST LEVEL 2 - 61 x 452 = 27,572.00 □	=	0.6330 Ac
EXIST DRIVES - NORTH = 5400 □	=	0.1240 Ac
" " - SOUTH = 6625 □	=	0.1521 AC
SIDEWALKS CONNECTING LOTS = 2346 □ + RUNDOWN	=	0.0539 AC
		2.3616 Ac Imp
ROCK AREAS + STRIPS = 30,989 □	=	0.7114 Ac
LANDSCAPED AREAS - GRASS / TREES =		0.8470 Ac
		3.92 AC

URS Greiner

Job Ethicon | Project No. | Sheet 2 of 4
Description Hydrology | Computed By L. Johnson | Date 28 June 1999
Checked By H. Buckner | Date 13 July 99

per DPM table A-11 "C" values

100 yr storm - LAND TREATMENTS — 10 YR

D = 0.93 - IMPERVIOUS — 0.92

C = 0.62 - ROCK LANDSCAPING - 0.50

B = 0.45 - GRASS LANDSCAPING - 0.28

INTENSITY:

100 yr = 5.05 — 10 yr = 3.41

$Q = C I A$

$Q_{100} = (0.93)(5.05)(2.3616) + (.62)(5.05)(.7114) + (.45)(5.05)(.8470)$

$= 15.2$ cfs

$Q_{10} = (.92)(3.41)(2.3616) + (.50)(3.41)(.7114) + (.28)(3.41)(.8470)$

$= 9.4$ cfs

per MASTER DRAINAGE REPORT - Oct 1979

$Q_{100} = 15.1$ cfs → COMPARE TO CURRENT DEV. & METHOD - 15.2 (ok)
$Q_{10} = 7.5$ cfs → " " " " " 9.4

a little higher but within system capacity

URS Greiner

Job ETHICON PKG. Project No. E3 000000 32804 Sheet 3 of 7

Description RUNDOWN SIZING Computed By S Johnson Date 24 June 1999

Checked By _____ Date _____

NEW PARKING LEVEL, DRIVEWAY + LANDSCAPE AREA
DRAWING ID'D RUNDOWN
AREA
AREA OF NEW PAVEMENT

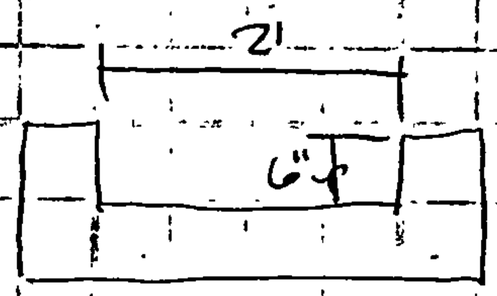
PARKING LOT ONLY → 32,026.25 □' = 0.7352 AC
DRIVEWAY: NEW PVMT → 2,848.00 □' = 0.0654 AC
~~LANDSCAPE AREA~~ →
0.8006 AC

ZONE ② - rainfall - 2.35'

peak discharge - parking lot only table A-9

excess precip = 4.70, treatment D

$Q_p = (4.70)(.7352ac) = 3.5$ cfs



USE 2' WIDE x 6" DEEP
SEE ATTACHED WORKSHEET

sheet 4 of 7

Worksheet
Worksheet for Rectangular Channel

Project Description	
Worksheet	PARKING LOT RUN DOWN
Flow Element	Rectangular Channe
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Slope	0.010000	ft/ft
Bottom Width	2.00	ft
Discharge	3.50	cfs — 100 yr

Results		
Depth	0.37	ft ← RUNDOWN IS 6" DEEP ok ✓
Flow Area	0.7	ft²
Wetted Perimeter	2.74	ft
Top Width	2.00	ft
Critical Depth	0.46	ft
Critical Slope	0.005281	ft/ft
Velocity	4.76	ft/s
Velocity Head	0.35	ft
Specific Energy	0.72	ft
Froude Number	1.38	
Flow Type	Supercritical	

Worksheet
Worksheet for Grate Inlet In Sag

Project Description	
Worksheet	Grate Inlet - 1
Type	Grate Inlet In Sag
Solve For	Spread

Input Data		
Discharge	24.50	cfs — MAX INFLOW TILL OVERTOPPING OCCURS
Gutter Width	2.00	ft
Gutter Cross Slope	0.060000	ft/ft
Road Cross Slope	0.018000	ft/ft
Grate Width	2.00	ft
Grate Length	6.39	ft
Local Depression	4.0	in
Local Depression Width	2.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	0.0	%

Results		
Spread	24.13	ft
Depth	0.85	ft
Gutter Depression	1.0	in
Total Depression	5.0	in
Open Grate Area	11.5	ft^2
Active Grate Weir Length	10.39	ft

Sheet 6 of 7

Worksheet
Worksheet for Circular Channel

Project Description	
Worksheet	18-INCH RCP - NORTH S
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.013	
Slope	0.029800	ft/ft
Diameter	18	in

Results		
Depth	1.50	ft
Discharge	18.13	cfs
Flow Area	1.8	ft²
Wetted Perimeter	4.71	ft
Top Width	0.00	ft
Critical Depth	1.45	ft
Percent Full	100.0	%
Critical Slope	0.026182	ft/ft
Velocity	10.26	ft/s
Velocity Head	1.64	ft
Specific Energy	3.14	ft
Froude Number	0.00	
Maximum Discharg	19.51	cfs
Discharge Full	18.13	cfs
Slope Full	0.029800	ft/ft
Flow Type	N/A	

Worksheet
Worksheet for Circular Channel

Sheet 7 of 7

Project Description	
Worksheet	24-INCH RCP - NORTH S
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.013	
Slope	0.220000	ft/ft
Diameter	24	in

Results		
Depth	2.00	ft
Discharge	106.10	cfs
Flow Area	3.1	ft²
Wetted Perimeter	6.28	ft
Top Width	0.00	ft
Critical Depth	2.00	ft
Percent Full	100.0	%
Critical Slope	0.215916	ft/ft
Velocity	33.77	ft/s
Velocity Head	17.73	ft
Specific Energy	19.73	ft
Froude Number	0.00	
Maximum Discharg	114.14	cfs
Discharge Full	106.10	cfs
Slope Full	0.220000	ft/ft
Flow Type	N/A	

ORIGINAL REPORT 1 of 3

DRAINAGE REPORT

ETHICON/JOHNSON & JOHNSON

PROPERTY IN

ALBUQUERQUE, NEW MEXICO

OCTOBER, 1979

MSM CONSULTANTS, INC.

Systems Planning Corporation

2601 Wyoming Boulevard NE

Albuquerque, New Mexico 87110

(505) 292-1936

ORIGINAL Report 2 of 3

TABLE 3

DEVELOPED FLOWS

Area Designated	Area in Acres	c factor	t_c min	DISCHARGE Q_{100}	DISCHARGE Q_{10}
A_1	8.41	.3	10	13.6	6.8
A_2	16.47	.312	10	27.8	13.8
A_3	2.08	.75	5	9.8	4.9
A_4	2.04	.81	5	10.4	5.2
A_5	4.0	.804	10	17.4	8.6
A_6	3.92	.714	10	15.1	7.5
A_7	0.68	.3	5	1.3	0.6
B_1	0.76	.3	5	1.4	0.7
B_2	4.23	.3	10	6.9	3.4
B_3	0.83	.9	5	4.8	2.4
B_4	2.82	.84	5	14.9	7.4
C	5.01	.3	10	8.1	4.0
D_1	11.73	.36	10	22.8	11.3
D_2	1.26	.35	10	2.4	1.2
E	2.57	.3	5	4.9	2.4
OS-A_2	12.0	.3	10	19.4	9.6
OS-A_3	4.5	.32	5	9.1	4.5
OS-A_7	0.83	.58	5	3.0	1.5
OS-a_2	1.4	.3	5	2.6	1.3
OS-D_2	1.7	.58	10	5.3	2.6
OS-D_3	11.5	.34	11.6	17.8	8.8
OS-D_4	21.7	.3	10	35.2	17.4
OS-E	1.16	.58	5	4.2	2.1
OS-B	0.71	.3	5	1.3	0.7
OS-C	0.28	.3	5	0.5	0.3
OS-D_1	0.83	.3	5	1.6	0.8

NO. 9990901

IGN STORM 10 YR. RECURRENCE INTERVAL

OR STORM 100 YR.

PUTATIONS BY D. MAIN DATE 10-3-79

CKD BY

DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

Area signation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f)	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	Δt (min)	
A6	3.92	.714			2.80		10	5.4	15.1				4%	555	4.0	2.31	Sheet flow
								2.68	7.5					280	5.6	.833	AT POINT 2
SA7	.83	.58			.48	0.68	5.0	6.3	4.3								AT POINT
A7	.67	.3			.20			3.14	2.1								e (INLET)
SA3	4.5	.32			1.44		5	6.3	9.1								AT POINT
								3.14	4.5								f (INLET)
SA2	12.0	.3			3.6		10	5.4	19.4				9.5	720	4.7	3.26	GRASSED WW AT POINT 1
								2.68	9.6								
OSA2 OSA3 OSA7 A7						5.72	10.59	5.3	30.3		30.3	36"	8%	600	17	.59	TO 2 AT
														110	"	.11	TO 3 POINT
								2.63	15.0					340	"	.33	TO 4 2
A6 THRU PIPE											15.1	24"	14	110	17	.11	TO 2
							.11										
OSA2,3,7 A7 A6					5.72	8.52	10.7	5.29	45.1		45.1	42"	8.0%				AT POINT
					2.80			2.62	22.3								2
A5 THRU PIPE							.11				17.9	24"	6.5	215	17	.21	
							.21										
OSA2,3,7 A5,6,7					322	11.74	11.02	5.25	61.6		61.6	42"	8%				AT POINT
								2.61	30.5								3

ORIG REPORT 3 of 3

CITY OF
Albuquerque

November 26, 1997

Martin J. Chávez, Mayor

Mark Holstad, P.E.
URS Greiner, Inc.
5971 Jefferson Blvd. NE
Albuquerque, NM 87109

RE: ETHICON GAS LINE PROTECTION (P15-D1). DRAINAGE PLAN REVISION FOR GRADING PERMIT. ENGINEER'S STAMP DATED 10-31-97.

Dear Mr. Holstad:

Based on the information provided on your October 31, 1997 submittal, the above referenced project is approved for grading permit. The City is only approving this plan for the hydrology design and makes no comment and does not take any responsibility for the gas line.

An Engineer's Certification will be required upon project completion.

If I can be of further assistance, please feel free to contact me at 924-3984.

Sincerely,

Lisa Ann Manwill, P.E.
Hydrology

c: Andrew Garcia
File

BUILD HEADWALLS PER NMSHTD SERIAL DWG H-1-61

APPROX. TOP OF EXIST. BANK

EXIST. 4" GAS LINE

6" MIN CLEAR

EXIST. SLOPE +/- 5%

APPROX. EXISTING FL. OF ARROYO

2 - 30" CMP

GRADE TO MEET EXISTING GROUND AT A SLOPE NOT EXCEEDING 12:1

SOIL COMPACTED TO 95%

6" GRAVEL FILTER

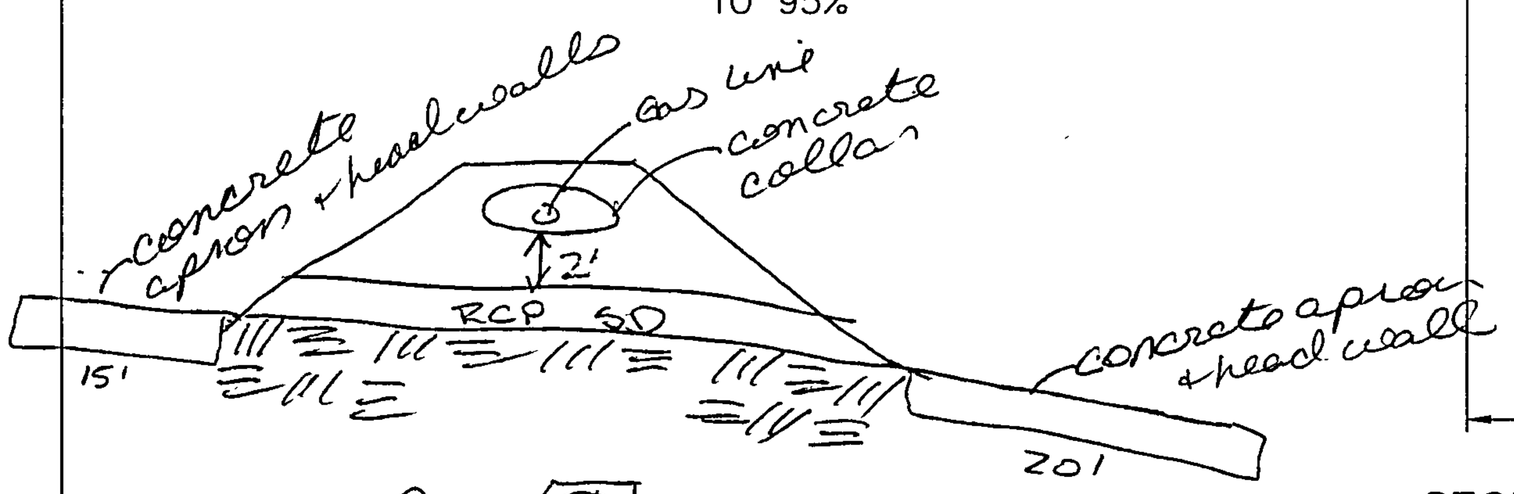
FILTER FABRIC

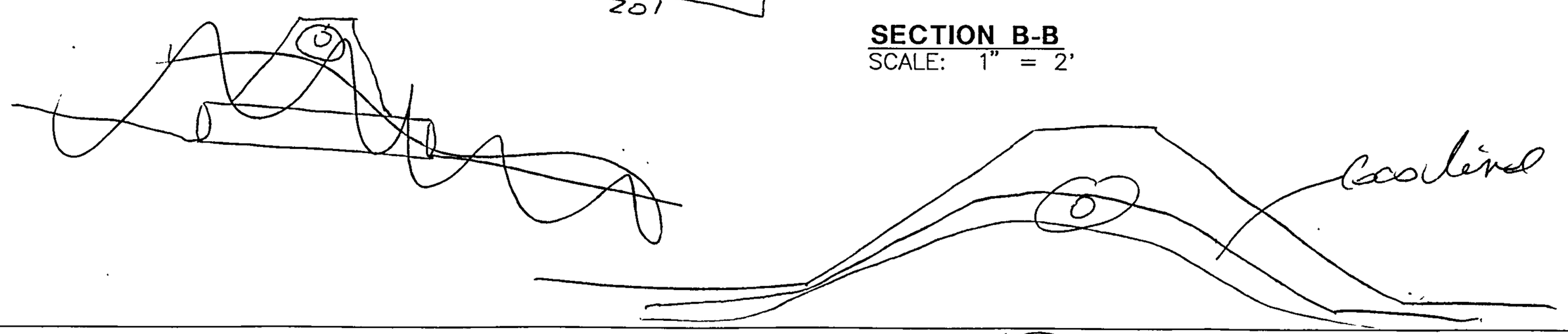
15' WIDE x 1.5' THICK DUMPED RIP RAP D_{50} = 6" PER COA STD SPEC 109

SOIL COMPACTED TO 90%

20'

SECTION B-B
SCALE: 1" = 2'





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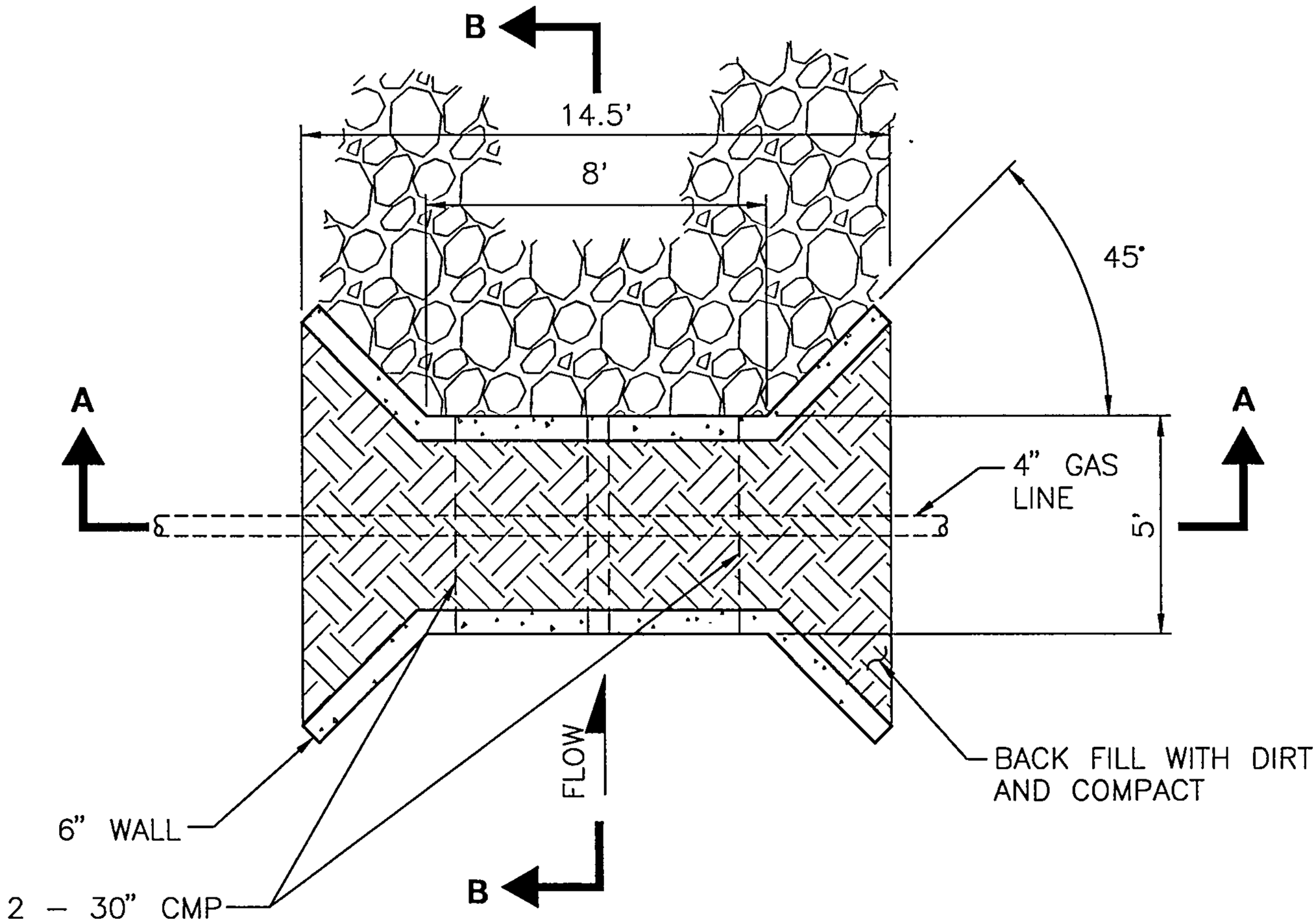
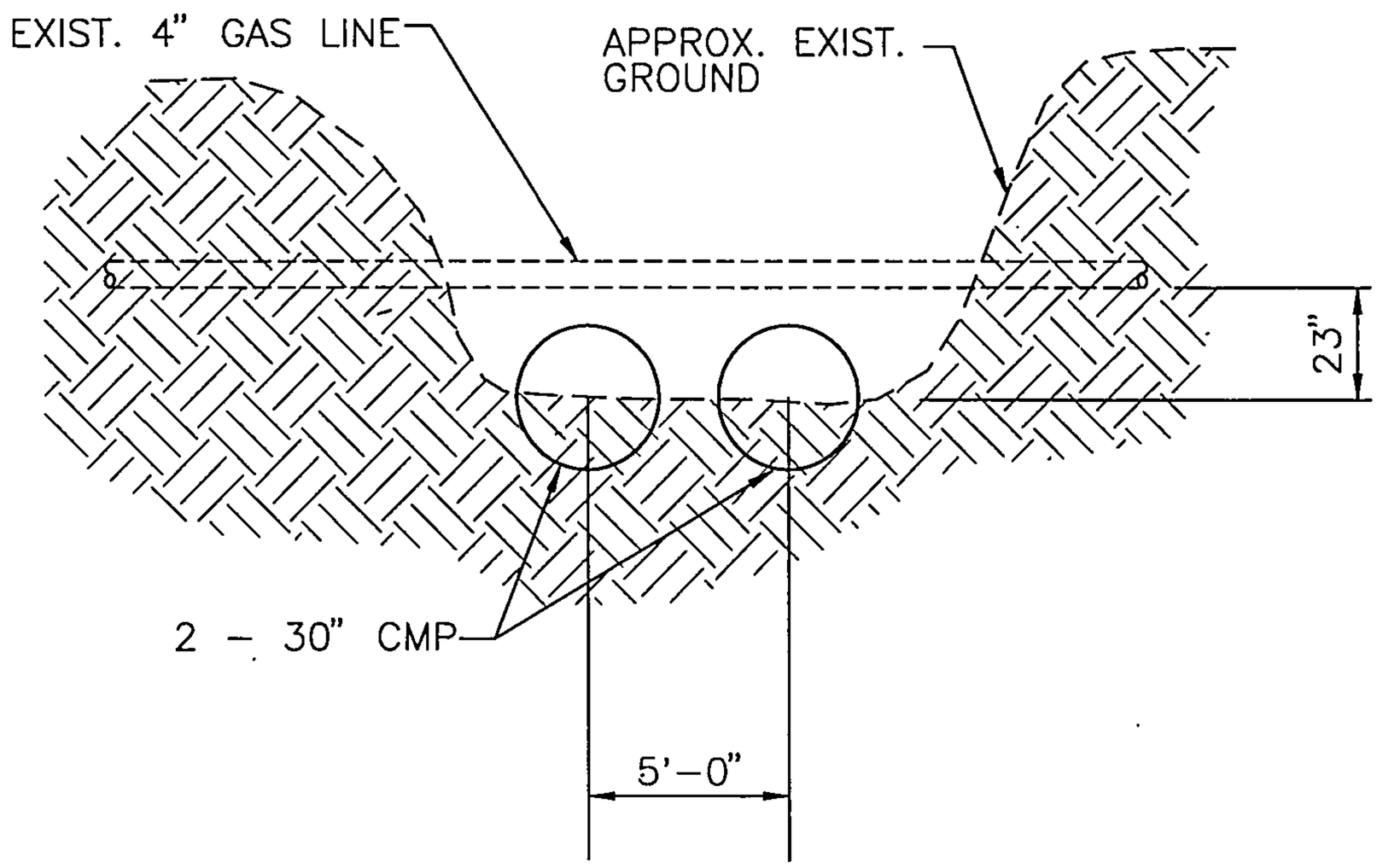
URS Greiner

REVISION 7

SHEET 2



PLAN VIEW
NTS



SECTION A-A
NTS

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URS Greiner

REVISION 7

SHEET 1

ETHICON ENDO-SURGERY
GAS LINE PROTECTION
DRAINAGE PLAN REVISION NO. 7
SEPTEMBER 1997

Ethicon Endo-Surgery wishes to correct a situation on their site involving an exposed 4-inch gas line. The gas line runs across an arroyo on the southern portion of the site in Basin D1 as shown on the attached Drainage Map. The arroyo is eroding under the gas line exposing it as shown on the attached sheet number 1.

The plan is to install 2 - 30-inch CMP's with headwalls under the gas line as shown in the attached drawings. Fill would be placed over the pipes and the exposed gas line giving it just over 2-feet of cover. This in an arroyo where it receives no traffic except an occasional maintenance person to inspect the structure.

Attached are calculations showing the area draining to the site and the Q 100 using the current DPM procedures. Pipe sizing and rip rap calculations are also included. Rip rap will be placed at the downstream end of the structure to transition back to the natural arroyo.

DRAINAGE INFORMATION SHEET

PROJECT TITLE: ETHICON GAS LINE PROTECTION ZONE ATLAS/DRNG. FILE #: P-15/D1

DRB #: N/A EPC #: N/A WORK ORDER #: _____

LEGAL DESCRIPTION: SEC. 9, T9N, R3E, ALBUQUERQUE, NM

CITY ADDRESS: 3801 UNIVERSITY BLVD. SE

ENGINEERING FIRM: URS GREINER INC CONTACT: MARK HOLSTAD, PE

ADDRESS: 5971 JEFFERSON BLVD NE PHONE: 345-3999

OWNER: ETHICON/JOHNSON & JOHNSON CONTACT: TOM MONTOYA

ADDRESS: 3801 UNIVERSITY BLVD SE PHONE: _____

ARCHITECT: N/A CONTACT: —

ADDRESS: — PHONE: —

SURVEYOR: N/A CONTACT: —

ADDRESS: — PHONE: —

CONTRACTOR: ETHICON/JOHNSON & JOHNSON CONTACT: SEE ABOVE

ADDRESS: _____ PHONE: _____

TYPE OF SUBMITTAL:

____ DRAINAGE REPORT
X DRAINAGE PLAN REVISION
____ CONCEPTUAL GRADING & DRAINAGE PLAN
____ GRADING PLAN
____ EROSION CONTROL PLAN
____ ENGINEER'S CERTIFICATION
____ OTHER _____

PRE-DESIGN MEETING:

____ YES
X NO
____ COPY PROVIDED

RECEIVED
SEP 15 1997
HYDROLOGY SECTION

CHECK TYPE OF APPROVAL SOUGHT:

____ SKETCH PLAT APPROVAL
____ PRELIMINARY PLAT APPROVAL
____ S. DEV. PLAN FOR SUB'D. APPROVAL
____ S. DEV. PLAN FOR BLDG. PERMIT APPROVAL
____ SECTOR PLAN APPROVAL
____ FINAL PLAT APPROVAL
____ FOUNDATION PERMIT APPROVAL
____ BUILDING PERMIT APPROVAL
____ CERTIFICATE OF OCCUPANCY APPROVAL
____ GRADING PERMIT APPROVAL
____ PAVING PERMIT APPROVAL
____ S.A.D. DRAINAGE REPORT
____ DRAINAGE REQUIREMENTS
X OTHER ON-SITE IMPROVEMENTS (SPECIFY)

DATE SUBMITTED: SEPT. 12, 1997

BY: MARK HOLSTAD, PE

Greiner

Job ETHICON | Project No. | Sheet 1 of 8
Description DETERMINE FLOW TO PROJECT AREA | Computed By S [illegible] | Date 17 July 97
Checked By | Date

TOTAL AREA DRAINING TO PROJECT SITE

OS D_4 = 21.7 acres - UPSTREAM OF UNIV. BLVD CULVERT
OS D_2 = 1.7 " from UNIV. BLVD

D_2 = 0.84 " " " "

ONSITE PORTION OF D_1 = 2.02 " area in D_1 draining to problem area in arroyo - SEE SHEET 4

SITE IS IN AREA (2)

	LAND TREATMENTS
21.7	A
2.54	D
2.02	A

TABLE A-9 PEAK DISCHARGE

Q_{100} = (21.7 × 1.56) + (2.54 × 4.70) + (2.02 × 1.56) = 48.9 cfs

INLET CONTROL FOR CMP with HW/D = 1 or less

ROUND	PIPE ARCH EQUAL (SPAN x RISE)		
1 - 42"	49 x 33		
2 - 36"	42 x 29		
2 - 30"		w/ HW/D = 1.1	HW = 2.75' ←
3 - 30"	35 x 24	→ Arch = 1.25	HW = 2.50
3 - 24"		w/ HW/D = 1.2	HW = 2.4'
2 - 24"		HW/D = 1.9	HW = 3.8

SEE SHEET 4

Velocity - Q each barrel = 48.9/2 = 24.5 cfs at pipe flow
2 - 30" CMP @ 24.5/4.909 = 4.99 fps

2 - 24" CMP @ 24.5/3.142 = 7.80 fps

RECEIVED
SEP 15 1997
HYDROLOGY SECTION

USE (2) 30" CMP

Greiner

Job Ethicon | Project No. | Sheet 2 of 3
Description RIP RAP SIZE | Computed By [signature] | Date 8 Sept 97
Checked By | Date

Velocity in riprap channel D/S of pipes

per Mannings = 7.11 fps - channel - use pipe vel shown below

depth = 0.79 Ft (calc sheet 3)

USE METHOD PER USFHA HEC No. 11 - use of rip rap for bank protection

SEE ATTACHED TABLE 1 + 2 - USE TRIAL + ERROR TO DETERMINE RIP RAP SIZE

pipe vel. per mannings (non pressure) = 10.1 fps

K	K/d	Vs/V	Vs	Table 2-k
.5'	.63	.85	8.4	.49 — OK

SEE ATTACHED calc sheets 5-8

MIN D_{50} (equivalent spherical diameter of the 50% stone size) = 6"

CON VL

RIPRAP CHANNEL DOWNSTREAM OF PIPES
Worksheet for Trapezoidal Channel

Sheet 3 | 8

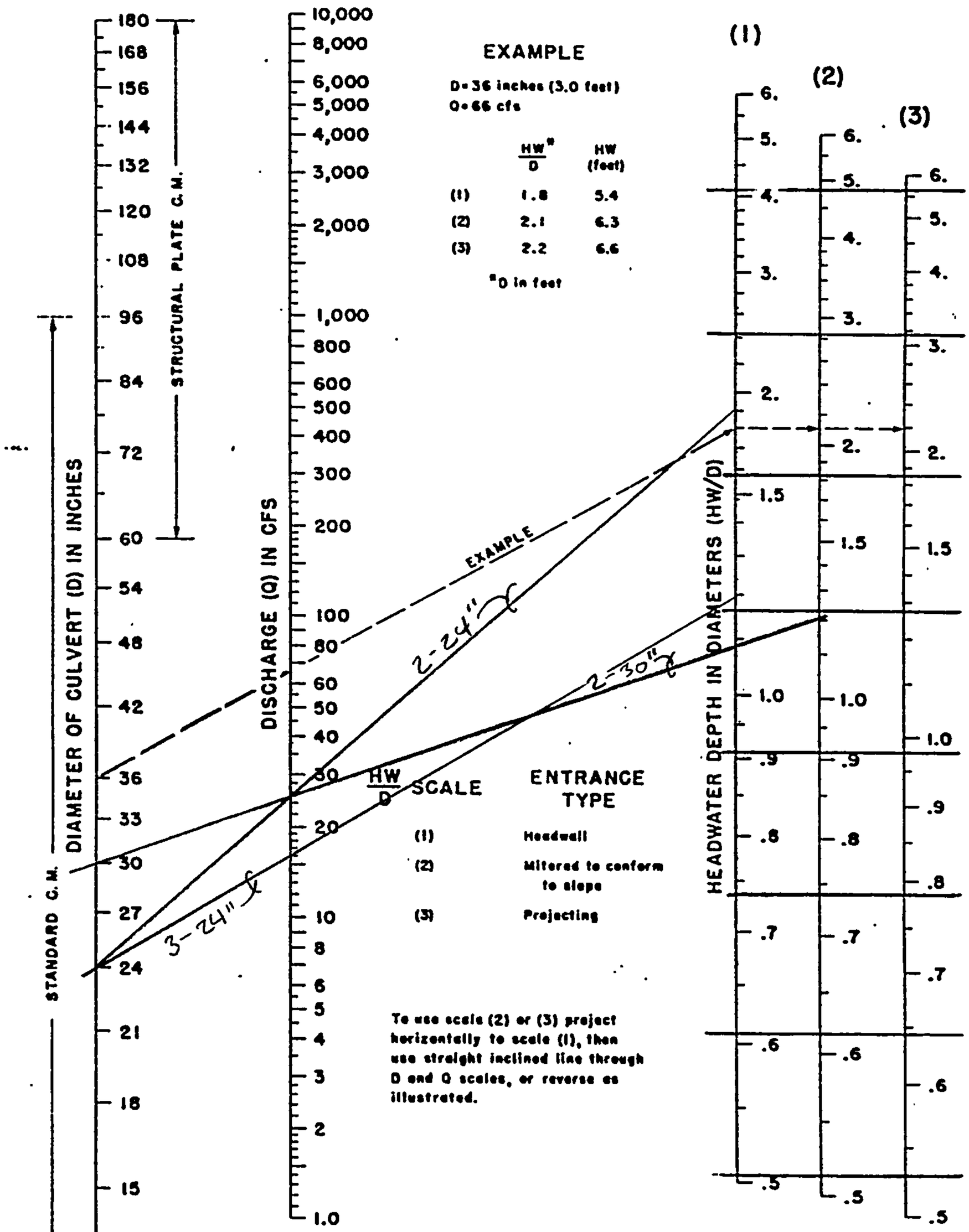
Project Description	
Project File	p:\engr\ethicon.fm2
Worksheet	RIPRAP CHANNEL DOWNSTREAM OF PIPES
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.050000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	7.08	ft
Discharge	49.00	cfs

Results		
Depth	0.79	ft
Flow Area	6.89	ft^2
Wetted Perimeter	10.64	ft
Top Width	10.26	ft
Critical Depth	1.03	ft
Critical Slope	0.020015	ft/ft
Velocity	7.11	ft/s
Velocity Head	0.79	ft
Specific Energy	1.58	ft
Froude Number	1.53	
Flow is supercritical.		

FIGURE 804-1E

sheet 4 | 8



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

A filter layer under all riprap is essential (3) unless the bank material meets the filter requirements. (See section 2.7.)

(1) Dumped riprap is graded stone dumped on a prepared slope in such a manner that segregation will not take place. Dumped stone riprap is the most flexible of the types considered here and will adjust itself to uneven bank settlement. In most areas dumped stone is the least costly type.

(2) Hand-placed riprap is stone laid carefully by hand or by derrick following a more or less definite pattern with the voids between the larger stone filled with smaller stone and the surface kept relatively even. The resulting protection approaches good dry rubble in quality and appearance, but this type of riprap is rigid and lacks the strength necessary to bridge even minor movement of the surface which it protects.

(3) Wire-enclosed riprap is stone placed in wire baskets or in wire covered mats. Wire-enclosed riprap is generally used because rock of suitable size is not available. This riprap is effective until the wire enclosure fails.

(4) Grouted riprap is riprap with the interstices filled with portland cement mortar. The use of grouted riprap is seldom justifiable when stone of suitable size is available.

(5) Concrete riprap in bags is concrete in cement sacks or suitable burlap bags that are hand placed in contact with adjacent bags.

(6) Concrete-slab riprap is plain or reinforced concrete slabs poured or placed on the surface to be protected. The slabs poured or placed on the surface to be protected. The slabs are not connected to each other.

II - DESIGN

2.1 - Design of Dumped-Stone Riprap

The resistance of dumped stone to displacement by moving water depends upon:

(1) Weight, size, shape, and composition of the individual stones

(2) The gradation of the stone

(3) The depth of water over the stone blanket

(4) The steepness and stability of the protected slope

(5) The stability and effectiveness of the filter blanket on which the stone is placed.

(6) The velocity of the flowing water against the stone

(7) The protection of toe and terminals of the stone blanket

The design of a dumped-stone blanket for bank protection is similar to that for a stone-lined channel discussed in section 4.12 of reference 8. The principal difference between stone linings and stone bank protection is that in linings the channel bed is also lined, and the lining is generally continuous throughout the length of channel wherein erosion is imminent. Bank protection is generally limited to problem areas. The toe and terminals of the bank protection are particularly vulnerable to attack by the current. At some locations, wave action may present a more severe form of attack than water flowing parallel to the embankment; such cases may require heavier protection. Protection from wave action is discussed in references 1, 4, 6, and 7.

2.1.1 - Size of Stone

The size of stone needed to protect a streambank or highway embankment from erosion by a current moving parallel to the embankment is determined by the use of figures 1 and 2. Size (k) is the diameter, in feet, of a spherical stone that would have the same weight as the 50 percent size of stone. The size of stone is found by a trial-and-error procedure which consists of first estimating a stone size.

The mean velocity (V_m) of the stream during the design flood must then be converted to velocity against the stone by use of figure 1. The ratio ($\frac{k}{d}$) of the equivalent spherical diameter of the 50 percent stone size to the depth of flow during the design flood is computed by using 0.4 of the total depth when the depth of flow exceeds about 10 feet. The reason for this is that use of the total depth would result in a stone size which would be adequate at the total depth but which might be too light to provide protection near the water surface.

With the velocity against the stone (V_s) enter figure 2 and read the stone size for the embankment slope. The stone size from figure 2 is the 50 percent (median) size, by weight, of a well-graded mass of stone with a unit weight of 165 pounds per cubic foot. If the stone size from figure 2 agrees with the assumed stone size, this is the correct size. If not, the procedure is repeated until the assumed size is in reasonable agreement with the size from figure 2.

When the unit weight of the stone is other than 165 pounds per cubic foot, the size from figure 2 should be corrected by Creager's equation (discussion of in reference 4):

$$k_w = \frac{102.5\ k}{w - 62.5}$$

where k = stone size from figure 2

k_w = stone size for stone of w pounds per cubic feet

Sheet 7 / 8

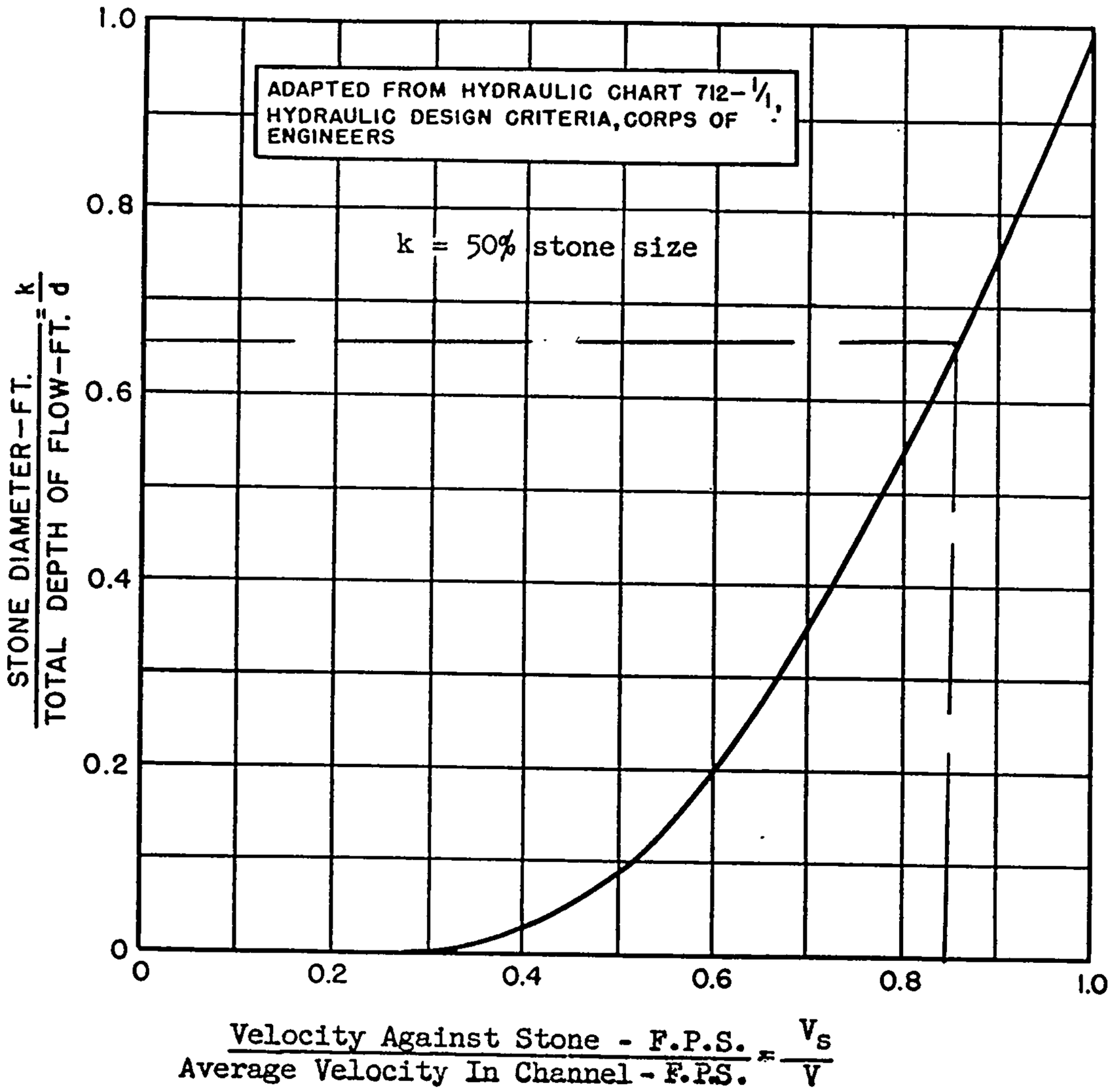


FIG. 1 - VELOCITY AGAINST STONE ON CHANNEL BOTTOM

The size of stone required to resist displacement from direct impingement of the current as might occur with a sharp change in stream alinement is greater than the value obtained from figure 2, although research data is lacking on just how much larger the stone should be. The California Division of Highways (6) recommends doubling the velocity against the stone as determined for straight alinement before entering figure 2 for stone size. Lane (9) recommends reducing the allowable velocity by 22 percent for very sinuous channels; for determining stone size by figure 2, the velocity (V_s) would be increased by 22 percent. Until data are available for determining the stone size at the point of impingement, a factor which would vary from 1 to 2 depending upon the severity of the attack by the current, should be applied to the velocity V_s before entering figure 2.

NOTE

ESTIMATE $K = 0.5' \rightarrow \frac{K}{d} = 0.63$ $\quad d = .79$

and $\frac{V_s}{V} = 0.85$ $\quad V = 10.1$

therefore $V_s = 8.5$

Sheet 8/8

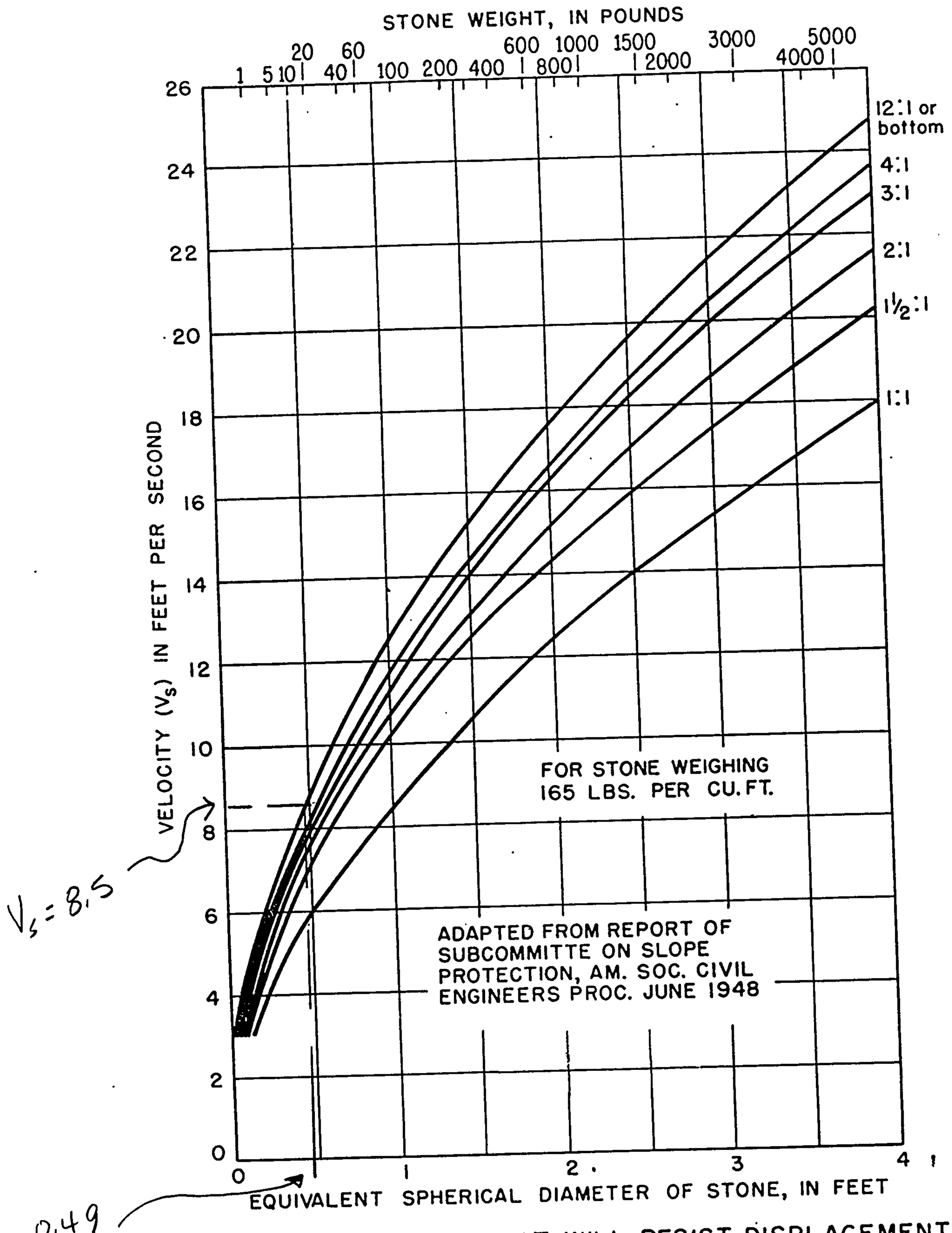
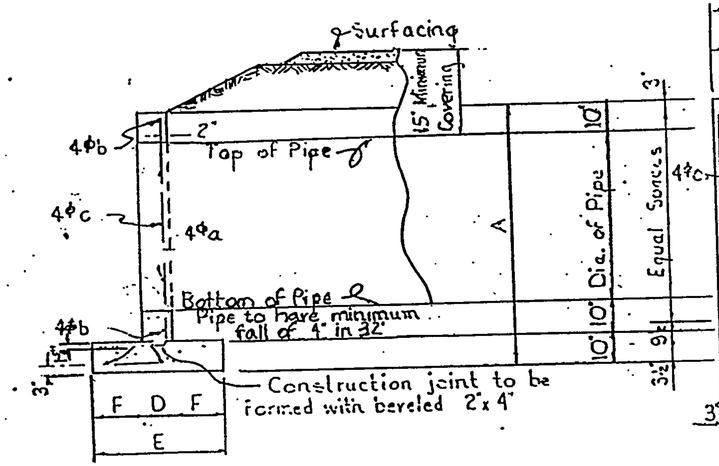


FIG. 2-SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

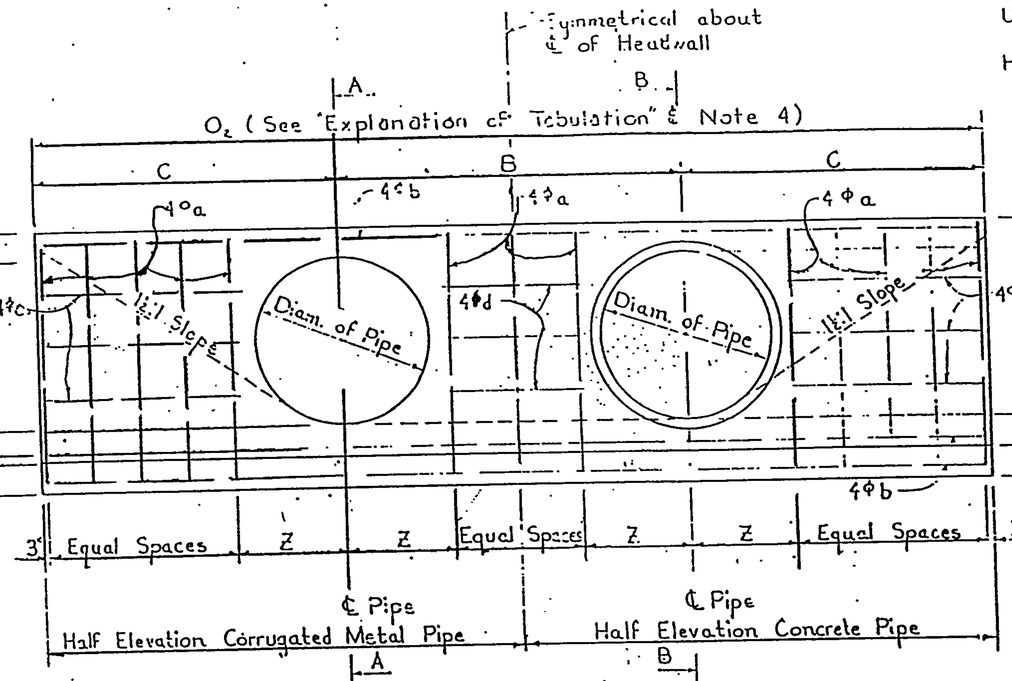
FED. ROAD DIV. NO.	STATE		FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	NEW MEXICO				

DESIGN DATA

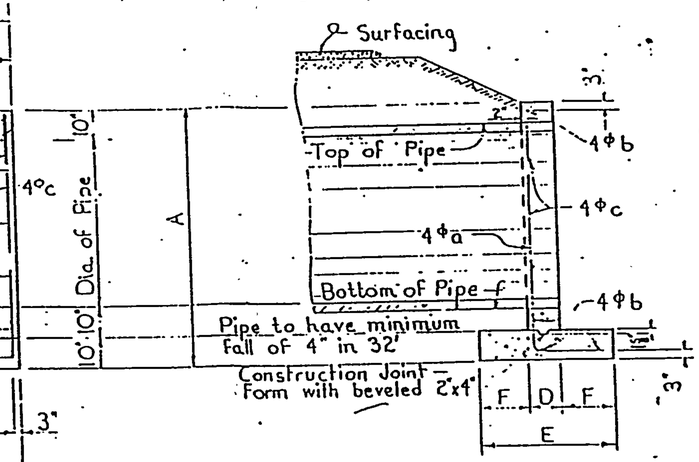
Design according to AASHO Spec's., 1957.
Unit Stresses: Reinforced Concrete: $f_c = 1200$ #/□"; $f_s = 20{,}000$ #/□"; $n = 10$
Horizontal earth pressure = 44.5 # equivalent fluid pressure (sloping surcharge.)



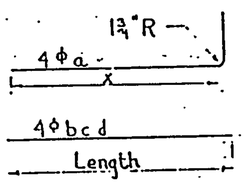
SECTION A-A
(TYPICAL ALONG ℄ OF CORRUGATED METAL PIPE)



ELEVATION - HEADWALL FOR DOUBLE CULVERT



SECTION B-B
(TYPICAL ALONG ℄ OF CONCRETE PIPE)



BAR BENDING DIAGRAMS
(See table for bars required).

GENERAL NOTES

1. Workmanship and materials to conform to AASHTO Standard Specifications.
2. Design based on a minimum concrete compressive strength of 3000 pounds per square inch at 28 days. Chamfer all exposed edges ¾" unless noted otherwise.
3. All reinforcing steel to be deformed bars, conforming to AASHTO M-31, Grade 60. All dimensions refer to the centerline of bar.
4. While the details on this drawing are for a typical culvert with 2 pipes, this drawing applies to culvert headwalls with any number of pipes. The central portion of the wall of length "B" is repeated as many times as required by the number of pipes.

CONCRETE - HEADWALLS

Bar spacings shown are approximate only.

Quantities shown are for two headwalls.

Diam. of Pipe	DIMENSIONS A	B	C	D	E	F	O_1	REQUIRED FOR TWO HEADWALLS WITH ONE PIPE: 4Φa bars No.	Length	x	Spacing	Z	4Φb No.	Length	4Φc bars No.	Length	Spacing	Quantities: Reinforcing Steel-lbs.	Concrete-Cu. Yds. C.P.C.	C.M.C.	ADD FOR EACH ADDITIONAL PIPE: 4Φa No.	4Φd bars No.	Length	Spacing	Quantities: Reinforcing Steel-lbs.	Concrete-Cu. Yds. C.P.C.	C.M.C.	Diam. of Pipe
18"	4'-0"	3'-0"	3'-3"	8"	2'-2"	9"	6'-6"	12	4'-6"	3'-5"	1'-0"	1'-1"	8	O_n-3"	4	2'-0"	1'-4"	75	1.74	1.80	4	2	1'-0"	1'-4"	29	0.73	0.78	18"
24"	4'-6"	4'-0"	4'-0"	8"	2'-2"	9"	8'-0"	12	5'-0"	3'-11"	1'-3"	1'-4½"	8	O_n-3"	4	2'-6"	1'-7"	88	2.28	2.36	4	2	1'-3"	1'-7"	36	1.02	1.10	24"
30"	5'-0"	5'-0"	4'-9"	8"	2'-6"	11"	9'-6"	12	5'-9"	4'-5"	1'-5"	1'-8"	8	O_n-3"	8	3'-3"	1'-3"	113	3.05	3.18	4	4	1'-9"	1'-3"	47	1.43	1.56	30"
36"	5'-6"	6'-0"	5'-9"	8"	2'-8"	1'-0"	11'-6"	16	6'-3"	4'-11"	1'-2"	1'-11"	8	O_n-3"	8	4'-0"	1'-5"	148	4.02	4.19	6	4	2'-3"	1'-5"	63	1.85	2.02	36"
42"	6'-0"	7'-0"	6'-6"	10"	3'-0"	1'-1"	13'-0"	16	7'-0"	5'-5"	1'-4"	2'-3"	8	O_n-3"	8	4'-6"	1'-6"	167	5.68	5.96	6	4	2'-9"	1'-6"	73	2.65	2.93	42"
48"	6'-6"	8'-0"	7'-3"	10"	3'-4"	1'-3"	14'-6"	20	7'-9"	5'-11"	1'-2"	2'-6½"	8	O_n-3"	12	4'-9"	1'-3"	216	6.92	7.28	6	6	3'-0"	1'-3"	86	3.31	3.67	48"
54"	7'-0"	9'-0"	8'-0"	10"	3'-6"	1'-4"	16'-0"	24	8'-5"	6'-5"	1'-0"	2'-10"	8	O_n-3"	12	5'-0"	1'-5"	257	8.12	8.57	8	6	3'-6"	1'-5"	106	3.95	4.39	54"
60"	7'-6"	10'-0"	8'-9"	10"	3'-9"	1'-5½"	17'-6"	28	9'-0"	6'-11"	0'-11"	3'-1½"	8	O_n-3"	12	5'-6"	1'-6½"	305	9.51	10.04	10	6	3'-9"	1'-6½"	129	4.68	5.22	60"

EXPLANATION OF TABULATION

$O_1 = 2C$ $\quad$ $O_2 = 2C + B$
$O_3 = 2C + 2B$ $\quad$ $O_n = 2C + (n-1)B$
Where n = number of pipes

IDENT. NO.	DESCRIPTION	DATE	BY
3	REVISED NOTE #1,#3	5-10-94	FH
2	General Serial Revision	4/6/61	CR
1			

REVISIONS (OR CHANGE NOTICES)

NEW MEXICO
STATE HIGHWAY DEPARTMENT

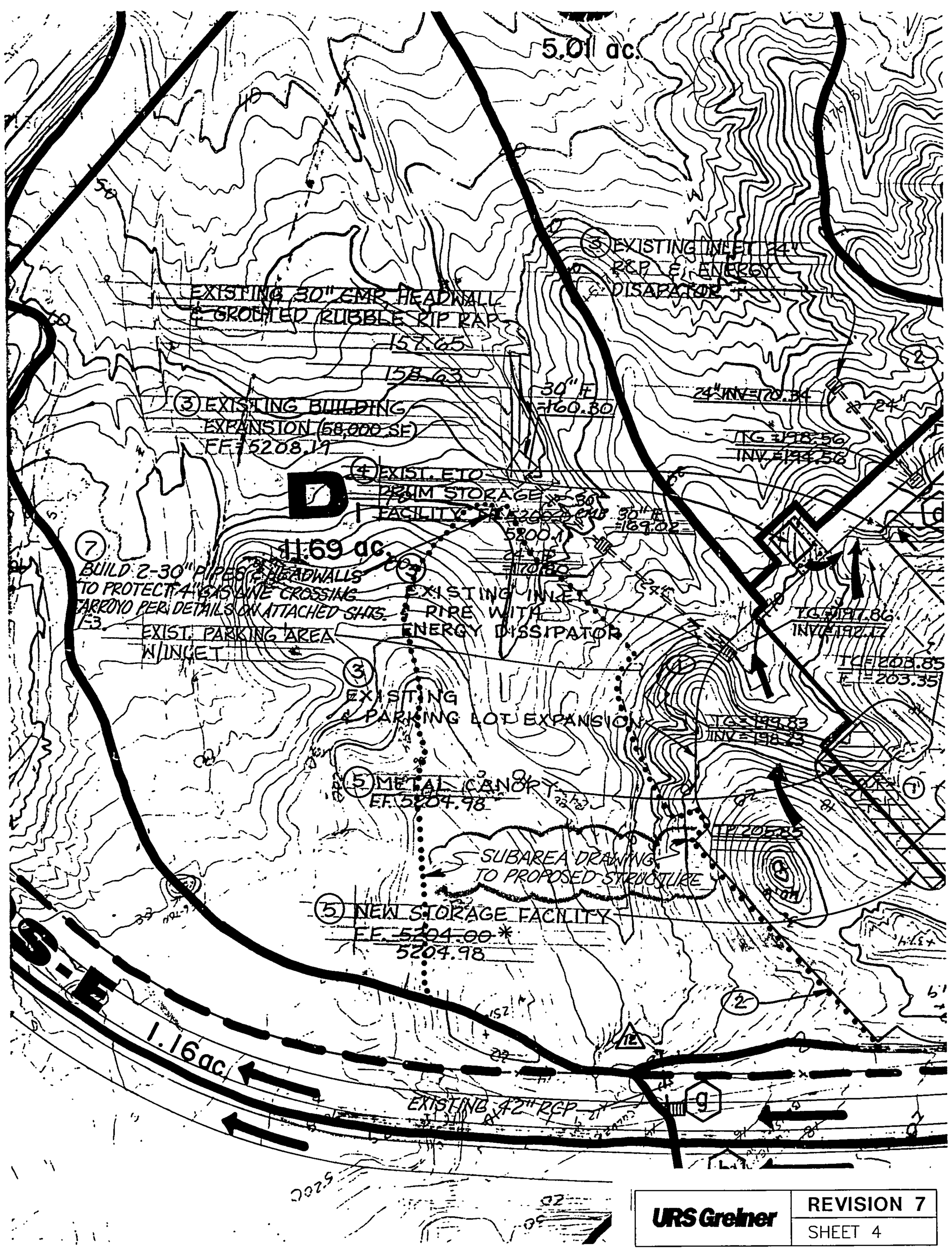
PIPE CULVERT
HEADWALLS

URS Greiner

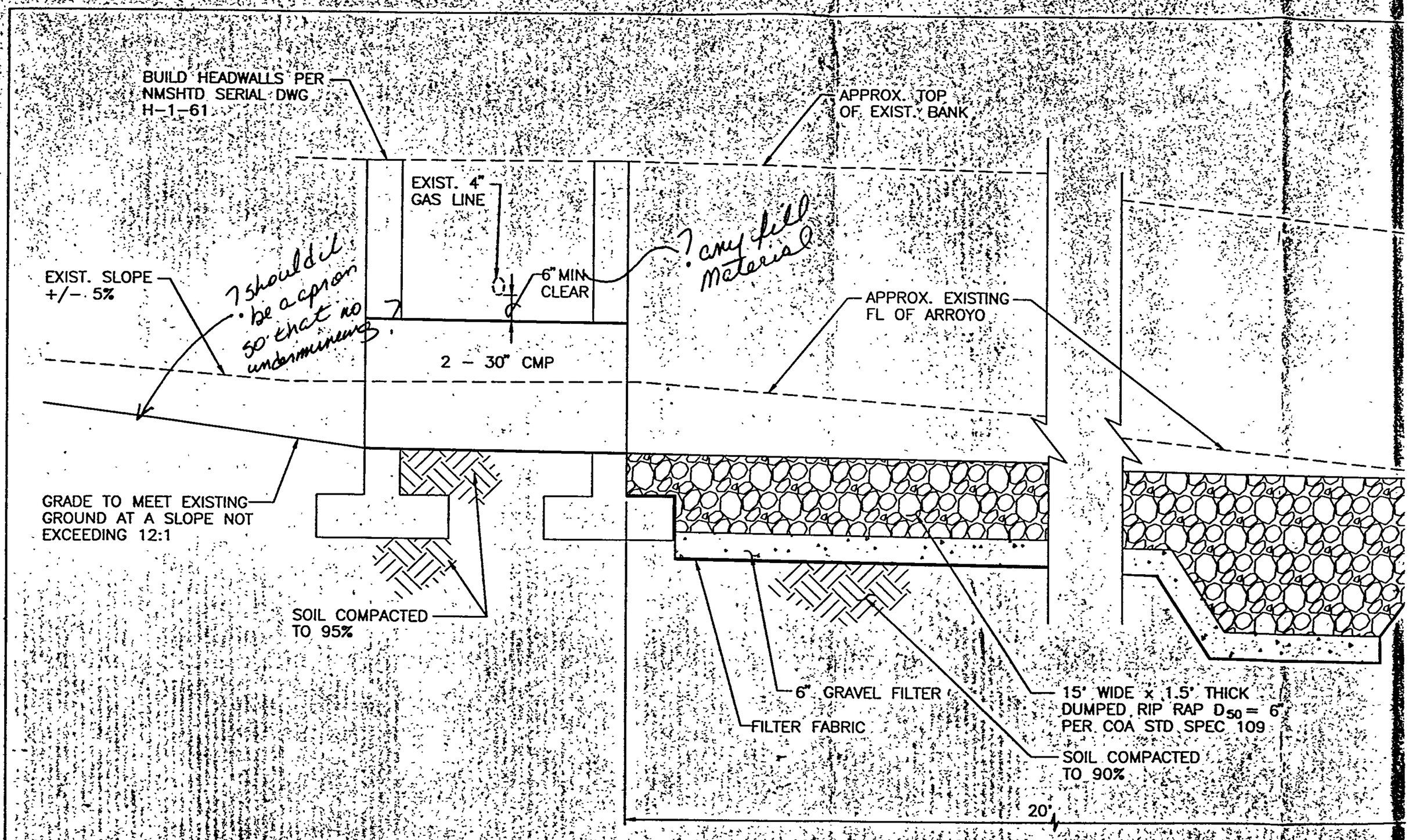
REVISION 7
SHEET 3

SERIAL H-1-61

APPRO: [illegible] 4-6-61



URS Greiner	REVISION 7
	SHEET 4



SECTION B-B
SCALE: 1" = 2'

DETAIL2.DWG

DRAINAGE INFORMATION SHEET

PROJECT TITLE: ETHICON GAS LINE PROTECTION ZONE ATLAS/DRNG. FILE #: P-15/D1

DRB #: N/A EPC #: N/A WORK ORDER #: _____

LEGAL DESCRIPTION: SEC. 9, T9N, R3E, ALBUQUERQUE, NM

CITY ADDRESS: 3801 UNIVERSITY BLVD. SE

ENGINEERING FIRM: URS GREINER INC CONTACT: MARK HOLSTAD, PE

ADDRESS: 5971 JEFFERSON BLVD NE PHONE: 345-3999

OWNER: ETHICON / JOHNSON & JOHNSON CONTACT: TOM MONTOYA

ADDRESS: 3801 UNIVERSITY BLVD SE PHONE: _____

ARCHITECT: N/A CONTACT: —

ADDRESS: — PHONE: —

SURVEYOR: N/A CONTACT: —

ADDRESS: — PHONE: —

CONTRACTOR: ETHICON / JOHNSON & JOHNSON CONTACT: SEE ABOVE

ADDRESS: _____ PHONE: _____

TYPE OF SUBMITTAL:

____ DRAINAGE REPORT
X DRAINAGE PLAN REVISION
____ CONCEPTUAL GRADING & DRAINAGE PLAN
____ GRADING PLAN
____ EROSION CONTROL PLAN
____ ENGINEER'S CERTIFICATION
____ OTHER _____

PRE-DESIGN MEETING:

____ YES
X NO
____ COPY PROVIDED

CHECK TYPE OF APPROVAL SOUGHT:

____ SKETCH PLAT APPROVAL
____ PRELIMINARY PLAT APPROVAL
____ S. DEV. PLAN FOR SUB'D. APPROVAL
____ S. DEV. PLAN FOR BLDG. PERMIT APPROVAL
____ SECTOR PLAN APPROVAL
____ FINAL PLAT APPROVAL
____ FOUNDATION PERMIT APPROVAL
____ BUILDING PERMIT APPROVAL
____ CERTIFICATE OF OCCUPANCY APPROVAL
____ GRADING PERMIT APPROVAL
____ PAVING PERMIT APPROVAL
____ S.A.D. DRAINAGE REPORT
____ DRAINAGE REQUIREMENTS
X OTHER ON-SITE IMPROVEMENTS (SPECIFY)

DATE SUBMITTED: OCT. 31, 1997

BY: MARK HOLSTAD, PE

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OCT 31 1997
HYDROLOGY SECTION

ETHICON ENDO-SURGERY
GAS LINE PROTECTION
DRAINAGE PLAN REVISION NO. 7
SEPTEMBER 1997

Ethicon Endo-Surgery wishes to correct a situation on their site involving an exposed 4-inch gas line. The gas line runs across an arroyo on the southern portion of the site in Basin D1 as shown on the attached Drainage Map. The arroyo is eroding under the gas line exposing it as shown on the attached sheet number 1.

The plan is to install 2 - 30-inch CMP's with headwalls under the gas line as shown in the attached drawings. Fill would be placed over the pipes and the exposed gas line giving it just over 2-feet of cover. This in an arroyo where it receives no traffic except an occasional maintenance person to inspect the structure.

Attached are calculations showing the area draining to the site and the Q 100 using the current DPM procedures. Pipe sizing and rip rap calculations are also included. Rip rap will be placed at the downstream end of the structure to transition back to the natural arroyo.

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OCT 31 1997
HYDROLOGY SECTION

Greiner

Job ETHICON | Project No. | Sheet 1 of 8
Description DETERMINE FLOW TO PROJECT AREA | Computed By S [signature] | Date 17 July 97
Checked By | Date

TOTAL AREA DRAINING TO PROJECT SITE

OS D_4 = 21.7 acres - UPSTREAM OF UNIV. BLVD CULVERT
OS D_2 = 1.7 " from UNIV. BLVD

D_2 = 0.84 " " " "

ONSITE PORTION OF D_1 = 2.02 " area in D_1 draining to problem area in arroyo - SEE SHEET 4.

SITE IS IN AREA (2)

	LAND TREATMENTS
21.7	A
2.54	D
2.02	A

TABLE A-9 PEAK DISCHARGE

Q_{100} = (21.7 × 1.56) + (2.54 × 4.70) + (2.02 × 1.56) = 48.9 cfs

INLET CONTROL FOR CMP with HW/D = 1 or less

ROUND	PIPE ARCH EQUAL (SPAN x RISE)		
1 - 42"	49 x 33		
2 - 36"	42 x 29		
2 - 30"		w/ HW/D = 1.1	HW = 2.75' ←
3 - 30"	35 x 24	→ Arch = 1.25	HW = 2.50
3 - 24"		w/ HW/D = 1.2	HW = 2.4'
2 - 24"		HW/D = 1.9	HW = 3.8

SEE CALC SHEET 4

Velocity - Q each barrel = 48.9/2 = 24.5 cfs at pipe full flow
2 - 30" cmp @ 24.5/4.909 = 4.99 fps ←

2 - 24" cmp @ 24.5/3.142 = 7.80 fps

USE (2) 30" cmp

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OCT 31 1997
HYDROLOGY SECTION

Greiner

Job Ethicon | Project No. | Sheet 2 of 3
Description RIP RAP SIZE | Computed By [signature] | Date 8 Sept 97
Checked By | Date

Velocity in riprap channel D/S of pipes

per Mannings = 7.11 fps - channel - use pipe vel shown below

depth = 0.79 Ft (calc sheet 3)

USE METHOD PER USFHA HEC No. 11 - use of rip rap for bank protection

SEE ATTACHED TABLE 1 + 2 - USE TRIAL + ERROR TO DETERMINE RIP RAP SIZE

pipe vel. per mannings (non pressure) = 10.1 fps

K	K/d	Vs/V	Vs	Table 2-k
.5'	.63	.85	8.4	.49 — OK

SEE ATTACHED calc sheets 5-8

MIN D_{50} (equivalent spherical diameter of the 50% stone size) = 6"

CON VL

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HYDROLOGY SECTION

RIPRAP CHANNEL DOWNSTREAM OF PIPES
Worksheet for Trapezoidal Channel

Sheet 3 | 8

Project Description	
Project File	p:\engr\ethicon.fm2
Worksheet	RIPRAP CHANNEL DOWNSTREAM OF PIPES
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.050000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	7.08	ft
Discharge	49.00	cfs

Results		
Depth	0.79	ft
Flow Area	6.89	ft^2
Wetted Perimeter	10.64	ft
Top Width	10.26	ft
Critical Depth	1.03	ft
Critical Slope	0.020015	ft/ft
Velocity	7.11	ft/s
Velocity Head	0.79	ft
Specific Energy	1.58	ft
Froude Number	1.53	
Flow is supercritical.		

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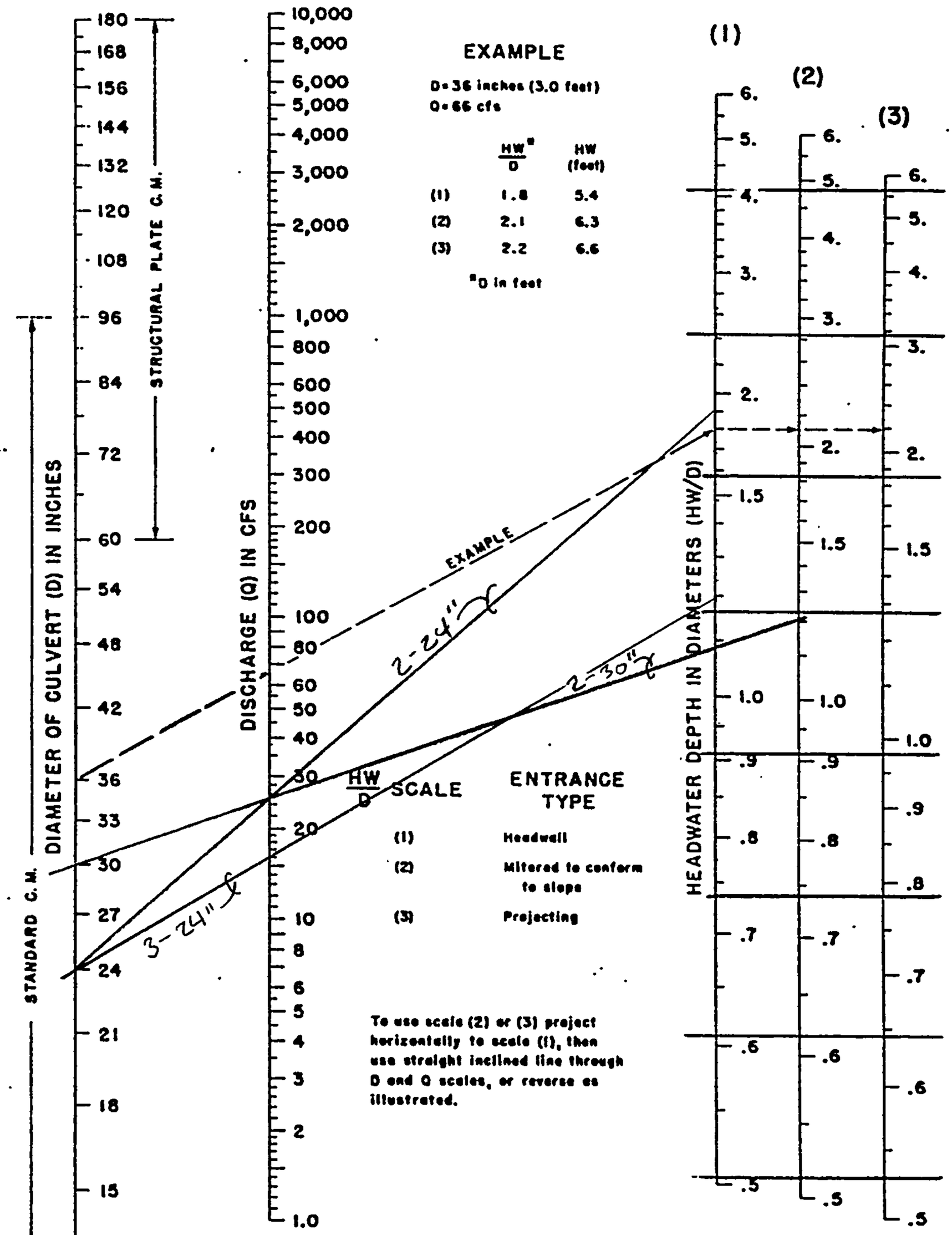
HYDROLOGY SECTION

FIGURE 804-1E

Sheet 4 | 8



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

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HYDROLOGY SECTION

A filter layer under all riprap is essential (3) unless the bank material meets the filter requirements. (See section 2.7.)

(1) Dumped riprap is graded stone dumped on a prepared slope in such a manner that segregation will not take place. Dumped stone riprap is the most flexible of the types considered here and will adjust itself to uneven bank settlement. In most areas dumped stone is the least costly type.

(2) Hand-placed riprap is stone laid carefully by hand or by derrick following a more or less definite pattern with the voids between the larger stone filled with smaller stone and the surface kept relatively even. The resulting protection approaches good dry rubble in quality and appearance, but this type of riprap is rigid and lacks the strength necessary to bridge even minor movement of the surface which it protects.

(3) Wire-enclosed riprap is stone placed in wire baskets or in wire covered mats. Wire-enclosed riprap is generally used because rock of suitable size is not available. This riprap is effective until the wire enclosure fails.

(4) Grouted riprap is riprap with the interstices filled with portland cement mortar. The use of grouted riprap is seldom justifiable when stone of suitable size is available.

(5) Concrete riprap in bags is concrete in cement sacks or suitable burlap bags that are hand placed in contact with adjacent bags.

(6) Concrete-slab riprap is plain or reinforced concrete slabs poured or placed on the surface to be protected. The slabs poured or placed on the surface to be protected. The slabs are not connected to each other.

II - DESIGN

2.1 - Design of Dumped-Stone Riprap

The resistance of dumped stone to displacement by moving water depends upon:

(1) Weight, size, shape, and composition of the individual stones

(2) The gradation of the stone

(3) The depth of water over the stone blanket

(4) The steepness and stability of the protected slope

(5) The stability and effectiveness of the filter blanket on which the stone is placed.

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HYDROLOGY SECTION

(6) The velocity of the flowing water against the stone

(7) The protection of toe and terminals of the stone blanket

The design of a dumped-stone blanket for bank protection is similar to that for a stone-lined channel discussed in section 4.12 of reference 8. The principal difference between stone linings and stone bank protection is that in linings the channel bed is also lined, and the lining is generally continuous throughout the length of channel wherein erosion is imminent. Bank protection is generally limited to problem areas. The toe and terminals of the bank protection are particularly vulnerable to attack by the current. At some locations, wave action may present a more severe form of attack than water flowing parallel to the embankment; such cases may require heavier protection. Protection from wave action is discussed in references 1, 4, 6, and 7.

2.1.1 - Size of Stone

The size of stone needed to protect a streambank or highway embankment from erosion by a current moving parallel to the embankment is determined by the use of figures 1 and 2. Size (k) is the diameter, in feet, of a spherical stone that would have the same weight as the 50 percent size of stone. The size of stone is found by a trial-and-error procedure which consists of first estimating a stone size.

The mean velocity (V_m) of the stream during the design flood must then be converted to velocity against the stone by use of figure 1. The ratio ($\frac{k}{d}$) of the equivalent spherical diameter of the 50 percent stone size to the depth of flow during the design flood is computed by using 0.4 of the total depth when the depth of flow exceeds about 10 feet. The reason for this is that use of the total depth would result in a stone size which would be adequate at the total depth but which might be too light to provide protection near the water surface.

With the velocity against the stone (V_s) enter figure 2 and read the stone size for the embankment slope. The stone size from figure 2 is the 50 percent (median) size, by weight, of a well-graded mass of stone with a unit weight of 165 pounds per cubic foot. If the stone size from figure 2 agrees with the assumed stone size, this is the correct size. If not, the procedure is repeated until the assumed size is in reasonable agreement with the size from figure 2.

When the unit weight of the stone is other than 165 pounds per cubic foot, the size from figure 2 should be corrected by Creager's equation (discussion of in reference 4):

$$k_w = \frac{102.5\ k}{w - 62.5}$$

where k = stone size from figure 2

k_w = stone size for stone of w pounds per cubic feet

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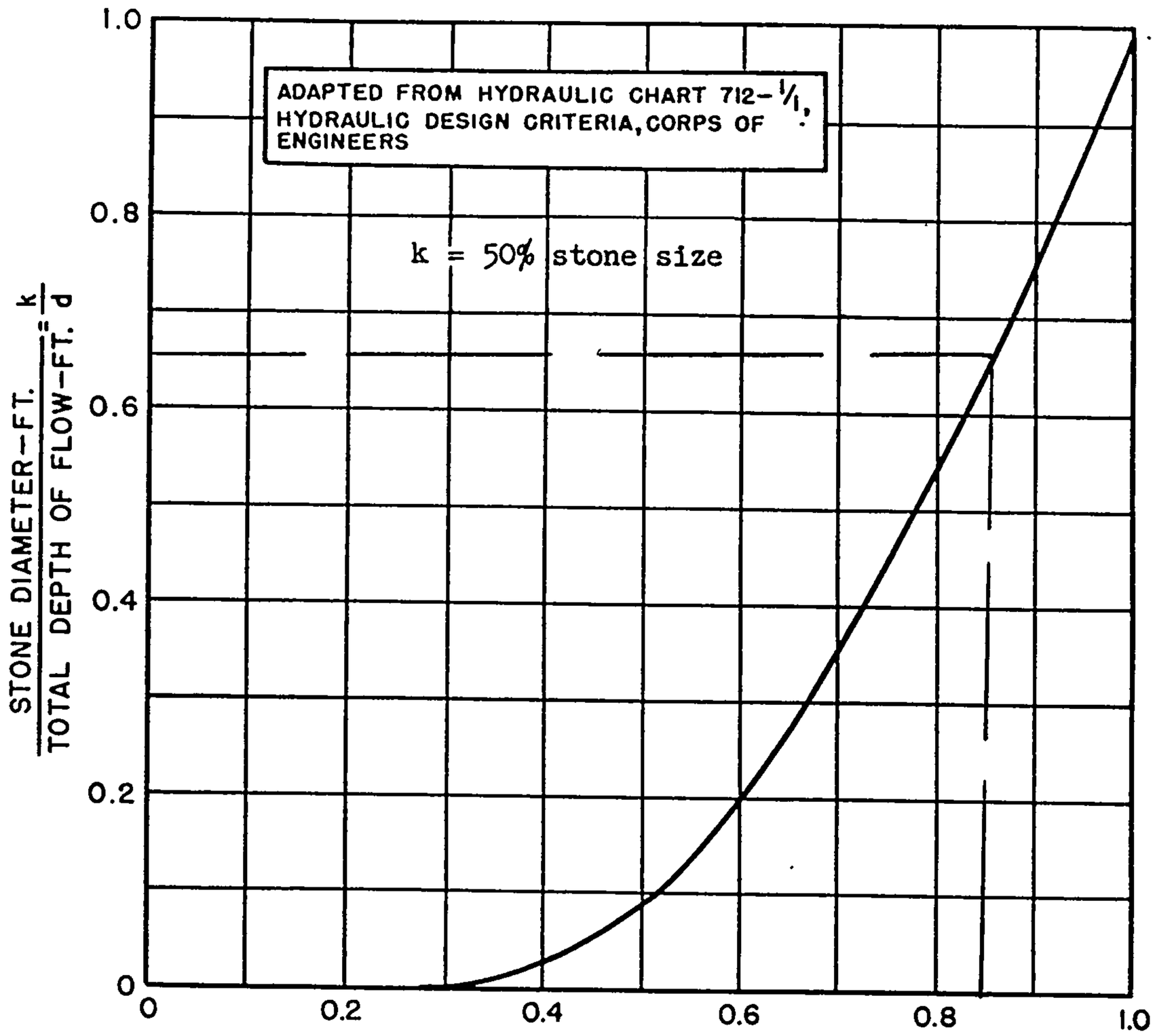
HYDROLOGY SECTION

Sheet 7 / 8



$$\frac{\text{Velocity Against Stone - F.P.S.}}{\text{Average Velocity In Channel - F.P.S.}} = \frac{V_s}{V}$$

FIG. 1 - VELOCITY AGAINST STONE ON CHANNEL BOTTOM

The size of stone required to resist displacement from direct impingement of the current as might occur with a sharp change in stream alinement is greater than the value obtained from figure 2, although research data is lacking on just how much larger the stone should be. The California Division of Highways (6) recommends doubling the velocity against the stone as determined for straight alinement before entering figure 2 for stone size. Lane (9) recommends reducing the allowable velocity by 22 percent for very sinuous channels; for determining stone size by figure 2, the velocity (V_s) would be increased by 22 percent. Until data are available for determining the stone size at the point of impingement, a factor which would vary from 1 to 2 depending upon the severity of the attack by the current, should be applied to the velocity V_s before entering figure 2.

NOTE

ESTIMATE $K = 0.5' \rightarrow \frac{K}{d} = 0.63$ $\quad d = .79$

and $\frac{V_s}{V} = 0.85$ $\quad V = 10.1$

therefore $V_s = 8.5$

Sheet 8/8

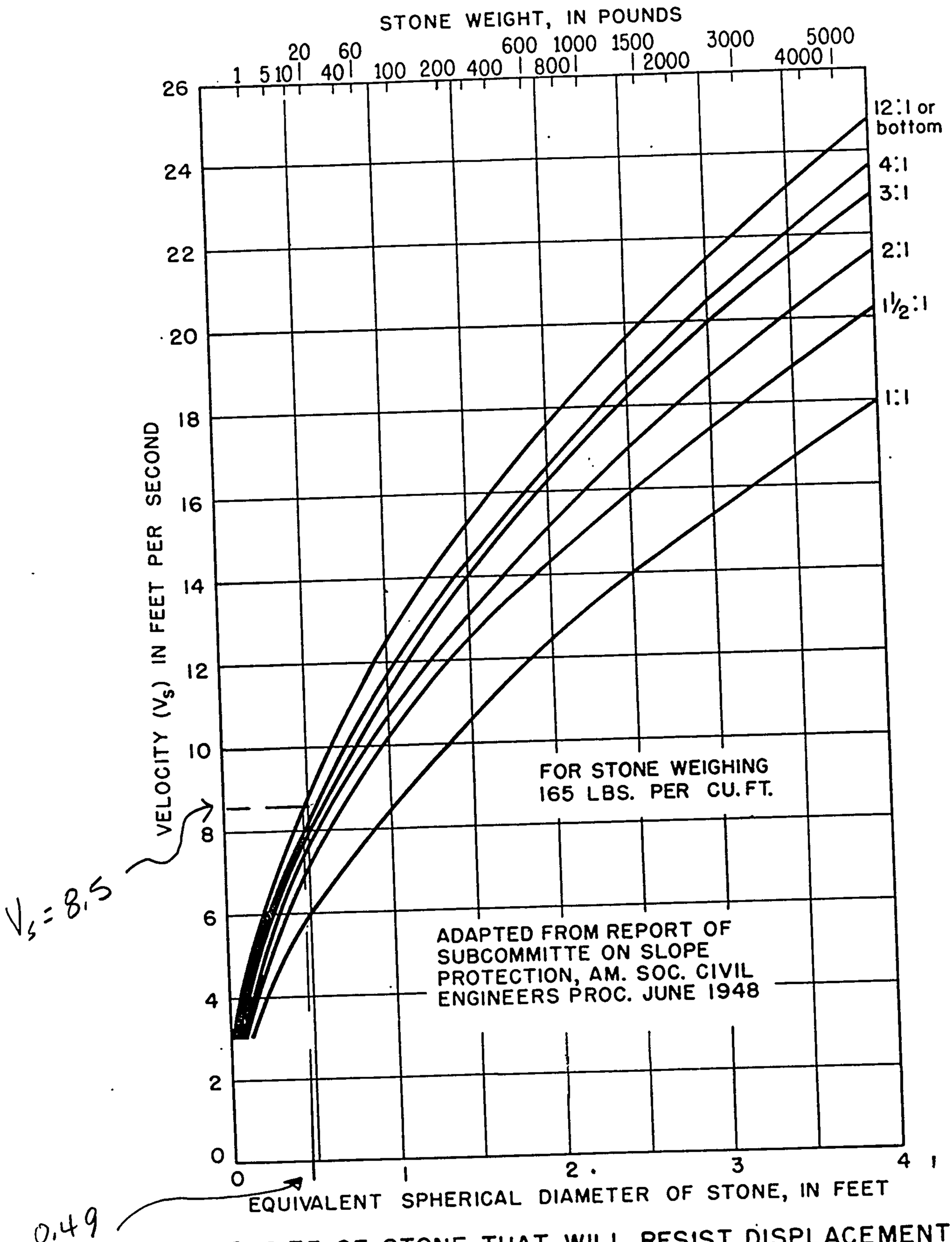
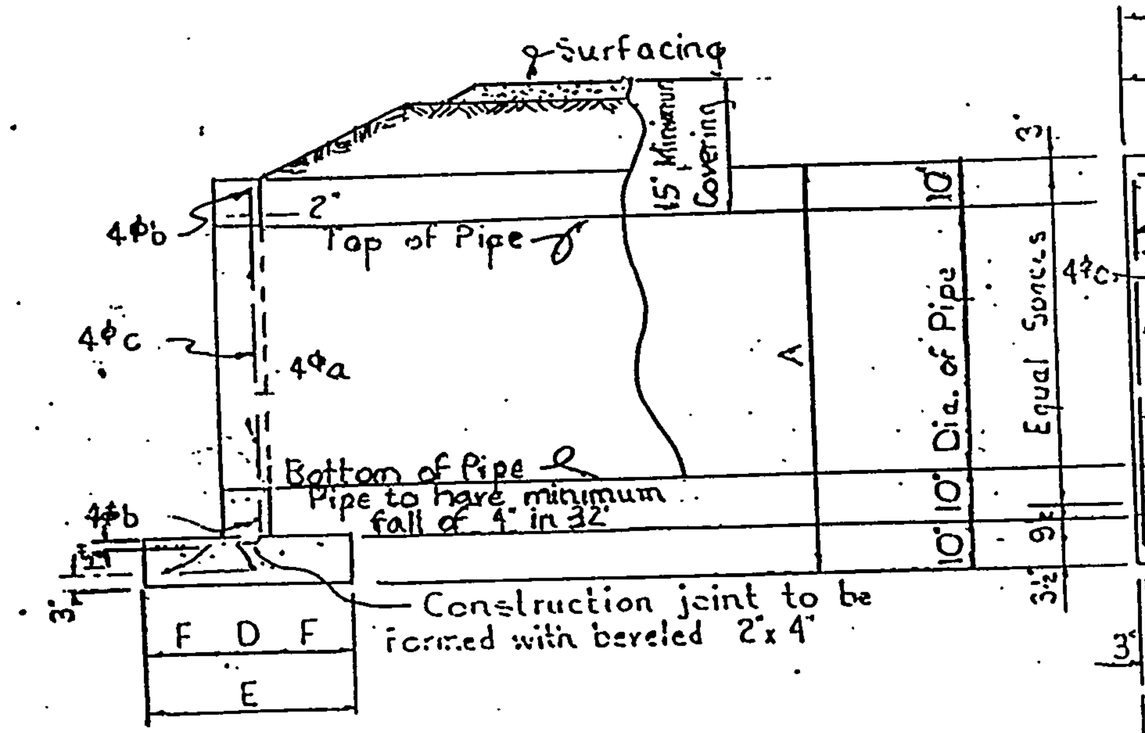


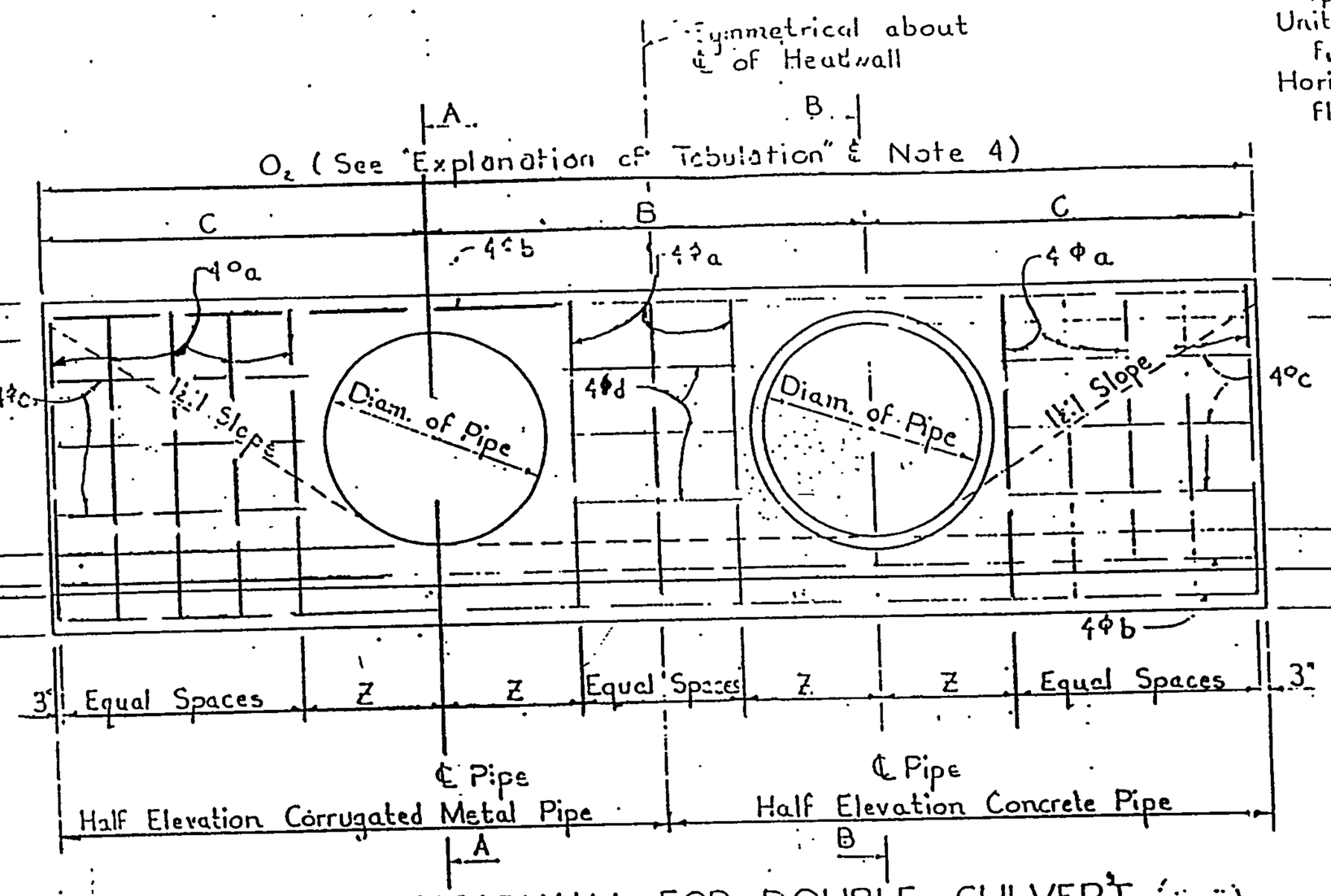
FIG. 2-SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

DESIGN DATA

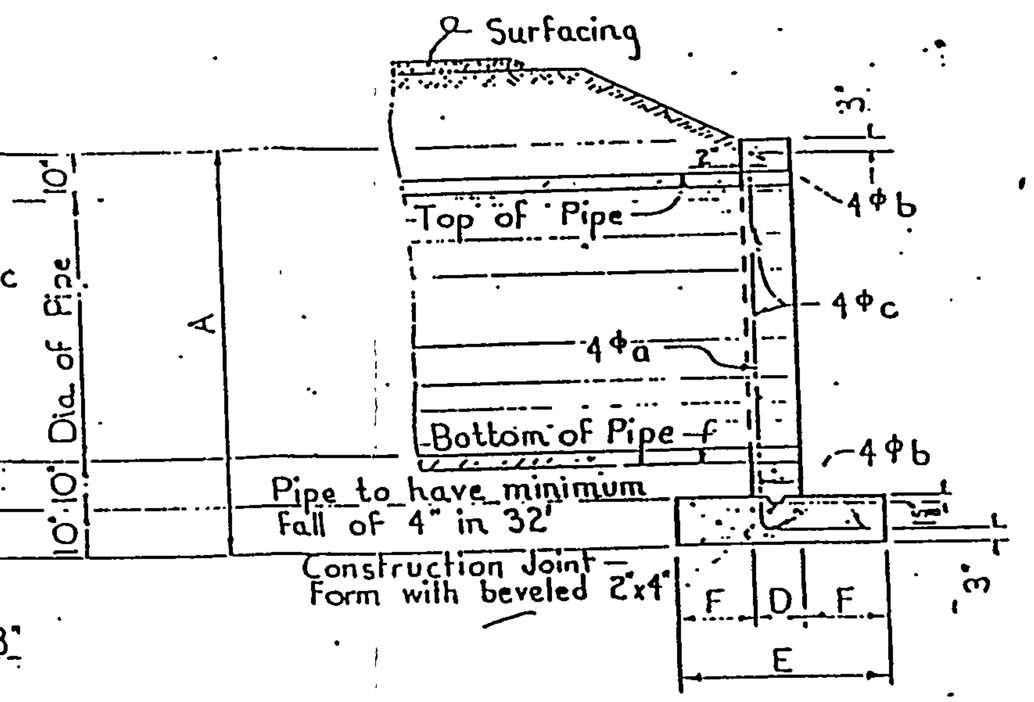
Design according to AASHO. Spec's., 1957.
Unit Stresses: Reinforced Concrete: f_c = 1200 #/□" ;
f_s = 20,000 #/□" ; n = 10
Horizontal earth pressure = 44.5 # equivalent fluid pressure (sloping surcharge.)



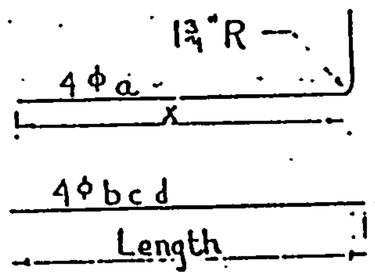
SECTION A-A
(TYPICAL ALONG ℄ OF CORRUGATED METAL PIPE)



ELEVATION - HEADWALL FOR DOUBLE CULVERT



SECTION B-B
(TYPICAL ALONG ℄ OF CONCRETE PIPE)



BAR BENDING DIAGRAMS
(See table for bars required)

GENERAL NOTES

1. Workmanship and materials to conform to AASHTO Standard Specifications.
2. Design based on a minimum concrete compressive strength of 3000 pounds per square inch at 28 days. Chamfer all exposed edges ¾" unless noted otherwise.
3. All reinforcing steel to be deformed bars, conforming to AASHTO M-31, Grade 60. All dimensions refer to the centerline of bar.
4. While the details on this drawing are for a typical culvert with 2 pipes, this drawing applies to culvert headwalls with any number of pipes. The central portion of the wall of length "B" is repeated as many times as required by the number of pipes.

CONCRETE - HEADWALLS

Bar spacings shown are approximate only.

Quantities shown are for two headwalls.

Diam. of Pipe	DIMENSIONS A	B	C	D	E	F	O_1	REQUIRED FOR TWO HEADWALLS WITH ONE PIPE: 4Φa bars No.	Length	x	Spacing	Z	4Φb No.	Length	4Φc bars No.	Length	Spacing	Quantities Reinforcing Steel-lbs	Concrete-Cu. Yds C.P.C.	C.M.C.	ADD FOR EACH ADDITIONAL PIPE: 4Φa No.	4Φd bars No.	Length	Spacing	Quantities Reinforcing Steel-lbs.	Concrete-Cu. Yds. C.P.C.	C.M.C.	Diam of Pipe
18"	4'-0"	3'-0"	3'-3"	8"	2'-2"	9"	6'-6"	12	4'-6"	3'-5"	1'-0"	1'-1"	8	O_n-3"	4	2'-0"	1'-4"	75	1.74	1.80	4	2	1'-0"	1'-4"	29	0.73	0.78	18"
24"	4'-6"	4'-0"	4'-0"	8"	2'-2"	9"	8'-0"	12	5'-0"	3'-11"	1'-3"	1'-4½"	8	O_n-3"	4	2'-6"	1'-7"	88	2.28	2.36	4	2	1'-3"	1'-7"	36	1.02	1.10	24"
30"	5'-0"	5'-0"	4'-9"	8"	2'-6"	11"	9'-6"	12	5'-9"	4'-5"	1'-5"	1'-8"	8	O_n-3"	8	3'-3"	1'-3"	113	3.05	3.18	4	4	1'-9"	1'-3"	47	1.43	1.56	30"
36"	5'-6"	6'-0"	5'-9"	8"	2'-8"	1'-0"	11'-6"	16	6'-3"	4'-11"	1'-2"	1'-11½"	8	O_n-3"	8	4'-0"	1'-5"	148	4.02	4.19	6	4	2'-3"	1'-5"	63	1.85	2.02	36"
42"	6'-0"	7'-0"	6'-6"	10"	3'-0"	1'-1"	13'-0"	16	7'-0"	5'-5"	1'-4"	2'-3"	8	O_n-3"	8	4'-6"	1'-6"	167	5.68	5.96	6	4	2'-9"	1'-6"	73	2.65	2.93	42"
48"	6'-6"	8'-0"	7'-3"	10"	3'-4"	1'-3"	14'-6"	20	7'-9"	5'-11"	1'-2"	2'-6½"	8	O_n-3"	12	4'-9"	1'-3"	216	6.92	7.28	6	6	3'-0"	1'-3"	86	3.31	3.67	48"
54"	7'-0"	9'-0"	6'-0"	10"	3'-6"	1'-4"	16'-0"	24	8'-3"	6'-5"	1'-0"	2'-10"	8	O_n-3"	12	5'-0"	1'-5"	257	8.12	8.57	8	6	3'-6"	1'-5"	106	3.95	4.39	54"
60"	7'-6"	10'-0"	8'-9	10"	3'-9	1'-5½"	17'-6	28	9'-0"	6'-11"	0'-11"	3'-1½"	8	O_n-3"	12	5'-6"	1'-6½"	305	9.51	10.04	10	6	3'-9"	1'-6½"	129	4.68	5.22	60"

EXPLANATION OF TABULATION

$O_1 = 2C$ $\quad$ $O_2 = 2C + B$
$O_3 = 2C + 2B$ $\quad$ $O_n = 2C + (n-1)B$
Where n = number of pipes

URS Greiner

REVISION 7
SHEET 3

IDENT. NO.	DESCRIPTION	DATE	BY
3	REVISED NOTE #1, #3	5-10-74	PH
2	General Serial Revision	7/6/61	CK

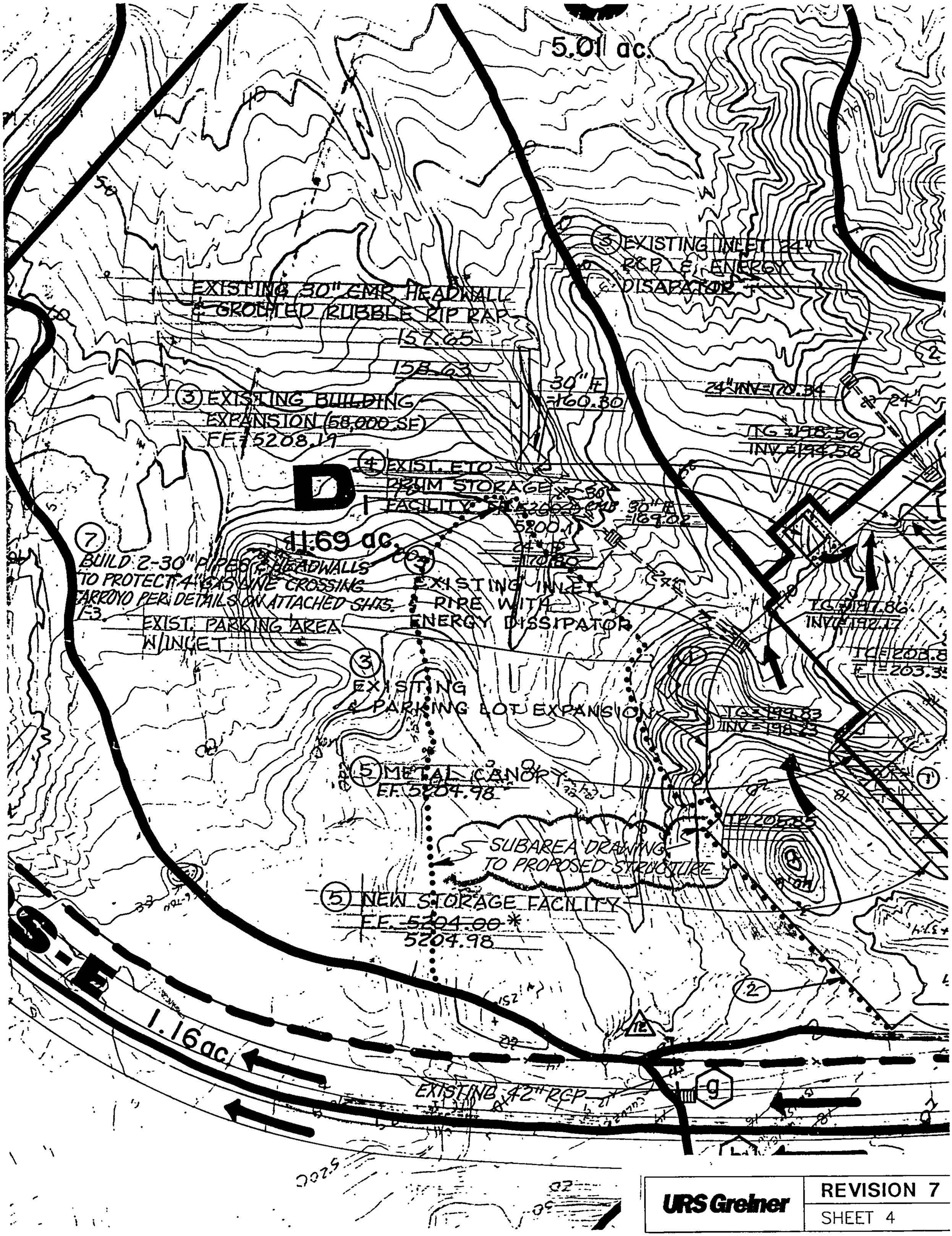
REVISIONS (OR CHANGE NOTICES)

NEW MEXICO
STATE HIGHWAY DEPARTMENT

PIPE CULVERT
HEADWALLS

SERIAL H-1-61

APPROVED: [illegible] 4-6-61



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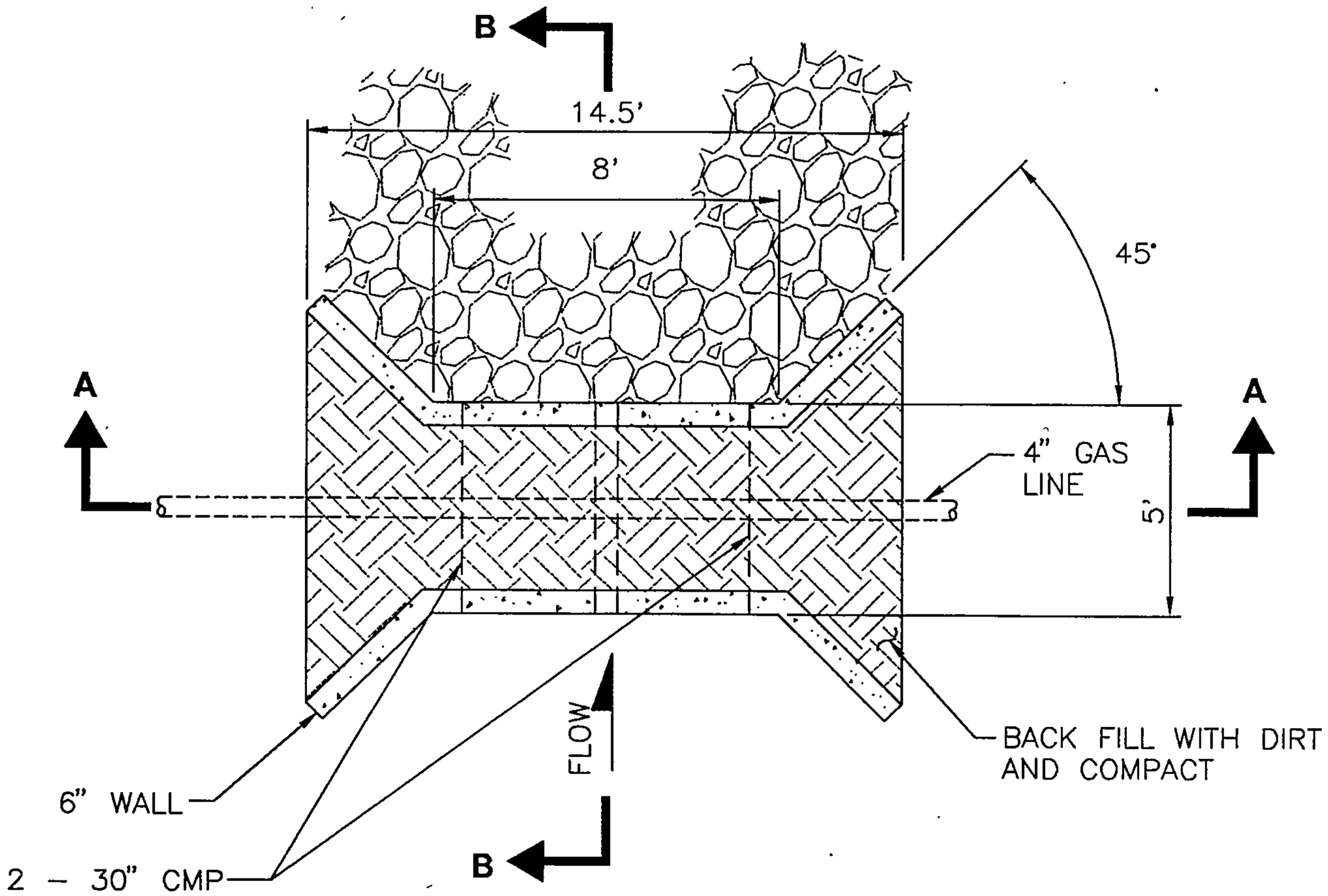
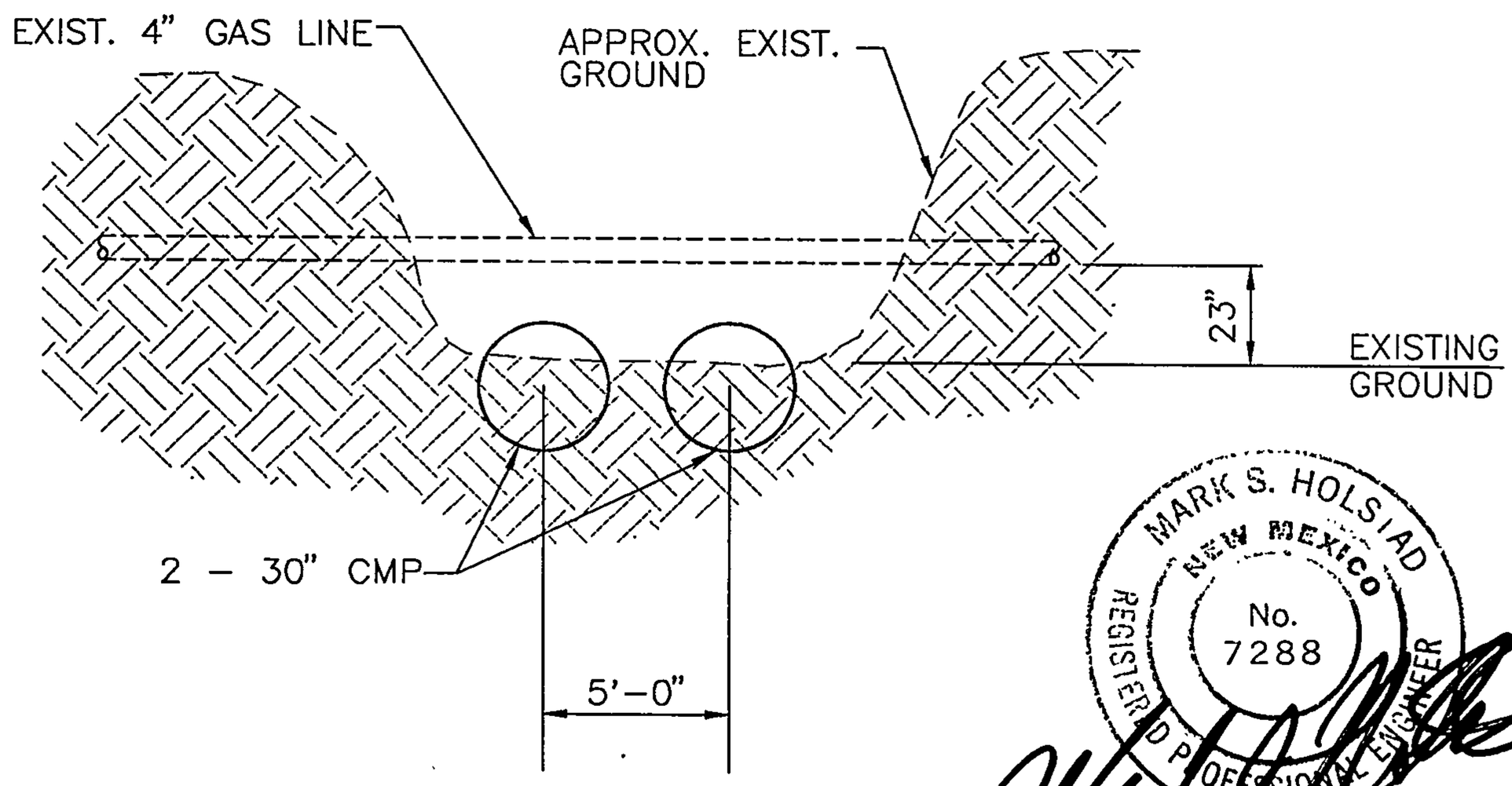
REVISION 7

SHEET 4



PLAN VIEW
NTS



SECTION A-A
NTS

MARK S. HOLSIAD
NEW MEXICO
No. 7288
REGISTERED PROFESSIONAL ENGINEER

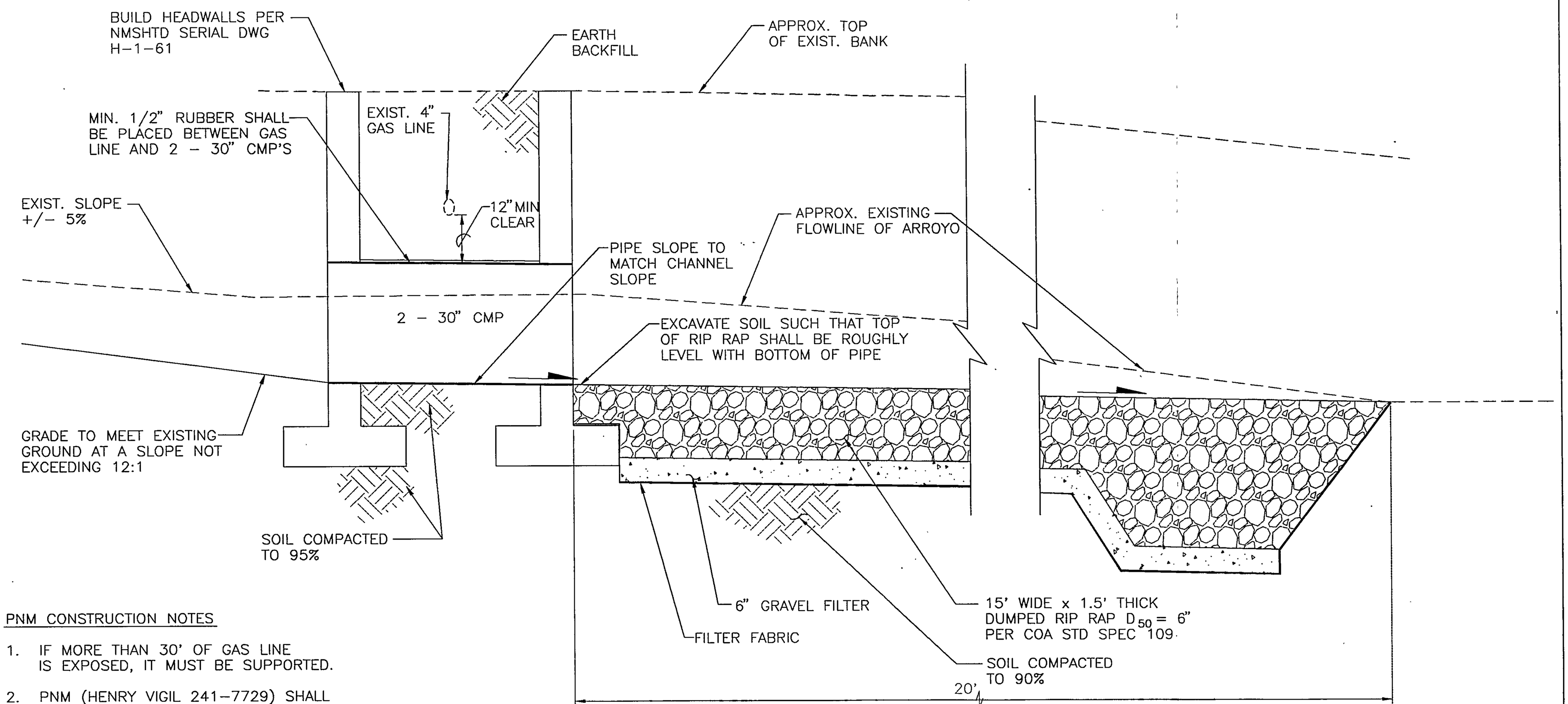
10/31/97

URS Greiner

REVISION 7

SHEET 1

P:\CADD\DETAIL.DWG



SECTION B-B
SCALE: 1" = 2'

PNM CONSTRUCTION NOTES

1. IF MORE THAN 30' OF GAS LINE IS EXPOSED, IT MUST BE SUPPORTED.
2. PNM (HENRY VIGIL 241-7729) SHALL BE NOTIFIED PRIOR TO BACKFILLING THE GAS LINE. 24 HOUR NOTICE IS REQUIRED FOR INSPECTION ONLY. 5 DAY NOTICE IS REQUIRED FOR ANY CONSTRUCTION BY PNM.

Tim Cynova 10/30/97
TIM CYNOVA DATE
APPROVAL BY PNM

MARK S. HOLSIAD
NEW MEXICO
No. 7288
REGISTERED PROFESSIONAL ENGINEER
10/31/97

URS Greiner

REVISION 7
SHEET 2

P:\CADD\DETAIL2.DWG

DRAINAGE INFORMATION

PROJECT TITLE: ETHICON STERILIZATION BLDG. ZONE ATLAS/DRNG. FILE #: P-15 /21

DRB#: _____ EPC #: _____ WORK ORDER #: _____

LEGAL DESCRIPTION: TRACT B, LANDS OF UNM

CITY ADDRESS: 3801 University Blvd. SE

ENGINEERING FIRM: Chavez-Grieves CONTACT: Joe Kelley

ADDRESS: 5639 Jefferson NE PHONE: 344-4080

OWNER: ETHICON ENDO-SURGERY CONTACT: Gary Bouchard

ADDRESS: _____ PHONE: 768-5254

ARCHITECT: Haldeman Powell and Partners CONTACT: Tim Norton

ADDRESS: _____ PHONE: 1-214-701-9000

SURVEYOR: See Engineer CONTACT: _____

ADDRESS: _____ PHONE: _____

CONTRACTOR: Gerald Martin CONTACT: Don Gorez

ADDRESS: 8501 Jefferson NE PHONE: 822-1144

TYPE OF SUBMITTAL:

____ DRAINAGE REPORT

____ DRAINAGE PLAN

____ CONCEPTUAL GRADING & DRAINAGE PLAN

____ GRADING PLAN

____ EROSION CONTROL PLAN

_X_ ENGINEER'S CERTIFICATION

____ OTHER

PRE-DESIGN MEETING:

____ YES

_X_ NO

____ COPY PROVIDED

CHECK TYPE OF APPROVAL SOUGHT:

____ SKETCH PLAT APPROVAL

____ PRELIMINARY PLAT APPROVAL

____ S. DEV. PLAN FOR SUB'D. APPROVAL

____ S. DEV. PLAN FOR BLDG. PRMT. APPROVAL

____ SECTOR PLAN APPROVAL

____ FINAL PLAT APPROVAL

____ FOUNDATION PERMIT APPROVAL

____ BUILDING PERMIT APPROVAL

_X_ CERTIFICATE OF OCCUPANCY APPROVAL

____ GRADING PERMIT APPROVAL

____ PAVING PERMIT APPROVAL

____ S.A.D. DRAINAGE REPORT

____ DRAINAGE REQUIREMENTS

____ OTHER _____ (SPECIFY)

_____

DATE SUBMITTED: September 26, 1996

BY: JOE KELLEY, P.E.

SEP 27 1996

CITY OF
Albuquerque

October 2, 1997

Martin J. Chávez, Mayor

Mark Holstad, P.E.
URS Greiner, Inc.
5971 Jefferson Blvd. NE
Albuquerque, NM 87109

RE: ETHICON GAS LINE PROTECTION (P15-D1). DRAINAGE PLAN REVISION FOR GRADING PERMIT. ENGINEER'S STAMP DATED 9-12-97.

Dear Mr. Holstad:

Based on the information provided on your September 15, 1997 submittal, City Hydrology has the following comments:

1. Show some contours, spot elevations, invert elevations, more dimensions etc. on your attachments. The level of detail should be at least the same as construction drawings.

2. Who will maintain this facility?

3. Concurrence from PNM will be required prior to any permitting.

4. What will you use to support the gas line? More clearance may be needed between the gas line and the 30-inch pipe. Is it possible to elevate the gas line and encase it in concrete?

5. It appears that the gas line will be exposed on top. As a safety consideration, contemplate covering the gas line.

Comments 4, and 5 may be disregarded as long as PNM has no problem with the proximity of the gas line to the storm drain pipes. PNM should sign off on your drawings. If I can be of further assistance, please feel free to contact me at 924-3984.

Sincerely,

Lisa Ann Manwill, P.E.
Hydrology

c: Doug Campbell - PNM
Andrew Garcia
File

DRAINAGE INFORMATION

PROJECT TITLE: ETHICON STERILIZATION BLDG. ZONE ATLAS/DRNG. FILE #: P-15 /201/

DRB#: _____ EPC #: _____ WORK ORDER #: _____

LEGAL DESCRIPTION: TRACT B, LANDS OF UNM

CITY ADDRESS: 3801 University Blvd. SE

ENGINEERING FIRM: Chavez-Grieves CONTACT: Joe Kelley

ADDRESS: 5639 Jefferson NE PHONE: 344-4080

OWNER: ETHICON ENDO-SURGERY CONTACT: Gary Bouchard

ADDRESS: _____ PHONE: 768-5254

ARCHITECT: Haldeman Powell and Partners CONTACT: Tim Norton

ADDRESS: _____ PHONE: 1-214-701-9000

SURVEYOR: See Engineer CONTACT: _____

ADDRESS: _____ PHONE: _____

CONTRACTOR: Gerald Martin CONTACT: Don Gorez

ADDRESS: 8501 Jefferson NE PHONE: 822-1144

TYPE OF SUBMITTAL:

____ DRAINAGE REPORT

____ DRAINAGE PLAN

____ CONCEPTUAL GRADING & DRAINAGE PLAN

____ GRADING PLAN

____ EROSION CONTROL PLAN

_X_ ENGINEER'S CERTIFICATION

____ OTHER

PRE-DESIGN MEETING:

____ YES

_X_ NO

____ COPY PROVIDED

CHECK TYPE OF APPROVAL SOUGHT:

____ SKETCH PLAT APPROVAL

____ PRELIMINARY PLAT APPROVAL

____ S. DEV. PLAN FOR SUB'D. APPROVAL

____ S. DEV. PLAN FOR BLDG. PRMT. APPROVAL

____ SECTOR PLAN APPROVAL

____ FINAL PLAT APPROVAL

____ FOUNDATION PERMIT APPROVAL

____ BUILDING PERMIT APPROVAL

_X_ CERTIFICATE OF OCCUPANCY APPROVAL

____ GRADING PERMIT APPROVAL

____ PAVING PERMIT APPROVAL

____ S.A.D. DRAINAGE REPORT

____ DRAINAGE REQUIREMENTS

____ OTHER _____ (SPECIFY)

30 day Temp Co. issued on 10-28-96 Ag

DATE SUBMITTED: 10-23-96

BY: JOE KELLEY, P.E.

RECEIVED
OCT 24
HYDROLOGY

CHAVEZ · GRIEVES
CONSULTING ENGINEERS, INC.
THE ENGINEERING FIRM OF CHOICE

5639 JEFFERSON STREET NE · ALBUQUERQUE, NEW MEXICO 87109 · PHONE (505) 344·4080 · FAX (505) 343·8759

October 23, 1996

Ms. Lisa Ann Manwill
City of Albuquerque Hydrology
P.O. Box 1293
Albuquerque, NM 87103

RE: ETHICON STERILIZATION BUILDING (P15/D1)
C-G PROJECT NUMBER: H23-100-5195

Dear Ms. Manwill:

Enclosed is the Engineer's certification for this project revised per your comments dated October 11, 1996. Your comments have been addressed as follows:

1. The Engineer stamp date was changed because a new plot was made of the drawing. As you may be aware we use AutoCAD on all of our drawings and it is easier for us to make changes electronically rather than by hand, so we have redated the engineers stamp date with the July 2 date to show that it is the same submittal as before.

2. The engineers certification has been stamped.

3. Finished elevations that had been shot have been checked.

4. Chavez-Grieves did the as-built survey.

Should you have any questions prior to giving certificate of occupancy approval, please feel free to give me a call.

Sincerely,

CHAVEZ-GRIEVES CONSULTING ENGINEERS, INC.

Joe Kelley

Joe P. Kelley, P.E.
Senior Engineer

JPK/lr

CY: Don Gorenz, Gerald Martin Contractors
Fax: 828-9491

RECEIVED
OCT 24
HYDROLOGY

G:\H23\100\DOCUMENT\ETHICON2 WPD

THE ENGINEERING FIRM OF CHOICE

CHAVEZ · GRIEVES CONSULTING ENGINEERS, INC.

5639 JEFFERSON STREET NE · ALBUQUERQUE, NEW MEXICO 87109 · PHONE (505) 344·4080 · FAX (505) 343·8759

LETTER OF TRANSMITTAL

TO: City Hydrology

DATE: 9/26/96

JOB # H23-100-5195

RE: Ethicon Sterilization

ATTN:

WE ARE SENDING YOU X **ATTACHED** ___ **UNDER SEPARATE COVER, THE FOLLOWING ITEMS:**

___SHOP DRAWINGS	X PLANS	___SPECIFICATIONS	___DISKETTE
___CHANGE ORDER	___PRINTS	___CALCULATIONS	___PROPOSAL INFO
___COPY OF LETTER	___SAMPLES	___REPORT	___ _____

COPIES	DATE	NO.	DESCRIPTION
1	Drainage Information sheet		
1	C2.0		Grading + Drainage Plan

THESE ARE TRANSMITTED AS CHECKED BELOW:

X FOR YOUR USE	___FOR REVIEW & COMMENT
___AS REQUESTED	___RETURNED AFTER LOAN TO US
___PLEASE CORRECT AND RESUBMIT	___SUBMIT___COPIES FOR DISTRIBUTION
___RESUBMITTAL IS NOT REQUIRED	___RETURN___CORRECTED PRINTS
CORRECTIONS, IF ANY, ARE NOTED	___BIDS/PROPOSALS DUE _____ 199_

REMARKS:

COPIES TO: Ethicon Endo-Surgery and Haldeman Powell + Partners file

SIGNED: Donna Beldung

IF ENCLOSURES ARE NOT AS NOTED, KINDLY NOTIFY US AT ONCE.

REV.9/95

XC: COVER only

DRAINAGE REPORT

ETHICON/JOHNSON & JOHNSON

PROPERTY IN

ALBUQUERQUE, NEW MEXICO

P15-D1

OCTOBER, 1979

RECEIVED

OCT 19 1979

CITY ENGINEER

Prepared by:

Meurer, Serafini and Meurer, Inc.
2601 Wyoming Boulevard N.E.
Albuquerque, New Mexico 87112

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DRAINAGE REPORT

ETHICON/JOHNSON & JOHNSON

PROPERTY IN

ALBUQUERQUE, NEW MEXICO

PURPOSE AND SCOPE

Ethicon/Johnson & Johnson is developing an industrial plant in the Albuquerque area on approximately 66.8 acres in the southeast quadrant at the northeast corner of I-25 and Rio Bravo which turns into the future extension of University Boulevard. This property fronts along I-25 from this intersection to the south boundary of the University of New Mexico golf course. On September 18, 1979, Meurer, Serafini and Meurer, Inc. was hired by Chakos, Zentner, Marcum Architects for this project, to do a drainage report for this site that would satisfy the requirements of AMAFCA and the City of Albuquerque. This report will show that the developed flows from this site as a whole will be less in peak magnitude than the undeveloped condition, while taking into consideration the future paving of University Boulevard.

SITE LOCATION AND TOPOGRAPHY

This site is located within the City of Albuquerque in Zone Atlas Sheet P-15, and is covered under the present sector plan for this general area of the City. More specifically, this site is located in Section 9, Township 9 North, Range 3 East, of the New Mexico Principal Meridian, Bernalillo County, New Mexico. The land slopes from the east to the west from 2 to 15%. There has been some significant alteration of the natural topography in the past by excavation for the future University Boulevard which has cut off some flows

from the east that have been planned to go through this site by this report. There presently exists two major pipes within the proposed right-of-way of University Boulevard, one 36"CMP draining into area A and one 48"CMP with a berm across the proposed University Boulevard right-of-way draining into area D. The USDA soil classification for this area is BKD, Bluepoint Kokan Association. A copy of the portion of the Soil Survey of Bernalillo County by S.C.S. that applies to this site is included in Appendix 1. The soil for this site is generally a loamy fine sand to gravely sand. There is slight desert vegetation on this site with the majority of the area planned for development already stripped in the recent past. A major portion of this tract will be left in its native condition.

DESIGN CONSIDERATIONS

The major design considerations for this site are the hydrologic method, the proposed University Boulevard extension, the existing pipes across the proposed University Boulevard, the capacity of the existing pipes under I-25, and the manner used to offset the effects of development on the runoff.

In analyzing the storm runoff both offsite and onsite flows the rational formula Q = CIA was used where:

Q = Runoff quantity cubic feet/second

A = Contributing area in acres

I = Intensity and interest/hour for a duration equal to the time of accumulation (duration) measured in minutes and obtained from figure 4 (Note: Where time of concentration T_c is less than 10 minutes for a major area the intensity valve, derived from T_c equal to 10 minutes is employed).

C = Runoff coefficient (no unit) this coefficient represents the intergrated effects of infiltration detention storage evaporation retention and interception which all effect the time distribution and peak rate of runoff.

The proposed University Boulevard extension will create additional runoff in this area which can be conveyed through this site at points 1, 11, 12 and 14. The proposed right-of-way has previously been graded to an approximate subgrade of the future roadway in much of this area, and pipes have been installed at points 1 and 11 which convey flow from offsite areas through this site. In addition, a berm has been built up between points 11 and 12 that direct the majority of the flow intercepted in this proposed right-of-way through area D.

It is the owners desire not to have ponding around the buildings or on the parking lots on this site, therefore, it was decided to construct two major detention dams to offset the effects of the development of this site due to the increased impervious area. Neither of these dams will hold water permanently but will only serve to reduce the peak flow during major storms.

ESTIMATED RUNOFF UNDEVELOPED STATE

Drainage through this site is primarily conveyed through two major arroyos, two minor arroyos, and the proposed right-of-way of University Boulevard. The major arroyos are contained within area A and area D. Both area A and area D are conveying a significant amount of flow from offsite through them in a channelized condition. In both cased the arroyos have approximately 5' to 20' bottoms with varying side slopes

from the proposed University Boulevard to I-25, where they discharge into existing 60" concrete pipes. The flows entering area A from offsite are transported through a 36"CMP at point 1 (see Figure 1). The flows entering area D-1 occur through an existing 48"CMP and a berm across the proposed University Boulevard right-of-way. Both of the minor arroyos in area B and area C drain only the areas onsite.

The following Table 1 is the summary of the historic runoff conditions for the various areas. Table 2 following it shows the summation of flows at key points.

TABLE 1

UNDEVELOPED AREA FLOWS

Area Designation	Area Acres	c Factor	t_c	DISCHARGE Q_{100}	DISCHARGE Q_{10}
A	35.74	.3	10	57.9	28.7
B	6.96	.3	5	13.2	6.6
C	6.32	.3	10	10.3	5.1
D_1	11.97	.3	10	17.4	9.6
D_2	2.57	.3	5	4.9	2.4
E	2.57	.3	5	4.9	2.4
F	0.68	.3	5	1.3	.7
OS-a_2	1.4	.3	5	2.6	1.3
OS-A_2	12.0	.3	10	19.4	9.6
OS-A_3	4.5	.3	10	7.3	3.6
OS-B	0.71	.3	5	1.3	0.7
OS-C	0.28	.3	5	0.5	0.3
OS-D_1	0.83	.3	5	1.6	0.8
OS-D_2	1.53	.3	10.58	2.4	1.2
OS-D_3	11.5	.3	11.6	17.8	8.8
OS-D_4	21.7	.3	10	35.2	17.4
OS-E	1.16	.3	5	2.2	1.1
OS-F_1	1.02	.3	10.6	1.6	0.8

TABLE 2

POINT SUMMATION OF UNDEVELOPED FLOWS

Point Designation	Contributing Acres	c X A	t_c min.	DISCHARGE Q_{100}	DISCHARGE Q_{10}
1	12.0	3.6	10	19.4	9.6
6	49.1	14.73	17.85	65.0	32.0
9	7.67	2.30	5	14.5	7.2
10	6.6	1.98	10	10.7	5.3
11	21.7	6.51	10	35.2	17.4
12	43.5	13.05	15.7	60.6	29.9
13	56.3	16.89	19.9	71.1	35.0
14	3.8	1.2	5	7.1	3.5

ESTIMATED RUNOFF DEVELOPED CONDITIONS

Figure 2 shows the developed drainage areas for the ultimate planned expansion of this site. All flows shown in this report were determined based on the ultimate expansion of this site so that no future drainage study would be necessary unless the master plan for this site changes. As shown on Figure 2 the offsite flows are conveyed through this property at approximately the same locations as in the undeveloped case. At point 1 the existing 36"CMP is used and extended through area A-2 with additional inlets by others anticipated with the development of University Boulevard. With the elimination of the berm between points 11 and 12 a new pipe will need to be installed by the City with the development of University Boulevard and additional inlets to be located at this point also.

To offset the effects of the proposed development, detention dams are planned to be built at points 5 and 8 in area A and in area B, respectively, since the majority of the development will occur in these drainage areas. In area A-2 the arroyo will be filled in and offsite drainage will be conveyed by a storm sewer pipe which will also collect the flow from areas A-4, A-5, and A-6 through sump inlets and branch storm drainage pipes. This system will then discharge up stream of dam 1 and at point 4.

All of the B areas to be developed are collected and discharged at point 7, these will include sump inlets and roof drains. This flow then runs down the existing arroyo in area B-2 to the proposed dam 2.

The only developed area that is not draining directly to dam 1 or dam 2 is the proposed right-of-way of University Boulevard in OSD2 and the future parking lot in area D-1 of approximately 1.19 acres. Even with three uncontrolled developed flows, the flow at point 13 is still not significantly above the undeveloped rate, and the primary increase

is due to the paving of University Boulevard and draining it through area D-1.

Both detention dams 1 and 2 have been designed with a minimum of 2' of siltation volume at the bottom of the dams and will have a pipe running through the dams and then have a riser pipe at least 2' high to allow for infiltration and siltation. Dam 3 at area A-3 is proposed for assethetic purposes only and is not necessary to be constructed. Its primary purpose is to slow down the runoff from the roof drains draining into area A-2. It will not significantly affect the drainage into A-2 and the outflow hydrograph from dam 1. It will however, help control the erosion of the area draining upstream of dam 1.

The flows were routed through both dam 1 and 2 and then combined with areas not upstream of the dams to calculate the flows at point 6 and point 9 which produced flows significantly below the historic condition. In order to obtain an accurate storm hydrograph the peak flows obtained from the rational formula were used upstream of each dam then the total 6 hour volume for the areas upstream of each dam were calculated and this was divided by the peak flow to determine a time base assuming a time to peak of 1/3 of the total time base. This methodology makes the volume under the hydrograph equal to the total six hour volume. The resulting modified time to peak was then used in routing a triangular hydrograph through each of the dams. These calculations and hydrographs are shown in the appendices. The following Table 3 shows the developed flow conditions for both the 100 year and 10 year frequency for all of the areas both onsite and offsite in the developed condition. Table 4 shows the summation of flows at key points. These points are shown on Figure 2 and are consistant with the point numbering on Figure 1 for easy comparison purposes.

TABLE 3

DEVELOPED FLOWS

Area Designated	Area in Acres	c factor	t_c min	DISCHARGE Q_{100}	DISCHARGE Q_{10}
A_1	8.41	.3	10	13.6	6.8
A_2	16.47	.312	10	27.8	13.8
A_3	2.08	.75	5	9.8	4.9
A_4	2.04	.81	5	10.4	5.2
A_5	4.0	.804	10	17.4	8.6
A_6	3.92	.714	10	15.1	7.5
A_7	0.68	.3	5	1.3	0.6
B_1	0.76	.3	5	1.4	0.7
B_2	4.23	.3	10	6.9	3.4
B_3	0.83	.9	5	4.8	2.4
B_4	2.82	.84	5	14.9	7.4
C	5.01	.3	10	8.1	4.0
D_1	11.73	.36	10	22.8	11.3
D_2	1.26	.35	10	2.4	1.2
E	2.57	.3	5	4.9	2.4
OS-A_2	12.0	.3	10	19.4	9.6
OS-A_3	4.5	.32	5	9.1	4.5
OS-A_7	0.83	.58	5	3.0	1.5
OS-a_2	1.4	.3	5	2.6	1.3
OS-D_2	1.7	.58	10	5.3	2.6
OS-D_3	11.5	.34	11.6	17.8	8.8
OS-D_4	21.7	.3	10	35.2	17.4
OS-E	1.16	.58	5	4.2	2.1
OS-B	0.71	.3	5	1.3	0.7
OS-C	0.28	.3	5	0.5	0.3
OS-D_1	0.83	.3	5	1.6	0.8

TABLE 4

POINT SUMMATION OF DEVELOPED FLOWS

Point Designation	Area in acres	c factor	t_c min	DISCHARGE Q100	Q10
a	3.92	2.8	10	15.1	7.5
b	4.0	3.22	10	17.4	8.6
c	2.4	1.65	5	10.4	5.2
d	2.82	2.37	5	14.9	7.4
e	1.5	0.68	5.0	4.3	2.1
f	4.5	1.44	5	9.1	4.5
g	2.96	1.43	10	7.7	3.8
h	11.5	3.91	11.6	20.2	10.0
1	12.0	3.6	10	19.4	9.6
2	21.92	8.52	10.7	45.1	22.3
3	25.92	11.74	11.02	61.6	30.5
4	27.96	13.39	11.48	69.4	34.5
5	46.51	20.09	13.38	98.8	48.8
6	56.33	*	25	48.0	-
7	3.66	3.126	5.28	19.5	9.7
8	7.93	4.466	7.28	26.2	13.0
9	9.39	*	30	12.9	-
10	5.29	1.587	10	8.6	4.3
11	21.7	6.51	10	35.2	17.4
12	36.16	11.85	11.73	61.0	30.2
13	48.72	16.32	16.15	74.7	36.9
14	3.73	1.444	5	9.1	4.5
15	1.19	1.07	5	6.7	3.4

* Routed thru Dam 1 and 2.

EXPLANATION OF RESULTS

The development of this site as shown by the following Table 5, actually reduces the peak flow downstream.

TABLE 5

COMPARISON OF FLOWS

Point Designation	Q capacity cfs	Historic Q_{100} cfs	Developed Q_{100} cfs
6	133	65.0	48.0
4	55	14.5	12.9
10	70	10.7	8.6
13	170	71.1	74.7
20*	-	92.0	91.5

* Point downstream offsite where flow from points 9, 10 and 13 combine (only area upstream of I-25 included in calculation, for comparison purposes only).

The actual volume of runoff from this site will be increased, but the downstream facilities appear adequate, and the South Diversion Channel is only about 2000 feet downstream.

The siltation volume upstream of dams 1 and 2 are 2100 cubic feet and 11,000 cubic feet respectively. As noted previously this design is for ultimate planned development, and in the interium the peak discharges will be even less than shown in this report.

RECOMMENDATIONS

The following recommendations are made to enable the developer of this site and the local government to complete this project within the design criteria:

1. The storm sewer lines across the proposed University Boulevard should be left in place or replaced, and additonal inlets should be constructed as part of the University Boulevard project by the City of Albuquerque.

2. The arroyo in area A-2 is to be filled, and the flows conveyed by a storm sewer pipe as shown in Figure 2.
3. All drainage from the parking lots and buildings shall be collected at sump inlets or rundowns are discharged at the location shown.
4. Drainage easements at least 10 foot in width shall be provided on the final plat for this site on all major drainage ways; these easements may be relocated in the future if necessary.
5. Detention dams 1 and 2 shall be constructed at the locations shown, and the material onsite shall be used for the necessary fill and compacted in accordance with recommendations by a registered soils engineer.
6. The outflow structures at dam 1 and 2 shall be designed to provide 1' to 2' of siltation storage upstream of the respective dams. This siltation area shall be drained by a small pipe covered with filter cloth.
7. Detention dam 3 may be constructed at the owner's discretion to reduce erosion upstream of dam 1.
8. Emergency spillways out of existing soil shall be constructed at dam 1 and dam 2 at a height at least 1 foot below the crest, and shall be constructed across virgin material and not across the main embankment of the dam.
9. No additional drainage approval shall be required for future expansions of this site as long as they conform approximately to this master drainage plan.
10. To avoid excessive siltation of the sump inlets at point a,b, c and d 12" to 18" berms shall be constructed around future paved areas that drain into phase 1 paved areas to control erosion.

11. The site shall be graded to conform to the ultimate planned expansion as much as possible in conformance with 9 above.

Respectifully Submitted:

Jeryl D. Hart, Jr.,
N.M.P.E. No. 6788

10/18/

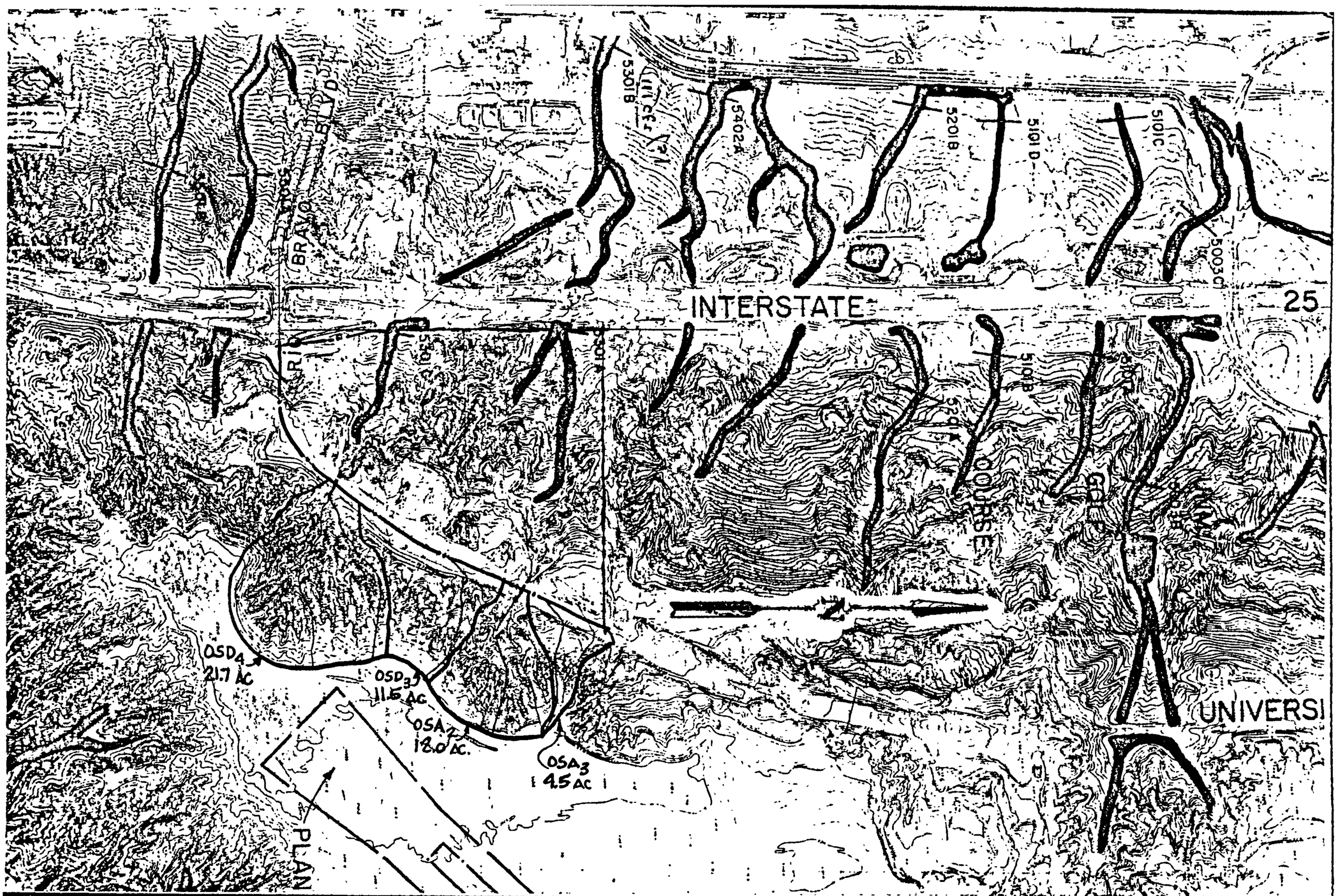
Date

JERYL D. HART, JR.
NEW MEXICO
6788
REGISTERED PROFESSIONAL ENGINEER

Approved:

for A.M.A.F.C.A.

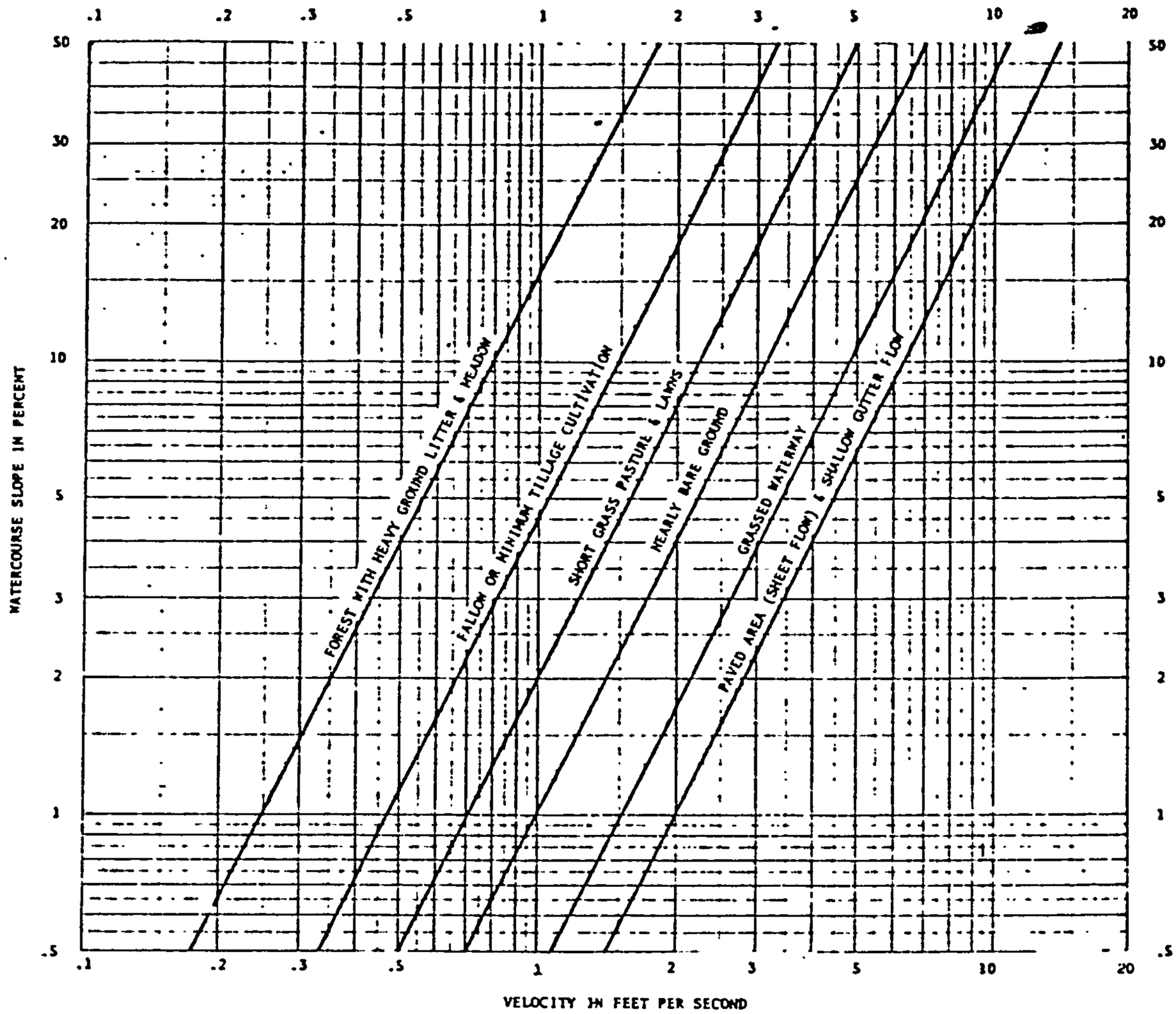
Date



1" = 800'

FIGURE 3

MEURER, SERAFINI AND MEURER, INC.
CONSULTING ENGINEERS • SURVEYORS • PLANNERS
2601 Wyoming Blvd., N.E. Albuquerque, New Mexico 87110
(505) 292-1936



Average velocities for estimating travel time for overland flow.

REPRODUCED FROM
"URBAN HYDROLOGY FOR
SMALL WATERSHEDS"
TECH. RELEASE NO. 55
JANUARY 1975.
PAGE 3-2

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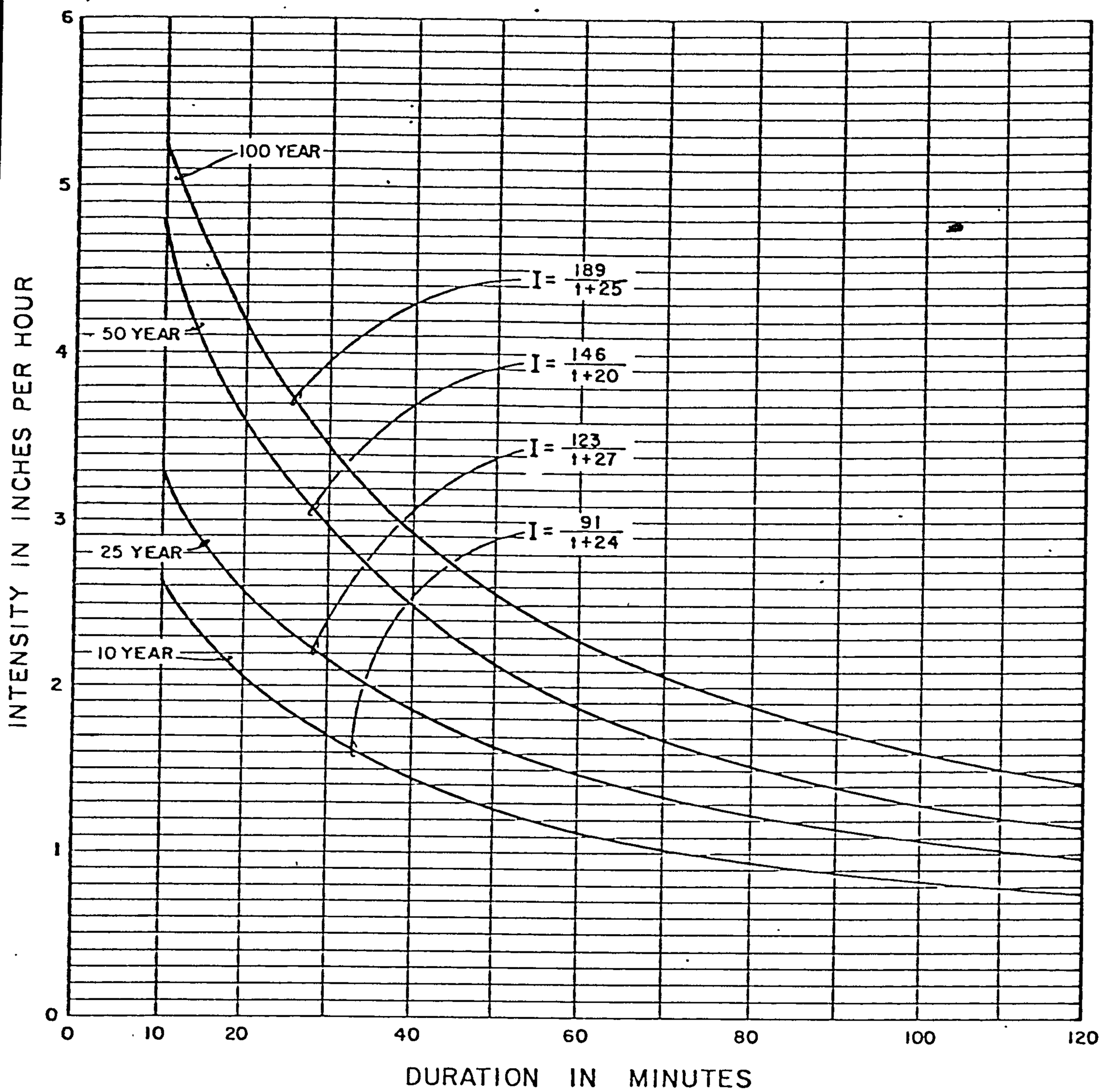
FIGURE 4



MASTER PLAN OF DRAINAGE
PREPARED BY:
GORDON HERKENHOFF & ASSOCIATES
ALBUQUERQUE, NEW MEXICO

INTENSITY DURATION FREQUENCY CURVES
(ALBUQUERQUE AREA, 1961)

FIGURE 5

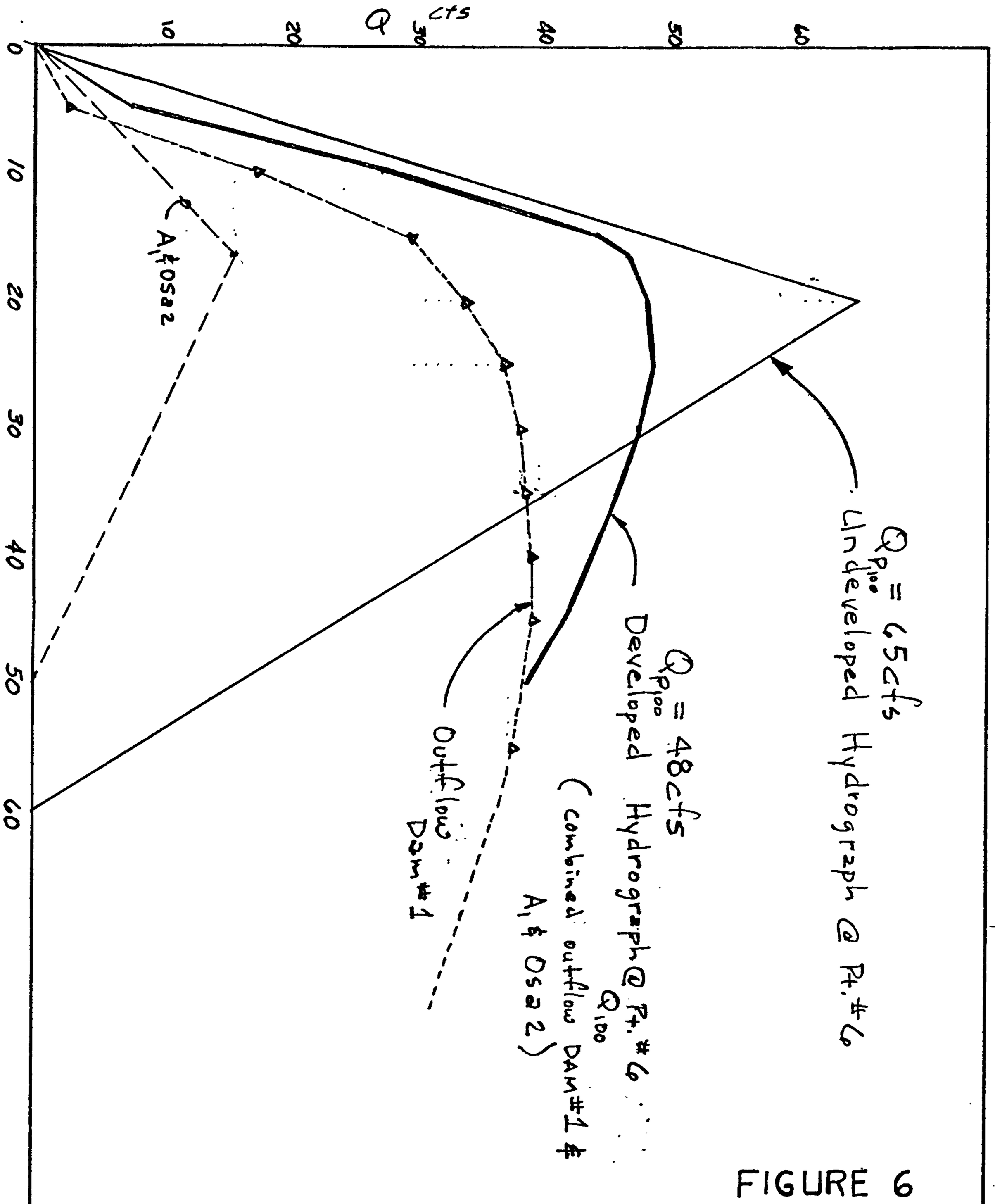


FIGURE 6

UNDEVELOPED & DEVELOPED 100 YR. HYDROGRAPH @ POINT #6

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JOB NO. [illegible] DATE 10/17/79

PROJECT [illegible]

SCALE

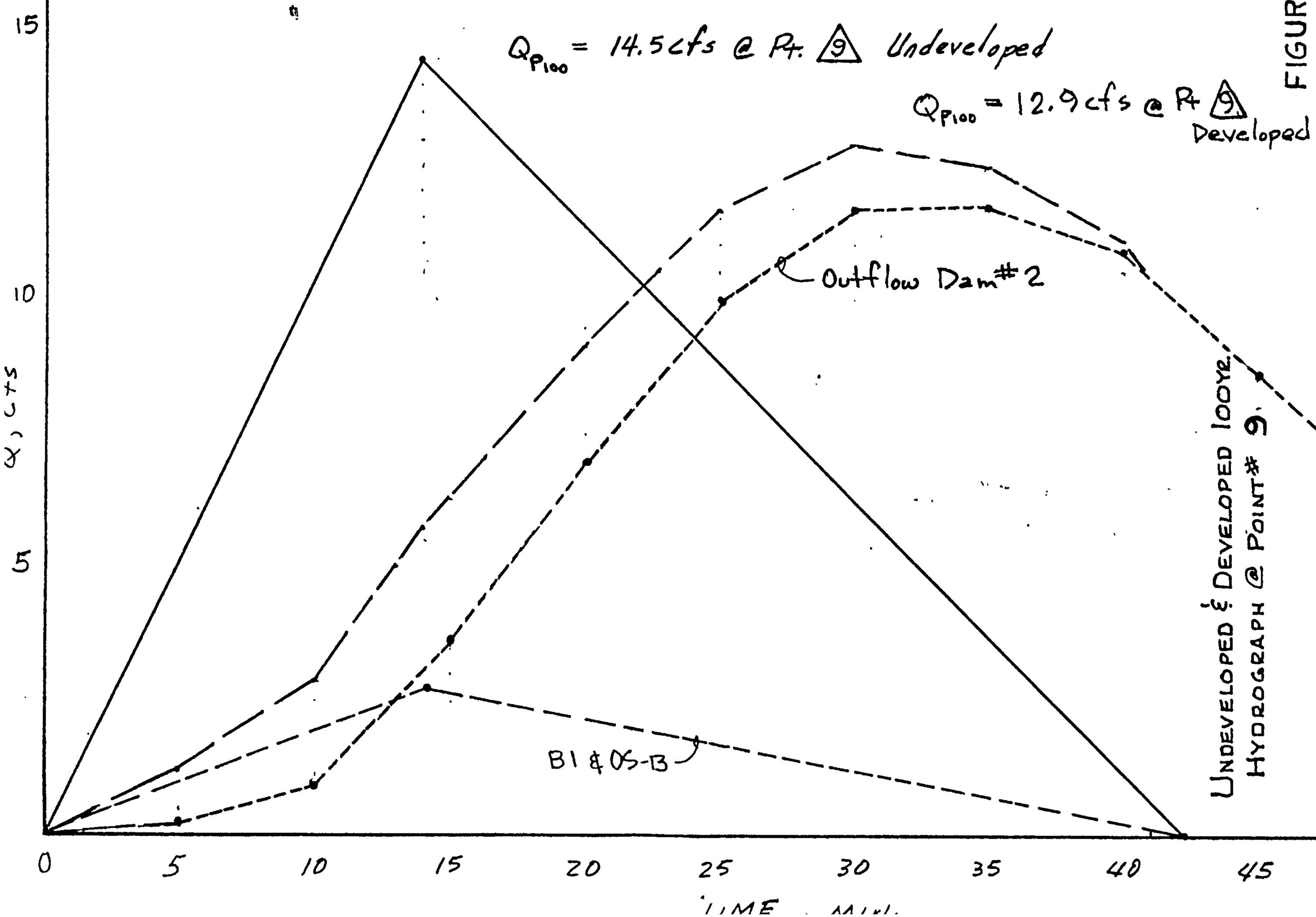

FIGURE 7

UNDEVELOPED & DEVELOPED 100YR. HYDROGRAPH @ POINT# 9

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PROJECT _____

SCALE JH

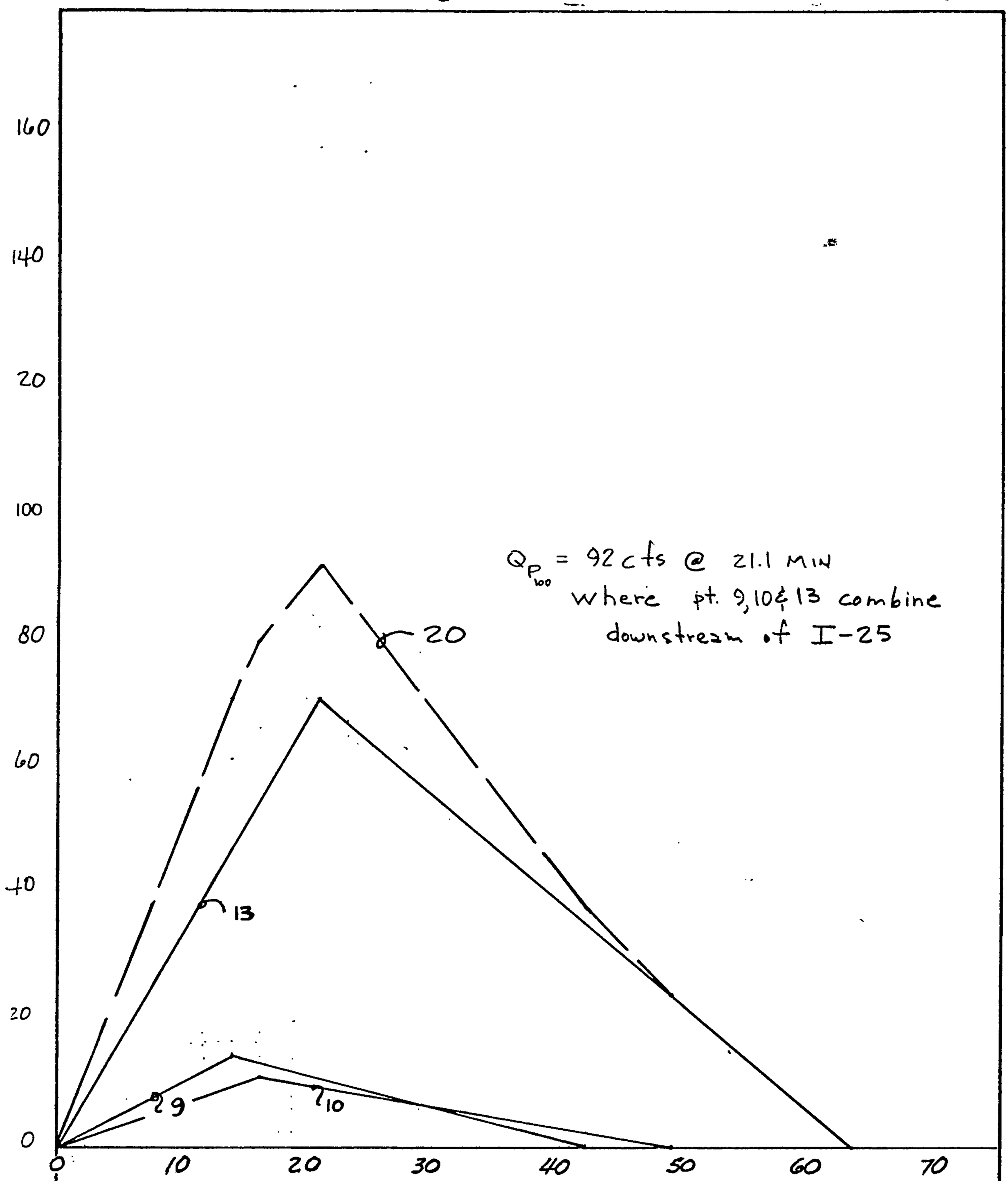

FIGURE 8

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JOB NO. _____ DATE 10/17/79

PROJECT Undeveloped 100yr Hydrograph @ Pt. 20 SCALE _____

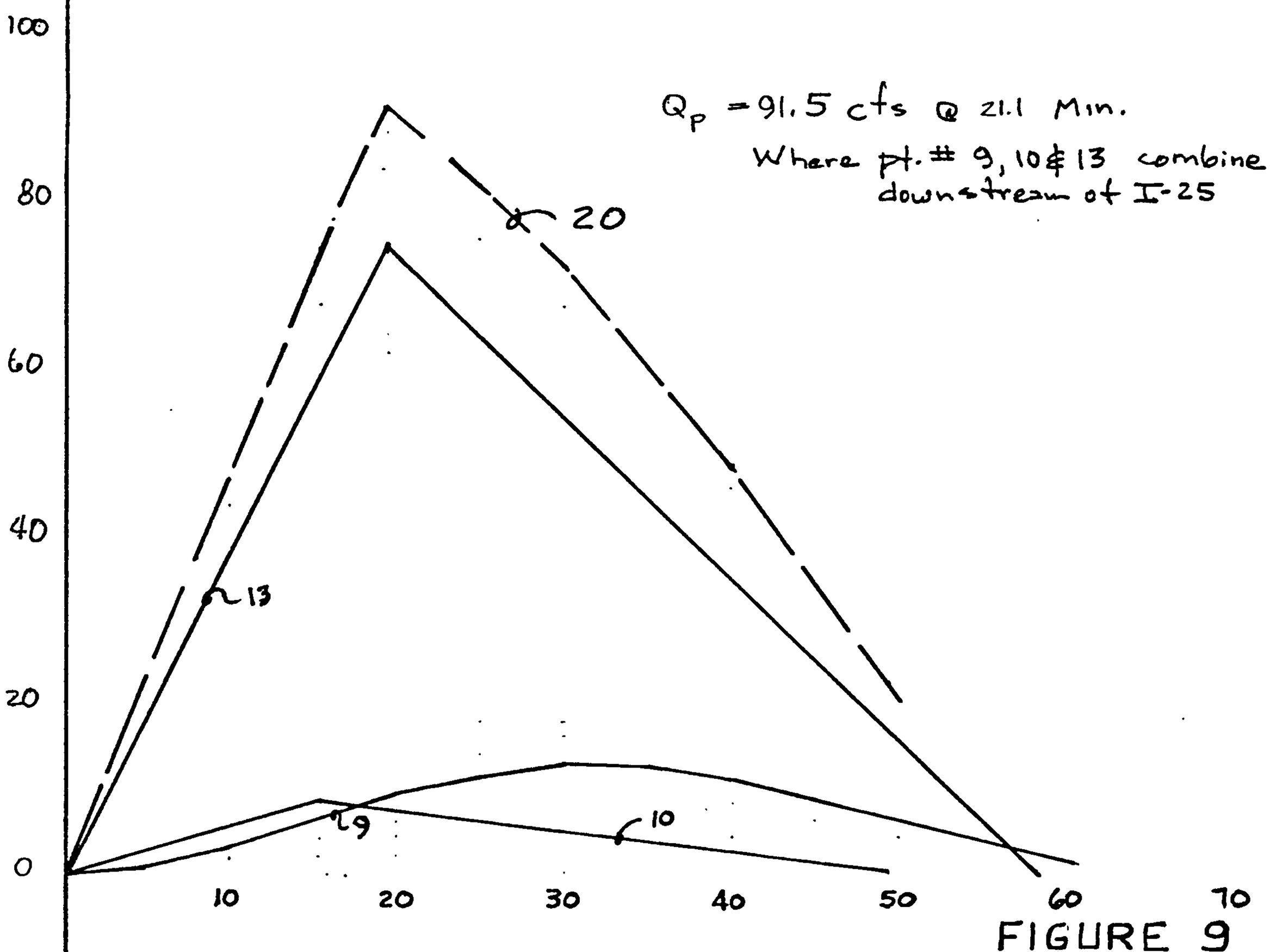

FIGURE 9

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JOB NO. _____ DATE 10/17/79

PROJECT Developed 100yr Hydrograph @ Pt. 20

SCALE _____

A P P E N D I C E S

A P P E N D I C E S

Appendix 1 - Excerpts from Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties; New Mexico by U.S.D.A. Soil Conservation Service, et. al., 1977.

Appendix 2 - Undeveloped Drainage Flows

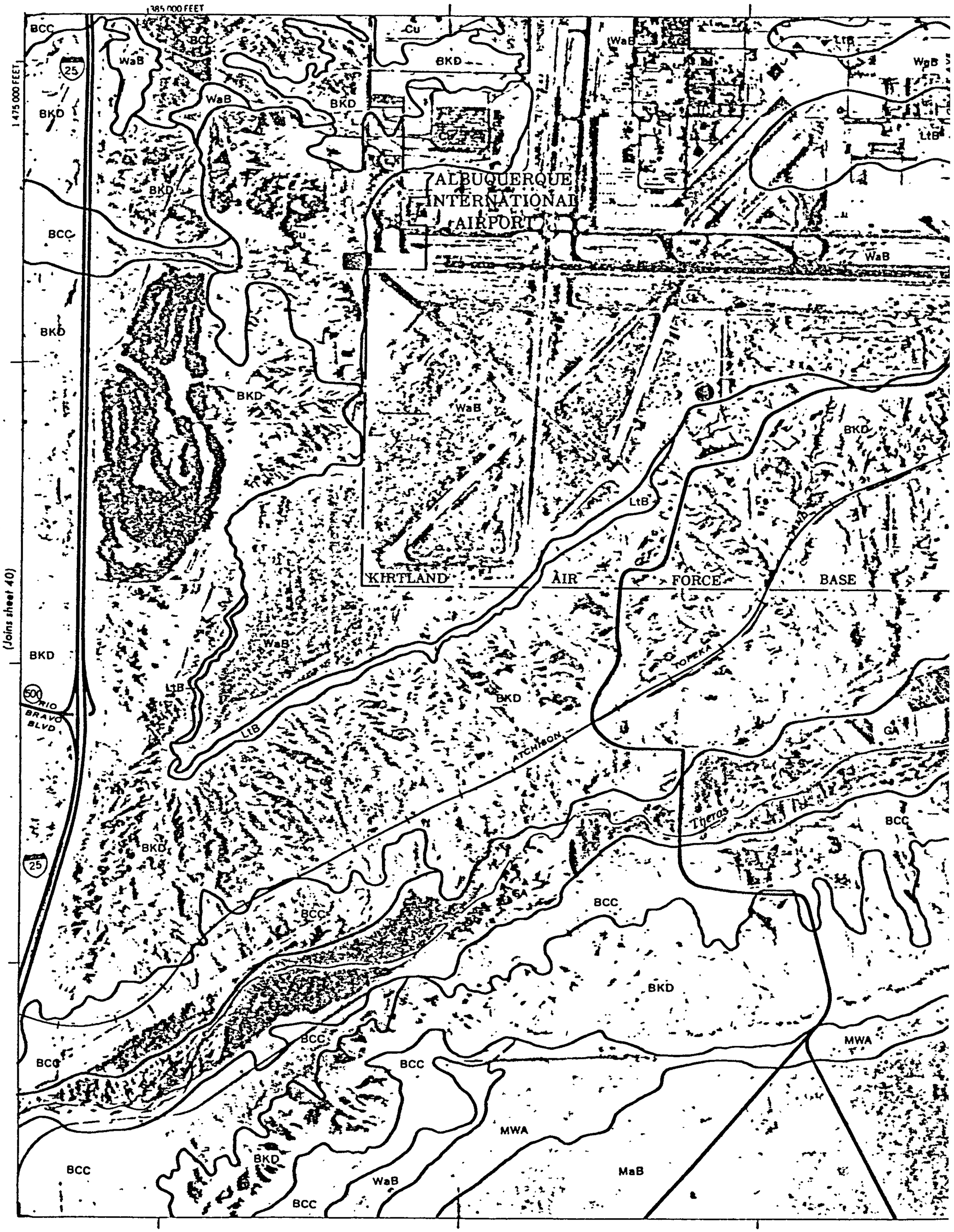
Appendix 3 - Developed Drainage Flows

Appendix 4 - Flood Routing through Dam 1 and Dam 2

Appendix 5 - Hydrograph Calculations

APPENDIX 1

EXCERPTS FROM SOIL SURVEY OF BERNALILLO COUNTY AND PARTS OF SANDOVAL AND VALENCIA COUNTIES; NEW MEXICO BY USDA SOIL CONSERVATION SERVICE, ET.AL. 1977


385 000 FEET
1 475 000 FEET
(Joins sheet 40)
ALBUQUERQUE INTERNATIONAL AIRPORT
KIRTLAND AIR FORCE BASE
RIO BRAVO BLVD
ATCHISON TOPEKA
Tijeras
BCC
BKD
WaB
LtB
Cu
MWA
MaB
GA

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Irrigated capability unit		Dryland capability subclass	Native plant community	
			Symbol	Page	Symbol	Symbol	Page
TgB	Tijeras gravelly fine sandy loam, 1 to 5 percent slopes	41	-------	--	VIIe	4	51
To	Tome very fine sandy loam	41	-------	--	VIIe	4	51
Va	Vinton loamy sand	43	IIIe-11	47	------	--	--
VbA	Vinton sandy loam, 0 to 1 percent slopes	43	IIIe-11	47	------	--	--
Vc	Vinton clay loam	43	IIs-4	47	------	--	--
WaB	Wink fine sandy loam, 0 to 5 percent slopes	44	-------	--	VIIe	4	51
WeB	Wink-Embudo complex, 0 to 5 percent slopes	44	-------	--	VIIe	4	51

MEDIUM-INTENSITY SURVEY

Map symbol	Mapping unit	Described on page	Dryland capability subclass	Native plant community		Timber suitability group
			Symbol	Symbol	Page	Symbol
BCC	Bluepoint loamy fine sand, 1 to 9 percent slopes	13	VIIe	2	50	--
BKD	Bluepoint-Kokan association, hilly	13	VIIe	--	--	--
	Bluepoint soil	--	------	2	50	--
	Kokan soil	--	------	3	50	--
BOF	Borolls-Rock outcrop association, very steep	14	------	--	--	--
	Borolls soil	--	VIIs	11	52	5
	Rock outcrop	--	VIIIs	--	--	--
BUE	Burnac gravelly loam, 20 to 60 percent slopes	16	VIIe	11	52	4
CAF	Carlito complex, 15 to 80 percent slopes	17	VIIe	7	51	--
GA	Gila fine sandy loam	19	VIIe	4	51	--
GF	Gila complex, moderately alkali	20	VIIe	1	50	--
GH	Gila-Hantz complex	20	VIIe	1	50	--
ILC	Ildefonso gravelly sandy loam, 1 to 9 percent slopes	22	VIIe	7	51	--
KD	Kim-Badland association	22	------	--	--	--
	Kim soil	--	VIe	9	52	--
	Badland soil	--	VIIIe	--	--	--
KOE	Kokan gravelly sand, 10 to 40 percent slopes	23	VIIe	3	50	--
KR	Kokan-Rock outcrop association	23	------	--	--	--
	Kokan soil	--	VIIe	3	50	--
	Rock outcrop	--	VIIIs	--	--	--
KS	Kolob stony loam	23	VIIe	11	52	2
KT	Kolob-Rock outcrop association	24	-------	--	--	--
	Kolob soil	--	VIIe	11	52	2
	Rock outcrop	--	VIIIs	--	--	--
KU	Kolob-Sandia association	24	VIIe	11	52	4
KVE	Kolob stony loam, cold variant, 15 to 40 percent slopes	24	VIIe	12	52	3
LBE	Laporte-Rock outcrop complex, 20 to 45 percent slopes	25	VIIs	--	--	--
	Laporte soil	--	------	7	51	--
	Rock outcrop	--	------	--	--	--
LRD	Laporte-Rock outcrop-Escabosa complex, 5 to 20 percent slopes	25	VIIs	--	--	--
	Laporte soil	--	------	7	51	--
	Rock outcrop	--	------	--	--	--
	Escabosa soil	--	------	7	51	--
MWA	Madurez-Wink association, gently sloping	27	VIIe	4	51	--

West of the Rio Puerco, Badland consists of weathered soft shale and weakly consolidated sandstone, siltstone, and conglomerate. Included in mapping are mainly areas of Shingle and Kim soils.

In the foothills, Badland is mainly weathered soft shale, but commonly has a thin mantle of limestone, sandstone, granite, gneiss, or schist. Included in mapping is mainly Borolls-Rock outcrop association, very steep.

Permeability is variable, runoff is rapid to very rapid, and the hazard of water erosion is severe. Active geologic erosion is prevalent.

Badland is used for watershed and has limited use for wildlife habitat. Dryland capability subclass VIIIe.

Bluepoint Series

The Bluepoint series consists of deep, somewhat excessively drained soils that formed in sandy alluvial and eolian sediments on alluvial fans and terraces. Slopes are 1 to 15 percent. The native vegetation is principally mesa dropseed and Indian ricegrass and some giant dropseed and black grama. Elevations range from 4,850 to 6,000 feet. The mean annual precipitation is 7 to 10 inches, the mean annual air temperature is 58° to 60° F, and the frost-free season is 165 to 195 days. Bluepoint soils are associated with Kokan, Latene, Madurez, and Wink soils.

In a representative profile, the surface layer is pale brown loamy fine sand about 8 inches thick. The underlying material to a depth of 60 inches or more is pale brown and light yellowish brown loamy sand. The soil is slightly calcareous and mildly alkaline or moderately alkaline.

Permeability is rapid. Available water capacity is 4 to 5.5 inches. Effective rooting depth is 60 inches or more.

Bluepoint soils are used for range, irrigated crops, watershed, wildlife habitat, and community development.

Representative profile of Bluepoint loamy fine sand, 1 to 9 percent slopes, 30 feet west of the El Paso Natural Gas Pipeline Road, northeast corner of sec. 5, T. 11 N., R. 2 E.

A1—0 to 8 inches, pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; single grained; loose; many fine and very fine roots and interstitial pores; slightly calcareous; mildly alkaline; clear, wavy boundary.

C1—8 to 20 inches, pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; massive; slightly hard, very friable; few very fine and fine roots; many very fine interstitial pores; slightly calcareous; moderately alkaline; clear, wavy boundary.

C2—20 to 60 inches, light yellowish brown (10YR 6/4) loamy sand, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, very friable; few fine and very fine roots; many very fine interstitial pores; slightly calcareous in spots; mildly alkaline.

The A horizon has value of 5 to 7 dry and 4 to 6 moist and chroma of 2 to 4. It is sand, loamy fine sand, and loamy sand. The C horizon has hue of 5YR to 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It is loamy sand or loamy fine sand. Gravel content ranges from 0 to 15 percent throughout the profile.

Where mapping units BCC and Bd3 occur west of the Rio Puerco, the mean annual temperature is a few degrees cooler than is defined as the range for the series. This difference, however, does not alter use and management.

Bb—Bluepoint fine sand, hummocky. This gently rolling to r lling soil is on the piedmont east of the Rio Puerco and in areas near basalt flows. It occurs as low dunes 8 to 50 feet high of reworked sand. The windward side is generally a blowout, and the leeward side is low dunes. Areas generally are 15 to 100 acres in size. Vegetation is sparse. Slopes are 5 to 15 percent.

This soil has a profile similar to that described as representative of the series, but the surface layer differs in texture.

Runoff is slow. The hazard of soil blowing is severe.

This soil is used for range, watershed, wildlife habitat, and recreation. Dryland capability subclass VIIe; native plant community 2.

BcA—Bluepoint loamy fine sand, 1 to 3 percent slopes. This nearly level soil is along the margin of the irrigated Rio Grande Valley. It has a profile similar to that described as representative of the series, but on about 10 percent of the acreage the surface layer is fine sand. Included in mapping are areas of Pajarito and Vinton soils, which make up about 10 percent of the unit.

Runoff is slow, and the hazard of soil blowing is severe.

This soil is used for irrigated alfalfa, row crops, and pasture. It is also used for wildlife habitat and community development. Irrigated capability unit IIIe-11.

BCC—Bluepoint loamy fine sand, 1 to 9 percent slopes. This soil is nearly level to moderately sloping. It has the profile described as representative of the series, but on about 10 percent of the acreage the surface layer is sand. Included in mapping are areas of Madurez, Pajarito, and Wink soils, which make up about 15 percent of the unit.

Runoff is slow, and the hazard of soil blowing is severe.

This soil is used for range, watershed, wildlife habitat, recreation, and community development. Dryland capability subclass VIIe; native plant community 2.

Bd3—Bluepoint-Wink, severely eroded complex. This mapping unit is about 45 percent a Bluepoint loamy fine sand that has 3 to 15 percent slopes and 35 percent a severely eroded Wink sandy loam that has 5 to 15 percent slopes (fig. 3).

The Bluepoint soil is in low swales and drainageways where runoff is slow but the hazard of soil blowing is severe. The Wink soil occurs as eroded remnants of narrow ridges where runoff is rapid and the hazard of water erosion is severe. It has a profile similar to that described as representative of the Wink series, but the surface layer is sandy loam and the soil is severely eroded.

Included in this unit in mapping are areas of Vinton, Penistaja, and Kokan soils, which make up about 15 percent of the unit. Also included are areas where the upper 30 inches of the soil is 10 to 15 percent gravel.

This mapping unit is used for watershed, wildlife habitat, and range. Dryland capability subclass VIIe; native plant community 2 for Bluepoint soil and 6 for Wink soil.

BKD—Bluepoint-Kokan association, hilly. This mapping unit is about 50 percent a Bluepoint loamy fine sand that has 5 to 15 percent slopes and 40 percent a Kokan gravelly sand that has 15 to 40 percent slopes. The gently rolling to rolling Bluepoint soil is on fans between gravelly ridges of the hilly to steep Kokan soil.

The Kokan soil has the profile described as representatative of the Kokan series. On about 10 percent of the acreage, however, it has a high lime layer in the substratum.

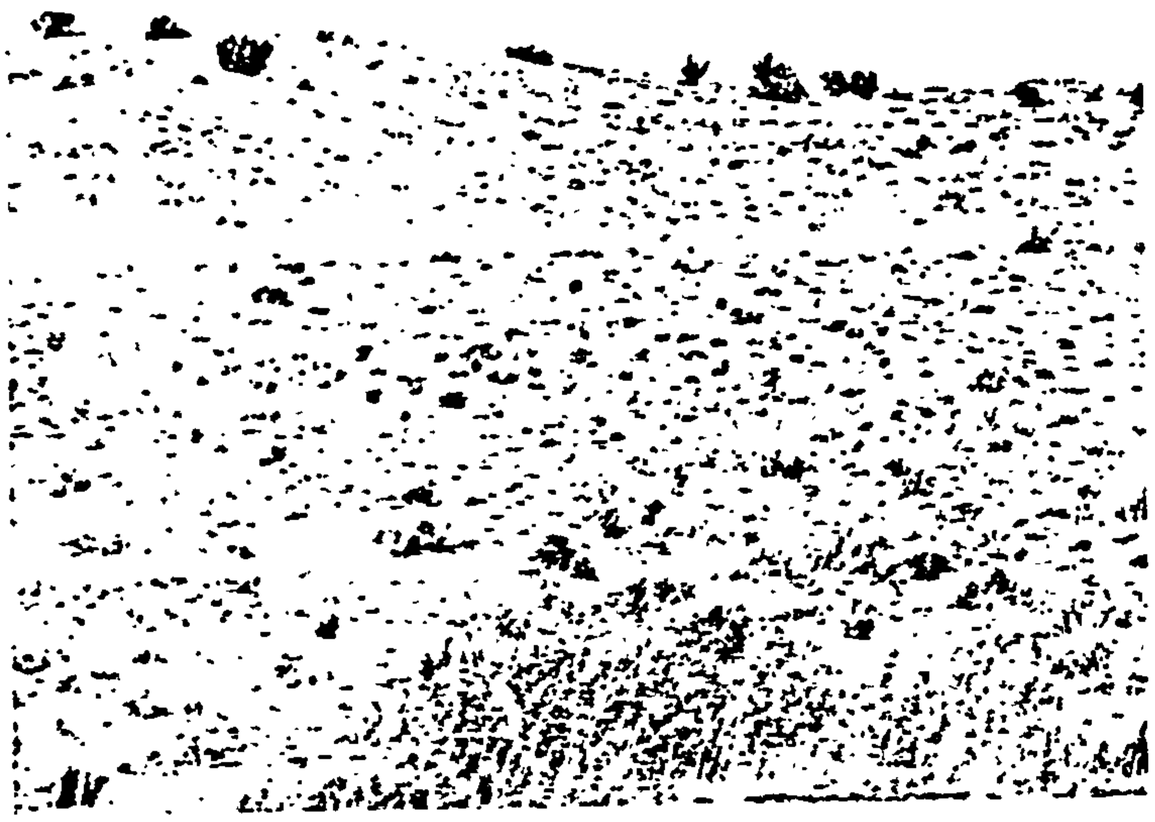


Figure 3.—An area of Bluepoint-Wink, severely eroded complex.

On both soils, runoff is slow and the hazard of water erosion is moderate or severe.

This mapping unit is used for range, watershed, wildlife habitat, recreation, and community development. In Bernalillo County it is also a major source of sand and gravel. Dryland capability subclass VIIe; native plant community 2 for Bluepoint soil and 3 for Kokan soil.

Bond Series

The Bond series consists of shallow, well drained soils that formed in residuum weathered from sandstone bedrock on uplands. Slopes are 5 to 15 percent. The native vegetation is principally blue grama, side-oats grama, pinyon pine, and juniper. Elevations range from 6,000 to 8,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is about 50° to 54° F, and the frost-free season is 110 to 150 days. Bond soils are associated with Laporte, Penistaja, and Travessilla soils.

In a representative profile, the surface layer is brown fine sandy loam about 3 inches thick. The subsoil is brown and strong brown sandy clay loam about 15 inches thick. Hard, brown sandstone bedrock is at a depth of about 18 inches. The soil is moderately alkaline throughout.

Permeability is moderately slow. Available water capacity is 1 inch to 3 inches. Effective rooting depth is 12 to 20 inches.

Bond soils are used for range, watershed, and wildlife habitat.

In this survey area, Bond soils are mapped only with Penistaja soils and Rock outcrop.

Representative profile of Bond fine sandy loam, from an area of Penistaja-Bond association in SW¼NE¼NE¼ sec. 27, T. 11 N., R. 3 W.

A1—0 to 3 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; single grained; loose, many roots of all sizes; many fine interstitial pores; moderately alkaline; abrupt, smooth boundary.

B2t—3 to 12 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots of all sizes; many fine interstitial pores; moderately alkaline; clear, smooth boundary.

B3—12 to 18 inches, strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots of all sizes; common interstitial pores; moderately alkaline; abrupt, smooth boundary.

R—18 inches, brown (7.5YR 5/4) hard sandstone.

The A horizon has hue of 7.5 or 10YR and value of 4 or 5 dry and 3 or 4 moist. It is stony heavy sandy loam to fine sandy loam. The B horizon has value of 5 to 7 dry and 4 to 6 moist and chroma of 4 to 6 dry and moist. It is sandy clay loam or clay loam that is 0 to 20 percent rock fragments. Depth to bedrock is 12 to 20 inches.

Borolls

Borolls are shallow to deep, well drained soils that formed mostly in residuum weathered from limestone, sandstone, granite, gneiss, and schist on the sides of canyons and mountains in a cool climate. Slopes are 50 to 80 percent. The native vegetation is variable, but is principally ponderosa pine, Douglas-fir, Gambel oak, mountainmahogany, bottlebrush squirreltail, and junegrass. Elevations range from 8,000 to 9,500 feet. The mean annual precipitation is 16 to 25 inches, the mean annual air temperature is 40° to 45° F, and the frost-free season is 70 to 100 days. Borolls soils are mainly associated with Rock outcrop.

Borolls are variable, but they have some features in common. The surface layer is brown, dark brown, or dark grayish brown stony loam, cobbly loam, or very stony loam. The subsoil is stony sandy clay loam to very stony clay. Bedrock is at a depth of 10 to more than 60 inches. The soils are mainly noncalcareous and neutral to mildly alkaline.

Permeability is moderate to slow. Available water capacity is 1 inch to 6 inches. Effective rooting depth is 10 to 60 inches.

Borolls are used for wildlife habitat, watershed, recreation, timber, and range.

BOF—Borolls-Rock outcrop association, very steep. This mapping unit is about 70 percent Borolls, 20 percent Rock outcrop, and 10 percent a very shallow soil and Orthids. It is on the west face of the Sandia, Manzanita, and Manzano Mountains at elevations higher than 8,000 feet.

Borolls are shallow to deep and stony, cobbly, or very stony soils on very steep canyon and mountain walls between the outcrops of bedrock. Runoff is medium, and the hazard of water erosion is moderate. Rock outcrop occurs where resistant limestone, schist, gneiss, sandstone or granite has been exposed through faulting, uplifting, or geologic erosion. Runoff is very rapid, and the hazard of water erosion is moderate. There is little or no vegetation. About 20 percent of the surface area of this mapping unit is covered with boulders 3 to 15 feet in diameter.

10 percent cobblestones; weakly cemented with soft caliche; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C2ca—29 to 60 inches, light brown (7.5YR 6/4) very gravelly coarse sandy loam, brown (7.5YR 5/4) moist; massive; soft, very friable; few fine roots; 55 percent gravel and 5 percent cobblestones; strongly calcareous; moderately alkaline.

The A horizon has hue of 10YR or 7.5YR, value of 4 to 6 dry and 4 or 5 moist, and chroma of 3 or 4. It is gravelly loam or gravelly fine sandy loam. The Cca horizon has hue of 10YR or 7.5YR, value of 6 to 8 dry and 4 to 6 moist, and chroma of 2 to 4. The content of calcium carbonate is 20 to 30 percent. The content of gravel is 40 to 70 percent.

ILC—Ildefonso gravelly sandy loam, 1 to 9 percent opes. This nearly level to moderately sloping soil is in areas near Hell Canyon Wash and west of the Manzano Mountains. It has a profile similar to that described as representative of the series, but the surface layer differs in texture. Included in mapping are small areas of Latene soils.

Runoff is medium, and the hazard of water erosion is moderate.

This soil is used for range, watershed, and wildlife habitat. Dryland capability subclass VIIe; native plant community 7.

Kim Series

The Kim series consists of deep, well drained soils that formed in alluvium weathered mainly from interbedded shale and sandstone on uplands. Slopes are 0 to 8 percent. The native vegetation is principally alkali sacaton, galleta, Russian-thistle, and annuals. Elevations range from about 5,500 to 6,000 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is about 53° to 55° F, and the frost-free season is 120 to 155 days. Kim soils are associated with Shingle, Hantz, and Travessilla soils.

In a representative profile, the surface layer is light olive brown sandy loam about 3 inches thick. Next is 9 inches of light olive brown loam. Below this to a depth of 60 inches or more is light yellowish brown loam and clay loam. The soil is moderately calcareous and mildly alkaline or moderately alkaline.

Permeability is moderate. Available water capacity is 10.5 to 12 inches. Effective rooting depth is 60 inches or more.

Kim soils are used for range, wildlife habitat, and watershed.

Representative profile of Kim sandy loam, from an area of Shingle, eroded-Kim association, 20 feet north of the fence on SW¼SE¼SW¼ sec. 8, T. 11 N., R. 2 W.

A1—0 to 3 inches, light olive brown (2.5Y 5/4) sandy loam, light olive brown (2.5Y 5/4) moist; weak, thin, platy structure; soft, friable, slightly sticky; few fine roots; many very fine interstitial pores; moderately calcareous; mildly alkaline; abrupt, smooth boundary.

AC—3 to 12 inches, light olive brown (2.5Y 5/3) loam, olive brown (2.5Y 4/4) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine roots and tubular pores; moderately calcareous; mildly alkaline; clear, smooth boundary.

C1—12 to 18 inches, light yellowish brown (2.5Y 6/4) light clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; moderately calcareous; moderately alkaline; clear, smooth boundary.

C2—18 to 60 inches, light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine tubular pores; moderately calcareous; mildly alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It is sandy loam, loam, or silty clay loam. The C horizon has hue of 10YR to 5Y, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 4. It is loam, light clay loam, and silty clay loam. Depth to weathered interbedded sandstone and shale ranges from 40 to more than 60 inches.

KaB—Kim fine sandy loam, 1 to 8 percent slopes. This nearly level to moderately sloping soil is between drainageways and uplands west of the Rio Puerco. It has a profile similar to that described as representative of the series, but the surface layer differs in texture and is about 5 inches thick. In some areas, gullies have formed. Included in mapping are small areas of Shingle and Hantz soils and Badland.

Runoff is medium, and the hazard of water erosion is severe.

This soil is used for range, watershed, and wildlife habitat. Dryland capability subclass VIe; native plant community 9.

KbB—Kim silty clay loam, 3 to 5 percent slopes. This gently sloping soil is between drainageways and uplands west of the Rio Puerco. It has a profile similar to that described as representative of the series, but the surface layer differs in texture and is about 6 inches thick. In some areas, gullies have formed. Included in mapping are small areas of Shingle and Hantz soils and Badland.

Runoff is moderate, and the hazard of water erosion is severe.

This soil is used for range, watershed, and wildlife habitat. Dryland capability subclass VIe; native plant community 1.

KD—Kim-Badland association. This mapping unit is about 55 percent a Kim sandy loam that has 0 to 5 percent slopes and 25 percent Badland that has 12 to 40 percent slopes.

The Kim soil is between drainageways and the areas of Badland. Runoff is moderate, and the hazard of water erosion is severe. On Badland, which consists mainly of soft shale bedrock, runoff is rapid and the hazard of water erosion is severe.

Included in this unit in mapping are areas of Shingle and Hantz soils and sandstone rock outcrop, which make up 20 percent of the unit.

This mapping unit is used for range, watershed, and wildlife habitat. Dryland capability subclass VIe for Kim soil and VIIIe for Badland; native plant community 9 for Kim soil.

Kokan Series

The Kokan series consists of deep, excessively drained soils that formed in old alluvial sand and gravel of mixed sources from the Santa Fe geological formation on dissected terraces. Slopes are 10 to 45 percent. The native vegetation is broom snakeweed and blue grama. Elevations range from 4,850 to 6,000 feet. The mean annual precipitation is 7 to 10 inches, the mean annual air tem-

perature is 58° to 60° F, and the frost-free season is 165 to 195 days. Kokan soils are associated with Bluepoint, Wink, Madurez, and Pajarito soils.

In a representative profile, the soil to a depth of 60 inches or more is very pale brown, stratified gravelly and very gravelly sand. It is slightly calcareous and mildly alkaline.

Permeability is very rapid. Available water capacity is 2 to 3 inches. Effective rooting depth is 60 inches or more.

Kokan soils are used for range, wildlife habitat, and watershed. They are also used as a source of sand and gravel.

Representative profile of Kokan gravelly sand, from an area of Bluepoint-Kokan association, hilly, in NE¼ NE¼SE¼ sec. 8, T. 9 N., R. 3 E.

C—0 to 60 inches, vary pale brown (10YR 7/3) stratified gravelly and very gravelly sand, pale brown (10YR 6/3) moist; single grained; loose; few fine roots to a depth of 15 inches; 45 to 75 percent gravel; slightly calcareous; mildly alkaline.

The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry and 4 to 6 moist, and chroma of 2 to 4. It is gravelly sandy loam to very gravelly sand. An A1 horizon occurs in places.

West of the Rio Puerco, the annual soil temperature is a few degrees cooler than is defined as the range for the series, but this difference does not alter use or management.

KOE—Kokan gravelly sand, 10 to 40 percent slopes. This rolling to steep soil is along the west side of the Rio Puerco Valley. It has a profile similar to that described as representative of the series, but it has a thin surface layer of gravelly sandy loam.

Included with this soil in mapping are areas of Bluepoint, Pajarito, and Vinton soils, which make up 15 percent of the unit.

Runoff is slow, and the hazard of water erosion is moderate.

This soil is used for range, wildlife habitat, and watershed and as a source of sand and gravel. Dryland capability subclass VIIe; native plant community 3.

KR—Kokan-Rock outcrop association. This mapping unit is about 75 percent a Kokan gravelly sand that has 25 to 45 percent slopes and 10 percent nearly vertical basalt rock outcrop. It is at the edge of the basalt mesa breaks on the West Mesa.

The Kokan soil occurs on the lower part of the breaks where runoff is slow and the hazard of water erosion is moderate. The Rock outcrop is on the basalt cap where runoff is rapid and the hazard of water erosion is slight. Basalt boulders 3 to 4 feet in diameter cover 40 percent of the surface of this unit.

Included in this unit in mapping are small areas of Bluepoint soils.

This mapping unit is used for wildlife habitat and watershed. Dryland capability subclass VIIe for Kokan soil and VIIIs for Rock outcrop; native plant community 3 for Kokan soil.

Kolob Series

The Kolob series consists of deep, well drained soils that formed in residuum weathered from limestone on the sides on mountains. Slopes are 15 to 80 percent. The native vegetation is principally Douglas-fir, white fir, ponderosa pine, Gambel oak, oregongrape, and mountain brome. Elevations range from 8,400 to 9,500 feet. The mean annual precipitation is 18 to 25 inches, the mean annual air temperature is 43° to 45° F, and the frost-free season is 60 to 100 days. Kolob soils are associated with Sandia soils.

In a representative profile, the surface layer is dark grayish brown stony loam and stony clay loam about 13 inches thick. The subsoil is brown stony clay and very stony clay about 29 inches thick. Limestone bedrock is at a depth of 42 inches. The soil is noncalcareous and slightly acid or neutral.

Permeability is moderately slow. Available water capacity is 5 to 5.5 inches. Effective rooting depth is 40 to 60 inches.

Kolob soils are used for timber, range, recreation, watershed, and wildlife habitat.

Representative profile of Kolob stony loam, from an area of Sandia-Kolob complex, 15 to 40 percent slopes, in SW¼ sec. 5, T. 11 N., R. 5 E.

O1—½ inch to 0, litter layer of undecomposed and partly decomposed fir needles, oak leaves, twigs, and bark.

A1—0 to 3 inches, dark grayish brown (10YR 4/2) stony loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine interstitial pores; 10 percent stones and 5 percent gravel; neutral; clear, smooth boundary.

A3—3 to 13 inches, dark grayish brown (10YR 4/2) stony clay loam, very dark brown (10YR 2/2) moist; weak, fine and medium, subangular blocky structure; hard, firm, slightly sticky and plastic; common fine, medium and coarse roots; common very fine and fine interstitial pores; 15 percent stones, 10 percent cobblestones, and 10 percent gravel; slightly acid; clear, smooth boundary.

B21t—13 to 18 inches, brown (7.5YR 5/4) stony clay, dark brown (7.5YR 4/4) moist; ped coatings dark brown (7.5YR 3/2) dry and moist; moderate, fine, subangular blocky structure; very hard, firm, sticky and plastic; few fine and common medium and coarse roots; few very fine interstitial pores; few thin clay films; 25 percent gravel; neutral; clear, smooth boundary.

B22t—18 to 42 inches, brown (7.5YR 5/4) very stony clay, dark brown (7.5YR 4/4) moist; ped coatings dark brown (7.5YR 3/2) dry and moist; moderate, fine and medium, subangular blocky structure; very hard, very firm, sticky and plastic; few fine and many medium and coarse roots; few very fine interstitial pores; few thin clay films; 35 percent stones, 30 percent cobblestones, and 20 percent gravel; neutral; clear, irregular boundary.

R—42 inches, fractured limestone bedrock.

The A horizon has hue of 7.5YR to 10YR and value of 4 or 5 dry. The content of rock fragments is 10 to 40 percent stones, 0 to 20 percent cobblestones, and 0 to 15 percent gravel. Reaction is slightly acid to mildly alkaline. The B horizon has hue of 7.5YR to 10YR and value of 4 or 5 dry. It ranges from stony clay loam to very stony clay that is 35 to 50 percent clay. Rock fragments are 50 to 75 percent stones, 5 to 25 percent cobblestones, and 5 to 15 percent gravel. Reaction is neutral to moderately alkaline.

KS—Kolob stony loam. This moderately steep to steep soil is on the sides of mountains in the Cibola National Forest. It has a profile similar to that described as representative of the series, but depth to bedrock is about 55 inches. Slopes are 15 to 40 percent.

Native Plant Communities[4]

A natural plant community is the product of all environmental factors, including, but not limited to, climate, soil, and topography. Soils are grouped into plant communities according to their capacity to produce similar kinds, amounts, and proportions of native plants. The information that follows can be adapted to the management of range sites.

The plant communities in this survey area never develop a high density of ground cover. At the lower elevations precipitation is low, evaporation is high, and the ground cover seldom exceeds 20 percent. The higher elevations have more precipitation, less evaporation, and a somewhat denser plant cover.

Plant communities are affected by any abnormal disturbance, such as soil blowing and water erosion, fire, traffic, and excessive animal use. Depending on the kinds of soil and plants in the community certain plants are replaced in part or entirely by other plants that adapt to the altered and more adverse growing conditions induced by the influences exerted on the plant community. The plant community can be completely destroyed by a severe disturbance. If the site is not deteriorated significantly under such disturbance, plant succession progresses in the direction of the natural potential plant community for the soil.

Changes occur in the plant community because of particular kinds of use or disturbance. How a plant reacts to a disturbance depends on the species, the kind of influence, and the duration of the disturbance.

Knowledge of the plant communities, both present and potential, and information on the soils provide a basis for selecting alternative uses. Any use of a native plant community should be compatible with conservation objectives and provide a plant cover that protects and improves the soil and water resources and also meets the desires and needs of the user.

Native plant communities of the survey area are described on the following pages. Plants are listed in order of their dominance in the plant community.

Not assigned to native plant communities are land areas having only limited vegetative growth and irrigated soils, which are managed mainly as irrigated cropland or tame pasture. The native plant community is listed for each applicable soil in the "Guide to Mapping Units."

NATIVE PLANT COMMUNITY NO. 1

This plant community is on bottom land along drainageways and flood plains of the Rio Grande and Rio Puerco. It receives runoff from the surrounding slopes. The soils are deep and commonly saline-alkali silty clay loams, silty clays, sandy loams, or loamy sands. Elevations are mainly 4,850 to 6,000 feet, but in places range to 7,500 feet. Annual precipitation ranges from 7 to 14 inches.

This plant community is a grass-shrub mixture that covers approximately 20 percent of the soil surface. Alkali sacaton, the dominant plant, is 50 percent of the total vegetation by weight. Associated grass plants are vine-mesquite, blue grama, western wheatgrass, tobosa, galleta, burrograss, inland saltgrass, and mat muhly. Fourwing saltbush is the major shrub. Less abundant are rubber rabbitbrush, winterfat, and shadscale. Mesquite has invaded this plant community in places. Common annual plants are Russian-thistle, cocklebur, and sunflowers.

If this plant community is disturbed, the kinds and amounts of annual plants become more prominent. There is an increase in the fourwing saltbush and other shrubby plants and a decrease in the amount of grasses. The more persistent grass plants are burrograss, inland saltgrass, and tobosa.

NATIVE PLANT COMMUNITY NO. 2

This plant community is mostly in gently undulating to rolling areas, some of which occur as dunes. The soils are deep and mainly are loamy fine sands or sandy loams. Elevations range from 4,850 to 6,000 feet. Annual precipitation ranges from 7 to 10 inches.

This plant community is a grass-shrub mixture that generally covers about 15 percent of the soil surface. Indian ricegrass is the dominant grass. Associated grass plants are black grama, giant dropseed, bush muhly, galleta, sand dropseed, mesa dropseed, spike dropseed, sand bluestem, little bluestem, blue grama, and threeawn. These perennial grasses are about 75 percent of the total vegetation by weight. Sand sagebrush is the dominant shrub. Less abundant are fourwing saltbush, Mormon-tea, wolfberry rubber, rabbitbrush, winterfat, broom dalea, broom snakeweed, and bush mint. Cholla cactus, pricklypear cactus, and small soapweed are in a few places. These shrub plants are 15 percent of the total vegetation by weight. Annual plants are jimsonweed, fiddleneck, daisy, verbena, tansymustard, aster, lambsquarters, and six-weeks grama. These annual plants are about 10 percent of the total vegetation by weight.

If this plant community is disturbed, the hazard of soil blowing is severe, blowout areas become more dominant, and shrubby plants increase.

NATIVE PLANT COMMUNITY NO. 3

This plant community has deep soils that are gravelly fine sandy loams to very gravelly sands. Elevations range 4,850 to 6,000 feet. Annual precipitation ranges from 7 to 10 inches.

This plant community is a grass-shrub mixture that covers approximately 10 percent of the soil surface. Black grama and bush muhly, the dominant grasses, are 25 to 50 percent of the total vegetation by weight. Associated grasses are Indian ricegrass, bottlebrush squirreltail, needleandthread, New Mexico feathergrass, sand dropseed, mesa dropseed, three-awn, and galleta. Grasses are about 75 percent of the total vegetation by weight. Fourwing saltbush is the major shrub. Less abundant are sand sagebrush, creosotebush, winterfat, broom snakeweed, brickellbush, and rubber rabbitbrush and, generally, sotol and cholla cactus. Shrubs are about 15 percent of the total vegetation by weight. Globemallow, groundsel, buffalobur, and herbaceous sage are the major perennial forbs. Common annual plants are fiddleneck, lambsquarters, Indian paintbrush, and loco, which are about 10 percent of the vegetation by weight.

This plant community is stable because of the gravelly soils. If it is disturbed, however, the annual plants in-

[4] HENRY E. WALL, area range conservationist, and RICHARD FARMER, district conservationist, Soil Conservation Service, helped prepare this section.

crease and become more prominent and the shrub plants increase in size and amount. Also, pricklypear cactus and cholla cactus invade the plant community.

NATIVE PLANT COMMUNITY NO. 4

This plant community has moderately deep or deep soils that are gravelly fine sandy loams, fine sandy loams, sandy loams, or very fine sandy loams. Elevations range from 4,800 to 6,500 feet. Annual precipitation ranges from 7 to 10 inches.

This plant community is mainly grasses mixed with some shrubs and annual plants. It normally covers about 15 percent of the soil surface. Black grama, the dominant grass, is about 35 percent of the total vegetation by weight. Less abundant are sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. In places there are broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Annual plants, which increase in years of above average precipitation, are tansymustard, Indian paintbrush, woolly Indian-wheat, lambsquarters, Russian-thistle, and bladderpod. Woody plants are in the drainageways. Apache-plume is the dominant shrub.

If this plant community is disturbed, annual plants increase. Sand dropseed becomes prominent, and cactus, catclaw mimosa, and broom snakeweed increase significantly.

NATIVE PLANT COMMUNITY NO. 5

This plant community is on the foot slopes on the west side of the Sandia Mountains. The soils are deep stony sandy loams. Elevations range from 6,000 to 7,000 feet. The annual precipitation ranges from 10 to 14 inches.

This plant community is a mixture of trees, shrubs, and understory plants. Oneseed juniper is common and gives the plant community an evergreen woodland aspect. Oakbrush is dominant among the abundant shrub plants. Less abundant are skunkbush sumac, sacahuista, range ratany, feather dalea, and rubber rabbitbrush. Apache-plume is common in drainageways and small soapweed, broom snakeweed, cholla cactus, and pricklypear cactus occur in small amounts. Black grama, the dominant grass, is about 25 percent of the total vegetation by weight. Less abundant are blue grama, hairy grama, bush muhly, bluegrass, New Mexico feathergrass, sand dropseed, three-awn, and bottlebrush squirreltail. Globemallow, groundsel, and brickellbush are the most prominent perennial forbs. Annual plants are Indian paintbrush, bladderpod, cheatgrass, six-weeks grama, lambsquarters, and fiddleneck.

If this plant community is disturbed, oneseed juniper and oakbrush become the most prominent plants and the understory is a few grasses and numerous annual plants.

NATIVE PLANT COMMUNITY NO. 6

This plant community has deep soils that are sandy loams or loamy fine sands. The soils are susceptible to severe soil blowing if the plant community is disturbed. Elevations range from 4,800 to 7,000 feet. Annual precipitation ranges from 7 to 14 inches.

This plant community is mainly grasses that cover approximately 15 percent of the soil surface. Indian ricegrass, the dominant plant, is about 50 percent of the total vegetation by weight. Less abundant are black grama, sand dropseed, spike dropseed, mesa dropseed, giant dropseed, bush muhly, New Mexico feathergrass, and galleta. Fourwing saltbush, winterfat, wolfberry, and Mormon-tea are the major shrubs. Small soapweed occurs in varying amounts. In years of above average precipitation, such annual plants as fiddleneck, daisy, loco, tansymustard, and verbena are conspicuous because of their colored flowers.

If this plant community is disturbed, annual plants and such woody plants as wolfberry, tea bush, and small soapweed increase. Sand dropseed and galleta also increase, and broom snakeweed, rubber rabbitbrush, and mesquite invade the plant community in places.

NATIVE PLANT COMMUNITY NO. 7

This plant community is on the west slope of the Sandia Mountains and on the east slope in the vicinity of San Antonito. The soils are very shallow to deep very fine sandy loams to extremely stony loams. Elevations range from 6,000 to 8,000 feet. Annual precipitation ranges from 10 to 18 inches.

This plant community covers about 25 percent of the soil surface. It is characterized by pinyon pine and oneseed juniper. Cottonwoods and willows grow along the water courses. Oakbrush is the dominant shrub. Less abundant are big sagebrush, rubber rabbitbrush, mountainmahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Understory vegetation is primarily grasses. Side-oats grama is 25 to 50 percent of the total vegetation by weight, and blue grama is also abundant. Less abundant are western wheatgrass, black grama, galleta, bottlebrush squirreltail, needleandthread, New Mexico feathergrass, wolftail, sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave generally occur.

If this site is disturbed, pinyon pine, oneseed juniper, alligator juniper, and oakbrush become the dominant vegetation. Blue grama, galleta, and broom snakeweed also increase, and annual plants become prominent.

NATIVE PLANT COMMUNITY NO. 8

This plant community is on the mesa west of the Rio Grande. The soils are shallow cobbly sandy loams. Elevations range from 5,200 to 5,800 feet. Annual precipitation ranges from 7 to 10 inches.

This plant community covers about 10 percent of the soil surface. It is mainly grasses. Galleta and black grama are about 50 percent of the total vegetation by weight. Less abundant are sand dropseed, spike dropseed, mesa dropseed, bottlebrush squirreltail, Indian ricegrass, bush muhly, silver bluestem, three-awn, blue grama, and side-oats grama. Fourwing saltbush, winterfat, and wolfberry are the dominant shrubs. Creosotebush, broom snakeweed, allthorn, and rubber rabbitbrush occur in places. Annual plants are loco, groundsel, fiddleneck, verbena, sunflower, lambsquarters, Russian-thistle, brickellbush, cheatgrass, and six-weeks grama.

If this plant community is disturbed, there is a decrease in black grama and bush muhly and an increase in galleta, sand dropseed, and annual plants.

TABLE 3.—*Suitable selected*

[Plants require frequent irrigation even after

Soil groups	Coniferous trees—		
	More than 30 feet	20 to 30 feet	Less than 20 feet
A	Italian cypress, ponderosa pine, Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] Colorado blue spruce, ornamental arborvitae.	American arborvitae, bristlecone pine, eastern redcedar, Japanese black pine, pinyon pine, Rocky Mountain juniper.[1]
B	Italian cypress, ponderosa pine,[1] Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] Colorado blue spruce, ornamental arborvitae.	American arborvitae, eastern redcedar, Japanese black pine, pinyon pine,[2] Rocky Mountain juniper.[1]
C	Douglas-fir,[2] Engelmann spruce,[2] Italian cypress, ponderosa pine,[2] Scotch pine,[1] white fir.[2]	Austrian pine,[1] Colorado blue spruce,[1] ornamental arborvitae.	American arborvitae, bristlecone pine,[1] Japanese black pine, pinyon pine,[2] Rocky Mountain juniper.[2]
D	Italian cypress, white fir	Arizona cypress, Colorado blue spruce, ornamental arborvitae.	American arborvitae, eastern redcedar, Japanese black pine, pinyon pine,[1] Rocky Mountain juniper.[1]
E	Engelmann spruce, Italian cypress, white fir.[2]	Arizona cypress, Colorado blue spruce,[1] ornamental arborvitae.	American arborvitae, Japanese black pine, pinyon pine,[2] Rocky Mountain juniper.[2]
F	Italian cypress,[1] Scotch pine [1]	Arizona cypress,[1] Austrian pine,[1] Colorado blue spruce.[1]	Pinyon pine,[1] Rocky Mountain juniper.[1]
G	Italian cypress, ponderosa pine, Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] ornamental arborvitae.	American arborvitae, bristlecone pine, eastern redcedar, Japanese black pine, pinyon pine,[1] Rocky Mountain juinper.[1]
H	Italian cypress, ponderosa pine,[1] Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] ornamental arborvitae.	American arborvitae, eastern redcedar, Japanese black pine, pinyon pine,[1] Rocky Mountain juniper.[1]
I	Italian cypress, ponderosa pine, Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] ornamental arborvitae.	American arborvitae, bristlecone pine, eastern redcedar, Japanese black pine, pinyon pine,[2] Rocky Mountain juniper.[1]
J	Italian cypress, ponderosa pine,[1] Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] ornamental arborvitae.	American arborvitae, Japanese black pine, pinyon pine.[1]
K	Italian cypress, ponderosa pine, Scotch pine, white fir.	Arizona cypress, Austrian pine,[1] ornamental arborvitae.	American arborvitae, bristlecone pine, Japanese black pine, pinyon pine.[1]

[1] Plants require infrequent irrigation after establishment. During extended periods of drought more frequent irrigation helps plants to grow vigorously.

Rangeland habitats reflect the moisture regime and the long history of livestock grazing. The plant communities in the Sandia foothills are complex and have local value as browse for mule deer.

Croplands are restricted to those areas where irrigation water is available. Hay and grain crops are an important source of feed for mourning dove and scaled quail and to some extent for pheasant.

Important game species include Rocky Mountain bighorn sheep, mule deer, turkey, scaled quail, Gambel's quail, antelope, and mourning dove. Nongame species include cottontail rabbit, coyote, chipmunk, bobcat, ground squirrel, prairie dog, raven, raccoon, and road runner. There is a large population of resident and migratory songbirds. The New Mexico Department of Game and Fish stocks trout in several irrigation drains during the winter. These drains, as well as Sawmill Pond and Tingley Beach, provide warm-water fishing from April to November and trout fishing in winter.

Table 5 rates the soils according to their suitability

trees, by soil groups

establishment except where noted]

Deciduous trees—		
More than 30 feet	20 to 30 feet	Less than 20 feet
American sycamore, Arizona sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Black locust,[1] catalpa, flowering crab, globe willow, golden willow, green ash, Russian-olive,[1] Siberian elm,[2] standard apple, weeping willow.	Eastern redbud, flowering apricot, golden-rain-tree, hawthorn, mimosa, ornamental pear, white mulberry.[1]
American sycamore, Arizona sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Black locust, catalpa, flowering crab, globe willow, golden willow, green ash, Russian-olive,[2] Siberian elm,[2] standard apple, weeping willow.	Eastern redbud, flowering apricot, golden-rain-tree, hawthorn, mimosa, ornamental pear, white mulberry.
American sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Catalpa,[1] flowering crab,[1] golden willow, green ash,[2] Siberian elm,[2] standard apple.[1]	Eastern redbud,[1] flowering apricot,[1] golden-rain-tree, hawthorn, mimosa, ornamental pear,[1] white mulberry.[2]
American sycamore, Arizona sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Black locust, flowering crab, globe willow, golden willow, green ash, Russian-olive,[1] Siberian elm,[2] standard apple, weeping willow.	Eastern redbud, flowering apricot, golden-rain-tree, hawthorn, mimosa, ornamental pear, white mulberry.
American sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Flowering crab,[1] golden willow, green ash,[2] Siberian elm,[2] standard apple.[1]	Eastern redbud,[2] flowering apricot,[1] golden-rain-tree, hawthorn, mimosa, ornamental pear,[1] white mulberry.[2]
Arizona sycamore,[1] Lombardy poplar,[1] red mulberry,[1] Rio Grande cottonwood.[1]	Globe willow,[1] golden willow,[1] green ash,[1] Russian-olive,[1] Siberian elm,[1] weeping willow.[1]	Golden-rain-tree,[1] hawthorn,[1] ornamental pear,[1] white mulberry.[1]
Arizona sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Black locust,[1] flowering crab, globe willow, golden willow, green ash, Russian-olive,[1] Siberian elm,[1] standard apple, weeping willow.	Eastern redbud, flowering apricot, golden-rain-tree, hawthorn, ornamental pear, white mulberry.[1]
Arizona sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Black locust, flowering crab, globe willow, golden willow, Russian-olive,[1] Siberian elm,[2] standard apple, weeping willow.	Flowering apricot, golden-rain-tree, hawthorn, ornamental pear, white mulberry.
Arizona sycamore, Fremont cottonwood, Lombardy poplar, narrowleaf cottonwood, red mulberry, Sargent cottonwood.	Black locust,[1] flowering crab, globe willow, golden willow, green ash, Russian-olive,[1] Siberian elm,[2] standard apple, weeping willow.	Flowering apricot, golden-rain-tree, hawthorn, ornamental pear, white mulberry.[2]
Red mulberry	Russian-olive,[1] Siberian elm [1]	Golden-rain-tree, hawthorn, white mulberry.
Red mulberry	Russian-olive,[1] Siberian elm [1]	Golden-rain-tree, hawthorn, ornamental pear, white mulberry.[1]

[2] Plants are suited to dryland after establishment with irrigation. Engineering structures can be used to divert runoff for supplemental water.

for improving, maintaining, or creating specific elements of wildlife habitat as well as for general kinds of wildlife. Ratings are based on potential rather than present land use. A rating of *good* means that habitat is easily improved, maintained, or created. There are few or no soil limitations to habitat management, and satisfactory results can be expected. *Fair* means that habitat can be improved, maintained, or created, but moderate soil limitations affect habitat management or development. Moderately intense management and fairly frequent attention may be required to insure satisfactory results. *Poor* means that habitat can be improved, maintained, or created, but the soil limitations are severe. Habitat management can be difficult and expensive and can require intensive efforts. Results are questionable. *Very poor* means that, under the prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitat. Unsatisfactory results are probable.

The specific elements of wildlife habitat are described in the following paragraphs.

TABLE 4.—*Suitable selected shrubs,*

[Plants require frequent irrigation even

Soil groups	Evergreen shrubs—			Deciduous shrubs—
	More than 8 feet	4 to 8 feet	Less than 4 feet	More than 8 feet
A	Juniper pfitzer, pyracantha.	Cotoneaster glancophyua, evergreen euonymus, mugho pine.	Cotoneaster microphylla, creeping juniper.	American plum, Amur honeysuckle, desert willow,[2] giant reed, lilac, red-berried cotoneaster, tamarisk, Tartarian honeysuckle, winterberry eunonymus.
B	Juniper pfitzer, pyracantha.	Cotoneaster glancophyua, evergreen euonymus, mugho pine.	Cotoneaster microphylla,[1] creeping juniper.	American plum, Amur honeysuckle, lilac, redberried cotoneaster, tamarisk,[1] Tartarian honeysuckle, winterberry euonymus.
C	Juniper pfitzer[1]	Mugho pine	Cotoneaster microphylla,[1] creeping juniper.[1]	American plum,[1] Amur honeysuckle,[2] lilac, red-berried cotoneaster,[1] Tartarian honeysuckle, winterberry euonymus.[2]
D	Juniper pfitzer, pyracantha.	Cotoneaster glancophyua, evergreen euonymus, mugho pine.	Cotoneaster microphylla,[1] creeping juniper.	American plum, Amur honeysuckle, lilac, red-berried cotoneaster, tamarisk,[1] Tartarian honeysuckle, winterberry euonymus.
E	Juniper pfitzer[1]	Mugho pine	Cotoneaster microphylla,[1] creeping juniper.[1]	American plum,[1] Amur honeysuckle,[1] lilac, red-berried cotoneaster,[1] Tartarian honeysuckle, winterberry euonymus.[2]
F	Pyracantha[1]	Cotoneaster glancophyua,[1] evergreen euonymus.[1]	Cotoneaster microphylla.[1]	Amur honeysuckle,[1] giant reed,[1] tamarisk,[1] winterberry euonymus.[1]
G	Juniper pfitzer, pyracantha.	Cotoneaster glancophyua, evergreen euonymus, mugho pine.	Cotoneaster microphylla, creeping juniper.	Amur honeysuckle, desert willow,[1] red-berried cotoneaster, tamarisk, Tartarian honeysuckle, winterberry euonymus.
H	Juniper pfitzer, pyracantha.	Cotoneaster glancophyua, evergreen euonymus, mugho pine.	Cotoneaster microphylla,[1] creeping juniper.	Amur honeysuckle, red-berried cotoneaster, tamarisk,[1] Tartarian honeysuckle, winterberry euonymus.
I	Juniper pfitzer, pyracantha.	Cotoneaster glancophyua, evergreen euonymus, mugho pine.	Cotoneaster microphylla, creeping juniper.	Amur honeysuckle, desert willow,[2] red-berried cotoneaster, tamarisk, Tartarian honeysuckle, winterberry euonymus.
J	Juniper pfitzer	Cotoneaster glancophyua, mugho pine.	Cotoneaster microphylla,[1] creeping juniper.	American plum, Amur honeysuckle, red-berried cotoneaster, Tartarian honeysuckle, winterberry euonymus.
K	Juniper pfitzer	Cotoneaster glancophyua, mugho pine.	Cotoneaster microphylla,[1] creeping juniper.	American plum, Amur honeysuckle, red-berried cotoneaster, Tartarian honeysuckle, winterberry euonymus.

[1] Plants require infrequent irrigation after establishment. During extended periods of drought more frequent irrigation helps plants to grow vigorously.

Grain and seed crops are domestic grains or other seed-producing annuals that are planted to provided food for wildlife. Examples are corn, sorghum, oats, barley, rye, millet, and sunflower.

Domestic grasses and legumes are perennial grasses and herbaceous legumes that are planted to provide food and cover for wildlife. Examples are switchgrass, orchardgrass, smooth brome, tall wheatgrass, clover, alfalfa, and bermudagrass.

Wild herbaceous plants are native or established rangeland grasses and forbs that provide food and cover for wildlife. Examples are gramagrass, Indian ricegrass, alkali sacaton, galleta, dropseed, saltgrass, globemallow, woolly Indian-wheat, Russian-thistle, lambsquarters, and broom snakeweed.

Coniferous plants[7] are cone-bearing trees, shrubs, or

[7] Only eight mapping units have been rated for coniferous plants and woodland wildlife. These ratings are in footnotes at the end of table 5.

ground cover plants, and vines

after establishment except where noted]

Deciduous shrubs—Continued		Ground cover plants	Vines
4 to 8 feet	Less than 4 feet		
Autumn-olive, forsythia, Japanese barberry, silver buffaloberry, skunkbush sumac.[2]	Sand cherry	Rocky Mountain penstemon	Grape, Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive, forsythia, Japanese barberry, skunkbush sumac.[2]	Sand cherry	Rocky Mountain penstemon	Grape, Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive,[1] forsythia,[1] Japanese barberry, silver buffaloberry,[2] skunkbush sumac.[2]	Sand cherry	Bearberry, Rocky Mountain penstemon.[2]	Grape, Halls honeysuckle,[1] Virginia creeper,[1] western virgins-bower.[1]
Autumn-olive, forsythia, Japanese barberry, skunkbush sumac.[2]	----------	Rocky Mountain penstemon	Grape, Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive,[1] forsythia,[1] Japanese barberry, silver buffaloberry,[2] skunkbush sumac.[2]	----------	Bearberry, Rocky Mountain penstemon.[2]	Grape, Halls honeysuckle,[1] Virginia creeper,[1] western virgins-bower.[1]
Autumn-olive,[1] Japanese barberry,[1] silver buffaloberry,[1] skunkbush sumac.[1]	----------	Rocky Mountain penstemon [1]	Grape,[1] Halls honeysuckle.[1]
Autumn-olive, forsythia, skunkbush sumac.[1]	----------	Rocky Mountain penstemon	Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive, forsythia, skunkbush sumac.[2]	----------	Rocky Mountain penstemon	Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive, forsythia, skunkbush sumac.[2]	----------	Rocky Mountain penstemon	Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive, forsythia, skunkbush sumac.[1]	Sand cherry	Rocky Mountain penstemon	Halls honeysuckle, Virginia creeper, western virgins-bower.
Autumn-olive, forsythia, skunkbush sumac.[1]	Sand cherry	Rocky Mountain penstemon	Halls honeysuckle, Virginia creeper, western virgins-bower.

[2] Plants are suited to dryland after establishment with irrigation. Engineering structures can be used to divert runoff for supplemental water.

ground cover plants that provide cover for wildlife or supply food in the form of browse, seeds, or fruitlike cones. Examples are ponderosa pine, pinyon pine, juniper, white fir, and Douglas-fir.

Shrubs are native or established woody shrubs that provide cover for wildlife or supply food in the form of browse or mast. Examples are fourwing saltbush, mountainmahogany, skunkbush sumac, mesquite, oakbrush, fringed sagebrush, and small soapweed.

Wetland plants are annual and perennial wild herbaceous plants, exclusive of submerged or floating aquatics, in moist to wet areas. They provide food and cover for wetland wildlife. Examples are smartweed, wild millet, rushes, sedges, and cattail.

Shallow water areas are natural or constructed areas of shallow water that average less than 5 feet deep. Examples are marshes, flooded cropfields, wildlife watering developments, and wildlife ponds.

The criteria used in rating soils for these elements of wildlife habitat include depth of soil to bedrock, soil

TABLE 7.—*Engineering classification*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soils. Because the to other series that appear in the first column of this table. The

Soil series and map symbols	Depth to—		Depth from surface	USDA texture of representative profile	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				*Percent*
Agua: Af, Ag	>5	[1] >5	0-10	Loam or silty clay loam.	CL-ML or CL	A-4 or A-6	----------
			10-24	Loam and very fine sandy loam.	CL-ML or SM	A-4	----------
			24-60	Fine sand	SP or SP-SM	A-3	----------
Agua variant: Ah	>5	[1] 1-3	0-13	Loam	CL-ML or CL	A-4 or A-6	----------
			13-30	Loamy very fine sand.	SM or ML	A-4	----------
			30-60	Sand	SP or SP-SM	A-3	----------
*Akela: AkC. No valid estimates for Rock outcrop part.	0.5-1.5	>5	0-15	Cobbly sandy loam and gravelly sandy loam.	GM or SM	A-1 or A-2	15-50
			15	Bedrock.			
Alameda: AmB	1.5-3.5	>5	0-9	Sandy loam and loam.	SM, SC, or SC-SM	A-2 or A-4	----------
			9-26	Gravelly, cobbly, and very cobbly sandy loam.	SM, SC, or SC-SM	A-2 or A-4	15-55
			26	Bedrock.			
Anapra: An, Ao	>5	[1] >5	0-8	Silt loam or silty clay loam.	CL-ML or CL	A-4 or A-6	----------
			8-24	Clay loam	CL-ML or CL	A-6	----------
			24-60	Sand	SP or SP-SM	A-3	----------
Armijo: Ar	>5	>5	0-8	Clay loam	CL-ML or CL	A-6	----------
			8-46	Clay	CL, MH, or CH	A-7	----------
			46-67	Loamy sand	SP-SM or SM	A-3 or A-2	----------
Badland: Ba. No valid estimates; material too variable.	>5	>5					
*Bluepoint: Bb, BcA, BCC, Bd3, BKD. For Wink part of Bd3, see Wink series; for Kokan part of BKD, see Kokan series.	>5	>5	0-60	Loamy fine sand and loamy sand.	SP-SM or SM	A-3 or A-2	----------
Bond. Mapped only with Rock outcrop and Penistaja soils.	1-1.5	>5	0-18	Sandy clay loam	SC-SM or SC	A-2, A-4, or A-6	0-15
			18	Bedrock.			
*Borolls: BOF. No valid estimates; material too variable.	1-5	>5					

See footnotes at end of table.

and estimated properties

soils in such mapping units can have different properties and limitations, it is necessary to follow carefully the instructions for referring symbol > means more than; the symbol < means less than]

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
						Inches per hour	*Inches per inch of soil*	*pH*	*Millimhos per centimeter at 25° C*			
--------	100	85-100	60-90	20-35	5-15	0.6-2.0	0.16-0.20	7.9-8.4	1-4	Moderate	Moderate	Low.
--------	100	70-95	45-70	15-25	0-5	0.6-2.0	0.13-0.17	7.9-8.4	1-4	Low	Moderate	Low.
--------	100	50-90	0-10	[2]NP	NP	6.0-20.0	0.05-0.07	7.9-8.4	0-1	Low	Low	Low.
--------	100	85-100	60-90	20-35	5-15	0.2-2.0	0.13-0.15	8.5-9.0	4-8	Moderate	High	Low.
--------	100	90-95	40-60	NP	NP	0.6-2.0	0.08-0.10	8.5-9.0	4-8	Low	High	Low.
--------	100	50-90	0-10	NP	NP	6.0-20.0	0.05-0.07	7.9-8.4	1-4	Low	High	Low.
40-70	25-60	20-45	15-30	NP	NP	0.6-2.0	0.05-0.10	7.9-8.4	0-1	Low	High	Low.
90-100	90-100	85-95	30-50	15-25	0-10	0.6-2.0	0.14-0.18	7.9-8.4	2-4	Low	Moderate	Low.
65-85	60-80	50-75	20-45	20-30	5-10	0.6-2.0	0.07-0.11	7.9-8.4	2-4	Low	Moderate	Low.
--------	100	90-100	75-90	20-35	5-15	0.2-0.6	0.19-0.21	7.9-8.4	1-4	Low to moderate.	Moderate	Low.
--------	100	90-100	75-85	25-40	10-20	0.2-0.6	0.19-0.21	7.9-8.4	1-4	Moderate	Moderate	Low.
--------	100	50-90	0-10	NP	NP	6.0-20.0	0.05-0.07	7.9-8.4	0-1	Low	Low	Low.
--------	100	90-100	75-85	25-35	10-15	0.2-0.6	0.17-0.19	7.9-8.4	1-4	Moderate	High	Low.
--------	100	90-100	85-100	40-60	20-30	<0.06	0.12-0.14	7.9-8.4	1-4	High	High	Low.
--------	100	50-90	5-20	NP	NP	6.0-20.0	0.05-0.07	7.9-8.4	1-4	Low	Low	Low.
90-100	85-100	70-95	5-20	NP	NP	6.0-20.0	0.07-0.09	7.4-8.4	0-1	Low	Low	Low.
85-100	80-100	65-90	25-50	20-35	5-15	0.2-0.6	0.12-0.14	7.9-8.4	0-1	Moderate	Moderate	Low.

TABLE 7.—*Engineering classification*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	USDA texture of representative profile	Classification Unified	Classification AASHTO	Coarse fraction greater than 3 inches
	Feet	*Feet*	*Inches*				*Percent*
Brazito: Br, Bs, Bt	>5	>5	0–9	Fine sandy loam to silty clay loam.	SM, CL–ML, or CL	A-4 or A-6	----------
			9–60	Sand	SP or SP–SM	A-3	----------
Burnac: BUE	>5	>5	0–6	Gravelly loam and very gravelly loam.	GM	A-2 or A-4	5–20
			6–14	Gravelly sandy clay loam.	SC–SM or SC	A-2, A-4, or A-6	5–15
			14–60	Clay	CH	A-7	----------
Carlito: CAF	>5	>5	0–4	Stony loam	CL–ML or CL	A-4	15–45
			4–60	Clay and silty clay.	CL or CH	A-7	----------
Cut and fill land: Cu. No valid estimates; material too variable.	>5	>5					
*Embudo: EmB, EtC. For Tijeras part of EtC, see Tijeras series.	>5	>5	0–20	Gravelly fine sandy loam and gravelly sandy loam.	SM	A-2, A-4	----------
			20–60	Gravelly loamy coarse sand.	SM	A-1	----------
Escabosa. Mapped only with Laporte soils and Rock outcrop.	1.5–3.5	>5	0–15	Loam	CL–ML or ML	A-4	----------
			15–23	Gravelly loam	GM or CL–ML	A-4	0–10
			23	Bedrock.			
*Gila:							
GA, Gb, Ge, GH. For Hantz part of GH, see Hantz series.	>5	[1]>5	0–44	Stratified loam to sandy loam.	SM or ML	A-4	----------
			44–60	Sand	SP or SP–SM	A-3	----------
Gc, Gd, GF	>5	[1]3–>5	0–60	Stratified loam to sandy loam.	SM or ML	A-4	----------
Glendale: Gk, Gm, Gs	>5	[1]>5	0–6	Clay loam or loam.	CL–ML or CL	A-4 or A-6	----------
			6–38	Silt loam	CL	A-6	----------
			38–60	Clay loam	CL	A-6	----------
Hantz: Ha	>5	[4]>5	0–65	Silty clay	CL or MH	A-7	----------
Ildefonso: ILC	>5	>5	0–60	Gravelly and very gravelly sandy loam.	GM or SM	A-1 or A-2	0–15
*Kim: KaB, KbB, KD. No valid estimates for Badland part of KD.	>5	>5	0–60	Loam and clay loam.	CL–ML or CL	A-4 or A-6	----------
*Kokan: KOE, KR. No valid estimates for Rock outcrop part of KR.	>5	>5	0–60	Gravelly sand and very gravelly sand.	GP, GP–GM, or GM	A-1	0–30

See footnotes at end of table.

and estimated properties—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
						Inches per hour	*Inches per inch of soil*	*pH*	*Millimhos per centimeter at 25° C*			
--------	100	70–100	40–95	15–35	0–15	0.6–2.0	0.13–0.21	7.9–8.4	1–4	Low to moderate.	Moderate	Low.
--------	100	65–85	0–10	NP	NP	6.0–20.0	0.05–0.07	7.9–8.4	0–1	Low	Low	Low.
40–70	35–65	30–60	20–50	<30	NP–5	0.6–2.0	0.09–0.11	6.6–7.3	0–1	Low	Low	Low.
70–80	65–75	55–65	20–40	20–35	5–15	0.6–2.0	0.12–0.14	6.1–6.5	0–1	Low	Low	Low.
90–100	85–95	35–90	70–85	50–65	25–35	<0.06	0.14–0.16	6.1–7.3	0–1	High	High	Low.
95–100	90–100	75–100	60–90	20–30	5–10	0.2–0.6	0.14–0.18	7.4–7.8	0–1	High	High	Low.
--------	100	90–100	75–95	40–55	20–30	0.06–0.2	0.15–0.18	7.8–8.4	0–1	High	High	Low.
85–95	70–85	40–75	25–50	NP	NP	0.6–0.2	0.07–0.09	7.9–8.4	0–1	Low	Low	Low.
80–95	50–70	20–45	10–25	NP	NP	>20	0.04–0.06	7.9–8.4	0–1	Low	Low	Low.
--------	100	85–95	60–70	20–35	5–10	0.6–2.0	0.16–0.18	7.9–8.4	0–1	Low	High	Low.
65–95	60–90	50–85	40–65	20–30	0–5	0.6–2.0	0.13–0.15	7.9–8.4	0–1	Low	High	Low.
--------	100	95–100	40–60	NP	NP	0.6–2.0	0.13–0.18	7.9–8.4	0–1	Low	Moderate	Low.
--------	100	50–90	0–10	NP	NP	6.0–2.0	0.05–0.07	7.9–8.4	0–1	Low	Low	Low.
--------	100	95–100	40–75	NP	NP	0.6–2.0	0.07–0.12	7.9–9.0	4–8	Low	High	Low.
--------	100	90–100	60–80	25–35	5–15	0.2–0.6	[3]0.16–0.20	7.4–7.8	[3]1–4	Moderate	High	Low.
--------	100	90–100	75–90	30–40	10–15	0.2–0.6	[3]0.19–0.21	7.9–8.4	[3]1–4	Moderate	High	Low.
--------	100	90–100	70–80	30–40	10–15	0.2–0.6	[3]0.19–0.21	7.4–8.4	[3]1–4	Moderate	High	Low.
--------	100	95–100	90–95	40–65	20–30	<0.06	0.10–0.12	8.5–9.0	4–8	High	High	Low.
40–75	35–60	20–40	10–30	20–25	0–4	2.0–6.0	0.06–0.08	7.9–9.0	2–4	Low	High	Low.
--------	100	85–100	60–80	25–35	5–15	0.6–2.0	0.16–0.20	7.4–8.4	0–1	Moderate	Moderate	Low.
45–60	40–55	20–45	0–20	NP	NP	>20.0	0.03–0.05	7.4–7.8	0–1	Low	High	Low.

TABLE 8.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. Because the to other series that appear in the first column of this

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill (trench type) [1]	Local roads and streets
Agua:						
Af	Slight	Severe: seepage.	Severe: cutbanks cave.	Slight	Severe: seepage.	Slight
Ag	Slight	Severe: seepage.	Severe: cutbanks cave.	Moderate: shrink swell.	Severe: seepage.	Moderate: shrink swell.
Agua variant: Ah	Severe: wet	Severe: wet	Severe: cutbanks cave.	Severe: wet	Severe: wet	Moderate: wet.
*Akela: AkC. For Rock outcrop part, see Rock outcrop.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Alameda: AmB	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.
Anapra: An, Ao	Slight	Severe: seepage.	Severe: cutbanks cave.	Moderate: shrink swell.	Severe: too sandy; seepage.	Moderate: shrink swell.
Armijo: Ar	Severe: percs slowly.	Slight	Severe: too clayey.	Severe: shrink swell; low strength.	Severe: too clayey.	Severe: shrink swell; low strength.
Badland: Ba	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
*Bluepoint: Bb, BcA, BCC, Bd3, BKD. For Wink part of Bd3, see Wink series; for Kokan part of BKD, see Kokan series.	Slight if slope is 1 to 8 percent, moderate if 8 to 15.	Severe: seepage.	Severe: cutbanks cave.	Slight if slope is 1 to 8 percent, moderate if 8 to 15.	Moderate: too sandy.	Slight if slope is 1 to 8 percent, moderate if 8 to 15.
*Bond. Mapped only with Rock outcrop and Penistaja soils.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope; depth to rock.
*Borolls: BOF. For Rock outcrop part, see Rock outcrop.	Severe: slope; depth to rock.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Brazito: Br, Bs, Bt	Slight	Severe: seepage.	Severe: cutbanks cave.	Slight	Severe: seepage; too sandy.	Slight
Burnac: BUE	Severe: slope; percs slowly.	Severe: slope.	Severe: slope.	Severe: slope; high shrink swell.	Severe: slope; too clayey.	Severe: slope; too clayey.

See footnotes at end of table.

interpretations

soils in such mapping units can have different properties and limitations, it is necessary to follow carefully the instructions for referring table. Some terms in this table are defined in the glossary]

Suitability as source of—				Soil features affecting—		Hydrologic soil group
Road fill	Sand	Gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	
Fair: low strength.	Good	Unsuited	Good	Seepage	Piping; low strength; unstable fill.	B
Fair: low strength.	Good	Unsuited	Fair: too clayey.	Seepage	Piping; low strength; unstable fill.	B
Fair: low strength.	Good	Unsuited	Fair: excess salt.	Seepage	Piping; low strength; unstable fill.	B
Poor: thin layer	Unsuited	Unsuited	Poor: thin layer; area reclaim; small stones.	Depth to rock	Thin layer	C
Poor: area reclaim; thin layer.	Unsuited	Unsuited	Fair: thin layer; area reclaim.	Depth to rock	Piping; low strength.	C
Fair: shrink swell.	Good	Unsuited	Fair: too clayey.	Seepage	Piping	B
Poor: shrink swell; low strength.	Unsuited	Unsuited	Poor: too clayey.	Seepage	Compressible; low strength; hard to pack.	D
Poor: slope	Unsuited	Unsuited	Poor: slope	Slope	Hard to pack; thin layer.	C
Good	Fair: excess fines.	Unsuited	Poor: too sandy.	Seepage	Piping; seepage	A
Poor: thin layer	Unsuited	Unsuited	Poor: thin layer.	Depth to rock	Thin layer	D
Poor: slope	Unsuited	Unsuited	Poor: slope	Slope	Thin layer	D
Good	Fair: excess fines.	Unsuited	Fair: thin layer.	Seepage	Seepage; piping; erodes easily.	A
Poor: shrink swell; slope.	Unsuited	Unsuited	Poor: stones; slope.	Slope	Low strength; shrink swell.	C

TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill (trench type) [1]	Local road and streets
Carlito: CAF	Severe: slope; percs slowly.	Severe: slope.	Severe: slope; too clayey.	Severe: slope; shrink swell.	Severe: too clayey.	Severe: low strength; shrink swell.
Cut and fill land: Cu	Slight if slope is 1 to 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Moderate: cutbanks cave; slope.	Slight if slope is 1 to 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Slight if slope is 1 to 8 percent, moderate if 8 to 15, severe if more than 15.
*Embudo: EmB, EtC. For Tijeras part of EtC, see Tijeras series.	Slight [2]	Severe: seepage.	Moderate: [2] small stones.	Slight [2]	Severe: seepage.	Slight
Escabosa. Mapped only with Laporte soils and Rock outcrop.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.
*Gila: GA, Gb, Ge, GH. For Hantz part of GH, see Hantz series.	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Slight	Moderate: low strength.
Gc, Gd, GF	Severe: wet	Moderate: seepage; wet.	Moderate: wet.	Slight	Severe: wet	Moderate: low strength.
Glendale:						
Gk, Gm	Severe: percs slowly.	Slight	Moderate: too clayey.	Moderate: shrink swell.	Moderate: too clayey.	Moderate: shrink swell.
Gs	Severe: percs slowly.	Moderate: wet	Moderate: too clayey.	Moderate: shrink swell.	Severe: wet; too clayey.	Moderate: shrink swell
Hantz: Ha	Severe: percs slowly; floods.	Slight	Severe: too clayey; rarely floods.	Severe: shrink swell; floods.	Severe: too clayey; floods.	Severe: shrink swell; floods.
Ildefonso: ILC	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Severe if slope is more than 15 percent: small stones.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.
*Kim: KaB, KbB, KD. For Badland part of KD, see Badland.	Slight	Moderate: seepage.	Slight	Moderate: low strength; shrink swell.	Slight	Moderate: shrink swell.
*Kokan: KOE, KR. For Rock outcrop part of KR see Rock outcrop.	Moderate if slope is 10 to 15 percent, severe if more than 15.	Severe: seepage; slope.	Severe: cutbanks cave; small stones.	Moderate if slope is 10 to 15 percent, severe if more than 15.	Severe: seepage; small stones.	Moderate if slope is 10 to 15 percent, severe if more than 15.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—				Soil features affecting—		Hydrologic soil group
Road fill	Sand	Gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	
Poor: low strength; shrink swell.	Unsuited	Unsuited	Poor: thin layer.	Slope	Hard to pack; low strength; compressible.	C
Good if slope is less than 15 percent, fair if more than 15.	Fair: excess fines.	Unsuited	Poor: small stones.	Seepage	Hard to pack; seepage.	A
Good	Poor: excess fines.	Poor: excess fines.	Poor: small stones.	Seepage	Piping; compressible.	B
Poor: thin layer.	Unsuited	Poor: excess fines.	Poor: thin layer; small stones.	Depth to rock; seepage.	Piping; compressible.	C
Fair: low strength.	Poor: excess fines.	Poor: excess fines.	Good	Seepage	Piping	B
Fair: low strength.	Poor: excess fines.	Poor: excess fines.	Poor: excess salts.	Seepage	Piping	B
Fair: shrink swell.	Unsuited	Unsuited	Fair: too clayey.	Favorable	Low strength; piping.	B
Fair: shrink swell.	Unsuited	Unsuited	Poor: excess fines.	Favorable	Low strength; piping.	B
Poor: shrink swell.	Unsuited	Unsuited	Poor: too clayey.	Favorable	Compressible; low strength.	D
Good if slope is less than 15 percent, fair if 15 to 25, poor if more than 25.	Poor: excess fines.	Poor: excess fines.	Poor: small stones.	Seepage	Favorable	B
Fair: low strength.	Unsuited	Unsuited	Good	Seepage	Piping; low strength.	B
Good if slope is 10 to 15 percent, fair if 15 to 25, poor if more than 25.	Good	Good	Poor: small stones.	Seepage	Seepage	A

TABLE 9.—*Highway*

[Tests performed by the New Mexico State Highway Department, Materials and Testing Division, in accordance with

Soil name and location	Parent material	New Mexico State Highway Department Report Number	Depth	Estimated percent by volume, of coarse fragments greater than 3 inches	Mechanical analysis: Percentage passing sieve— 5 inches	2 inches
			Inches			
Alemeda sandy loam, 0 to 5 percent slopes: Northwest corner of sec. 28, T. 11 N., R. 2 E. (Modal profile)	Wind-laid sediments and material weathered from basalt bedrock.	6S-15376	0-4	----------	----------	----------
		6S-15377	4-9	----------	----------	----------
		6S-15378	9-13	----------	----------	----------
		6S-15379	13-18	20	100	51
		6S-15380	18-26	40	----------	100
Bluepoint loamy fine sand, 1 to 9 percent slopes: Northwest corner of sec. 5, T. 11 N., R. 3 E. (Modal profile)	Sandy alluvium and wind-laid sediments.	6S-15351	8-20	----------	----------	----------
		6S-15352	20-40	----------	----------	----------
Bluepoint fine sand, hummocky: NW¼SE¼SE¼ sec. 8, T. 10 N., R. 1 E. (Coarser textured than modal profile)	Wind-laid sand.	6S-15362	0-60	----------	----------	----------
Latene sandy loam, 1 to 5 percent slopes: NE¼SW¼NW¼ sec. 26, T. 11 N., R. 1 E. (Modal profile)	Old alluvium and mixed wind-laid sediments.	6S-15358	0-7	----------	----------	----------
		6S-15359	7-15	----------	----------	100
		6S-15360	15-24	----------	----------	----------
		6S-15361	24-41	----------	----------	----------
Millett stony sandy loam in an area of Tesajo-Millett stony sandy loams: SW¼SE¼ sec. 4, T. 10 N., R. 4 E. (Modal profile)	Decomposed granitic alluvium.	6S-15369	0-4	20	----------	----------
		6S-15370	4-10	10	----------	----------
		6S-15371	10-23	10	----------	----------
Pajarito loamy fine sand, 1 to 9 percent slopes: W½ sec. 17, T. 11 N., R. 1 E. (Modal profile)	Eolian and alluvial sediments on old alluvial mesas and upland piedmonts, mainly from the Santa Fe Geological Formation.	6S-15355	0-3	----------	----------	----------
		6S-15356	3-23	----------	----------	----------
		6S-15357	23-42	----------	----------	----------
Tesajo stony sandy loam in an area of Tesajo-Millett stony sandy loams: SW¼NE¼ sec. 14, T. 11 N., R. 4 E. (Modal profile)	Alluvial sediments from granite rocks.	6S-15368	9-27	10	----------	----------
Tijeras gravelly fine sandy loam, 1 to 5 percent slopes: SE¼SE¼ sec. 4, T. 10 N., R. 4 E. (Modal profile)	Old alluvial sediments mainly from granitic rocks.	6S-15363	0-4	----------	----------	----------
		6S-15364	4-9	----------	----------	----------
		6S-15365	9-14	----------	----------	----------
		6S-15366	14-19	----------	----------	----------
		6S-15367	19-40	----------	----------	----------

[1] NP means nonplastic.

Some of the terms used in this soil survey have special meanings in soil science that may not be familiar to engineers. The Glossary defines many of these terms.

Engineering soil classification systems

The two systems most commonly used in classifying soils for engineering are the Unified system (*7*) used by the Soil Conservation Service engineers, Department of Defense, and others and the AASHTO system adopted by the American Association of State Highway and Transportation Officials (*1*). These classification systems are explained in the PCA Soil Primer (*4*).

The Unified system classifies soils according to particle-size distribution, plasticity, liquid limit, and organic-matter content. In this system soils are grouped in 15 classes. Eight classes are coarse grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes are fine grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class is highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by the symbols for both classes, as in CL-ML.

test data

standard procedures of the American Association of State Highway and Transportation Officials (AASHTO)]

Mechanical analysis—Continued							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued									AASHTO	Unified
1 inch	¾ inch	⅜ inch	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
				100	91	36	[1] NP	NP	A-4 (1)	SM
				100	94	45	21	5	A-4 (2)	CL-ML
				100	92	51	22	1	A-4 (3)	ML
				41	36	19	27	7	A-2-4 (0)	GM
47	45	43	42	78	66	31	25	5	A-2-4 (0)	CL-ML
88	84	81	79							
				100	92	17	NP	NP	A-2-4 (0)	SM
				100	90	18	NP	NP	A-2-4 (0)	SM
				100	97	2	NP	NP	A-3 (0)	SP
				100	95	40	NP	NP	A-4 (1)	SM
				84	76	41	24	5	A-4 (1)	SM-SC
99	98	95	89	100	76	35	NP	NP	A-2-4 (0)	SM
				100	70	29	36	8	A-2-4 (0)	SM
				100	47	37	NP	NP	A-4 (1)	SM
				76	57	37	31	7	A-4 (1)	SM-SC
	100	99	93	47	31	20	30	8	A-2-4 (1)	SM-SC
	100	96	81							
				100	99	24	NP	NP	A-2-4- (0)	SM
				100	98	42	NP	NP	A-4 (1)	SM
				100	93	69	24	5	A-4 (7)	CL-ML
	100	95	80	54	37	21	NP	NP	A-1-b (0)	SM
		99	93	75	60	45	NP	NP	A-4 (2)	SM
		99	95	86	77	56	24	5	A-4 (4)	CL-ML
		99	95	85	77	60	25	4	A-4 (5)	CL-ML
		98	93	78	62	44	24	4	A-4 (2)	CL-ML
		99	89	64	45	27	NP	NP	A-2-4 (0)	SM

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups on the basis of grain-size distribution, liquid limit, and plasticity index. The groups range from A-1, or gravelly soils, which have high bearing strength and are the best soils for foundation or subgrade, to A-7, or clay soils, which have low strength if wet and are the poorest soils for subgrade. Where sufficient laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided into groups A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 9; the estimated classification for all soils mapped in the survey area, without group index numbers, is shown in table 7.

TABLE 12.—*Climatic data*

[All data from Albuquerque International Sunport, Bernalillo County, New Mexico, elevation 5,314 feet, for the period August 1939 through December 1970]

Month	Temperature					Precipitation		
	Average daily maximum	Average daily minimum	Daily mean	Extreme maximum	Extreme minimum	Average total	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Inches		Inches
January	47	24	35	68	[1] −7	0.31	1	1.8
February	53	27	40	72	−5	.40	2	1.7
March	59	32	46	81	8	.47	2	1.7
April	70	41	56	89	19	.47	2	.3
May	80	51	65	98	28	.56	2	(2)
June	89	60	75	102	43	.53	1	0
July	92	65	79	104	54	1.37	4	0
August	90	63	77	100	52	1.38	4	0
September	83	57	70	98	37	.83	4	(2)
October	72	45	58	87	25	.78	2	(2)
November	57	32	44	74	10	.34	1	1.2
December	48	25	37	72	3	.52	2	2.6

[1] An extreme minimum of −17° was subsequently recorded on Janury 7, 1971. [2] Trace.

TABLE 13.—*Annual averages of temperature and precipitation* [1]

[For Bernalillo County, New Mexico]

Station	Elevation	Temperature			Precipitation		Average date of—		Average number of frost-free days
		Average maximum	Average minimum	Years of record	Average annual	Years of record	Last freezing temperature in spring	First freezing temperature in fall	
	Feet	°F	°F	Number	Inches	Number			
Albuquerque International Sunport.	5,314	70	44	21	7.88	21	April 16	October 29	196
Barton	6,875	64	37	11	15.90	12	May 11	October 14	156
Experiment Farm	4,928	71	36	19	6.82	19	April 24	October 10	169
Netherwood Park	5,130	72	40	22	8.32	22	April 16	October 24	191
Rio Grande Industrial School.	5,000	70	36	10	8.31	10	May 8	October 12	157
Sandia Park	7,130	65	33	18	18.16	19	May 17	October 7	143
Sandia Ranger Station.	6,300	66	32	36	14.61	49	May 22	September 30	131

[1] Period of record: Barton, 1914-1925; Experiment Farm, 1938-1957; Netherwood Park, 1935-1957; Rio Grande Industrial School, 1911-1921; Sandia Park, 1954-1965; Albuquerque International Sunport and Sandia Ranger Station, 1939-1960.

from late in May to early in October. Temperatures are generally mild at the lower elevations, and nights cool rapidly after sundown. Large diurnal and annual ranges in temperature, which are characteristic of a continental climate, occur in the area. Albuquerque, for example, has an average diurnal temperature range of 27 degrees.

Average annual relative humidity at Albuquerque is 43 percent, but ranges from near 60 percent early in the morning to nearly 30 percent in the afternoon. In June, the average afternoon relative humidity is nearly 20 percent and occasionally falls as low as 4 percent.

Sunshine occurs more than 75 percent of the possible hours, or nearly 3,400 hours a year, and is fairly evenly distributed in all seasons.

The average annual windspeed is 9 miles per hour. Spring is the windy season, and if weather is dry, soil blows occasionally. A brief period of soil blowing can also occur just before a thunderstorm. Winds blow most frequently from the north in winter, and from the south along the river valley in summer. In Tijeras Canyon the heavy cold air held back by the Sandia and Manzano Mountains finds access to the basin and literally pours through the Canyon, spreading out on the mesa and valley below in gusts of up to 50 miles per hour.

APPENDIX 2

UNDEVELOPED DRAINAGE FLOWS

SUBDIVISION HN & WS
LOCATION UNIV. & I-25 SW
JOB NO. 0990901
DESIGN STORM 10 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY D. MAIN DATE 10-4-79
CHECKED BY "

UNDEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

PAGE 1

Area Designation	A (Acres)	C	C_f	$\bar{C}$ = (C x C_f)	A·$\bar{C}$	ΣA·$\bar{C}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{C}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	SCS VEL V fps	Δt (min)	
A	35.7	.3			10.72		10	5.4	57.9				6.66	1860	3.93	7.85	TO POINT 6
								2.68	28.7								
OSA2	1.4	.3			.42		5.0	6.3	2.6								
								3.14	1.31								
OSA2	12	.3			3.6		10	5.4	19.4				9.5	920	4.7	3.26	GRASSED WW AT POINT 1
								2.68	9.6								
Σ A, OSA2, OSA2						14.74	17.85	4.41	65.0								AT POINT 6
								2.17	32.0								
													[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
													[illegible]	[illegible]	[illegible]		
B	6.96	.3			2.09		5.	6.3	13.2				9.7	310	3.1	1.67	NEARLY FLATS & GRASSED WW
								3.14	6.6				6.8	1115	4.0	4.65	TO POINT 9
OSB	.71	.3			.213		5.	6.3	1.37								TO POINT 9
								3.14	0.7								
Σ B, OSB						2.3	5	6.3	14.5								AT POINT 9
								3.14	7.2								

DIVISION NS & HN
LOCATION UNIVERSITY & I-25 SW
JOB NO. 0000001
DESIGN STORM 10 YR. RECURRENCE INTERVAL
FOR STORM 100 YR.
COMPUTATIONS BY D. MAN DATE 10-2-79
CHECKED BY

UNDEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

PAGE 2 OF

Area Designation	A (Acres)	C	C_f	$\bar{C}$ = (C x C_f)	A·$\bar{C}$	ΣA·$\bar{C}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{C}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	SCS VEL V fps	Δt (min)	
C	6.32	.3			1.97		10	5.4	10.3				14.8 9.3	230 860	3.8 4.6	1.01 3.12	
								2.68	5.1								TO POINT 10
OSC	.28	.3			.084		5	6.3	0.5								
								3.14	0.3								TO POINT 10
Σ C OSC						1.984	10	5.4	10.7								AT POINT
								2.68	5.3								10
D_1	11.97	.3			3.59		10	5.4	19.4				7.9	1075	4.2	4.25	GRASSED WW TO POINT 13
								2.68	9.6								
D_2	2.57	.3			.771		5	6.3	4.9					1270			INTO OSD2
								3.14	2.4								
OSD_1	.83	.3			.249		5	6.3	1.6				8.6	420	2.9	2.41	TO POINT 13
								3.14	.8								
OSD_2	1.53	.3			.459		10.58	5.31	2.4				1%	1270	2	10.58	INTO D1
								2.63	1.2								
OSD_3	11.5	.3			3.45		11.6	5.16	17.8				10 .9 11.3	200 800 530	3.2 1.5 5.3	1.04 9.69 1.67	INTO OSD2
								2.56	8.8								
OSD_4	21.7	.3			6.51		10	5.4	35.2				6.7 8.6	300 900	3.95 4.5	1.27 3.33	TO POINT 11
								2.68	17.4								
CONTINUED																	

SUBDIVISION JH J JO IN
LOCATION UNIV - 125 SW
JOB NO. 9990901
DESIGN STORM 10 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY D. MAIN DATE 10-4-79
CHECKED BY J.H. 10/15/79

UNDEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

Area Designation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f)	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	Δt (min)	
F	.68	.3			.21		5	6.3	1.3								INTO OSF1
								3.14	.7								
OSF1	1.02	.3			.3		10.6	5.3	1.6				1.5	830	1.3	10.6	INTO OSD2
								2.63	.8								
OSA3	4.5	.3			1.35		10	5.4	7.3				7.5 7.7	400 520	3	5.1	INTO OSF1
								2.68	3.6								
Σ D12 OSD1234 F OSF1, OSA3						16.89	19.9	4.21	71.0								AT POINT 13
								2.07	35.0								
Σ D2, F, OS: D2, BA OS-A3 & OSF1	48.5					13.05	15.76	4.64	60.6								AT POINT 12
								2.29	29.9								
E	2.57	.3			.771		5	6.3	4.9				16 17	250 1000	4 7	1.04 2.27	INTO OSE
								3.14	2.4								
OSE	1.16	.3			.348		5	6.3	2.2				8	1000.	5.6	2.97	TO POINT 14
								3.14	1.1								
Σ OSE E						1.12	5	6.3	7.1								AT POINT 14
								3.14	3.5								

APPENDIX 3

DEVELOPED DRAINAGE FLOWS

SUBDIVISION JOHNSON & JOHNSON
LOCATION UNIVERSITY & I-25 SW
JOB NO. 9990901
DESIGN STORM 10 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY D MAIN DATE 10-2-79
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DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

$t_c = \frac{L}{V.60}$

$I_{100} = \frac{189}{T_c+25}$

$I_{10} = \frac{91}{t_c+24}$

PAGE 1 C

Area Designation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	SCS GRAPH VEL V fps	Δt (min)	
A_1	8.41	.3			2.523		10	5.4	13.6				5188-5106 82'	1060	4.25	4.16	GRASSED WW
								2.68	6.8				7.74				
A_2	16.47	.312			5.14		10.7	5.4	27.8				5238-5130 108'	1725	3.8	7.57	GRASSED WW TO POINT 5
								2.68	13.8				6.26				
A_3	2.08	.75			1.56		15	6.3	9.8				1.5% 38'	190 160'	1.45 9.0	2.18 .30	ROOF GRASSED WW
								3.14	4.9				20.6			2.48	
A_4	2.04	.81			1.65		15	6.3	10.4				6%	835	4.9	2.84	AT POINT C
								3.14	5.2								
A_5	4.00	.804			3.22		10	5.4	17.4				.5 3.31 6.0	150 785 110'	1.45 3.6 3.0	1.72 3.63 2.61	ROOF PARKING OVERLAND AT POINT b
								2.68	8.6								
A_{5b}	.52	.84			[illegible]		[illegible]	[illegible]	[illegible]				.5 8.5	100 200	1.46 4.45	1.15 .72	ROOF GRASSED WW
								.52	1.5								

DIVISION JOHNSON & JOHNSON
CATION UNIVERSITY & I-25 SW
NO. 9990901
SIGN STORM 10 YR. RECURRENCE INTERVAL
JOR STORM 100 YR.
MPUTATIONS BY D. MAIN DATE 10-3-79
CKD BY

DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

PAGE 2

Area Designation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f)	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	Δt (min)	
A6	3.92	.714			2.80		10	5.4	15.1				4%	555	4.0	2.31	Sheet flow
								2.68	7.5					280	5.6	.833	AT POINT 2
OSA7	.83	.58			.48	0.68	5.0	6.3	4.3								
A7	.67	.3			.20			3.14	2.1								AT POINT e (INLET)
OSA3	4.5	.32			1.44		5	6.3	9.1								AT POINT f (INLET)
								3.14	4.5								
OSA2	12.0	.3			3.61		10	5.4	19.4				9.5	420	4.7	3.26	GRASSED WW AT POINT 1
								2.68	9.6								
Σ OSA2 OSA3 OSA7 A7	.8	.32			.49	5.72	10.59	5.3	30.3		30.3	36"	8%	600	17	.59	TO 2
								2.63	15.0					110	"	.11	TO 3
														340	"	.33	TO 4 — AT POINT 2
A6 THRU PIPE											15.1	24"	14	110	17	.11	TO 2
							.11										
Σ OSA2,3,7 A7 A6					5.72	8.52	10.7	5.29	45.1		45.1	42"	8.0%				AT POINT 2
					2.80			2.62	22.3								
A5 THRU PIPE							.11				17.4	24"	6.5	215	17	.21	
							.21										
Σ OSA2,3,7 A5,6,7					3.22	11.74	11.02	5.25	61.6		61.6	42"	8%				AT POINT 3
								2.61	30.5								

SUBDIVISION JOHNSON & JOHNSON
LOCATION UNIV & I-25 SW
JOB NO. 9990901
DESIGN STORM 10 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY D MAIN DATE 10-4-79
CKD BY

DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

Area Designation	A (Acres)	C	C_f	$\bar{C}$ = (C x C_f)	A·$\bar{C}$	ΣA·$\bar{C}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{C}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	ΔT (min)	
THRU A4 PIPE							.33				10.4	24	13	130	.17	.13	
							.13										
Σ OS A 2,3,7				11.74	11.74	13.39	11.48	5.18	69.4		69.4	42	8.0				AT POINT 4
Σ A4,5,6,7				1.65	1.65			2.56	34.3								
POINT 4 TO DAM 1							1.9						6.4	440	3.85	1.9	
Σ OS A 2,3,7	A2				5.14	20.09	13.38	4.92	98.8								AT POINT 5
Σ A 2,3,4,5,6,7	A3				1.56			2.43	48.8								

BDIVISION JOHNSON & JOHNSON
CATION UNIV & I-25 SW
J NO. 9990001
SIGN STORM 10 YR. RECURRENCE INTERVAL
JOR STORM 100 YR.
IMPUTATIONS BY MAIN DATE 10-2-79
CKD BY

DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

PAGE 4

Area Designation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f)	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	Δt (min)	
B_1	.76	.3			.228		5.0	6.3	1.4				5166 5118 38	340	.52	1.09	GRASSED WW
								3.14	1.7				11.2				
B_2	4.26	.3			1.278		10	5.4	6.9				5205 5132 78	680	5.00	2.27	GRASSED WW
								2.68	3.4				10.7	600		2.0	POINT 7 TO POINT 8
B_3	.84	.9			.756		5.1	6.3	4.8				.5	230'	1.95	2.64	ROOF
								3.14	2.4								
B_4	2.82	.84			2.37		5	6.3	14.9				5227 5205 22 4.2	520'	4.1	2.11 1.14	PARKING AT POINT 9
								3.14	7.4								
B_4 THRU PIPE					2.37		5.28	6.24	14.8		14.8	24"	.9	270	17	.28	
								3.1	7.3								
ΣB_{43}						3.126	5.28	6.24	19.5								AT POINT 7
								3.1	9.7								
ΣB_2 POINT 7					3.126	4.466	7.28	5.86	26.2								AT POINT 8
					1.34			2.91	13.0								

BDIVISION JOHNSON & JOHNSON
CATION UNIVS I-25 SW
D NO. 9990901
SIGN STORM 10 YR. RECURRENCE INTERVAL
JOR STORM 100 YR.
OMPUTATIONS BY D MAIN DATE 10-2-79
CKD BY

DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

PAGE 5

Area Designation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f)	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	Δt (min)	
C	5.01	.3			1.503		10	5.4	8.1				.21	200	4.5	3.52	OVERLAND GRASSEDWY TO POINT 10
								2.68	4.0				8.5	750	4.5		
ΣC OSC	.28	3				1.587	10	5.4	8.6								AT POINT 10
								2.68	4.3								
D1	11.73	.36			4.22 ✓		10	5.4	22.8				7.2	1140	4.3 ok	4.42	GRASSED WY
								2.68	11.3				8.6	1230	4.5	4.56	
OSD4	21.7	.3			6.51 ✓		10	5.4	35.2								
								2.68	17.4								
D2+OSD2	1.26	.35			.441 ✓	1.43 ✓	10	5.4	7.7				8	120	2	.613	AT POINT 9
	1.7	.58			.986			2.68	3.8				3.0	1400	3.7		
OSD3	11.5	.34				3.91 ✓	11.6	5.16	20.2								AT POINT 11
								2.56	10.0								
ΣD2 OSD2,34	THRU PIPE	.3			.711	11.85	11.73	5.15	61.0		9.09		16	130	.17	.13	AT POINT 12
								2.55	30.2				12				
ΣD12 OSD1,2,3,4						16.32	16.25	4.58	74.7								AT POINT 13
								2.26	36.9								
D1 - PARKING ONLY	1.19	.97			1.07		5	6.3	6.7				.26	1090	1.6	10.1	AT POINT 15
								3.14	3.4								

DIVISION JOHNSON & JOHNSON
ATION UNITS 1-25 SW
NO. 0990901
IGN STORM 10 YR. RECURRENCE INTERVAL
OR STORM 100 YR.
PUTATIONS BY D MAIN DATE 10-4-79
CKD BY

DEVELOPED

RUNOFF COMPUTATIONS
(Rational Method)

PAGE 6 O

Area osignation	A (Acres)	c	c_f	$\bar{c}$ = (c x c_f	A·$\bar{c}$	ΣA·$\bar{c}$	tc (min)	I (in/hr)	Q = (ΣA·$\bar{c}$) x I cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Slope %	Length ft.	VEL V fps	At (min)	
E,	2.57	.3			.771		5	6.3	4.9				16	250	4	1.09	
								3.14	2.4				12	1000	7	2.27	
OSE	1.16	.58			.673		5	6.3	4.2				5210 5150 .8	1000	5.6	2.97	
								3.14	2.1								
OSE E						1.444	5	6.3	9.1								AT POINT 14
								3.14	4.5								

APPENDIX 4

FLOOD ROUTING THROUGH

DAM 1 AND DAM 2

FLOOD ROUTING

DAM #1 — 24" Riser Inlet @ Elev. 32

TIME min	Q_{IN} 100 cfs	Q_{OUT} 100 cfs	ELEV.
5	27.4	2.8	32.7
10	54.9	18.3	34.35
15	82.3	29.9	35.91
20	93.3	34.3	37.13
25	79.6	37.2	38.05
30	65.9	38.5	38.45
35	52.1	39.1	38.65
40	38.4	39.6	38.85
45	24.7	39.5	38.80
50	11.0	38.7	38.55
55	–	37.7	38.2

DAM #2 — 18" riser @ Elev 34

5	8.7	.3	34.2
10	17.5	0.9	34.42
15	26.2	3.7	35.02
20	21.9	7.1	35.53
25	17.5	10.0	35.90
30	13.1	11.7	36.10
35	8.7	11.7	36.10
40	4.4	10.9	36.00
45	0	8.6	35.73

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JOB NO. _____ DATE _____
PROJECT _____
_____ SCALE _____

DAM #1

Elev	Area ft^2	Incremental Volume ft^3	TOTAL VOLUME ft^3	
30	0			
32	2100	2100	—	Reserved for siltation
34	7400	9500	9500	
36	10,800	16,900	26,400	
38	19,300	27,700	54,100	
40	27,900	55,600	109,700	overflow spillway @ 40°
42	42,100	70,000	179,700	

DAM #2

32	3300	0	0	
34	7700	11,000	0	Reserved for siltation
36	12,700	20,400	20,400	
38	18,200	30,900	51,300	Overflow spillway @ 37°

APPENDIX 5

HYDROGRAPH CALCULATIONS

POINT	Condition	ΣCA	V_p ft³	t_c, MIN	V_c	t_p, MIN	Q_{p100} cfs
5	dev.	20.09	160,440	13.38	119,153	18.0	98.8
6	under	14.73	117,714	17.85	104,423	20	65.0
6	dev.	*	—	—	—	25	48.0
8	dev.	4.466	35,665	7.28	17,166	15	26.2
9	dev.	*	—	—	—	30	12.9
9	under.	2.30	18,368	5	6525	14.1	14.5
10	dev	1.587	12,674	10	7740	16.4	8.6
10	under.	1.98	15,812	10	9630	16.4	10.7
13	dev.	16.32	130,332	16.15	108,576	19.4	74.7
13	under.	16.89	134,884	19.9	127,340	21.1	71.1

* See Hydrographs.

V_p = 6-hr runoff volume based on 100-yr. frequency rainfall of 2.2"

V_c = Volume under unmodified triangular hydrograph = $1.5\, Q_p\, t_c$

t_p = modified time to peak to give same volume as V_p without changing Q_p = $t_c \frac{V_p}{V_c}$

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JOB NO. _____ DATE 10/11/79

PROJECT _____

SCALE _____

#6 Undeveloped

6 hr

$V_{u_6} = 2.2/12(43{,}560)(14.74)$ ΣA·C $= 117{,}714\ ft^3$

$V_u = 3/2\ Q_p\ t_p = 3/2(65)(60\ sec/min)(17.85) = 104{,}423$

$\frac{V_u}{V_{u_6}} = .887 \qquad t_{p'} = \frac{t_p}{\frac{V_u}{V_{u_6}}} = 20\ MIN$

ΣA, & OS a2

$V_A = 2.2/12\ (43{,}560)(2.943) = 23{,}503$

$V_{A'} = 3/2\ Q_p t_p = 1.5(15.89)(60)(10) = 14{,}301$

$\frac{V_{A'}}{V_A} = .6085$

$t_{p'} = \frac{t_p}{.6085} = 16.5$

$t_B' = 3t_p' = 49.5\ MIN$

Pt #9 Undeveloped

$V_9 = 2.2/12\ (43560)(2.3)$ ΣA·C $= 18{,}368\ ft^3$

$V_{9'} = 3/2\ Q_p\ t_p = 3/2(14.5)(60)(5) = 6525\ ft^3$

$t_p' = \frac{t_p\ V_9}{V_{9'}} = 14.1\ min$

$t_B' = 42.3\ min$

ΣB1 & OS·B

$V_B = 2.2/12\ (43560)(.441) = 3522\ ft^3$

$V_B' = 3/2\ Q_p t_p = 1.5(2.78)(60)(5) = 1251\ ft^3$

$t_p' = \frac{t_p}{V_{B'}} V_B = 14.1\ MIN$

$t_B' = 3t_p' = 42.3\ MIN$

IMPORTANT MESSAGE

FOR Bruno

DATE 10-11 TIME 10:55 A.M. P.M.

WHILE YOU WERE AWAY

M Walt Wegrzynek

OF M.S.M.

PHONE NO.

TELEPHONED		RET'D YOUR CALL	
PLEASE CALL		URGENT	
WILL CALL AGAIN		WANTS TO SEE YOU	

MESSAGE Johnson & Johnson

drainage study will

be delivered 10-19-79

SIGNED LC