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Coal Combustion Residuals Landfill Run-on and Run-off Control System Plan

Conemaugh Generating Station
Conemaugh Station Ash/Refuse Disposal Site
New Florence, Pennsylvania

GAI Project Number: C151611.02, Task 001

October 2016
Rev. 01, September 2021

Prepared by: GAI Consultants, Inc.
Pittsburgh Office
385 East Waterfront Drive
Homestead, Pennsylvania 15120-5005

Prepared for: Conemaugh Generating Station
1442 Power Plant Road
New Florence, Pennsylvania 15944-9154

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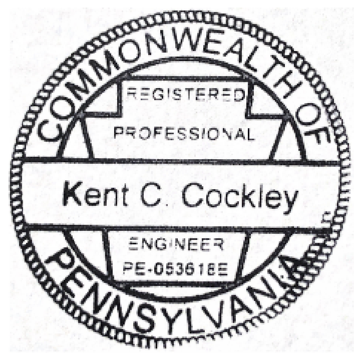
Professional Engineer's Certification

The Run-on and Run-off Control System Plan for the Conemaugh Station Ash/Refuse Disposal Site was prepared by GAI Consultants, Inc. (GAI). The Plan was based on certain information that, other than for information GAI originally prepared, GAI has relied on but not independently verified. Therefore, this Professional Engineer's Certification is limited to the information available to GAI at the time the Plan was written. On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Pennsylvania, that the Plan has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances and at the time and in the same locale. It is my professional opinion that the Plan was prepared consistent with the requirements of Section 257.81 of the United States Environmental Protection Agency's "Disposal of Coal Combustion Residuals from Electric Utilities," published in the Federal Register on April 17, 2015 with an effective date of October 19, 2015.

The use of the words "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

Kent C. Cockley
Digitally signed by Kent C. Cockley
DN: E=k.cockley@gaiconsultants.com, CN=Kent C. Cockley
Date: 2021.09.10 18:49:57-04'00'

Kent C. Cockley, P.E.
Vice President



Plan Revisions

Revision	Date	Reason	Description	Reviewer
0	Oct. 2016		Original Document	NRG, GAI Consultants
1	Sept. 2021	Comprehensive review and as-needed revisions per CCR Rule, Section 257.81(c)(4) requirements (review of plan required every five years)	Remove GenOn/NRG, additional miscellaneous administrative changes, revised run-on and run-off control system descriptions to reflect Stage IIIA construction and current conditions	Conemaugh Station, GAI Consultants

1.0 Introduction

The Conemaugh Generating Station is a steam electric generating station located along the Conemaugh River in West Wheatfield Township, Indiana County, Pennsylvania (PA). The station consists of two 850-megawatt (nominal net maximum load) coal-fired units. The station commenced operation in 1970.

The Conemaugh Station Ash/Refuse Disposal Site (disposal site) is permitted under PA Department of Environmental Protection (DEP) Solid Waste Permit No. 300876 and receives Coal Combustion Residuals (CCR) generated by the Conemaugh Generating Station. The disposal site is divided into three stages: Stages I (closed), II (currently active), and III (Stage IIIA is currently active; additional areas in Stage III may be developed to receive future CCR).

Stage I is approximately 160 acres and is located in the northern-most limits of the disposal site. Stage I started receiving CCR in 1970 and was closed in 1987 with cover/topsoil and vegetated. Stage II covers approximately 120 lined acres and is located directly south of Stage I, closer to the Conemaugh Generating Station. Stage III could ultimately cover approximately 110 lined acres; approximately 25 acres of Stage III were developed in 2017-2018 as part of Construction Phase IIIA. When the ultimate development is reached, the northern side of Stage III will abut a portion of Stage II. Stage III will terminate approximately 600 feet north of the existing Ash Disposal Site Leachate Surge Pond (Surge Pond) when ultimate development is complete. The CCR placed on the disposal site consists mostly of bottom ash, fly ash, pyrites, and Flue Gas Desulfurization (FGD) by-product.

2.0 Run-on and Run-off Control System Plan

This Run-on and Run-off Control System Plan (RRCSP) (§257.81) sets forth the techniques that are utilized to minimize stormwater run-on, and divert and collect stormwater run-off during operation of the disposal site. The purpose of the Run-on and Run-off Control System is to limit flow of stormwater run-on from a 24-hour, 25-year storm onto the active portion of the disposal site; and to divert and collect run-off from the soil-covered and vegetated portions and the active portions of the disposal site (resulting from a 24-hour, 25-year storm) during operation. Stormwater controls at the disposal site consist of the following:

- Temporary/permanent stormwater diversion and collection channels;
- Culverts;
- Slope Drains; and
- Stormwater Equalization (Surge) Pond (existing).

All surface run-on along the perimeter of the closed Stage I area is discharged into a stormwater diversion channel that is separated from the run-off from the active areas of Stages II and III. The surface run-on along the perimeter of Stage II and the Stage III area is or will be conveyed to diversion channels that are directed to unnamed tributaries of the Conemaugh River.

The run-off to be diverted for Stage II and Stage III includes stormwater run-off from the closed (vegetated) Stage I portion of the disposal site and stormwater run-off from closed (soil covered and vegetated) areas of Stage II.

The run-off to be collected will include stormwater run-off from the active portion of Stage II prior to burial by the Stage III area, some stormwater run-off from soil-covered and vegetated portions of Stage II not buried by Stage III, and the active portion of Stage III during its development. All run-off from the active portion of Stage II and the Stage III area is conveyed to the existing Surge Pond that is located to the south of the disposal site for subsequent treatment.

2.1 Stormwater Run-on Control

Stormwater run-on to the disposal site is controlled via the installation of diversion features. Disposal site control features consist of diversion channels and culverts.

All run-on diversion channels designed for Stage II development are designed for the 24-hour, 100-year storm event. Temporary run-on diversion channels for Stage III development are designed for the 24-hour, 25-year storm and permanent run-on diversion channels are designed for the 24-hour, 100-year storm event. The culverts are designed based on the design of the receiving channel. Therefore, all run-on diversion channels and culverts have been designed to meet Section 257.81 of the Federal CCR Rule.

2.1.1 Run-on Channel and Culvert Design

2.1.1.1 Existing Stage I and II Features

Refer to Drawing No. 42-E-0209 (sheets 1 and 2) and Appendix A (Stage II Form I Calculations) for information concerning the Stage I and Stage II run-on diversion channels.

Diversion channels are located on the east and west sides of Stage II to prevent stormwater from entering the collection channels and the existing Surge Pond. Stormwater from north of the site and from revegetated Stage I and Stage II areas is diverted through three culverts that cross underneath Clay Pike Road, which is located to the west of the landfill. A Type H channel and a Type A channel discharge to the northernmost culvert (a six-foot by 12-foot concrete box culvert). Two separate Type A channels discharge to either a 30-inch diameter corrugated metal pipe (CMP), or a 48-inch diameter CMP.

A Type F channel and a Type H channel, located to the north of the above-mentioned culverts, divert additional run-on from the west side of the site while Type B, C, and K channels divert stormwater run-on from the east side of the site. These features discharge to the West Diversion Channel and the East Diversion Channel, respectively, and prevent run-on from entering the collection channels and the existing Surge Pond.

2.1.1.2 During Development of Stage III

The existing and proposed run-on control drainage features for the Stage III area are designed for the peak flow from either a 24-hour, 25-year storm event or a 24-hour, 100-year storm event. Each diversion channel was sized to handle the 24-hour, 25-year peak flow. The permanent drainage features were sized for a 24-hour, 100-year peak flow and compared to the design for the 25-year storm event. The deepest resulting channel flow depth was then selected. The Stage III construction was planned to take place in five intermediate phases referred to as Stages IIIA, IIIB, IIIC, IIID, and IIIE. Temporary channels and culverts designed for the intermediate phases were designed for the 24-hour, 25-year storm. Refer to Drawing 728-1182 for diversion channel layout during the intermediate phases. As noted above, construction of Stage IIIA was completed in 2018; this area has been lined and the designed channels constructed. Below is a list of the permanent and temporary features included in the Stage III development design. The intermediate phases of Stage III will be built as necessary to support Station operations.

<u>Temporary Run-on Features</u>

- Stage IIIA
  - Culvert 6A conveys the flow from the existing Eastern Diversion Channel to the southeast of Stage III and north of the Surge Pond – Drawing No. 728-1181 and Appendix B (Stage III Form I Calculations).

- Culvert 4 (downstream of permanent Type T channel) conveys run-on from the Type T channel to a temporary Type XX channel – Drawing No. 728-1182 and Appendix B.

▪ Stage IIIB
  - Channel WD1 will divert run-on water from the west side of the site to the existing West Haul Road Diversion Channel – Drawing No. 728-1182 and Appendix B.

▪ Stage IIIC
  - Channel WD2 (to be constructed upstream from WD1) will convey the run-on from the western perimeter of the disposal site to the existing West Haul Road Diversion Channel – Drawing No. 728-1182 and Appendix B.

<u>Permanent Run-on Features</u>

▪ Stage IIIA
  - Type T channel diverts run-on from the east side of the site away from the working area to ultimately discharge to the existing East Diversion Channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type AA channel diverts run-on from the east side of the site away from the working area to ultimately discharge to the East Valley Stream – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Culvert 1C conveys flow from the Type AA channel to the East Valley Stream– Drawing Nos. 728-1181 and 728-1182 and Appendix B.

▪ Stage IIIC
  - Type A channel will divert run-on and run-off from soil-covered and vegetated areas from the western highpoint of the working area to the Type B channel for discharge through an existing culvert and the existing Stage II Western Diversion Channel for ultimate discharge into an unnamed tributary to the Conemaugh River – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type B channel will divert run-on and run-off from soil-covered and vegetated areas from the western side of the working area to an existing culvert and the existing Stage II Western Diversion Channel for discharge into an unnamed tributary to the Conemaugh River – Drawing Nos. 728-1181 and 728-1182 and Appendix B.

▪ Stage IIID
  - Type X channel (downstream of extended permanent diversion Type T) will convey run-on from the eastern perimeter of the disposal site to Culvert 5 – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Culvert 5 (downstream of Type X channel) will convey run-on from the Type X channel to the Type XX channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type XX channel (downstream of Culvert 5) will convey the flow from Culvert 5 to the existing Eastern Diversion Channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.

▪ Stage IIIE/Final Landfill Configuration
  - Type M channel will convey run-on to the existing West Haul Road Diversion Channel – Drawing No. 728-1181 and Appendix B.

- Culvert 6A will be removed and replaced with Culvert 6B – Drawing No. 728-1181 and Appendix B.

Upon Stage III closure, all slopes and benches will be vegetated, so the perimeter collection channels will be diverted into the existing diversion channels.

2.2 Stormwater Run-off Control

Stormwater run-off from soil-covered and vegetated areas is diverted around the active areas of the site. Stormwater run-off from active areas is collected and treated prior to off-site discharge through a National Pollutant Discharge Elimination System (NPDES)-licensed outfall. All run-off will be managed by run-off controls, such as diversion or collection channels, slope drains, culverts, and the existing Surge Pond. All features are sized to accommodate the volume of water from at least a 24-hour, 25-year storm event.

2.2.1 Run-off Channel and Slope Drain Design

2.2.1.1 Existing Stage I and II Features

All run-off channels and slope drains were designed to manage the 24-hour, 100-year storm event which exceeds the amount of flow expected from the 24-hour, 25-year storm event. Refer to Drawing No. 42-E-0209 (sheets 1 and 2) and Appendix A for the Stage I and Stage II run-off channels.

Stormwater from north of the site and from revegetated Stage I and Stage II areas is diverted through three culverts that cross underneath Clay Pike Road, which is located to the west of the landfill. A Type H channel and a Type A channel discharge to the northernmost culvert (a six-foot by 12-foot concrete box culvert). Two separate Type A channels discharge to either a 30-inch diameter corrugated metal pipe (CMP), or a 48-inch diameter CMP. A drainage swale was included on the revegetated top of Stage II to divert run-off from soil-covered and vegetated areas into the existing western diversion channels.

Run-off channels are located along the Stage II haul road and on the east side of Stage II. They are identified as the Haul Road Channel and East Collector, respectively, and they collect run-off from the active portion of Stage II. The East Collector receives flow from Types AA, BB, CC, R, and D collection channels. Both run-off channels extend into the Stage IIIA collector channels and discharge into the fabric-formed concrete-lined Main Collector Channel that flows into to the Surge Pond. Once in the Surge Pond, the effluent is sent to the disposal site wastewater treatment plant.

Benches constructed on the completed disposal site face collect stormwater from the slopes. The benches discharge to either perimeter run-off channels or the fabric-formed slope drains. A berm is constructed at the leading edge of the active bench face to direct run-off from the active areas drains directly to nearby run-off channels.

2.2.1.2 During Development of Stage III Area

The existing and proposed run-off control drainage features for the Stage III area are designed for the peak flow from either a 24-hour, 25-year storm event or a 24-hour, 100-year storm event. Each run-off channel was sized to handle the 24-hour, 25-year peak flow. The permanent run-off features were sized for a 24-hour, 100-year peak flow and compared to the design for the 25-year storm event. The deepest resulting channel flow depth was then selected. As previously stated, the Stage III construction was planned to take place in five intermediate phases referred to as Stages IIIA, IIIB, IIIC, IIID, and IIIE. Temporary run-off channels and culverts designed for the intermediate phases were designed for the 24-hour, 25-year storm. Refer to Drawing 728-1182 for the run-off channel layout during the intermediate phases. As previously stated, construction of Stage IIIA was completed in 2018; this area has been lined and the designed channels constructed. Below is a list of the permanent and temporary features for the Stage III development design. The intermediate phases of Stage III will be built as necessary to support Station operations.

Temporary Run-off Features

- Stage IIIA
  - Channel HR1 conveys run-off from the haul road to Culvert 1 – Drawing No. 728-1182 and Appendix B.
  - Channel WC1 conveys run-off from the western side of the landfill to Culvert 1 and continues from the culvert to the Main Collector Channel which flows to the Surge Pond – Drawing No. 728-1182 and Appendix B.
  - Channel WC2 conveys upstream run-off from the western side of the landfill to channel WC1 – Drawing No. 728-1182 and Appendix B.
- Stage IIIB
  - Channel WC3 will convey run-off from the western side of development to channel WC1 – Drawing No. 728-1182 and Appendix B.
  - Channel WC4 will convey run-off from the western side of development to channel WC3 – Drawing No. 728-1182 and Appendix B.
- Stage IIIC
  - Channel HR2 will convey run-off from eastern side of the haul road to Channel HR1 – Drawing No. 728-1182 and Appendix B.
  - Channel HR3 will convey run-off from the western side of the haul road to the Type Q channel – Drawing No. 728-1182 and Appendix B.
  - Slope drain, SD2, will drain the south-western portion of the benched areas to temporary channel WC5 – Drawing No. 728-1182 and Appendix B.
  - Channel WC5 will convey run-off from the western side of the development upstream of Channel WC3 – Drawing No. 728-1182 and Appendix B.
- Stage IIID
  - Culvert 7-T will convey flow along the western perimeter of the development area and discharge to a dissipater basin before being discharged to the Main Collector Channel – Drawing 728-1182 and Appendix B.
  - Channel WC7 will be placed downstream of Culvert 1 – Drawing 728-1181 and Appendix B.

Permanent Run-off Features

- Stage IIIA
  - A Type Q channel was built along the eastern perimeter, running parallel to the Type AA run-on diversion channel for ultimate discharge to Existing Main Site Collector Channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type U channel was built downstream of the Type Q channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.

- Slope drain, SD1, conveys run-off from the eastern benched area to the Type U channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.

- Stage IIIC
  - Type L channel will collect run-off from the high point and along the western side of the development area to Channel WC5– Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Slope drain SD4 will divert run-off from the uppermost western portion of the vegetated benched area to the Type B diversion channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type A channel will divert run-on and run-off from soil-covered and vegetated areas from the western highpoint of the working area to the Type B channel for discharge through an existing culvert and the existing Stage II Western Diversion Channel for ultimate discharge into an unnamed tributary to the Conemaugh River – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type B channel will divert run-on and run-off from soil-covered and vegetated areas from the western side of the working area to an existing culvert and the existing Stage II Western Diversion channel for discharge into an unnamed tributary to the Conemaugh River – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
- Stage IIID
  - Type U channel will be modified to discharge to a dissipater basin – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type W channel will be constructed south of the development area and discharge directly to the Main Collector Channel – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
  - Type NN channel will convey flow from Culvert 7-T to discharge to a dissipater basin – Drawing Nos. 728-1181 and 728-1182 and Appendix B.
- Stage IIIE
  - Type LL channel will convey run-off from the southwestern portions of the development area to the Type N channel– Drawing No. 728-1181 and Appendix B.
  - Type N channel will convey run-off from southern portion of development area through Culvert 2 for ultimate discharge to a dissipater basin Drawing No. 728-1181 and Appendix B.
  - Channel HR5 will convey run-off north-west along the haul road to Channel HR4 – Drawing No. 728-1181 and Appendix B.
  - Culvert 2 will convey run-off from the Type N channel to the Type NN channel – Drawing No. 728-1181 and Appendix B.
  - Culvert 3 will convey flow across the haul road – Drawing No. 728-1181 and Appendix B.
  - Slope Drain SD3 will drain the south-western benched area to the Type N channel – Drawing No. 728-1181 and Appendix B.

2.2.2 Stormwater Equalization Pond Design

The existing stormwater equalization pond (i.e. Surge Pond) is permitted by PADEP under Water Quality Management Permit No. 3284211, NPDES Permit No. PA0005011, and Bureau of Dams and Waterway Management Permit No. D32-083. The Surge Pond is designed to store the run-off from two 24-hour, 10-year storm events separated by a 24-hour dry period from the maximum drainage area of 393 acres considering the outflow to the treatment plant. The Pond's principal outlet is to the Disposal Site Treatment Plant and has a capacity to handle the peak inflow from a 24-hour, 100-year storm which meets the requirements in Section 257.81 of the CCR Rule. The existing Surge Pond was designed in accordance with applicable State and Local Erosion and Sediment Control Regulations.

2.3 Plan Amendment

The initial RRCSP can be amended (257.81(c)(2)) at any time, and must be amended whenever there is a change in conditions that would substantially affect the written plan. In addition, a plan must be prepared every 5 years (257.81(c)(4)). Revision 1 (September 2021) of this RRCSP was created by reviewing the initial RRCSP and updating relevant portions accordingly to reflect current conditions at the disposal site. The RRCSP must be included into the facilities operating record (257.105(g)(3)).

3.0 References

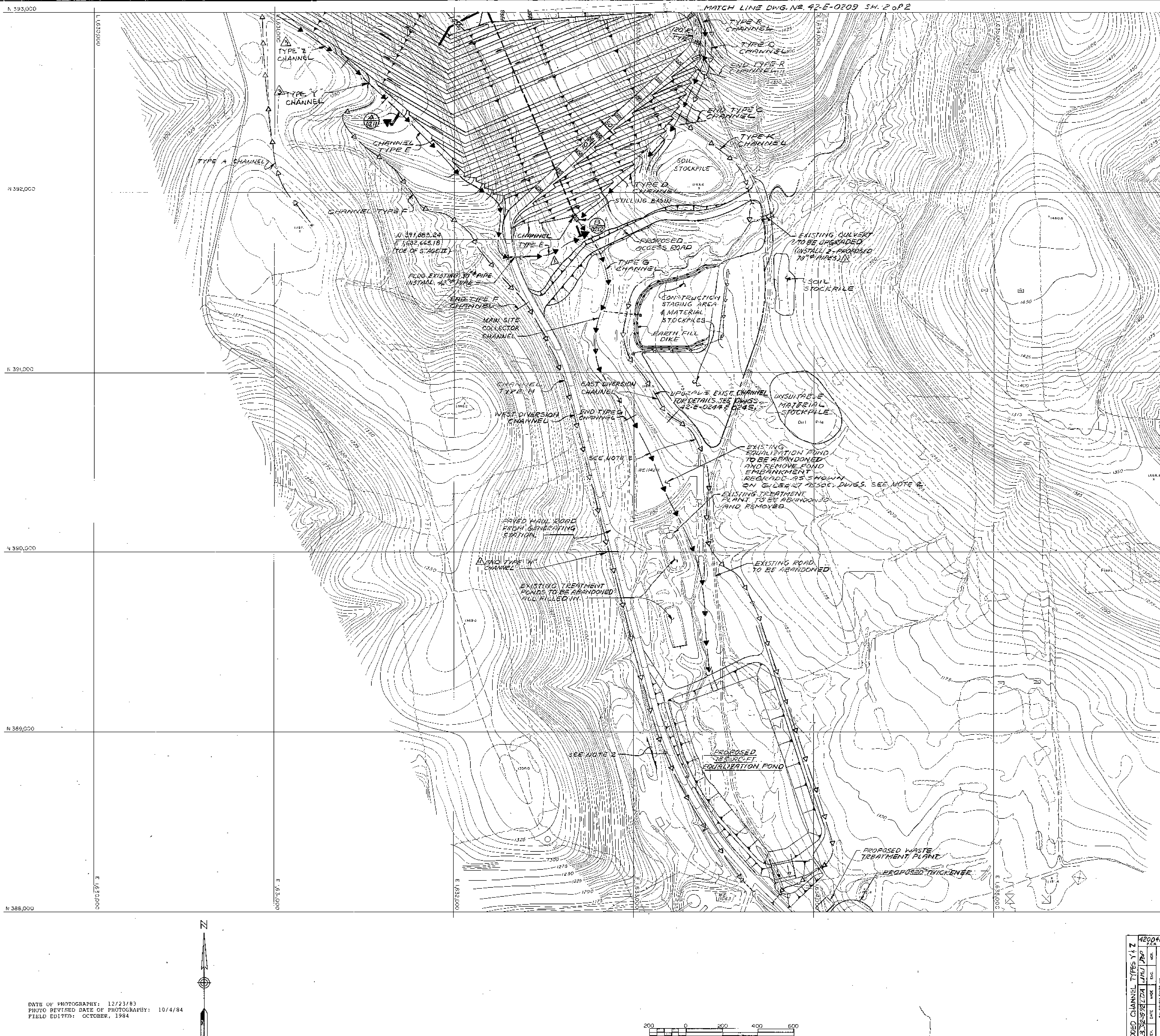
GAI Consultants, Inc., Conemaugh Station Ash/Refuse Disposal Site Stage IIIA Liner Construction, October 2015.

Major Permit Modification Residual Waste Permit # 300876, Stage III – Conemaugh Station Ash/Refuse Disposal Site, March 2014 (revised December 2014).

Pennsylvania Department of Environmental Protection, Residual Waste Major Permit Modification, Conemaugh Station Disposal Site, Form I Soil Erosion and Sedimentation Controls, May 1997.

United States Environmental Protection Agency (USEPA) 40 CFR Parts 257 and 261 Hazardous and Solid Waste Management Disposal System; Disposal of Coal Combustion Residual from Electric Utilities, Final Rule April 2015.

DRAWINGS



DATE OF PHOTOGRAPHY: 12/23/83
PHOTO REVISED DATE OF PHOTOGRAPHY: 10/4/84
FIELD EDITED: OCTOBER, 1984

LEGEND

- OFF-SITE DIVERSION CHANNEL
- ON-SITE COLLECTOR CHANNEL
- HIGH POINT
- DIRECTION OF FLOW
- —1235— PROPOSED CONTOURS
- --1235-- EXISTING DISPOSAL PILE CONTOURS
- STREAM OR WATER SURFACE
- TOP OF SLOPE
- TOE OF SLOPE
- EXISTING TOP OF SLOPE
- EXISTING TOE OF SLOPE
- CULVERT LOCATION
- DISPOSAL PILE INTERFACE BETWEEN STAGE I AND II AND STAGE II AND III DEVELOPMENT.
- MAIN LEACHATE COLLECTION PIPE

GENERAL NOTES:

1. STAGE I EXISTING CONTOURS TAKEN FROM PENELEC DWG. Nº. 1198-A AND DWG. Nº. 42-D-0066
2. SEE PENELEC TREATMENT PLANT PERMIT APPLICATION # 3284211 DATED 12/17/84 FOR ADDITIONAL TREATMENT PLANT INFORMATION.
3. SITE CONFIGURATION SHOWN IS CONCEPTUAL, AND MAY CHANGE DURING DETAILED DESIGN.
4. CHANNEL LOCATIONS ARE APPROXIMATE, AND MAY CHANGE DURING DETAILED DESIGN.

JAMES EDWIN MIECE
PROFESSIONAL ENGINEER
No. 11296-E
COMMONWEALTH OF PENNSYLVANIA

James Edwin Miece 7/8/85

EXHIBIT 11.12

SHEET 1 OF 2

GAI CONSULTANTS, INC.

PROJ. NO. 82-134

DWG. NO. 82-134-F86

JOHNSTOWN PENNA.

PENNSYLVANIA ELECTRIC COMPANY
GENERATION DIV. ENG'R.

STATION
CONEMAUGH STATION
DISPOSAL SITE
STAGE II DEVELOPMENT PLAN
PA. D.E.R. PERMIT DRAWING 2

DRAFTING MADE	DRAFTING CHECKED	ARCH	CIVIL	ELEC	MECH.	APP'D DEPT. HD.
RTB	ASB		HCP			JEN
DATE 6/17/85	7/8/85		7/8/85			7/8/85

SCALE	WORK ORDER	DRAWING NUMBER	REV.
1"=200'	0420-00066-501	42-E-0209 SH.1 of 2	3

REVISIONS

NO	DATE	DESCRIPTION	MADE	CHECKED	APPROVED
1	7-9-86		GY	JMJ	JHA
2	9-23-86	REVISED TITLE / RELOCATED ACCESS ROAD TO STAGING AREA, ELIMINATED 54"Ø CULVERT IN PROPOSED ACCESS ROAD, ADDED "END TYPE H CHANNEL" NOTE, ADD 2-PROPOSED 78"Ø PIPES, ELIMINATE SHEET COLLECTOR CHANNEL ALONG STAGE II TOE.	JJP	TAG	
3	3-25-92	ADDED CHANNEL TYPES Y & Z	LDA	JMJ	

420046 P.C.N.
GAI CONSULTANTS, INC.

FOLDER 2474 CARD 6011

DATE OF PHOTOGRAPHY: 12/23/83
PHOTO REVISED DATE OF PHOTOGRAPHY: 10/4/84
FIELD EDITED: OCTOBER, 1984

JOSEPH D. PHILLIPS

JAMES EDWIN NIECE

EXHIBIT 11.12

SHEET 2 OF 2

GAI CONSULTANTS, INC.

PROJ. NO. 82-134

DWG. NO. 82-134-F87

JOHNSTOWN PENNA.

PENNSYLVANIA ELECTRIC COMPANY
GENERATION DIV. ENG'R.

STATION

CONEMAUGH STATION

DISPOSAL SITE

STAGE II DEVELOPMENT PLAN

PA. D.E.R. PERMIT DRAWING

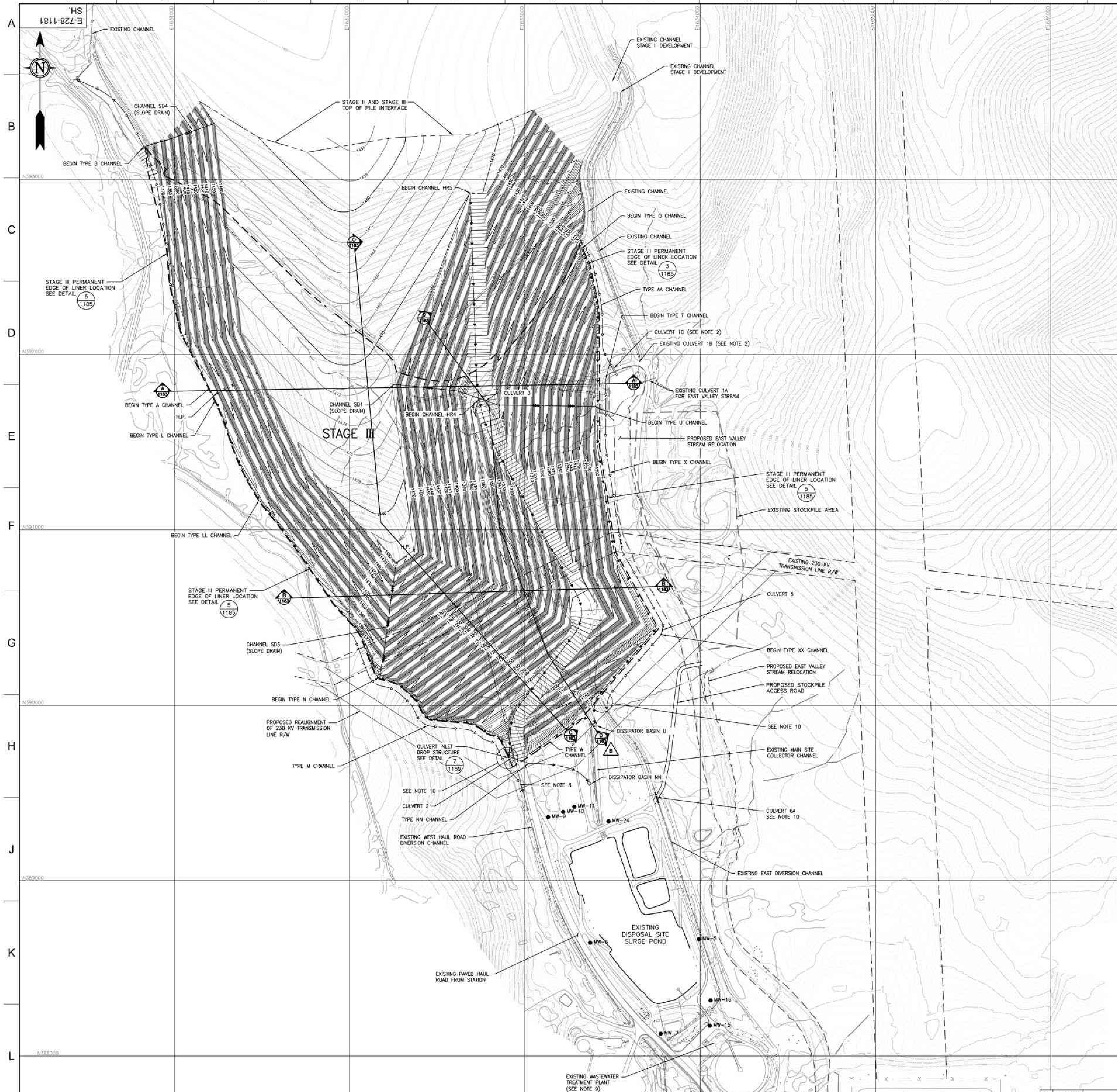
NO	DATE	MADE	CHECKED	APPROVED	REVISIONS
3	12-13-95	DWM	LJM/MJ	JDP	REVISED TYPE AB CHANNEL, ADDED TYPE AA, BB AND CC COLLECTION CHANNEL DESIGNATIONS
2	11-22-94	DWM	NEVER ISSUED		ADDED TYPE AA AND AB EAST COLLECTION CHANNELS AND EXTENDED TYPE B EAST DIVERSION CHANNEL
1	9-23-86	JLP	TAG	PPM	REVISED TITLE

423116 R.C.N.

DRAFTING MADE	CHECKED	ENGINEER APPROVALS ARCH.	CIVIL	ELEC	MECH	APP'D DEPT HD.
BPB DATE 6/12/85	ASB 7/3/85		HCP 7/5/85			JEN 7/5/85

SCALE	WORK ORDER	DRAWING NUMBER	REV.
1"=200'	0420-00066-501	42-E-0209 SH. 2 of 2	3

FOLD 52 2474 CAL. 0012



LEGEND

- EXISTING GRADE CONTOUR
- FINAL PILE CONTOUR
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING STREAM
- EXISTING COLLECTION CHANNEL
- EXISTING DIVERSION CHANNEL
- PROPOSED COLLECTION CHANNEL
- PROPOSED DIVERSION CHANNEL
- PROPOSED COLLECTION SLOPE DRAIN
- PROPOSED DIVERSION SLOPE DRAIN
- MONITORING WELL (MW-9)
- DETAIL IDENTIFICATION NUMBER (1) / DRAWING NUMBER ON WHICH DETAIL IS DRAWN (1185)
- DETAIL: DETAIL IDENTIFICATION NUMBER (1) / DRAWING NUMBER ON WHICH DETAIL IS REFERENCED (1179)

NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF PHOTOGRAMMETRIC DIGITAL MAPPING PERFORMED BY SAMCO DATED MAY 3, 2007; GENON PROVIDED TOPOGRAPHY OF STAGE II PILE DEVELOPMENT ON AUGUST 13, 2013; PROPOSED EAST VALLEY STREAM ENCLOSURE AND RELOCATION CONTOURS; AND PROPOSED FINAL STAGE II PILE DEVELOPMENT CONTOURS.
2. CULVERT 1B IS AN EXISTING CULVERT THAT WILL BE REPLACED AS PART OF THE EAST VALLEY STREAM RELOCATION. CULVERT 1C WILL BE CONSTRUCTED AS PART OF THE EAST VALLEY STREAM RELOCATION AND THE TYPE AA CHANNEL WILL BE DIRECTED TO IT.
3. FINAL SITE CONFIGURATION IS PRELIMINARY AND MAY CHANGE SLIGHTLY DURING DETAILED DESIGN.
4. CHANNEL LOCATIONS ARE APPROXIMATE AND MAY CHANGE SLIGHTLY DURING DETAILED DESIGN.
5. BENCH SLOPES ARE A MINIMUM OF 1% AND A MAXIMUM OF 3%.
6. FOR CHANNEL AND CULVERT SCHEDULES, SEE DRAWING NO. E-728-1189.
7. DISSIPATER BASIN U WILL BE:
   - 19' L x 15' W x 5.5' D CONCRETE TYPE II U.S. BUREAU OF RECLAMATION BASIN OR
   - 23' L x 3' W (UPSTREAM), 19' W (DOWNSTREAM) U.S. DEPARTMENT OF TRANSPORTATION R-6 RIPRAP BASIN

   DISSIPATOR BASIN NN WILL BE:
   - 16' L x 15' W x 4.5 D CONCRETE TYPE II U.S. BUREAU OF RECLAMATION BASIN OR
   - 21' L x 5' W (UPSTREAM), 19' W (DOWNSTREAM) U.S. DEPARTMENT OF TRANSPORTATION R-6 RIPRAP BASIN
8. EXTEND UNIFORM SECTION MAT CHANNEL LINING OF TYPE M CHANNEL INTO EXISTING WEST HAUL ROAD DIVERSION CHANNEL AND PROVIDE RIPRAP PROTECTION IN THE CHANNEL DIRECTLY DOWNSTREAM.
9. SEE PENELEC TREATMENT PLANT PERMIT APPLICATION #3284211 FOR ADDITIONAL TREATMENT PLANT INFORMATION.
10. UPON STAGE III CLOSURE (TENTATIVELY SCHEDULED FOR 2041) PERIMETER COLLECTION CHANNELS WILL BE DIVERTED INTO THE EXISTING DIVERSION CHANNELS, SIMILAR TO DIVERSION CHANNELS M AND XX. CULVERT 6A WILL BE REMOVED OR REPLACED WITH CULVERT 6B.

THIS DRAWING SUPERSEDES DRAWING 42-E-0210

FOR PERMIT ONLY

SCALE: 1" = 200'

200 0 200 400

gai consultants
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385 East Waterfront Drive
Homestead, PA 15120
412-476-2000

nrg

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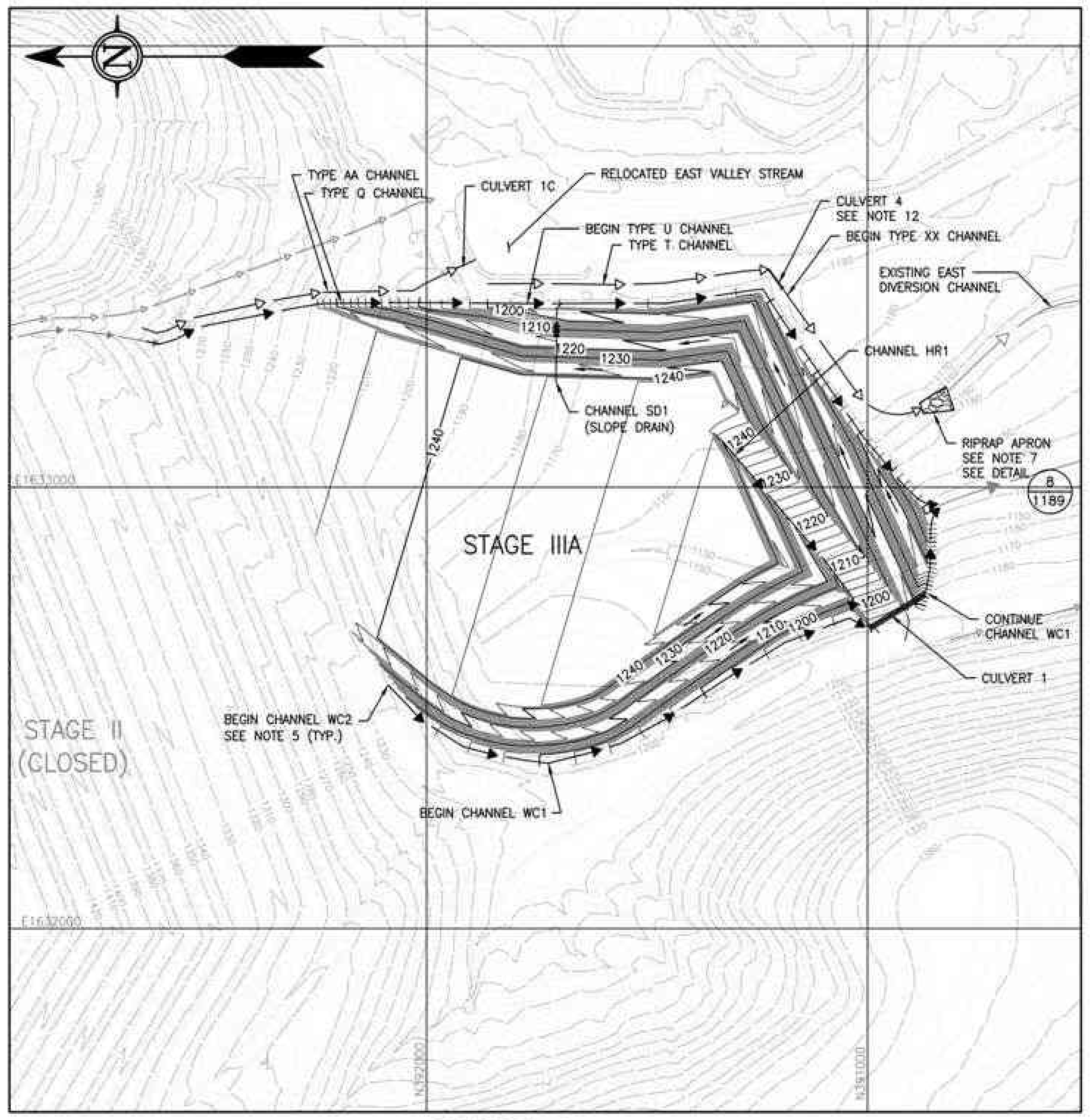
STAGE III
FINAL PILE DEVELOPMENT PLAN
RESIDUAL WASTE PERMIT DRAWING

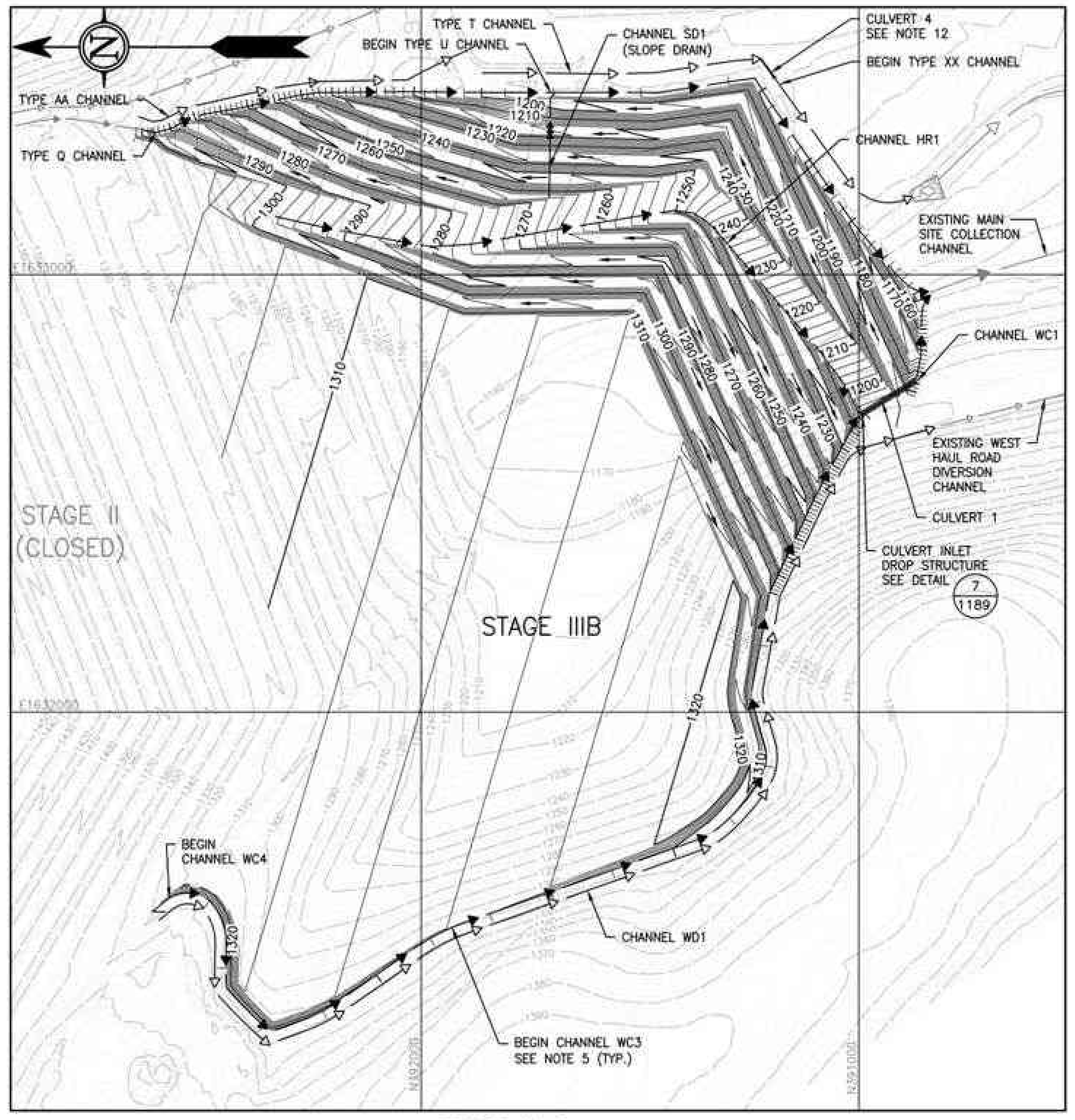
NO.	DATE	REVISION	BY	CHK.	APP.
B	12/10/2014	ADDED SECTION D-D	EJM	KRH	JMJ

DRAWN: 3/11/2014	DMM	DRAWING NUMBER
CHECKED 3/11/2014	JFS	E-728-1181
APPROVED 3/20/2014	JMJ	SHEET: 1 OF 1
SIZE: E 34X44		REV: B
DISCIPLINE: CIVIL	SCALE: AS SHOWN	FILE: C130770-00-001-00-E-F004

GAI CAD FILE PATH: Z:\Energy\2013\C130770.00 - Conemaugh Stage III\CAD\Production Drawings\C130770-00-001-00-E-F004.dwg PLOTTED ON: 12/8/14 PLOTTED BY: Joe Neiman PLOT FILE: NEEDEE.ctb



STAGE III A



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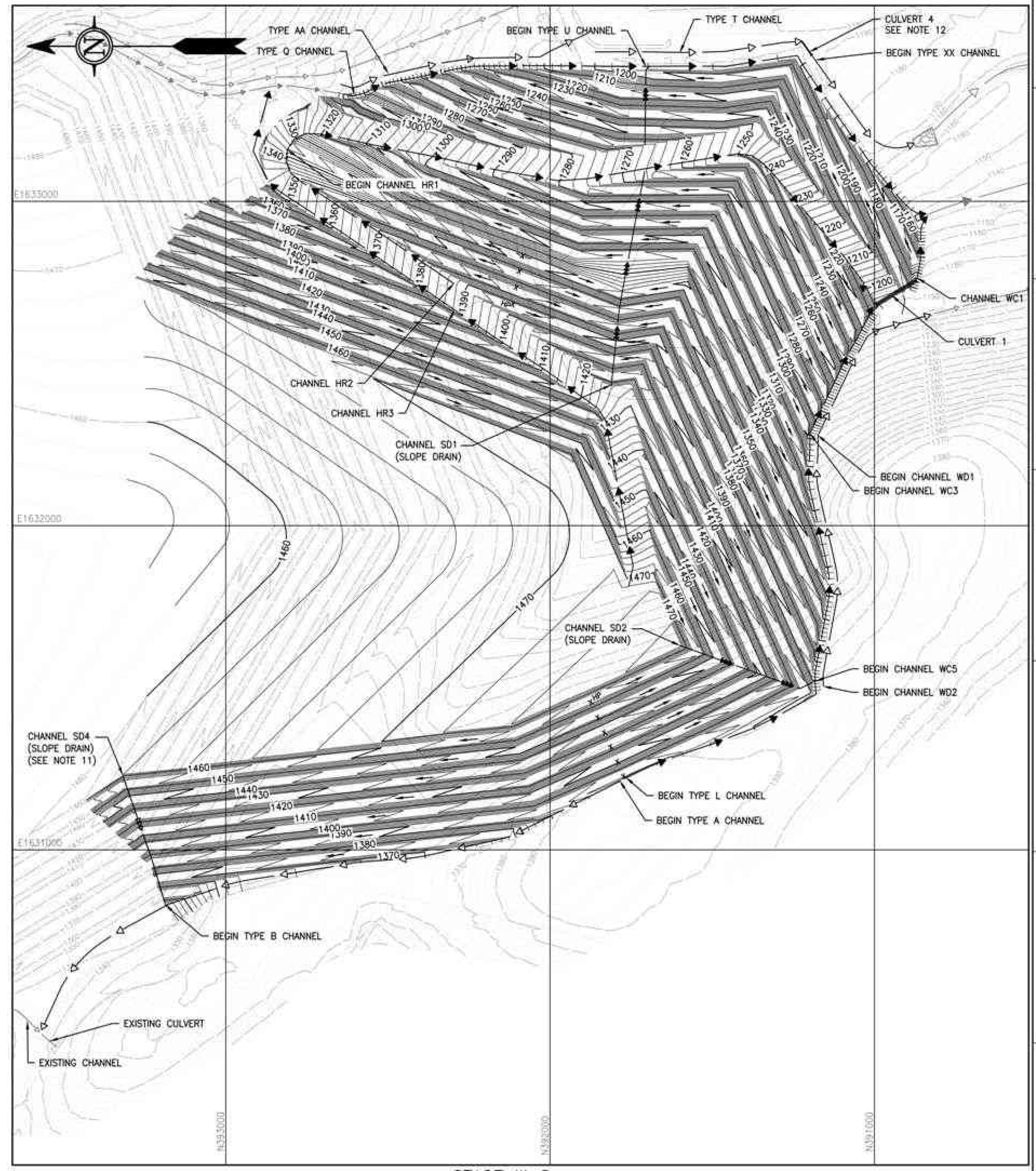

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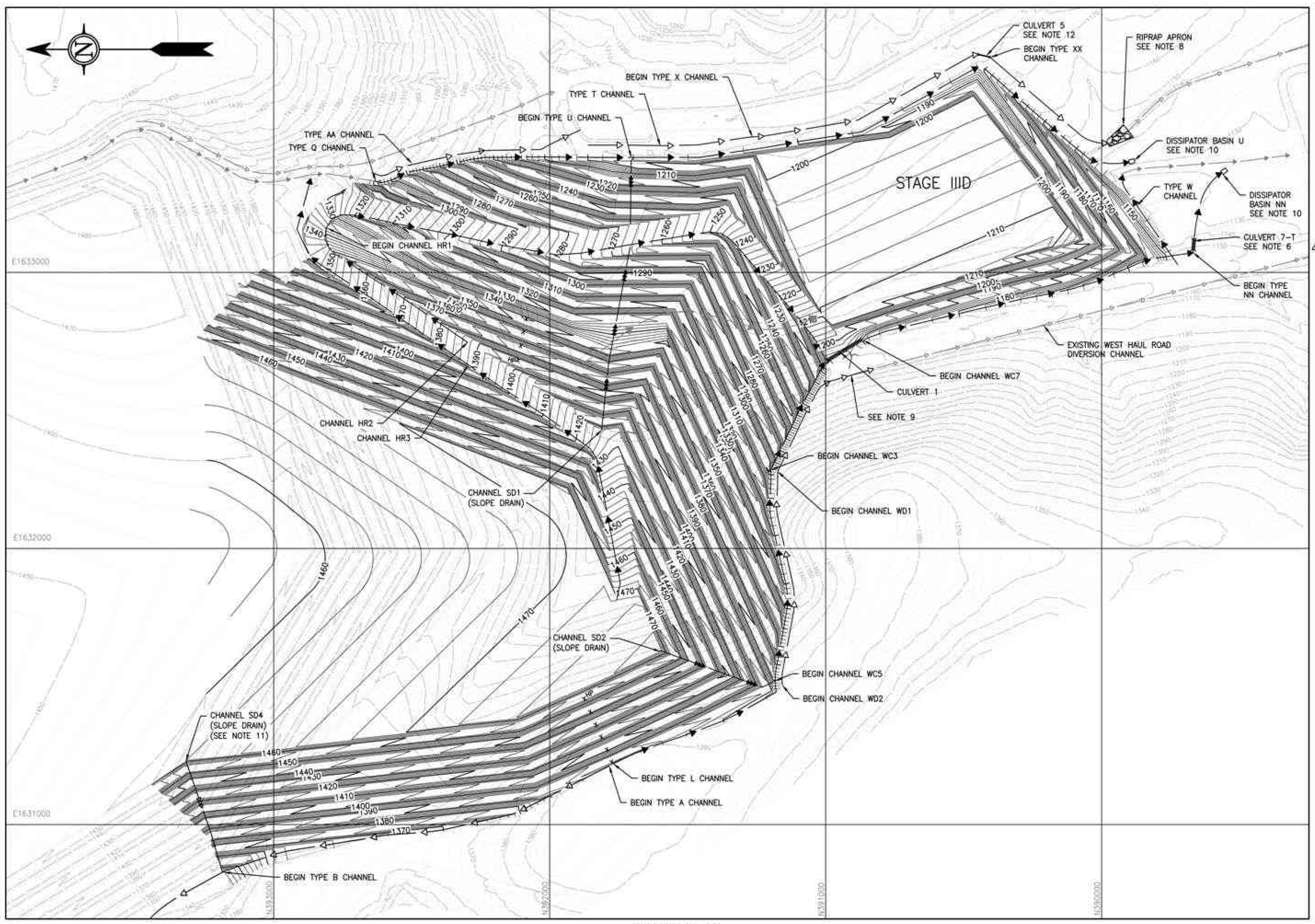

STAGE III D

LEGEND

- EXISTING GRADE CONTOURS
- FINAL PILE CONTOURS
- EXISTING DIVERSION CHANNEL
- EXISTING COLLECTION CHANNEL
- PROPOSED DIVERSION CHANNEL
- PROPOSED COLLECTION CHANNEL
- SLOPE DRAIN

NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF PHOTOGRAMMETRIC DIGITAL MAPPING PERFORMED BY SAMCO DATED MAY 3, 2007; GENON PROVIDED TOPOGRAPHY OF STAGE II PILE DEVELOPMENT ON AUGUST 13, 2013; PROPOSED EAST VALLEY STREAM ENCLOSURE AND RELOCATION CONTOURS; AND PROPOSED FINAL STAGE II PILE DEVELOPMENT CONTOURS.
2. STAGING CONFIGURATION IS PRELIMINARY AND MAY CHANGE DURING DETAILED DESIGN.
3. CHANNEL LOCATIONS ARE APPROXIMATE AND MAY CHANGE DURING DETAILED DESIGN
4. BENCH SLOPES ARE A MINIMUM OF 1% AND A MAXIMUM OF 3%.
5. FOR CHANNEL AND CULVERT SCHEDULES, SEE DRAWING NO. E-728-1189.
6. FUTURE TEMPORARY CULVERT 7-T FOR STAGE IIIE LINER INSTALLATION FOR CONSTRUCTION OF TEMPORARY ACCESS ROAD. (B)
7. TEMPORARY RIPRAP APRON WILL BE USED FOR STAGE IIIA THROUGH IIIC.
8. PERMANENT RIPRAP APRON.
9. EXTEND UNIFORM SECTION MAT CHANNEL LINING OF CHANNEL WD 1 INTO EXISTING WEST HAUL ROAD DIVERSION CHANNEL AND MAINTAIN RIPRAP PROTECTION IN THE CHANNEL DIRECTLY DOWNSTREAM.
10. DISSIPATOR BASIN U WILL BE:
    - 19' L x 15' W x 5.5' D CONCRETE TYPE II U.S. BUREAU OF RECLAMATION BASIN

    OR
    - 23' L x 3' W (UPSTREAM), 19' W (DOWNSTREAM) U.S. DEPARTMENT OF TRANSPORTATION R-6 RIPRAP BASIN

    DISSIPATOR BASIN NN WILL BE:
    - 16' L x 15' W x 4.5 D CONCRETE TYPE II U.S. BUREAU OF RECLAMATION BASIN

    OR
    - 21' L x 5' W (UPSTREAM), 19' W (DOWNSTREAM) U.S. DEPARTMENT OF TRANSPORTATION R-6 RIPRAP BASIN
11. SLOPE DRAIN SD4 IS TO RECEIVE ONLY NON-CONTACT WATER FROM RECLAIMED REVEGETATED SURFACES.
12. CULVERTS 4 AND 5 ARE TO ALLOW A POTENTIAL CONNECTION OF THE PERIMETER ACCESS ROAD TO A MAINTENANCE ROAD ALONG THE WEST SIDE OF THE EAST VALLEY STREAM RELOCATION.

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SCALE: 1" = 200'
200 0 200 400

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STAGE III
PILE DEVELOPMENT PHASING PLAN
RESIDUAL WASTE PERMIT DRAWING

B	12/10/2014	LABELED CULVERT 7-T	DMM	KMB2	JMJ	DRAWN: 3/11/2014	DMM	DRAWING NUMBER
						CHECKED 3/11/2014	JFS	E-728-1182
						APPROVED 3/20/2014	JMJ	SHEET: 1 OF 1
						SIZE: E 34X44		REV: B
NO.	DATE	REVISION	BY	CHK.	APP.	DISCIPLINE: CIVIL	SCALE: AS SHOWN	FILE: C130770-00-001-00-E-F005

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APPENDIX A
Stage II Form I Calculations

APPENDIX I-1-A

FORM I

EXISTING STAGE II DRAINAGE FACILITIES AND
PROPOSED STAGE III DRAINAGE FACILITIES -
CALCULATIONS FROM PREVIOUS SOLID WASTE PERMIT APPLICATION

APPENDIX I-1-A

FORM I

EXISTING STAGE II DRAINAGE FACILITIES AND
PROPOSED STAGE III DRAINAGE FACILITIES -
CALCULATIONS FROM PREVIOUS SOLID WASTE PERMIT APPLICATION

TABLE OF CONTENTS

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 1-3-86 PROJ NO 85-134-11
CHKD. BY RFO DATE 1/6/86 SHEET NO. 1 OF 1

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Hydrology Study

This hydrology study is conducted in order that Question 16, Module No 9, of the solid waste permit for the Conemaugh Station may be addressed.

The hydrology analysis will determine the peak runoff discharge for pre, during and post operational phases. The method of analysis will be the TR 20 (SCS) method, and calculations will be conducted for 2 yr, 10 yr and 100 yr - 24 hr rainfalls.

The hydrology will be analyzed for the main valley of the Conemaugh site since runoff from the nearby valley (east) will not be significantly affected during the pre, during and post operational phases.

The next 3 sheets consist of tables which summarizes all the information and resulting peak discharges which were used and calculated in the hydrology calcs. The hydrology calculations follow the summary tables.

SUBJECT Penelec - Conemaugh Solid Refuse Disposal
Summary of Hydrology Calcs

BY MLL DATE 1-6-86 PROJ NO. 82-134-11
CHKD BY RFD DATE 1/6/86 SHEET NO 1 OF 3

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Stage and Location	PPT (inches) 2 yr	10 yr	100 yr	Drainage Area (mi²)	Curve Numbers	Time of Concentration (hr)	Q peak (cfs) to Main Valley Collector 2 yr	10 yr	100 yr	Q peak (cfs) to West Valley 2 yr	10 yr	100 yr
Preparation							209	535	984	0	0	0
Subarea A	2.7	4.0	5.5	0.256	90	1.04	33	93	178			
B	2.7	4.0	5.5	0.320	90	0.74	52	144	276			
C	2.7	4.0	5.5	0.464	73.4	0.22	190	427	754			

Stage and Location	PPT (inches) 2 yr.	10 yr.	100 yr.	Drainage Area (mi.²)	Curve Numbers	Time of Concentration (hrs)	Qpeak to South of Main Valley Conduit 2 yr.	10 yr.	100 yr.	Qpeak to West Valley (cfs) 2 yr.	10 yr.	100 yr.
Diversions							44	179	281	203	491	569
Point A										186	456	324
a	2.7	4.0	5.5	0.184	70	0.70				31	88	169
b	2.7	4.0	5.5	0.108	70	0.65				19	53	102
c	2.7	4.0	5.5	0.059	70	0.30				15	40	76
d	2.7	4.0	5.5	0.005	70	0.25				1	4	7
e	2.7	4.0	5.5	0.172	75	0.60				50	117	206
f	2.7	4.0	5.5	0.172	80	0.45				61	165	270
g	2.7	4.0	5.5	0.111	80	0.90				36	74	122
Point B										23	53	91
h	2.7	4.0	5.5	0.024	70	0.26				6	17	33
i	2.7	4.0	5.5	0.011	70	0.10				4	10	18
j	2.7	4.0	5.5	0.016	82	0.43				9	17	27
k	2.7	4.0	5.5	0.021	82	0.91				8	15	24
Point C - l	2.7	4.0	5.5	0.060	85	0.56	35	65	101			
Point D - m	2.7	4.0	5.5	0.086	85	0.28	64	118	183			
Point E - n	2.7	4.0	5.5	0.011	70	0.41	2	7	13			

Total Peak Discharge for Main Valley: Q_2 = 285 cfs Q_{10} = 64[illegible] cfs Q_{100} = 1118 cfs

SUBJECT: Penelec - Conemaugh Solid Refuse Disposal
Summary of Hydrology Calcs

BY: M.L.A. DATE: 1-6-86 PROJ. NO: 82-134-11
CHKD. BY: RFD DATE: 1/6/86 SHEET NO.: 3 OF 3

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Stage and Location	PPT (inches) 2 yr	PPT (inches) 10 yr	PPT (inches) 100 yr	Drainage Area (mi²)	Curve Number	Time of Concentration (hrs)	Q peak to South of Main Valley Constr. 2 yr	Q peak to South of Main Valley Constr. 10 yr	Q peak to South of Main Valley Constr. 100 yr	Q peak to West Valley (cfs) 2 yr	Q peak to West Valley (cfs) 10 yr	Q peak to West Valley (cfs) 100 yr
Post Operation							61	135	232	166	441	820
Point A										155	412	771
a	2.7	4.0	5.5	0.184	70	0.70				31	88	169
b	2.7	4.0	5.5	0.108	70	0.65				19	53	102
c	2.7	4.0	5.5	0.059	70	0.30				15	40	76
d	2.7	4.0	5.5	0.005	70	0.25				1	4	7
e	2.7	4.0	5.5	0.172	75	0.60				60	117	206
f	2.7	4.0	5.5	0.172	75	0.43				58	133	231
g	2.7	4.0	5.5	0.111	75	0.90				26	59	104
Point B										20	48	86
h	2.7	4.0	5.5	0.024	70	0.26				6	11	33
i	2.7	4.0	5.5	0.011	70	0.10				4	10	18
j	2.7	4.0	5.5	0.016	78	0.43				7	14	24
k	2.7	4.0	5.5	0.021	78	0.91				6	13	22
Point C-l	2.7	4.0	5.5	0.040	78	0.56	23	50	83			
Point D-m	2.7	4.0	5.6	0.066	78	0.28	47	90	151			
Point E-n	2.7	4.0	5.5	0.011	70	0.41	2	7	13			

Total Peak Discharge for Main Valley: Q_2 = 263 cfs Q_{10} = 660 cfs Q_{100} = 1086 cfs

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 1-3-86 PROJ. NO. 82-134-11
CHKD. BY RFD DATE 1/6/86 SHEET NO. 1 OF 7

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Pre Operational Phase

All the runoff from the main valley will exit the valley at the Stage III toe.

Input data for the TR 20 computer analysis.

1. PPT ⇒ 2 yr - 24 hr : 2.7 inches
   10 yr - 24 hr : 4.0 inches
   100 yr - 24 hr : 5.5 inches
   (Ref: "SCS Engineering Field Manual," Chapter 2, Indiana Co.)

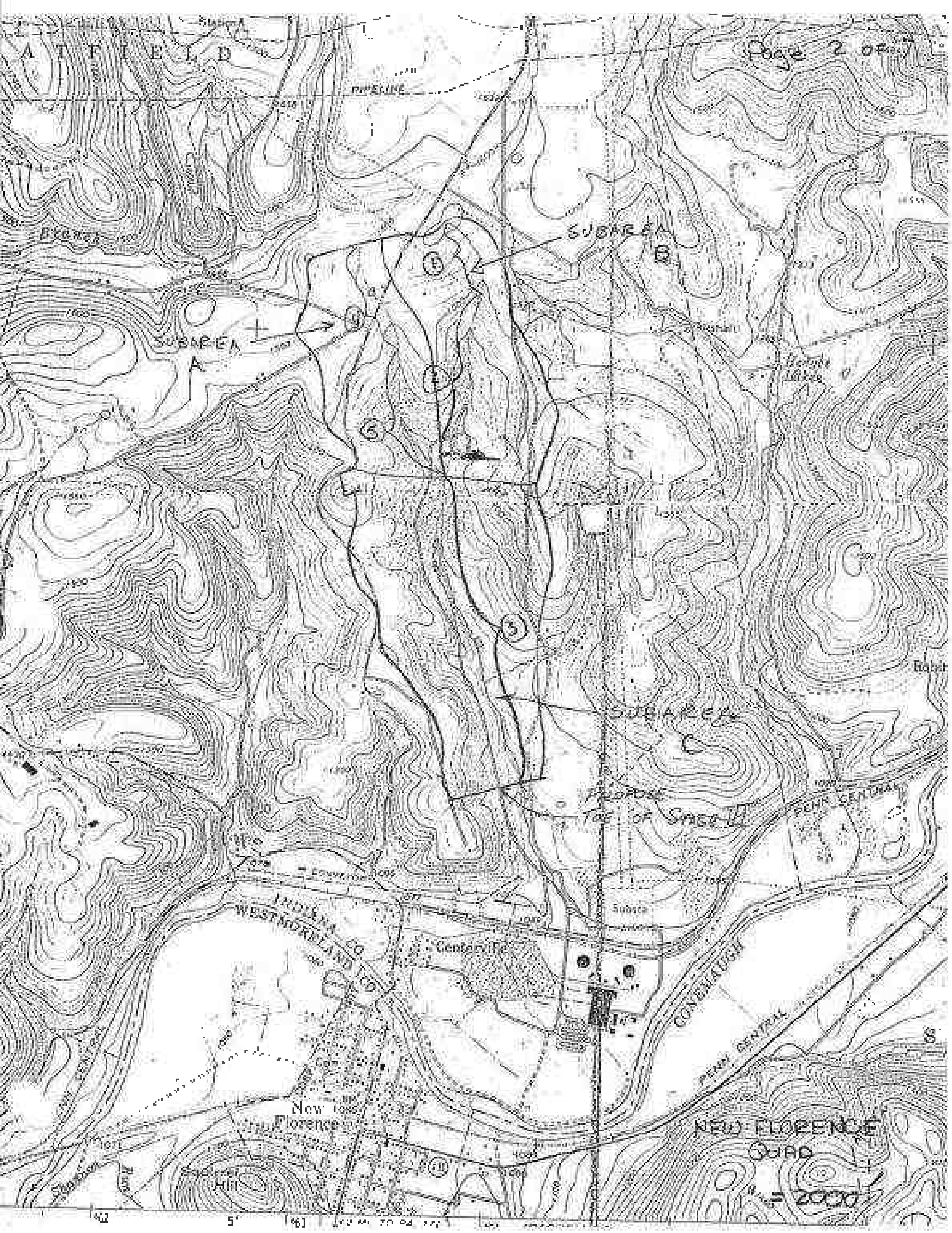
2. Antecedent Moisture Condition II (average conditions)
3. Hydrologic Soil Group C (based on soil survey info.)
4. Drainage Area (Ref: Drawing No. 42-E-5210 Sht 1 & 2; and USGS New Florence Quad)

Total Area
Offsite = 257 acres
Onsite = 409 acres
666 acres

The total area is subdivided into 3 subareas to consider the two northern branches and the stream that the two branches merge into.

Note: Sheet 2 of 6 of these calcs is a copy of an old USGS topo quad. It is used to show the division of the subareas and the drainage paths.

		% Pasture	% Woods
Subarea A	= 164 acres	0	100 %
Subarea B	= 205 acres	0	100 %
Subarea C	= 297 acres	101/297 = 34 %	196/297 = 66 %


Page 2 of 7
PIPELINE
SUBAREA B
SUBAREA A
SUBAREA C
PENN CENTRAL
INDIANA CO
WESTMORELAND CO
Centerville
CONEMAUGH
PENN CENTRAL
New Florence
NEW FLORENCE QUAD
= 2000

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5. CN Number

CN = 70 for woods

CN = 80 for pasture

Weighted CN

Subarea A = 70

Subarea B = 70

Subarea C = $\frac{101(80) + 196(70)}{297}$ = 73.4

6. Time of Concentration

To calculate t_c, the average velocity method is used

Subarea A

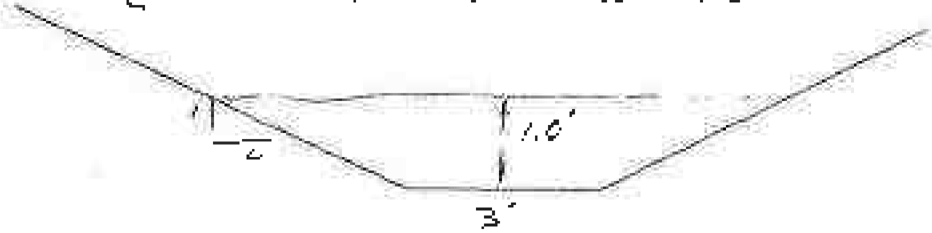
Path 4 & 5

(4) Overland flow length - 2100 ft @ $\frac{1580 - 1450}{2100}$ = 6.2%

(5) Channel length - 2570 ft @ $\frac{1460 - 1240}{2570}$ = 8.2%

Overland flow thru woods @ 6.2% → V = 0.62 fps
(see sheet 4 of 6)

Flow thru natural stream with rock and vegetation @ 8.2% assume the following cross-section:



REF A GUIDE TO HYDROLOGIC ANALYSIS USING SCS METHODS
by RICHARD H. McCUEN

SHT 4 OF 7

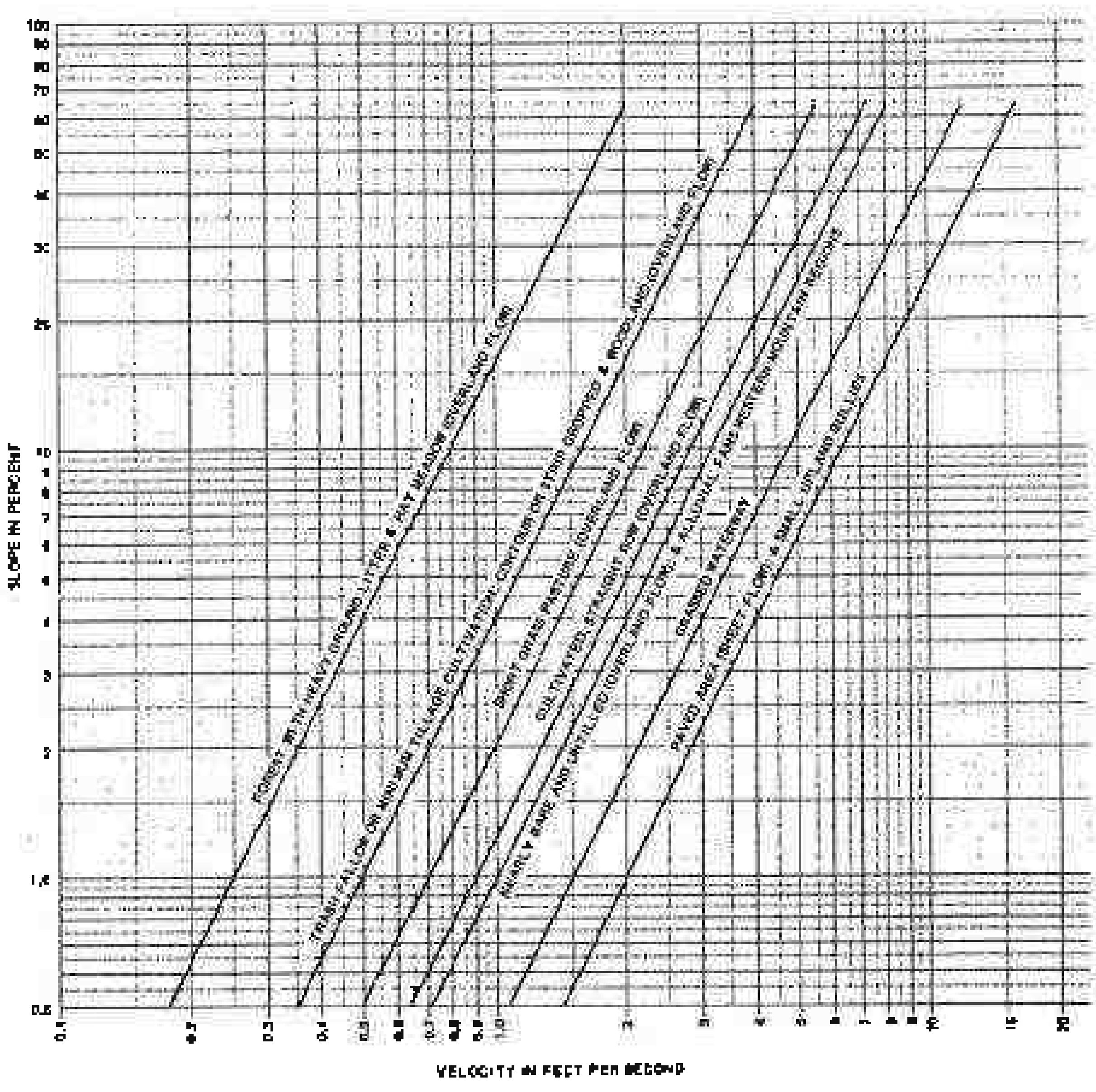


Figure 8. Velocities for upland method of estimating T_c

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

$$= \frac{1.49}{0.045} \left(\frac{\frac{3(1.0) + 2(1.0)^2}{3 + 2(1.0)(\sqrt{5})}} \right)^{2/3} 0.022^{1/2}$$

(n = 0.045, SEE "OPEN CHANNEL HYDRAULICS", CHOW)

= 7.25 FPS

$$t_c = \frac{2105}{0.62} + \frac{2570}{7.25}$$

= 3742 SECONDS = 1.04 HR

SUBAREA B:

PATH 1 & 2:

(1) OVERLAND FLOW THRU WOODS = 1690 FT @ SLOPE = 150/1690 = 8.9%

(2) CHANNEL LENGTH = 3250 FT @ SLOPE = 220/3250 = 6.8%

OVERLAND FLOW THRU WOODS @ 8.9% → V = 0.75 FPS

FLOW THRU NATURAL STREAM WITH ROCK AND VEGETATION @ 6.8%
ASSUME THE FOLLOWING CROSS-SECTION:

$$V = \frac{1.49}{0.045} \left(\frac{3(1.5) + 2(1.5)^2}{3 + 2(1.5)(\sqrt{5})} \right)^{2/3} 0.068^{1/2}$$

= 8.2 FPS

$$t_c = \frac{1690}{0.75} + \frac{3250}{8.2} = 2650 \text{ SECONDS} = 0.74 \text{ HR}$$

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SUBAREA C:

PATH 3:

(3) CHANNEL LENGTH = 5680 FT @ SLOPE $= \frac{1240 - 1125}{5680} = 2.0\%$

FLOW THRU NATURAL STREAM WITH ROCK AND VEGETATION @ 2.0%
ASSUME THE FOLLOWING CROSS-SECTION:

$$V = \frac{1.49}{0.045}\left(\frac{15(2.5) + 2(2.5)^2}{15 + 2(2.5)\sqrt{5}}\right)^{2/3} 0.020^{1/2}$$

$= 7.2$ FPS

$t_c = 5680 / 7.2$

$= 789$ SECONDS $= 0.22$ HR

7 TOTAL PEAK DISCHARGE - EXTRACTED FROM COMPUTER PRINTOUTS

THE TOTAL PEAK DISCHARGE IS COMPUTED AS FOLLOWS

1. RUNOFF FROM SUBAREA A IS COMPUTED
2. RUNOFF FROM SUBAREA B IS COMPUTED
3. THE RESULTING HYDROGRAPH FROM A IS ADDED TO THE RESULTING HYDROGRAPH FROM B
4. THE SUM OF THE TWO HYDROGRAPHS IS ROUTED THRU CHANNEL REACH 3.
5. THE RUNOFF FROM SUBAREA C IS COMPUTED
6. THE ROUTED HYDROGRAPH FROM SUBAREA A AND B IS ADDED TO THE HYDROGRAPH FROM SUBAREA C.

SUBJECT Penelec – Conemaugh Solid Waste Disposal Permit
– Peak Runoff Flows

BY MLC DATE 1-3-86 PROJ NO. 82-134-11

CHKD. BY ______ DATE ______ SHEET NO. 7 OF 7

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7. THE SUM OF THE ROUTED HYDROGRAPH FROM SUBAREAS A AND B AND THE HYDROGRAPH FROM SUBAREA C IS THE HYDROGRAPH FOR THE MAIN VALLEY. THE MAXIMUM PEAK FLOW FROM THIS RESULTING HYDROGRAPH IS THE PEAK DISCHARGE FOR THE MAIN VALLEY, PRE-OPERATIONAL PHASE. THE MAIN VALLEY PEAK FLOWS FOR THE VARIOUS STORMS ARE LISTED BELOW:

1. 2 YR – Q_P = 209 CFS
2. 10 YR – Q_P = 555 CFS
3. 100 YR – Q_P = 984 CFS

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 12/18/85 PROJ. NO. 87-134-11
CHKD BY DMK DATE 12/30/85 SHEET NO. 1 OF 15

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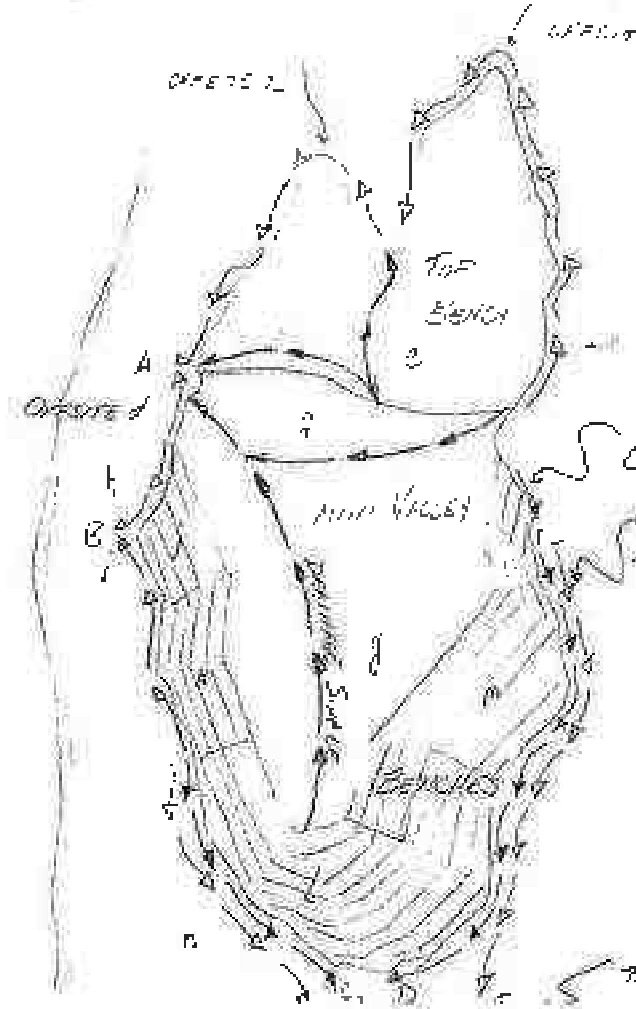
Post - Operation

Calculate the total maximum discharge that will occur in the main valley after the construction of the pile has been completed and the benches have been revegetated.

Note: Again, the runoff from the East Valley and portions of the east offsite in the main valley will be omitted since the these areas will not be disturbed (and, thus, the peak discharge from these areas should not change)

The ultimate configuration of the pile will result in a drainage pattern that resembles the following diagram



Note: The diversion channel on the east side is omitted in these calcs since it collects runoff from areas which should not be affected.

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The peak flows that need to be calculated are the flows that occur at points A, B, C, D, and E (F is omitted). After calculating each of these individual flows, the hydrographs corresponding to these flows are added together to obtain the peak flow for the main valley, post operation. The calculations for the discharge at A & B are extracted from the hydrology calcs submitted in the Coal Refuse Disposal Permit.

Methods used in calculating flows are based on average antecedent moisture conditions and procedures outlined in SCS's technical handbook, Release No. 20.

Input data for the TR 20 computer analysis:

Point A:

1. PPT => 2 yr - 24 hr : 2.7 inches
10 yr - 24 hr : 4.0 inches
100 yr - 24 hr : 5.5 inches

(Ref: SCS Engineering Field Manual, Chapter 2, page 2-5002, Indiana County)

2. Antecedent Moisture Condition II
3. Hydrologic Soil Group C - based on soil survey info
4. Drainage Areas - measured off USGS topo quad. or 1"2400 scale mapping

Subarea	Description	Drainage Area	
a	upland offsite, west	118 acres	= 0.184 mi²
b	upland offsite, east	69	= 0.108 mi²
c	adjacent offsite, east	38	= 0.0594 mi²
d	adjacent offsite, west	3	= 0.00469 mi²
e	top bench of Stage I	110	= 0.172 mi²
f	top bench of Stage II	110	= 0.172 mi²
g	top bench of Stage III	71	= 0.111 mi²

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5. Curve Numbers

Subarea	Land Use	CN value
a	Offsite Woods	70
b	Offsite Woods	70
c	Offsite Woods	70
d	Offsite Woods	70
e	Stage I Revegetated (top)	75
f	Stage II Revegetated (top)	75
g	Stage III Revegetated (top)	75

6. Time of Concentration

To find t_c, the longest flow path for each area should be determined. Flow paths for subareas a, b, c, d, e, f & g are shown on sheet 1, USGS quad copy and drawings included in the solid waste permit package.

Path a:

runoff from western drainageway of upland offsite

- ~ 1000' overland thru woods @ slope ≈ 4%
- ~ 950' grassed waterway thru farmland @ slope ≈ 4%
- ~ 760' grassed waterway thru woods @ slope ≈ 11%
- ~ 2180' in Stage I perimeter channel @ slope ≈ 0.7%

Overland flow thru woods @ 4% → V ~ 0.5 fps
Grassed waterway @ 4% → V ~ 3 fps
Grassed waterway @ 11% → V ~ 5 fps
Channel velocity @ 0.7% → V ~ 7.5 fps
(engineering judgement)

SUBJECT Fenelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 12/19/85 PROJ NO 82-134-11

CHKD. BY DMK DATE 12/30/85 SHEET NO. 4 OF 15

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$t_c \sim 1000/0.5 + 950/8 + 750/5$

$\sim$ 2467 seconds = 0.68 hr → use 0.70

$t_t \sim 2180/7.5 \sim 291$ seconds = 0.10 hr → use 0

Path b:

Eastern drainageway of upland offsite areas
~ 1800' overland flow thru woods @ slope ~ 9%
~ 4870' in Stage I perimeter channel @ slope ~ 0.6%

Overland flow thru woods @ 9% → V ~ 0.75 ft/sec
Channel velocity @ 0.6% → V ~ 7 ft/sec
(engineering judgement)

$t_c \sim 1800/0.75$

$\sim$ 2400 seconds = 0.67 hr → use 0.66

$t_t \sim 4870/7$

~ 696 seconds = 0.19 hr → use 0.25

Path c:

Drainage from adjacent eastern offsite area
~ 750' overland thru woods @ slope ~ 7%
~ 7760' in Stage I perimeter channel @ slope ~ 0.8%

Overland flow thru woods @ 7% → V ~ 0.65 fps
Channel velocity @ 0.8% → V ~ 6 fps
(engineering judgement)

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$t_c = 750/0.65$

$\approx$ 1154 SECONDS = 0.32 HR → USE 0.30

$t_t = 7760/6$

$\approx$ 1293 SECONDS = 0.36 HR → USE 0.25 HR

PATH d:

DRAINAGE FROM ADJACENT WESTERN OFFSITE AREA

$\sim$ 650' OVERLAND FLOW THRU WOODS @ SLOPE = 9%

OVERLAND FLOW THRU WOODS @ 9% ⇒ V = 0.75 FPS

$t_c = 650/0.75$

$\approx$ 866 SECONDS = 0.24 HRS → USE 0.25

$t_t = 0$ HR

PATH e:

DRAINAGE FROM REVEGETATED STAGE I

$\sim$ 900' OVERLAND FLOW ALONG TOP BENCH @ SLOPE = 4.5%

$\sim$ 7760' FLOW IN STAGE I PERIMETER CHANNEL @ SLOPE = 0.8%

OVERLAND FLOW ALONG TOP BENCH @ 4.5% ⇒ V = 1.1 FPS

CHANNEL VELOCITY @ 0.8% ⇒ V = 6 FPS

$t_c = 900/1.1 + 7760/6$

$\approx$ 2112 SECONDS = 0.59 HR → USE 0.60

$t_t = 0$ DUE TO DRAINAGE SCHEME FOR STAGE I

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 12/19/85 PROJ NO. 86-134-11
CHKD BY DMK DATE 12/30/85 SHEET NO. 6 OF 15

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Path f:

drainage from revegetated Stage II
~ 3000' along drainage swale on top bench @ slope = 1.5%

overland flow in top bench drainage swale @ 1.5% → V = 1.8 fps

$t_c \sim 3000/1.8 \sim 16'$

$\sim$ 1667 seconds = 0.46 hrs → use 0.45

$t_t = 0$

Path g:

drainage from revegetated Stage III
~ 4950' along drainage swale on top bench @ slope 1%

overland flow on top bench @ 1% → V = 1.5 fps

$t_c \sim 4950/1.5 \rightarrow 3300$ seconds = 0.92 hrs

$t_t \sim 0$

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flow

BY MLA DATE 12-20-85 PROJ NO 82-134-11
CHKD BY DMK DATE 12/30/85 SHEET NO 7 OF 15

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Summary of data

Subarea	CN	DA	t_c	t_t	Q_2	Q_{10}	Q_{100}
a	70	0.184 mi^2	0.79 hr	0	30.1	87.8	168.5
b	70	0.108	0.65	0.25	18.6	53.4	102
c	70	0.069	0.30	0.25	14.6	40.4	74.4
d	70	0.0047	0.25	0	1.37	3.1	6.7
e	75	0.172	0.60	0	49.8	116.9	205.6
f	75	0.172	0.45	0	57.7	132.7	231.4
g	75	0.111	0.90	0	25.0	59.0	104.1

Total peak flow at Point A equals Q_2 = 155 cfs
Q_{10} = 412 cfs
Q_{100} = 774 cfs

The above flows were calculated as follows:

1. The runoff from subarea C is computed
2. The hydrograph from subarea C is routed to subarea b.
3. The runoff from subarea b is computed
4. The hydrograph from subarea b and routed hydrograph from subarea c is added.
5. The sum of b and c hydrographs is routed to subarea a.
6. The runoff from subarea a is computed.
7. The sum hydrograph routed from subarea C + b is added to the hydrograph from subarea a.
8. The sum hydrograph of subareas a, b and c is routed to point A
9. The runoff from subarea d is computed
10. The hydrograph from d is added to the routed sum hydrograph from a, b and C.
11. The hydrograph from subarea e, f and g is computed
12. Hydrographs from e, f and g is added to the sum hydrograph from a, b, c and d. The resulting hydrograph contains the peak flow at point A.

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POINT B:

1. PPT → 2 YR - 24 HR : 2.7 INCHES
   10 YR - 24 HR : 4.0 INCHES
   100 YR - 24 HR : 5.5 INCHES

2. ANTECEDENT MOISTURE CONDITION II
3. HYDROLOGIC SOIL GROUP C
4. DRAINAGE AREAS

SUBAREA	DESCRIPTION	DRAINAGE AREA
h	ADJACENT OFFSITE, NORTH PART OF WEST	15 ACRES = 0.024 mi²
i	ADJACENT OFFSITE, SOUTH PART OF WEST	7 ACRES = 0.011 mi²
j	STAGE II REVEGETATED BENCHES	10 ACRES = 0.016 mi²
k	STAGE III REVEGETATED BENCHES	13.6 ACRES = 0.021 mi²

5. CURVE NUMBERS

SUBAREA	DESCRIPTION	CURVE NUMBER
h	OFFSITE WOODS, NORTH PART	70
i	OFFSITE WOODS, SOUTH PART	70
j	STAGE II, REVEGETATED BENCHES	78
k	STAGE III REVEGETATED BENCHES	78

6. TIME OF CONCENTRATION

PATH h:

RUNOFF FROM NORTH OF WEST ADJACENT OFFSITE
~ 380' OVERLAND FLOW THROUGH WOODS @ SLOPE = 13.5%
~ 1800' IN ROADSIDE DITCH - GRASS LINED @ SLOPE = 5%

OVERLAND FLOW THROUGH WOODS @ 13.5% → V = 0.95 FPS
FLOW IN GRASSLINE DITCH @ 5% → V = 3.4 FPS

SUBJECT Penelec - Conemaugh Solid Waste Disposal Point
Peak Runoff Flows

BY MLA DATE 12-20-85 PROJ. NO. 82-134-11 CONSULTANTS, INC.

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$t_c = 380/0.95 + 1800/3.4$

≈ 929 seconds = 0.26 hr

$t_L = 0$

Path i

Runoff from south of west adjacent offsite
~ 2100' flow in existing diversion channel @ 8%

flow in channel @ 8% → V = 7.5 fps

$t_c = 2100/7.5$ → 280 seconds = 0.08 hr → use 0.15 hr

$t_L = 0$

Path j

Runoff from Stage II revegetated benches
~ 1840' along bench @ 1%
~ 1000' in existing diversion channel @ 10%

Flow along bench @ 1% → V = 1 fps
flow in grass channel @ 10% → V = 4.8 fps
(TR-55, 1/75, pg 3-2)

$t_c = 1840/1 + 1000/4.8$

~ 1548 seconds = 0.43 hr

$t_L = 0$

Path K:

Runoff from Stage III benches
~ 3065' flow along bench @ 1%
~ 1000' flow in existing channel to culvert @ 10%

Flow along bench @ 1% ⟶ V = 1 fps
Flow in existing channel @ 10% ⟶ V = 4.8 fps

$t_c = \frac{3065}{1} + \frac{1000}{4.8}$

~ 3273 seconds = 0.91 hr

$t_t = 0$

Summary of Data

Subarea	CN	DA	t_c	t_t	Q_2	Q_{10}	Q_{100}
h	70	0.024	0.26	0	6.4	17.4	32.7
i	70	0.011	0.10	0	4.1	10.2	18.3
j	78	0.016	0.43	0	6.7	14.3	24.1
k	78	0.021	0.91	0	5.4	12.8	21.7

Total peak flow for Point B equals Q_2 = 19.8 cfs
Q_{10} = 48.1 cfs
Q_{100} = 86.1 cfs

The above flows are calculated as follows:
1. Runoff from subarea h is computed
2. " " " i " "
3. " " " j " "
4. " " " k
5. The hydrographs from subareas h, i, j and k are added together.

POINT C:

1. PPT ⇒ 2 YR - 24 HR : 2.7 INCHES
10 YR - 24 HR : 4.0 INCHES
100 YR - 24 HR : 5.5 INCHES

2. AMC II
3. HYDROLOGIC SOIL GROUP C
4. DRAINAGE AREAS

SUBAREA	DESCRIPTION	DRAINAGE AREAS
1	STAGE III REV BENCHES DRAINING WEST OF TOE OF PILE	39 ACRES = 0.060 MI²

5. CURVE NUMBERS

SUBAREA	LAND USE	CN VALUE
1	REVEGETATED BENCHES	78

6. TIME OF CONCENTRATION

PATH 1:
RUNOFF FROM STAGE III REVEGETATED BENCHES
~ 1965' FLOW ALONG REVEGETATED BENCH @ 1%
~ 940' FLOW ALONG COLLECTION CHANNEL @ 17%

FLOW ALONG BENCH @ 1% → V = 1 FPS
(ENGINEERING JUDGEMENT)
FLOW ALONG COLLECTION CHANNEL @ 17% → V = 25 FPS
(ENGINEERING JUDGEMENT FOR CONCRETE CHANNEL)

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 12-20-85 PROJ. NO. 82-134-11

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$t_c = 1965/1 + 940/25$

$\sim$ 2003 seconds = 0.56 hr

$t_t \sim 0$

Total flow at Point C equals Q_2 = 23.1 cfs
Q_{10} = 49.6 cfs
Q_{100} = 83.4 cfs

Point D:

1. PPT #? 2yr - 24 hr : 2.7 inches
   10yr - 24hr : 4.0 inches
   100yr - 24hr : 5.5 inches

2. AMC II
3 Hydrologic Soil Group C
4 Drainage Areas

Subarea	Description	Drainage Areas
M.	Stage III revegetated benches draining east of toe of pile	55 acres = 0.086 mi.^{2}

5 Curve Numbers

Subarea	Land Use	CN Value
M.	Revegetated Benches	78

6 Time of Concentration

Path M:

$\sim$ 825' flow along bench @ 1%
$\sim$ 3945' flow along collection channel @ 9%

FLOW ALONG BENCH @ 1% → V = 1 FPS
FLOW WITH COLLECTION CHANNEL @ 9% → V = 20 FPS
(ENGINEERING ASSUMPTION FOR CONCRETE CHANNEL)

$t_c = 825/1 + 3945/20$

$\sim$ 1022 SECONDS = 0.28 HR

$t_t = 0$

TOTAL PEAK FLOW AT POINT D EQUALS Q_2 = 42.4 CFS
Q_{10} = 90.4 CFS
Q_{100} = 151.4 CFS

POINT E:

1 PPT => 2YR - 24 HR : 2.7 INCHES
10 YR - 24 HR : 4.0 INCHES
100 YR - 24 HR : 5.5 INCHES

2 AMC II
3 HYDROLOGIC SOIL GROUP C
4 DRAINAGE AREAS

SUBAREA	DESCRIPTION	DRAINAGE AREA
H	WEST OFFSITE, SOUTH OF STAGE III TOE	6.8 ACRES = 0.011

5. CURVE NUMBERS

SUBAREA	LAND USE	CN VALUE
H	OFFSITE, WOODS	70

SUBJECT Penelec - Cavenaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 12-23-85 PROJ NO. 85-134-11
CHKD. BY DTK DATE 12/30/86 SHEET NO. 14 OF 15

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1. Time of Concentration

Point H
Runoff from wooded offsite southwest of Stage III toe.
~ 1470' overland flow through woods @ 14%

overland flow through woods @ 14% → V = 1.0 fps

$t_c = 1470/1$

= 1470 seconds = 0.41 hr

$t_t = 0$

Total peak flow at Point E equals $Q_2 = 2.5$ cfs
$Q_{10} = 6.7$ cfs
$Q_{100} = 12.6$ cfs

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLL DATE 1-10-86 PROJ. NO 82-134-11

CHKD. BY ______ DATE ______ SHEET NO. 15 OF 15

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Calculate total flow exiting from main valley:

In calculating the total peak discharge exiting from the main valley, the hydrographs at points A and B are added to obtain the flow exiting to the west valley, and the hydrographs at points C, D and E are added to obtain the flow exiting from the main valley at the toe of Stage II. The two resulting hydrographs are, then, added to obtain the total flow that is expected to exit from the main valley. Refer to calcs, "Conemaugh - Solid Waste Permit, Peak Flow for Pts. A+B, and C, D+E," by RFD, 1/6/86, 82-134-11, for the sum of peak flows from the hydrographs from A+B, and C, D+E.

Summary Table

Location	Flows (cfs)		
	Q_2	Q_{10}	Q_{100}
Point A	155	412	774
Point B	20	46	86
Point C	23	50	83
Point D	42	90	151
Point E	2	7	13
Total to West Valley	166	441	830
Total to Stage III Toe	61	135	232
Total in Main Valley	223	560	1026

SUBJECT Pendley - Catawba Solid Waste Disposal Permit Peak Runoff Flows			GAI CONSULTANTS, INC.
BY MLA	DATE 12-26-85	PROJ. NO 82-134-11	Engineers • Geologists • Planners
CHKD. BY DHK	DATE 12/30/85	SHEET NO. 1 OF 2	Environmental Specialists

During Operation

In calculating the peak runoff flow for the main valley during operation, the stage of the pile development that will cause the greatest amount of runoff is chosen to be used for the drainage area analyzed in these calcs. The stage that produces the greatest amount of runoff is the stage when the pile is completely developed except for the Rf bench; most of the top bench is re-vegetated (Stage I and portions of Stage II) except for the portion near the front face of the pile. In the area, the last bit of grading is being completed and most of Stage II + Stage III top benches have just been reseeded. Also, the benches on the front face of the pile is in the process of being reseeded.

Thus, in the actual calculation of the peak runoff during the last stage of development, the calcs used for post operation are used since the pile relatively has the same configuration for both instances, and, thus, the information for the last stage of development is the same for post operation except the CN values.

The next sheet summarizes all the info for the during operation calculation.

SUBJECT Penelec - Conemaugh Solid Waste Disposal Permit
Peak Runoff Flows

BY MLA DATE 12-26-85 PROJ NO. 82-134-11

CHKD BY DMK DATE 12/30/85 SHEET NO 2 OF 2

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Summary table

Location	PPT (inches)	AMC	Soil Group	Drainage Area (m.²)	CN Value	t_c (hr)	t_t (hr)	Flow (cfs)
Point A								Q_2, Q_{10}, Q_{100}
a	2.7, 4.0, 5.5	II	C	0.194	70	0.70	0	31, 98, 169
b	" " "	"	"	0.108	70	0.63	0.25	19, 53, 102
c	" " "	"	"	0.059	70	0.30	0.25	15, 40, 76
d	" " "	"	"	0.0047	70	0.25	0	1, 4, 7
e	" " "	"	"	0.172	75	0.60	0	50, 117, 202
f	" " "	"	"	0.172	80	0.45	0	81, 165, 270
g	" " "	"	"	0.111	80	0.90	0	36, 74, 132
G								184, 454, 824
Point B								
h	" " "	"	"	0.0:0	70	0.26	0	6, 17, 23
i	" " "	"	"	0.C:1	70	0.10	0	4, 10, 18
j	" " "	"	"	0.016	82	0.43	0	9, 17, 27
k	" " "	"	"	0.0<1	82	0.91	0	8, 15, 24
								[illegible]3, 53, 91
Point C								
l	" " "	"	"	0.060	85	0.66	0	35, 65, 101
Point D								
m	" " "	"	"	0.096	85	0.28	0	64, 118, 183
Point E								
n	" " "	"	"	0.011	70	0.41	0	2, 7, 13

Total Peak Flow for the Main Valley During Operation

To: Toe of Stage III	To: West Valley	Total Main Valley
Q_2 = 94	Q_2 = 203	Q_2 = 285 cfs
Q_{10} = 179	Q_{10} = 491	Q_{10} = 640 cfs
Q_{100} = 281	Q_{100} = 889	Q_{100} = 1118 cfs

SUBJECT CONEMAUGH - SOLID WASTE PERMIT
PEAK FLOW FOR PTS A+B, + C,D+E

BY KFD DATE 1/6/86 PROJ. NO. 82-134-11

CHKD. BY DAY DATE 1/6/86 SHEET NO. 1 OF 5

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THE FOLLOWING CALCULATIONS WERE PERFORMED TO DETERMINE THE PEAK FLOW AT THE CONFLUENCE OF POINTS A+B, AND C, D, + E. THE PEAK FLOW WAS DETERMINED FOR THE 2, 10, 100 YEAR - 24 HOUR STORMS, DURING AND POST-OPERATION OF FLY ASH/COAL REFUSE DISPOSAL OPERATION.

THE CALCULATIONS WERE BASED ON VALUES OBTAINED ON COMPUTER PRINT OUTS. THE PRINT OUTS SUMMARIZE DATA TAKEN FROM H+H CALCULATIONS OF THE MAIN VALLEY UTILIZING THE TR-20 PROGRAM BY MLA.

SUBJECT CONEMAUGH - SOLID WASTE PERMIT
PEAK FLOW FOR PTS A,B + C,D,E

BY RFD DATE 1/3/86 PROJ. NO. 82-134-11
CHKD. BY DAY DATE 1/6/86 SHEET NO. 2 OF 5

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DURING OPERATION

PTS A+B -

2 YR STORM

HR	12.0	12.2	12.4	12.6	12.8	13.0	13.2
A	128.34	183.26	172.51	149.91	122.33	95.93	76.39
B	22.12	20.73	16.25	13.07	9.81	7.74	6.16
TOTAL	150.46	202.99	188.76	162.98	132.14	103.67	82.55

$PEAK\ FLOW_{2\,YR} = 202.99$ cfs @ T = 12.2 HR

10 YR STORM

HR	12.0	12.2	12.4	12.6	12.8
A	330.40	447.49	419.21	347.99	266.79
B	51.91	43.52	32.62	25.62	18.86
TOTAL	382.31	491.01	451.83	373.61	285.65

$PEAK\ FLOW_{10\,YR} = 491.01$ cfs @ T = 12.2 HR

100 YR STORM

HR	12.0	12.2	12.4
A	621.31	816.55	750.27
B	91.01	72.28	52.90
TOTAL	712.32	888.83	803.17

$PEAK\ FLOW_{100\,YR} = 888.83$ cfs @ T = 12.2 HR

SUBJECT CONEMAUGH - SOLID WASTE PERMIT
PEAK FLOW FOR PTS A,B + C,D,E

BY RFD DATE 1/3/86 PROJ. NO. 82-134-11

CHKD. BY DRY DATE 1/6/86 SHEET NO. 3 OF 5

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DURING OPERATION (CONT)

PTS C,D,E

2 YR STORM

HR	12.0	12.2	12.4	12.6
C	28.22	35.34	26.74	17.48
D	64.36	43.83	20.65	15.39
E	1.86	2.48	1.60	1.15
TOTAL	94.44	81.65	48.99	34.02

HR	11.8
C	12.82
D	42.84
E	0.45
	56.11

PEAK FLOW = 94.44 cfs @ T = 12.0 h

10 YR STORM

HR	11.8	12.0	12.2	12.4
C	26.64	54.53	65.09	48.09
D	85.41	118.19	77.53	35.81
E	2.64	6.00	6.55	3.42
TOTAL	114.69	178.72	149.17	87.82

PEAK FLOW = 178.72 cfs @ T = 12.0 h

100 YR STORM

HR	11.8	12.0	12.2	12.4
C	43.94	86.56	100.59	73.33
D	137.79	182.24	117.04	53.44
E	6.09	11.88	12.06	7.01
TOTAL	187.82	280.68	229.69	133.78

PEAK FLOW = 280.68 cfs @ T = 12 HR

SUBJECT CONEMAUGH - SOLID WASTE PERMIT
PEAK FLOW FOR PTS A+B, + C, D, + E
BY RFO DATE 1/6/86 PROJ. NO. 82-134-11
CHKD BY DAY DATE 1/6/86 SHEET NO 4 OF 5

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POST- OPERATION

POINTS A+B

2 YR STORM

HR	12.0	12.2	12.4	12.6	12.8
A	96.58	149.14	148.36	132.72	110.32
B	18.88	17.26	13.48	10.98	
TOTAL	115.46	166.40	161.84	143.70	

PEAK FLOW$_2$ = 166.40 cfs @ T = 12.2 HR

10 YR STORM

HR	11.8	12.0	12.2	12.4	12.6
A	121.66	285.34	402.51	387.06	325.56
B	26.78	47.48	38.95	29.05	
TOTAL	148.44	332.82	441.46	416.11	

PEAK FLOW$_{10}$ = 441.46 cfs @ T = 12.2 HR

100 YR STORM

HR	11.8	12.0	12.2	12.4	12.6
A	265.53	566.11	763.33	712.83	574.17
B	54.01	85.74	67.01	48.85	
TOTAL	319.54	651.85	830.34	761.68	

PEAK FLOW$_{100}$ = 830.34 cfs @ T = 12.2 HR

SUBJECT CONEMAUGH – SOLID WASTE PERMIT
PEAK FLOW FOR PTS A+B, + C,D+E
BY RFD DATE 1/6/86 PROJ. NO. 82-134-11
CHKD. BY DAY DATE 1/6/86 SHEET NO 5 OF 5

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POST – OPERATION

POINTS C, D, + E

2 YR STORM

HR	12.0	12.2	12.4	12.6	11.8
C	16.59	23.07	18.31	12.38	6.26
D	42.21	30.94	15.14		23.33
E	1.86	2.48	1.60		0.45
TOTAL	60.66	56.49	35.05		30.04

PEAK FLOW$_{2YR}$ = 60.66 cfs @ T = 12.0 HR

10 YR STORM

HR	12.0	12.2	12.4	12.6	11.8
C	39.11	49.58	37.74	24.77	17.43
D	90.37	62.10	29.40		58.90
E	6.00	6.55	3.92		2.64
TOTAL	135.48	118.23	71.06		78.97

PEAK FLOW$_{10YR}$ = 135.48 cfs @ T = 12.0 HR

100 YR STORM

HR	12.0	12.2	12.4	11.8
C	68.65	83.26	62.02	32.75
D	151.37	100.55	46.75	106.44
E	11.88	12.06	7.01	6.09
TOTAL	231.90	195.87	115.78	145.28

PEAK FLOW$_{100}$ = 231.90 cfs @ T = 12.0 HR

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SUBJECT [illegible]
MODULE 13 - STAGE II H & H STUDY

BY MLK	DATE 1-27-85	PROJ. NO. 82-134-11	
CHKD. BY DEM	DATE 7-3-85	SHEET NO. 1	OF 34

INTRODUCTION:

THE SET OF CALCULATIONS IS CONCERNED WITH A HYDROLOGIC AND HYDRAULIC STUDY FOR THE ULTIMATE CONFIGURATION OF STAGE II. SPECIFICALLY, THIS ANALYSIS CONSISTS OF THE EVALUATION AND DESIGN OF MOST OF THE PERMANENT DRAINAGE FEATURES FOR STAGE II, SUCH AS; DIVERSION CHANNELS, COLLECTION CHANNELS, CULVERTS, DISSIPATORS AND SLOPE DRAINS. SOME FEATURES WILL BE DESIGNED FORMALLY WHILE OTHERS WILL ONLY BE CALLED OUT ON A PLAN VIEW.

THIS H AND H STUDY IS CONDUCTED FOR THE PURPOSE OF SUBMITTING A COAL REFUSE DISPOSAL PERMIT APPLICATION TO DER. THE INFORMATION RESULTING FROM THIS STUDY WILL BE USED TO COMPLETE MODULE 13 OF THE PERMIT.

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SUBJECT [illegible]
[illegible] STAGE II [illegible]
BY M.L.A. DATE 6-27-95 PROJ. NO. [illegible]-134-11
CHKD. BY DEM DATE 7-7-95 SHEET NO. 2 OF 34

HYDROLOGY

FOR THE HYDROLOGY ANALYSIS ALL SURFACE DRAINAGE FEATURES ARE CONSIDERED PERMANENT, THEREFORE, THE DESIGN STORM FLOW WILL BE CALCULATED FOR THE 100 YR - 24 HR RAINFALL IN ACCORDANCE WITH PENNSYLVANIA REGS FOR COAL REFUSE DISP. THE STORM FLOW WILL BE DETERMINED USING THE ATTACHED HYDROLOGY PLAN VIEWS AND THE METHOD OF ANALYSIS OUTLINED IN THE SOIL CONSERVATION SERVICE'S TECHNICAL HANDBOOK RELEASE NO. 20

ANOTHER IMPORTANT CONSIDERATION FOR THE HYDROLOGIC ANALYSIS IS THAT THE ULTIMATE CONFIGURATION OF STAGE II DOES NOT NECESSARILY REFLECT THE WORST POSSIBLE CONDITION (MAXIMUM POSSIBLE FLOW) FOR EACH SURFACE DRAINAGE FEATURE. DIFFERENT STAGES OF CONSTRUCTION FOR STAGE II MUST BE EXAMINED, AND THE STAGE THAT DEPICTS THE WORST CONDITION FOR A CHANNEL WILL BE USED TO DESIGN THAT PARTICULAR CHANNEL.

I. West Main Valley:
1. Collection Channels

[W]orst condition for the West Main Valley collection channel is depicted on drawing number [illegible]. This condition occurs during the last stage of construction of Stage II.

Input data for the TR 20 computer analysis
A. PPT = 5.5 inches (Ref: "SCS Engineering Field Manual," Chapter 2, page 2-50.05, Indiana County)

B. Antecedent Moisture Condition II
C. Hydrologic Soil Group C - based on soil survey info
D. Drainage Area (Ref: Worksheet 11c)
Total Area = 40.3 acres = 0.0630 mi²
i. Revegetated Benches - 37.0 acres
ii. Offsite - pasture - 3.3 acres

E. Curve Numbers
i. Revegetated Benches = 78
ii. Pasture = 80

F. Weighted CN

$$CN = \frac{37.0(78) + 3.3(80)}{40.3}$$

$$= 78.16$$

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6 TIME OF CONCENTRATION, t_c

SINCE WE ARE CONCERNED WITH THE MAXIMUM PEAK FLOW THAT WILL OCCUR IN THE WEST COLLECTION CHANNEL, IT IS NECESSARY TO EXAMINE THE LAYOUT OF THE WEST CHANNEL AND LOCATE THE PLACE WHERE THE PEAK FLOW WILL MOST LIKELY OCCUR. USUALLY THE MAXIMUM PEAK FLOW OCCURS AT THE POINT WHERE THE CONCERNED CHANNEL MERGES INTO ANOTHER CHANNEL. HOWEVER, THE MAXIMUM PEAK FLOW FOR THE WEST COLLECTOR CHANNEL IS EXPECTED TO OCCUR AT THE POINT WHERE THE CHANNEL EMPTIES INTO A NATURAL DEPRESSION WHICH IS LOCATED WEST OF THE HAUL ROAD (POINT 1), WHILE ANY FLOW DOWNSTREAM WILL BE BASICALLY CONTROLLED BY THIS DEPRESSION.

THREE OTHER POINTS WHICH SHOULD ALSO BE HYDROLOGICALLY CONSIDERED ARE THE POINTS WHERE THE COLLECTED FLOW ENTERS INTO CULVERTS (POINTS 2 AND 3) AND WHERE THE FLOW ENTERS INTO THE MAIN COLLECTION CHANNEL (POINT 4) (THESE POINTS WILL BE CONSIDERED LATER IN THE ANALYSIS). THESE POINTS ARE NOT AS CRITICAL FOR FINDING THE MAXIMUM PEAK FLOW, SINCE THE FLOW FOR THESE POINTS ARE BASICALLY CONTROLLED BY THE DEPRESSIONS (ENERGY DISSIPATORS) THAT ARE LOCATED PRIOR TO THE ENTRIES OF THE CULVERTS.

TO FIND THE TIME OF CONCENTRATION, THE AVERAGE VELOCITY METHOD WILL BE USED. FOR THIS METHOD, THE LONGEST FLOW PATH TO POINT 1 IS MEASURED, AND THE FLOW VELOCITIES IN DIFFERENT SECTIONS OF THE FLOW PATH ARE DETERMINED BY

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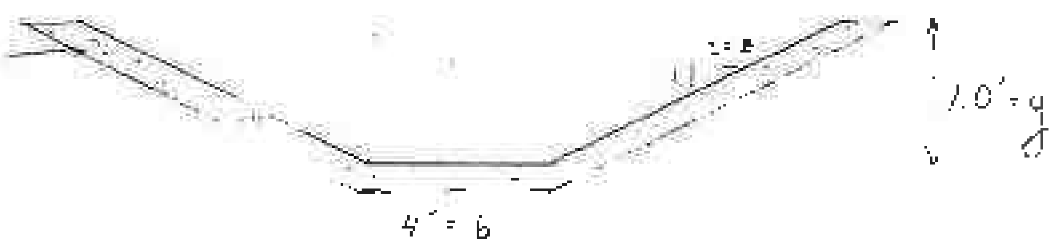
SEE SHEET 5a

USING THE ATTACHED GRAPH, THE LONGEST FLOW PATH FOR THE WEST COLLECTION [illegible] IS BROKEN DOWN INTO THE FOLLOWING SECTIONS.

i FLOW PATH ALONG BENCH – 2590 FT @ 1–5%
" " " PROPOSED CONSTRUCTED CHANNEL – 2100 FT @ 7% AVE.

ii VELOCITIES ALONG BENCH – 2.4 FPS (ASSUMPTION)

VELOCITIES ALONG PROPOSED CHANNEL:
ASSUME THE FOLLOWING CROSS-SECTION



NOTE: COLLECTION CHANNELS MUST BE LINED WITH IMPERVIOUS MATERIAL SUCH AS CONCRETE OR SYNTHETIC LINER. CONCRETE IS USED FOR STEEP SLOPES AND SYNTHETIC LINER IS USED FOR MILD SLOPES.

$$V = \frac{1.49}{n} R^{2/3} S^{1/2} \quad \text{WHERE} \quad R = \frac{(bd + zd^2)}{b + 2d\sqrt{1+z^2}}$$

$$n = 0.012$$

$$= \frac{1.49}{0.012}\left(\frac{4(1) + 2(1^2)}{4 + 2(1)\sqrt{1+2^2}}\right)^{2/3} 0.07^{1/2}$$

$$= 26.1 \text{ FPS}$$

From: A Guide to Hydrologic Analysis Using SCS Methods
by Richard H. McCuen

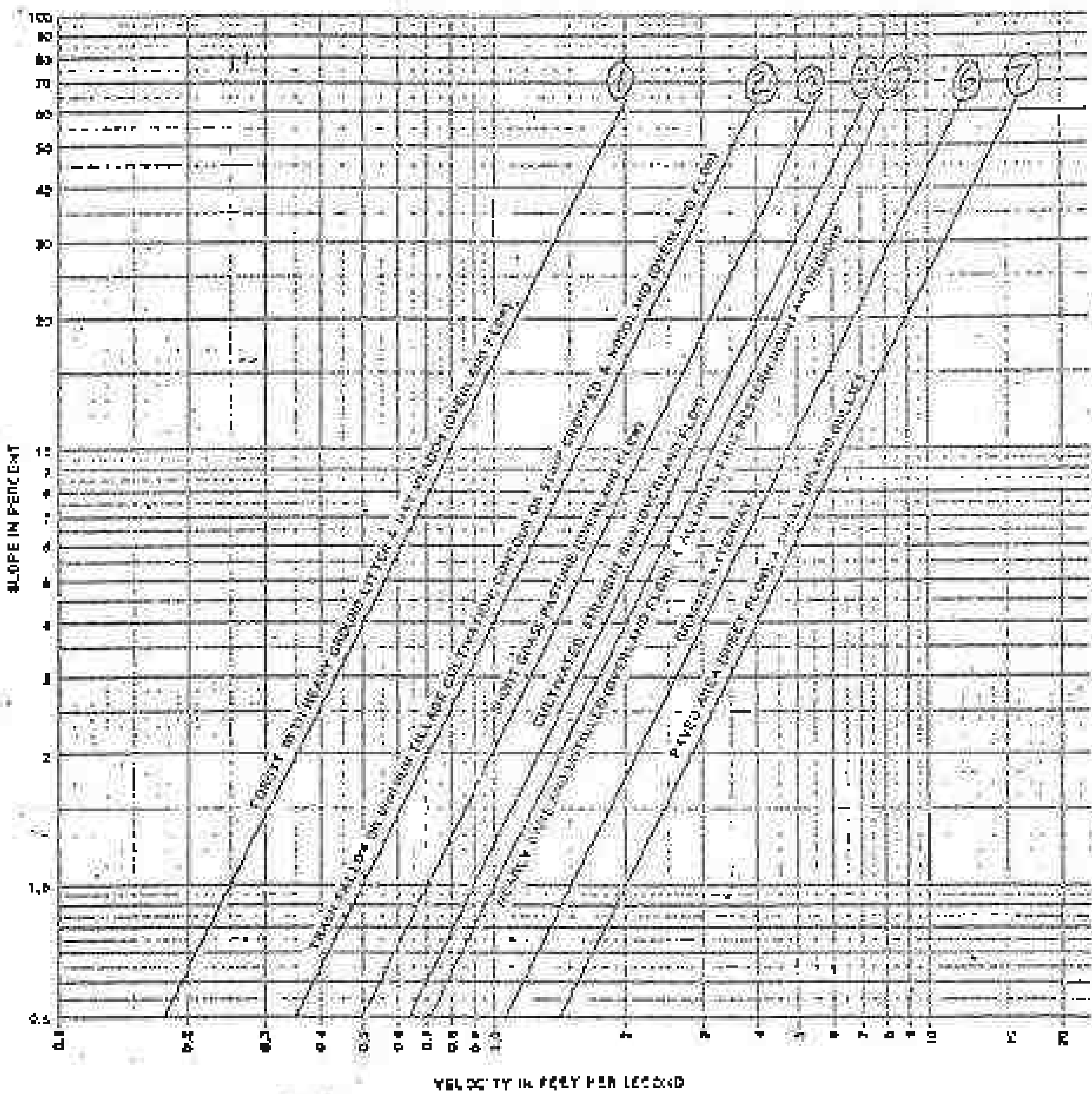


Figure 8. Velocities for upland method of estimating T_c

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$$T_c = \frac{2500\ FT}{3.0\ FPS} + \frac{2130\ FT}{26.1\ FPS}$$
$$= 1360\ SEC$$
$$= 0.38\ HR$$

H. AFTER RUNNING THE TR 20 THE RESULTING Q_P = 100 CFS.

I. REFER TO THE HYDROLOGY SUMMARY TABLES FOR A COMPUTER PRINTOUT SUMMARIZING THE ABOVE CALCULATION

J. THE OTHER CHANNEL REACHES BETWEEN POINTS 2 AND 3 AND POINTS 3 AND 4 WILL ALSO BE DESIGNED FOR Q_P = 100 CFS SINCE

i. THE Q_{PEAK} IN THESE REACHES ARE EXPECTED TO BE LESS SINCE THE FLOW WILL BE CONTROLLED BY THE ENERGY DISSIPATORS AND CULVERTS LOCATED ALONG THESE REACHES.

ii. SINCE THESE CHANNEL REACHES ARE REASONABLY SMALL, THE MARGINAL COST BETWEEN CONSTRUCTING ONE KIND OF CHANNEL FOR THE COLLECTION CHANNEL COMPARED TO CONSTRUCTING ONE REACH (≈ 3100 FT) WITH A PARTICULAR SIZE AND TWO SMALLER REACHES (≈ 200 FT & ≈ 400 FT) WITH SLIGHTLY SMALLER SIZES IS REASONABLY NEGLIGIBLE.

iii. CONSTRUCTION IS EASIER IF DESIGN IS CONSISTENT.

K. THE HYDROGRAPH CORRESPONDING TO Q_P = 100 CFS WILL BE ROUTED DOWNSTREAM TO THE MAIN COLLECTOR CHANNEL.

I West Main Valley (continue)
2 Diversion Channels

The worst condition for the west diversion channel occurs during one of the interim stages of Stage II. At this interim stage, Stage II reaches approximately elevation 1310, and the west diversion channel collects runoff from Stage I revegetated benches and offsite west of the site.

The west diversion channel will be divided into two reaches. The first reach will be analyzed to point N 391,400, E 1,632,420, and the second reach will be analyzed to point N 387,300, E 1,633,125. At point N 391,400, E 1,632,420, a hydrograph for the corresponding subarea will be computed, and this hydrograph will be routed to point N 391,400, E 1,632,420. At N 391,400 & E 1,632,420, a hydrograph for the lower subarea will be computed, and this hydrograph will be added to the routed hydrograph to find the peak flow.

Input Data:

a. PPT = 5.5 inches
b. AMC II
c. Hydrologic Soil Group C
d. Drainage Area

N 391,400, E 1,632,420 - Subarea 1

Total	= 95.1 acres = 0.148
Revegetated Benches	= 34.1 acres
Pasture	= 25.2 acres
Woods	= 35.8 acres

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iii N 387,000 E 1,635,125 - Subarea 2
Additional Offsite = 48.2 acres = 0.0753
Pasture = 15.0 acres
Wooded = 33.2 acres

e Curve Numbers
i Revegetated Benches - 79
ii Pasture - 80
iii Wooded - 70

f Weighted Curve Numbers
i Subarea 1

$$CN = \frac{34.1(79) + 25.7(80) + 35.3(70)}{95.1}$$

= 75.52

ii Subarea 2
CN = 73.11

g Time of Concentration
i Subarea 1
The longest flow path starts across the top 20' width bench of Stage I and continues along the west perimeter of the site

a Lengths
- Flow path along bench - 1560' @ 1-3%
- " " from " to channel - 843' @ 15%
- " " along channel that will eventually be buried by other interim stages - 3260' @ 1%
- Flow path along proposed channel to point 1. 391,400 E 1,632,420 - 1530 @ 12%

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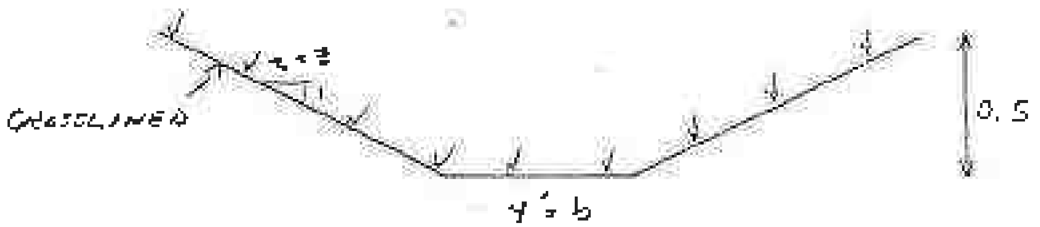
b Velocities

- Velocity along Bench - 2.0 fps
- Velocity for channel that will carry the bench flow to the channel that runs along the perimeter of the site.

Assume:



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$V = \frac{1.49}{n} R^{2/3} S^{1/2}$ where $n = 0.045$

$= \frac{1.49}{0.045} \left(\frac{4(0.5) + 2(0.5)^2}{4 + 2(0.5)1.42} \right)^{2/3} 0.15^{1/2}$

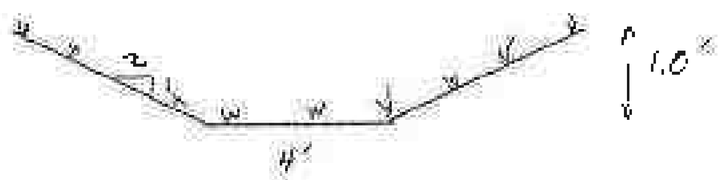
$= 7.0$ fps

V = 7.0 fps is too high of a value for grasslined channel, therefore, Enkamat should be used, n for Enkamat equals 0.040.

$V = \frac{1.49}{0.040} \left(\frac{4(0.5) + 2(0.5^2)}{4 + 2(0.5)\sqrt{5}} \right)^{2/3} 0.15^{1/2}$

$= 7.8$ fps

→ Velocity for channel that will eventually be buried by other interim stages.



$V = \frac{1.49}{0.045} \left(\frac{4(1) + 2(1)^2}{4 + 2(1)\sqrt{5}} \right)^{2/3} 0.01^{1/2}$

$= 2.6$ fps

→ Velocity for proposed channel to point N 391,400, E 1,632,420

Grasslined w Enkamat

$V = \frac{1.49}{0.040} \left(\frac{4(1) + 2(1^2)}{4 + 2(1)\sqrt{5}} \right)^{2/3} 0.12^{1/2}$

$= 10.2$ fps

c. T_c

$$T_c = \frac{1562}{[illegible]} + \frac{[illegible]}{7.8} + \frac{3240}{8.6} + \frac{1545}{10.[illegible]}$$

$= 2295 \text{ sec} = 0.64 \text{ hr}$

ii. Subarea 2

The hydrograph resulting from Subarea 1 will be routed to Subarea 2. However, the T_c for Subarea 2 needs to be calculated.

a. Lengths
- Flow path for offsite – 750' @ 25%
- " " " channel – 2533 @ 1%

b. Velocities
- Velocity for offsite – 1.25 fps
- Velocity for channel from N 391,400, E 1,632,420 to N 397,000, E 1,633,125

$$V = \frac{1.49}{0.045}\left(\frac{5(3) + 2(3)^2}{5 + 2(3)\sqrt{5}}\right)^{2/3} 0.01^{1/2}$$

$= 4.88 \text{ fps}$

c. $T_c = \frac{750'}{1.25} + \frac{2533}{4.88}$

$= 1119 \text{ sec} = 0.31 \text{ hr}$

H. After running the TR 20

i. Subarea 1 Q_p = 175.6 cfs

ii. Subarea 2 Q_p = 225.0 cfs

II East Main Valley

1. Collection Channel

The worst condition for the east collection channel occurs during the last few interim stages of construction. The upper portion of the channel is mostly affected during the ultimate stage of construction which is depicted on drawing No. C- and the lower portion of the channel is mostly affected when the top bench of Stage II reaches a max elevation of approximately 1480 ft and drains to the East Valley via a slope pipe.

The east collection channel is divided into three reaches. The first reach starts at point N 394, 317, E 1,633,185 and extends to point N 393,450 E 1,633,515. The second reach starts at N 393,450 E 1,633,515 and extends to N 392,685, E 1,633,365. The third reach starts at N 392,685, E 1,633,365 and extends to N 391,870, E 1,632,630. Since the second reach's subarea is a very small area, the first and second reach will be combined into one reach; however, the hydrograph for Reach 1 still needs to be analyzed separately for the channel designs of Stage..

Input Data:

a. PPT = 5.5 inches
b. AMC II
c. Hydrologic Soil Group C
d. Drainage Area
  i. At point N 393,450, E 1,633,515 - Subarea 1
    Total = 13.9 acres = 0.0217 mi
    Revegetated Benches = 8.6 acres
    Wooded = 5.3 acres

ii. At point N 392,685, E 1,633,365 - Subarea 1+2
Additional Area
Revegetated Benches = 5.5 acres
Total = 13.9 + 5.5 = 19.4 acres = 0.0303 m
iii. At point N 391,370, E 1,632,690 - Subarea 3 + 4
Additional Area
Revegetated Benches = 8.2 acres = 0.0128 m
Top Bench = 123.1 acres = 0.192 m
(Top bench is treated as separate subarea)

e. Curve Numbers
i. Revegetated Benches - 78
ii. Wooded - 70
iii. Top Bench - Active - 85

f. Weighted Curve Numbers
i. N 393,450, E 1,633,515 - Subarea 1

$$CN = \frac{8.6(78) + 5.3(70)}{13.9}$$

= 74.9

ii. Subarea 1 & 2

$$CN = \frac{14.1(78) + 5.3(70)}{19.4}$$

= 75.8

iii. Subarea 3 - Top bench - Active disposal
CN = 85
Subarea 4 - Revegetated Benches
CN = 78

g. Time of Concentration
i. N 393,450, E 1,633,515 - Subarea 1
a. Lengths
- Flow path along bench - 1560 ft @ 1-3%
- Flow path along proposed channel - 970 ft @ 1%

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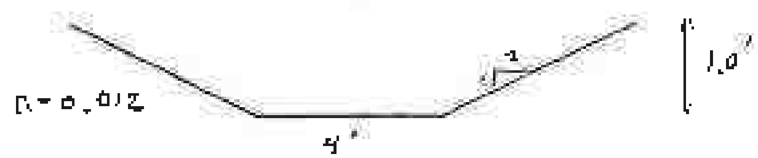
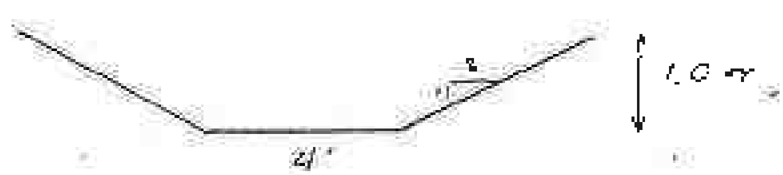
b. Velocities
- Velocity along bench - 2.0 fps
- Velocity in proposed channel
Assume:



$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$
$$= \frac{1.49}{0.012}\left(\frac{4(1) + 2(1^2)}{(4 + 2(1))\sqrt{5}}\right)^{2/3}(0.01)^{1/2}$$
$$= 9.86 \text{ fps}$$

c. $T_c = \frac{1560'}{2 \text{ fps}} + \frac{970'}{9.86 \text{ fps}}$
$= 878 \text{ sec} = 0.24 \text{ hr}$

ii. At point N 392,685, E 1,633,365 - Subarea 11 & 12
a. Lengths
- Flow path along continuation of channel
- 882 ft @ 15%
b. Velocity in proposed channel
Assume



$$V = \frac{1.49}{0.012}\left(\frac{4(1) + 2(1)^2}{(4 + 2(1))\sqrt{5}}\right)^{2/3}(0.15)^{1/2}$$
$$= 38.2 \text{ fps}$$

c. $T_c = 0.24 \text{ hr} + \frac{882 \text{ ft}}{38.2 \text{ fps}}\left(\frac{\text{hr}}{3600 \text{ sec}}\right)$
$= 0.27 \text{ hr}$

Note: The hydrograph for Subareas 1 & 2 must be routed to point N 391,870 E 1,632,680 (east collection channel merges with the main site collector). The length of route is 1040'.

iii. N 391,870, E 1,632,680 Subarea 3 and 4

Subarea 3 - Top Bench

a. Lengths
- Flow path along swale - 3000' @ 1%

b. Velocity
- Velocity along swale = 4 fps

c. T_c

$$T_c = \frac{3000'}{4 \text{ fps}}$$

$$= 750 \text{ sec} = 0.21 \text{ hr}$$

Note: The hydrograph for subarea 3 is to be routed through a slope pipe that is 300 ft long @ ± 11% and through a channel 1040' @ ± 14% until it reaches to point N 391,870, E 1,632,680. At this point the routed hydrograph from subarea 3 will be added to subarea 4 hydrograph.

Subarea 4 - Revegetated Benches

a. Length
- Flow path along bench - 570' @ 1-3%
- " " " channel - 650 @ 14%

b. Velocity
- Velocity for bench = 2 fps

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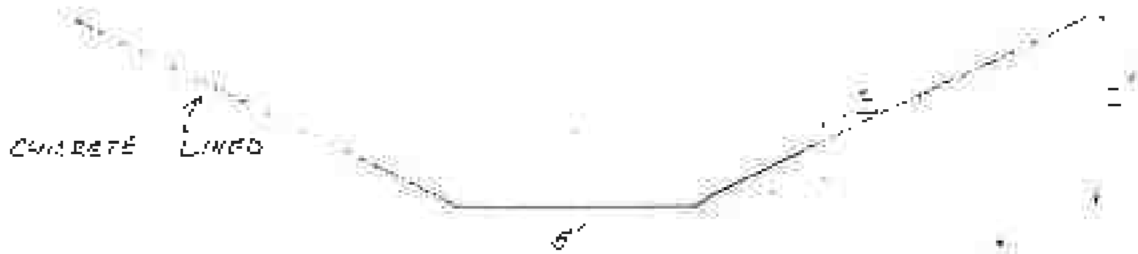
- Velocity for channel
Assume:



$$V = \frac{1.49}{0.013}\left(\frac{5(2)+2(2)^2}{5+2(\;)5}\right)^{2/3} 0.14^{1/2}$$
$= 55.1$ fps

c. T_c

$$T_c = \frac{[illegible]}{[illegible]} + \frac{655}{55.1\text{ fps}}$$
$= 347$ sec $= 0.10$ hr

ii. After running TR 20, Q_p for the various subareas are:

i. Subarea 1 - Q_p = 35.3 cfs
ii. Subarea 1 & 2 - Q_p = 50.1 cfs
iii. Subarea 3-4 Q_p = 505.7 cfs

II East Hill Valley
a Diversion Channel

The worst condition for the east collection channel occurs during the last few interim stages of construction when the top bench of Stage II reaches a max elevation of approximately 1430 ft and drains to the East Valley via a slope pipe.

The east diversion channel is divided into three reaches. The first reach extends to point N 393,450, E 1,633,560. The second reach starts at point N 393,450, E 1,633,560 and extends to point N 392,390, E 1,633,290. The third reach starts at N 392,380, E 1,633,290 and extends to N 391,840, E 1,633,645 where it meets the natural channel.

Input Data:

a. PPT = 5.5 inches
b. AMC II
c. Hydrologic Soil Group C
d. Drainage Area

i. Subarea 1 – N 393,450, E 1,633,560

Total	= 22.8 acres = 0.035 mi
Wooded	= 22.8 acres

ii. Subarea 2 – N 392,390, E 1,633,290

Total	
Wooded	= 8.2 acres = 0.0128 mi

iii. Subarea 3 – N 391,840, E 1,633,645

Total	
Wooded	= 6.0 acres = 0.0094 mi

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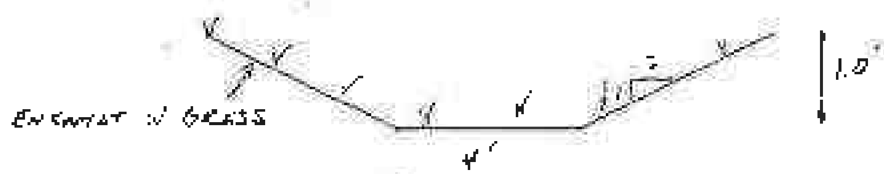
e. CURVE NUMBERS
  i. WOODED = 70

f. WEIGHTED CURVE NUMBERS
  i. SUBAREA 1
    CN = 70
  ii. SUBAREA 2
    CN = 70
  iii. SUBAREA 3
    CN = 70

4. TIME OF CONCENTRATION
  i. SUBAREA 1
    a. LENGTHS
      - FLOW PATH ALONG OFFSITE = 530' @ 8 %
        CHANNEL = 2140' @ 2 %

    b. VELOCITIES
      - VELOCITY ALONG OFFSITE = 0.7 FPS (USE GRAPH)

      - VELOCITY IN CHANNEL
        ASSUME:



$$V = \frac{1.49}{0.045}\left(\frac{4(1)+2(1)^2}{4+2(1)\sqrt{5}}\right)^{2/3} 0.02^{1/2}$$

$= 5.3$ FPS

c. $T_c = \frac{530}{0.7} + \frac{2140'}{5.3}$

$= 1161$ SEC $= 0.32$ HR

SUBJECT Penelec - Conemaugh
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Note: The hydrograph for subarea 1 is routed through a channel (that is 1340 ft long) to point N 392,980, E 1,633,290.

ii. Subarea 2

a. Lengths
- Flow path along offsite = 370' @ 11%
- " " " channel = 1240' @ 15%

b. Velocities
- Velocity along offsite = 0.8 fps
- Velocity in channel
  Assume:

$$V = \frac{1.49}{0.032}\left(\frac{4(1)+3(1)^2}{4+2(1)\sqrt{5}}\right)^{2/3} 0.15^{1/2}$$
$$= 14.3 \text{ fps}$$

c. $T_c = \frac{370}{0.8} + \frac{1240}{14.3}$
$= 549 \text{ sec} = 0.15 \text{ hr}$

Note: The hydrograph at this point is added to the routed hydrograph from subarea 1, and the sum of the two hydrographs is routed to point N 391,940, E 1,633,…
The length of route is 1240 ft.

iii. Subarea 3

a. Lengths
- Flow path along offsite – 840' @ 34%
- " " " channel – 690' @ 7%

b. Velocities
- Velocity along offsite – 1.25 fps
- Velocity in channel

Assume:

$$V = \frac{1.49}{0.012}\left(\frac{4(2) + 2(2)^2}{4 + 2(2)\sqrt{5}}\right)^{2/3} 0.07^{1/2}$$

$= 37.8$ fps

c. $T_c = \frac{840}{1.25} + \frac{690}{37.8}$

$= 718$ sec $= 0.19$ hr

Note: The hydrograph for subarea 3 is added to the routed hydrograph from subareas 1 and 2.

H. After running TR 20
i. Subarea 1 $Q_p = 45.1$ cfs
ii. Subarea 2 $Q_p = 61.9$ cfs
iii. Subarea 3 $Q_p = 44.6$ cfs

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V Main Site Collector

THE MAIN SITE COLLECTOR BEGINS APPROXIMATELY AT COORDINATE N 391,870, E 1,632,789 WHERE IT MERGES WITH THE EAST SITE COLLECTOR, THE LEACHATE FLOW FROM THE STILLING BASIN AT THE TOE OF STAGE II AND THE SMALL AMOUNT OF RUNOFF FROM THE LOWEST STAGE II BENCHES. THE MAIN SITE COLLECTOR TRAVELS SOUTH WHERE IT RECEIVES RUNOFF FROM THE SURROUNDING OFFSITE AND FLOW FROM THE WEST COLLECTION CHANNEL, AND IT EXTENDS TO A TREATMENT PLANT FURTHER DOWNSTREAM.

IN ANALYZING THE MAIN SITE COLLECTOR CHANNEL, THE LEACHATE FLOW AND THE SMALL RUNOFF FLOW FROM THE LOWER STAGE II BENCHES ARE ASSUMED TO BE NEGLIGIBLE COMPARED TO THE TOTAL SURFACE RUNOFF.

THE HYDROLOGY ANALYSIS OF THE MAIN SITE COLLECTOR WILL ONLY EXTEND TO POINT N 390,750 E 1,633,000, SINCE GILBERT & ASSOCIATES IS SUPPOSED TO DESIGN THE STRUCTURES DOWNSTREAM FROM THIS POINT.

THE PEAK FLOW FOR THE MAIN SITE COLLECTION CHANNEL IS CALCULATED BY ROUTING THE EAST COLLECTION CHANNEL TO WHERE THE MAIN SITE COLLECTION CHANNEL MERGES WITH THE WEST COLLECTION CHANNEL. AT THIS POINT THE EAST AND WEST COLLECTION CHANNEL HYDROGRAPHS ARE ADDED. THE SUM OF THESE HYDROGRAPHS IS THEN ROUTED TO POINT N390,750, E 1,633,000 WHERE THE FLOW HYDROGRAPH OF THE SURROUNDING OFFSITE IS ADDED TO THE ROUTED HYDROGRAPH OF THE EAST AND WEST COLLECTION CHANNELS.

SUBJECT Fehrles - Conemaugh
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Input data for the TR 20 computer analysis

A. PPT = 5.5 inches
B. AMC II
C. Hydrologic Soil Group C
D. Drainage Area
    Total = 10.9 acres = 0.017 mi²
    Offsite Disturbed = 10.9 acres
E. Curve Numbers
    Fair Pasture = 80
F. Weighted Curve Numbers
    CN = 80
G. Time of Concentration
    a. Lengths
    - Flow path along offsite - 658 @ 14% (from soil stockpile to main collector)
    - Flow path along main site collector to Pt N 390,750 E 1,633,000 - 1104 @ 0.9%

    b. Velocities
    - Velocity along offsite = 2.7 fps (short fail short pasture)
    - Velocity along channel
      Assume:

$$V = \frac{1.49}{0.012}\left(\frac{15(2) + 2(2)^2}{15 + 2(2)\sqrt{5}}\right)^{2/3} 0.009^{1/2}$$

$= 16$ FPS

SUBJECT Fairfield - Coleraugh[illegible]
Mobile 13 Stage I H&H Study

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c. $T_4 = \frac{653'}{2.7} + \frac{1104'}{16}$

$= 312.7$ sec $= 0.09$ hr

H. After running the TR 20, the resulting Q_p at Point N 390,750 E 1,633,000 equals

$Q_p = 619.0$ cfs

III Slope Drain

A slope drain is required for the Stage II benches that are draining to the west collection channel. The slope drain will be designed to accommodate the maximum flow that it is expected to receive during the span of its lifetime. The maximum flow may occur during the construction of Stage II or Stage III. The below calculation computes the maximum flow that is expected to occur during Stage II. The flow will be compared to the flow computed for Stage III, and the higher flow will be the design flow for the slope drain.

Input Data:

A. PPT = 5.5 inches

B. AMC II

C. Hydrologic Soil Group C

D. Drainage Area

Revegetated Benches = 15.1 acres

E. Curve Numbers

Revegetated Benches - 78

F. Time of Concentration

i. Longest flow path - 2560 ft @ 1-3%

ii. Velocity along bench - 2.0 fps (short grass pasture)

iii. $T_c = \frac{2560 ft}{2.0 fps}$

= 1280 sec = 0.36 hr

H. After running TR 20, $Q_p = 37.9$ cfs

I. Refer to Stage II calcs, sheet for comparison

HYDRAULICS

FOR THE HYDRAULIC PART OF THE ANALYSIS, A CHANNEL WILL BE DESIGNED FOR THE FLOWS CALCULATED IN THE HYDROLOGY SECTION. THE ONE MAJOR RESTRICTION IN THE DESIGN IS THAT COLLECTION CHANNELS WILL HAVE TO BE LINED WITH AN IMPERMEABLE LINER, SUCH AS, CONCRETE OR SYNTHETIC LINER/ROCK. DIVERSION CHANNELS MAYBE GRASSLINED, ENKAMAT/GRASSLINED, ROCK LINED, GROUTED ROCK OR CONCRETE LINED.

FOR A SUMMARY OF CHANNEL DESIGN RESULTS REFER TO THE PLAN VIEWS AND CROSS-SECTIONS INCLUDED IN THE PERMITTING PACKAGE

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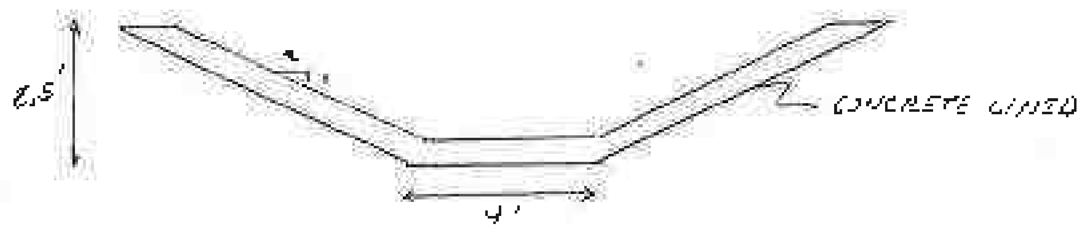
SUBJECT Penelec – Conemaugh
Module 13   Stage I   H/A Study
BY MLA   DATE 4-2-85   PROJ. NO. 82-134-11
CHKD. BY DEM   DATE 7-3-85   SHEET NO. 21 OF 34

I West Main Valley
1. West Collection Channel

The channel dimensions are found by using Manning's equation; using the minimum slope of the channel reach to find the depth; and use the maximum slope to find the appropriate channel liner.

Channel Dimensions:

i. Channel depth – minimum slope = 1%



$$Q_p = 100.1 \text{ cfs} \rightarrow \frac{Qn}{b^{8/3} S^{1/2}}$$

$$= \frac{100.1\,(0.012)}{(4)^{8/3}\,(0.01)^{1/2}}$$

$$= 0.298$$

$$d/b = 0.33$$

$$d = 1.32$$ recommend $d = 2.5'$ for freeboard

ii. Since this channel is a dirty water channel and most of the channel reach has bed slopes greater than a synthetic liner can withstand, we recommend using concrete as liner

SUBJECT Penelec Conemaugh
Module IE Stage II H&H Study
BY MAK DATE 7-2-85 PROJ. NO. 82-134-11
CHKD. BY DEM DATE 7-3-85 SHEET NO. 27 OF 34

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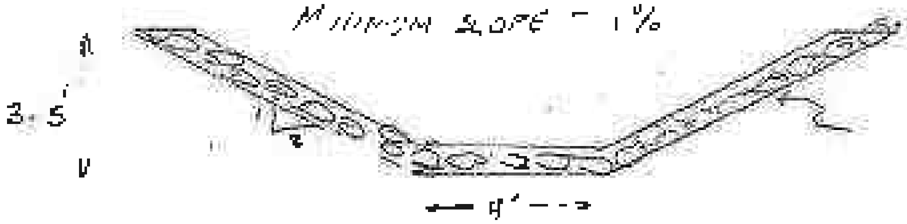
2. West Diversion Channel
Channel Dimensions
A Reach 1 – to point N 391,400 E 1,532,420
i Channel Depth
Minimum slope = 1%



$Q_R = 175.6$ cfs $\rightarrow \dfrac{Qn}{b^{8/3} S^{1/2}}$

$= \dfrac{175.6(0.025)}{(4)^{8/3}(0.01)^{1/2}}$ for n see below calc

$= 1.09$

$d/b = 0.63$

$d = 2.52$ recommend $d = 3.5'$ for freeboard

ii. Channel Lining – Max slope = 12.5%
a. Try Enkamat $n = 0.040$ $d = 1.72'$

$$V = \frac{1.49}{0.040}\left(\frac{4(1.72) + 2(1.72)^2}{4 + 2(1.72)\sqrt{5}}\right)^{2/3} 0.125^{1/2}$$

= 14.0 fps Enkamat cannot withstand such high velocity

b. Try grouted rock $n = 0.025$ $d = 1.36$

$$V = \frac{1.49}{0.025}\left(\frac{4(1.36) + 2(1.36)^2}{4 + 2(1.36)\sqrt{5}}\right)^{2/3} 0.125^{1/2}$$

= 19.74 fps acceptable for grouted rock

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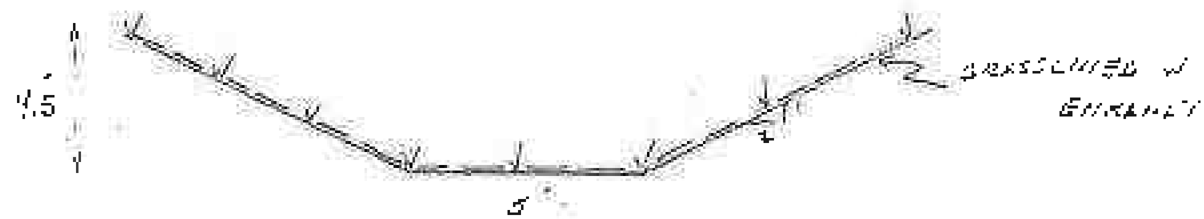
B. Reach 2 - to point N 387,000 E 1,633,135

i. Channel Depth - minimum slope 1%



$Q_p = 225.0$ cfs $\rightarrow \dfrac{(225.0)(0.040)}{(5)^{8/3}(0.01)^{1/2}}$

$= 1.23$

$d/b = 0.67$

$d = 3.35'$ use $4.5'$ for freeboard

ii. Channel Lining - Max slope - 2.2%

a. Try grasslined $n = 0.045$ $d = 2.9'$

$$V = \frac{1.49}{0.045}\left(\frac{5(2.90) + 2(2.90)^2}{5 + 2\cdot 2.90\sqrt{5}}\right)^{2/3} 0.022^{1/2}$$

$= 7.1$ fps too high for grasslined

b. Try Enkamat $n = 0.040$ $d = 2.75'$

$$V = \frac{1.49}{0.040}\left(\frac{5(2.75) + 2(2.75)^2}{5 + 2(2.75)\sqrt{5}}\right)^{2/3} 0.022^{1/2}$$

$= 7.8$ fps acceptable for Enkamat/grass

SUBJECT Revised Conemaugh
Module 13 Stage II H: H Study
BY MLA DATE 7-2-95 PROJ. NO. 92-134-11
CHKD BY DEM DATE 7-3-95 SHEET NO 29 OF 34

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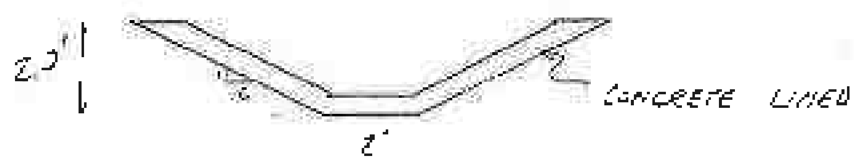
II East Main Valley
1. East Collection Channel
Channel Dimensions
a. Reach 1 - Subarea 1 and 2 - to point N392,655, E 1,653,365
i. Channel Depth - Minimum Slope - 1%



$Q_p = 50.1$ cfs $\rightarrow \dfrac{(50.1)(0.012)}{(2)^{8/3}(0.01)^{1/2}}$

$= 0.947$

$d/b = 0.59$

$d = 1.18$ ft recommend $d = 2.0'$ for freeboard

ii. Channel lining - Maximum slope = 28%

For dirty water and steep slopes, use concrete lining

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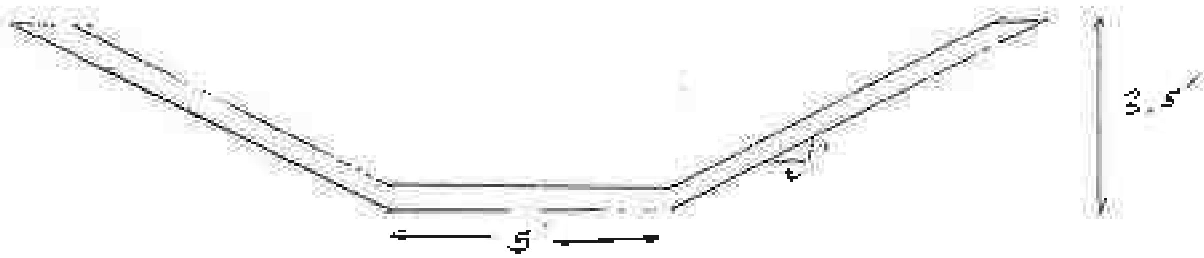
B Reach 2 – to point N 391,370, E 1,632,680

i. Channel depth – Minimum slope – 7%



Q_p = 505.7 cfs → $\frac{(505.7)(0.015)}{(5)^{8/3}(0.07)^{1/2}}$

= 0.313

d/b = 0.34

d = 1.70 recommend d = 3.5 for freeboard

ii. Channel lining – Maximum slope – 25%

For dirty water and steep slopes, use concrete lining.

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2. East Diversion Channel
Channel Dimensions
A Reach 1 - to point N 393,450, E 1,633,660
i Channel depth
Minimum slope 1%

$Q_p = 45.1 \text{ cfs} \longrightarrow \frac{45.1(0.045)}{3^{8/3}(0.01)^{1/2}}$

$= 1.08$

$d/b = 0.62$

$d = 1.86$ ft recommend $d = 2.5'$
for freeboard

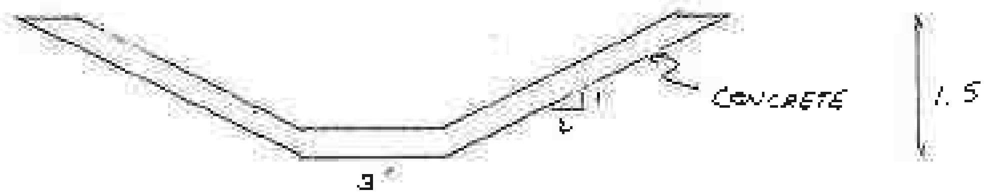
ii Channel Lining
Maximum slope - 1%

a Try grasslined $n = 0.045$ $d = 1.86$ ft

$$V = \frac{1.49}{0.045}\left(\frac{3(1.86)+2(1.86)^2}{3+2(1.86)\sqrt{5}}\right)^{2/3} 0.01^{1/2}$$

$= 3.5$ fps acceptable for grasslined channel

B Reach 2 - to point N 392,380, E 1,633,290
i Channel depth
Minimum slope - 18.5%



$Q_p = 61.9$ cfs $\rightarrow \frac{61.9(0.012)}{(3)^{8/3}(0.185)^{1/2}}$

$= 0.092$

$d/b = 0.18$

d = 0.54' use d = 1.5' for freeboard

ii Channel lining
Maximum slope - 30.0%

a. Try grouted rock n = 0.025 d = 0.69 ft

$V = \frac{1.49}{0.025}\left(\frac{3(.69) + 2(.69)^2}{3 + 2(.69)\sqrt{5}}\right)^{2/3} 0.30^{1/2}$

= 20.47 fps Recommend using concrete since velocity may be too harsh for grouted rock.

SUBJECT: PENELEC CONEMAUGH
MODULE 13 STAGE II H & H STUDY

BY: MLA DATE: 7-2-85 PROJ. NO. 82-134-11
CHKD. BY: DEM DATE: 7-3-85 SHEET NO. 33 OF 34

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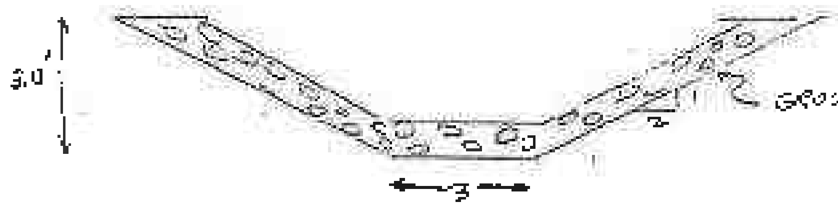
c. REACH 3 - TO POINT N 391,840, E 1,[illegible]

i. CHANNEL DEPTH
MINIMUM SLOPE - 1%



$$Q_p = 74.6 \text{ cfs} \rightarrow \frac{74.6\,(0.025)}{3^{8/3}\,(0.01)^{1/2}}$$

$$= 0.996$$

$$d/b = 0.61$$

$d = 1.83$ USE $d = 3.0$ FOR FREEBOARD

ii. CHANNEL LINING
MAXIMUM SLOPE - 14%

a. TRY GROUTED ROCK $n = 0.025$ $d = 0.93$ FT

$$V = \frac{1.49}{0.025}\left(\frac{3(0.93) + 2(0.93)^2}{3 + 2(.93)\sqrt{5}}\right)^{2/3} 0.14^{1/2}$$

$= 16.41$ FPS GROUTED ROCK IS SUITABLE FOR THIS VELOCITY

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SUBJECT Penelec Conemaugh
Module 13 Stage II H&H Study
BY MLA DATE 7-2-85 PROJ. NO. 82-134-11
CHKD. BY DEM DATE 7-3-85 SHEET NO. 34 OF 34

II Mill Site Collector
Channel Dimensions
i Channel Depth
Minimum Slope – 0.9 %

$$Q_D = 419.0 \text{ cfs} \longrightarrow \frac{419.0\,(0.012)}{(15)^{8/3}\,(0.009)^{1/2}}$$

$$= 0.057$$

$$d/b = 0.13$$

$d = 1.95$ ft → USE $d = 5.0$ FOR FREEBOARD & SUPERELEVATION

ii Channel Lining
Maximum Slope – 0.9 %

For the time length of use for this channel and the acidity of the water, concrete lining is recommended.

APPENDIX I-1-B

FORM I

EXISTING STAGE I AND STAGE II DRAINAGE FACILITIES -
CALCULATIONS FROM 1985 COAL REFUSE PERMIT APPLICATION

APPENDIX I-1-B

FORM I

EXISTING STAGE I AND STAGE II DRAINAGE FACILITIES - CALCULATIONS FROM 1985 COAL REFUSE PERMIT APPLICATION

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SUBJECT PENELEC – CONEMAUGH STATION
DESIGN OF DRAINAGE DITCHES

BY RTJ DATE 1-12-82 PROJ. NO. 82-134-1

CHKD. BY JMJ DATE 1/20/82 SHEET NO. 1 OF 26

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I.) DESIGN OF TEMPORARY ON-SITE COLLECTOR DITCHES:

A.) DETERMINE PEAK DISCHARGES:

THE DISPOSAL AREA HAS BEEN DIVIDED INTO DRAINAGE SUBAREAS FOR THE PURPOSE OF DESIGNING THE COLLECTOR DITCHES. THESE SUBAREAS AND DITCHES ARE INDICATED ON THE FINAL LAYOUT AND SURFACE DRAINAGE PLAN, FOR THE OPERATION PHASE OF THE SITE. (SEE SHEET 25).

THE PEAK DISCHARGE FOR THE DESIGN STORM, THE 100-YEAR PRECIPITATION EVENT, IS DETERMINED FOR EACH SUBAREA ACCORDING TO THE RATIONAL METHOD:

$$Q = ciA$$ (SEE NOTE 1)

WHERE
- Q = PEAK DISCHARGE, IN CFS,
- C = RUNOFF COEFFICIENT,
- i = RAINFALL INTENSITY, IN INCHES/HOUR,
- A = DRAINAGE AREA, IN ACRES.

THE RUNOFF COEFFICIENT FOR THE DISTURBED AREAS IS ASSUMED TO BE ON THE ORDER OF 0.60 (SEE SHEET 6). THE RAINFALL INTENSITY FOR EACH SUBAREA IS TAKEN FROM THE PENN DOT "RAINFALL INTENSITY – DURATION – FREQUENCY CURVES" (SEE SHEET 7), BASED ON THE TIME OF CONCENTRATION. THE TIME OF CONCENTRATION, T_c, FOR EACH DITCH IS DETERMINED ACCORDING TO

$$T_c = \left(\frac{11.9 L^3}{H}\right)^{0.385}$$ (SEE NOTE 2)

NOTE 1: REF – "HANDBOOK OF APPLIED HYDROLOGY", V. T. CHOW, McGRAW HILL BOOK CO., 1964.

WHERE T_c = TIME OF CONCENTRATION, IN HOURS,
L = LENGTH OF LONGEST FLOW PATH, IN MILES,
H = ELEVATION DIFFERENCE, IN FT.

THE TIME OF CONCENTRATION IS DEFINED AS THE TRAVEL TIME OF WATER FROM THE HYDRAULICALLY MOST DISTANT POINT OF THE WATERSHED TO THE POINT OF INTEREST.

THE DRAINAGE AREAS ARE PLANIMETERED ON THE FINAL LAYOUT AND SURFACE DRAINAGE PLAN.

DITCH 1 — SUBAREA 1:

D.A. ≅ 14.7 ACRES

FLOW PATH: L = 1530 + 280 = 1810 FT
(OVER PILE) (IN DITCH)

ELEVATION CHANGE ≅ (1490 − 1450) + (1450 − 1448)
≅ 42 FT

$$T_c = \left[\frac{(11.9)\left(\frac{1810}{5280}\right)^3}{42} \right]^{0.385} \cong 0.179 \text{ HRS} \cong \underline{10.7} \text{ MIN.}$$

FROM RAINFALL INTENSITY CURVES, ASSUMING THE PITTSBURGH, PA CURVES ARE MOST APPLICABLE,

FOR T_c = 11 MIN, $i_{100\text{-}YR}$ = 6.1 IN/HR

NOTE 2: REF.- DESIGN OF SMALL DAMS, U.S. BUREAU OF RECLAMATION, U.S. GOVT. PRINTING OFFICE, 1977.

$$\therefore \quad Q_{100} = CLA = (0.60)(6.1)(14.7)$$
$$= 53.8 \approx \underline{54} \text{ CFS}$$

DITCH 2 – SUBAREAS 1, 2:

$$D.A. = DA_1 + DA_2$$
$$= 14.7 + 19.0 = \underline{33.7} \text{ ACRES}$$

DISCHARGE IN DITCH 2 CONSISTS OF RUNOFF FROM SUBAREA 2 AS WELL AS FROM DITCH 1 (SUBAREA 1). THUS, TO ACCOUNT FOR THE ROUTING OF THE FLOW FROM SUBAREA 1, BOTH SUBAREAS 1 AND 2 WILL BE CONSIDERED AS ONE DRAINAGE AREA.

FLOW PATH: $L = 1810 + 1600 = \underline{3410}$ FT

ELEVATION DIFFERENCE $= (1490 - 1448) + (1448 - 1200)$
$= 42 + 248 = \underline{290}$ FT

$$T_c = \left[\frac{(11.9)\left(\frac{3410}{5280}\right)^3}{290} \right]^{0.385} = 0.177 \text{ HRS} = \underline{10.6} \text{ MIN.}$$

(NOTE: ALTHOUGH T_c FOR THE COMBINED AREA (AREAS 1+2; 10.6 MIN.) IS LESS THAN THAT OF SUBAREA 1 ALONE (10.7 MIN.), THIS VALUE IS CONSERVATIVE AND WILL BE USED IN THE DESIGN.)

FOR $T_c = 11$ MIN $\quad \therefore \; i_{100} = 6.1$

$$\therefore \; Q = CLA = (0.60)(6.1)(33.7) = \underline{123} \text{ CFS}$$

(NOTE: THE LOWEST BENCH DOES NOT ACTUALLY CONTRIBUTE FLOW TO THIS DITCH; HOWEVER, ITS AREA IS MINIMAL, AND THUS HAS LITTLE EFFECT ON THE TOTAL AREA AND DISCHARGE.)

SUBJECT Penelec - Conemaugh Station
Design of Drainage Ditches
BY DJS DATE 1-13-82 PROJ. NO. 82-134-1
CHKD. BY JMJ DATE 1/20/82 SHEET NO. 4 OF 26

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Ditch 3 – Subarea 3:

D.A. = 31.3 ACRES

FLOW PATH: L = 860 (SHEET FLOW) + 3170 (IN CHANNEL) = 4030 FT

ELEVATION DIFFERENCE = 1505 – 1457 = 48 FT

$$T_c = \left[\frac{(11.9)\left(\frac{4030}{5280}\right)^3}{48} \right]^{0.385} = 0.428 \text{ HRS} = 25.6 \text{ MIN}$$

FOR T_c = 26 MIN, i_{100} = 3.6 IN/HR

$Q = ciA = (0.60)(3.6)(31.3) = 67.6$ CFS $\approx$ 68 CFS

Ditch 4 – Subareas 3, 4:

D.A. = 42.6 (DA_4) + 31.3 (DA_3) = 73.9 ACRES

FLOW PATH = 4030 + 3000 = 7030 FT

ELEVATION CHANGE = 1505 – 1428 = 77 FT

$$T_c = \left[\frac{(11.9)\left(\frac{7030}{5280}\right)^3}{77} \right]^{0.385} = 0.678 \text{ HRS} = 40.7 \text{ MIN.}$$

FOR T_c = 41 MIN, i_{100} = 2.7 IN/HR

$Q = ciA = (0.60)(2.7)(73.9) = 120$ CFS

SUBJECT	PENELEC – CONEMAUGH STATION		
	DESIGN OF DRAINAGE DITCHES		
BY DJS	DATE 1-17-82	PROJ. NO 82-134-1	
CHKD. BY JMJ	DATE 1/20/82	SHEET NO. 5 OF 26	

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DITCH 5 – SUBAREAS 5, D:

$$D.A. \cong \underset{(D.A._5)}{14.7} + \underset{(D.A._D)}{4.7} = \underline{19.4} \text{ ACRES}$$

FLOW PATH: $L \cong \underline{3300}$ FT

ELEVATION DIFFERENCE $\cong$ 1460 – 1324 $\cong$ $\underline{136}$ FT

$$T_c \approx \left[\frac{(11.9)\left(\frac{3300}{5280}\right)^3}{136} \right]^{0.385} = 0.227 \text{ HRS} = \underline{13.6} \text{ MIN}$$

FOR $T_c = \underline{14}$ MIN, $i_{100} = \underline{5.4}$ IN./HR

$$Q = CiA = (0.60)(5.4)(19.4) = 62.9 \approx \underline{63} \text{ CFS}$$

(ASSUME C = 0.60 FOR ENTIRE AREA – CONSERVATIVE)

DITCH 6 – SUBAREA 6:

D.A. = $\underline{2.6}$ ACRES

FLOW PATH: $L \cong \underline{830}$ FT

ELEVATION DIFFERENCE $\cong$ 1350 – 1253 = $\underline{97}$ FT

$$T_c = \left[\frac{(11.9)\left(\frac{830}{5280}\right)^3}{97} \right]^{0.385} \cong 0.053 \text{ HRS} = \underline{3.2} \text{ MIN.}$$

ASSUMING A MINIMUM $T_c = 5$ MIN, $i_{100} = 9.0$ IN/HR

$$Q \cong CiA = (0.60)(9.0)(2.6) \cong \underline{14} \text{ CFS}$$

TABLE 2.12.12.1

RUNOFF FACTORS FOR THE RATIONAL EQUATION

Type of Drainage Area or Surface	Runoff Factor "C" Minimum	Runoff Factor "C" Maximum
Pavements, concrete or bituminous concrete	0.75	0.95
Pavements, bituminous macadam or surface-treated gravel	0.65	0.80
Pavements, gravel, macadam, etc.	0.25	0.60
Sandy soil, cultivated or light growth	0.15	0.30
Sandy soil, woods, or heavy brush	0.15	0.30
Gravel, bare or light growth	0.20	0.40
Gravel, woods or heavy brush	0.15	0.35
Clay soil, bare or light growth	0.35	0.75
Clay soil, woods or heavy growth	0.25	0.60
City business sections	0.60	0.80
Dense residential sections	0.50	0.70
Suburban, normal residential areas	0.35	0.60
Rural areas, parks, golf courses	0.15	0.30

NOTE: Higher values are applicable to denser soils and steep slopes.

Consideration should be given to future land use changes in the drainage area in selecting the "C" factor.

For drainage area containing several different types of ground cover, a weighted value of "C" must be used.

In special situations where sinkholes, stripped abandoned mines, etc. exist, careful evaluation shall be given to the selection of a suitable runoff factor with consideration given to possible reclamation of the land in the future.

SOURCE: PennDOT Manual Part 2, Vol. I

RAINFALL INTENSITY – DURATION – FREQUENCY CURVES

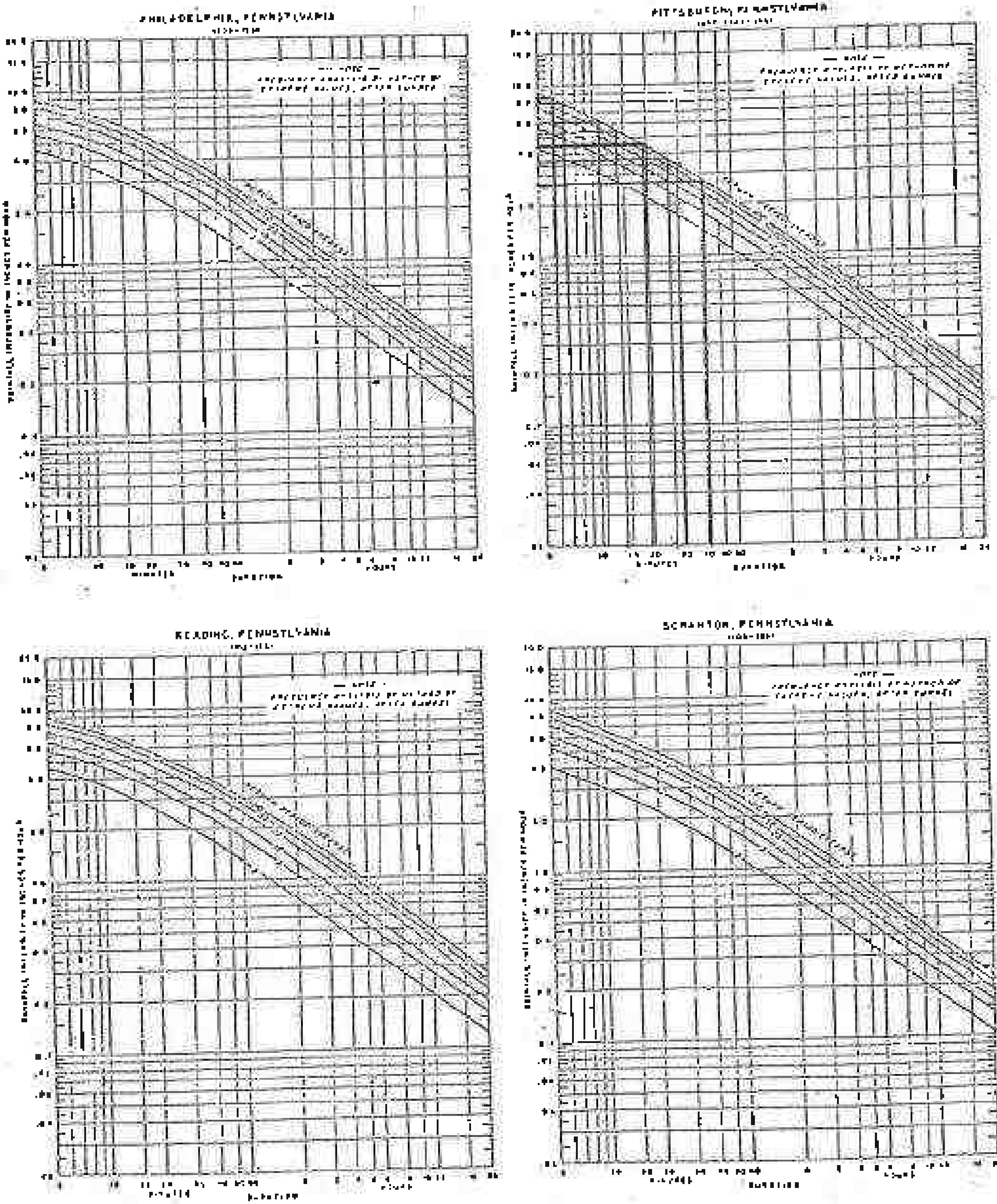

FIGURE 1

SOURCE: PENN DOT MANUAL, PART 2, VOL. I.

B.) DESIGN OF DITCHES.

THE COLLECTOR DITCHES ALONG THE TOP OF THE PILE (1,3,4) ARE DESIGNED TO BE WIDE AND SHALLOW, SUCH THAT THEY MAY BE EASILY EXCAVATED BY USING A SCRAPER. THESE CHANNELS ARE TO BE TEMPORARY, TO BE FILLED AND VEGETATED UPON COMPLETION OF THE OPERATION.

THE COLLECTOR DITCHES RUNNING ALONGSIDE THE FRONT FACE OF THE PILE (DITCHES 2 AND 5) WILL BE "PERMANENT", AND WILL BE EXCAVATED INTO ROCK FOR STABILITY DUE TO THE STEEPNESS. THE DEPTHS OF THESE DITCHES MAY BE GREATER THAN WHAT IS DESIGNED IN ORDER TO ATTAIN THE ROCK BASE.

ASSUME UNIFORM FLOW USING MANNING'S EQUATION:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$ (SEE NOTE 3)

WHERE
Q = DISCHARGE, IN CFS,
n = MANNING'S ROUGHNESS COEFFICIENT,
A = FLOW AREA, IN FT^2,
S = SLOPE, IN FT/FT,
R = HYDRAULIC RADIUS = A/P_w, IN FT,
P_w = WETTED PERIMETER.

NOTE 3: REF. – "DESIGN CHARTS FOR OPEN CHANNEL FLOW," U.S. DEPT. OF TRANSPORTATION, HYDRAULIC DESIGN SERIES NO. 3, 1973.

DITCH 1 : $Q_{100} \doteq 54$ CFS

$$S_{MIN} = \frac{1930-1918}{230} = 0.007$$

$$S_{MAX} = \frac{1975.6-1950}{400} = 0.064$$

A TRAPEZOIDAL SHAPED CHANNEL WITH 2H:1V SIDE-SLOPES AND 10-FT BOTTOM WIDTH WILL BE USED. IT WILL BE ASSUMED THAT n IS ON THE ORDER OF 0.030, EXCAVATED CHANNEL WITH SHORT GRASS (SEE NOTE 3).

FIND THE REQUIRED DEPTH OF CHANNEL:

TRY $d = 1.2$ FT, WITH $S = 0.007$

$$A = 10d + 2d^2 = 14.88 \text{ FT}^2$$
$$P_W = 10 + 4.47d = 15.36 \text{ FT}$$
$$\therefore R = 14.88/15.36 = 0.97 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.03}\right)(14.88)(0.97)^{2/3}\sqrt{0.007} = \underline{61} \text{ CFS} \quad \text{OK}$$
$$V = 61/14.88 = 4.1 \text{ FT/SEC}$$

TRY $d = 0.6$ FT WITH $S = 0.064$

$$A = 10d + 2d^2 = 6.72 \text{ FT}^2$$
$$P_W = 10 + 4.47d = 12.68 \text{ FT}$$
$$\therefore R = 6.72/12.68 = 0.53 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.03}\right)(6.72)(0.53)^{2/3}\sqrt{0.064} = \underline{55} \text{ CFS} \quad \text{OK}$$
$$V = 55/6.72 = 8.2 \text{ FT/SEC}$$

THUS, A GRASS-LINED TRAPEZOIDAL CHANNEL WITH 2H:1V SIDE-SLOPES AND 10-FT BOTTOM WIDTH WILL BE USED, WITH A DEPTH OF 2.0 FT, ALLOWING FOR FREEBOARD. IN THE STEEPER SECTION, IT MIGHT BE ADVISABLE TO USE RIP-RAP LINING FOR

CHANNEL PROTECTION. HOWEVER, DUE TO THE TEMPORARY NATURE OF THE CHANNEL, IT IS NOT ABSOLUTELY NECESSARY, PROVIDED THAT ADEQUATE MAINTENANCE IS PERFORMED REGULARLY AND AS NEEDED.

DITCH 2: $Q_{100} = \underline{123}$ CFS

$S_{min} = \frac{1250-1240}{150} = 0.067$ FT/FT

ASSUME $S_{MAX} = \frac{15}{38} = 0.39$ FT/FT (SLOPE OF STEEPEST FACE)

A TRAPEZOIDAL-SHAPED CHANNEL WITH 2H:1V SIDE-SLOPES AND 3-FT BOTTOM WIDTH WILL BE USED. THE CHANNEL WILL BE EXCAVATED INTO ROCK. ASSUME THAT n IS ON THE ORDER OF 0.035 (SEE NOTE 3, SHEET 8).

TRY d = 1.7 WITH S = 0.067 FT/FT

$A = 3d + 2d^2 = 10.88$ FT²
$P_w = 3 + 4.47d = 10.60$ FT
$R = 10.88/10.60 = 1.03$ FT

$Q = \left(\frac{1.49}{0.035}\right)(10.88)(1.03)^{2/3}\sqrt{0.067} = \underline{122}$ CFS OK
$V = 122/10.88 = 11.2$ FPS

TRY d = 1.1 FT WITH S = 0.39

$A = 3d + 2d^2 = 5.72$ FT²
$P_w = 3 + 4.47d = 7.92$ FT
$R = 5.72/7.92 = 0.72$ FT.

$Q = \left(\frac{1.49}{0.035}\right)(5.72)(0.72)^{2/3}\sqrt{0.39} = \underline{122}$ CFS OK
$V = 122/5.72 = 21.3$ FPS

THE VELOCITIES IN THE DITCH RANGE UP TO 22.1 FT/SEC. THE DITCH WILL BE EXCAVATED INTO ROCK, IN ORDER TO PROVIDE FOR STABILITY. THE MINIMUM DEPTH OF THE DITCH WILL BE 2.5-FEET.

SUBJECT: PENELEC ~ CONEMAUGH STATION

DESIGN OF DRAINAGE DITCHES

BY: DJS DATE: 1-19-82 PROJ. NO. 82-174-1

CHKD. BY: JMJ DATE: 1/25/82 SHEET NO. 12 OF 26

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DITCH 3: $Q_{100} = \underline{68}$ CFS

$$S_{MIN} = \frac{1460.1 - 1458.2}{660} = 0.003$$

$$S_{MAX} = \frac{1474.4 - 1471.2}{280} = 0.011$$

A TRAPEZOIDAL-SHAPED GRASS-LINED CHANNEL WILL BE USED, WITH 2H:1V - SIDE-SLOPES AND A 10-FT BOTTOM WIDTH. ASSUME n = 0.030.

FIND THE REQUIRED DEPTH OF CHANNEL:

TRY d = 1.6 FT, WITH S = 0.003

$$A = 10d + 2d^2 = 21.12 \text{ FT}^2$$
$$P_w = 10 + 4.47d = 17.15 \text{ FT}$$
$$R = 21.12/17.15 = 1.23 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.03}\right)(21.12)(1.23)^{2/3}\sqrt{0.003} = \underline{66} \text{ CFS, } \underline{OK}.$$
$$V = 66/21.12 = \underline{3.1} \text{ FPS, OK.}$$

TRY d = 1.1 FT, WITH S = 0.011

$$A = 10d + 2d^2 = 13.42 \text{ FT}^2$$
$$P_w = 10 + 4.47d = 14.92 \text{ FT}$$
$$R = 13.42/14.92 = 0.90 \text{ FT}$$

$$Q = \frac{1.49}{0.03}(13.42)(0.90)^{2/3}\sqrt{0.011} = \underline{65} \text{ CFS, OK.}$$
$$V = 65/13.42 = \underline{4.8} \text{ FPS, OK.}$$

THEREFORE, USE A 2.0-FT. DEEP GRASS-LINED CHANNEL.

DITCH 4: $Q_{100} = \underline{120}$ CFS

$$S_{MIN} = \frac{1457-1453}{1440} = 0.0028 \text{ FT/FT}$$

(A CONSTANT SLOPE OF 0.0028 FT/FT WILL BE USED ALONG THE UPSTREAM PORTION OF THE DITCH WHICH RUNS ADJACENT THE WEST PERIPHERAL DRAINAGE DITCH.)

$$S_{MIN} = \frac{1453-1428}{1560} = 0.016 \text{ FT/FT}$$

(A CONSTANT SLOPE OF 0.016 FT/FT WILL BE USED ALONG THE DOWNSTREAM PORTION OF THE DITCH)

A GRASS-LINED TRAPEZOIDAL-SHAPED CHANNEL WILL BE USED, WITH 2H:1V SIDE-SLOPES AND 10-FT BOTTOM WIDTH. ASSUME $n = 0.030$.

FIND THE REQUIRED DEPTH OF CHANNEL:

TRY $d = 2.2$ FT, WITH $S = 0.0028$

$$A = 10d + 2d^2 = 31.68 \text{ FT}^2$$
$$P_w = 10 + 4.47d = 19.83 \text{ FT}$$
$$R = 31.68/19.83 = 1.60 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.03}\right)(31.68)(1.60)^{2/3}\sqrt{0.0028} = \underline{114} \text{ CFS}$$ (OK, SINCE LIMITING SLOPE IN UPSTREAM PORTION)

$$V = 114/31.68 = \underline{3.6} \text{ FPS} \quad OK$$

TRY $d = 1.4$, WITH $S = 0.016$

$$A = 10d + 2d^2 = 17.92 \text{ FT}^2$$
$$P_w = 10 + 4.47d = 16.26 \text{ FT}$$
$$R = 17.92/16.26 = 1.10 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.03}\right)(17.92)(1.10)^{2/3}\sqrt{0.016} = \underline{120} \text{ CFS}$$
$$V = 120/17.92 = \underline{6.7} \text{ FPS}$$

ALTHOUGH THE VELOCITY IN THE STEEPER PORTION OF THE CHANNEL IS SLIGHTLY EXCESSIVE, IT IS CONSIDERED ACCEPTABLE DUE TO THE TEMPORARY NATURE OF THE CHANNEL, PROVIDED THAT ADEQUATE MAINTENANCE IS PERFORMED AS NECESSARY.

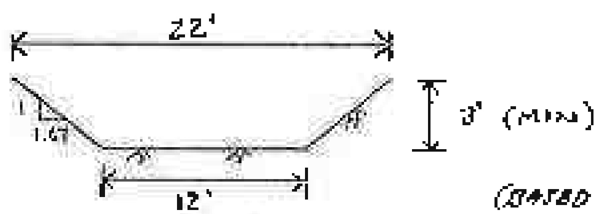
THUS, A 2.5-FT DEEP GRASS-LINED TRAPEZOIDAL-SHAPED CHANNEL WILL BE USED.

THE CHANNEL WILL BE EXTENDED TO CONNECT WITH THE EXISTING UPPER COLLECTOR DITCH, AS SHOWN ON THE FINAL LAYOUT AND SURFACE DRAINAGE PLAN (SEE SHEET 25). THE SLOPE OF THIS EXTENSION = (1428 - 1426)/330 = 0.006. THUS, THE DIMENSIONS OF DITCH 4 WILL BE ADEQUATE FOR THIS EXTENSION.

DETERMINE IF EXISTING UPPER COLLECTOR DITCH IS ADEQUATELY SIZED TO CARRY DISCHARGE:

$$S_{MIN} = \frac{1426-1420}{600} = 0.01 \text{ FT/FT}$$; ASSUME $n = 0.040$ (SEE NOTE 3, SHEET 8). (GRASS-LINED)

EXISTING CHANNEL:



(BASED ON FIELD MEASUREMENT.

DETERMINE CAPACITY @ d = 2.5 FT (ALLOWING 0.5 FT FREEBOARD):

$$A = 12d + 1.67d^2 = 40.44 \text{ FT}^2$$
$$P_w = 12 + 3.89d = 21.73 \text{ FT}$$
$$\therefore R = 40.44/21.73 = 1.86 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.040}\right)(40.44)(1.86)^{2/3}\sqrt{0.01} = \underline{227} \text{ CFS} > \underline{120} \text{ CFS} \quad \underline{OK}$$
$$V = 227/40.44 = \underline{5.6} \text{ FPS OK.}$$

THEREFORE, EXISTING CHANNEL IS ADEQUATE TO CONVEY 100-YR. DISCHARGE.

SUBJECT PENELEC - CONEMAUGH STATION
DESIGN OF DRAINAGE DITCHES

BY DSS DATE 1-16-82 PROJ. NO. 82-134-1

CHKD. BY JMJ DATE 1/26/82 SHEET NO. 15 OF 26

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DITCH 5: $Q_{100} = \underline{63}$ CFS

$$S_{MIN} = \frac{1427 - 1420}{220} = 0.032 \text{ FT/FT}$$

$$S_{MAX} = \frac{1380 - 1370}{50} = 0.20 \text{ FT/FT}$$

A TRAPEZOIDAL - SHAPED CHANNEL WITH 2H : 1V SIDE-SLOPES AND 3-FT BOTTOM WIDTH WILL BE USED. THE CHANNEL WILL BE EXCAVATED INTO ROCK. ASSUME $\underline{n}$ IS ON THE ORDER OF $\underline{0.035}$ (SEE NOTE 3, SHEET 8).

TRY d = 1.5 FT WITH S = 0.032

$$A = 3d + 2d^2 = 9.00 \text{ FT}^2$$
$$P_w = 3 + 4.47d = 9.70 \text{ FT}$$
$$R = 9.00 / 9.70 = 0.93 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.035}\right)(9.00)(0.93)^{2/3}\sqrt{0.032} = \underline{65} \text{ CFS} \quad OK$$
$$V = 65 / 9.0 = \underline{7.2} \text{ FPS}$$

TRY d = 1.0 FT WITH S = 0.20

$$A = 3d + 2d^2 = 5.00 \text{ FT}^2$$
$$P_w = 3 + 4.47d = 7.47 \text{ FT}$$
$$R = 5.00 / 7.47 = 0.67 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.035}\right)(5.00)(0.67)^{2/3}\sqrt{0.20} = \underline{73} \text{ CFS}$$
$$V = 73 / 5.0 = 14.6 \text{ FPS}$$

THUS, A 2.0-FT DEEP DITCH WILL BE USED. THE CHANNEL WILL BE EXCAVATED INTO ROCK, TO PROVIDE A STABLE BOTTOM AND SIDEWALLS.

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DITCH 6: $Q_{100} \approx \underline{14}$ CFS

$$S_{AVG} \approx \frac{1350-1253}{830} \approx 0.117 \text{ FT/FT}$$

A TRIANGULAR SHAPED CHANNEL WITH 2H:1V SIDE-SLOPES WILL BE USED. ASSUME $n = 0.030$, GRASS-LINED.

FIND THE REQUIRED DEPTH OF CHANNEL:

TRY $d \approx 0.9$ FT:

$$A = 2d^2 \approx 1.62 \text{ FT}^2$$
$$P_w \approx 4.47d \approx 4.02 \text{ FT}$$
$$R = 1.62/4.02 = 0.40 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.03}\right)(1.62)(0.40)^{2/3}\sqrt{0.117} \approx 15 \text{ CFS}$$
$$V = 15/1.62 \approx \underline{9.2} \text{ FPS}$$

THUS, A TRIANGULAR-SHAPED CHANNEL WILL BE USED, WITH DEPTH ≈ 1.5 FT. ALTHOUGH THE VELOCITY IS SLIGHTLY EXCESSIVE, A GRASS-LINING WILL PROBABLY BE SUFFICIENT, SINCE THE DESIGN PEAK DISCHARGE IS ONLY 14 CFS, AND PROVIDED THAT ADEQUATE MAINTENANCE IS PERFORMED AS NEEDED. THE FLOW IS CARRIED UNDER THE HAUL ROAD BY A CULVERT AND INTO THE MAIN CHANNEL, AS SHOWN ON THE SURFACE DRAINAGE PLAN.

II) CHECK ADEQUACY OF EXISTING OFF-SITE DIVERSION DITCHES

THE DRAINAGE AREA UPGRADIENT OF THE SITE HAS BEEN DIVIDED INTO SUBAREAS, IN ORDER TO DETERMINE IF THE "PERIPHERAL DRAINAGE DITCHES," AS LABELED ON THE FINAL LAYOUT AND SURFACE DRAINAGE PLAN, ARE HYDRAULICALLY ADEQUATE TO CONVEY THE RUNOFF FROM THE 100-YEAR PRECIPITATION EVENT AWAY FROM THE DISTURBED AREA. THE SUBAREAS ARE DESIGNATED ON THE USGS 7.5-MINUTE QUAD, SHOWN ON SHEET 24, AND ON SHEET 25. ONLY PORTIONS OF DIVERSION DITCHES WHICH RUN ADJACENT TO THE DISPOSAL AREA ARE ANALYZED HERE.

DITCH A – SUBAREA A: (UPSTREAM PORTION OF WEST PERIPHERAL DRAINAGE DITCH)

D.A. = 35 ACRES (SHEET 24)

FLOW PATH: $L \approx 3300$ FT

ELEVATION CHANGE = 1510 – 1455 = 55 FT

$$T_c = \left[\frac{(11.9)\left(\frac{3300}{5280}\right)^3}{55} \right]^{0.385} = 0.322 \text{ HR} = 19.3 \text{ MIN.}$$

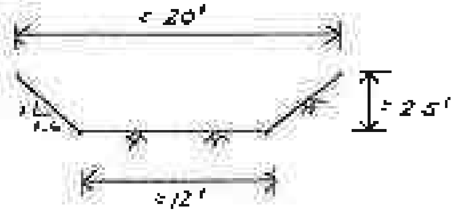
FOR T_c = 19 MIN, $i_{100} \approx 4.5$ IN/HR

ASSUME c IS ON THE ORDER OF 0.40 (WOODS, BRUSH, STEEP SLOPE; SEE SHEET 6.)

$$Q = ciA = (0.40)(4.5)(35) = 63 \text{ CFS}$$

DETERMINE WHETHER THE EXISTING CHANNEL IS CAPABLE OF CONVEYING THE 100-YEAR DISCHARGE:

EXISTING DIVERSION DITCH:



ASSUME S_{MIN} ≈ 0.033 FT/FT, SIMILAR TO PARALLEL COLLECTOR DITCH 3 (SEE SHEET 12). ASSUME n ≈ 0.040 (GRASS-LINED CHANNEL; SEE NOTE 3, SHEET 8).

DETERMINE CAPACITY @ d = 2.0 FT (ALLOWING 0.5 FT FREEBOARD):

$A = 12d + 1.6d^2 = 30.4$ FT²
$P_w = 12 + 3.77d = 19.54$ FT
∴ $R = 30.4/19.54 = 1.56$ FT

$Q = \left(\frac{1.49}{0.040}\right)(30.4)(1.56)^{2/3}\sqrt{0.033} = \underline{83}$ CFS > $\underline{63}$ CFS
$V = 83/30.4 = 2.7$ FT/SEC

THEREFORE, EXISTING CHANNEL IS ADEQUATE TO CONVEY 100-YR DISCHARGE.

DITCH B - SUBAREAS A, B: (PORTION OF WEST PERIPHERAL DRAINAGE DITCH)

D.A. = 35 (A) + 55.5 (B) = 90.5 ACRES (SHEET 24)

FLOW PATH: L = 3300 + 1740 = 5040 FT

ELEVATION CHANGE = 1510 – 1450 = 60 FT

$T_c = \left[\frac{(11.9)\left(\frac{5040}{5280}\right)^3}{60}\right]^{0.385} = 0.508$ HRS = $\underline{30.5}$ MIN

FOR T_c = 30 MIN., i_{100} = 3.4 IN/HR

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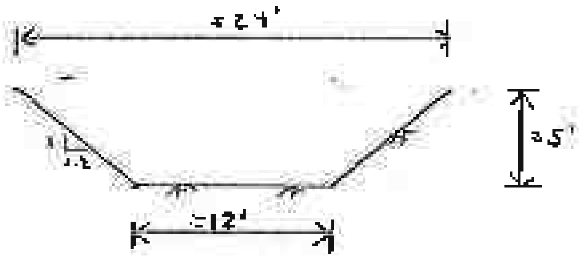
ASSUMING $C = 0.40$ (WOODS, BRUSH; SEE SHEET 6),

$$Q = CiA = (0.40)(3.4)(90.5) = \underline{123} \text{ CFS}$$

<u>EXISTING CHANNEL</u>:



ASSUME $S_{MIN} = 0.0028$, SIMILAR TO PARALLEL COLLECTOR DITCH 4 (SEE SHEET 13). ASSUME $n = 0.040$.

DETERMINE CAPACITY @ $d = 4.5$ FT

$$A = 12d + 1.2d^2 = 78.3 \text{ FT}^2$$
$$P_W = 12 + 3.12d = 26.04 \text{ FT}$$
$$\therefore R = 78.3 / 26.04 = 3.01 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.040}\right)(78.3)(3.01)^{2/3}\sqrt{0.0028} = \underline{321} \text{ CFS} > \underline{123} \text{ CFS} \quad \text{OK}$$

THEREFORE, EXISTING CHANNEL IS ADEQUATE TO CONVEY 100-YEAR DISCHARGE.

<u>DITCH C – SUBAREA C</u>

DITCH C CONSISTS OF THE UPPER PORTION OF THE "EAST PERIPHERAL DRAINAGE DITCH", AS LABELED ON THE FINAL LAYOUT AND SURFACE DRAINAGE PLAN.

D.A. = 8.7 ACRES (INCLUDES ONLY AREA UPGRADIENT OF DISPOSAL AREA, SEE SHEET 24.)

Flow Path : L = 1400 FT

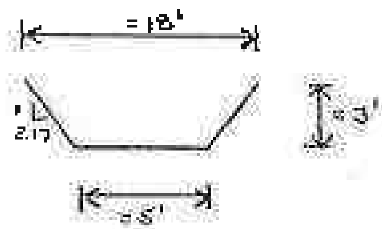
Elevation Change = 1510 – 1445 = 65 FT

$$T_c = \left[\frac{(11.9)\left(\frac{1400}{5280}\right)^3}{65}\right]^{0.385} = 0.112 \text{ HRS} = 6.7 \text{ MIN}$$

For T_c = 7 minutes, i_{100} = 8.0 IN/HR

$$Q = CiA = (0.40)(8.0)(8.7) = 28 \text{ CFS}$$

Existing Channel :



$$S_{min} = \frac{1446-1444}{850} = 0.0024$$, assuming constant slope along the lower portion of the ditch.

Determine capacity @ d = 2.5 FT :

$$A = 5d + 2.17d^2 = 26.06 \text{ FT}^2$$
$$P_w = 5 + 4.78d = 16.95 \text{ FT}$$
$$R = 26.06 / 16.95 = 1.54 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.040}\right)(26.06)(1.54)^{2/3}\sqrt{0.0024} = 63 \text{ CFS} > 28 \text{ CFS OK}$$

Therefore, the existing channel is adequate to convey the 100-year discharge.

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EXISTING LOWER COLLECTOR DITCH – SUBAREAS 5, D, E : (SHEET 25)

$$D.A. \doteq \underset{(DA_5)}{14.7} + \underset{(DA_D)}{4.7} + \underset{(DA_E)}{12.0} = \underline{31.4} \text{ ACRES}$$

FLOW PATH : $L \doteq 3300 + 1350 \doteq \underline{4650}$ FT

ELEVATION DIFFERENCE $\doteq 1460 - \underset{(ASSUMED)}{1310} \doteq \underline{150}$ FT

$$T_c \doteq \left[\frac{(11.9)\left(\frac{4650}{5280}\right)^3}{150} \right]^{0.385} = 0.326 \text{ HRS} = \underline{19.5} \text{ MIN}$$

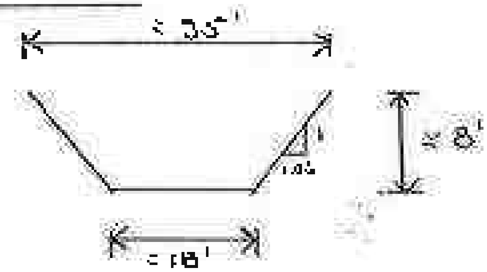
FOR $T_c \doteq 20$ MIN. , $i_{100} \doteq 4.4$ IN/HR ;

$$Q = ciA = (0.60)(4.4)(31.4) = \underline{83} \text{ CFS}$$

(ASSUMES C = 0.60 FOR ENTIRE AREA – CONSERVATIVE)

DETERMINE WHETHER THE EXISTING CHANNEL IS CAPABLE OF CONVEYING THE 100-YEAR DISCHARGE.

EXISTING DIVERSION DITCH :



$$S = \frac{1316 - 1311}{1350} = 0.0037$$

(ASSUMED CHANNEL INVERTS)

ASSUME $n \approx 0.040$ (GRASS-LINED CHANNEL).

DETERMINE CAPACITY @ $d \approx 7.5$ FT :

$$A = 18d + 1.46d^2 = 194.6 \text{ FT}^2$$

$$P_w = 18 + 2.91d = 39.8 \text{ FT}$$

$$R = 194.6 / 39.8 = 4.89 \text{ FT}$$

SUBJECT	PENELEC – CONEMAUGH STATION
	DESIGN OF DRAINAGE DITCHES
BY	DJS
DATE	1-21-82
PROJ. NO.	82-134-1
CHKD. BY	JMJ
DATE	1/22/82
SHEET NO.	22 OF 26

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$$Q = \left(\frac{1.49}{0.040}\right)(194.6)(4.89)^{2/3}\sqrt{0.0037} = \underline{1270} \text{ cfs} \quad \text{OK}$$

THEREFORE, THE CHANNEL IS ADEQUATE TO CONVEY THE 100-YEAR DISCHARGE.

EXISTING UPPER DIVERSION DITCHES – SUBAREAS F, G: (SHEET 25)

SUBAREA F: D.A. = 2.7 ACRES (SHEET 25)

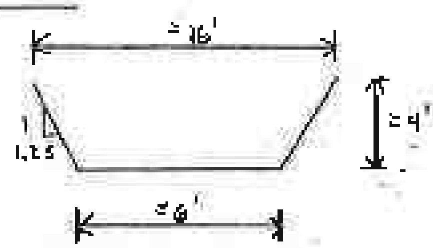
FLOW PATH = 1060 FT
ELEVATION DIFFERENCE = 1477 – 1425 = 52 FT

$$T_c = \left[\frac{(11.9)\left(\frac{1060}{5280}\right)^3}{52}\right]^{0.385} = 0.089 \text{ HRS} = \underline{5.3} \text{ MIN.}$$

FOR T_c = 5 MIN., i_{100} = 9.0 IN./HR

$\therefore Q = CiA = (0.40)(9.0)(2.7) = 10$ CFS

EXISTING CHANNEL:



$S = \frac{1436 - 1425}{750} = 0.015$ FT/FT ; ASSUME $n = 0.040$ (GRASS-LINED CHANNEL)
(ASSUMED CHANNEL INVERTS)

DETERMINE CAPACITY @ $d = 3.5$ FT :

SUBJECT: Penelec – Conemaugh Station
Design of Drainage Ditches

BY: DJS DATE: 1-22-82 PROJ NO. 82-134-1

CHKD. BY: JMJ DATE: 1/22/82 SHEET NO. 23 OF 26

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$$A = 6d + 1.25d^2 = 36.3 \text{ FT}^2$$
$$P_w = 6 + 3.20d = 17.2 \text{ FT}$$
$$R = 36.3/17.2 = 2.11 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.040}\right)(36.3)(2.11)^{2/3}\sqrt{0.015} = \underline{272} \text{ CFS OK}$$

THEREFORE, EXISTING CHANNEL IS ADEQUATE TO CONVEY 100-YEAR DISCHARGE.

<u>SUBAREA G:</u> D.A. = 2.8 ACRES (SHEET 25)

FLOW PATH = 1180 FT

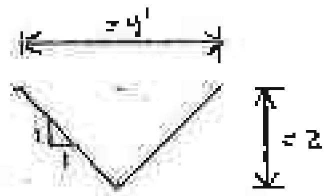
ELEVATION DIFFERENCE = 1477 − 1333 = 144 FT

$$T_c = \left[\frac{11.9\left(\frac{1180}{5280}\right)^3}{144}\right]^{0.385} = 0.068 \text{ HRS} = 4.07 \text{ MIN}$$

FOR $T_{c\text{-}MIN} = 5$ MIN, $i_{100} = 9.0$ IN/HR

$$Q = CiA = (0.40)(9.0)(2.8) = \underline{10} \text{ CFS}$$

<u>EXISTING CHANNEL:</u>



$$S_{AVG} = \frac{1436 - 1333}{870} = 0.118 \text{ FT/FT}$$

ASSUME $n = 0.040$ (GRASS AND GABION LINED CHANNEL)

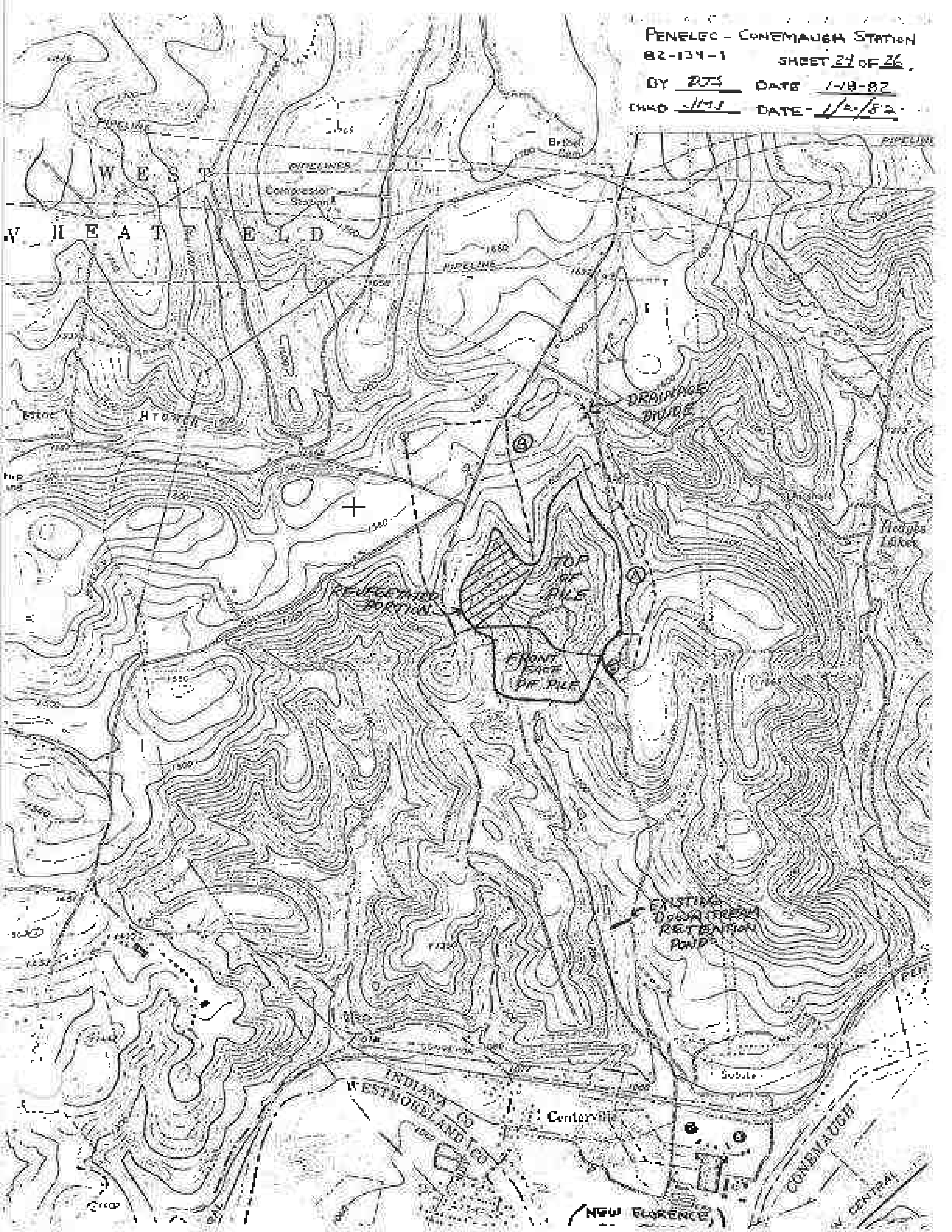
DETERMINE CAPACITY @ $d = 1.5$ FT:

$$A = d^2 = 2.25 \text{ FT}^2; \quad P_w = 2.83d = 4.25 \text{ FT}$$
$$R = 2.25/4.25 = 0.53 \text{ FT}$$

$$Q = \left(\frac{1.49}{0.04}\right)(2.25)(0.53)^{2/3}\sqrt{0.118} = \underline{18.8} \text{ CFS} > \underline{10} \text{ CFS OK.}$$

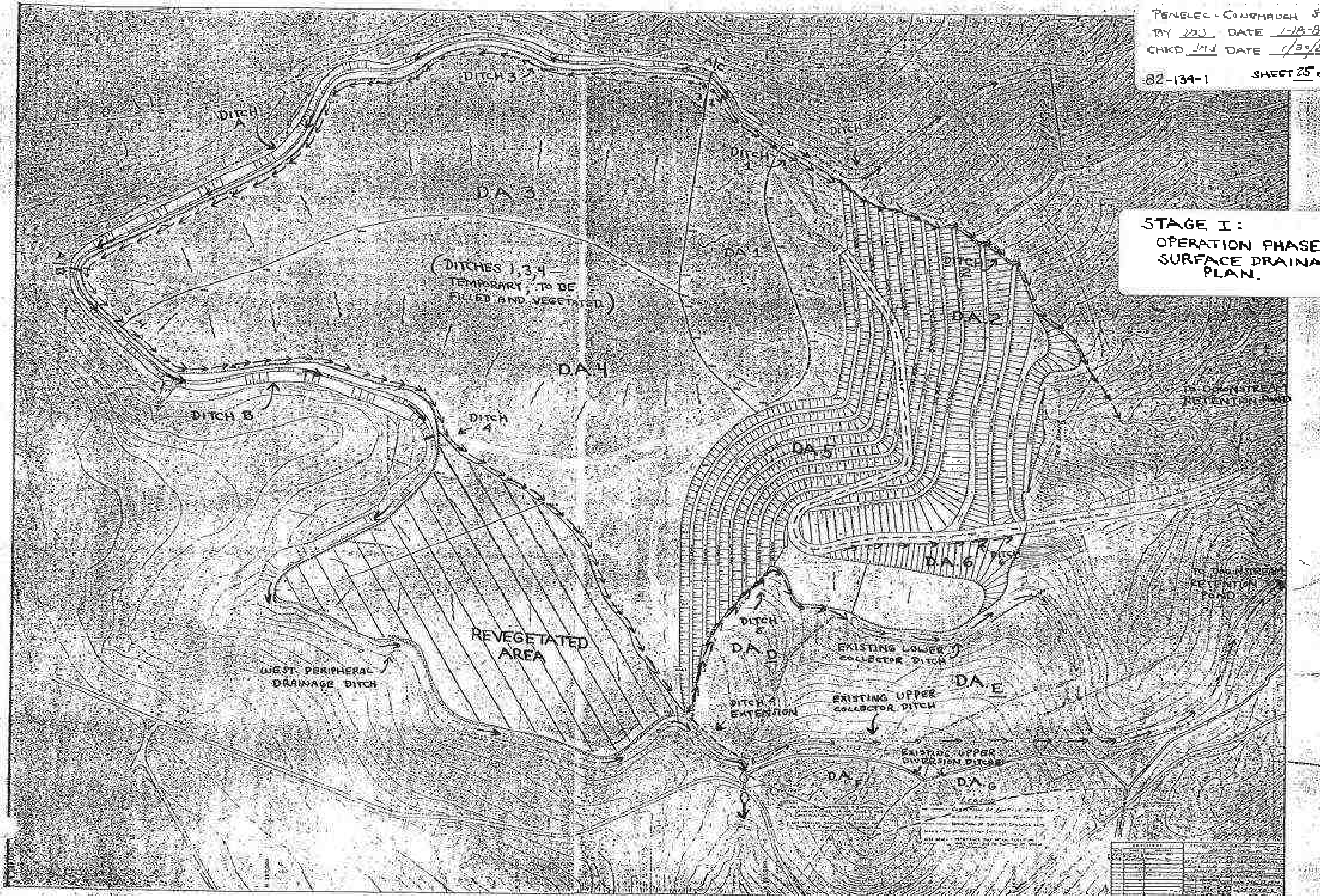
THEREFORE, THE EXISTING CHANNEL IS ADEQUATE TO CONVEY THE 100-YR DISCHARGE.

PENELEC - CONEMAUGH STATION
82-134-1 SHEET 24 OF 26
BY DJS DATE 1-18-82
CHKD JMJ DATE 1/4/82

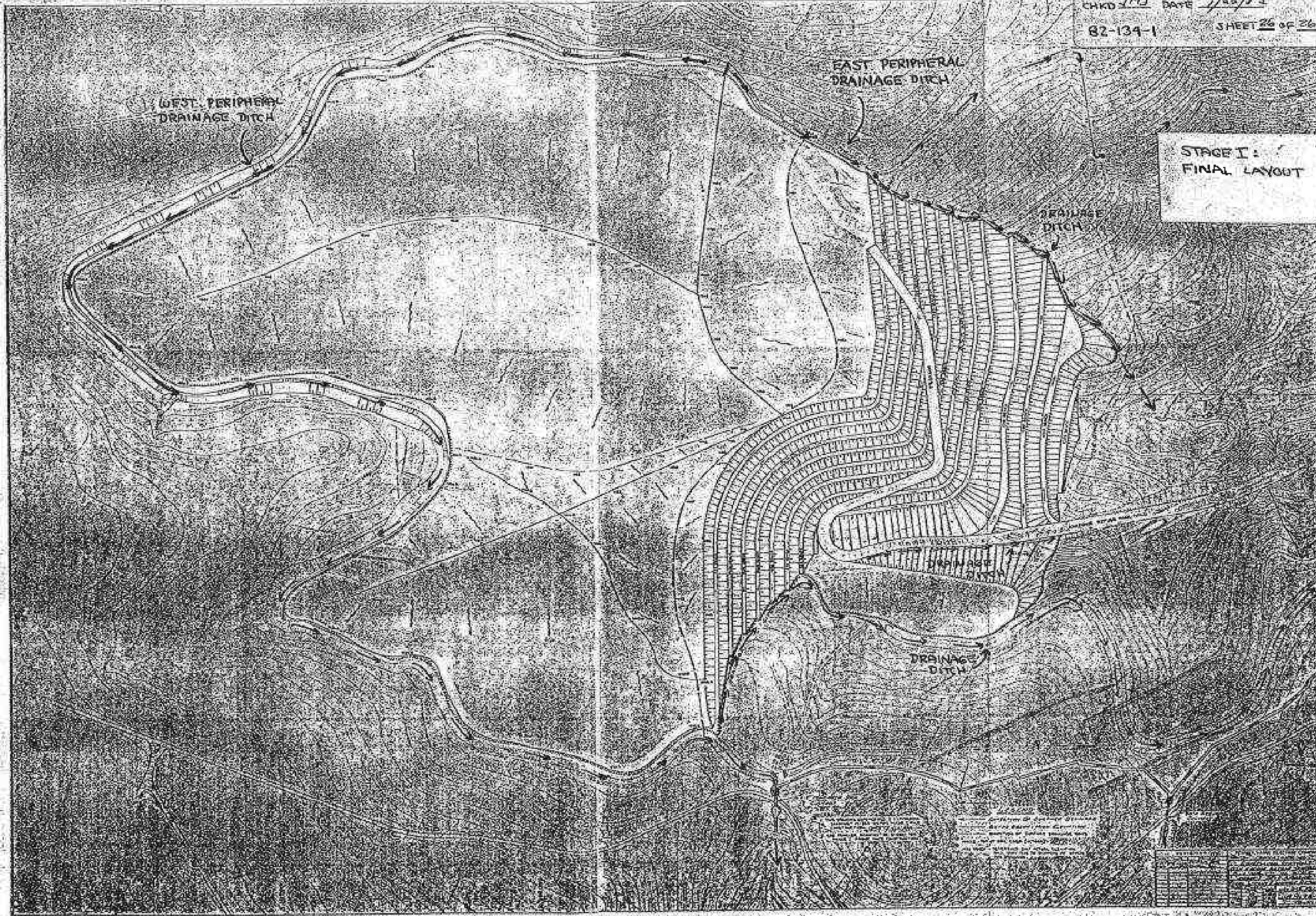


PENELEC - CONEMAUGH STATION
BY [illegible] DATE 1-18-82
CHKD [illegible] DATE 1/30/82
82-134-1 SHEET 25 OF 36

STAGE I:
OPERATION PHASE
SURFACE DRAINAGE PLAN.



PENELEC - CONEMAUGH STATION
BY ___ DATE 1-18-82
CHKD JMJ DATE 1/20/82
82-134-1 SHEET 26 OF 26



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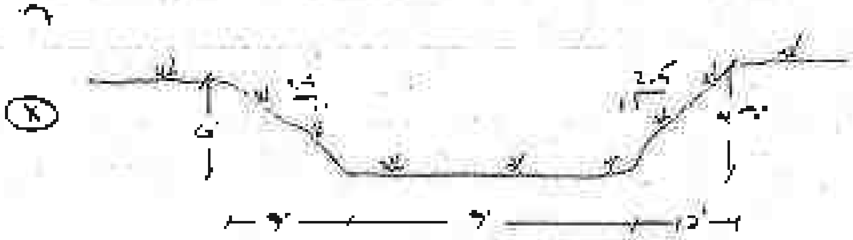
SUBJECT [illegible]
Lower Valley
BY [illegible] DATE 6/26/85 PROJ. NO. 83-134-11
CHKD. BY TRV DATE 7/3/85 SHEET NO. 1 OF

Hydraulic Analyses
Check Capacities of Channels
by Manning Equation

Upper Culvert
Section 7



$A = 9y + \frac{1}{2}(1.5 + 2.5)y^2$

$P_w = 9 + (1.80 + 2.69)y$

$A = 9y + 2.0y^2 \approx 86$ sf

$P_w = 9 + 4.49y \approx 30$ ft

(substituting $y \approx 4.7$ ft)

Slope (based on Δ elevation of channel invert from Section 7 to Section 9) (see Plate)

$S = (92.1 - 91.7)/[illegible]' \approx 0.003$ ft/ft

Roughness Coefficient

$n = 0.035$ (estimated from field photographs, based on Chow, Open Channel Hydraulics, 1959, p. 112-113).

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SUBJECT [illegible] Conservation
Deep Valley

BY KLF DATE 6/26/85 PROJ. NO. 83-134-11

CHKD. BY TRV DATE 7/3/85 SHEET NO. 2 OF ____

Hydraulic Analyses

Capacities

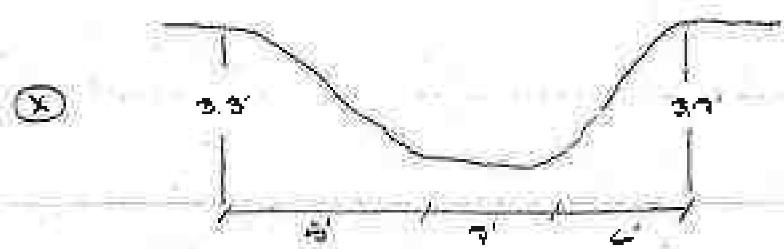
Upper Culvert

Section 7

$$Q = 1.49/n \; A^{5/3} \; P_w^{-2/3} \; S^{1/2}$$

$$Q \approx 404 \text{ cfs}$$ Capacity

Section 8



For $y = 3.3$ ft

$A = 7y + 1.55y^2 \approx 40$ ft^2

$P_w = 7 + 3.69y \approx 19.2$ ft

$n = 0.030$ (as before)

From 1:400 scale mapping $S \approx (1429 - 1423)/387.5' \approx 0.015$ ft/ft

$$Q = 1.49/n \; A^{5/3} \; P_w^{-2/3} \; S^{1/2}$$

$$Q \approx 395 \text{ cfs}$$ Capacity

SUBJECT	Penelec Conemaugh West Valley
BY	KLF
DATE	6/26/85
PROJ. NO.	82-134-11
CHKD. BY	TRV
DATE	7/3/85
SHEET NO.	3
OF	

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

Hydraulic Analysis
Flow Capacities
Upper Culvert
Section 3

"Box Culvert - Inlet Control should govern
Ref. OPEN CHANNEL FLOW, Henderson, p. 263

$$Q = \tfrac{2}{3}\ C_B B H \left(\tfrac{2}{3} g H\right)^{1/2}$$

Box Culvert is ~ 5.6' H × 12.0' W (12.4' measured on skew, as given by 4/25/85 survey notes. Refer to "Supporting Applications for Culvert Approval, Conemaugh Station, Penelec, D'Appolonia", and "Field Visit Memo & Photos (& Field Notes), Conemaugh Station, Culvert Reconnaissance, 12/84", 83-136-11.)

$Q = \Sigma Q_i$ as given above (for several vertical slices).

$C_B \approx 0.9$
$B \approx 12.0$ ft
$H \approx 5.6$ ft

$Q \approx 443$ cfs if culvert flows (barely) full.

Top of Roadway is ~1429.5 (from 1:600 scale mapping)

From the 12/84 field survey info (cited above), the maximum headwater height was measured as 8'.

Since 8/5.6 ≈ 1.4, which is greater than 1.2, (HW/D > 1.2), and therefore the flow equation changes to (same Ref., p. 265).

SUBJECT Pennsylvania Commonwealth

West Valley

BY LL DATE 6/26/95 PROJ. NO. 92-164-11

CHKD. BY TRV DATE 7/3/95 SHEET NO. 4 OF

Hydraulic Analyses

Flow Capacities

Upper Culvert

Section 9 - Box Culvert (cont'd)

$$Q = C_h B D \left(2g(H - C_h D)\right)^{1/2}$$

C_h ~ 0.6

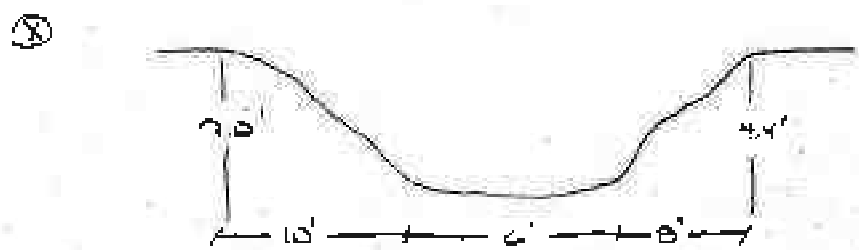
B ~ 12.0 ft

D ~ 3.6 ft

H ~ 8.0 ft

Q ~ 695 cfs   Capacity

Section 11 - Section below Box Culvert



for y ~ 4.4 ft

$A = 6y + 1.6y^2$ → 57.4 ft²

$P_w = 6 + 3.78y$ → 22.6 ft

n ~ 0.030

Slope ~ (8.4 - 10.9)/78'

(from 4/25/95 survey)

S ~ 0.032 ft/ft

SUBJECT [illegible] Conservancy

West Valley

BY [illegible] DATE 6/26/85 PROJ. NO. 83-134-1

CHKD. BY TRV DATE 7/3/85 SHEET NO. 5 OF

GAI CONSULTANTS, INC.

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Hydraulic Analyses

Flow Capacities

Upper Culvert

Section 11 (con't)

$$Q = \frac{1.49}{n} A^{5/3} P_w^{-2/3} S^{1/2}$$

$Q \approx 930$ cfs Capacity

SUBJECT Penelec Conemaugh
Laurel Valley
BY [illegible] DATE 6/30/85 PROJ. NO. 59-134-11
CHKD. BY TRY DATE 7/3/85 SHEET NO. 6 OF

GAI CONSULTANTS, INC.
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Hydraulic Analyses
Upper Culvert

From "Hydrology" calculations, sheet 13, the peak flow at the existing RC box culvert is estimated at 941 cfs. The TR-20 runoff is estimated at 842 cfs.

It has been estimated that, using the available headwater, the hydraulic capacity of the existing RC box culvert is 695 cfs. ("Hydraulic Analyses" calculations, sheet 4) (5.6' H × 12.0' W).

Estimate box culvert size required to pass the estimated peak flow of 842 cfs. (Use TR-20 value)

Using Henderson, OPEN CHANNEL FLOW, 1966, p. 263,

Estimate

Maintaining same channel invert, obtain the maximum culvert height opening of ....

Top of Roadway ~ 1429.5
Channel Invert (upstream) ~ 1419.9
↳ Δ = 9.6'

Culvert originally 12' W × 6' H
↳ Assume culvert cleaned out to original dimensions

∴ Channel Invert (upstream) ~ 1419.5

Assume available headwater = 1429.5 − 1419.5

= 10' − 2' for freeboard
↳ 8 ft

SUBJECT Drainage
Lowery Valley

BY KJP DATE 6/30/85 PROJ. NO. 80-134-11

CHKD. BY TRV DATE 7/3/85 SHEET NO. 7 OF

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Hydraulic Analysis
Upper Culvert

$HW/D = 8'/6' \sim 1.3$

I use

$$Q = C_h B D \left(2g\left(H - C_h D\right)\right)^{1/2}$$

$C_h = 0.8$ Rounded Edges
$B =$ unknown
$D_{max} \sim 6$ ft
$H_{max} \sim 8.0$ ft
$Q \sim 842$ cfs
$B \sim 12$ ft

$Q \sim 837$ cfs Almost!

Solve for H
$Q = 842$ cfs,

$H \sim 8.1$ ft OK

Existing Box Culvert is Barely
Adequate for Maximum Predicted

SUBJECT Pavement Crossings
West Valley
BY KLH DATE 6/28/85 PROJ. NO. 83-134-11
CHKD. BY TRV DATE 7/3/85 SHEET NO. 8 OF

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Hydraulic Analyses
Flow Capacities
Lower Culvert
Section 1

$A \approx 1.5y + 2.4y^2 \rightarrow @\, y = 1.2',\ A \approx 5.3\ ft^2$

$P_w \approx 1.5 + 5.2y \rightarrow @\, y = 1.2',\ P_w \approx 7.7\ ft$

$n \approx 0.035$ grown ditch
(field photographs - clean)

$S \approx$ from Section 1 to Section 3

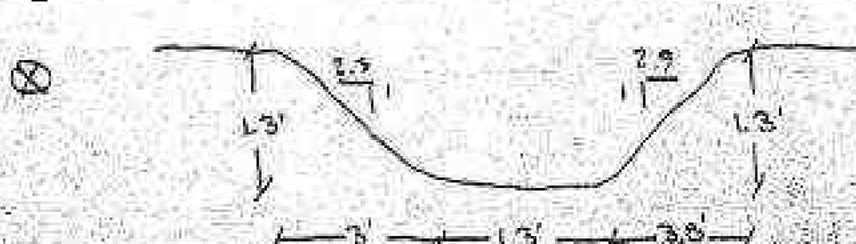
$(1331.65 - 1331.36)/54'$ (approx)

$S \approx 0.005\ ft/ft$

$Q = 1.49/n\ A^{5/3}\ P_w^{-2/3}\ S^{1/2}$

$Q \approx 12$ cfs Capacity

Section 2



SUBJECT Residues Containment
West Valley

BY RLF DATE 6/25/85 PROJ. NO. 83-134-11

CHKD. BY TRV DATE 7/3/85 SHEET NO. 9 OF

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Hydraulic Analyses
Flow Capacities

Section 2 (con't)

$A \sim 1.3y + 2.6y^2$ 2 → $A \sim 6.1$ ft²

$P_w \sim 1.3 + 5.6y$ 2 → $P_w \sim 8.6$ ft

$n \sim 0.035$ crown vetch

$S \sim$ from Section 2 to Section 3

(1331.74 − 1331.36)/50'

$S \sim 0.008$ ft/ft

$$Q = \frac{1.49}{n} A^{5/3} P_w^{-2/3} S^{1/2}$$

$Q \sim 18$ cfs Capacity

Section 3

⊗

$A \sim 5y + 2.1y^2$ 2 → 19.8 ft²

$P_w \sim 5 + 4.8y$ 2 → 15.1 ft

$n \sim 0.035$ crown vetch

$S \sim 0.006$ ft/ft (estimated from other channel slopes)

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SUBJECT Pipeline Construction
West Valley

BY K.L. DATE 6/28/85 PROJ. NO. 84-134-11

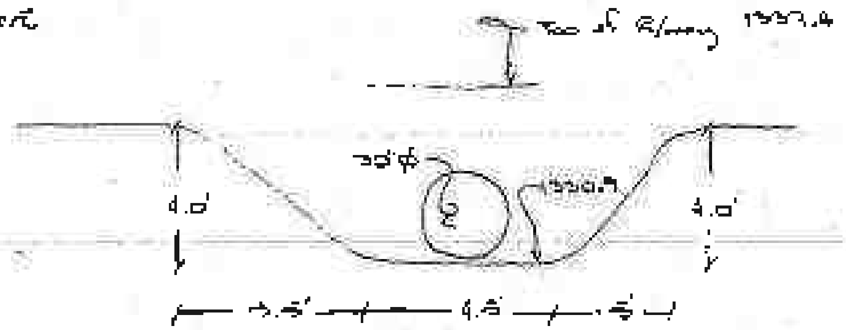
CHKD. BY TRY DATE 7/3/85 SHEET NO. 12 OF

Hydraulic Analyses
Flow Capacities
Section 3 (cont'd)

$$Q = \frac{1.49}{n} A^{5/3} P^{-2/3} S^{1/2}$$

$Q \approx 78$ cfs Capacity

30" CMP Culvert



Available Headwater Depth = 1337.4 − 1330.9 ≈ 6.5'
Usable Headwater Depth ≈ 5.0' by roadway
(1.5' freeboard)

~ pile top = 1340, so backwater onto the pile does not appear to be as critical as the roadway

Length ≈ 111 ft

Inlet Control Conditions
From field photographs, entrance is projecting, with high & thick grasses

From "Hydraulic Charts for The Selection Of Highway Culverts", H.E.C. No. 5, Federal Highway Administration, June 1980, Chart 5, p. 5-25

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SUBJECT Pipeline Construction
Worm Valley

BY KJ   DATE 6/28/85   PROJ. NO. 52-134-11

CHKD. BY TRV   DATE 7/3/85   SHEET NO. 11   OF

Hydraulic Analysis
Flow Capacity
30" Ø CMP Culvert

$HW/D = 5/2.5' = 2$

projecting entrance

$Q = 40$ cfs   Inlet Control Conditions

Outlet Control Conditions
same Ref.

$$H = \left(1 + k_e + 29n^2L/R_h^{4/3}\right) Q^2/2gA^2$$

Assume pipe flows full

$R_h = D/4 = 0.625$ ft
$A = \pi D^2/4 = 4.9$ ft^2
$n = 0.025$ CMP
$k_e = 0.9$ projecting

$$H = 0.00366\ Q^2$$

Drop in elevation along culvert is 0.85 ft

Assume Tailwater at crown of pipe

$\therefore h_o = 2.5$ ft

$HW = H + h_o - LS = H + 1.65$ ft

For $HW = 5$ ft, $H = 3.35$ ft

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SUBJECT Reverse Causeway
Wash Valley
BY KLA DATE 6/25/85 PROJ. NO. 83-134-11
CHKD. BY TRV DATE 7/3/85 SHEET NO. 12 OF

Hydraulic Analyses
Flow Capacities
Lower Culvert

For $H = 0.00366\ Q^2$

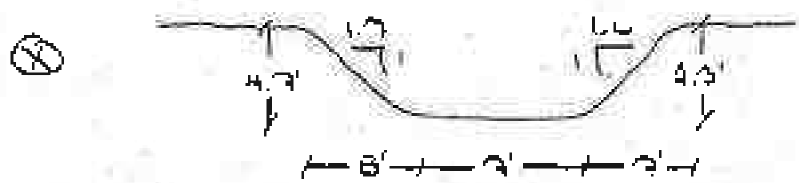
and $H = 3.35$ ft,

$Q = 30$ cfs

Outlet Control Flow Conditions Govern ($Q_{outlet} = 30$ cfs & $Q_{inlet} = 40$ cfs), And The Flow Capacity is

$Q = 30$ cfs Capacity

Section 4



$A = 7y + 1.65y^2 \approx 69.6\ ft^2$

$P_w = 7 + 3.84y \approx 23.6$ ft

$n = 0.035$ grasses, uncommon

$S =$ Culvert Outlet to Section 4

$(1330.04 - 1329.73)/49 = 0.006$ ft/ft

$Q = 374$ cfs Capacity

SUBJECT [illegible] Causeway
Deep Valley

BY [illegible] DATE 6/30/85 PROJ. NO. [illegible]

CHKD. BY TRV DATE 7/3/85 SHEET NO. 13 OF ____

CONSULTANTS, INC.
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Hydraulic Analysis
Lower Culvert

From "Hydrology" calculations, sheet ??, the peak flow to the lower culvert is estimated to be 76 cfs.

It has been estimated that the existing 30"ϕ CMP can pass approximately 30 cfs, making use of 5' of Headwater Depth. (sheet 17)

Estimate necessary culvert size.

Ref: "Hydraulic Charts for the Selection of Highway Culverts", H.E.C. No. 5; Federal Highway Administration, June 1980.

Assume: 5' Available Headwater
CMP Culvert (Lined)
Headwall & Wingwalls

Inlet Control Conditions
Using Chart 5, p. 5-25,
Q = 76 cfs

D	36"	48"	54"	60"
HW/D	>3.	1.25	1.0	0.825
HW	—	5'	4.5'	4.1'

Outlet Control Conditions

L = 115 ft (111' + just in case)
k_e = 0.5 square-edges w/ headwall & wingwalls
n = 0.012 "Handbook of Steel Drainage & Highway Construction Products", US Steel, 2nd ed., 1971, p. 157

SUBJECT Penalic Conversion
West Valley

BY K.L. DATE 6/30/85 PROJ. NO. 90-136-11

CHKD. BY TRY DATE 7/3/85 SHEET NO. 16 OF

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Hydraulic Analysis
Lower Culvert

Outlet Control Conditions (cont'd)

adjust length factor to reflect reduced n

n CMP ~ 0.024 (Ref, Chart 11, p. 3-34)

n CMP lined ~ 0.013 (p. 3-30)

$$L' = L\,(n'/n)^2$$

$$L' = 29\ \text{ft}$$

Chart 11 no good, use equation

From p. 3-6,

$$H = \left(1 + k_e + \frac{29 n^2 L}{R_h^{4/3}}\right) Q^2/2gA^2$$

Assume: pipe flows full
i.e. $R_h = D/4$
$A = \pi D^2/4$

$$H = \left(1 + 0.5 + \frac{29(0.013)^2(115)}{(D/4)^{4/3}}\right) (156)^2 / 2g(\pi/4)^2 D^4$$

$$H = (1.5 + 3.05 D^{-4/3})(330 D^{-4})$$

D	48"	54"	60"
H	1.8'	1.1'	0.7'

Assume tailwater = critical depth

From Ref, Chart 16, p. 3-39

SUBJECT Parallel Conveyance
Lower Valley

BY KLL DATE 6/30/95 PROJ. NO. 93-134-11

CHKD. BY TRV DATE 7/3/95 SHEET NO. 15 OF

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Hydraulic Analyses
Lower Culverts

Outlet Control Conditions, (cont'd)

D	48"	54"	60"
H	1.8'	1.1'	0.9'
h_o	2.95'	2.85'	2.75'
LS	0.85'	0.85'	0.85'
HW	3.9'	3.1'	2.8'

LS = 0.85' , from field notes of 4/20/95 survey

HW = H + h_o − LS

Inlet Control Conditions Govern HW. Note, however, that outlet control conditions may occur if the tailwater elevation is greater than approximately the crown of the culvert at its outlet.

SUBJECT [illegible] Consulting

West Valley

BY KLF DATE 7/2/85 PROJ. NO. 82-134-11

CHKD. BY TRV DATE 7/6/85 SHEET NO. 1 OF 2

GAI CONSULTANTS, INC.
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Hydraulic Analysis
- Upper Culvert

Estimate Flow Depth In Diversion Channels.

Upstream of Box Culvert

Q_d ~ 302 cfs (TR-20 output, step 10)

Channel Geometry (Dwg. 82-134-f111)

$A \sim 9y + 2y^2$

$P_w \sim 9 + 4.49y$

$S \sim 0.003$ ft/ft

(Section 7, "Hydraulic Analyses", sheet 1) & Dwg. 82-134-f111

Q capacity ~ 404 cfs

$Q_d\, n / 1.49 S^{1/2} \approx 130 \approx (9y + 2y^2)^{5/3}\, (9 + 4.49y)^{-2/3}$

$y \sim 4.1$ ft

Downstream of Box Culvert

$A \sim 6y + 1.6y^2$

$P_w \sim 6 + 3.78y$

$S \sim 0.032$ ft/ft

Q capacity ~ 950 cfs

$n \sim 0.030$

("Hydraulic Analysis", Section 11) & Dwg. 82-134-f111

GAI CONSULTANTS, INC
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Hydraulic Analyses

Upper Culvert

Downstream Section

$Q_{design} \sim 840$ cfs (TE-20, STA 20)

$$Q_d\, n / 1.49\, S^{1/2} = 95 = (6y + 1.6y^2)^{5/3} (6 + 3.77y)^{-2/3}$$

$$y \sim 4.2 \text{ ft}$$

SUBJECT Pennine Contracting

West Valley

BY KLC DATE 7/2/85 PROJ. NO. 85-156-11

CHKD. BY TRV DATE 7/6/85 SHEET NO. 1 OF 2

GAI CONSULTANTS, INC.
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Hydraulic Analysis

Lower Culvert

Estimate water surface elevation at inlet of existing 30" φ and proposed 48" φ CMP culvert.

Assume Inlet Control Conditions

Ref. "Hydraulic Charts For The Selection Of Highway Culverts", H.E.C. No. 5, Federal Highway Administration, June 1965

Using Chart 5, p. 5-25, culverts with headwalls

Q	30" φ HW/D	30" φ HW	48" φ HW/D	48" φ HW
25	1.09	2.725'		
30	1.26	3.15'		
→ 35	1.47	3.675'		
40	1.71	4.275'		
45				
50			0.78	3.12'
→ 55			0.83	3.32'
60			0.875	3.5'
65			0.93	3.72'

Q ~ 88 cfs ∴ Say 90 cfs for this analysis

for Q ~ 90 cfs, and matching Headwater depths,

Q in 30" φ ~ 35 cfs
Q in 48" φ ~ 55 cfs
→ HW ~ 3.5'

SUBJECT Penelec Conemaugh
Lower Valley

BY KLL DATE 11/21/95 PROJ. NO. 93-154-11

CHKD. BY TRV DATE 7/6/95 SHEET NO. 1 OF 1

CONSULTANTS, INC.
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Hydraulic Analyses
Lower Culvert

Velocity in 30" Φ CMP

$V = Q/A$

$Q = 35$ cfs

$A = 4.9$ ft² (flowing full)

$V = 7.1$ ft/s

Velocity in 48" Φ CMP

$V = Q/A$

$Q = 60$ cfs

Using Chow, OPEN CHANNEL HYDRAULICS, Appendix A,

$y/D = 3.5'/4' \approx 0.88$

$\therefore A/D^2 = 0.7320$

$A = 11.7$ ft²

$V = 5.1$ ft/s

SUBJECT Proposed Cemetery
West Valley

BY [illegible] DATE 7/2/85 PROJ. NO. 83-134-11

CHKD. BY TRV DATE 7/6/85 SHEET NO. 1 OF 2

GAI CONSULTANTS, INC.
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Hydraulic Analyses
Lower Culvert

Upstream of 30" ø (existing) & 48" ø (proposed) CMP Culverts

$A = 5y + 2y^2$

$P_w = 5 + 4.47y$

$n = 0.035$ grass-lining

$S = 0.005$ ft/ft

$Q_{capacity}$ 12 cfs (existing)

("Hydraulic Analysis", Section 3, & Dwg 83-134-A111)

$Q_{design} = 33$ cfs (TR-20, step 1)

$$\frac{Q_d n}{1.49 S^{1/2}} = 11.0 = (5y + 2y^2)^{5/3} (5 + 4.47y)^{-2/3}$$

$y = 1.5$ ft

Channel to be improved as shown on Dwg 83-134-A111

Downstream of CMP Culverts

$A = 7y + 1.7y^2$

$P_w = 7 + 3.9y$

$S = 0.006$ ft/ft

$n = 0.035$

$Q_{capacity} = 374$ cfs (existing)

("Hydraulic Analysis", Section 4, & Dwg 83-134-A111)

SUBJECT Penelec Conemaugh

West Valley

BY KLF DATE 7/2/95 PROJ. NO. 93-134-11

CHKD. BY TRK DATE 7/6/95 SHEET NO. 2 OF 2

GAI CONSULTANTS, INC

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Environmental Specialists

Hydraulic Analyses

Lower Culvert

Downstream Section

Qdesign = 88 cfs

$$\frac{Qn}{1.49 S^{1/2}} = 26.7 = (7y + 1.7y^2)^{5/3} (7 + 3.9y)^{-2/3}$$

$$y = 2.1 \text{ ft}$$

EXECUTIVE CONTROL CARD   OPERATION LIST   PASS- 1

LISTING OF DATA IN CORE

1   CONEHAUGH PERMITTING

VELOCITY INCREMENT
0.2000

1 CTABLE

8	0.0300	0.0800	0.1800	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7950	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8650	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8900	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

STRUCT NO.
3 STRUCT   1

	ELEVATION	DISCHARGE	STORAGE
8	1400.0000	0.0000	50.0000

9 ENDTBL

STRUCT NO.
3 STRUCT   2

	ELEVATION	DISCHARGE	STORAGE
8	1400.0000	0.0000	50.0000

9 ENDTBL

TIME INCREMENT

4 DIMHYD

8	0.0000	0.0300	0.1000	0.1900	0.3100
8	0.4700	0.6600	0.5200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.6800	0.5600	0.4600	0.3900	0.3300
8	0.2800	0.2410	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0550	0.0470	0.0400	0.0340	0.0290

3

8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000
9 ENDTBL					

COMPUTED PEAK K FACTOR = 454.00

5 RAINFL 1 TIME INCREMENT 0.5000

8	0.0000	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1220	0.1250	0.1400	0.1560
8	0.1740	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5830	0.6240	0.6545	0.6820
8	0.7050	0.7230	0.7480	0.7670	0.7840
8	0.8000	0.8160	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9263	0.9360	0.9460	0.9550	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000
9 ENDTBL					

5 RAINFL 2 TIME INCREMENT 0.0200

8	0.0000	0.0100	0.0200	0.0200	0.0300
8	0.0400	0.0500	0.0600	0.0700	0.0800
8	0.1000	0.1100	0.1300	0.1600	0.1700
8	0.1700	0.2200	0.2700	0.3500	0.4400
8	0.5200	0.6300	0.6300	0.6600	0.6800
8	0.7000	0.7250	0.7400	0.7500	0.7700
8	0.7900	0.8030	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9800	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

5 RAINFL 3 TIME INCREMENT 0.5000

8	0.0000	0.0053	0.0103	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0481	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1089	0.1203	0.1328	0.1467	0.1625
8	0.1808	0.2042	0.2351	0.2813	0.6632
8	0.7351	0.7724	0.7989	0.8157	0.8380
8	0.8533	0.8675	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9513	0.9588	0.9651	0.9717	0.9777
8	0.9835	0.9892	0.9945	1.0000	1.0000
9 ENDTBL					

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1    1    5    0.0236    78.0000    0.3500 1 0 1 0 0
6 RUNOFF 1    2    6    0.0217    74.9000    0.2600 1 0 1 0 0
  ENDATA

END OF LISTING
```

PASS= 1

EXECUTIVE CONTROL CARD   OPERATION INCREM,   MAIN TIME INCREMENT= 0.20
EXECUTIVE CONTROL CARD   OPERATION COMPUT,   FROM XSECTN/STRUCT 0/ 1   TO XSECTN/STRUCT 0/ 2
STARTING TIME= 0.00   RAIN DEPTH= 5.50   RAIN DURATION= 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF STRUCTURE 1
AREA= 0.02   INPUT RUNOFF CURVE= 78.5   TIME OF CONCENTRATION= 0.16
***** IN PEAK - MAXI = 126

PEAK TIMES 12.05   PEAK DISCHARGES 37.069   PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05
8.00	DISCHG	0.08	0.12	0.16	0.20	0.25	0.29	0.35	0.42	0.48	0.54
10.00	DISCHG	0.66	0.80	0.98	1.13	1.44	1.68	2.21	2.94	5.64	23.02
12.00	DISCHG	37.34	32.16	16.36	10.97	7.25	5.55	4.69	3.93	3.63	3.18
14.00	DISCHG	2.94	2.78	2.61	2.53	2.34	2.24	2.12	1.99	1.93	1.81
16.00	DISCHG	1.78	1.71	1.63	1.57	1.53	1.50	1.45	1.39	1.36	1.32
18.00	DISCHG	1.30	1.27	1.23	1.21	1.17	1.15	1.12	1.09	1.08	1.06
20.00	DISCHG	1.05	1.03	1.00	0.99	0.96	0.94	0.93	0.93	0.92	0.89
22.00	DISCHG	0.87	0.86	0.86	0.85	0.83	0.81	0.81	0.80	0.80	0.75
24.00	DISCHG	0.77	0.52	0.15	0.04	0.01	0.00				

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 3.1665   CFS-HRS= 47.92   ACRE-FT= 3.96

SUBROUTINE RUNOFF STRUCTURE 2
AREA= 0.02   INPUT RUNOFF CURVE= 71.9   TIME OF CONCENTRATION= 0.26
***** IN PEAK - MAXI = 125

PEAK TIMES 11.99   PEAK DISCHARGES 35.279   PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.02	0.05	0.09	0.13	0.18	0.23	0.28	0.36
10.00	DISCHG	0.42	0.55	0.68	0.81	1.08	1.24	1.82	2.35	6.01	24.83
12.00	DISCHG	35.26	21.99	10.17	7.91	5.06	4.46	3.71	3.23	3.05	2.61
14.00	DISCHG	2.51	2.34	2.23	2.17	1.97	1.93	1.79	1.71	1.67	1.56
16.00	DISCHG	1.54	1.46	1.41	1.38	1.32	1.30	1.24	1.20	1.19	1.15
18.00	DISCHG	1.14	1.10	1.07	1.06	1.01	1.01	0.97	0.95	0.94	0.92
20.00	DISCHG	0.92	0.89	0.88	0.86	0.83	0.82	0.82	0.81	0.80	0.77
22.00	DISCHG	0.76	0.76	0.75	0.75	0.72	0.72	0.71	0.70	0.70	0.68
24.00	DISCHG	0.67	0.31	0.05	0.01	0.00					

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 2.8444   CFS-HRS= 39.33   ACRE-FT= 3.29

ENDCMP

END OF 1 JOBS IN THIS RUN

EAST & WEST COLL. CHANNELS PERMITTING 07-02-85

TR-20 HYDROLOGY

PROGRAM DATE - FEB. 14, 1974 S/360

9

LISTING OF DATA IN CORE

0   EAST & WEST COLL. CHANNELS   PERMITTING

		VELOCITY INCREMENT			
1 CTABLE		0.2000			
8	0.0000	0.0800	0.1800	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300
9 ENDTBL					

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	1	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
9 ENDTBL				

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	2	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
8		1.0000	265.4000	7.0000
8		2.0000	991.4000	18.0000
8		3.0000	2261.8000	33.0000
8		4.0000	4175.0000	52.0000
9 ENDTBL				

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	3	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
8		1.0000	265.4000	7.0000

```
8                          4.0000   5175.0000     52.0000
9 ENDTBL

        XSECTN NO.      DRAINAGE AREA
2 XSECTN     4             1.0800

                          ELEVATION   DISCHARGE    END AREA
8                          0.0000       0.0000      0.0000
9 ENDTBL

        XSECTN NO.      DRAINAGE AREA
2 XSECTN     5             1.0000

                          ELEVATION   DISCHARGE    END AREA
8                          0.0000       0.0000      0.0000
8                          0.5000      44.6300      2.5000
8                          1.0000     156.6000      6.0000
8                          1.5000     340.4000     10.5000
8                          2.0000     605.4000     16.0000
9 ENDTBL

        XSECTN NO.      DRAINAGE AREA
2 XSECTN     6             1.0000

                          ELEVATION   DISCHARGE    END AREA
8                          0.0000       0.0000      0.0000
8                          1.0000     192.9000     17.0000
8                          2.0000     609.0000     38.0000
8                          3.0000    1261.6000     63.0000
8                          4.0000    2151.6001     92.0000
9 ENDTBL

        XSECTN NO.      DRAINAGE AREA
2 XSECTN     7             1.0000

                          ELEVATION   DISCHARGE    END AREA
8                          0.0000       0.0000      0.0000
8                          1.0000     192.9000     17.0000
8                          2.0000     690.0000     38.0000
8                          3.0000    1261.8000     63.0000
8                          4.0000    2151.6001     92.0000
9 ENDTBL

                       TIME INCREMENT
4 DIMHYD

8                 0.0000     0.0300     0.1000     0.1900     0.3100
8                 0.4700     0.6600     0.8200     0.9300     0.9900
8                 1.0000     0.9900     0.9300     0.8500     0.7800
8                 0.6800     0.5600     0.4600     0.3900     0.3300
8                 0.2800     0.2410     0.2070     0.1740     0.1470
8                 0.1260     0.1070     0.0910     0.0770     0.0660
8                 0.0550     0.0470     0.0400     0.0340     0.0290
8                 0.0250     0.0210     0.0180     0.0150     0.0130
8                 0.0110     0.0090     0.0080     0.0070     0.0060
9                 0.0050     0.0040     0.0030     0.0020     0.0010
```

```
COMPUTED PEAK R FACTOR =   484.00


                       TIME INCREMENT
5 RAINFL 1                     0.5000

8               0.0000      0.0080      0.0170      0.0260      0.0350
8               0.0450      0.0560      0.0650      0.0760      0.0870
8               0.0990      0.1220      0.1250      0.1400      0.1560
8               0.1740      0.1940      0.2190      0.2540      0.3030
8               0.5150      0.5030      0.6740      0.6540      0.6920
8               0.7050      0.7270      0.7480      0.7670      0.7840
8               0.8000      0.8160      0.8300      0.8440      0.8570
8               0.8700      0.8820      0.8930      0.9050      0.9160
8               0.9260      0.9360      0.9460      0.9550      0.9650
8               0.9740      0.9830      0.9920      1.0000      1.0000
9 ENDTBL


                       TIME INCREMENT
5 RAINFL 2                     0.0200

8               0.0000      0.0100      0.0200      0.0200      0.0300
8               0.0400      0.0500      0.0600      0.0700      0.0800
8               0.1000      0.1100      0.1300      0.1600      0.1700
8               0.1900      0.2200      0.2700      0.3500      0.4400
8               0.5200      0.6000      0.6300      0.6600      0.6800
8               0.7000      0.7200      0.7400      0.7600      0.7700
8               0.7900      0.8000      0.8200      0.8300      0.8400
8               0.8500      0.8700      0.8800      0.8900      0.9000
8               0.9100      0.9200      0.9300      0.9400      0.9500
8               0.9567      0.9633      0.9700      0.9800      0.9900
8               1.0000      1.0000      1.0000      1.0000      1.0000
9 ENDTBL


                       TIME INCREMENT
5 RAINFL 3                     0.5000

8               0.0000      0.0053      0.0108      0.0164      0.0223
8               0.0284      0.0347      0.0414      0.0483      0.0555
8               0.0632      0.0712      0.0797      0.0887      0.0984
8               0.1089      0.1203      0.1328      0.1467      0.1625
8               0.1808      0.2042      0.2351      0.2833      0.6632
8               0.7351      0.7724      0.7989      0.8197      0.8380
8               0.8538      0.8676      0.8801      0.8914      0.9019
8               0.9115      0.9206      0.9291      0.9371      0.9446
8               0.9519      0.9588      0.9653      0.9717      0.9777
8               0.9836      0.9892      0.9947      1.0000      1.0000
9 ENDTBL
```

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1  1       1     0.0303     75.0000   0.27001 1 0 0 0 0
6 REACH  3  2  1    2  1640.0000      0.0000   1.00001 1 0 0 0 0
6 RUNOFF 1  3       3     0.1923     85.0000   0.21001 1 0 0 0 0
6 REACH  3  2  3    4  1840.0000      0.0000   1.00001 1 0 0 0 0
6 ADDHYD 4  2  2 4  5                                1 1 0 0 0 0
6 RUNOFF 1  2       6     0.0120     78.0000   0.80001 1 0 0 0 0
6 ADDHYD 4  2  5 6  7                                1 1 0 0 0 0
6 REACH  3  6  7    1   810.0000      0.0000   1.05001 1 0 0 0 0
6 RUNOFF 1  4       2     0.0630     78.2000   0.38001 1 0 0 0 0
6 REACH  3  5  2    3  1000.0000      0.0000   1.00001 1 0 0 0 0
6 REACH  3  6  3    4    60.0000      0.0000   1.00001 1 0 0 0 0
6 ADDHYD 4  6  1 4  5                                1 1 0 0 0 0
6 REACH  3  7  5    6   430.0000      0.0000   1.00001 1 0 0 0 0
6 RUNOFF 1  7       7     0.0170     80.0000   0.09001 1 0 0 0 0
6 ADDHYD 4  7  6 7  1                                1 1 0 0 0 0
  ENDATA

END OF LISTING
```

PASS= 1

EXECUTIVE CONTROL CARD   OPERATION INCREM,   MAIN TIME INCREMENT= 0.20

EXECUTIVE CONTROL CARD   OPERATION COMPUT,   FROM XSECTN/STRUCT 1/ 0   TO XSECTN/STRUCT 7/ 0

STARTING TIME= 0.00   RAIN DEPTH= 5.50   RAIN DURATION= 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2

ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF   CROSS SECTION 1

AREA= 0.03   INPUT RUNOFF CURVE= 75.8   TIME OF CONCENTRATION= 0.27

***** IN PEAK - MAXI = 123

PEAK TIMES 11.99   PEAK DISCHARGES 50.085   PEAK ELEVATIONS (RUNOFF)

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.03		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
8.00	DISCHG	0.01	0.04	0.09	0.13	0.18	0.24	0.31	0.39	0.46	0.59
10.00	DISCHG	0.67	0.86	1.05	1.23	1.56	1.88	2.69	3.45	8.79	35.10
12.00	DISCHG	50.07	32.58	15.23	11.49	7.33	6.38	5.32	4.63	4.35	3.72
14.00	DISCHG	3.57	3.35	3.17	3.08	2.91	2.76	2.56	2.42	2.37	2.22
16.00	DISCHG	2.19	2.07	1.99	1.96	1.87	1.85	1.77	1.70	1.65	1.62
18.00	DISCHG	1.61	1.56	1.51	1.50	1.44	1.42	1.38	1.34	1.33	1.31
20.00	DISCHG	1.30	1.27	1.24	1.23	1.18	1.17	1.16	1.15	1.14	1.09
22.00	DISCHG	1.08	1.07	1.06	1.06	1.02	1.01	1.00	0.99	0.99	0.97
24.00	DISCHG	0.95	0.46	0.08	0.01	0.00					

SUBROUTINE REACH   CROSS SECTION 2

LENGTH= 1040.00   INPUT COEFFICIENT= 0.6000   INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 37.971   AVERAGE ROUTING COEFF= 0.9571   NUMBER OF ROUTINGS= 0.04

***** IN PEAK - MAXI = 125

PEAK TIMES 12.00   PEAK DISCHARGES 49.519   PEAK ELEVATIONS 0.19

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.03		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
8.00	DISCHG	0.01	0.05	0.08	0.12	0.18	0.24	0.31	0.38	0.45	0.57
10.00	DISCHG	0.66	0.85	1.04	1.22	1.62	1.87	2.66	3.49	8.60	34.15
12.00	DISCHG	49.52	33.21	15.86	11.63	7.49	6.41	5.36	4.53	4.36	3.75
14.00	DISCHG	3.58	3.34	3.18	3.07	2.82	2.76	2.56	2.43	2.37	2.23
16.00	DISCHG	2.19	2.03	2.00	1.96	1.87	1.85	1.77	1.71	1.68	1.63
18.00	DISCHG	1.61	1.55	1.52	1.50	1.44	1.42	1.38	1.34	1.33	1.31
20.00	DISCHG	1.30	1.27	1.26	1.23	1.18	1.17	1.16	1.15	1.14	1.09
22.00	DISCHG	1.08	1.07	1.05	1.36	1.02	1.01	1.00	0.99	0.99	0.97
24.00	DISCHG	0.95	0.48	0.09	0.07	0.00					

SUBROUTINE RUNOFF   CROSS SECTION 3

AREA= 0.19   INPUT RUNOFF CURVE= 85.0   TIME OF CONCENTRATION= 0.23

***** IN PEAK - MAXI = 124

PEAK TIMES 11.95   PEAK DISCHARGES 436.959   PEAK ELEVATIONS (RUNOFF)

TIME											
[illegible]	DISCHG	0.00	0.00	0.03	0.00	.02	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.40	0.64
6.00	DISCHG	0.36	1.13	1.35	1.64	1.97	2.22	2.61	2.93	3.27	3.74
8.00	DISCHG	4.05	4.63	5.05	5.52	6.23	6.67	7.71	8.36	9.11	10.53
10.00	DISCHG	11.14	13.93	15.46	17.52	21.92	23.44	34.20	39.63	117.64	350.76
12.00	DISCHG	425.44	191.85	97.57	77.92	49.59	46.09	36.53	33.07	31.06	26.41
14.00	DISCHG	25.34	23.64	22.84	22.02	19.98	19.73	17.92	17.31	16.87	15.81
16.00	DISCHG	15.67	14.61	14.23	13.95	13.29	13.71	12.41	12.12	11.94	11.53
18.00	DISCHG	11.49	10.95	10.75	10.58	10.16	10.11	9.67	9.50	9.43	9.26
20.00	DISCHG	9.24	8.89	8.76	8.62	8.27	8.25	8.16	8.13	8.03	7.67
22.00	DISCHG	7.63	7.53	7.50	7.41	7.26	7.13	7.04	7.00	6.94	6.77
24.00	DISCHG	6.71	2.91	0.20	0.01						

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 1840.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 43.913 AVERAGE ROUTING COEFF= 0.9627 NUMBER OF ROUTINGS= 0.06
OOOOO IN PEAK - MAXI = 125

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	430.018	1.23

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.19

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.18	0.39	0.63
6.00	DISCHG	0.85	1.11	1.36	1.62	1.95	2.21	2.59	2.91	3.25	3.71
8.00	DISCHG	4.03	4.60	5.03	5.50	6.23	6.65	7.65	8.32	9.09	10.45
10.00	DISCHG	11.10	13.77	15.37	17.41	21.67	23.35	33.59	39.38	113.31	345.25
12.00	DISCHG	421.70	204.96	102.45	79.02	51.18	46.29	37.07	33.26	31.17	26.67
14.00	DISCHG	25.87	23.77	22.39	22.07	20.10	19.74	18.08	17.36	16.90	15.67
16.00	DISCHG	15.68	14.67	14.25	13.96	13.33	13.21	12.46	12.14	11.95	11.55
18.00	DISCHG	11.48	10.97	10.76	10.59	10.19	10.12	9.69	9.51	9.43	9.27
20.00	DISCHG	9.24	8.91	8.77	8.63	8.31	8.25	8.16	8.13	8.01	7.69
22.00	DISCHG	7.63	7.54	7.50	7.41	7.17	7.13	7.04	7.00	6.94	6.78
24.00	DISCHG	6.71	2.27	0.30	0.02	0.00					

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,4 OUTPUT HYDROGRAPH= 5
OOOOO IN PEAK - MAXI = 125

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	478.816	1.29

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.22

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.18	0.39	0.63
6.00	DISCHG	0.85	1.11	1.36	1.62	1.95	2.21	2.59	2.91	3.25	3.71
8.00	DISCHG	4.06	4.63	5.11	5.62	6.41	6.89	7.96	8.71	9.55	11.02
10.00	DISCHG	11.77	14.62	16.41	18.63	23.30	25.22	36.26	42.83	121.91	379.40
12.00	DISCHG	471.23	238.15	118.71	90.65	58.67	52.70	42.43	37.89	35.54	30.41
14.00	DISCHG	29.45	27.11	26.06	25.16	22.92	22.48	20.64	19.77	19.27	18.09
16.00	DISCHG	17.86	16.75	16.25	15.93	15.20	15.06	14.23	13.84	13.63	13.18
18.00	DISCHG	13.09	12.53	12.28	12.08	11.63	11.54	11.07	10.06	10.76	10.50
20.00	DISCHG	10.55	10.18	10.01	9.86	9.49	9.42	9.32	9.28	9.15	8.79
22.00	DISCHG	8.71	8.61	8.57	8.47	8.19	8.14	8.04	8.00	7.93	7.75
24.00	DISCHG	7.67	2.75	0.39	0.04	0.00					

AREA= 0.01 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.10
00000 IN PEAK - MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.90	27.045	(RUNOFF)
12.90	2.827	(RUNOFF)
13.90	1.575	(RUNOFF)
14.90	1.211	(RUNOFF)
15.90	0.964	(RUNOFF)
16.90	0.814	(RUNOFF)
17.90	0.703	(RUNOFF)
18.90	0.625	(RUNOFF)
19.90	0.572	(RUNOFF)
20.91	0.538	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.04
8.00	DISCHG	0.06	0.09	0.11	0.14	0.16	0.18	0.23	0.26	0.32	0.37
10.00	DISCHG	0.40	0.55	0.60	0.80	0.93	1.01	1.69	5.86	13.17	22.14
12.00	DISCHG	25.58	5.57	5.15	3.35	2.73	2.74	1.97	1.96	1.66	1.55
14.00	DISCHG	3.56	1.38	1.30	1.24	1.19	1.20	1.05	1.03	0.98	0.95
16.00	DISCHG	0.95	0.87	0.86	0.82	0.81	0.81	0.76	0.74	0.75	0.70
18.00	DISCHG	0.70	0.66	0.66	0.63	0.62	0.67	0.50	0.58	0.57	0.57
20.00	DISCHG	0.57	0.54	0.54	0.52	0.51	0.51	0.50	0.50	0.48	0.47
22.00	DISCHG	0.47	0.45	0.45	0.45	0.44	0.44	0.43	0.43	0.42	0.42
24.00	DISCHG	0.42	0.01								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7
00000 IN PEAK - MAXI = 125

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	505.659	1.33

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.18	0.39	0.63
6.00	DISCHG	0.85	1.11	1.36	1.62	1.95	2.21	2.59	2.92	3.29	3.75
8.00	DISCHG	4.10	4.72	5.71	5.76	6.51	7.08	8.19	8.97	9.87	11.39
10.00	DISCHG	12.17	15.18	17.02	19.44	24.23	26.29	37.35	66.68	135.08	401.55
12.00	DISCHG	496.01	243.72	123.87	94.00	61.39	55.43	44.43	39.86	37.20	31.97
14.00	DISCHG	31.01	28.49	27.44	26.40	24.11	23.68	21.69	20.84	20.25	19.05
16.00	DISCHG	18.82	17.62	17.11	16.75	16.01	15.67	14.97	14.58	14.14	13.85
18.00	DISCHG	13.80	13.19	12.93	12.71	12.25	12.16	11.66	11.44	11.34	11.15
20.00	DISCHG	11.12	10.72	10.54	10.37	10.09	9.92	9.82	9.79	9.62	9.25
22.00	DISCHG	9.18	9.07	9.03	8.91	8.63	8.50	8.47	8.43	8.35	8.15
24.00	DISCHG	8.09	2.76	0.39	0.04	0.00					

SUBROUTINE REACH CROSS SECTION 6
LENGTH= 310.00, INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 14.378 AVERAGE ROUTING COEFF= 0.8975 NUMBER OF ROUTINGS= 0.07
00000 IN PEAK - MAXI = 125

PEAK TIMES PEAK DISCHARGES PEAK ELEVATIONS

TIME		[illegible]									
0.00	DISCHG	0.00	0.00	0.03	0.30	0.	0.00	0.00	0.00	0.00	0.30
2.00	DISCHG	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.03	0.30	0.00	0.00	0.02	0.17	0.37	0.61
6.00	DISCHG	0.83	1.10	1.34	1.60	1.93	2.19	2.57	2.90	3.25	3.72
8.00	DISCHG	4.07	4.63	5.19	5.72	6.52	7.63	8.11	8.92	9.81	11.27
10.00	DISCHG	12.11	14.97	16.89	19.27	23.90	26.10	37.16	66.23	128.95	383.46
12.00	DISCHG	490.35	260.89	132.03	96.03	63.61	55.84	45.15	40.17	37.38	32.32
14.00	DISCHG	31.07	28.66	27.51	26.47	24.27	23.71	21.83	20.99	20.29	19.13
16.00	DISCHG	18.83	17.70	17.14	16.77	16.06	15.88	15.03	14.61	14.36	13.91
18.00	DISCHG	13.50	13.23	12.95	12.73	12.28	12.17	11.69	11.45	11.36	11.86
20.00	DISCHG	11.12	10.74	10.56	10.38	10.02	9.93	9.83	9.76	9.64	9.28
22.00	DISCHG	9.18	9.08	9.03	8.92	8.65	8.58	8.46	8.43	8.36	8.18
24.00	DISCHG	8.09	3.17	0.55	0.06	0.06					

SUBROUTINE RUNOFF CROSS SECTION 6
AREA= 0.06 INPUT RUNOFF CURVE= 78.2 TIME OF CONCENTRATION= 0.38
80000 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.06	100.062	(RUNOFF)

TIME		HYDROGRAPH, TZERO=	0.00			DELTA T= 0.20			DRAINAGE AREA=	0.06	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.15
8.00	DISCHG	0.23	0.33	0.44	0.54	0.65	0.81	0.96	1.15	1.32	1.51
10.00	DISCHG	1.80	2.16	2.63	3.04	3.85	4.52	5.84	7.83	14.72	58.27
12.00	DISCHG	97.84	48.05	46.57	30.62	20.41	15.35	12.60	10.68	9.81	8.01
14.00	DISCHG	7.93	7.49	7.01	6.79	6.30	6.03	5.71	5.35	5.19	4.92
16.00	DISCHG	4.76	4.59	4.37	4.28	4.11	4.01	3.89	3.72	3.65	3.55
18.00	DISCHG	3.49	3.41	3.30	3.25	3.14	3.08	3.01	2.92	2.88	2.84
20.00	DISCHG	2.81	2.76	2.69	2.65	2.57	2.52	2.50	2.48	2.46	2.38
22.00	DISCHG	2.34	2.31	2.29	2.28	2.22	2.18	2.16	2.14	2.13	2.09
24.00	DISCHG	2.05	1.45	0.48	0.14	0.04	0.01	0.00			

SUBROUTINE REACH CROSS SECTION 5
LENGTH= 1000.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 22.076 AVERAGE ROUTING COEFF= 0.9235 NUMBER OF ROUTINGS= 0.06
80000 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.07	98.401	0.74

TIME		HYDROGRAPH, TZERO=	0.00			DELTA T= 0.20			DRAINAGE AREA=	0.06	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.14
8.00	DISCHG	0.23	0.32	0.43	0.53	0.67	0.80	0.95	1.14	1.31	1.56
10.00	DISCHG	1.79	2.13	2.61	3.02	3.50	4.48	5.76	7.71	14.32	55.73
12.00	DISCHG	95.53	38.62	48.99	31.55	21.00	15.65	12.95	10.80	9.86	8.68
14.00	DISCHG	7.97	7.51	7.03	6.80	6.33	6.02	5.73	5.37	5.20	4.94
16.00	DISCHG	4.77	4.60	4.39	4.28	4.17	4.02	3.90	3.73	3.66	3.56
18.00	DISCHG	3.49	3.41	3.30	3.25	3.15	3.09	3.01	2.92	2.88	2.84
20.00	DISCHG	2.81	2.76	2.69	2.65	2.58	2.53	2.50	2.48	2.46	2.39
22.00	DISCHG	2.34	2.31	2.29	2.28	2.22	2.10	2.16	2.14	2.13	2.09
24.00	DISCHG	2.06	1.48	0.54	0.16	0.04	0.01	0.00			

SUBROUTINE REACH   CROSS SECTION 6
LENGTH= 60.00   INPUT COEFFICIENT= 0.0000   INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 0.000   AVERAGE ROUTING COEFF= 0.0000   NUMBER OF ROUTINGS= 0.00
88888 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.07	98.401	0.56

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.06

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.14
8.00	DISCHG	0.23	0.32	0.43	0.53	0.67	0.80	0.95	1.14	1.31	1.56
10.00	DISCHG	1.79	2.13	2.61	3.02	3.40	4.46	5.76	7.71	14.32	55.71
12.00	DISCHG	95.53	88.62	48.99	31.55	21.00	15.65	12.95	10.30	9.84	8.63
14.00	DISCHG	7.97	7.51	7.03	6.80	6.33	6.02	5.73	5.37	5.20	4.94
16.00	DISCHG	4.77	4.60	4.39	4.28	4.12	4.02	3.90	3.73	3.66	3.56
18.00	DISCHG	3.49	3.41	3.30	3.25	3.15	3.09	3.01	2.92	2.88	2.84
20.00	DISCHG	2.81	2.76	2.69	2.65	2.58	2.53	2.50	2.48	2.46	2.39
22.00	DISCHG	2.34	2.31	2.29	2.28	2.22	2.18	2.16	2.14	2.13	2.09
24.00	DISCHG	2.06	1.48	0.56	0.16	0.04	0.01	0.00			

SUBROUTINE ADDHYD   CROSS SECTION 6
INPUT HYDROGRAPHS= 1,4   OUTPUT HYDROGRAPH= 5
88888 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.98	588.386	1.95

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.30

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.17	0.37	0.63
6.00	DISCHG	0.83	1.10	1.34	1.60	1.93	2.19	2.57	2.92	3.32	3.87
8.00	DISCHG	4.30	5.00	5.61	6.25	7.18	7.63	9.07	10.05	11.41	12.94
10.00	DISCHG	13.90	17.11	19.50	22.29	27.70	30.57	42.92	51.94	163.27	439.19
12.00	DISCHG	585.17	349.51	180.99	127.58	84.61	71.48	58.10	50.97	47.24	41.00
14.00	DISCHG	39.04	36.17	34.55	33.27	30.60	29.74	27.56	26.77	25.48	24.06
16.00	DISCHG	23.61	22.30	21.93	21.05	20.18	19.90	18.93	18.34	18.02	17.47
18.00	DISCHG	17.29	16.64	16.25	15.98	15.43	15.25	14.71	14.38	14.23	14.90
20.00	DISCHG	13.93	13.51	13.25	13.04	12.60	12.45	12.33	12.26	12.10	11.66
22.00	DISCHG	11.52	11.39	11.33	11.20	10.87	10.77	10.64	10.58	10.49	10.27
24.00	DISCHG	10.15	4.60	1.10	0.22	0.04	0.01	0.00			

SUBROUTINE REACH   CROSS SECTION 7
LENGTH= 439.00   INPUT COEFFICIENT= 0.0000   INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 15.973   AVERAGE ROUTING COEFF= 0.9038   NUMBER OF ROUTINGS= 0.03
88888 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.98	582.397	1.79

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.30

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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8.00	DISCHG	4.29	4.98	5.59	6.23	7.13	7.81	9.02	10.82	11.08	12.73
10.00	DISCHG	13.87	17.00	19.41	22.19	27.52	30.47	42.49	51.63	140.12	428.95
12.00	DISCHG	580.81	357.67	156.80	129.42	56.09	71.94	58.56	51.22	47.37	41.22
14.00	DISCHG	39.11	36.27	34.60	33.31	30.69	29.73	27.63	26.31	25.31	24.11
16.00	DISCHG	23.62	22.35	22.55	21.07	20.21	19.91	18.96	18.35	18.03	17.49
18.00	DISCHG	17.13	16.66	16.27	15.99	15.45	15.26	14.72	14.39	14.23	14.01
20.00	DISCHG	13.93	13.52	13.26	13.04	12.61	12.46	12.33	12.26	12.10	11.63
22.00	DISCHG	11.53	11.40	11.33	11.20	10.88	10.77	10.65	10.59	10.49	10.25
24.00	DISCHG	10.15	4.50	1.22	0.25	0.35	0.01	0.00			

SUBROUTINE RUNOFF CROSS SECTION 7
AREA= 0.02 INPUT RUNOFF CURVE= 80.0 TIME OF CONCENTRATION= 0.09
33333 IN PEAK - MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.92	37.561	(RUNOFF)
12.90	3.857	(RUNOFF)
13.90	2.181	(RUNOFF)
14.30	1.910	(RUNOFF)
14.90	1.660	(RUNOFF)
15.90	1.318	(RUNOFF)
16.90	1.112	(RUNOFF)
17.90	0.966	(RUNOFF)
18.90	0.852	(RUNOFF)
19.90	0.779	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
6.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.09	0.10	0.13
8.00	DISCHG	0.15	0.19	0.22	0.27	0.31	0.34	0.42	0.45	0.55	0.61
10.00	DISCHG	0.65	0.07	0.96	1.29	1.45	1.55	2.58	2.79	20.79	31.64
12.00	DISCHG	35.58	7.41	7.11	4.47	3.75	3.76	2.70	2.70	2.24	2.13
14.00	DISCHG	2.13	1.89	1.89	1.68	1.63	1.64	1.43	1.43	1.33	1.30
16.00	DISCHG	1.30	1.18	1.18	1.12	1.10	1.10	1.01	1.01	0.97	0.96
18.00	DISCHG	0.96	0.90	0.90	0.86	0.85	0.85	0.79	0.79	0.78	0.77
20.00	DISCHG	0.77	0.73	0.73	0.70	0.69	0.69	0.68	0.68	0.65	0.64
22.00	DISCHG	0.64	0.63	0.63	0.60	0.60	0.60	0.59	0.59	0.57	0.57
24.00	DISCHG	0.56	0.01								

SUBROUTINE ADDHYD CROSS SECTION 7
INPUT HYDROGRAPHS- 6,7 OUTPUT HYDROGRAPH= 1
33333 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.90	619.082	1.66

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.12

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.16	0.37	0.60
6.00	DISCHG	0.83	1.09	1.34	1.60	1.93	2.21	2.61	2.96	3.41	3.99
8.00	DISCHG	4.44	5.17	5.81	6.50	7.46	8.14	9.44	10.47	11.63	13.39
10.00	DISCHG	14.52	17.89	20.37	23.43	28.97	32.02	45.07	54.42	160.91	450.62
12.00	DISCHG	616.40	365.08	193.91	133.89	89.84	75.70	61.27	53.91	49.61	43.34
14.00	DISCHG	41.24	38.15	36.49	34.99	32.32	31.40	29.07	27.74	26.84	25.41
16.00	DISCHG	24.93	23.53	22.74	22.18	21.31	21.01	19.97	19.37	19.00	18.44
18.00	DISCHG	18.24	17.56	17.15	16.94	16.29	16.10	15.52	15.19	15.01	14.70

24[illegible]	DISCHG	10.[illegible]	[illegible].80	1.22	0.25	[illegible]05	0.01	0.00

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

90

TR-20 HYDROLOGY

PROGRAM DATE — FEB. 14, 1974

S/360

23

EXECUTIVE CONTROL CARD   OPERATION LIST   PASS= 1

LISTING OF DATA IN CORE

0   WEST DIVERSION CHANNEL   PERMITTING

VELOCITY INCREMENT 0.2000

1 CTABLE

8	0.0000	0.0900	0.1400	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	1	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000

9 ENDTBL

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	2	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
8		0.5000	5.5000	3.0000
8		1.0000	18.9000	7.0000
8		1.5000	40.4000	12.0000
8		2.0000	70.6000	18.0000
8		2.5000	110.6000	25.0000
8		3.0000	161.7000	33.0000
8		4.0000	297.6000	52.0000

9 ENDTBL

TIME INCREMENT

4 DIMHYD

8	1.0000	0.9900	0.9300	0.8600	0.7200
8	0.6800	0.5600	0.4500	0.3900	0.3300
8	0.2800	0.2410	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0530	0.0470	0.0400	0.0340	0.0290
8	0.0250	0.0210	0.0190	0.0150	0.0130
8	0.0110	0.0090	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000

9 ENDTBL

COMPUTED PEAK K FACTOR = 484.00

TIME INCREMENT

5 RAINFL 1 0.5000

8	0.0000	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1220	0.1250	0.1400	0.1560
8	0.1740	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5930	0.6240	0.6540	0.6820
8	0.7050	0.7270	0.7480	0.7670	0.7840
8	0.8000	0.8160	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9260	0.9360	0.9460	0.9550	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000

9 ENDTBL

TIME INCREMENT

5 RAINFL 2 0.0200

8	0.0000	0.0100	0.0200	0.0200	0.0300
8	0.0400	0.0500	0.0600	0.0700	0.0800
8	0.1000	0.1100	0.1300	0.1400	0.1700
8	0.1900	0.2200	0.2700	0.3300	0.4400
8	0.5200	0.6000	0.6300	0.6600	0.6800
8	0.7000	0.7200	0.7400	0.7600	0.7700
8	0.7900	0.8000	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9800	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

TIME INCREMENT

5 RAINFL 3 0.5000

8	0.0000	0.0053	0.0108	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0483	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1089	0.1203	0.1328	0.1467	0.1625
8	0.1803	0.2042	0.2351	0.2833	0.6632
8	0.7351	0.7724	0.7989	0.8157	0.8380
8	0.8538	0.8676	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9513	0.9581	0.9653	0.9717	0.9777
8	0.9835	0.9891	0.9947	1.0000	1.0000

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1   1         1       0.1486     75.5000       0.64001 1 0 0 0 0
6 REACH  3   2    1    2    2533.0000      0.0000       1.00001 1 0 0 0 0
6 RUNOFF 1   2         3       0.0753     73.1000       0.31001 1 0 0 0 0
6 ADDHYD 4   2    2 3  4                                      1 1 0 0 0 0
  ENDATA

END OF LISTING
```

PASS= 1

```
EXECUTIVE CONTROL CARD        OPERATION  INCREM,      MAIN TIME INCREMENT=  0.20
EXECUTIVE CONTROL CARD        OPERATION  COMPUT,      FROM XSECTN/STRUCT   1/ 0     TO XSECTN/STRUCT   2/ 0
        STARTING TIME=  0.00  RAIN DEPTH=  5.30      RAIN DURATION=  1.00      RAIN TABLE NO.= 3      SOIL CONDITION= 2
        ALTERNATE NO.= 0      STORM NO.= 0
```

```
SUBROUTINE RUNOFF    CROSS SECTION   1
           AREA=   0.33     INPUT RUNOFF CURVE-  75.5     TIME OF CONCENTRATION=  0.64
00000 IN PEAK - MAXI =  131

      PEAK TIMES              PEAK DISCHARGES            PEAK ELEVATIONS
        12.23                    175.556                    (RUNOFF)

                     HYDROGRAPH, TZERO=   0.00      DELTA T= 0.20       DRAINAGE AREA=   0.15
```

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
8.00	DISCHG	0.00	0.03	0.11	0.26	0.46	0.73	0.96	1.29	1.62	2.02
10.00	DISCHG	2.47	3.06	3.75	4.59	5.69	7.05	8.86	11.76	19.99	59.64
12.00	DISCHG	129.92	174.74	151.50	106.13	74.30	53.27	40.26	32.06	26.70	22.93
14.00	DISCHG	20.17	18.36	17.08	16.11	15.23	14.36	13.63	12.89	12.25	11.71
16.00	DISCHG	11.22	10.81	10.37	9.99	9.66	9.36	9.10	8.78	8.51	8.26
18.00	DISCHG	8.07	7.91	7.70	7.51	7.34	7.16	7.00	6.82	6.67	6.55
20.00	DISCHG	6.46	6.37	6.25	6.13	6.00	5.86	5.76	5.69	5.64	5.55
22.00	DISCHG	5.43	5.33	5.27	5.22	5.15	5.05	4.98	4.93	4.85	4.83
24.00	DISCHG	4.74	4.20	2.83	1.45	0.67	0.32	0.15	0.07	0.03	0.01
26.00	DISCHG	0.00									

```
SUBROUTINE REACH     CROSS SECTION   2
           LENGTH=   2533.00     INPUT COEFFICIENT=  0.0030     INPUT ROUTINGS=  1.00

           AVERAGE WATER VELOCITY=   4.709      AVERAGE ROUTING COEFF= 0.7348      NUMBER OF ROUTINGS=  0.55
00000 IN PEAK - MAXI =  131

      PEAK TIMES              PEAK DISCHARGES            PEAK ELEVATIONS
        12.39                    161.446                     -3.00

                     HYDROGRAPH, TZERO=   0.00      DELTA T= 0.20       DRAINAGE AREA=   0.15
```

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.01	0.05	0.16	0.33	0.54	0.78	1.06	1.38	1.75
10.00	DISCHG	2.16	2.64	3.25	4.02	4.95	6.13	7.65	9.95	14.75	34.92
12.00	DISCHG	84.11	141.63	161.36	134.92	97.30	68.98	50.15	38.29	30.75	25.76
14.00	DISCHG	22.24	19.77	18.03	16.82	15.85	14.97	14.15	13.40	12.71	12.10
16.00	DISCHG	11.57	11.10	10.69	10.26	9.90	9.58	9.29	9.00	8.70	8.44
18.00	DISCHG	8.23	8.04	7.85	7.65	7.46	7.28	7.11	6.94	6.77	6.64
20.00	DISCHG	6.53	6.44	6.33	6.21	6.09	5.95	5.83	5.74	5.63	5.61
22.00	DISCHG	5.51	5.40	5.32	5.26	5.20	5.12	5.03	4.97	4.91	4.87
24.00	DISCHG	4.80	4.54	3.71	2.40	1.26	0.61	0.29	0.14	0.06	0.03
26.00	DISCHG	0.00									

```
SUBROUTINE RUNOFF    CROSS SECTION   2
           AREA=   0.08     INPUT RUNOFF CURVE=  77.1     TIME OF CONCENTRATION-  0.31
00000 IN PEAK - MAXI =  126
```

TIME			HYDROGRAPH, TZERO=	0.00		DELTA T= 0.20		DRAINAGE AREA=	0.08		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.02	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.04	0.14	0.27	0.43	0.59	0.81
10.00	DISCHG	1.01	1.36	1.76	2.15	2.93	3.50	4.98	6.77	55.79	68.33
12.00	DISCHG	108.12	83.15	39.90	28.63	18.65	15.32	13.03	11.06	10.42	8.93
14.00	DISCHG	8.45	7.99	7.54	7.34	6.73	6.51	6.16	5.77	5.64	5.31
16.00	DISCHG	5.20	4.97	4.75	4.67	4.47	4.40	4.23	4.07	4.01	3.89
18.00	DISCHG	3.83	3.73	3.61	3.57	3.44	3.39	3.30	3.21	3.18	3.12
20.00	DISCHG	3.11	3.04	2.96	2.93	2.82	2.79	2.76	2.74	2.72	2.62
22.00	DISCHG	2.58	2.56	2.54	2.52	2.45	2.42	2.40	2.34	2.36	2.31
24.00	DISCHG	2.28	1.33	0.30	0.05	0.01	0.00				

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
DDDDD IN PEAK - HALF = 131

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.22	224.953	3.47

TIME			HYDROGRAPH, TZERO=	0.00		DELTA T= 0.20		DRAINAGE AREA=	0.22		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.03	0.01	0.04	0.16	0.37	0.67	1.05	1.49	1.97	2.56
10.00	DISCHG	3.17	4.00	5.01	6.17	7.87	9.63	12.63	16.62	30.54	103.29
12.00	DISCHG	192.23	224.83	201.76	163.55	115.95	86.30	63.13	49.34	41.17	34.74
14.00	DISCHG	30.72	27.71	25.57	24.16	22.58	21.48	20.28	19.18	18.34	17.41
16.00	DISCHG	16.77	16.08	15.43	14.93	14.37	13.97	13.52	13.07	12.71	12.32
18.00	DISCHG	12.05	11.76	11.46	11.22	10.99	10.62	10.41	10.15	9.95	9.75
20.00	DISCHG	9.63	9.47	9.29	9.14	8.91	8.74	8.59	8.49	8.40	8.23
22.00	DISCHG	8.04	7.96	7.86	7.78	7.64	7.53	7.43	7.34	7.23	7.18
24.00	DISCHG	7.08	5.87	4.01	2.46	1.28	0.61	0.29	0.14	0.06	0.03
26.00	DISCHG	0.00									

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

EAST DIVERSION CHANNEL - PERMITTING

07-02-85

TR-20 HYDROLOGY

59

PROGRAM DATE - FEB. 14, 1974

3/360

LISTING OF DATA IN CORE

1   EAST DIVERSION CHANNEL - PERMITTING

1 CTABLE   VELOCITY INCREMENT 0.2000

8	0.0000	0.0800	0.1800	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

2 XSECTN   XSECTN NO. 1   DRAINAGE AREA 1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000

9 ENDTBL

2 XSECTN   XSECTN NO. 2   DRAINAGE AREA 1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000
8	0.5000	24.5000	2.5000
8	1.0000	85.0000	6.0000
8	1.5000	188.9000	10.5000

9 ENDTBL

2 XSECTN   XSECTN NO. 3   DRAINAGE AREA 1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000
8	0.5000	44.6000	2.5000
8	1.0000	155.6200	5.0000

```
8                       2.5000     950.0000     22.5000
9 ENDTBL

                 TIME INCREMENT
4 DIMHYD

8              0.0000      0.0300      0.1000      0.1300      0.3100
8              0.4700      0.6600      0.8200      0.9300      0.9900
8              1.0000      0.9900      0.9300      0.3600      0.7800
8              0.6900      0.5600      0.4600      0.3900      0.3300
8              0.2800      0.2400      0.2070      0.1740      0.1470
8              0.1260      0.1070      0.0910      0.0770      0.0660
8              0.0550      0.0475      0.0409      0.0340      0.0290
8              0.0250      0.0210      0.0180      0.0150      0.0130
8              0.0110      0.0090      0.0080      0.0070      0.0060
8              0.0050      0.0040      0.0030      0.0020      0.0010
8              0.0003      0.0000      0.0000      0.0000      0.0000
9 ENDTBL
  COMPUTED PEAK K FACTOR =  484.00


                 TIME INCREMENT
5 RAINFL 1                 0.5000

8              0.0000      0.0080      0.0170      0.0260      0.0350
8              0.0450      0.0550      0.0650      0.0760      0.0870
8              0.0990      0.1220      0.1250      0.1400      0.1560
8              0.1740      0.1940      0.2190      0.2540      0.3030
8              0.4150      0.5830      0.6240      0.6540      0.6820
8              0.7050      0.7270      0.7480      0.7670      0.7850
8              0.8000      0.8160      0.8300      0.8440      0.8570
8              0.8700      0.8820      0.8930      0.9050      0.9160
8              0.9260      0.9360      0.9460      0.9550      0.9650
8              0.9740      0.9830      0.9920      1.0000      1.0000
9 ENDTBL

                 TIME INCREMENT
5 RAINFL 2                 0.0200

8              0.0000      0.0100      0.0200      0.0200      0.0300
8              0.0400      0.0500      0.0600      0.0700      0.0800
8              0.1000      0.1100      0.1300      0.1400      0.1700
8              0.1900      0.2200      0.2700      0.3500      0.4400
8              0.5200      0.6000      0.6300      0.6600      0.6800
8              0.7000      0.7200      0.7400      0.7600      0.7700
8              0.7900      0.8000      0.8200      0.8300      0.8490
8              0.8500      0.8700      0.8830      0.8900      0.9000
8              0.9100      0.9200      0.9300      0.9400      0.9500
8              0.9567      0.9633      0.9700      0.9800      0.9900
8              1.0000      1.0000      1.0000      1.0000      1.0000
9 ENDTBL

                 TIME INCREMENT
5 RAINFL 3                 0.5000

8              0.0000      0.0053      0.0103      0.0166      0.0223
```

8	0.1089	0.1203	0.1128	0.1467	0.3625
8	0.1808	0.2042	0.2153	0.2333	0.6632
8	0.7351	0.7724	0.7989	0.8197	0.8380
8	0.8538	0.8676	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9519	0.9588	0.9653	0.9717	0.9773
8	0.9835	0.9892	0.9947	1.0060	1.0000

9 ENDTBL

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1   1         1      0.0356    70.0000     0.3200 1 1 0 0 0 0
6 REACH  3   2     1   2   1240.0000     0.0000     1.0000 1 1 0 0 0 0
6 RUNOFF 1   2         3      0.0129    70.0000     0.1500 1 1 0 0 0 0
6 ADDHYD 4   2     2 3 4                                   1 1 0 0 0 0
6 REACH  3   3     4   5    690.0000     0.0000     1.0000 1 1 0 0 0 0
6 RUNOFF 1   3         6      0.0094    70.0000     0.1300 1 1 0 0 0 0
6 ADDHYD 4   3     5 6 7                                   1 1 0 0 0 0
  ENDATA

END OF LISTING
```

EXECUTIVE CONTROL CARD   OPERATION INCREM,   MAIN TIME INCREMENT= 0.20
EXECUTIVE CONTROL CARD   OPERATION COMPUT,   FROM XSECT/STRUCT 1/ 0   TO XSECT/STRUCT 3/ 0
STARTING TIME= 0.00   RAIN DEPTH= 5.50   RAIN DURATION= 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF   CROSS SECTION 1
AREA= 0.04   INPUT RUNOFF CURVE= 70.0   TIME OF CONCENTRATION= 0.32
00000 IN PEAK - MAXI = 120

PEAK TIMES 12.04   PEAK DISCHARGES 45.089   PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TIBEG= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.04

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10
10.00	DISCHG	0.18	0.23	0.44	0.60	0.38	1.12	1.56	2.15	5.77	26.50
12.00	DISCHG	44.64	36.93	17.70	12.71	8.37	6.74	5.19	4.53	4.03	3.93
14.00	DISCHG	3.76	3.55	3.35	3.26	3.00	2.89	2.73	2.37	2.33	2.33
16.00	DISCHG	2.31	2.22	2.12	2.03	2.00	1.96	1.89	1.82	1.79	1.73
18.00	DISCHG	1.71	1.67	1.62	1.60	1.54	1.52	1.49	1.44	1.42	1.40
20.00	DISCHG	1.39	1.36	1.33	1.31	1.27	1.25	1.24	1.23	1.22	1.15
22.00	DISCHG	1.15	1.13	1.14	1.17	1.10	1.09	1.08	1.07	1.06	1.04
24.00	DISCHG	1.02	0.82	0.15	0.03	0.01	0.00				

SUBROUTINE REACH   CROSS SECTION 2
LENGTH= 1240.00   INPUT COEFFICIENT= 0.0000   INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 11.276   AVERAGE ROUTING COEFF= 0.8690   NUMBER OF ROUTINGS= 0.13
00000 IN PEAK - MAXI = 125

PEAK TIMES 12.06   PEAK DISCHARGES 43.325   PEAK ELEVATIONS 0.65

HYDROGRAPH, TIBEG= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.04

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09
10.00	DISCHG	0.17	0.24	0.42	0.58	0.84	1.09	1.53	2.27	5.32	23.75
12.00	DISCHG	42.23	37.41	20.17	13.38	8.95	7.09	5.32	5.07	4.63	4.03
14.00	DISCHG	3.79	3.57	3.37	3.27	3.03	2.91	2.76	2.59	2.52	2.39
16.00	DISCHG	2.32	2.23	2.13	2.09	2.01	1.97	1.93	1.83	1.79	1.74
18.00	DISCHG	1.72	1.67	1.62	1.60	1.55	1.52	1.49	1.44	1.42	1.40
20.00	DISCHG	1.39	1.36	1.33	1.31	1.27	1.25	1.24	1.23	1.22	1.19
22.00	DISCHG	1.16	1.15	1.14	1.13	1.10	1.09	1.08	1.07	1.06	1.04
24.00	DISCHG	1.03	0.67	0.21	0.05	0.01	0.00				

SUBROUTINE RUNOFF   CROSS SECTION 2
AREA= 0.01   INPUT RUNOFF CURVE= 70.0   TIME OF CONCENTRATION= 0.15
00000 IN PEAK - MAXI = 120

PEAK TIMES 11.95   PEAK DISCHARGES [illegible]   PEAK ELEVATIONS (RUNOFF)

TIME		HYDROGRAPH, TZERO= 0.00					DELTA T= 0.20		DRAINAGE AREA= 0.01		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05
10.00	DISCHG	0.00	0.15	0.19	0.27	0.38	0.49	0.20	0.98	5.25	14.95
12.00	DISCHG	19.61	6.16	4.34	3.42	2.34	2.31	1.74	1.67	1.52	1.33
14.00	DISCHG	1.33	1.20	1.10	1.12	1.03	1.03	0.92	0.91	0.87	0.83
16.00	DISCHG	0.83	0.76	0.75	0.73	0.70	0.70	0.65	0.65	0.63	0.61
18.00	DISCHG	0.61	0.58	0.56	0.56	0.54	0.54	0.51	0.51	0.51	0.50
20.00	DISCHG	0.50	0.49	0.47	0.46	0.45	0.45	0.44	0.44	0.43	0.42
22.00	DISCHG	0.42	0.41	0.41	0.40	0.39	0.39	0.38	0.38	0.38	0.37
24.00	DISCHG	0.37	0.04	0.00							

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
ERROR IN PEAK - MAXI = 126

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.03	61.907	0.80

TIME		HYDROGRAPH, TZERO= 0.00					DELTA T= 0.20		DRAINAGE AREA= 0.05		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.35
10.00	DISCHG	0.25	0.43	0.62	0.85	1.22	1.54	2.39	3.25	10.57	38.70
12.00	DISCHG	61.85	41.57	24.51	16.05	11.29	9.31	7.66	6.65	6.37	5.41
14.00	DISCHG	5.12	4.77	4.56	4.39	4.06	3.94	3.68	3.50	3.39	3.21
16.00	DISCHG	3.15	2.99	2.89	2.82	2.71	2.67	2.55	2.47	2.43	2.36
18.00	DISCHG	2.33	2.25	2.20	2.16	2.09	2.07	2.00	1.95	1.93	1.90
20.00	DISCHG	1.89	1.84	1.80	1.77	1.72	1.70	1.69	1.67	1.65	1.60
22.00	DISCHG	1.58	1.56	1.55	1.53	1.49	1.45	1.46	1.45	1.44	1.41
24.00	DISCHG	1.39	0.72	0.21	0.05	0.01	0.00				

SUBROUTINE REACH CROSS SECTION 3
LENGTH= 690.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 18.677 AVERAGE ROUTING COEFF= 0.9166 NUMBER OF ROUTINGS= 0.05
ERROR IN PEAK - MAXI = 126

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.02	60.903	0.57

TIME		HYDROGRAPH, TZERO= 0.00					DELTA T= 0.20		DRAINAGE AREA= 0.05		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.14
10.00	DISCHG	0.25	0.42	0.61	0.84	1.21	1.53	2.39	3.21	10.22	37.37
12.00	DISCHG	60.76	44.43	25.40	17.16	11.55	9.41	7.74	6.74	6.19	5.49
14.00	DISCHG	5.14	4.74	4.57	4.39	4.08	3.94	3.69	3.51	3.39	3.22
16.00	DISCHG	3.15	3.00	2.89	2.82	2.72	2.67	2.56	2.46	2.43	2.36
18.00	DISCHG	2.33	2.26	2.20	2.16	2.09	2.07	2.05	1.95	1.93	1.90
20.00	DISCHG	1.89	1.85	1.81	1.74	1.72	1.70	1.65	1.67	1.65	1.63

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SUBROUTINE RUNOFF     CROSS SECTION    3
           AREA=   0.01      INPUT RUNOFF CURVE=  70.0      TIME OF CONCENTRATION=  0.19
88888 IN PEAK - MAXI =  123

           PEAK TIMES                    PEAK DISCHARGES                  PEAK ELEVATIONS
             11.96                           14.356                         (RUNOFF)

   TIME                             HYDROGRAPH, TZERO=   0.00         DELTA T= 0.20        DRAINAGE AREA=   0.01
   0.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   2.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   4.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   6.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   8.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.01      0.04
  10.00    DISCHG      0.06      0.10      0.14      0.19      0.27      0.33      0.55      0.70      2.81     10.09
  12.00    DISCHG     13.57      5.89      3.35      2.74      1.78      1.70      1.33      1.23      1.15      0.99
  14.00    DISCHG      0.98      0.89      0.87      0.84      0.76      0.76      0.67      0.67      0.65      0.63
  16.00    DISCHG      0.61      0.56      0.55      0.54      0.52      0.52      0.48      0.47      0.47      0.45
  18.00    DISCHG      0.43      0.43      0.42      0.42      0.40      0.40      0.38      0.38      0.37      0.37
  20.00    DISCHG      0.37      0.35      0.35      0.34      0.33      0.33      0.32      0.32      0.32      0.31
  22.00    DISCHG      0.30      0.30      0.30      0.30      0.29      0.29      0.28      0.28      0.28      0.27
  24.00    DISCHG      0.27      0.06      0.00

SUBROUTINE ADDHYD     CROSS SECTION    3
           INPUT HYDROGRAPHS= 5,6      OUTPUT HYDROGRAPH= 7
88888 IN PEAK - MAXI =  126

           PEAK TIMES                    PEAK DISCHARGES                  PEAK ELEVATIONS
             12.01                           74.634                           0.63

   TIME                             HYDROGRAPH, TZERO=   0.00         DELTA T= 0.20        DRAINAGE AREA=   0.06
   0.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   2.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   4.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   6.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
   8.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.06      0.12
  10.00    DISCHG      0.31      0.52      0.75      1.03      1.48      1.85      2.90      3.92     13.03     67.67
  12.00    DISCHG     74.63     50.31     28.75     19.90     13.23     11.11      9.07      7.57      7.35      6.44
  14.00    DISCHG      6.11      5.68      5.44      5.23      4.84      4.70      4.37      4.18      4.04      3.81
  16.00    DISCHG      3.76      3.56      3.46      3.36      3.23      3.19      3.04      2.95      2.89      2.81
  18.00    DISCHG      2.70      2.68      2.62      2.58      2.50      2.47      2.39      2.33      2.30      2.27
  20.00    DISCHG      2.26      2.19      2.15      2.12      2.05      2.03      2.01      2.00      1.97      1.93
  22.00    DISCHG      1.90      1.85      1.85      1.83      1.78      1.76      1.74      1.73      1.72      1.69
  24.00    DISCHG      1.66      0.81      0.24      0.06      0.01      0.00


ENDCMP


ENDJOB CARD ENCOUNTERED.  END OF JOB.
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END OF . JOBS IN THIS RUN

EXECU — CONTROL CARS   OPERATION LIST

LISTING OF DATA IN CORE

1 BASIC INPUT FILE FOR TR20

VELOCITY INCREMENT 0.2000

1 ETABLE

8	0.0000	0.0300	0.1300	0.2300	0.3700
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8500	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

STRUCT NO.
3 STRUCT 1

	ELEVATION	DISCHARGE	STORAGE
8	1165.0000	0.0000	50.0000

9 ENDTBL

STRUCT NO.
3 STRUCT 2

	ELEVATION	DISCHARGE	STORAGE
8	1285.0000	0.0000	50.0000

9 ENDTBL

STRUCT NO.
3 STRUCT 3

	ELEVATION	DISCHARGE	STORAGE
8	1215.0000	0.0000	50.0000

9 ENDTBL

STRUCT NO.
3 STRUCT 4

ELEVATION DISCHARGE STORAGE

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8                              1198.0000      0.0000      50.0000
9 END

              STRUCT NO.
3 STRUCT           5

                               ELEVATION    DISCHARGE    STORAGE
8                              1330.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRUCT           6

                               ELEVATION    DISCHARGE    STORAGE
8                              1350.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRUCT           7

                               ELEVATION    DISCHARGE    STORAGE
8                              1150.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRUCT           8

                               ELEVATION    DISCHARGE    STORAGE
8                              1120.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRALCT          9

                               ELEVATION    DISCHARGE    STORAGE
8                              1230.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRUCT          10

                               ELEVATION    DISCHARGE    STORAGE
8                              1270.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRUCT          11

                               ELEVATION    DISCHARGE    STORAGE
8                              1205.0000      0.0000      50.0000
9 ENDTBL

              STRUCT NO.
3 STRUCT          12
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                              ELEVATION   DISCHARGE     STORAGE
 8                            1140.0000      0.0000     50.0000
 9 ENDTBL

          STRUCT NO.
 3 STRUCT     13

                              ELEVATION   DISCHARGE     STORAGE
 8                            1210.0000      0.0000     50.0000
 9 ENDTBL

          STRUCT NO.
 3 STRUCT     14

                              ELEVATION   DISCHARGE     STORAGE
 8                            1123.0000      0.0000     50.0000
 9 ENDTBL

          STRUCT NO.
 3 STRUCT     15

                              ELEVATION   DISCHARGE     STORAGE
 8                            1123.0000      0.0000     50.0000
 9 ENDTBL

                        TIME INCREMENT
 4 DIMHYD

 8                   0.0000      0.0300      0.1000      0.1900      0.3100
 8                   0.4700      0.6600      0.8200      0.9300      0.9900
 8                   1.0000      0.9900      0.9300      0.8600      0.7800
 8                   0.6800      0.5600      0.4600      0.3900      0.3300
 8                   0.2800      0.2410      0.2070      0.1740      0.1470
 8                   0.1260      0.1070      0.0910      0.0770      0.0660
 8                   0.0550      0.0470      0.0400      0.0340      0.0290
 8                   0.0250      0.0210      0.0180      0.0150      0.0130
 8                   0.0110      0.0090      0.0080      0.0070      0.0060
 8                   0.0050      0.0040      0.0030      0.0020      0.0010
 8                   0.0000      0.0000      0.0000      0.0000      0.0000
 9 ENDTBL

   COMPUTED PEAK K FACTOR =  484.00


                        TIME INCREMENT
 5 RAINFL 1                  0.5000

 8                   0.0000      0.0080      0.0170      0.0260      0.0350
 8                   0.0450      0.0550      0.0650      0.0760      0.0870
 8                   0.0990      0.1120      0.1250      0.1400      0.1560
 8                   0.1740      0.1940      0.2190      0.2540      0.3030
 8                   0.5150      0.5830      0.6240      0.6540      0.6820
 8                   0.7050      0.7270      0.7450      0.7670      0.7840
 8                   0.8000      0.8160      0.8300      0.8440      0.8570
 8                   0.8700      0.8820      0.8930      0.9050      0.9160
 8                   0.9260      0.9360      0.9460      0.9550      0.9650
 8                   0.9740      0.9830      0.9920      1.0000      1.0000
 9 ENDTBL
```

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5 RAINFL            TIME INCREMENT
                        0.0200

8          0.0000      0.0100      0.0200      0.0200      0.0300
8          0.0400      0.0500      0.0600      0.0700      0.0800
8          0.1000      0.1100      0.1300      0.1400      0.1700
8          0.1900      0.2200      0.2700      0.3500      0.4400
8          0.5200      0.6000      0.6300      0.6600      0.6800
8          0.7000      0.7200      0.7400      0.7600      0.7800
8          0.7900      0.8000      0.8200      0.8300      0.8400
8          0.8500      0.8700      0.8800      0.8900      0.9000
8          0.9100      0.9200      0.9300      0.9400      0.9500
8          0.9567      0.9633      0.9700      0.9800      0.9900
8          1.0000      1.0000      1.0000      1.0000      1.0000
9 ENDTBL

                    TIME INCREMENT
5 RAINFL 3              0.5000

8          0.0000      0.0053      0.0108      0.0164      0.0223
8          0.0284      0.0347      0.0414      0.0483      0.0555
8          0.0632      0.0712      0.0797      0.0887      0.0984
8          0.1089      0.1203      0.1328      0.1467      0.1625
8          0.1808      0.2042      0.2351      0.2833      0.6632
8          0.7351      0.7724      0.7989      0.8197      0.8380
8          0.8533      0.8676      0.8801      0.8914      0.9019
8          0.9115      0.9206      0.9291      0.9371      0.9446
8          0.9513      0.9583      0.9653      0.9717      0.9777
8          0.9836      0.9892      0.9947      1.0000      1.0000
9 ENDTBL
```

```
6 RUNOFF 1     1       1     0.0120     50.0000     0.13001 0 0 0 0 0
6 RUNOFF 1     2       6     0.0074     80.0000     0.13001 0 0 0 0 0
6 RUNOFF 1     3       7     0.2600     74.0000     0.43001 0 0 0 0 0
6 ADDHYD 4     3 6 7 5                                    1 0 0 0 0 0
6 RUNOFF 1     4       6     0.0320     80.0000     0.30001 0 0 0 0 0
6 ADDHYD 4     4 5 6 2                                    1 0 0 0 0 0
6 RUNOFF 1     5       5     0.0052     78.0000     0.09201 0 0 0 0 0
6 RUNOFF 1     6       6     0.0270     78.0000     0.45001 0 0 0 0 0
6 ADDHYD 4     6 5 6 4                                    1 0 0 0 0 0
6 RUNOFF 1     7       5     0.0330     76.0000     0.78001 0 0 0 0 0
6 ADDHYD 4     7 4 5 6                                    1 0 0 0 0 0
6 RUNOFF 1     8       7     0.0512     78.0000     0.20301 0 0 0 0 0
6 ADDHYD 4     8 6 7 3                                    1 0 0 0 0 0
6 RUNOFF 1     9       5     0.0210     78.0000     0.43001 0 0 0 0 0
6 RUNOFF 1    10       6     0.1100     85.0000     0.46001 0 0 0 0 0
6 ADDHYD 4    10 5 6 4                                    1 0 0 0 0 0
6 RUNOFF 1    11       5     0.0070     74.0000     0.33001 0 0 0 0 0
6 ADDHYD 4    11 4 5 6                                    1 0 0 0 0 0
6 RUNOFF 1    12       5     0.0130     76.0000     0.57001 0 0 0 0 0
6 RUNOFF 1    13       7     0.0160     74.0000     0.53001 0 0 0 0 0
6 ADDHYD 4    13 5 7 4                                    1 0 0 0 0 0
6 ADDHYD 4    13 4 6 5                                    1 0 0 0 0 0
6 RUNOFF 1    14       6     0.0156     74.0000     0.45001 0 0 0 0 0
6 ADDHYD 4    14 5 6 4                                    1 0 0 0 0 0
6 RUNOFF 1    15       5     0.0082     78.0000     0.00561 0 0 0 0 0
  ENDATA

END OF LISTING
```

```
EXEC    CONTROL CARD          OPERATION  INCREM.     MAIN 1     INCREMENT=  0.20
EXECUT  CONTROL CARD          OPERATION  COMPUT.     FROM XSECT/STRUCT    0/  1      TO XSECTN/STRUCT    0/  1
        STARTING TIME=  0.00  RAIN DEPTH=  5.50     RAIN DURAT=   1.00     RAIN TABLE NO.= 3    SOIL CONDITION= 2
        ALTERNATE NO.= 0      STORM NO.= 0

SUBROUTINE RUNOFF    STRUCTURE   1
        AREA=   0.01     INPUT RUNOFF CURVE=  80.9      TIME OF CONCENTRATION=  0.19
***** IN PEAK - MAXI =  124

        PEAK TIMES            PEAK DISCHARGES            PEAK ELEVATIONS
          11.95                  24.595                    (RUNOFF)

  ENDCMP
```

Channel M

```
EXECU-     CONTROL CARD              OPERATION  COMPUT,      FROM XS    /STRUCT   0/  2      TO XSECTN/STRUCT   0/  4
            TING TIME=   0.00        RAIN DEPTH=   5.50      RAIN DURATIO   1.00     RAIN TABLE NO.= 3     SOIL CONDITION= 2
            RNATE NO.= 0             STORM NO.= 0                                                       PASS=  2

SUBROUTINE RUNOFF    STRUCTURE    2
           AREA=   0.01      INPUT RUNOFF CURVE=  80.0      TIME OF CONCENTRATION=  0.13
00000 IN PEAK - MAXI =  123

           PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             11.93                       16.030                    (RUNOFF)
             15.90                        0.573                    (RUNOFF)

SUBROUTINE RUNOFF    STRUCTURE    3
           AREA=   0.28      INPUT RUNOFF CURVE=  74.0      TIME OF CONCENTRATION=  0.49
00000 IN PEAK - MAXI =  129

           PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             12.15                      330.431                    (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE    3
           INPUT HYDROGRAPHS= 6,7     OUTPUT HYDROGRAPH= 5
00000 IN PEAK - MAXI =  129

           PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             12.14                      336.468                    (NULL)

SUBROUTINE RUNOFF    STRUCTURE    4
           AREA=   0.03      INPUT RUNOFF CURVE=  80.0      TIME OF CONCENTRATION=  0.30
00000 IN PEAK - MAXI =  125

           PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             12.00                       58.049                    (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE    4
           INPUT HYDROGRAPHS= 4,5     OUTPUT HYDROGRAPH= 2
00000 IN PEAK - MAXI =  129

           PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             12.11                      384.830                    (NULL)

ENDCMP
```

Channel P

Channel S

Channel T

9

```
                                                                                                          PASS=  3
EXEC    VE CONTROL CARD            OPERATION  COMPUT,      FROM X    IN/STRUCT    0/  5      NO ASECTN/STRUCT    0/  3
        STARTING TIME=  0.00    RAIN DEPTH=  3.50      RAIN DURAT       1.00      RAIN TABLE NO.= 3      SOIL CONDITION= 2
        ALTERNATE NO.= 0           STORM NO.= 0

SUBROUTINE RUNOFF    STRUCTURE   5                                                            Channel L
             AREA=   0.01    INPUT RUNOFF CURVE=  78.0     TIME OF CONCENTRATION=  0.09
***** IN PEAK - MAXI =  122

             PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
               11.91                        11.519                     (RUNOFF)
               12.90                         1.149                     (RUNOFF)
               13.90                         0.540                     (RUNOFF)
               14.30                         0.566                     (RUNOFF)
               14.90                         0.493                     (RUNOFF)
               15.90                         0.392                     (RUNOFF)
               16.90                         0.331                     (RUNOFF)
               17.90                         0.288                     (RUNOFF)
               18.90                         0.254                     (RUNOFF)
               19.90                         0.232                     (RUNOFF)

SUBROUTINE RUNOFF    STRUCTURE   6                                                            Slope Drain
             AREA=   0.03    INPUT RUNOFF CURVE=  78.0     TIME OF CONCENTRATION=  0.46
***** IN PEAK - MAXI =  127

             PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
               12.12                        39.554                     (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE   5
             INPUT HYDROGRAPHS= 5,6     OUTPUT HYDROGRAPH= 4
***** IN PEAK - MAXI =  127

             PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
               12.09                        47.945                     (NULL)

SUBROUTINE RUNOFF    STRUCTURE   7
             AREA=   0.03    INPUT RUNOFF CURVE=  78.0     TIME OF CONCENTRATION=  0.78
***** IN PEAK - MAXI =  132

             PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
               12.31                        37.135                     (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE   7
             INPUT HYDROGRAPHS= 4,5     OUTPUT HYDROGRAPH= 6
***** IN PEAK - MAXI =  132

             PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
               12.15                        77.047                     (NULL)

SUBROUTINE RUNOFF    STRUCTURE   8
             AREA=   0.00    INPUT RUNOFF CURVE=  78.0     TIME OF CONCENTRATION=  0.08
***** IN PEAK - MAXI =  122

             PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
               11.93                         2.551                     (RUNOFF)
               12.90                         0.265                     (RUNOFF)
               13.30                         0.109                     (RUNOFF)
```

```
     13.90                      0.140              (RUNOFF)
     14.30                      0.131              (RUNOFF)
     14.90                      0.114              (RUNOFF)
     15.30                      0.099              (RUNOFF)
     15.90                      0.090              (RUNOFF)
     16.90                      0.076              (RUNOFF)
     23.90                      0.044              (RUNOFF)

 SUBROUTINE ADDHYD   STRUCTURE   9                           Channel N
          INPUT HYDROGRAPHS= 6,7     OUTPUT HYDROGRAPH= 5
 20000 IN PEAK - MAXI =  132

          PEAK TIMES             PEAK DISCHARGES          PEAK ELEVATIONS
            12.13                    77.997                  (NULL)

  ENDCMP
```

7

```
                                                                                                PASS=  4
EXECUTIVE CONTROL CARD          OPERATION   COMPUT,     FROM XSECTN/STRUCT    0/  9     TO XSECTN/STRUCT    0/ 14
 STARTING TIME=  0.00         RAIN DEPTH=   5.30     RAIN DUR=    1=  1.00      RAIN TABLE NO.= 3      SOIL CONDITION= 2
 ALTERNATE NO.= 0             STORM NO.= 0

SUBROUTINE RUNOFF    STRUCTURE   9
          AREA=   0.02      INPUT RUNOFF CURVE=  73.0      TIME OF CONCENTRATION=  0.40
88888 IN PEAK - MAXI =  125

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.07                       12.761                       (RUNOFF)

SUBROUTINE RUNOFF    STRUCTURE  10
          AREA=   0.11      INPUT RUNOFF CURVE=  85.0      TIME OF CONCENTRATION=  0.46   Top Surface
88888 IN PEAK - MAXI =  125

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.10                      156.920                       (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE  10
          INPUT HYDROGRAPHS= 5,6      OUTPUT HYDROGRAPH= 4
88888 IN PEAK - MAXI =  128

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.10                      229.550                       (NULL)

SUBROUTINE RUNOFF    STRUCTURE  11
          AREA=   0.01      INPUT RUNOFF CURVE=  73.0      TIME OF CONCENTRATION=  0.33
88888 IN PEAK - MAXI =  125

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.03                       11.657                       (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE  11
          INPUT HYDROGRAPHS= 4,5      OUTPUT HYDROGRAPH= 6                          Channel K
88888 IN PEAK - MAXI =  128

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.09                      240.845                       (NULL)

SUBROUTINE RUNOFF    STRUCTURE  12
          AREA=   0.03      INPUT RUNOFF CURVE=  78.0      TIME OF CONCENTRATION=  0.57
88888 IN PEAK - MAXI =  129

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.19                       45.016                       (RUNOFF)

SUBROUTINE RUNOFF    STRUCTURE  13
          AREA=   0.02      INPUT RUNOFF CURVE=  78.0      TIME OF CONCENTRATION=  0.53
88888 IN PEAK - MAXI =  128

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            12.17                       22.470                       (RUNOFF)

SUBROUTINE ADDHYD    STRUCTURE  13                                                  Slope Drain
```

```
                INPUT HYDROGRAPHS= 5,7      OUTPUT HYDROGRAPH= 4
 3882   IN PEAK - MAXI =  127

                PEAK TIMES              PEAK DISCHARGES              PEAK ELEVATIONS
                  12.10                      67.451                       (NULL)

 SUBROUTINE ADDHYD    STRUCTURE  13
                INPUT HYDROGRAPHS= 4,5      OUTPUT HYDROGRAPH= 5
 38283 IN PEAK - MAXI =  129

                PEAK TIMES              PEAK DISCHARGES              PEAK ELEVATIONS
                  12.11                     303.522                       (NULL)

 SUBROUTINE RUNOFF    STRUCTURE  14
                AREA=   0.01     INPUT RUNOFF CURVE=  78.0     TIME OF CONCENTRATION=  0.46
 38822 IN PEAK - MAXI =  127

                PEAK TIMES              PEAK DISCHARGES              PEAK ELEVATIONS
                  12.12                      22.030                     (RUNOFF)

 SUBROUTINE ADDHYD    STRUCTURE  14
                INPUT HYDROGRAPHS= 5,6      OUTPUT HYDROGRAPH= 4
 38283 IN PEAK - MAXI =  129

                PEAK TIMES              PEAK DISCHARGES              PEAK ELEVATIONS
                  12.11                     325.046                       (NULL)

   ENDCMP
```

Channel U

Channel V

11

EXE   NE CONTROL CARD   OPERATION COMPUT.   FROM   TR/STRUCT 0/ 15   TO XSECTN/STRUCT 0/ 15
STARTING TIME= 0.00   RAIN DEPTH= 5.30   RAIN DURA= 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

Channel/W

SUBROUTINE RUNOFF   STRUCTURE 55
AREA= 0.03   INPUT RUNOFF CURVE= 73.0   TIME OF CONCENTRATION= 0.01
32220 IN PEAK - BAXI = 121

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.52	1.409	(RUNOFF)
12.31	0.333	(RUNOFF)
12.90	0.187	(RUNOFF)
13.30	0.129	(RUNOFF)
13.90	0.101	(RUNOFF)
14.30	0.093	(RUNOFF)
14.90	0.078	(RUNOFF)
15.30	0.063	(RUNOFF)
15.90	0.062	(RUNOFF)

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

12.

SCS TR-20 "Watershed Hydrology"

PASS- 1

```
EXECUTIVE CONTROL CARD        OPERATION  INCREM,     MAIN TIME INCREMENT=  0.20
EXECUTIVE CONTROL CARD        OPERATION  COMPUT,     FROM XSECTN/STRUCT   1/  0      TO XSECTN/STRUCT   1/  0
          STARTING TIME=  0.00    RAIN DEPTH=  5.50     RAIN DURATION=  1.00     RAIN TABLE NO.= 3     SOIL CONDITION= 2
          ALTERNATE NO.= 0        STORM NO.= 0

SUBROUTINE RUNOFF    CROSS SECTION   1
          AREA=   0.02     INPUT RUNOFF CURVE=  70.0     TIME OF CONCENTRATION=  0.26
XXXXX IN PEAK - MAXI =  125

          PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             12.00                      32.750                     (RUNOFF)
```

TIME		HYDROGRAPH, TZERO= 0.00					DELTA T= 0.20			DRAINAGE AREA= 0.02	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.30	0.00
4.00	DISCHG	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09
10.00	DISCHG	0.13	0.22	0.32	0.43	0.64	0.79	1.24	1.69	4.73	21.52
12.00	DISCHG	32.76	21.04	10.03	7.78	5.00	4.42	3.63	3.21	3.05	2.60
14.00	DISCHG	2.53	2.34	2.23	2.18	1.98	1.54	1.81	1.72	1.68	1.59
16.00	DISCHG	1.56	1.47	1.42	1.40	1.33	1.32	1.26	1.22	1.20	1.16
18.00	DISCHG	1.15	1.11	1.03	1.07	1.03	1.02	0.93	0.96	0.96	0.94
20.00	DISCHG	0.94	0.91	0.89	0.88	0.85	0.84	0.83	0.83	0.82	0.79
22.00	DISCHG	0.78	0.77	0.77	0.76	0.74	0.73	0.72	0.72	0.71	0.70
24.00	DISCHG	0.59	0.31	0.05	0.01	0.00					

```
SUBROUTINE RUNOFF    CROSS SECTION   1
          AREA=   0.01     INPUT RUNOFF CURVE=  70.0     TIME OF CONCENTRATION=  0.10
XXXXX IN PEAK - MAXI =  122

          PEAK TIMES                PEAK DISCHARGES             PEAK ELEVATIONS
             11.94                      18.334                     (RUNOFF)
             12.91                       2.093                     (RUNOFF)
             13.51                       1.160                     (RUNOFF)
             14.30                       1.029                     (RUNOFF)
             14.91                       0.900                     (RUNOFF)
             15.90                       0.719                     (RUNOFF)
             16.90                       0.613                     (RUNOFF)
             17.90                       0.532                     (RUNOFF)
             18.90                       0.471                     (RUNOFF)
             19.90                       0.432                     (RUNOFF)
```

TIME		HYDROGRAPH, TZERO= 0.00					DELTA T= 0.20			DRAINAGE AREA= 0.01	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.03	0.00	0.00	0.05	0.06	0.00	0.00	0.00	0.00	0.09
4.00	DISCHG	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.09
6.00	DISCHG	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.03	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.01	0.01
10.00	DISCHG	0.08	0.13	0.17	0.25	0.34	0.40	0.74	0.87	7.05	13.95
12.00	DISCHG	17.61	3.94	3.63	2.42	1.93	1.99	1.44	1.46	1.22	1.14
14.00	DISCHG	1.15	1.02	1.02	0.97	0.83	0.89	0.78	0.79	0.71	0.71

2	DISCHG	0.43	0.41	0.41	0.39	.35	0.33	0.39	0.33	0.35	0.36
2	DISCHG	0.36	0.35	0.33	0.34	.33	0.33	0.33	0.33	0.32	0.32
24	DISCHG	0.12	0.01								

SUBROUTINE ADDHYD CROSS SECTION 1

INPUT HYDROGRAPHS= 1,2 OUTPUT HYDROGRAPH= 3
33333 IN PEAK - MAXI = 125

PEAK TIMES 11.97 PEAK DISCHARGES 55.701 PEAK ELEVATIONS (NULL)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.04

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.13
10.00	DISCHG	0.21	0.35	0.50	0.70	0.98	1.19	1.98	2.56	11.73	35.48
12.00	DISCHG	50.37	24.98	11.77	10.20	6.98	6.41	5.12	4.05	4.27	3.75
14.00	DISCHG	3.66	3.35	3.25	3.09	2.87	2.83	2.59	2.50	2.41	2.29
16.00	DISCHG	2.27	2.12	2.07	2.01	1.94	1.92	1.81	1.77	1.74	1.69
18.00	DISCHG	1.68	1.61	1.58	1.55	1.50	1.49	1.43	1.40	1.39	1.37
20.00	DISCHG	1.37	1.32	1.30	1.27	1.23	1.22	1.21	1.21	1.18	1.14
22.00	DISCHG	1.14	1.12	1.12	1.10	1.07	1.06	1.05	1.05	1.01	1.06
24.00	DISCHG	1.01	0.32	0.05	0.01	0.00					

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.02 INPUT RUNOFF CURVE= 85.0 TIME OF CONCENTRATION= 0.43
33333 IN PEAK - MAXI = 127

PEAK TIMES 12.08 PEAK DISCHARGES 29.424 PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04
6.00	DISCHG	0.06	0.03	0.10	0.12	0.14	0.17	0.19	0.22	0.25	0.26
8.00	DISCHG	0.31	0.35	0.39	0.42	0.47	0.52	0.57	0.64	0.70	0.79
10.00	DISCHG	0.87	0.93	1.16	1.30	1.56	1.80	2.20	2.85	4.78	26.73
12.00	DISCHG	28.41	27.05	15.61	9.75	6.53	4.71	3.82	3.13	2.81	2.63
14.00	DISCHG	2.26	2.12	1.93	1.91	1.78	1.69	1.61	1.50	1.45	1.34
16.00	DISCHG	1.33	1.28	1.22	1.19	1.15	1.11	1.09	1.04	1.01	0.98
18.00	DISCHG	0.95	0.94	0.91	0.90	0.87	0.85	0.83	0.81	0.79	0.78
20.00	DISCHG	0.77	0.76	0.74	0.73	0.71	0.69	0.69	0.65	0.67	0.66
22.00	DISCHG	0.64	0.63	0.63	0.62	0.61	0.60	0.59	0.59	0.58	0.57
24.00	DISCHG	0.56	0.43	0.17	0.06	0.02	0.01	0.00			

SUBROUTINE ADDHYD CROSS SECTION 1
INPUT HYDROGRAPHS= 3,4 OUTPUT HYDROGRAPH= 5
33333 IN PEAK - MAXI = 127

PEAK TIMES 12.00 PEAK DISCHARGES 78.763 PEAK ELEVATIONS (NULL)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.05

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

6	DISCHG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	DISCHG	0.31	0.15	0.39	0.42	.47	0.52	0.57	0.64	0.73	0.92
10.[illegible]	DISCHG	1.08	1.25	1.66	2.00	.54	3.00	4.15	5.41	16.51	52.21
12.[illegible]	DISCHG	78.79	52.03	29.38	19.96	[illegible]	11.12	8.95	7.79	7.08	6.23
14.00	DISCHG	5.91	5.48	5.23	5.00	.65	4.51	4.19	4.00	3.85	3.67
16.00	DISCHG	3.59	3.40	3.29	3.20	3.08	3.06	2.89	2.91	2.75	2.67
18.00	DISCHG	2.65	2.55	2.49	2.44	2.37	2.34	2.26	2.21	2.19	2.15
20.00	DISCHG	2.14	2.08	2.04	2.00	1.94	1.92	1.99	1.89	1.85	1.80
22.00	DISCHG	1.78	1.76	1.75	1.72	1.68	1.66	1.64	1.63	1.62	1.59
24.00	DISCHG	1.57	0.73	0.23	0.07	0.02	0.01	0.00			

SUBROUTINE RUNOFF   CROSS SECTION   1
AREA= 0.02   INPUT RUNOFF CURVE= 75.0   TIME OF CONCENTRATION= 0.43
99999 IN PEAK - MAXI = 127

PEAK TIMES 12.11   PEAK DISCHARGES 21.785   PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.01	0.03	0.05	0.08	0.11	0.15	0.19	0.23
10.00	DISCHG	0.28	0.35	0.45	0.53	0.69	0.84	1.09	1.50	2.76	10.97
12.00	DISCHG	20.58	20.82	12.37	7.94	5.40	3.94	3.23	2.66	2.43	2.12
14.00	DISCHG	1.93	1.82	1.71	1.64	1.56	1.46	1.39	1.30	1.26	1.20
16.00	DISCHG	1.16	1.12	1.07	1.04	1.00	0.97	0.95	0.91	0.89	0.86
18.00	DISCHG	0.85	0.83	0.80	0.79	0.77	0.75	0.73	0.71	0.70	0.69
20.00	DISCHG	0.58	0.67	0.66	0.65	0.63	0.61	0.61	0.60	0.60	0.58
22.00	DISCHG	0.57	0.56	0.56	0.55	0.54	0.53	0.53	0.52	0.52	0.51
24.00	DISCHG	0.50	0.38	0.16	0.05	0.02	0.01	0.00			

SUBROUTINE ADDHYD   CROSS SECTION   1
INPUT HYDROGRAPHS= 3,4   OUTPUT HYDROGRAPH= 5
99999 IN PEAK - MAXI = 127

PEAK TIMES 12.00   PEAK DISCHARGES 70.931   PEAK ELEVATIONS (NULL)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.05

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.01	0.03	0.05	0.08	0.11	0.15	0.24	0.36
10.00	DISCHG	0.49	0.71	0.94	1.23	1.67	2.03	3.07	4.06	14.49	46.45
12.00	DISCHG	70.94	45.80	26.14	16.11	12.38	10.36	8.36	7.31	6.67	5.87
14.00	DISCHG	5.59	5.18	4.96	4.74	4.40	4.29	3.98	3.80	3.61	3.49
16.00	DISCHG	3.42	3.24	3.13	3.05	2.94	2.90	2.76	2.68	2.62	2.55
18.00	DISCHG	2.53	2.44	2.38	2.33	2.26	2.24	2.16	2.11	2.09	2.06
20.00	DISCHG	2.05	1.99	1.95	1.92	1.86	1.84	1.82	1.81	1.78	1.73
22.00	DISCHG	1.71	1.69	1.69	1.65	1.61	1.60	1.58	1.57	1.55	1.53
24.00	DISCHG	1.51	0.70	0.21	0.06	0.02	0.01	0.00			

SUBROUTINE RUNOFF   CROSS SECTION   1
AREA= 0.02   INPUT RUNOFF CURVE= 85.0   TIME OF CONCENTRATION= 0.91
99999 IN PEAK - MAXI = 133

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
6.00	DISCHG	0.04	0.06	0.08	0.10	0.13	0.16	0.19	0.22	0.26	0.29
8.00	DISCHG	0.33	0.37	0.42	0.47	0.52	0.57	0.63	0.70	0.78	0.86
10.00	DISCHG	0.95	1.07	1.21	1.37	1.53	1.84	2.17	2.65	3.93	8.14
12.00	DISCHG	16.18	26.10	26.46	23.15	17.82	13.26	10.04	7.71	6.15	5.06
14.00	DISCHG	4.26	3.69	3.28	2.97	2.72	2.52	2.37	2.23	2.11	2.00
16.00	DISCHG	1.91	1.83	1.75	1.69	1.62	1.56	1.51	1.46	1.41	1.37
18.00	DISCHG	1.33	1.30	1.26	1.23	1.20	1.17	1.14	1.12	1.09	1.07
20.00	DISCHG	1.05	1.03	1.01	0.99	0.97	0.95	0.93	0.92	0.90	0.89
22.00	DISCHG	0.89	0.86	0.85	0.84	0.82	0.81	0.80	0.79	0.78	0.77
24.00	DISCHG	0.76	0.71	0.59	0.42	0.26	0.15	0.09	0.05	0.03	0.02
26.00	DISCHG	0.01	0.01	0.00							

SUBROUTINE ADDHYD CROSS SECTION 1
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7
22222 IN PEAK - MAXI = 133

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.03	87.691	(NULL)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.07

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
6.00	DISCHG	0.04	0.06	0.08	0.10	0.13	0.16	0.19	0.22	0.26	0.29
8.00	DISCHG	0.33	0.38	0.43	0.49	0.57	0.65	0.74	0.85	1.01	1.22
10.00	DISCHG	1.45	1.77	2.15	2.60	3.25	3.88	5.24	6.71	18.49	54.59
12.00	DISCHG	87.12	69.91	52.60	41.31	30.20	23.57	18.39	15.02	12.82	10.93
14.00	DISCHG	9.86	9.87	8.24	7.70	7.12	6.81	6.35	6.03	5.78	5.47
16.00	DISCHG	5.33	5.06	4.88	4.73	4.56	4.46	4.27	4.14	4.04	3.92
18.00	DISCHG	3.86	3.73	3.65	3.57	3.47	3.41	3.30	3.23	3.18	3.12
20.00	DISCHG	3.10	3.02	2.96	2.91	2.83	2.79	2.75	2.73	2.69	2.62
22.00	DISCHG	2.58	2.55	2.52	2.49	2.44	2.41	2.38	2.36	2.33	2.30
24.00	DISCHG	2.27	1.42	0.80	0.48	0.28	0.16	0.09	0.05	0.03	0.02
26.00	DISCHG	0.01	0.01	0.00							

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.02 INPUT RUNOFF CURVE= 75.0 TIME OF CONCENTRATION= 0.91
22222 IN PEAK - MAXI = 133

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.41	19.623	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.01	0.03	0.05	0.08	0.12	0.16	0.21
10.00	DISCHG	0.26	0.32	0.40	0.50	0.63	0.78	0.98	1.28	2.15	5.00
12.00	DISCHG	10.90	17.23	19.62	17.69	13.86	10.43	8.05	6.27	5.06	4.21
14.00	DISCHG	3.58	3.12	2.79	2.54	2.34	2.17	2.05	1.93	1.83	1.74
16.00	DISCHG	1.66	1.59	1.52	1.46	1.41	1.36	1.32	1.28	1.24	1.20
18.00	DISCHG	1.17	1.14	1.11	1.08	1.06	1.03	1.01	0.99	0.96	0.94
20.00	DISCHG	0.92	0.91	0.89	0.88	0.85	0.84	0.83	0.81	0.80	0.79

2 DISCHG 0.01 0.03 0.00

SUBROUTINE ADDHYD CROSS SECTION 1
INPUT HYDROGRAPHS= 3,6 OUTPUT HYDROGRAPH= 7
***** IN PEAK - MAXI = 133

	PEAK TIMES		PEAK DISCHARGES			PEAK ELEVATIONS					
	12.02		82.164			(NULL)					
TIME			HYDROGRAPH, TZERO=	0.00		DELTA T= 0.20			DRAINAGE AREA=	0.07	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.01	0.04	0.08	0.13	0.19	0.28	0.40	0.57
10.00	DISCHG	0.75	1.03	1.35	1.73	2.29	2.01	4.05	5.34	16.64	51.45
12.00	DISCHG	81.84	63.03	45.76	35.78	26.24	20.79	16.40	13.59	11.73	10.08
14.00	DISCHG	9.17	8.30	7.75	7.28	6.74	6.46	6.02	5.73	5.49	5.22
16.00	DISCHG	5.08	4.83	4.65	4.51	4.35	4.26	4.09	3.95	3.86	3.75
18.00	DISCHG	3.70	3.58	3.49	3.42	3.32	3.27	3.17	3.10	3.05	3.00
20.00	DISCHG	2.97	2.90	2.85	2.79	2.72	2.68	2.64	2.62	2.58	2.52
22.00	DISCHG	2.48	2.45	2.43	2.40	2.34	2.32	2.29	2.27	2.25	2.21
24.00	DISCHG	2.18	1.34	0.73	0.43	0.29	0.14	0.09	0.05	0.03	0.02
26.00	DISCHG	0.01	0.01	0.00							

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

SCS TR-20 "Watershed Hydrology"

Hydrograph Input Data

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1  1        1      0.0590   70.0000   0.30001 1 0 0 0 0
6 REACH  3  2  1     2   2590.0000    0.0000   1.00001 1 0 0 0 0
6 RUNOFF 1  2        3      0.1030   70.0000   0.65001 1 0 0 0 0
6 ADDHYD 4  2  2 3   4                               1 1 0 0 0 0
6 REACH  3  3  4     5   2690.0000    0.0000   1.00001 1 0 0 0 0
6 RUNOFF 1  3        6      0.1840   70.0000   0.75001 1 0 0 0 0
6 ADDHYD 4  3  5 6   7                               1 1 0 0 0 0
6 REACH  3  4  7     1   2180.0000    0.0000   1.00001 1 0 0 0 0
6 RUNOFF 1  4        2      0.0050   70.0000   0.25001 1 0 0 0 0
6 ADDHYD 4  4  1 2   3                               1 1 0 0 0 0
6 RUNOFF 1  4        4      0.1720   85.0000   0.45001 1 0 0 0 0
6 ADDHYD 4  4  3 4   5                               1 1 0 0 0 0
6 RUNOFF 1  4        4      0.1720   75.0000   0.60001 1 0 0 0 0
6 ADDHYD 4  4  3 4   5                               1 1 0 0 0 0
6 RUNOFF 1  4        6      0.1720   85.0000   0.15001 1 0 0 0 0
6 ADDHYD 4  4  5 6   7                               1 1 0 0 0 0
6 RUNOFF 1  4        6      0.1720   75.0000   0.45001 1 0 0 0 0
6 ADDHYD 4  4  5 6   7                               1 1 0 0 0 0
6 RUNOFF 1  4        1      0.1110   85.0000   0.70001 1 0 0 0 0
6 ADDHYD 4  4  1 7   2                               1 1 0 0 0 0
6 RUNOFF 1  4        1      0.1110   75.0000   0.90001 1 0 0 0 0
6 ADDHYD 4  4  1 7   2                               1 1 0 0 0 0
  ENDATA

END OF LISTING
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36c

EXECUTIVE CONTROL CARD OPERATION INCREM. MAIN TIME INCREMENT= 0.20
EXECUTIVE CONTROL CARD OPERATION COMPUT. FROM XSECTN/STRUCT 1/ 0 TO XSECTN/STRUCT 6/ 0
STARTING TIME= 0.00 RAIN DEPTH= 5.50 RAIN DURATION= 1.00 RAIN TABLE NO.= 3 SOIL CONDITION= 2
ALTERNATE NO.= 0 STORM NO.= 0

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.06 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.30
80000 IN PEAK - MAXI = 126

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.02	76.427	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.06

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.17
10.00	DISCHG	0.31	0.51	0.76	1.01	1.50	1.88	2.84	4.00	10.23	46.74
12.00	DISCHG	76.12	57.88	27.81	20.61	13.25	11.09	9.42	8.04	7.59	6.55
14.00	DISCHG	6.21	5.84	5.53	5.39	4.93	4.78	4.50	4.25	4.15	3.93
16.00	DISCHG	3.83	3.66	3.50	3.45	3.30	3.25	3.12	3.00	2.95	2.83
18.00	DISCHG	2.84	2.75	2.67	2.64	2.55	2.51	2.44	2.37	2.35	2.32
20.00	DISCHG	2.30	2.25	2.20	2.17	2.09	2.07	2.05	2.04	2.02	1.94
22.00	DISCHG	1.92	1.90	1.89	1.87	1.82	1.80	1.78	1.77	1.76	1.72
24.00	DISCHG	1.70	0.95	0.20	0.04	0.01	0.00				

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 2890.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 3.593 AVERAGE ROUTING COEFF= 0.6788 NUMBER OF ROUTINGS= 0.76
80000 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.23	65.167	1451.44

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.06

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07
10.00	DISCHG	0.17	0.31	0.53	0.74	1.03	1.45	1.95	2.83	4.83	15.47
12.00	DISCHG	44.16	66.76	56.18	33.16	22.36	15.15	11.62	9.73	8.40	7.60
14.00	DISCHG	6.75	6.28	5.89	5.59	5.36	5.01	4.79	4.53	4.30	4.14
16.00	DISCHG	3.95	3.83	3.69	3.56	3.44	3.32	3.24	3.13	3.03	2.96
18.00	DISCHG	2.89	2.83	2.76	2.69	2.64	2.56	2.51	2.45	2.39	2.35
20.00	DISCHG	2.37	2.30	2.25	2.21	2.17	2.11	2.07	2.05	2.04	2.01
22.00	DISCHG	1.96	1.92	1.90	1.89	1.87	1.83	1.80	1.78	1.77	1.75
24.00	DISCHG	1.72	1.57	0.97	0.37	0.12	0.03	0.00			

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.11 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.65
80000 IN PEAK - MAXI = 131

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.23	102.275	(RUNOFF)

[illegible]	DISCHG	0.00	0.00	0.00	0.00	.02	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
6.00	DISCHG	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12
10.00	DISCHG	0.25	0.53	0.85	1.26	1.79	2.48	3.43	4.88	9.01	30.30
12.00	DISCHG	72.00	101.06	91.58	65.79	46.59	33.96	25.93	20.77	17.33	14.96
14.00	DISCHG	11.16	11.97	11.14	10.51	9.95	9.39	8.92	8.44	8.03	7.69
16.00	DISCHG	7.37	7.10	6.82	6.57	6.36	6.16	5.99	5.79	5.61	5.47
18.00	DISCHG	5.34	5.22	5.09	4.97	4.85	4.73	4.61	4.51	4.42	4.34
20.00	DISCHG	4.28	4.22	4.14	4.07	3.99	3.89	3.82	3.78	3.75	3.69
22.00	DISCHG	3.61	3.55	3.50	3.47	3.42	3.34	3.31	3.26	3.25	3.22
24.00	DISCHG	3.15	2.82	1.91	1.00	0.45	0.23	0.11	0.05	0.02	0.01
26.00	DISCHG	0.00									

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
ZZZZZ IN PEAK - MAXI = 131

PEAK TIMES 12.24 PEAK DISCHARGES 167.348 PEAK ELEVATIONS 1452.46

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.17

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.13
10.00	DISCHG	0.46	0.84	1.35	1.99	2.82	3.93	5.37	7.31	13.84	45.77
12.00	DISCHG	116.16	165.82	145.76	98.93	68.95	49.12	37.73	30.54	25.72	22.56
14.00	DISCHG	19.91	18.25	17.03	16.11	15.31	14.45	13.73	12.97	12.33	11.63
16.00	DISCHG	11.32	10.93	10.49	10.11	9.80	9.49	9.21	8.92	8.64	8.43
18.00	DISCHG	8.22	8.05	7.85	7.66	7.49	7.30	7.14	6.96	6.80	6.70
20.00	DISCHG	6.60	6.52	6.40	6.27	6.15	6.00	5.90	5.83	5.78	5.70
22.00	DISCHG	5.56	5.47	5.41	5.36	5.29	5.19	5.12	5.06	5.02	4.97
24.00	DISCHG	4.58	4.38	2.89	1.17	0.60	0.26	0.11	0.05	0.02	0.01
26.00	DISCHG	0.00									

SUBROUTINE REACH CROSS SECTION 3
LENGTH= 2690.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 1.00

AVERAGE WATER VELOCITY= 4.948 AVERAGE ROUTING COEFF= 0.7443 NUMBER OF ROUTINGS= 0.56
ZZZZZ IN PEAK - MAXI = 131

PEAK TIMES 12.49 PEAK DISCHARGES 153.518 PEAK ELEVATIONS 1437.19

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.17

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09
10.00	DISCHG	0.28	0.53	1.00	1.56	2.26	3.18	4.29	6.14	9.86	25.56
12.00	DISCHG	70.17	129.38	153.55	128.81	91.21	65.16	46.65	36.10	29.40	24.97
14.00	DISCHG	21.85	19.52	17.94	16.79	15.89	15.03	14.21	13.49	12.79	12.20
16.00	DISCHG	11.68	11.21	10.80	10.38	10.03	9.71	9.42	9.14	8.84	8.59
18.00	DISCHG	8.37	8.18	7.99	7.79	7.61	7.45	7.29	7.09	6.93	6.78
20.00	DISCHG	6.67	6.53	6.48	6.36	6.23	6.10	5.97	5.88	5.82	5.74
22.00	DISCHG	5.65	5.54	5.44	5.40	5.34	5.26	5.17	5.10	5.09	5.01

SUBROUTINE RUNOFF   CROSS SECTION   3
AREA=   0.18   INPUT RUNOFF CURVE= 73.0   TIME OF CONCENTRATION= 0.73
20000 IN PEAK - MAXI = 132

PEAK TIMES 12.27 | PEAK DISCHARGES 168.513 | PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.18

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.16
10.00	DISCHG	0.44	0.82	1.36	2.02	2.89	4.02	5.56	7.86	14.80	46.46
12.00	DISCHG	111.71	164.40	156.56	117.11	84.00	61.92	46.39	37.52	31.11	26.61
14.00	DISCHG	23.32	20.94	19.33	18.19	17.27	16.20	15.38	14.56	13.83	13.21
16.00	DISCHG	12.67	12.19	11.71	11.28	10.91	10.57	10.27	9.93	9.63	9.37
18.00	DISCHG	9.14	8.94	8.72	8.50	8.30	8.11	7.92	7.73	7.56	7.42
20.00	DISCHG	7.32	7.22	7.09	6.95	6.81	6.66	6.54	6.46	6.40	6.36
22.00	DISCHG	6.17	6.06	5.99	5.93	5.85	5.79	5.67	5.60	5.59	5.49
24.00	DISCHG	5.42	4.91	3.52	1.95	0.99	0.50	0.24	0.12	0.06	0.03
26.00	DISCHG	0.01	0.00								

SUBROUTINE ADDHYD   CROSS SECTION   3
INPUT HYDROGRAPHS= 5,6   OUTPUT HYDROGRAPH= 7
20000 IN PEAK - MAXI = 132

PEAK TIMES 12.34 | PEAK DISCHARGES 313.565 | PEAK ELEVATIONS 1438.20

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.35

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.27
10.00	DISCHG	0.72	1.40	2.36	3.58	5.14	7.19	9.94	14.01	24.66	72.02
12.00	DISCHG	181.89	293.73	310.31	245.92	175.21	126.08	93.54	73.62	60.55	51.60
14.00	DISCHG	45.17	40.45	37.27	34.97	33.06	31.24	29.59	28.05	26.62	25.41
16.00	DISCHG	24.35	23.40	22.51	21.67	20.94	20.29	19.68	19.07	18.47	17.93
18.00	DISCHG	17.51	17.12	16.71	16.30	15.91	15.54	15.18	14.82	14.48	14.20
20.00	DISCHG	13.99	13.80	13.57	13.31	13.04	12.76	12.51	12.34	12.22	12.05
22.00	DISCHG	11.82	11.60	11.44	11.32	11.19	11.01	10.84	10.70	10.60	10.50
24.00	DISCHG	10.36	9.61	7.37	4.35	2.19	1.04	0.48	0.22	0.10	0.03
26.00	DISCHG	0.01	0.00								

E. Offsite Area by Stage I perimeter channel

SUBROUTINE REACH   CROSS SECTION   4
LENGTH= 2280.00   INPUT COEFFICIENT= 0.0000   INPUT ROUTINGS= 1.00
AVERAGE WATER VELOCITY=   5.270   AVERAGE ROUTING COEFF= 0.7561   NUMBER OF ROUTINGS= 0.43
20000 IN PEAK - MAXI = 132

PEAK TIMES 12.45 | PEAK DISCHARGES 300.425 | PEAK ELEVATIONS 1423.37

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.35

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

6.[illegible]	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.17
10.00	DISCHG	0.50	1.06	1.83	2.97	4.36	6.15	8.56	11.98	19.43	49.16
12.00	DISCHG	128.07	236.78	298.27	271.56	210.92	151.98	110.85	84.32	67.50	56.33
14.00	DISCHG	40.97	42.94	38.96	36.18	34.05	32.17	30.44	28.84	27.35	26.04
16.00	DISCHG	24.90	23.89	22.97	22.10	21.32	20.62	19.99	19.33	18.78	18.22
18.00	DISCHG	17.74	17.32	16.92	16.51	16.11	15.79	15.36	15.00	14.63	14.34
20.00	DISCHG	14.10	13.90	13.68	13.44	13.18	12.93	12.64	12.43	12.28	12.14
22.00	DISCHG	11.94	11.72	11.53	11.39	11.26	11.10	10.92	10.77	10.66	10.55
24.00	DISCHG	10.43	9.97	8.56	5.89	3.34	1.67	0.79	0.37	0.17	0.08
26.00	DISCHG	0.03	0.00								

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.00 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.25

Offsite Area - South

88822 IN PEAK - MAXI = 124

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS (RUNOFF)
11.99	6.948	

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
10.00	DISCHG	0.03	0.05	0.07	0.09	0.13	0.17	0.26	0.36	1.05	4.60
12.00	DISCHG	6.95	4.21	2.06	1.60	1.02	0.92	0.76	0.67	0.63	0.54
14.00	DISCHG	0.52	0.49	0.47	0.45	0.41	0.40	0.37	0.36	0.35	0.33
16.00	DISCHG	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.25	0.24
18.00	DISCHG	0.24	0.23	0.23	0.22	0.21	0.21	0.21	0.20	0.20	0.20
20.00	DISCHG	0.20	0.19	0.19	0.18	0.18	0.17	0.17	0.17	0.17	0.16
22.00	DISCHG	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
24.00	DISCHG	0.14	0.06	0.01	0.00						

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 1,2 OUTPUT HYDROGRAPH= 3

Σ Offsite Areas at Test Culvert
(Compare 0)

88888 IN PEAK - MAXI = 132

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.44	302.211	1423.38

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.36

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.18
10.00	DISCHG	0.53	1.11	1.95	3.06	4.49	6.33	8.83	12.33	20.52	53.76
12.00	DISCHG	135.02	240.99	300.30	277.16	211.94	152.89	111.61	84.99	68.13	56.87
14.00	DISCHG	49.09	43.42	39.42	36.64	34.46	32.58	30.81	29.20	27.70	26.37
16.00	DISCHG	25.22	24.20	23.26	22.39	21.59	20.90	20.25	19.64	19.03	18.46
18.00	DISCHG	17.99	17.55	17.14	16.73	16.33	15.94	15.57	15.20	14.65	14.54
20.00	DISCHG	14.29	14.09	13.87	13.62	13.35	13.08	12.31	12.60	12.45	12.30
22.00	DISCHG	12.10	11.88	11.69	11.54	11.41	11.25	11.38	10.92	10.83	10.70
24.00	DISCHG	10.57	10.03	8.47	5.88	3.34	1.67	0.79	0.37	0.17	0.08
26.00	DISCHG	0.03	0.00								

SUBROUTINE RUNOFF CROSS SECTION 4

Stage 1 (actual) or b...

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.10	309.893	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.17

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.20	0.38
6.00	DISCHG	0.58	0.79	1.02	1.24	1.50	1.76	2.03	2.34	2.63	2.98
8.00	DISCHG	3.33	3.69	4.13	4.53	5.05	5.56	6.13	6.86	7.49	8.42
10.00	DISCHG	9.31	10.52	12.35	13.87	16.60	19.21	23.30	30.12	50.25	169.70
12.00	DISCHG	295.24	292.61	176.43	110.00	73.19	52.35	42.13	34.30	30.58	27.01
14.00	DISCHG	24.92	22.95	21.44	20.50	19.26	18.19	17.36	16.26	15.64	14.89
16.00	DISCHG	14.31	13.81	13.18	12.81	12.35	11.99	11.66	11.18	10.91	10.61
18.00	DISCHG	10.38	10.16	9.86	9.65	9.38	9.16	8.96	8.69	8.54	8.41
20.00	DISCHG	8.32	8.19	7.90	7.85	7.64	7.47	7.38	7.31	7.26	7.07
22.00	DISCHG	6.91	6.82	6.76	6.70	6.55	6.44	6.37	6.31	6.26	6.17
24.00	DISCHG	6.07	4.75	2.08	0.71	0.24	0.08	0.02	0.00		

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 3,4 OUTPUT HYDROGRAPH= 5
20000 IN PEAK - MAXI = 132

Compare I

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.23	535.153	1424.30

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.33

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.20	0.38
6.00	DISCHG	0.58	0.79	1.02	1.24	1.50	1.76	2.03	2.34	2.63	2.98
8.00	DISCHG	3.33	3.69	4.13	4.53	5.05	5.56	6.13	6.86	7.52	8.60
10.00	DISCHG	9.84	11.63	14.30	16.93	21.09	25.54	32.13	42.65	70.77	223.56
12.00	DISCHG	430.29	533.65	476.79	357.16	255.14	205.25	153.74	119.28	98.71	83.59
14.00	DISCHG	73.51	66.37	60.86	57.21	53.72	50.77	48.17	45.46	43.34	41.26
16.00	DISCHG	39.53	38.03	36.44	35.20	33.94	32.89	31.91	30.81	29.91	29.07
18.00	DISCHG	28.38	27.71	26.93	26.35	25.70	25.10	24.53	23.89	23.39	22.95
20.00	DISCHG	22.61	22.27	21.85	21.47	20.99	20.54	20.19	19.92	19.71	19.37
22.00	DISCHG	19.01	18.70	18.44	18.25	17.97	17.69	17.45	17.23	17.07	16.86
24.00	DISCHG	16.64	14.79	10.56	6.59	3.58	1.75	0.82	0.37	0.17	0.09
26.00	DISCHG	0.03	0.00								

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.17 INPUT RUNOFF CURVE= 75.0 TIME OF CONCENTRATION= 0.60
20000 IN PEAK - MAXI = 131

Stage 1 (unregressed)

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.21	205.590	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.17

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.01	0.06	0.20	0.41	0.67	0.98	1.33	1.72	2.17
10.00	DISCHG	2.69	3.31	4.17	5.11	6.40	7.97	10.07	13.36	23.34	73.71
12.00	DISCHG	159.74	205.51	168.98	114.71	79.69	56.99	43.55	34.96	29.19	25.63
14.00	DISCHG	22.51	20.71	19.30	18.25	17.30	16.30	15.55	14.64	13.94	13.34
16.00	DISCHG	12.73	12.32	11.82	11.43	11.03	10.67	10.39	10.03	9.72	9.47

22.00	DISCHG	6.21	6.11	6.04	5.99	[illegible]90	5.79	5.71	5.65	5.60	5.54
24.00	DISCHG	5.43	4.75	3.01	1.43	0.64	0.28	0.12	0.05	0.02	0.01
26.00	DISCHG	0.00									

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 3,4 OUTPUT HYDROGRAPH= 5
22222 IN PEAK - MAXI = 132

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.35	472.880	1424.15

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.53

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.01	0.06	0.20	0.41	0.67	0.98	1.33	1.75	2.36
10.00	DISCHG	3.22	4.42	6.12	8.17	10.89	14.30	18.90	25.89	43.86	127.45
12.00	DISCHG	294.76	446.50	469.28	393.87	291.64	209.88	155.16	115.95	97.44	82.30
14.00	DISCHG	71.60	64.16	58.73	54.93	51.76	48.88	46.32	43.84	41.64	39.71
16.00	DISCHG	38.01	36.52	35.09	33.79	32.63	31.59	30.65	29.66	28.75	27.93
18.00	DISCHG	27.22	26.61	25.95	25.33	24.72	24.13	23.57	23.00	22.48	22.04
20.00	DISCHG	21.70	21.39	21.02	20.66	20.22	19.78	19.41	19.13	18.92	18.66
22.00	DISCHG	18.31	17.99	17.73	17.53	17.31	17.04	16.79	16.57	16.41	16.23
24.00	DISCHG	16.00	14.78	11.48	7.31	3.98	1.95	0.92	0.42	0.19	0.08
26.00	DISCHG	0.03	0.00								

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.17 INPUT RUNOFF CURVE= 85.0 TIME OF CONCENTRATION= 0.35
22222 IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.03	341.321	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.17

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.26	0.46
6.00	DISCHG	0.66	0.88	1.11	1.33	1.60	1.86	2.15	2.46	2.74	3.13
8.00	DISCHG	3.46	3.86	4.31	4.69	5.20	5.74	6.39	7.15	7.73	8.83
10.00	DISCHG	9.62	11.12	13.04	14.45	17.85	20.07	25.49	32.72	62.19	226.43
12.00	DISCHG	339.87	273.32	133.14	88.87	58.24	44.95	37.78	31.60	29.29	25.44
14.00	DISCHG	23.66	22.27	20.83	20.23	18.68	17.99	16.94	15.85	15.41	14.56
16.00	DISCHG	14.16	13.59	12.94	12.68	12.34	11.89	11.48	11.03	10.81	10.45
18.00	DISCHG	10.31	10.05	9.72	9.58	9.26	9.09	8.56	8.55	8.49	8.35
20.00	DISCHG	8.29	8.12	7.93	7.80	7.54	7.42	7.35	7.29	7.23	6.95
22.00	DISCHG	6.86	6.79	6.73	6.68	6.49	6.40	6.34	6.29	6.25	6.12
24.00	DISCHG	6.06	3.98	1.11	0.23	0.07	0.01	0.00			

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7
22222 IN PEAK - MAXI = 132

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.18	720.274	1424.76

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.70

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

6.00	DISCHG	0.65	0.88	1.11	1.33	60	1.86	2.15	2.45	2.74	3.11
8.00	DISCHG	1.46	3.86	4.37	4.85	5.69	6.62	7.36	8.43	9.43	11.18
10.00	DISCHG	12.84	15.54	19.16	22.62	28.74	34.97	44.39	59.61	106.05	353.89
12.00	DISCHG	634.63	719.81	602.42	480.74	349.89	254.83	192.94	151.55	126.71	107.74
14.00	DISCHG	95.24	86.43	75.60	75.16	70.44	66.76	61.26	59.69	57.06	54.27
16.00	DISCHG	52.15	50.11	48.02	46.47	44.77	43.47	42.13	40.66	39.35	38.41
18.00	DISCHG	37.54	36.65	35.67	34.91	33.97	33.22	32.44	31.59	30.97	30.39
20.00	DISCHG	29.98	29.50	28.93	28.44	27.76	27.20	26.76	26.42	26.16	25.64
22.00	DISCHG	25.17	24.70	24.45	24.22	23.80	23.44	23.11	22.66	22.69	22.35
24.00	DISCHG	22.06	18.76	12.59	7.58	4.04	1.97	0.92	0.42	0.19	0.08
26.00	DISCHG	0.03	0.00								

SUBROUTINE RUNOFF CROSS SECTION 6

AREA= 0.17 INPUT RUNOFF CURVE= 75.0 TIME OF CONCENTRATION= 0.45

Stage II (mitigated)

00000 IN PEAK - MAXI = 128

PEAK TIMES 12.12 PEAK DISCHARGES 231.383 PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TIZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.17

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.01	0.10	0.29	0.54	0.83	1.16	1.55	1.55	2.66
10.00	DISCHG	3.00	3.70	4.71	5.66	7.25	8.91	11.49	15.74	20.95	110.87
12.00	DISCHG	212.80	224.47	139.39	89.03	60.37	43.76	35.57	29.13	26.07	23.10
14.00	DISCHG	20.93	19.71	18.45	17.74	16.63	15.74	15.04	14.11	13.58	12.95
16.00	DISCHG	12.46	12.06	11.50	11.18	10.80	10.49	10.21	5.79	9.56	9.31
18.00	DISCHG	9.12	8.93	8.65	8.49	8.26	8.07	7.90	7.67	7.54	7.43
20.00	DISCHG	7.35	7.24	7.06	6.95	6.76	6.61	6.54	6.40	6.45	6.27
22.00	DISCHG	6.13	6.06	6.03	5.96	5.86	5.73	5.67	5.61	5.58	5.49
24.00	DISCHG	5.41	4.24	1.85	0.63	0.22	0.07	0.02	0.00		

SUBROUTINE ADDHYD CROSS SECTION 4

INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7

00000 IN PEAK - MAXI = 132

PEAK TIMES 12.24 PEAK DISCHARGES 676.488 PEAK ELEVATIONS 1624.65

HYDROGRAPH, TIZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.70

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.02	0.16	0.49	0.96	1.50	2.13	2.05	3.70	4.82
10.00	DISCHG	5.22	8.13	10.82	13.83	18.14	23.21	30.39	41.54	72.81	238.34
12.00	DISCHG	507.56	670.97	608.67	430.96	352.01	253.65	190.73	149.04	123.51	105.40
14.00	DISCHG	32.53	83.87	77.18	72.67	68.40	64.61	61.35	57.95	55.23	52.65
16.00	DISCHG	50.47	48.58	46.58	44.97	43.42	42.08	40.86	39.46	38.31	37.24
18.00	DISCHG	36.34	35.33	34.60	33.82	32.97	32.20	31.48	30.57	30.02	29.47
20.00	DISCHG	29.05	28.63	28.08	27.59	26.98	26.40	25.95	25.61	25.36	24.93
22.00	DISCHG	24.44	24.03	23.73	23.49	23.14	22.77	22.45	22.13	21.99	21.73
24.00	DISCHG	21.41	19.02	13.36	7.96	4.19	2.02	0.94	0.42	0.19	0.03
26.00	DISCHG	0.03	0.00								

SUBROUTINE RUNOFF CROSS SECTION 4

(42)

Emerg III (exist?)

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.24	165.935	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.11

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.15
6.00	DISCHG	0.26	0.39	0.52	0.66	0.81	0.97	1.14	1.32	1.51	1.71
8.00	DISCHG	1.93	2.16	2.41	2.67	2.96	3.27	3.61	4.01	4.41	4.91
10.00	DISCHG	5.46	6.10	6.79	8.01	9.27	10.83	12.88	15.92	24.54	59.91
12.00	DISCHG	123.75	164.61	147.88	106.19	73.87	52.97	39.16	30.74	25.09	21.20
14.00	DISCHG	18.33	16.39	15.36	14.11	13.29	12.51	11.84	11.19	10.59	10.10
16.00	DISCHG	9.66	9.28	8.91	8.57	8.27	8.00	7.76	7.50	7.26	7.05
18.00	DISCHG	6.87	6.71	6.54	6.37	6.21	6.06	5.92	5.77	5.63	5.53
20.00	DISCHG	5.45	5.37	5.26	5.16	5.05	4.93	4.86	4.78	4.73	4.65
22.00	DISCHG	4.56	4.47	4.42	4.37	4.33	4.23	4.17	4.12	4.03	4.03
24.00	DISCHG	3.93	3.60	2.58	1.43	0.72	0.37	0.18	0.09	0.04	0.02
26.00	DISCHG	0.01	0.00								

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 1,7 OUTPUT HYDROGRAPH= 2
00000 IN PEAK - MAXI = 132

Composite III

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.24	842.298	1425.06

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.81

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.15
6.00	DISCHG	0.26	0.39	0.52	0.66	0.81	0.97	1.14	1.32	1.51	1.71
8.00	DISCHG	1.93	2.17	2.57	3.15	3.91	4.78	5.76	6.89	8.17	9.71
10.00	DISCHG	11.69	14.23	17.82	21.84	27.41	34.05	43.26	57.56	97.35	270.25
12.00	DISCHG	831.31	835.58	756.59	587.15	425.89	306.61	229.89	175.82	140.63	125.60
14.00	DISCHG	110.92	100.25	92.24	86.79	81.69	77.12	73.19	69.12	65.82	62.76
16.00	DISCHG	60.13	57.86	55.64	53.54	51.69	50.08	48.61	46.95	45.57	44.25
18.00	DISCHG	43.21	42.25	41.14	40.19	39.19	38.26	37.39	36.44	35.65	35.09
20.00	DISCHG	34.49	33.99	33.35	32.75	32.03	31.33	30.90	30.39	30.03	29.59
22.00	DISCHG	29.00	28.52	28.15	27.86	27.45	27.00	26.62	26.30	26.05	25.76
24.00	DISCHG	25.39	22.62	15.92	9.37	4.92	2.39	1.12	0.51	0.24	0.10
26.00	DISCHG	0.04	0.00								

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.11 INPUT RUNOFF CURVE= 75.0 TIME OF CONCENTRATION= 0.90
00000 IN PEAK - MAXI = 135

Emerg III (unmitigated?)

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.40	104.136	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.11

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.02	0.07	0.15	0.28	0.44	0.63	0.85	1.10
10.00	DISCHG	1.39	1.73	2.15	2.67	3.31	4.15	5.25	6.77	11.33	27.20
12.00	DISCHG	58.55	92.36	104.16	93.22	73.06	54.84	42.19	32.84	26.45	22.01
14.00	DISCHG	18.74	16.35	14.65	13.33	12.29	11.44	10.79	10.15	9.63	5.16

20.00	DISCHG	4.88	4.80	4.72	4.63	4.54	4.45	4.35	4.29	4.23	4.18
22.00	DISCHG	4.10	4.03	3.97	3.92	3.87	3.81	3.75	3.70	3.65	3.62
24.00	DISCHG	3.56	3.34	2.77	1.96	1.22	0.70	0.42	0.25	0.14	0.08
26.00	DISCHG	0.05	0.03	0.01	0.01	0.00					

SUBROUTINE ADDHYD   CROSS SECTION   4
INPUT HYDROGRAPHS= 1,7   OUTPUT HYDROGRAPH= 2
88888 IN PEAK - MAXI = 135

Continue III
Σ Areas
* Σ Ranges I, II, III (Unmitigated)

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.26	774.001	1426.89

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.81

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.02	0.18	0.55	1.11	1.76	2.57	3.51	4.54	5.97
10.00	DISCHG	7.61	9.85	12.98	16.51	21.45	27.37	35.63	48.41	84.14	265.53
12.00	DISCHG	566.11	763.31	712.63	574.17	425.07	308.51	232.91	181.72	149.96	127.41
14.00	DISCHG	111.27	100.22	91.63	86.00	80.68	76.06	72.13	68.11	64.85	61.51
16.00	DISCHG	59.21	56.95	54.63	52.71	50.87	49.20	47.83	46.20	44.84	43.58
18.00	DISCHG	42.51	41.55	40.47	39.54	38.56	37.64	36.79	35.86	35.09	34.43
20.00	DISCHG	33.92	33.43	32.80	32.22	31.53	30.84	30.31	29.90	29.60	29.11
22.00	DISCHG	28.55	28.09	27.70	27.41	27.01	26.58	26.21	25.89	25.65	25.35
24.00	DISCHG	24.97	22.35	16.11	9.90	5.41	2.73	1.36	0.67	0.33	0.17
26.00	DISCHG	0.08	0.03	0.01	0.01	0.00					

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

204

SUBJECT Proposed Conemaugh
Main Valley Mod. 14

BY KLF DATE 7/3/85 PROJ. NO. 82-156-11
CHKD. BY TRV DATE 7/6/85 SHEET NO. 1 OF

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

Hydrology

Valley Brook Road Diversion Channel -- Stage III

This channel is to divert the East Valley (offsite) runoff (above the road) around the proposed Stage III site to the Main Valley stream.

1. Design Storm 100-yr 24-hr (PaDER reg)

2. Precipitation 5.5 inches (TP-40)

3. Antecedent Moisture Condition II (std)

4. Hydrologic Soil Group C ('Soil Survey of Indiana County' & TR-55)

5. Curve Number
From "Worksheet of Watershed Area Used for The Sizing of Culverts, East Valley Natural Stream Encroachments" (Dual 78" ϕ CMP Hydrology), 85-195-E1

visual inspection
~ 60% woods
~ 40% pasture
at upstream end of diversion.

at downstream end of diversion, using USGS quad "New Florence", approximately same percentage exists.

CN woods 70 "Intra-Office Memo on
CN pasture 80 Coordination" & TR-55

Composite CN $\overline{CN}$ = 74

SUBJECT Proposed Continuity
East Valley
BY K.L. DATE 7/3/85 PROJ. NO. 82-134-11
CHKD. BY TRV DATE 7/6/85 SHEET NO. 2 OF

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Hydrology
Valley Brook Road Diversion Channel -- Stage III

6. Runoff Volume

$$RO = \frac{(P-0.2S)^2}{(P+0.8S)}$$ (TR-55)

P = 5.5"
S = 1000/CN - 10 ≈ 3.31

RO ~ 2.77 inches

7. Drainage Area
From Dwgs 82-134-C 88, 89 (Stage III Development Plans, 1"=2400 scale)

DA ~ 180 acres at upstream end of diversion
DA ~ 208 acres at confluence with Main Valley stream

8. Time-of-Concentration & Time-of-Travel
Kirpich equation

$$t_c = 0.0078\,L^{0.77}\,S^{-0.385}$$

(Schwab, et al, Soil & Water Conservation Eng'ing, 2nd edition, 1966, p. 93)

L ~ 4770 ft to start of diversion
L ~ 3600 ft in diversion channel to outlet

Δ elevation ~ 1341 to ~1210 (start of diversion)
Δ elevation ~ 1210 to ~ 1100 (in diversion channel to outlet)

SUBJECT Prudential Conservancy

East Valley

BY KLH DATE 3/13/85 PROJ. NO. 83-134-11

CHKD. BY TRV DATE 6/7/85 SHEET NO. 3 OF

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Hydrology

Valley Brook Road Diversion Channel -- Stage II

8. Time-of-Concentration (cont)

$$t_c = 0.0078\,(4770)^{0.77}\left(\frac{1341-1210}{4770}\right)^{-0.385}$$

t_c = 15 minutes ≈ 0.25 hr

t_t = 3000 ft at 3% slope

estimate channel velocity at 10 ft/s (engineering judgment)

t_t = 300 seconds ≈ 0.10 hr

9. Hydrograph Ordinate (peak)

Using TR-55, Tables 5.3,

for t_c = 0.25 hr & t_t = 0.10 hr, t_c = 0.25 hr

HO_p = 691 cfs/in/mi² HO_p = 529 cfs/in/mi²

10. Runoff flow

$Q = DA \cdot RO \cdot HO_p$

✓ Q ≈ 338 cfs at start of diversion (Valley Brook Road)

Q ≈ 614 cfs at outlet (main Valley stream)

SUBJECT Proposed Conveyance

East Valley

BY KLL DATE 3/11/85 PROJ. NO. 83-134-11

CHKD. BY TRY DATE 7/2/85 SHEET NO. 1 OF 2

GAI CONSULTANTS, INC.

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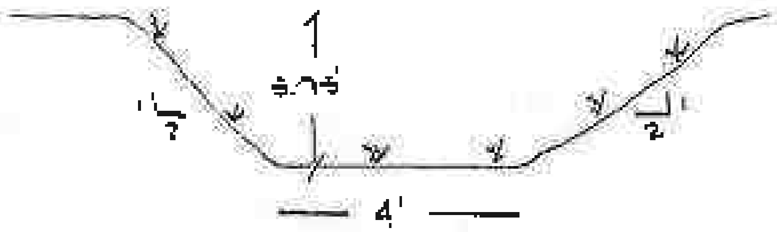
Hydraulic Analyses

Valley Brook Road Diversion Channel -- Channel Design

Use Manning Equation

Based upon coordination with Gilbert Associates, the following channel geometry has been established.



Grass Lining w/ EnkaMat®

$n = 0.030$ to 0.040 (depending upon presence of vegetation).

(see memo, DB to Maierhofer of EnkaMat®, 10/29/81)

Use 0.035 to reflect typical vegetated channel.

Q = 538 [illegible] cfs ("East Valley Hydrology" calculations, sheet 3)

$A = 4y + 2y^2$

$P_w = 4 + 4.47y$

For $y_{max} = 4.75'$ (allows 1' freeboard),

$A = 64.1 \text{ ft}^2$

$P_w = 25.2 \text{ ft}$

SUBJECT Pratt's Continuation
East Valley

BY KL DATE 5/1/85 PROJ. NO. 80-134-11

CHKD. BY TRV DATE 7/2/85 SHEET NO. 2 OF 2

Hydraulic Analysis
Valley Brook Road Diversion Channel – Channel Design

$$Q = \frac{1.49}{n} A^{5/3} P_w^{-2/3} S^{1/2}$$

solve for S

$$S \geq 0.011 \text{ ft/ft} \text{ to } 0.015 \text{ ft/ft}$$

Set Valley Brook Road Diversion Channel at Minimum Slope of 0.015 ft/ft to adequately pass the predicted design flow.

The topography and proposed location for this channel appears to provide for slopes at least on the magnitude as computed above.

SUBJECT Riverine Containment
Iron Valley

BY [illegible] DATE 3/1/85 PROJ. NO. [illegible]

CHKD. BY TRY DATE 7/2/85 SHEET NO. 1 OF 1

GAI CONSULTANTS, INC
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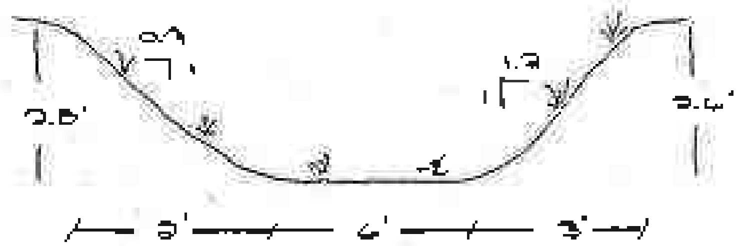
Hydraulic Analyses

Valley Brook Diversion Channel

Using Section 3 of field survey 3 June 1985



$A \approx 6y + 0.95y^2$, for $y = 2.6'$, $A \approx 22.0 \ ft^2$

$P_w \approx 6 + 2.8y$, for $y = 2.6'$, $P_w \approx 13.3 \ ft$

$n \approx 0.035$ grass-lining

$S \approx$ from Section 3 to Inlet

$\approx (1196.5 - 1194.6)/95'$

$S \approx 0.02 \ ft/ft$

$$Q = \frac{1.49}{n} A^{5/3} P_w^{-2/3} S^{1/2}$$

$Q \approx 185$ cfs

Design flow ≈ 530 cfs ("East Valley Hydrology", sheet 7)

by trial & error,

need $\approx 20'$ bottom width to pass design flow,

with some freeboard provided.

SUBJECT Remedial Construction

[illegible] Valley

BY RL DATE 7/1/85 PROJ. NO. 83-184-11

CHKD. BY TRV DATE 7/3/85 SHEET NO. 1 OF 1

GAI CONSULTANTS, INC.

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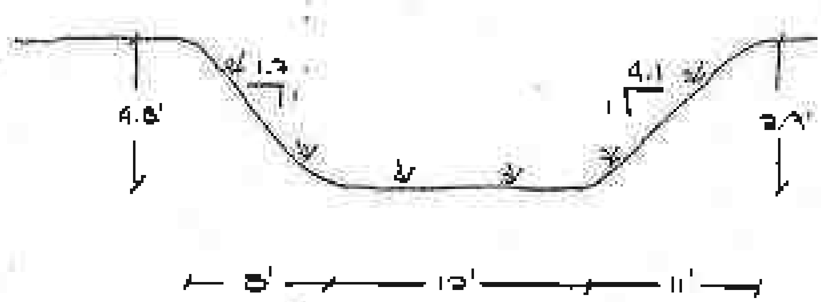
Hydraulic Analyses

Diversion Channel in Main Valley West of Staging Area -- Profile Reach 6

Use Section 2



$n \sim 0.035$ grass-lined

S from 1:600 scale mapping

$\frac{1155 - 1153}{310'} \approx 0.006$ ft/ft

$A \sim 12y + 2.7y^2 \approx$ for $y = 2.7'$, $A \sim 52.5$ ft²

$P_w \sim 12 + 6.3y \approx$ for $y = 2.7'$, $P_w \sim 28.7$ ft

$$Q = 1.49/n \; A^{5/3} \; P_w^{-2/3} \; S^{1/2}$$

$Q \sim 189$ cfs Capacity

for Design flow of ~ 335 cfs (= East Valley Natural Stream Diversion Channel -- Dual 30" Ø Culverts)

SUBJECT [illegible]
[illegible]

BY [illegible] DATE 6/28/85 PROJ. NO. 85-34-11

CHKD. BY TRY DATE 7/2/85 SHEET NO. 1 OF 1

GAI CONSULTANTS, INC
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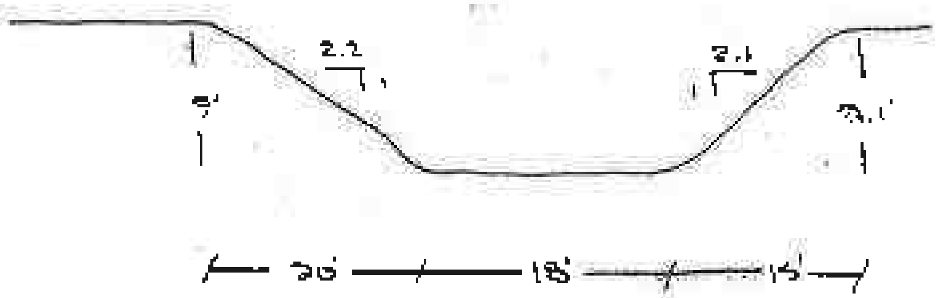
Hydraulic Analyses
Flow Capacities
Pond Spillway -- Profile Reach A

of the 4 sections taken, the smallest is used to estimate the flow capacity



$A \approx 18y + 2.15y^2 \approx 336 \text{ ft}^2$

$P_w \approx 18 + 4.74y \approx 51.6 \text{ ft}$

$n \approx 0.030$ cobble and silt/clay bed, crown vetch and grasses on banks

$S \approx$ taken between Section 1 & 4

$(1129.06 - 1121.93)/227' \approx$

$S \approx 0.03 \text{ ft/ft}$

$Q = \frac{1.49}{n} A^{5/3} P_w^{-2/3} S^{1/2}$

$Q \approx 4588$ cfs Capacity

SUBJECT Pennsylvania Conemaugh
East Valley

BY K.L. DATE 7/2/85 PROJ. NO. 83-136-11

CHKD. BY TRV DATE 7/6/85 SHEET NO. 1 OF 1

GAI CONSULTANTS, INC
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Environmental Specialists

Hydraulic Analyses
East Diversion Channel -- Stage II
Downstream of Valley Brook Road

Q design = 335 cfs

see "Hydrology for Dual 78" φ CMP Culverts in East Diversion Channel"

Use Section "Outlet", @ Valley Brook Road, as given by Section D-D on Exhibit 14.21

$A = 2.5y + 2.1y^2$

$P_w = 2.5 + 4.74y$

S = from Outlet to Section 1

$(1190.11 - 1188.01)/58 = 0.035$ ft/ft

$n = 0.035$ grass & rock-lined

"Hydraulic Analyses", Field Notes

$Qn/1.49 S^{1/2} = 53.6 = A^{5/3} P_w^{-2/3}$

widen channel to 6 ft cut deeper (slope available), use 2H:1V sideslopes

$A = 6y + 2y^2$
$P_w = 6 + 4.47y$

$y = 3.0$ ft

SUBJECT Paradise Consolidated
East Valley
BY KLK DATE 7/2/85 PROJ. NO. 83434-11
CHKD. BY TRV DATE 7/6/85 SHEET NO. ______ OF ______

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Hydraulic Analyses
East Diversion Channel
West of Staging Area

Q design ≈ 535 cfs

see "Hydrology for Dual 48" ⌀ CMP Culverts in East Diversion Channel"

Use Section 2, as given by Section C-C on Exhibit 14.21

∴ $A \approx 12y + 2.9y^2$

$P_w \approx 12 + 6.2y$

$S \approx (1158 - 1157)/310 \approx 0.003$ ft/ft

$n \approx 0.035$ grass-lined

Q capacity ≈ 189 cfs (existing)

Increase flow capacity by widening and berming.

Set $b = 20$ ft

$A \approx 20y + 2.9y^2$

$P_w \approx 20 + 6.2y$

$Q_d n / 1.49 S^{1/2} \approx 229 \approx (20y + 2.9y^2)^{5/3} (20 + 6.2y)^{-2/3}$

$y \approx 3.8$ ft

Engineering Worksheet - Stage I Permit Amendment 5&6 Plan

APPENDIX I-1-C

FORM I

MISCELLANEOUS DRAINAGE FACILITY CALCULATIONS

APPENDIX I-1-C

FORM I

MISCELLANEOUS DRAINAGE FACILITY CALCULATIONS

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SUBJECT Conemaugh - Penelec
Natural Stream Encroachment - Culverts
BY MLA DATE 6-17-85 PROJ. NO 85-195-4
CHKD. BY ASB DATE 6-20-85 SHEET NO. 1 OF 16

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Due to the necessity of building an access road from the toe of Stage II to the staging area, approval from the Dam Safety and Waterway Management division of DER must be obtained so that a culvert crossing may be placed in the natural stream draining from the East Valley. The following calculations contain a hydrology and hydraulic analysis for a culvert design. The analyses are based on DER design criteria which are stated in Pennsylvania Regulations, Title 25, Chapter 105, Subchapter C.

General Design Guidelines.

1. For rural areas, use 25 year - 24 hour storm but 100 yr - 24 hr storm must be able to flow around or over the culvert to maintain flow without creating too much damage.

Note: Since the East Valley stream receives runoff diverted around a disposal area, the design capacity of the culvert must be compatible with the Coal Refuse Disposal regulations regarding diversion channels. Therefore, the culvert is designed for the 100 yr - 24 hr storm. The culvert will also be designed for the 25 yr - 24 hr storm for comparison sake.

2. The standard SCS methods are used to calculate the design flows.

SUBJECT Conemaugh - Penelec
Natural Stream Encroachment - Culverts
BY MLA DATE 6-19-85 PROJ. NO. 85-195-4
CHKD. BY ASB DATE 6/20/85 SHEET NO. 2 OF 16

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3. Desired HW/D is ≈ 1.1 ft/ft for a 25 yr storm

4. DER recommends that the use of multiple pipes should be avoided.

Hydrology Analysis

1. Determine the surface runoff flow for the 25 yr 24 hr storm using the Soil Conservation Service Technical Release 20.

Note: The hydrology analysis is extended to a point downstream of the culverts because the same flow calcs will be used to calculate the downstream channel as part of a Coal Refuse Permit Application.

Input data for the TR 20 computer analysis

A. PPT: 4.5 inches (Ref: "SCS Engineering Field Manual," Chapter 2, page 2-50.02, Indiana County)

B. Antecedent Moisture Condition II

C. Hydrologic Soil Group C - based on soil survey info.

D. Drainage Area (Ref: Attached Worksheet)

Note: The maximum contributing area over the life of the culvert is used to determine max design flows.

Total area = 254.4 acres = 0.3975 mi²

i. Revegetated Benches - 11.5 acres
ii. Pasture - 82.0 acres
iii. Woods - 160.9 acres

E. Curve Numbers

i. Revegetated Benches - 78
ii. Pasture - 80
iii. Woods - 70

F. Weighted CN

$$CN = \frac{11.5(78) + 82.0(80) + 160.9(70)}{254.4}$$

$= 73.6$

SUBJECT CONEMAUGH - PENELEC
NATURAL STREAM ENCROACHMENT - CULVERTS
BY MLA DATE 6-18-85 PROJ. NO. 85-195-4
CHKD. BY ASB DATE 6-20-85 SHEET NO. 3 OF 16

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6 TIME OF CONCENTRATION, t_c

USE KIRPICH'S EQUATION FOR THE NATURAL DRAINAGE TO VALLEY BROOK ROAD

KIRPICH'S EQUATION: $T_c = \left[\frac{11.9\ L^3}{H}\right]^{0.385}$

WITH A CORRECTION FACTOR OF 1.26 TO COMPENSATE FOR THE CN VALUES (REF "DESIGN OF SMALL DAMS" BUREAU OF RECLAMATION, 1974, PAGE 67)

$L = 0.902$ MILES

$H = 1541 - 1197 = 344$ FT

$T_{c_1} = \left[\frac{11.9(0.902)^3}{344}\right]^{0.385} \times 1.26$

$= 0.306$ HR

FROM VALLEY BROOK ROAD TO A POINT SLIGHTLY DOWNSTREAM OF THE PROPOSED CULVERTS, AS SHOWN ON THE ATTACHED WORKSHEET; USE AVERAGE VELOCITY METHOD

$L = 1610$ FT

$S = 1.9\%$

$V = 5.6$ FT/SEC (ASSUMPTION)

$T_{c_2} = \frac{1610}{5.6} \times \frac{1\ HR}{3600\ SEC} = 0.080$ HR

$T_c = 0.306$ HR $+ 0.080$ HR

$= 0.386$ HR

$= 0.39$ HR

SUBJECT Conewich - Penelec

Natural Stream Encroachment - Culverts

BY MLA DATE 6-18-85 PROJ. NO. 85-195-4

CHKD. BY ASB DATE 6-20-85 SHEET NO. 4 OF 16

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H. After running the TR 20, the resulting Q_p = 374 cfs
See the "Hydrology Summary Tables" on sheet 9

2. Determine the surface runoff flow for the 100 yr - 24 hr storm.

A. P_{24} = 5.5 inches (Ref: "SCS Engineering Field Manual," Chapter 2, page 2-50.02, Indiana County)

B-G Same input used for the 25 yr - 24 hr

H. After running the TR 20, the resulting Q_p = 534.10
See the "Hydrology Summary Tables" on sheet 10

Hydraulic Analysis

The hydraulic analysis consists of designing a culvert for the 25 yr - 24 hr design storm and the 100 yr - 24 hr design storm. For each storm, both inlet and outlet control is tested to find which of the two conditions contain the governing headwater. The method used is described in the Hydraulic Engineering Circular No 5, "Hydraulic Charts for the Selection of Highway Culverts," December, 1965.

1. Inlet Control

A. $Q_{p\ 25yr}$ = 374 cfs ≈ 380 cfs

Desired HW/D is 1.1 ft/ft

Type of pipe considered - Aluminum coated CMP

Entry conditions - use standard CMP end sections

Using chart 5, resulting CMP size = 90" ø
or two 72" ø

See sheets 11 and 15

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FACTOR OF SAFETY FOR PASSING THE 25 YEAR STORM IS DETERMINED BY FINDING THE MAXIMUM FLOW CAPACITY OF THE CMP USING A MAXIMUM HEAD OF 3' ABOVE THE PIPE (WHICH CORRESPONDS TO THE MINIMUM DEPTH OF COVER) AND DIVIDING THAT FLOW BY THE DESIGN FLOW

$F.S._{95''\phi} = \frac{520}{380} = 1.37$
$F.S._{2-72''\phi} = \frac{325}{190} = 1.68$
} DESIRED F.S = 1.2 to 1.5

B $Q_{100 YR} = 539.9$ CFS ≈ 540 CFS

USE SAME CRITERIA THAT WAS USED FOR THE 25YR-24HR.
USING CHART 5, RESULTING CMP SIZE = 102"ϕ
OR TWO 78"ϕ

See SHEETS 11 AND 16

FACTOR OF SAFETY: $F.S._{102''\phi} = \frac{700}{540} = 1.30$

$F.S._{2-78''\phi} = \frac{370}{270} = 1.37$

IF THE 100 YR-24 HR STORM IS ACCOMODATED BY TWO 72"ϕ CMPS, THEN THE FACTOR OF SAFETY IS:

$F.S._{2-72''} = \frac{320}{270} = 1.19$

NOTE: THE 1.19 FACTOR OF SAFETY IS SMALLER THAN THE RECOMMENDED FACTOR OF SAFETY. EVENTHOUGH THE VALUE IS CLOSE ENOUGH TO PROBABLY BE ACCEPTABLE, THE MARGINAL COST DIFFERENCE BETWEEN A 72"ϕ AND A 78"ϕ CMP INFLUENCES OUR DECISION TO CONTINUE OUR ANALYSIS WITH A 78"ϕ CMP. ALSO, A LARGER PIPE WILL RESULT IN LESS HEADWATER & LESS FLOODING.

SUBJECT Conemaugh - Fenelec
Natural Stream Encroachment - Culverts
BY MLA DATE 6-18-85 PROJ. NO. 85-195-4
CHKD. BY ASB DATE 6-20-85 SHEET NO. 6 OF 16

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2. Outlet Control

A. For the 25yr - 24hr design flow

Parameters:

i. Slope of CMP ≈ 2% design slope

ii. $K_e = 0.5$ for CMP with end section conforming to fill slope. See sheet 13

iii. Length of culvert: $L = A + 2B$

Culvert diameters range from 6' to 7.5'
Width of top surface of road = 50'
Approximate protective cover = 3'min (use 4'min)
(Ref: Tele Memo by DEM to Norwood, 5/6/85, 85-195-4)

$L_{72} = 50 + 2(2(6' + 4')) = 90$ ft
$L_{90} = 50 + 2(2(7.5' + 4')) = 96$ ft
Note: Thinness of CMP is negligible

iv. Head - use chart 11, sheet 12

v. d_c - use chart 16, sheet 14

vi. TW: approximate method, assume uniform section

$Q = 380$ cfs
$n = 0.040$ (Ref: Open Channel Hydraulics, Chow, 1959, page 112)
$S = 0.02$ ft/ft

$$\frac{Qn}{b^{8/3}S^{1/2}} = \frac{380(0.040)}{(7)^{8/3}(0.02)^{1/2}} = 0.599$$

Note: Refer to sheet 7 for typical cross-section.

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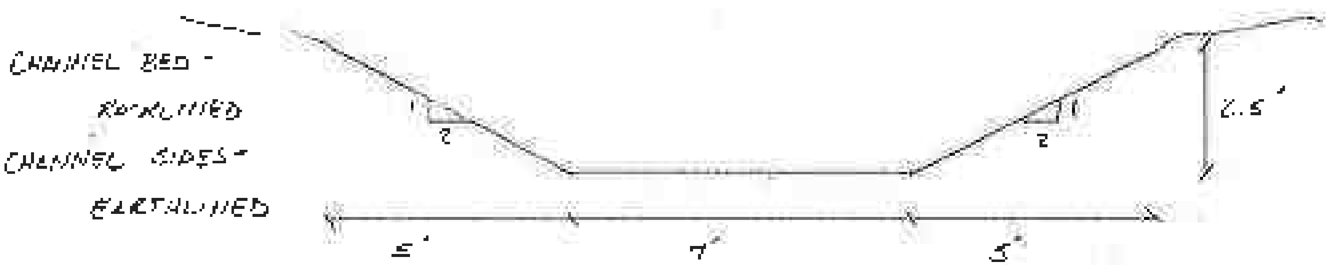
Typical cross-section of the channel in question is shown below.



(Ref: Survey Notes, "Penelec - Conemaugh, Channel Cross-Sections for Permitting," MLA, 6/5/85)

TWconc continue

$d/_b = 0.47$

$d = 0.47 \times 7' = 3.29$ ft

(Ref: HEC No 14, December, 1975, page III-17)

After using the respective charts, the culverts result in being inlet controlled, and the pipe size remains 6 ft. (use two pipe) and 7.5' (use one pipe)

See sheet 15

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B FOR THE 100 YR - 24 HR DESIGN FLOW

PERAMETERS

i SLOPE = 0.02

ii K_e = 0.5

iii $LENGTH_{TOT}$ = 50' + 2(3(6.5 FT + 4 FT)) = 92 FT L_{102} = RXIFI

iv HEAD - USE CHART 11, SHEET 13

v d_c - USE CHART 16, SHEET 14

vi TW:

Q = 540 CFS

n = 0.040

S = 0.02

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{540(0.04)}{7^{8/3}(0.02)^{1/2}} = 0.852$$

d/b = 0.56

d = 0.56 × 7 FT = 3.92 FT

vii AFTER USING THE RESPECTIVE CHARTS, THE CULVERTS RESULT IN BEING INLET CONTROLLED, AND THE PIPE SIZE REMAINS 6.5 FT. (USE TWIN PIPE AND 8.5' (USE ONE PIPE).

CONCLUSION

WE RECOMMEND THAT TWO 6.5 FT ∅ PIPES BE USED SINCE TWO PIPES WILL ADEQUATELY PASS THE 100 YR - 24 HR DESIGN FLOW WITHOUT DEVELOPING A LARGE HEAD. (SIGNIFICANT BACKWATER). DER RECOMMENDS THAT THE USE OF MULTIPLE PIPES SHOULD BE AVOIDED; HOWEVER, IN THIS CASE, TWO PIPES ARE BENEFICIAL FOR THE FOLLOWING REASONS:

1. MINIMIZES BACKWATER (AS MENTIONED ABOVE)
2. FACTOR OF SAFETY IS HIGHER
3. REDUCES THE AMOUNT OF FILL TO CONSTRUCT THE ROAD OVER THE CULVERTS.

Project No. 85-195-4

TABLE 1

HYDROLOGIC SUMMARY
EAST VALLEY PEAK FLOW FOR 25YR-24HR
USING TR 20

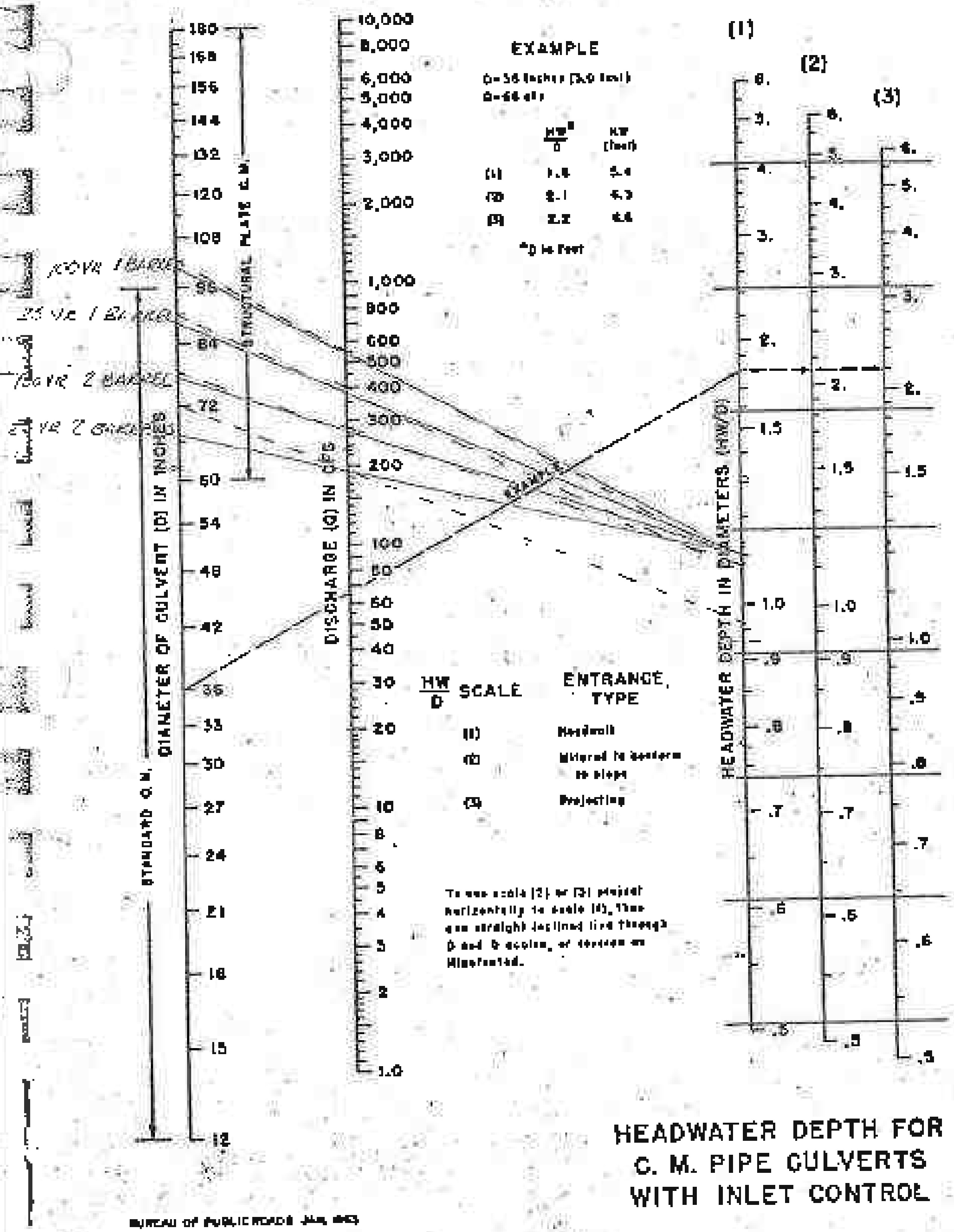
DESIGN STORM	25-year 24-hour
PRECIPITATION	4.5 inches
DRAINAGE AREA	
PASTURE AREA	82.0 acres
REVEGETATED AREA	11.5 acres
WOOD AREA	160.9 acres
TOTAL	254.4 acres
WEIGHTED CURVE NUMBER	73.6
TIME-OF-CONCENTRATION	.39 hours
PEAK FLOW - SURFACE RUNOFF	374.1 cfs
RUNOFF	1.94 inches
SURFACE RUNOFF VOLUME	41.2 acre-ft

Project No. 85-195-4

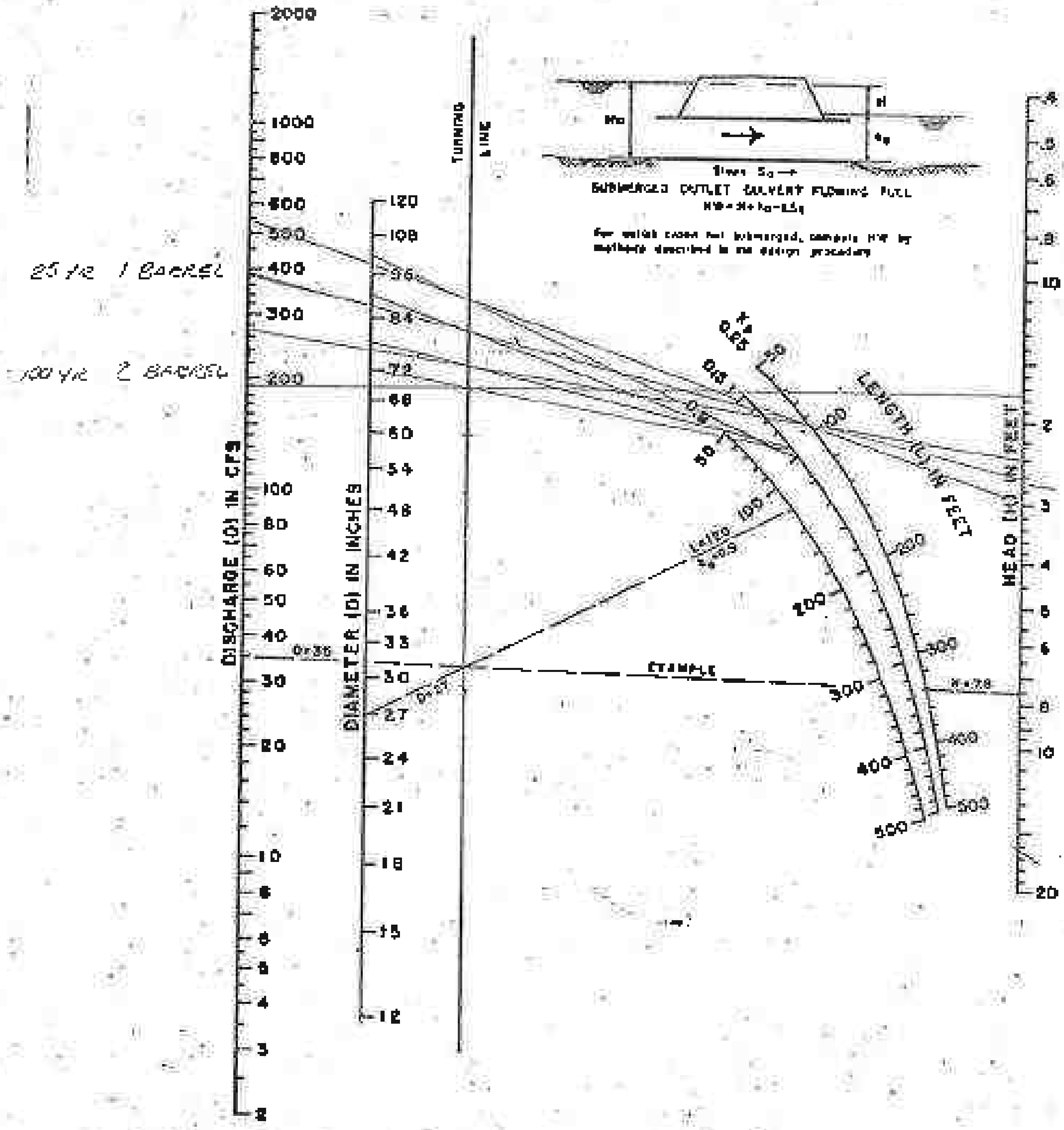
TABLE 2

HYDROLOGIC SUMMARY
EAST VALLEY PEAK FLOW FOR 100YR-24HR
USING TR 20

DESIGN STORM	100-year 24-hour
PRECIPITATION	5.5 inches
DRAINAGE AREA	
PASTURE AREA	82.0 acres
REVEGETATED AREA	11.5 acres
WOOD AREA	160.9 acres
TOTAL	254.4 acres
WEIGHTED CURVE NUMBER	73.6
TIME-OF-CONCENTRATION	.39 hours
PEAK FLOW - SURFACE RUNOFF	534.9 cfs
RUNOFF	2.73 inches
SURFACE RUNOFF VOLUME	57.9 acre-ft



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



BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL n=0.024

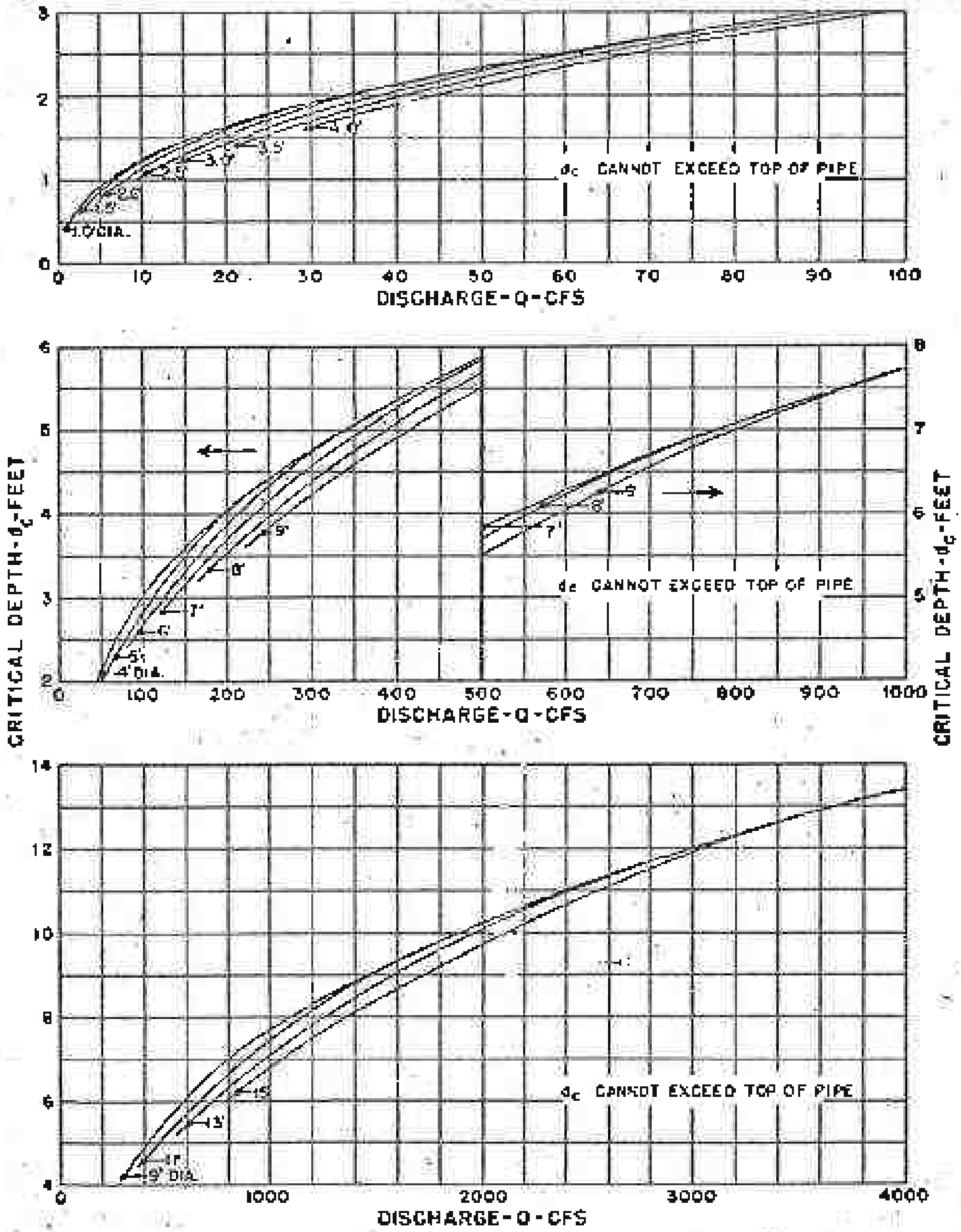
Table 1. - Entrance Loss Coefficients

Coefficient k_e to apply to velocity head $\frac{V^2}{2g}$ for determination of head loss at entrance to a structure, such as a culvert or conduit, operating full or partly full with control at the outlet.

$$\text{Entrance head loss } H_e = k_e \frac{V^2}{2g}$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls	
Square-edge	0.5
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension	0.2
Wingwalls at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7

*Note: "End Section conforming to fill slope", made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the bevelled inlet, p. 5-13.



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

PROJECT: 85-135-4

DESIGNER: MLA CKD 1/80

DATE: 6-19-85

For 25 YR - 24 HR Storm

HYDROLOGIC AND CHANNEL INFORMATION

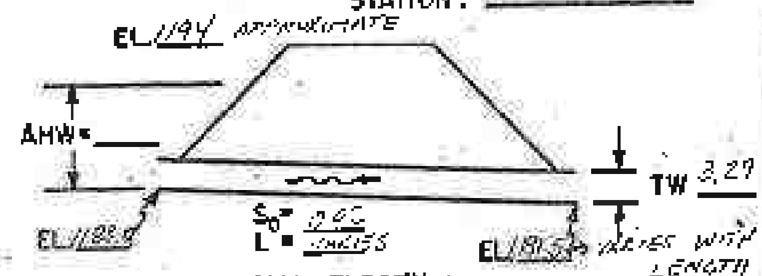
Q_1 = 380 CFS TW_1 = 3.29

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ______



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
1 CMP WITH STANDARD END	380	90"	1.27	9.02	0.5	2.56	5.1	6.3	3.29	6.3	1.92	6.96	9.02			INLET CONTROL
2 CMPS WITH STANDARD END	190	72"	0.96	5.76	0.5	1.75	3.8	4.9	3.29	4.9	1.80	4.85	5.76			INLET CONTROL

SUMMARY & RECOMMENDATIONS:

REF SHEETS: 11, 12, 13 AND 14

Figure 7

PROJECT: 85-195-4 DESIGNER: MLA Ch'd HB

DATE: 6-18-85

For 100yr - 24 hr storm

HYDROLOGIC AND CHANNEL INFORMATION

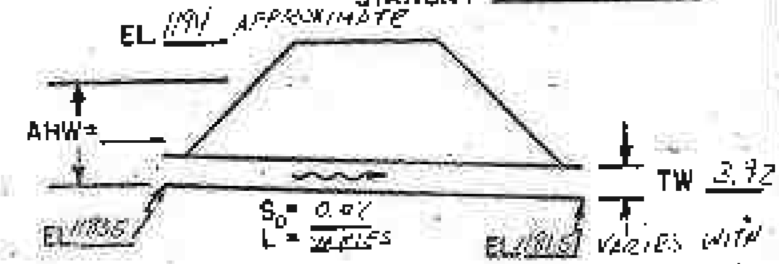
Q_1 = 540 cfs TW_1 = 3.92

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ______



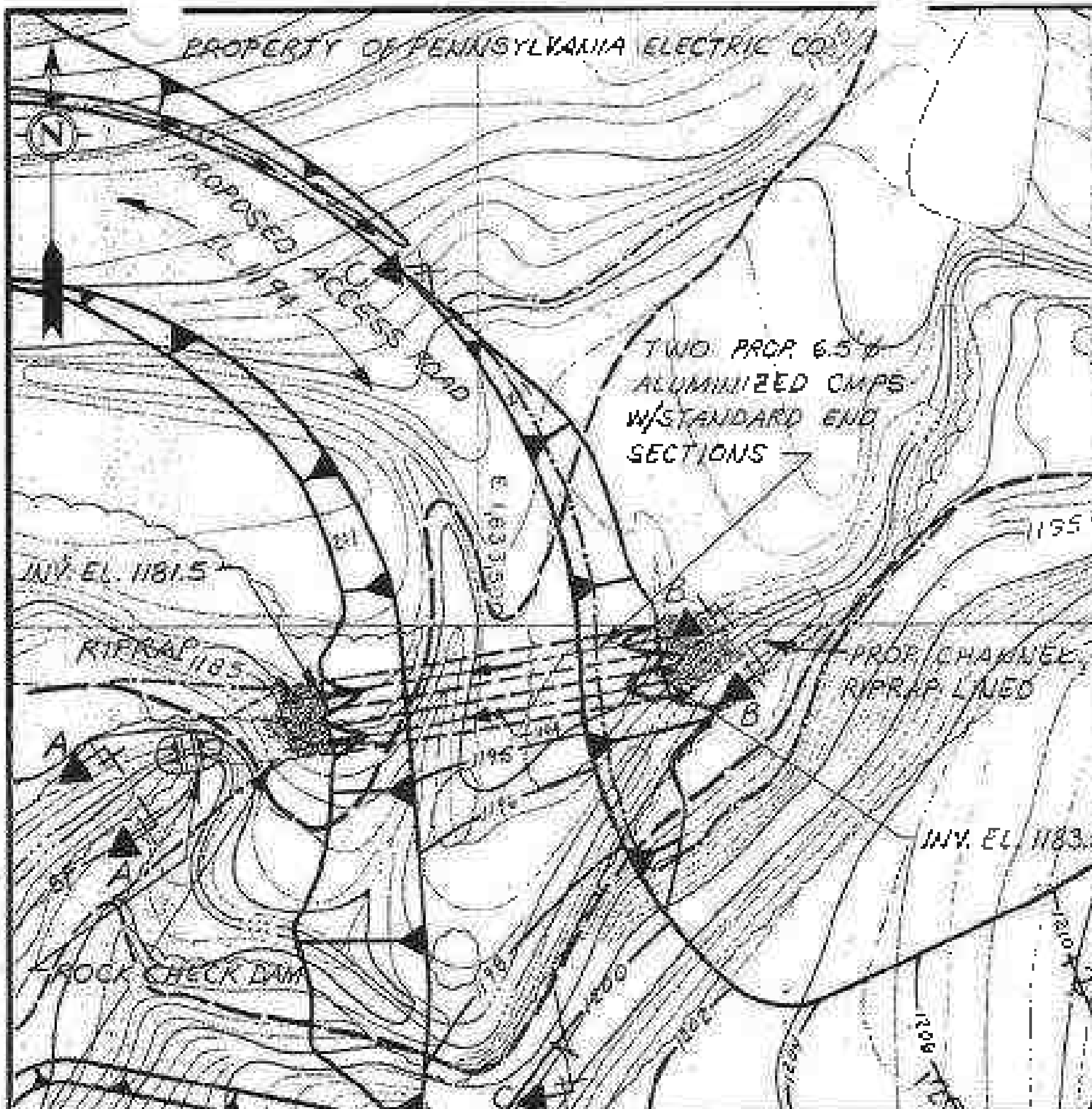
MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
1 CMP with standard end	540	102"	1.08	9.18	0.5	3.0	3.8	7.15	3.72	7.15	2.00	9.15	9.18			INLET CONTROL
2 CMP with standard end	270	78"	1.08	7.02	0.5	2.8	4.4	5.45	3.92	5.45	1.84	6.01	7.02			INLET CONTROL

SUMMARY & RECOMMENDATIONS:

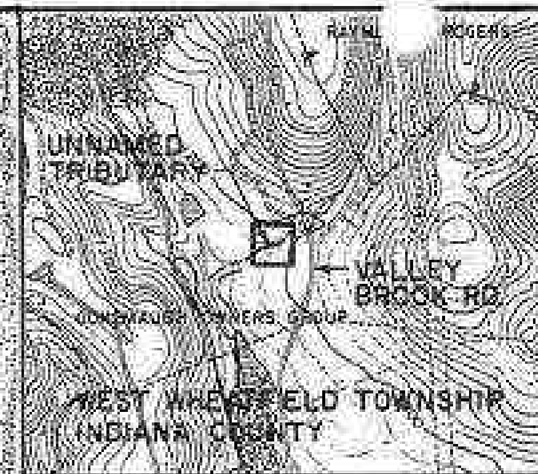
Ref Sheets: 11, 12, 13, 14

Figure 7



CHANNEL CONNECTING CULVERTS W/EXIST. CHANNEL

SCALE: 1" = 50'



LOCATION MAP

SCALE: 1000 0 1000 2000 FT.

NOTE: LOCATION MAP IS TAKEN FROM THE USGS NEW FLORENCE QUADRANGLE, PA 7.5 MINUTE SERIES, 1981.

LEGEND

- EXISTING 100 YR. FLOOD LEVEL
- PROPOSED 100 YR. FLOOD LEVEL
- EXISTING CHANNEL
- PROPOSED FEATURE

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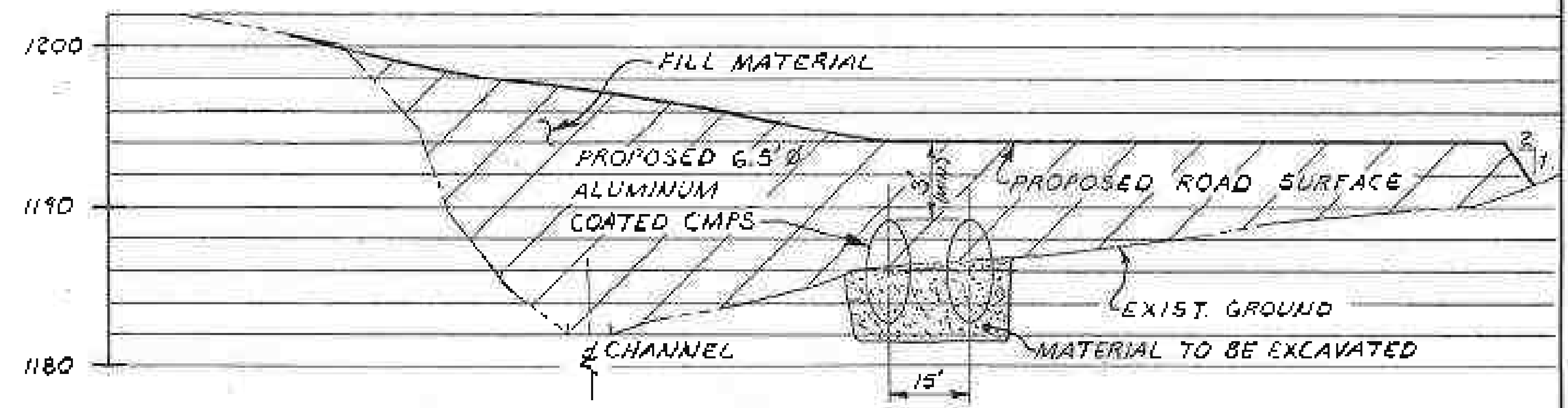
PENNSYLVANIA ELECTRIC COMPANY
CONEMAUGH STATION

PROPOSED CULVERT OVER AN UNNAMED TRIBUTARY AT WEST WHEATFIELD TWP., INDIANA COUNTY

DWN. AMZ	CHKD. MLA
APPD. HLP	DATE 6/24/85
SCALE: AS NOTED	
DRAWING NUMBER 85-195-A1	REV 0

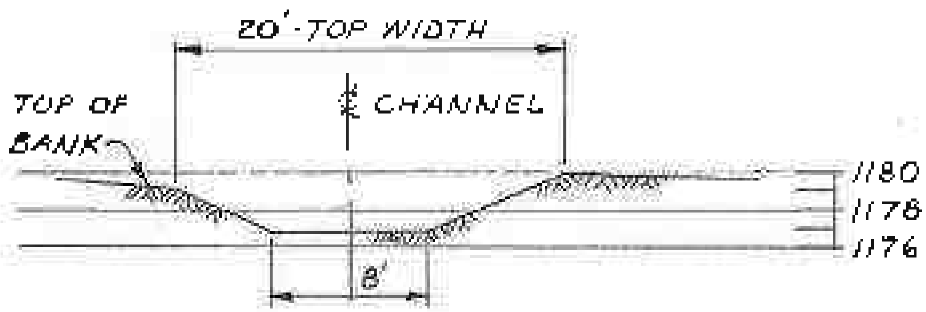


SECTION C-C

SCALE: HORIZ. 1" = 30', VERT. 1" = 10'

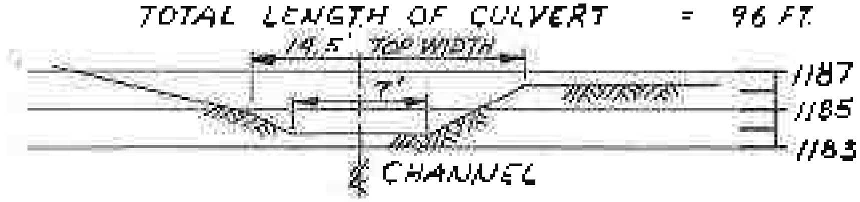
CULVERT*

DRAINAGE AREA	=	254 ACRES
SPAN	=	22'
UNDERCLEARANCE	=	6.5'
STREAM SLOPE	=	2%
EXPECTED DESIGN DISCHARGE	=	540 CFS
CULVERT DISCHARGE CAPABILITY	=	740 CFS
TOTAL LENGTH OF CULVERT	=	96 FT.



SECTION A-A

SCALE: 1" = 10'



SECTION B-B

SCALE: 1" = 10'

*DETAILED HYDROLOGIC AND HYDRAULIC CALCULATIONS ARE ATTACHED.

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PENNSYLVANIA ELECTRIC COMPANY
CONEMAUGH STATION

CROSS-SECTIONS AND DATA FOR THE PROP. CULVERT OVER AN UNNAMED TRIBUTARY AT WEST WHEATFIELD TWP., INDIANA COUNTY

DWN. RAZ CHKD. MLA
APPD. HLP DATE 6/24/85
SCALE: AS NOTED
DRAWING NUMBER 85-195-A2
REV 0

EXECUTIVE CONTROL CARD OPERATION LIST

LISTING OF DATA IN CORE

1 PEAK FLOWS FOR EAST VALLEY

VELOCITY INCREMENT 0.2000

1 GTABLE

8	0.0000	0.0900	0.1800	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

STRUCT NO.

3 STRUCT 7

	ELEVATION	DISCHARGE	STORAGE
8	1141.0000	0.0000	50.0900

9 ENDTBL

TIME INCREMENT

4 DIMHYD

8	0.0000	0.0300	0.1500	0.1900	0.3100
8	0.4700	0.6600	0.8200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.6800	0.5600	0.4600	0.3900	0.3300
8	0.2800	0.2410	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0552	0.0475	0.0400	0.0340	0.0299
8	0.0250	0.0210	0.0180	0.0150	0.0130
8	0.0110	0.0095	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000

9 ENDTBL

COMPUTED PEAK Q FACTOR = 49.00

```
                      TIME INCREMENT
5 RAINFL 1                 0.5000

8               0.0000     0.0080     0.0170     0.0260     0.0350
8               0.0450     0.0550     0.0650     0.0760     0.0870
8               0.0990     0.1120     0.1250     0.1400     0.1560
8               0.1740     0.1940     0.2190     0.2540     0.3030
8               0.5150     0.5830     0.6240     0.6540     0.6820
8               0.7050     0.7270     0.7480     0.7670     0.7840
8               0.8000     0.8160     0.8300     0.8440     0.8570
8               0.8700     0.8820     0.8930     0.9050     0.9160
8               0.9260     0.9360     0.9460     0.9550     0.9650
8               0.9740     0.9830     0.9920     1.0000     1.0000
9 ENDTBL

                      TIME INCREMENT
5 RAINFL 2                 0.5000

8               0.0000     0.0100     0.0200     0.0250     0.0300
8               0.0400     0.0500     0.0600     0.0700     0.0800
8               0.1000     0.1100     0.1300     0.1400     0.1700
8               0.1900     0.2200     0.2700     0.3500     0.4400
8               0.5200     0.6000     0.6300     0.6600     0.6800
8               0.7000     0.7200     0.7400     0.7600     0.7700
8               0.7900     0.8000     0.8200     0.8300     0.8400
8               0.8500     0.8700     0.8800     0.8900     0.9000
8               0.9100     0.9200     0.9300     0.9400     0.9500
8               0.9567     0.9633     0.9700     0.9800     0.9900
8               1.0000     1.0000     1.0000     1.0000     1.0000
9 ENDTBL

                      TIME INCREMENT
5 RAINFL 3                 0.5000

8               0.0000     0.0045     0.0108     0.0164     0.0221
8               0.0284     0.0347     0.0414     0.0483     0.0555
8               0.0632     0.0712     0.0797     0.0887     0.0984
8               0.1089     0.1203     0.1328     0.1467     0.1625
8               0.1808     0.2064     0.2354     0.2833     0.6632
8               0.7351     0.7724     0.7989     0.8197     0.8365
8               0.8538     0.8676     0.8801     0.8914     0.9017
8               0.9115     0.9206     0.9291     0.9371     0.9445
8               0.9519     0.9588     0.9653     0.9717     0.9777
8               0.9836     0.9892     0.9947     1.0000     1.0000
9 ENDTBL
```

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1     3     1          0.3933      13.4000      0.39901 1 1 0 0 0
  ENDATA

END OF LISTING
```

```
EXECUTIVE CONTROL CARD        OPERATION  INCREM,     MAIN TIME INCREMENT  0.20
EXECUTIVE CONTROL CARD        OPERATION  COMPUT,     FROM XSECTN/STRUCT  0/ 7     TO XSECTN/STRUCT  0/ 7
      STARTING TIME=  0.00    RAIN DEPTH=  4.50     RAIN DURATION=  1.00     RAIN TABLE NO.= 3     SOIL CONDITION= 2
      ALTERNATE NO.= 0        STORM NO.= 0

SUBROUTINE RUNOFF   STRUCTURE   7
         AREA=   0.40     INPUT RUNOFF CURVE=  71.6     TIME OF CONCENTRATION=  0.39

         NULL STRUCTURE...NO ELEVATIONS GIVEN
***** IN PEAK - MAXI =  127

         PEAK TIMES              PEAK DISCHARGES            PEAK ELEVATIONS
           12.09                    376.116                    (RUNOFF)

  TIME                              HYDROGRAPH, ZERO=   0.00     DELTA T= 0.20          DRAINAGE AREA=   0.40
  0.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  2.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  4.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  6.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  8.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.04      0.46
 10.00    DISCHG      1.08      1.99      3.22      4.55      6.22      8.96     12.90     18.92     40.44    187.51
 12.00    DISCHG    355.41    348.06    194.76    129.97     86.02     66.37     55.36     44.42     41.63     37.58
 14.00    DISCHG     34.54     32.71     30.71     29.75     27.70     26.41     25.19     23.81     22.90     21.77
 16.00    DISCHG     21.07     20.35     19.50     18.97     18.27     17.84     17.31     16.80     16.28     15.83
 18.00    DISCHG     15.56     15.21     14.73     14.51     14.07     13.80     13.49     13.06     12.92     12.73
 20.00    DISCHG     12.62     12.40     12.08     11.92     11.57     11.35     11.25     11.16     11.08     10.75
 22.00    DISCHG     10.54     10.43     10.34     10.28     10.03      9.86      9.77      9.68      9.63      9.46
 24.00    DISCHG      9.15      6.73      2.24      0.64      0.19      0.04      0.00

ENDCMP
```

PASS= 2

```
EXECUTIVE CONTROL CARD        OPERATION  COMPUT,     FROM XSECTN/STRUCT   0/  7     TO XSECTN/STRUCT   0/  3
        STARTING TIME=  0.00     RAIN DEPTH=  5.50    RAIN DURATION=  1.00     RAIN TABLE NO.= 3     SOIL CONDITION= 2
        ALTERNATE NO.= 0          STORM NO.= 0

SUBROUTINE RUNOFF    STRUCTURE   7
           AREA=   0.40     INPUT RUNOFF CURVE=  73.6     TIME OF CONCENTRATION=  0.35

           NULL STRUCTURE...NO ELEVATIONS GIVEN
*****  IN PEAK - MAXI =  123

           PEAK TIMES                   PEAK DISCHARGES               PEAK ELEVATIONS
             12.08                         534.876                       (RUNOFF)
```

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.40		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.05	0.38	0.97	1.63	2.45	3.30	4.45
10.00	DISCHG	5.99	7.19	9.36	11.40	15.12	18.56	24.89	34.41	67.80	287.84
12.00	DISCHG	515.23	488.31	269.35	177.43	119.25	89.41	74.59	42.14	57.02	50.20
14.00	DISCHG	46.19	43.59	40.19	39.56	36.81	35.03	33.42	31.31	30.35	28.83
16.00	DISCHG	27.89	26.92	25.49	25.07	24.13	23.55	22.85	21.81	21.47	20.87
18.00	DISCHG	20.50	20.04	19.40	19.09	18.51	18.15	17.76	17.23	16.91	16.72
20.00	DISCHG	16.57	16.23	15.86	15.65	15.18	14.89	14.75	14.63	14.53	14.07
22.00	DISCHG	13.81	13.67	13.54	13.46	13.13	12.98	12.79	12.61	12.65	12.38
24.00	DISCHG	12.23	8.80	7.74	0.86	0.24	0.06	0.01			

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

SUBJECT Penelec -- Conemaugh 1986 Stage II Const
Permanent Drainage Structures
BY MLA DATE 2/10/86 PROJ. NO. 86-197
CHKD. BY RED DATE 3/4/86 SHEET NO. 1 OF 102

GAI CONSULTANTS, INC.
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Environmental Specialists

Introduction:

These calculations involve designing permanent drainage structures for the ultimate Stage II configuration. These permanent drainage structures include:

1. Main Valley East Collection Channel
2. Main Valley West Collection Channel
3. Main Valley Collection Dissipator
4. Culvert for West Collection Channel

The above listed structures are shown on the attached engineer's worksheet.

Note: Many calcs, previous to these, have been performed for the purpose of designing permanent drainage structures for Stage II. Some of these calculations were used in the "Phase II - Coal Refuse Disposal Permit Application" submitted 12/85, and some were initiated for the purpose of using these structures in the 1985 Stage II Construction Package dated 3/85. Some portions of these calculations (i.e. assumptions, design criteria, etc.) are out-dated; therefore, designing these drainage structures involves revising and/or reinitiating calcs. Portions of the old calculations that are still applicable will be used as a basis for these new calcs or will be included as part of these new calcs.

(Types D & R Channels)

SUBJECT	PENELEC - CONEMAUGH 1986 STAGE II CONST. PERMANENT DRAINAGE STRUCTURES				
BY	MLA	DATE	2/10/86	PROJ. NO.	86-169
CHKD. BY	RFD	DATE	3/4/86	SHEET NO.	2 OF 102

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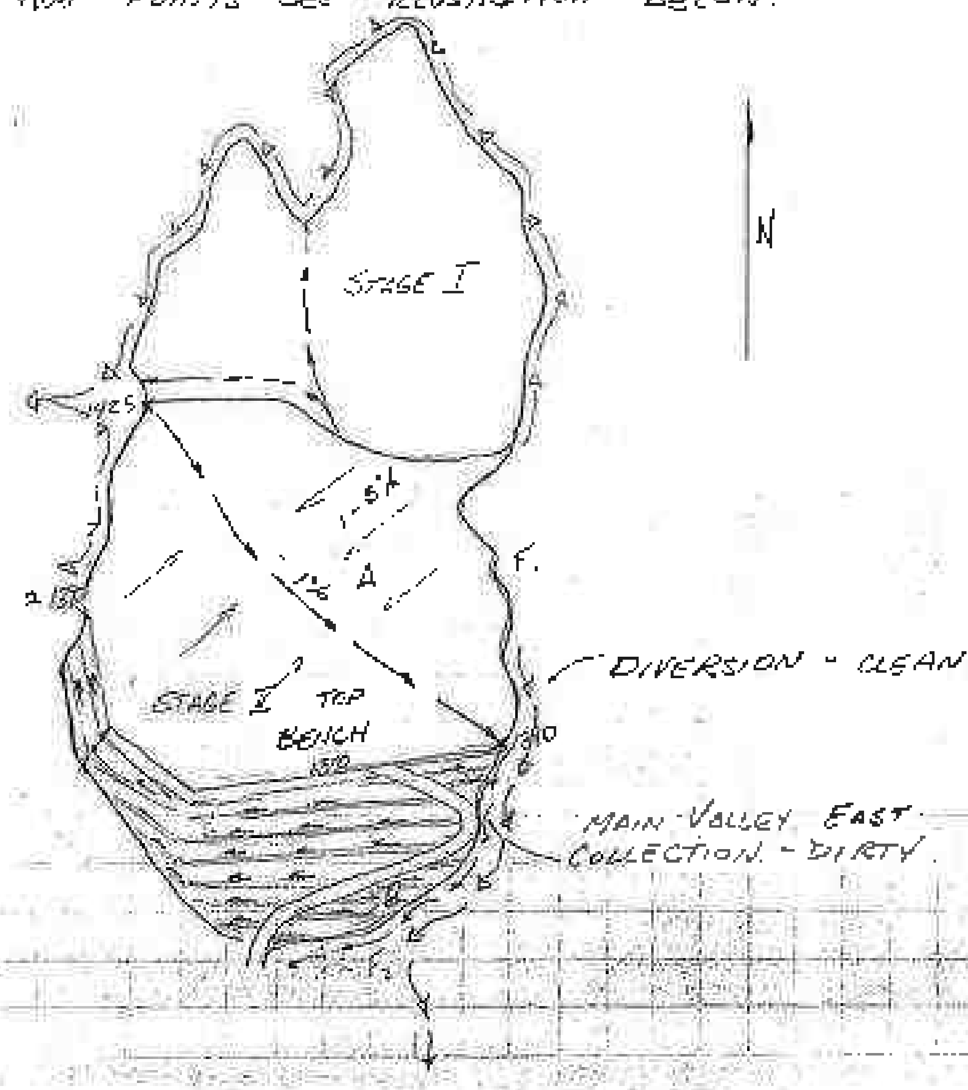
MAIN VALLEY EAST COLLECTION CHANNEL:

(1) HYDROLOGY:

THE WORST CONDITION FOR THE EAST COLLECTION CHANNEL OCCURS DURING THE LAST FEW INTERIM STAGES OF CONSTRUCTION. DURING THESE STAGES, THE TOP BENCH'S MAXIMUM ELEVATION IS APPROXIMATELY 1425 FT WHICH IS LOCATED AT A POINT NORTHWEST ON THE TOP BENCH. THE MINIMUM ELEVATION IS APPROXIMATELY 1390 FT WHICH IS LOCATED AT A POINT SOUTHEAST ON THE TOP BENCH. THE RUNOFF FROM THE TOP BENCH FLOWS IN A SWALE THAT RUNS BETWEEN THESE TWO POINTS SEE ILLUSTRATION BELOW.



THE MAIN VALLEY EAST COLLECTION CHANNEL COLLECTS THE RUNOFF FROM THE TOP BENCH SUBAREA A, FROM THE SLOPED BENCHES, SUBAREA B AND C, AND FROM A SMALL INCREMENT OF OFFSITE, SUBAREA F_1 AND F_2. SEE ATTACHED WORKSHEETS, 1A AND 1B.

THE HYDROLOGY FOR THE MAIN VALLEY EAST COLLECTION CHANNEL IS PERFORMED USING THE METHOD DESCRIBED IN SCS TR 20, AND SINCE THESE STRUCTURES ARE CONSIDERED PERMANENT STRUCTURES, THE STRUCTURES WILL BE DESIGNED FOR THE 100 YR STORM.

INPUT DATA:

A. PPT: 5.5 INCHES - 100YR - 24 HR (REF: SCS ENGINEERING FIELD
 4.0 - 10YR - 24 HR MANUAL," CHAPTER 2, PG
 2.7 - 2YR - 24 HR 2-30.02, INDIANA COUNTY)

B. AMC II

C. HYDROLOGIC SOIL GROUP C - BASED ON SOIL SURVEY INFO

D. DRAINAGE AREA

		AREA
i.	A - TOP BENCH - ACTIVE	140.9
ii.	B - REVEGETATED BENCHES NEAR TOE	7.4
iii.	C - REVEGETATED BENCHES NEAR TOP	2.0
iv.	F_1 - OFFSITE, EAST OF SITE	13.6
v.	F_2 - OFFSITE SOUTH OF SITE	1.7

E. CURVE NUMBERS

		CN
i.	A - ACTIVE	85
ii.	B - REVEGETATED SLOPE BENCH	78
iii.	C - REVEGETATED SLOPE BENCH	78
iv.	F_1 - WOODED OFFSITE	70
	F_2 - PASTURE OFFSITE (SOIL STOCKPILE)	80

(SEE ATTACHED INTRA OFFICE MEMO, EUK 85-195 & 85-203, 5/21/85)

FILA

SHT 4 of 102

INTRA-OFFICE MEMO

GAI CONSULTANTS
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Environmental Specialists

To: File

From: EHK

Subject: Meeting on Conemaugh & Keystone Hydrology

Project No. 85-195, 85-205

Date: 2/21/85

☑ For Information Only
☐ For Your Action
☐ For Review and Reply
☐ Non-Project File No. ______

Meeting between Ellen Kucharik, Tim Kyper and Anne Brendel was held to attain some kind of consistency between Conemaugh and Keystone hydrology.

Curve Numbers for certain areas were decided on as follows:

Revegetated pile - top surface	75
" " - bench faces	78
Off-site - fair pasture or range	80
Off-site - woods	70
Active disposal	85
Bench faces in process (seeded but not fully vegetated)	82
Paved haul road (If large enough area to separate)	90
Haul Road on pile	85
Top Surface in process (seeded but not fully vegetated)	80

Time of concentration determinations will be based ...

Distribution: ASB, TNK, EHK, GFB, DB, HCP, File, JRL

INTRA-OFFICE MEMO

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Environmental Specialists

To:
From:
Subject:
Project No.
Date:

☐ For Information Only ☐ For Your Action
☐ For Review and Reply ☐ Non-Project File No.

on the attached graph as follows: (velocities)

Active pile - Curve ⑤
Pile in process - Curve ③ (seeded but not fu...
Revegetated pile - " ②
Off-site pasture - " ② ③ -
" woods - " ①

Velocities in channels will be estimated base... on experience and checked with a quick channel design after flows are received from TR 20. TR2... will be rerun if the assumed velocity and the velocity from the channel design differ greatly.

Tim gave a quick review of the TR20 program... 3 levels of detail are possible from th... program.

1. "Detailed" Analysis
2. Addition of runoff hydrographs for each su... area
3. Considering ... as one "gross" ...

Distribution:

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It was decided that the level of detail will b[e] up to the design engineer and will depend o[n] available information.

Tim is available to help others get familiar wi[th] TR 20 and help them get going on the comp[uter]

Note:
Curve Numbers for Keystone's active area ma[y] dictated by the Curve Numbers used in the [ori]ginal permit. All parties involved will be notified if that is the case.

Distribution:

From: A Guide To Hydrologic Analysis Using SCS Meth.
by Richard H. McCuen

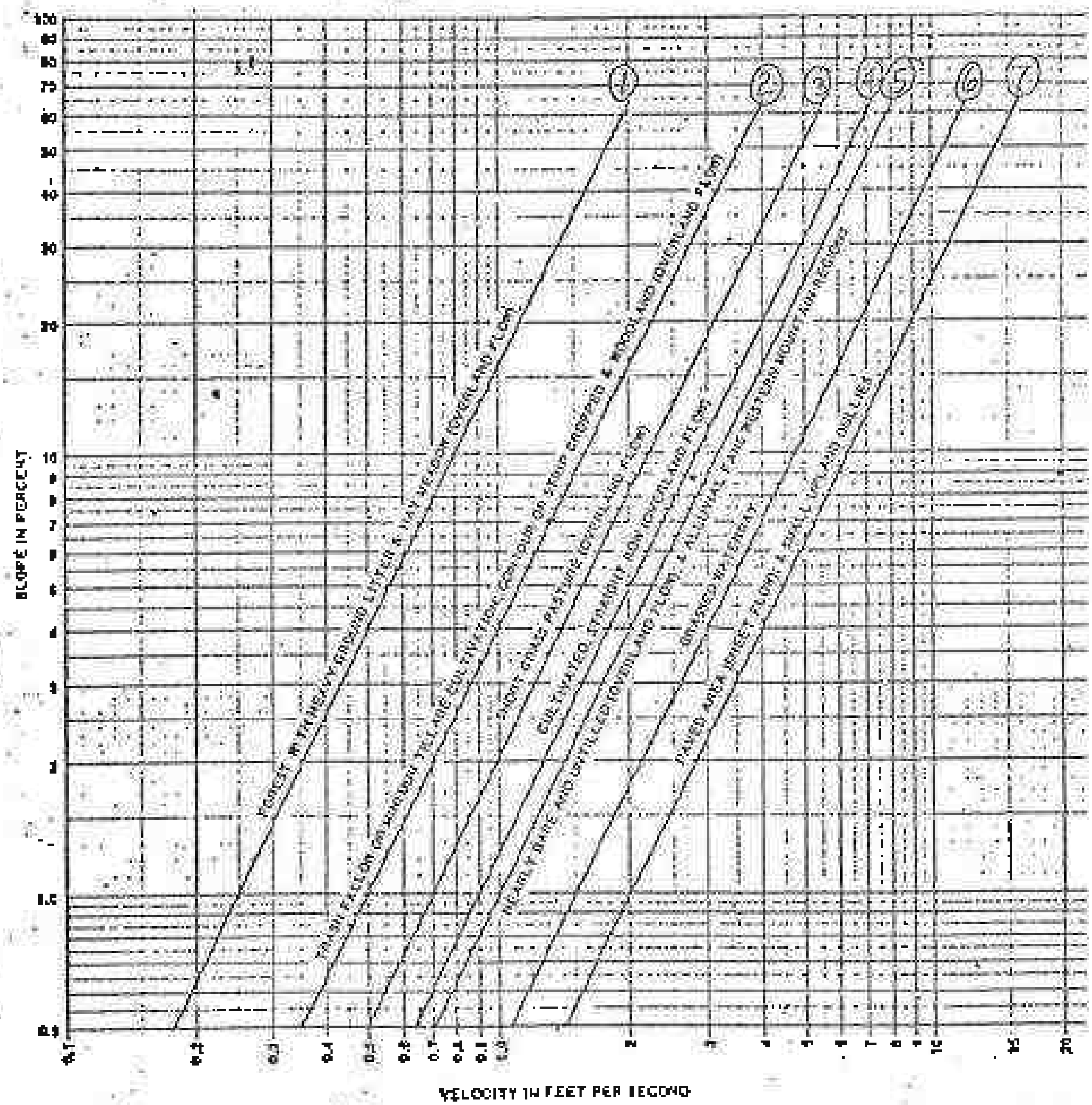

Figure 8. Velocities for upland method of estimating T_c

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- TIME OF CONCENTRATION:

  - TO POINT 1

    A - TOP BENCH

    LENGTH OF SWALE = 3456 FT
    SLOPE OF SWALE = 1 %
    VELOCITY OF FLOW ≈ 4 FPS
    (ASSUMPTION)

    $T_c = \frac{3456 \text{ FT}}{4 \text{ FPS}}$
    = 864 SECONDS
    = 0.240 HR = 0.24 HR

    F_1 - WOODED OFFSITE

    LENGTH OF FLOW ALONG LAND = 1363 FT
    SLOPE OF OVERLAND = 5 %
    VELOCITY OF FLOW = 0.6 FPS
    (SEE SHEET 9)

    $t_{c_1} = \frac{1363}{0.6}$
    = 2272 SEC
    = 0.631 HR

    LENGTH OF CHANNEL = 590 FT
    SLOPE OF CHANNEL = 11 %
    VELOCITY IN CHANNEL
    ASSUME

ASSUME y = 0.5'

CONCRETE LINED
n = 0.017
(REF. OPEN-CHANNEL HYDRAULICS
CHOW, 1959, PG. 111)

SUBJECT Penelec - Conemaugh 1986 Stage II Const
Permanent Drainage Structures
BY MLA DATE 2/11/86 PROJ. NO. 86-167
CHKD. BY RFD DATE 3/4/86 SHEET NO. 9 OF 162

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$V = \frac{1.49}{n} R^{2/3} S^{1/2}$

$= \frac{1.49}{0.013} \left(\frac{2(0.5) + 2(0.5)^2}{2 + 2(0.5)\sqrt{5}} \right)^{2/3} (0.11)^{1/2}$

$= 20.6$ fps

$t_{c_2} = \frac{590 \text{ ft}}{20.6 \text{ fps}}$

$= 28.6$ seconds

$= 0.008$ hr

$T_c = 0.631 \text{ hr} + 0.008 \text{ hr}$

$= 0.639 \text{ hr} \approx 0.64 \text{ hr}$

ii To point 2

C - Revegetated Benches near Top

Length of Bench = 600 ft

Slope of Bench = 1-3%

Velocity of flow = 2 fps (assumption)

$t_{c_1} = \frac{600}{2}$

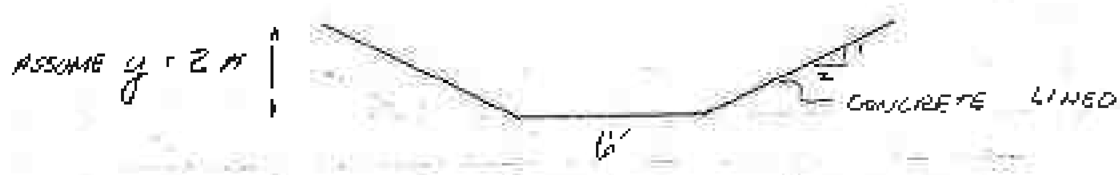
$= 300$ sec

$= 0.083$ hr

Length of channel = 410 ft

Slope of channel = 10%

Velocity of flow =



$V = \frac{1.49}{0.013} \left(\frac{6(2) + 2(2)^2}{6 + 2(2)\sqrt{5}} \right)^{2/3} 0.10^{1/2}$

$= 47.7$ fps

$t_{c2} = \frac{410}{47.7}$

= 8.6 SEC

= 0.002 HR

T_c = 0.083 + 0.002 = 0.085 HR ≈ 0.08 HR

NOTE: IN ROUTING FLOW FROM PT 1 TO PT 2, LENGTH OF CHANNEL EQUALS 480 FT

iii. TO POINT 3

B – REVEGETATED BENCHES NEAR TOE

LENGTH OF BENCH	= 630 FT
SLOPE OF BENCH	= 1-3%
VELOCITY OF FLOW	= 2 FPS (ASSUMPTION)

$t_{c1} = \frac{630}{2}$

= 315 SECONDS

= 0.088 HR

t_{c2} = FOR CHANNEL LENGTH, t_c IS VERY SMALL THEREFORE, NEGLIGIBLE

∴ T_c = 0.088 HR ± ≈ 0.09 HR

F_2 – OFFSITE, SOIL STOCKPILE

LENGTH OF OVERLAND	= 300 FT
SLOPE OF OVERLAND	= 7%
VELOCITY OF FLOW	= 2 FPS (SEE SHEET 7)

$t_{c1} = \frac{300}{2}$

= 0.042 HR

t_{c2} = IN CHANNEL, t_c IS VERY SMALL THEREFORE NEGLIGIBLE

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST
PERMANENT DRAINAGE STRUCTURES

BY MLA DATE 2/12/86 PROJ. NO. 86-167

CHKD. BY RFD DATE 3/4/86 SHEET NO. 11 OF 102

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T_c: 0.042HR ± ≈ 0.04 HR

NOTE: IN ROUTING FLOW FROM PT 2 TO PT 3, LENGTH OF CHANNEL EQUALS 1374 FT AT ≈ 14.5% SLOPE.

g. PEAK DISCHARGES:

i. AT POINT 1: Q_p = 497 CFS
ii. AT POINT 2: Q_p = 501 CFS
iii. AT POINT 3: Q_p = 525 CFS

SUBJECT Conemaugh - Conemaugh 1986 Stage II Conn
BY MLA DATE 2/13/86 SHEET NO. 12 OF 102
CHKD BY RFQ DATE 3/4/86 PROJECT NO. 86-167


```
HEC CONTROL CARD          OPERATION  LIST

LISTING OF DATA IN CORE

    0  CONEMAUGH - STAGE II 1986 - EAST CONNECTION

                          VELOCITY INCREMENT
1 CTABLE                       0.2000

8              0.0000    0.0800    0.1500    0.2500    0.3200
8              0.3700    0.4100    0.4500    0.4900    0.5100
8              0.5400    0.5700    0.5900    0.6100    0.6300
8              0.6500    0.6600    0.6700    0.6900    0.7000
8              0.7100    0.7200    0.7300    0.7400    0.7500
8              0.7600    0.7700    0.7700    0.7800    0.7900
8              0.7900    0.8000    0.8100    0.8100    0.8200
8              0.8200    0.8300    0.8300    0.8400    0.8400
8              0.8400    0.8500    0.8500    0.8600    0.8600
8              0.8600    0.8600    0.8700    0.8700    0.8700
8              0.8800    0.8800    0.8800    0.8900    0.8900
8              0.8900    0.8900    0.8900    0.8900    0.9000
8              0.9000    0.9000    0.9000    0.9000    0.9100
8              0.9100    0.9100    0.9100    0.9100    0.9100
8              0.9200    0.9200    0.9200    0.9200    0.9200
8              0.9200    0.9200    0.9200    0.9300    0.9300
9 ENDTBL

          XSECTN NO.       DRAINAGE AREA
2 XSECTN      1               1.0000

                       ELEVATION   DISCHARGE    END AREA
8                         0.0000      0.0000      0.0000
9 ENDTBL

          XSECTN NO.       DRAINAGE AREA
2 XSECTN      2               1.0000

                       ELEVATION   DISCHARGE    END AREA
8                         0.0000      0.0000      0.0000
8                         1.0000    282.5000      8.0000
8                         2.0000    953.7000     20.0000
9 ENDTBL

          XSECTN NO.       DRAINAGE AREA
2 XSECTN      3               1.0000

                       ELEVATION   DISCHARGE    END AREA
8                         0.0000      0.0000      0.0000
8                         1.0000    316.1000      8.0000
8                         2.0000   1146.4000     20.0000
9 ENDTBL

                   TIME INCREMENT
```

```
4 DI
8          0.0000    0.0300    0.1000    0.1900       .00
8          0.4700    0.6600    0.8200    0.9300    0.9900
8          1.0000    0.9900    0.9300    0.8600    0.7800
8          0.6800    0.5600    0.4600    0.3900    0.3300
8          0.2800    0.2410    0.2070    0.1740    0.1470
8          0.1260    0.1070    0.0910    0.0770    0.0660
8          0.0550    0.0470    0.0400    0.0340    0.0290
8          0.0250    0.0210    0.0180    0.0150    0.0130
8          0.0110    0.0090    0.0080    0.0070    0.0060
8          0.0050    0.0040    0.0030    0.0020    0.0010
8          0.0000    0.0000    0.0000    0.0000    0.0000
9 ENDING

 COMPUTED PEAK 6 FACTOR =  484.00


                   TIME INCREMENT
5 RAINFL 1                 0.5000

8          0.0000    0.0080    0.0170    0.0260    0.0350
8          0.0450    0.0550    0.0650    0.0760    0.0870
8          0.0990    0.1120    0.1250    0.1400    0.1560
8          0.1740    0.1940    0.2190    0.2540    0.3030
8          0.5150    0.5830    0.6240    0.6540    0.6820
8          0.7050    0.7270    0.7480    0.7670    0.7840
8          0.8000    0.8160    0.8300    0.8440    0.8570
8          0.8700    0.8820    0.8930    0.9050    0.9160
8          0.9260    0.9360    0.9460    0.9550    0.9650
8          0.9740    0.9830    0.9920    1.0000    1.0000
9 ENDING


                   TIME INCREMENT
5 RAINFL 2                 0.0200

8          0.0000    0.0100    0.0200    0.0200    0.0300
8          0.0400    0.0500    0.0600    0.0700    0.0800
8          0.1000    0.1100    0.1300    0.1400    0.1700
8          0.1900    0.2200    0.2700    0.3500    0.4400
8          0.5200    0.6000    0.6300    0.6600    0.6900
8          0.7000    0.7200    0.7400    0.7600    0.7700
8          0.7900    0.8000    0.8200    0.8300    0.8400
8          0.8500    0.8700    0.8800    0.8900    0.9000
8          0.9100    0.9200    0.9300    0.9400    0.9500
8          0.9567    0.9633    0.9700    0.9800    0.9900
8          1.0000    1.0000    1.0000    1.0000    1.0000
9 ENDING


                   TIME INCREMENT
5 RAINFL 3                 0.5000

8          0.0000    0.0053    0.0106    0.0164    0.0221
8          0.0284    0.0347    0.0414    0.0484    0.0555
8          0.0632    0.0712    0.0797    0.0887    0.0984
8          0.1089    0.1203    0.1328    0.1467    0.1625
8          0.1808    0.2042    0.2351    0.2833    0.6632
8          0.7351    0.7724    0.7989    0.8197    0.8380
8          0.8538    0.8676    0.8801    0.8914    0.9019
8          0.9115    0.9206    0.9291    0.9371    0.9446
8          0.9519    0.9580    0.9653    0.9717    0.9777
```

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
BY MLA DATE 2/12/86 SHEET NO. 14 OF 102
CHKD BY RFD DATE 3/4/86 PROJECT NO. 86-167

0.9836

0.9882

0.9967

1.0000

1.0000

SUBJECT [illegible] STAGE II CONST
BY MLA DATE 2/12/86 SHEET NO. 15 OF 102
CHKD BY RFO DATE 3/4/86 PROJECT NO. 84-167

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1   1       1     0.2200    85.0000    0.24001 1 0 0 0 0
6 RUNOFF 1   1       2     0.0210    70.0000    0.64001 1 0 0 0 0
6 ADDHYD 4   1   1 2 3                                1 1 0 0 0 0
6 REACH  3   2   3   5   430.0000     0.0000    0.00001 1 0 0 0 0
6 RUNOFF 1   2       4     0.0030    78.0000    0.05001 1 0 0 0 0
6 ADDHYD 4   2   4 5 6                                1 1 0 0 0 0
6 RUNOFF 1   3       7     0.0110    78.0000    0.09001 1 0 0 0 0
6 RUNOFF 1   3       1     0.0030    80.0000    0.04001 1 0 0 0 0
6 ADDHYD 4   3   7 1 2                                1 1 0 0 0 0
6 REACH  3   3   6   3  1314.0000     0.0000    0.00001 1 0 0 0 0
6 ADDHYD 4   3   2 3 4                                1 1 0 0 0 0
  ENDATA
```

END OF LISTING

Project: Pinelles Connector 1986 Stage II Const.
By: MLA Date: 3/10/86 Sheet No. 102
Chkd: RED Date: 3/20/86 Job No. 86-107


```
EXECUTIVE CONTROL CARD        OPERATION  INCREM,      RAIN TIME  INCREMENT=  0.20
EXECUTIVE CONTROL CARD        OPERATION  COMPUT,      FROM XSE   1 (XSEC)  1?  ?    TO XSECTN/STRUCT   1?  ?
   STARTING TIME=  0.00     RAIN DEPTH=  2.70     RAIN DURATION =  1.00     RAIN TABLE NO.= 1     SOIL CONDITION= 2
   ALTERNATE NO.= 0         STORM NO.= 0

SUBROUTINE RUNOFF     CROSS SECTION    1
          AREA=   0.22      INPUT RUNOFF CURVE=  85.0      TIME OF CONCENTRATION=  0.24
***** IS PEAK = MAXI =  125

          PEAK TIMES                     PEAK DISCHARGES               PEAK ELEVATIONS
            11.98                           171.169                       (RUNOFF)

  TIME                          HYDROGRAPH, TZERO=   0.00        DELTA T= 0.20        DRAINAGE AREA=   0.22
  0.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  2.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  4.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  6.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  8.00   DISCHG       0.00      0.00      0.00      0.04      0.17      0.44      0.56      0.79      1.03      1.35
 10.00   DISCHG       1.67      2.16      2.05      3.48      4.76      5.50      8.33     10.68     30.52    122.47
 12.00   DISCHG     171.16     97.74     47.22     37.15     23.86     21.40     17.53     15.52     14.69     12.52
 14.00   DISCHG      12.15     11.26     10.80     10.45      9.53      9.16      8.65      8.26      8.04      7.57
 16.00   DISCHG       7.49      7.05      6.62      6.71      6.39      6.14      6.01      5.84      5.76      5.57
 18.00   DISCHG       5.53      5.12      5.20      5.11      4.93      4.87      4.71      4.61      4.58      4.50
 20.00   DISCHG       4.49      4.34      4.26      4.21      4.09      4.02      3.98      3.96      3.91      3.75
 22.00   DISCHG       3.72      3.68      3.60      3.61      3.51      3.49      3.45      3.43      3.40      3.32
 24.00   DISCHG       3.29      1.30      0.37      0.02      0.00

SUBROUTINE RUNOFF     CROSS SECTION    2
          AREA=   0.02      INPUT RUNOFF CURVE=  70.0      TIME OF CONCENTRATION=  0.44
***** IS PEAK = MAXI =  126

          PEAK TIMES                     PEAK DISCHARGES               PEAK ELEVATIONS
            12.33                            3.659                        (RUNOFF)

  TIME                          HYDROGRAPH, TZERO=   0.00        DELTA T= 0.20        DRAINAGE AREA=   0.02
  0.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  2.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  4.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  6.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  8.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
 10.00   DISCHG       0.00      0.03      0.00      0.00      0.00      0.00      0.00      0.00      0.02      0.40
 12.00   DISCHG       1.60      1.46      1.60      2.81      2.15      1.63      1.30      1.04      0.92      0.62
 14.00   DISCHG       0.73      0.67      0.63      0.60      0.57      0.54      0.52      0.49      0.47      0.45
 16.00   DISCHG       0.43      0.42      0.40      0.35      0.38      0.37      0.36      0.35      0.34      0.33
 18.00   DISCHG       0.32      0.32      0.31      0.30      0.30      0.29      0.28      0.24      0.27      0.27
 20.00   DISCHG       0.26      0.25      0.26      0.25      0.25      0.24      0.24      0.24      0.23      0.23
 22.00   DISCHG       0.23      0.22      0.22      0.22      0.21      0.21      0.21      0.21      0.21      0.21
 24.00   DISCHG       0.20      0.18      0.17      0.06      0.03      0.01      0.01      0.00

SUBROUTINE ADDHYD     CROSS SECTION    1
          INPUT HYDROGRAPHS= 1,2      OUTPUT HYDROGRAPH= 3
***** IN PEAK = MAXI =  128

          PEAK TIMES                     PEAK DISCHARGES               PEAK ELEVATIONS
            11.98                           173.452                       (NONE)

  TIME                          HYDROGRAPH, TZERO=   0.00        DELTA T= 0.20        DRAINAGE AREA=   0.24
  0.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  2.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  4.00   DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.04
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SUBJECT Penelec - Conemaugh ABC Stage II Cont
BY MHA DATE 3/10/86 SHEET NO. 17A OF 122
CHKD. BY RPD DATE 3/26/86 PROJECT NO. 86-147

6.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.03	0.00	0.00	0.00
8.00	DISCHG	0.09	0.00	0.00	0.03	[illegible]	0.34	4.56	0.79	1.01	1.39
10.00	DISCHG	1.67	2.30	2.85	3.98	[illegible]	5.50	8.33	16.68	30.53	127.47
12.00	DISCHG	172.96	101.24	50.62	34.79	[illegible]	21.09	18.82	16.00	15.62	13.34
14.00	DISCHG	12.88	11.93	11.43	11.06	30.10	9.92	9.17	8.75	8.55	6.02
16.00	DISCHG	1.92	7.47	1.27	7.10	6.77	6.35	6.37	6.19	6.39	5.90
18.00	DISCHG	5.86	5.63	5.51	5.43	5.22	5.19	4.99	4.09	4.65	4.77
20.00	DISCHG	4.79	4.60	4.52	4.40	4.29	4.26	4.22	4.19	4.15	3.98
22.00	DISCHG	3.95	3.91	3.88	3.85	3.72	3.70	3.66	3.61	3.61	3.53
24.00	DISCHG	3.49	1.48	0.29	0.00	0.03	0.01	0.01	0.00		

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 439.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00
AVERAGE WATER VELOCITY= 32.653 AVERAGE ROUTING COEFF= 0.9507 NUMBER OF ROUTINGS= 0.02
[illegible] IN PEAK = MAXI = 120

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	172.437	0.06

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.03	0.17	0.34	0.56	1.79	3.03	1.19
10.00	DISCHG	1.67	2.20	2.84	3.47	4.72	5.49	8.28	10.64	30.19	120.87
12.00	DISCHG	172.11	102.50	51.70	40.19	20.03	23.84	16.90	16.84	15.89	13.30
14.00	DISCHG	12.89	11.95	11.49	11.09	10.12	9.91	9.16	8.76	8.55	8.03
16.00	DISCHG	7.92	7.40	7.23	7.10	6.75	6.71	6.38	6.39	6.10	5.90
18.00	DISCHG	5.86	5.61	5.51	5.41	5.35	5.14	5.00	4.89	4.65	4.37
20.00	DISCHG	4.75	4.60	4.54	4.46	4.29	4.26	4.22	4.20	4.15	3.98
22.00	DISCHG	3.95	3.91	3.88	3.85	3.72	3.70	3.66	3.64	3.61	3.53
24.00	DISCHG	3.49	1.53	0.33	0.09	0.03	0.01	0.01	0.00		

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.00 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.06
[illegible] IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	1.965	(RUNOFF)
12.30	0.427	(RUNOFF)
12.91	0.231	(RUNOFF)
13.31	0.160	(RUNOFF)
13.91	0.132	(RUNOFF)
14.31	0.117	(RUNOFF)
14.91	0.103	(RUNOFF)
15.31	0.090	(RUNOFF)
15.91	0.081	(RUNOFF)
16.91	0.071	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.31	0.01	0.04	0.05	0.62	1.39
12.00	DISCHG	1.90	0.41	0.41	0.25	0.72	0.22	0.15	0.16	0.17	0.13
14.00	DISCHG	0.13	0.12	0.12	0.10	0.10	0.10	0.09	0.09	0.08	0.06
16.00	DISCHG	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06
18.00	DISCHG	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

PROJECT Penelec - Conemaugh 1986 Stage II Const.
BY MLA DATE 3/10/86 SHEET NO. 18A OF 102
CHECKED BY RPC DATE 3/24/86 PROJECT NO 86-167

20.0	DISCHG	0.05	0.05	0.05	0.05	0	0.04	0.04	0.04	0.04	0.04
22.0	DISCHG	0.04	0.04	0.04	0.04		0.04	0.04	0.04	0.04	0.04
24.0	DISCHG	0.04	0.00								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 4,5 OUTPUT HYDROGRAPH= 6
***** IN PEAK = MAXI = 120

PEAK TIMES 11.98 PEAK DISCHARGES 176.369 PEAK ELEVATIONS 0.00

HYDROGRAPH, TZERO= 0.00 DELTA TF 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.03	0.17	0.34	0.56	0.79	1.03	1.39
10.00	DISCHG	1.67	2.28	2.89	3.47	4.72	5.50	6.31	10.69	30.81	172.27
12.00	DISCHG	114.01	102.90	52.10	40.43	26.26	23.36	19.06	16.80	15.77	13.51
14.00	DISCHG	11.02	12.06	11.55	11.19	10.27	10.01	9.27	8.85	8.64	8.11
16.00	DISCHG	8.00	7.55	7.30	7.17	6.85	6.78	6.44	6.25	6.16	5.96
18.00	DISCHG	5.92	5.69	5.57	5.49	5.26	5.24	5.05	4.94	4.90	4.62
20.00	DISCHG	4.80	4.65	4.57	4.50	4.34	4.30	4.26	4.24	4.19	4.03
22.00	DISCHG	3.99	3.95	3.51	3.89	3.76	3.74	3.70	3.67	3.65	3.56
24.00	DISCHG	1.51	1.51	0.31	0.09	0.03	0.01	0.01	0.00		

SUBROUTINE RUNOFF CROSS SECTION 3
AREA= 0.01 INPUT RUNOFF CURVE= 74.0 TIME OF CONCENTRATION= 0.09
***** IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	7.100	(RUNOFF)
12.95	0.544	(RUNOFF)
13.30	0.506	(RUNOFF)
13.91	0.483	(RUNOFF)
14.31	0.410	(RUNOFF)
14.91	0.378	(RUNOFF)
15.31	0.331	(RUNOFF)
15.91	0.306	(RUNOFF)
16.31	0.275	(RUNOFF)
16.91	0.255	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA TF 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.03	0.05	0.13	0.19	2.11	5.02
12.00	DISCHG	6.69	1.52	1.50	0.95	0.81	0.82	0.59	0.60	0.50	0.47
14.00	DISCHG	0.44	0.47	0.41	0.36	0.31	0.37	0.33	0.33	0.30	0.30
16.00	DISCHG	0.30	0.27	0.27	0.26	0.25	0.26	0.24	0.24	0.23	0.22
18.00	DISCHG	0.22	0.21	0.21	0.20	0.20	0.20	0.19	0.19	0.18	0.18
20.00	DISCHG	0.18	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.15	0.15
22.00	DISCHG	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.14
24.00	DISCHG	0.14	0.00								

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.00 INPUT RUNOFF CURVE= 80.0 TIME OF CONCENTRATION= 0.04
***** IN PEAK = MAXI = 121

SUBJECT Pensler - Conemaugh 1986 Stage II Const
BY MLL 3/10/86
CHKD. BY RFO 3/26/86
SHEET NO. 188 OF 102
PROJECT NO. 86-167

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	2.269	(RUNOFF)
12.31	0.469	(RUNOFF)
12.41	0.250	(RUNOFF)
13.31	0.180	(RUNOFF)
13.91	0.142	(RUNOFF)
14.31	0.122	(RUNOFF)
14.91	0.111	(RUNOFF)
15.31	0.097	(RUNOFF)
15.41	0.089	(RUNOFF)
16.31	0.080	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME												
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.01	0.07	0.17	0.01	0.06	0.00	1.02	1.71
12.00	DISCHG	2.18	0.45	0.45	0.24	0.24	0.24	0.17	0.18	0.14	0.14
14.00	DISCHG	0.14	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.09	0.09
16.00	DISCHG	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.00	DISCHG	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
20.00	DISCHG	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
22.00	DISCHG	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
24.00	DISCHG	0.04									

SUBROUTINE ADDHYD CROSS SECTION 3
INPUT HYDROGRAPHS= 7,1 OUTPUT HYDROGRAPH 2
PEAKS IN PEAK = MAXJ = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	9.366	0.03
12.91	1.094	0.00
13.31	0.786	0.00
13.91	0.625	0.00
14.31	0.557	0.00
14.91	0.488	0.00
15.31	0.428	0.00
15.41	0.392	0.00
16.31	0.356	0.00
16.91	0.334	0.00

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.01	0.02	0.04	0.08	0.19	0.27	3.13	4.73
12.00	DISCHG	9.01	1.46	1.94	1.18	1.05	1.06	0.77	0.77	0.64	0.61
14.00	DISCHG	0.62	0.55	0.55	0.49	0.48	0.40	0.42	0.42	0.39	0.39
16.00	DISCHG	0.39	0.35	0.35	0.33	0.33	0.33	0.30	0.30	0.29	0.29
18.00	DISCHG	0.29	0.27	0.27	0.26	0.26	0.26	0.24	0.24	0.24	0.24
20.00	DISCHG	0.24	0.22	0.22	0.21	0.21	0.21	0.21	0.21	0.20	0.20
22.00	DISCHG	0.20	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18
24.00	DISCHG	0.18	0.00								

SUBROUTINE REACH CROSS SECTION 3
LENGTH= 1174.00 INPUT COEFFICIENTS 0.0000 INPUT ROUTINGS= 0.00

SUBJECT Penelec - Conemaugh 1986 Stage II Cont
BY MLA DATE 3/10/86 SHEET NO. 204 OF 102
CHKD. BY RFD DATE 3/24/86 PROJECT NO. 86-147

***** [illegible]AK - MAXI = 128

PEAK TIMES 11.99 | PEAK DISCHARGES 171.734 | [illegible]AK ELEVATIONS 0.54

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.25

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.03	0.10	0.33	0.55	0.18	1.02	1.33
10.00	DISCHG	1.88	2.25	2.81	3.49	4.86	5.40	8.18	10.58	29.80	118.93
12.00	DISCHG	171.67	106.19	54.46	40.47	26.91	21.50	14.28	16.90	15.42	13.61
14.00	DISCHG	13.04	12.43	11.58	11.21	10.26	10.02	9.30	6.87	8.65	8.14
16.00	DISCHG	8.01	7.55	7.32	7.16	6.40	6.14	6.40	6.26	6.17	5.51
18.00	DISCHG	5.97	5.30	5.53	5.49	5.24	5.24	5.00	4.95	4.90	4.82
20.00	DISCHG	4.80	4.66	4.57	4.51	4.35	4.30	4.26	4.24	4.19	4.03
22.00	DISCHG	3.95	3.55	3.93	3.65	3.77	3.74	3.70	3.67	1.65	3.57
24.00	DISCHG	3.53	1.61	0.37	0.10	0.03	0.01	0.01	0.00		

SUBROUTINE ROUTE CROSS SECTION 1
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
***** IN PEAK - MAXI = 128

PEAK TIMES 11.99 | PEAK DISCHARGES 180.920 | PEAK ELEVATIONS 0.57

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.20

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.23	0.16	0.33	0.55	0.78	1.02	1.37
10.00	DISCHG	1.05	2.26	2.82	3.45	4.71	5.59	8.37	10.85	33.02	124.76
12.00	DISCHG	180.69	108.15	56.40	42.15	27.96	20.50	70.01	17.68	16.45	14.23
14.00	DISCHG	13.86	12.66	12.11	11.70	10.14	10.50	9.15	9.29	9.04	8.52
16.00	DISCHG	8.46	7.96	7.67	7.51	7.19	7.11	6.76	6.57	6.46	6.26
18.00	DISCHG	6.25	5.99	5.64	5.75	5.55	5.50	5.30	5.19	5.14	5.06
20.00	DISCHG	5.04	4.83	4.79	4.72	4.56	4.52	4.47	4.45	4.39	4.23
22.00	DISCHG	4.19	4.19	4.12	4.06	3.95	3.92	3.88	3.86	3.83	3.74
24.00	DISCHG	3.70	1.61	0.37	0.10	0.03	0.01	0.01	0.00		

ENDCMP

SUBJECT	Pohopoco - Cummins... ... Stage II Const
BY	MLA DATE 3/10/86 SHEET NO. 16.B OF 202
CHKD. BY	RFR DATE 3/26/86 PROJECT NO. 81-167

PASS 2

EXECU HYDROGRAPH CARD STARTING TIME= 0.00 ANTECEDENT MOISTURE NO.= 0
OPERATION COMPUT. RAIN DEPTH= 4.00 STORM NO.= 0
PEAK RAIN ... 5.00 RAIN TABLE NO.= 3
... 17 0 SOIL CONDITION= 2

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.22 INPUT RUNOFF CURVE= 65.0 TIME OF CONCENTRATION= 1.24
***** IN PEAK = MAXI = 125

PEAK TIMES 11.97 PEAK DISCHARGES 314.276 PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.22

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.90	0.00	0.00	0.01	0.13	0.35	0.53	0.74	0.97	1.24
8.00	DISCHG	1.48	1.61	2.11	2.42	2.88	3.20	3.79	4.28	4.78	5.88
10.00	DISCHG	6.30	7.76	8.95	10.74	13.19	14.40	20.80	25.43	67.10	240.96
12.00	DISCHG	311.50	175.95	41.39	63.34	40.07	16.22	29.45	56.05	24.01	20.94
14.00	DISCHG	20.29	18.77	11.98	13.13	15.82	15.54	14.33	13.60	13.37	12.51
16.00	DISCHG	12.30	11.64	11.25	11.05	10.53	13.43	9.89	9.55	9.47	9.14
18.00	DISCHG	9.08	8.72	8.52	8.40	8.07	8.01	7.76	7.54	7.48	7.35
20.00	DISCHG	7.31	7.08	6.95	6.88	6.60	6.59	6.48	6.45	6.38	6.33
22.00	DISCHG	6.06	5.99	5.96	5.90	5.10	5.67	5.60	5.57	5.53	5.50
24.00	DISCHG	5.44	2.11	0.28	0.03	0.00					

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.02 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.60
***** IN PEAK = MAXI = 129

PEAK TIMES 12.27 PEAK DISCHARGES 39.556 PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.16	0.51	2.50
12.00	DISCHG	6.79	10.33	9.00	7.02	5.08	3.75	2.90	2.35	1.94	1.73
14.00	DISCHG	1.53	1.40	1.31	1.24	1.17	1.13	1.06	1.00	0.95	0.91
16.00	DISCHG	0.88	0.85	0.81	0.79	0.76	0.74	0.72	0.70	0.67	0.66
18.00	DISCHG	0.64	0.63	0.61	0.60	0.55	0.57	0.56	0.55	0.53	0.53
20.00	DISCHG	0.52	0.51	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.45
22.00	DISCHG	0.44	0.43	0.43	0.42	0.42	0.41	0.41	0.40	0.40	0.39
24.00	DISCHG	0.39	0.34	0.21	0.12	0.05	0.03	0.01	0.01	0.00	

SUBROUTINE ADDHYD CROSS SECTION 1
INPUT HYDROGRAPHS= 1,2 OUTPUT HYDROGRAPH= 3
***** IN PEAK = MAXI = 129

PEAK TIMES 11.97 PEAK DISCHARGES 390.152 PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
6.00	DISCHG	0.00	0.06	0.50	0.01	0.14	0.31	0.54	0.74	0.91	1.24

SUBJECT Pebble - Cunningham 1986 Stage II Const
BY MCL DATE 3/10/86 SHEET NO. 178 OF 182
CHKD. BY KED DATE 3/24/86 JOB NO. 86-147

8.00	DISCHG	3.40	3.61	7.31	4.42	[illegible]	3.20	3.74	4.28	4.70	5.66
10.[illegible]	DISCHG	6.18	7.76	4.95	16.24	[illegible]	14.49	20.86	25.59	61.50	243.48
12.[illegible]	DISCHG	316.29	162.28	90.99	70.36	[illegible]	34.97	32.39	28.41	26.50	22.69
14.00	DISCHG	21.59	20.37	19.76	18.07	17.40	16.64	15.39	14.68	14.32	13.43
16.00	DISCHG	13.24	12.49	12.66	11.84	11.29	11.11	10.61	10.29	10.16	9.60
18.00	DISCHG	9.72	9.35	9.13	5.00	8.66	8.54	8.27	8.09	8.02	7.88
20.00	DISCHG	7.05	7.60	7.46	7.36	7.08	7.02	6.95	6.91	6.83	6.56
22.00	DISCHG	6.50	6.43	6.39	6.34	6.12	6.38	6.01	5.97	5.93	5.79
24.00	DISCHG	5.73	2.46	0.51	0.15	0.05	0.03	0.01	0.01	0.00	

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 430.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 33.705 AVERAGE ROUTING COEFF= 0.9520 NUMBER OF ROUTINGS= 0.02
***** IN PEAK = MAX[= 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.57	318.031	1.08

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.01	0.13	0.31	0.52	0.74	0.96	1.24
8.00	DISCHG	1.44	1.60	2.11	2.42	2.67	3.20	3.74	4.27	4.77	5.66
10.00	DISCHG	6.11	7.75	8.93	10.22	13.09	14.17	20.75	25.51	66.39	240.52
12.00	DISCHG	313.03	184.57	92.53	70.70	45.58	40.05	32.52	28.48	26.03	22.79
14.00	DISCHG	21.91	20.90	19.19	18.68	17.03	16.64	15.41	14.65	14.33	13.44
16.00	DISCHG	13.25	12.50	12.07	11.04	11.30	11.15	10.62	10.30	10.15	9.60
18.00	DISCHG	9.72	9.35	9.11	9.01	8.66	8.59	8.27	8.09	8.07	7.86
20.00	DISCHG	7.95	7.60	7.46	7.36	7.08	7.02	6.95	6.91	6.63	6.56
22.00	DISCHG	6.50	6.43	6.39	6.34	6.13	6.05	6.01	5.97	5.93	5.79
24.00	DISCHG	5.73	2.51	0.55	0.10	0.06	0.03	0.01	0.01	0.00	

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.09 INPUT RUNOFF CURVE= 76.0 TIME OF CONCENTRATION= 0.08
***** IN PEAK = MAX[= 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	3.950	(RUNOFF)
12.91	0.420	(RUNOFF)
13.36	0.305	(RUNOFF)
13.91	0.241	(RUNOFF)
14.30	0.213	(RUNOFF)
14.56	0.180	(RUNOFF)
15.40	0.163	(RUNOFF)
15.90	0.149	(RUNOFF)
16.49	0.134	(RUNOFF)
16.90	0.126	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02
10.00	DISCHG	0.03	0.04	0.05	0.06	0.09	0.10	0.18	0.21	1.85	3.10
12.00	DISCHG	3.77	0.78	0.77	0.46	0.41	0.41	0.30	0.39	0.25	0.24
14.00	DISCHG	0.24	0.21	0.21	0.19	0.16	0.10	0.16	0.15	0.15	0.15
16.00	DISCHG	0.15	0.13	0.13	0.13	0.12	0.12	0.11	0.11	0.11	0.11
18.00	DISCHG	0.11	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09
20.00	DISCHG	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.07

SUBJECT Penelec - Conemaugh 1986 Stage II Conv.
BY MLA DATE 3/17/86 SHEET NO. 18B OF 202
CHKD. BY RED DATE 3/26/86 PROJECT NO. 86-147

22.00	DISCHG	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
24.00	DISCHG	0.07	0.00								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 4,5 OUTPUT HYDROGRAPH= 6
***** IN PEAK - KRAI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.97	320.731	1.09

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.01	0.13	0.31	0.52	0.74	0.96	1.24
8.00	DISCHG	1.48	1.80	2.13	2.42	2.87	3.20	3.70	4.26	4.79	5.06
10.00	DISCHG	6.29	7.78	8.98	10.29	13.18	14.51	20.93	25.72	66.74	243.61
12.00	DISCHG	320.83	185.35	91.10	71.17	45.94	40.41	32.87	26.36	26.80	22.96
14.00	DISCHG	22.01	20.41	19.51	10.07	11.21	16.81	15.57	14.65	14.47	13.59
16.00	DISCHG	13.39	17.63	12.20	11.97	11.42	11.10	10.73	10.41	10.25	9.91
18.00	DISCHG	9.81	9.46	9.24	9.10	8.76	8.66	8.36	8.18	8.11	7.97
20.00	DISCHG	7.94	7.69	7.54	7.44	7.16	7.10	7.03	6.99	6.91	6.93
22.00	DISCHG	6.57	6.50	6.46	6.40	6.19	6.13	6.08	6.04	5.99	5.86
24.00	DISCHG	5.74	2.51	0.55	0.16	0.06	0.03	0.01	0.01	0.00	

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.01 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.09
***** IN PEAK - KRAI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	14.325	(RUNOFF)
12.90	1.567	(RUNOFF)
13.30	1.117	(RUNOFF)
13.93	0.882	(RUNOFF)
14.30	0.782	(RUNOFF)
14.90	0.687	(RUNOFF)
15.30	0.596	(RUNOFF)
15.90	0.545	(RUNOFF)
16.30	0.451	(RUNOFF)
15.90	0.402	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.06	0.00	0.00	0.01	0.02	0.04	0.06	0.09
10.00	DISCHG	0.19	0.16	0.19	0.27	0.33	0.37	0.67	0.76	0.11	11.72
12.00	DISCHG	11.67	2.92	2.03	1.77	1.51	1.52	1.04	1.09	0.91	0.61
14.00	DISCHG	0.87	0.77	0.77	0.69	0.67	0.57	0.59	0.59	0.55	0.54
16.00	DISCHG	0.54	0.49	0.49	0.46	0.46	0.46	0.42	0.42	0.40	0.40
18.00	DISCHG	0.40	0.37	0.37	0.36	0.35	0.35	0.33	0.33	0.33	0.32
20.00	DISCHG	0.32	0.31	0.31	0.29	0.29	0.29	0.29	0.29	0.27	0.27
22.00	DISCHG	0.27	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.24	0.24
24.00	DISCHG	0.29	0.00								

SUBROUTINE RUNOFF CROSS SECTION 3
AREA= 0.00 INPUT RUNOFF CURVE= 00.0 TIME OF CONCENTRATION= 0.00
***** IN PEAK - KRAI = 121

PEAK TIMES PEAK DISCHARGES PEAK ELEVATIONS

11.93	4.137	(RUNOFF)
12.37	0.804	(RUNOFF)
12.90	0.451	(RUNOFF)
13.39	0.171	(RUNOFF)
13.91	0.252	(RUNOFF)
14.30	0.224	(RUNOFF)
14.90	0.195	(RUNOFF)
15.30	0.170	(RUNOFF)
15.90	0.155	(RUNOFF)
16.30	0.140	(RUNOFF)

HYDROGRAPH, TIMES= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.04
10.00	DISCHG	0.04	0.06	0.07	0.11	0.12	0.13	0.23	1.25	2.57	3.52
12.00	DISCHG	4.10	0.50	0.62	0.43	0.44	0.44	0.31	0.71	0.25	0.25
14.00	DISCHG	0.25	0.22	0.22	0.19	0.19	0.19	0.17	0.17	0.15	0.15
16.00	DISCHG	0.15	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.11	0.11
18.00	DISCHG	0.11	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.09
20.00	DISCHG	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
22.00	DISCHG	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
24.00	DISCHG	0.07									

SUBROUTINE ADDHYD CROSS SECTION 3
INPUT HYDROGRAPHS= 7,1 OUTPUT HYDROGRAPH= 2
IN PEAK = AUXI # 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	18.068	0.00
12.90	2.018	0.00
13.30	1.445	0.00
13.98	1.134	0.00
14.30	1.068	0.00
14.90	0.833	0.00
15.30	0.767	0.00
15.90	0.700	0.00
16.30	0.654	0.00
16.90	0.594	0.00

HYDROGRAPH, TIMES= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.06	0.09	0.12
10.00	DISCHG	0.15	0.22	0.26	0.38	0.45	0.58	0.90	1.32	8.30	14.74
12.00	DISCHG	17.33	3.73	3.65	2.20	1.74	1.95	1.41	1.41	1.16	1.12
14.00	DISCHG	1.12	0.55	0.97	0.80	0.56	0.67	0.76	0.76	0.70	0.69
16.00	DISCHG	0.69	0.63	0.61	0.59	0.59	0.59	0.54	0.56	0.52	0.53
18.00	DISCHG	0.53	0.46	0.44	0.46	0.45	0.45	0.45	0.43	0.42	0.42
20.00	DISCHG	0.42	0.39	0.39	0.38	0.37	0.37	0.37	0.37	0.35	0.34
22.00	DISCHG	0.35	0.34	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31
24.00	DISCHG	0.31	0.00								

SUBROUTINE REACH CROSS SECTION 3
LENGTH= 1174.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS 0.00

AVERAGE WATER VELOCITY= 39.596 AVERAGE ROUTING COEFF= 0.9500 NUMBER OF ROUTINGS 0.03
IN PEAK = AUXI = 129

SUBJECT Tenneco-Chickamauga 1986 Stage II Const
BY MLA DATE 3/10/86 SHEET NO. 118 OF 202
CHKD. BY RED DATE 3/24/86 PROJECT NO. 86-147

SUBJECT Pennypack - [illegible] 1986 Stage II Cost
BY [illegible] DATE 3/10/86 SHEET NO. 208 OF 702
CHKD BY RED DATE 3/24/86 PROJECT NO. 86-167

PEAK TIMES 11.76 | PEAK DISCHARGES 316.332 | PEAK ELEVATIONS 1.00

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.01	0.11	0.40	0.51	0.73	0.95	1.23
8.00	DISCHG	1.46	1.79	2.09	2.40	2.85	3.10	3.76	4.26	4.77	5.04
10.00	DISCHG	6.17	7.70	8.51	11.23	13.65	14.51	20.64	25.50	60.76	235.53
12.00	DISCHG	317.23	191.01	97.55	72.19	43.16	40.74	33.17	26.90	26.96	23.16
14.00	DISCHG	22.11	20.49	19.55	19.40	17.29	16.65	15.63	14.04	14.44	13.63
16.00	DISCHG	13.40	12.83	12.22	11.90	11.45	11.31	10.76	10.42	10.26	9.91
18.00	DISCHG	9.65	9.43	9.25	9.17	8.71	8.69	8.14	8.13	8.11	7.93
20.00	DISCHG	7.94	7.70	7.55	7.44	7.10	7.16	7.03	6.99	6.95	6.65
22.00	DISCHG	6.56	6.50	6.40	6.30	6.20	6.15	6.09	6.09	5.77	5.06
24.00	DISCHG	5.60	2.60	0.64	0.14	0.05	0.03	0.02	0.01	0.00	

SUBROUTINE ROUTE CROSS SECTION 3
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
SPEED OF PEAK = HALF = 129

PEAK TIMES 11.90 | PEAK DISCHARGES 250.627 | PEAK ELEVATIONS 1.02

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.26

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.03	0.13	0.30	0.51	0.11	0.95	1.23
8.00	DISCHG	1.46	1.79	2.09	2.43	2.86	3.20	3.80	3.32	4.80	5.76
10.00	DISCHG	6.47	7.92	9.10	11.01	13.59	15.01	21.51	20.52	75.06	250.47
12.00	DISCHG	115.00	195.13	101.20	74.39	49.83	42.08	34.38	30.37	26.12	24.23
14.00	DISCHG	23.73	21.40	20.54	19.70	16.35	17.71	16.33	15.65	15.19	14.37
16.00	DISCHG	14.04	13.29	12.85	12.53	12.03	11.89	11.30	10.90	10.17	10.44
18.00	DISCHG	10.35	9.95	9.73	9.57	9.24	9.14	8.80	8.61	8.53	8.39
20.00	DISCHG	8.35	8.09	7.90	7.67	7.55	7.44	7.40	7.16	7.26	6.99
22.00	DISCHG	6.92	6.84	6.80	6.73	6.52	6.47	6.40	6.30	6.30	6.17
24.00	DISCHG	6.10	2.07	0.64	0.17	0.06	0.03	0.01	0.05	0.00	

ENDCMP

SUBJECT Penelec – Conemaugh 1986 Sheet II Cons[illegible]
BY HLA DATE 2/12/86 SHEET NO. 146 OF 292
CHKD. BY RFO DATE 3/11/86 PROJECT NO. 86-137

PASS= 1

EXECUTIVE CONTROL CARD OPERATION INCREM MAIN TI INCREMENT 0.20
EXECUTIVE CONTROL CARD OPERATION COMPUTE FROM XSEC STRUCT 1/ 0 TO XSECTION/STRUCT 1/ 0
STARTING TIME= 0.00 RAIN DEPTH= 5.50 RAIN DURATION= 1.00 RAIN TABLE NO.= 3 SOIL CONDITION= 2
ALTERNATE NO.= 0 STORM NO.= 0

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.22 INPUT RUNOFF CURVE= 55.0 TIME OF CONCENTRATION= 0.24
***** IN PEAK - MAXI = 125

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	484.310	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.22

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.19	0.43	0.70
6.00	DISCHG	0.96	1.25	1.54	1.83	2.21	2.51	2.93	3.31	3.69	4.27
8.00	DISCHG	4.59	5.21	5.73	6.27	7.39	7.56	8.65	9.48	10.29	11.50
10.00	DISCHG	12.65	15.52	17.57	19.61	24.03	26.63	37.00	44.79	113.83	388.72
12.00	DISCHG	477.79	250.69	121.03	93.56	59.01	51.22	43.27	38.17	36.02	30.62
14.00	DISCHG	29.63	27.40	26.21	25.40	23.05	22.60	20.65	19.79	19.42	18.17
16.00	DISCHG	17.95	16.89	16.31	16.03	15.26	15.12	14.32	13.89	13.70	13.22
18.00	DISCHG	13.13	12.61	12.32	12.15	11.66	11.58	11.13	10.89	10.81	10.63
20.00	DISCHG	10.58	10.27	10.03	9.90	9.51	9.49	9.15	9.30	9.19	8.86
22.00	DISCHG	8.73	8.61	8.59	8.50	8.21	8.10	8.06	8.07	7.95	7.76
24.00	DISCHG	7.66	3.04	0.41	0.09	0.00					

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.02 INPUT RUNOFF CURVE= 10.0 TIME OF CONCENTRATION= 0.04
***** IN PEAK - MAXI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.24	20.201	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.02

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
10.00	DISCHG	0.06	0.10	0.17	0.25	0.35	0.49	0.07	0.96	1.81	6.11
12.00	DISCHG	14.76	20.01	17.74	12.60	8.98	6.53	4.96	3.98	3.34	2.89
14.00	DISCHG	2.54	2.32	2.16	2.04	1.93	1.82	1.73	1.64	1.56	1.49
16.00	DISCHG	1.43	1.36	1.32	1.28	1.23	1.20	1.16	1.12	1.09	1.06
18.00	DISCHG	1.04	1.01	0.99	0.96	0.94	0.92	0.90	0.88	0.86	0.84
20.00	DISCHG	0.83	0.82	0.80	0.79	0.77	0.76	0.74	0.73	0.71	0.72
22.00	DISCHG	0.70	0.69	0.68	0.67	0.67	0.65	0.64	0.60	0.63	0.63
24.00	DISCHG	0.61	0.54	0.37	0.19	0.09	0.04	0.02	0.01	0.00	

SUBROUTINE ADDHYD CROSS SECTION 1
INPUT HYDROGRAPHS= 1,2 OUTPUT HYDROGRAPH= 3
***** IN PEAK - MAXI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	497.169	(NONE)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.19	0.41	0.70

SUBJECT Penelec - Conemaugh 1986 Stage II Const. BY MLA DATE 2/12/86 SHEET NO. 176 OF 282
CHKD. BY RFO DATE 3/4/86 PROJECT NO. 84-167

6.[illegible]	DISCHG	0.96	1.25	1.54	1.83	[illegible]	2.51	2.93	3.38	3.84	4.32
8.	DISCHG	4.59	5.21	5.71	6.23	[illegible]	7.58	8.65	9.48	10.30	11.92
10.[illegible]	DISCHG	12.71	15.62	17.68	19.85	[illegible]	31.10	38.07	45.75	115.89	392.63
12.00	DISCHG	492.05	278.65	138.82	106.27	67.99	59.73	48.23	42.16	39.35	33.50
14.00	DISCHG	32.13	29.71	28.37	27.44	24.97	24.42	22.58	21.53	20.90	19.66
16.00	DISCHG	19.38	18.27	17.60	17.16	16.49	16.32	15.49	15.02	14.79	14.29
18.00	DISCHG	14.17	13.63	13.31	13.16	12.61	12.50	12.09	11.77	11.66	11.45
20.00	DISCHG	11.41	11.04	10.84	10.69	10.29	10.20	10.09	10.03	9.92	9.52
22.00	DISCHG	9.43	9.32	9.27	9.16	8.87	8.83	8.71	8.65	8.59	8.39
24.00	DISCHG	8.29	3.56	0.77	0.24	0.09	0.04	0.02	0.01	0.00	

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 410.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS 0.00

AVERAGE WATER VELOCITY= 37.661 AVERAGE ROUTING COEFF= 0.9568 NUMBER OF ROUTINGS= 0.02
ROUTE IN PEAK - NMAX = 129

PEAK TIMES PEAK DISCHARGES PEAK ELEVATIONS
11.97 495.036 1.34

TIME			HYDROGRAPH, TAERGE	0.00		DELTA T= 0.20		DRAINAGE AREA=	0.24		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.50	0.00	0.00	0.00	0.00	0.07	0.19	0.42	0.69
6.00	DISCHG	0.95	1.25	1.54	1.83	2.20	2.50	2.93	3.31	3.68	4.25
8.00	DISCHG	4.58	5.20	5.72	6.22	7.08	7.57	8.64	9.47	10.29	11.90
10.00	DISCHG	12.69	15.58	17.65	19.82	24.91	27.07	37.91	45.09	114.56	388.63
12.00	DISCHG	490.55	281.69	140.94	106.71	68.57	59.65	48.40	42.25	39.19	33.59
14.00	DISCHG	32.15	29.75	28.39	27.46	25.01	24.43	22.61	21.54	20.99	19.68
16.00	DISCHG	19.39	18.28	17.65	17.16	16.51	16.37	15.50	15.03	14.80	14.29
18.00	DISCHG	14.17	13.63	13.31	13.12	12.61	12.59	12.04	11.77	11.67	11.46
20.00	DISCHG	11.01	11.05	10.85	10.69	10.29	10.20	10.09	10.04	9.92	9.52
22.00	DISCHG	9.43	9.33	9.27	9.16	8.88	8.84	8.71	8.65	8.59	8.39
24.00	DISCHG	8.30	3.65	0.82	0.29	0.09	0.04	0.02	0.01	0.00	

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.00 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.06
ROUTE IN PEAK - NMAX = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.93	0.414	(RUNOFF)
12.90	0.664	(RUNOFF)
13.30	0.415	(RUNOFF)
13.90	0.370	(RUNOFF)
14.30	0.327	(RUNOFF)
14.90	0.284	(RUNOFF)
15.30	0.248	(RUNOFF)
15.90	0.226	(RUNOFF)
16.30	0.204	(RUNOFF)
16.90	0.193	(RUNOFF)

TIME			HYDROGRAPH, TZERO=	0.00		DELTA T= 0.20		DRAINAGE AREA=	0.00		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
8.00	DISCHG	0.01	0.02	0.03	0.03	0.04	0.04	0.06	0.06	0.04	0.09
10.00	DISCHG	0.09	0.11	0.14	0.20	0.22	0.24	0.40	0.44	1.56	5.28
12.00	DISCHG	0.05	1.42	1.21	0.17	0.64	0.64	0.45	0.46	0.38	0.36
14.00	DISCHG	0.36	0.37	0.32	0.29	0.28	0.29	0.25	0.25	0.21	0.22
16.00	DISCHG	0.32	0.20	0.20	0.19	0.19	0.19	0.17	0.17	0.17	0.16
18.00	DISCHG	0.16	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.13	0.13

SUBJECT Peebles @ Conemaugh 1986 Stage II Const
BY MLA DATE 2/14/86 SHEET NO. 18[illegible] OF 102
CHKD. BY RED DATE 3/4/86 PROJECT NO. 86-167

20	DISCHG	0.14	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.11	0.11
22	DISCHG	0.11	0.11	0.11	0.10	0	0.10	0.10	0.10	0.10	0.10
24	DISCHG	0.10	0.00								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 4,5 OUTPUT HYDROGRAPH= 6
ERROR IN PEAK = MAXI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	501.150	1.45

HYDROGRAPH, TZERO= 0.00 DELTA TR 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.19	0.82	0.69
6.00	DISCHG	0.94	1.25	1.54	1.83	2.20	2.54	2.93	3.31	3.69	4.42
8.00	DISCHG	4.63	5.22	5.74	6.20	7.11	7.62	8.69	9.53	10.36	11.99
10.00	DISCHG	12.79	15.11	17.79	20.02	25.13	27.30	38.31	46.37	116.13	391.91
12.00	DISCHG	496.59	281.33	142.15	197.43	69.33	60.44	48.56	42.71	39.77	33.95
14.00	DISCHG	32.56	30.07	28.33	27.74	25.99	24.71	22.46	21.79	21.22	19.91
16.00	DISCHG	19.61	18.49	17.65	17.50	16.70	16.56	15.61	15.20	14.96	14.46
18.00	DISCHG	14.34	13.79	13.47	13.26	12.76	12.64	12.18	11.91	11.80	11.59
20.00	DISCHG	11.54	11.18	10.97	10.61	10.41	10.32	10.21	10.15	10.03	9.63
22.00	DISCHG	9.54	9.41	9.38	9.24	8.98	8.91	8.81	8.75	8.69	8.49
24.00	DISCHG	8.19	3.65	0.82	0.24	0.09	0.04	0.02	0.01	0.00	

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.01 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.09
ERROR IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.93	23.312	(RUNOFF)
12.90	2.430	(RUNOFF)
13.90	1.355	(RUNOFF)
14.30	1.198	(RUNOFF)
14.90	1.097	(RUNOFF)
15.90	0.829	(RUNOFF)
16.90	0.700	(RUNOFF)
17.90	0.606	(RUNOFF)
18.90	0.537	(RUNOFF)
19.90	0.491	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04
8.00	DISCHG	0.05	0.07	0.09	0.12	0.14	0.16	0.20	0.23	0.28	0.32
10.00	DISCHG	0.34	0.48	0.52	0.71	0.81	0.91	1.47	1.60	12.29	19.20
12.00	DISCHG	22.00	4.61	4.43	2.76	2.34	2.35	1.69	1.69	1.40	1.33
14.00	DISCHG	1.34	1.16	1.10	1.00	1.01	1.03	0.90	0.90	0.63	0.62
16.00	DISCHG	0.82	0.74	0.74	0.70	0.69	0.69	0.64	0.64	0.51	0.60
18.00	DISCHG	0.60	0.57	0.56	0.54	0.53	0.53	0.50	0.50	0.49	0.49
20.00	DISCHG	0.49	0.45	0.46	0.44	0.44	0.40	0.43	0.43	0.41	0.40
22.00	DISCHG	0.40	0.40	0.40	0.36	0.38	0.38	0.37	0.37	0.36	0.36
24.00	DISCHG	0.36	0.00								

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.00 INPUT RUNOFF CURVE= 80.0 TIME OF CONCENTRATION= 0.00
ERROR IN PEAK = MAXI = 123

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
BY MLL DATE 2/12/86 SHEET NO. 190 of 192
CHKD. BY RED DATE 3/4/86 PROJECT NO. 86-162

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.92	6.045	(RUNOFF)
12.30	1.326	(RUNOFF)
12.90	0.687	(RUNOFF)
13.30	0.488	(RUNOFF)
13.90	0.382	(RUNOFF)
14.30	0.338	(RUNOFF)
14.90	0.243	(RUNOFF)
15.30	0.236	(RUNOFF)
15.90	0.233	(RUNOFF)
16.30	0.210	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02
8.00	DISCHG	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.10	0.11
10.00	DISCHG	0.12	0.16	0.17	0.24	0.26	0.28	0.44	0.50	4.03	5.77
12.00	DISCHG	6.43	1.34	1.26	0.66	0.66	0.66	0.41	0.48	0.38	0.38
14.00	DISCHG	0.38	0.33	0.33	0.29	0.29	0.29	0.25	0.25	0.23	0.23
16.00	DISCHG	0.23	0.21	0.21	0.19	0.19	0.19	0.15	0.18	0.17	0.17
18.00	DISCHG	0.17	0.16	0.16	0.15	0.15	0.15	0.14	0.14	0.14	0.14
20.00	DISCHG	0.14	0.13	0.14	0.12	0.12	0.12	0.12	0.12	0.11	0.11
22.00	DISCHG	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
24.00	DISCHG	0.10									

SUBROUTINE ADDHYD   CROSS SECTION 3
INPUT HYDROGRAPHS= 7,1   OUTPUT HYDROGRAPH= 2
ERROR IN PEAK - MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.93	30.159	0.10
12.90	2.317	0.01
13.90	1.737	0.01
14.30	1.536	0.00
14.90	1.335	0.00
15.30	1.165	0.00
15.90	1.061	0.00
16.30	0.959	0.00
16.90	0.896	0.00
17.30	0.811	0.00

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.06
8.00	DISCHG	0.08	0.11	0.11	0.17	0.19	0.22	0.28	0.31	0.38	0.42
10.00	DISCHG	0.46	0.64	0.69	0.95	1.06	1.14	1.41	2.10	16.03	24.97
12.00	DISCHG	28.41	5.65	5.09	3.42	3.06	3.02	2.17	2.16	1.78	1.71
14.00	DISCHG	5.73	1.53	1.52	1.34	1.31	1.32	1.15	1.15	1.06	1.05
16.00	DISCHG	1.05	0.95	0.94	0.90	0.89	0.89	0.81	0.81	0.78	0.77
18.00	DISCHG	0.77	0.72	0.72	0.69	0.68	0.68	0.64	0.64	0.63	0.62
20.00	DISCHG	0.62	0.59	0.59	0.56	0.56	0.56	0.55	0.55	0.52	0.52
22.00	DISCHG	0.52	0.51	0.51	0.49	0.49	0.48	0.48	0.48	0.46	0.46
24.00	DISCHG	0.46	0.44								

SUBROUTINE REACH   CROSS SECTION 3
LENGTH= 1374.00   INPUT COEFFICIENTS 0.0000   INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 43.519   AVERAGE ROUTING COEFF= 0.9921   NUMBER OF ROUTINGS= 0.04

SUBJECT Peveles - Cahenhaven 1986 Stage II Const
BY MLA DATE 2/18/86 SHEET NO. 20C of 192
CHKD BY RFO DATE 3/14/86 PROJECT NO. 86-147

******** PEAK - HAXI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.97	495.195	1.22

HYDROGRAPH, TXEHUE 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.24

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.18	0.41	0.68
6.00	DISCHG	0.94	1.24	1.52	1.82	2.19	2.49	2.91	3.29	3.67	4.20
8.00	DISCHG	4.58	5.19	5.72	6.24	7.08	7.59	8.65	9.50	10.33	11.92
10.00	DISCHG	12.75	15.58	17.70	19.92	24.91	27.21	37.89	45.74	115.07	382.18
12.00	DISCHG	492.23	292.14	148.15	108.93	70.84	60.27	49.36	42.47	39.99	34.20
14.00	DISCHG	32.62	30.18	28.77	27.74	25.40	24.14	22.53	21.03	21.24	19.56
16.00	DISCHG	19.62	18.53	17.88	17.52	16.73	16.52	15.71	15.22	14.97	14.48
18.00	DISCHG	14.30	13.81	13.48	13.27	12.78	12.65	12.23	11.92	11.60	11.60
20.00	DISCHG	11.55	11.19	10.98	10.82	10.43	10.32	10.21	10.15	10.01	9.65
22.00	DISCHG	9.55	9.44	9.38	9.28	8.99	8.92	8.81	8.76	8.69	6.50
24.00	DISCHG	4.40	3.88	0.94	0.27	0.10	0.04	0.02	0.01	0.00	

SUBROUTINE COMBINE CROSS SECTION 3
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
****** IN PEAK - HAXI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.97	534.961	1.25

HYDROGRAPH, TXEHUE 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.26

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.18	0.41	0.68
6.00	DISCHG	0.94	1.24	1.52	1.82	2.19	2.50	2.92	3.38	3.71	4.26
8.00	DISCHG	4.66	5.30	5.85	6.40	7.27	7.83	8.93	9.80	10.71	12.39
10.00	DISCHG	13.21	16.22	18.39	20.81	25.58	28.30	39.77	47.84	131.90	407.15
12.00	DISCHG	520.61	298.04	153.80	112.43	73.84	63.60	51.52	45.14	41.57	35.51
14.00	DISCHG	34.33	31.69	30.29	29.13	26.71	26.05	24.09	22.99	22.30	21.01
16.00	DISCHG	20.67	19.49	18.81	18.41	17.62	17.40	16.52	16.03	15.75	15.25
18.00	DISCHG	15.11	14.53	14.20	13.96	11.46	13.31	12.84	12.56	12.43	12.22
20.00	DISCHG	12.17	11.72	11.57	11.38	10.99	10.48	10.76	10.73	10.54	10.17
22.00	DISCHG	10.06	9.95	9.89	9.77	9.46	9.43	9.29	9.23	9.15	6.55
24.00	DISCHG	4.85	3.46	0.94	0.27	0.10	0.04	0.02	0.01	0.00	

ENDCMP

ENDJOB CARD ENCOUNTERED, END OF JOB.

SUBJECT Ruffner - Cakemount 1986 Stage II Const
Permanent Drainage Structures

BY MLA DATE 6/13/86 PROJ. NO. 86-167

CHKD. BY RFD DATE 3/4/86 SHEET NO. 21 OF 102

GAI Consultants, Inc.
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Environmental Specialists

(2) Hydraulics:

The Main Valley East Collection Channel is separated into two separate channels, the upper channel and the lower channel.

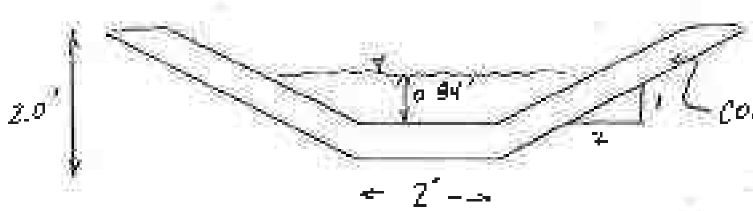
1. Upper Channel

Characteristics:

i. The channel extends from N 1,394,360 E 1,633,170 to N 1,393,370 E 1,633,480.
ii. The design flow equals 20.3 cfs, use 25 cfs.
iii. The upper channel drains horizontal portions of the top bench and the hillside offsite, F_1, with the top bench flow entering via the swale at the downstream point.
iv. Slope for the upper channel ranges from S = 1% to 20%.

Design:

i. Q = 25 cfs
ii. S = 1% - 20%
iii. n = 0.013 concrete lined for impermeable liner for contaminated water
iv. Channel depth



SUBJECT Keystone - Conemaugh 1986 Stage II Lower
Permanent Drainage Structures
BY MLL DATE 2/13/86 PROJ. NO. 86-167
CHKD. BY RFD DATE 3/4/86 SHEET NO. 22 OF 102

GAI CONSULTANTS, INC
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Environmental Specialists

Minimum slope = 1%

$Qn / b^{8/3} S^{1/2} = 0.472$ (Ref: HEC No 14, US DOT, December 1975, pg III 16-18)

$d/b = 0.42$

$d = 0.42 \times 2' = 0.84$ ft Recommend 2.0 ft for freeboard and super elevation

ii Maximum expected velocity

$V = \frac{1.49}{n} R^{2/3} S^{1/2}$ $d = 0.38$ ft

$= \frac{1.49}{0.012} \left(\frac{2(0.38) + 2(0.38)^2}{2 + 2(0.38)\sqrt{5}} \right)^{2/3} 0.20^{1/2}$

$= 24.0$ fps

2 Lower Channel

Characteristics:

i The channel extends from N 393,370 E 1,633,180 to N391,800 E 1,632,750

ii The design flow equals 525 cfs

iii The lower channel drains flow from the upper channel, the top bench drainage swale, the slope benches east of the haul road, and incremental portions of offsite south of the pile.

iv Slope ranges from 5 - 8% to 30%

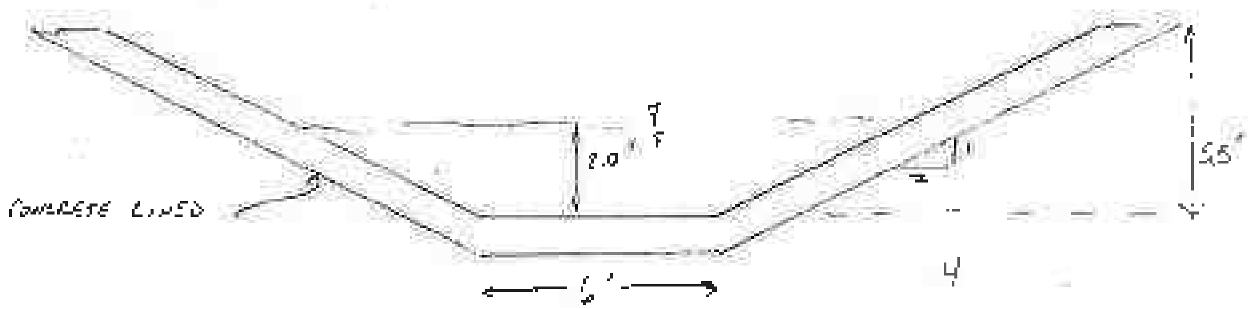
Design:

i. Q = 525 cfs (sheet 20 c)

ii. S = 8 - 30%

iii. n = 0.012 concrete lined for impermeable liner for contaminated water

iv. Channel Depth



Minimum slope = 8%

$\frac{Qn}{b^{8/3} S^{1/2}} = 0.187$

$d/b = 0.26$ (see sht 24)

$d = 0.26 \times 6' = 1.56$ ft use 5.2 ft for freeboard and superelev.

v. Maximum expected velocity $d = 1.08$

$$V = \frac{1.49}{0.012}\left(\frac{6(1.08) + 2(1.08)^2}{6 + 2(1.08)\sqrt{5}}\right)^{2/3} 0.30^{1/2}$$

= 59.3 fps

VI FREEBOARD AND SUPERELEVATION

$F.B. = 0.025\, V d^{1/3}$ (REF: "VIRGINIA COAL SURFACE MINING TECHNICAL HANDBOOK" DRAFT 5.1, P. 209)

$= 0.025\,(59.3)(1.08)^{1/3}$

$F.B. = 1.52$ FT

$S.E. = V^2 b / g R_c$ (REF. Open Channel Hydraulics, Chow, 1959, PG 448)

WHERE R_c IS THE RADIUS OF CURVATURE,
$R_{c\,CURVE}$ FOR CHANNEL = $\frac{5729.58}{D}$

D, DEGREE OF ANGLE = 18°

$R_c = 318$ FT

(REF: Elementary Surveying 6th Edition Brinker & Wolf, 1977, PG 438)

$S.E. = 59.3^2\,(6) / 32.2\,(318)$

$= 2.06$ FT

3.27

$d_{max} = 1.56 + 1.52 + 2.06 = 5.14$ FT ≈ 5.2 FT

IN STRAIGHT SECTIONS OF THE CHANNEL, ALLOWANCE FOR SUPERELEVA IS NOT MANDATORY, THEREFORE, THE DEPTH OF THE CHANNEL IN RELATIVELY STRAIGHT SECTIONS SHOULD BE AT THE MINIMUM 3 FEE

(NOTE: TYPE D CHANNEL)

(Type E channel)

SUBJECT Renfrew - Conemaugh 1986 Stage II Const
Permanent Drainage Structures

BY MLA DATE 2/14/86 PROJ. NO. 86-167

CHKD. BY RFO DATE 3/4/86 SHEET NO. 25 OF 102

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Main Valley West Collection Channel

(1) Hydrology:

The worst condition for the west collection channel occurs during the last stage of Stage II construction. The west collection channel drains the runoff from the benches west of the haul road, subarea D, and incremental offsite west of the pile, subarea F_3 and F_4. See worksheets 1A + 1B

Input Data:

a. PPT = 5.5 inches - 100 yr - 24 hr, 4.0 inches - 10 yr - 24 hr, 2.7 inches - 2 yr - 24 hr

b. AMC II

c. Hydrologic Soil Group C

d. Drainage Area

Total Area = 40.3 acres = 0.0630 mi²

i. D - Revegetated Benches -	37.0 acres
ii. F_3 + F_4 - Offsite Pasture -	3.3 acres

e. Curve Numbers

i. D - revegetated benches	78
ii. F_3 + F_4 - pasture offsite	80

$$\text{Weighted CN} = \frac{37.0(78) + 3.3(80)}{40.3}$$

$$= 78.16$$

f. Time of Concentration, T_c

Note: The west collection channel will be analyzed to the natural depression located west of the existing haul road, at N 391,800 E 1,632,250. The channel and any structures downstream from this point

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
Permanent Drainage Structures
BY MLA DATE 2/14/86 PROJ. NO. 86-167
CHKD. BY KFD DATE 3/4/86 SHEET NO. 26 OF 102

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most likely will have to be analyzed for another condition. See sheets 52 to 69.

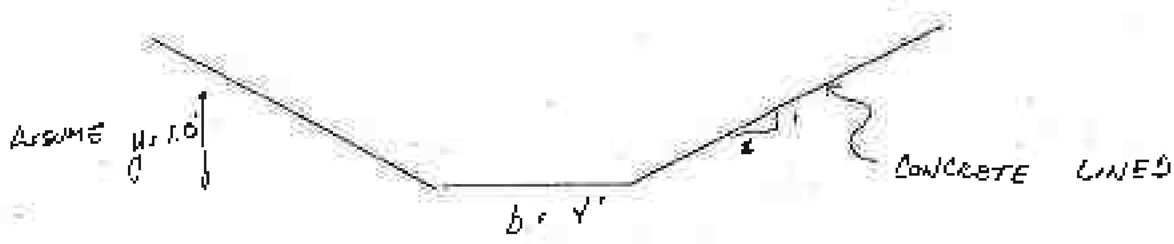
i. Tc at N 391,800 E 1,632,250

$D_3 F_3 + F_4$ - Combined Area

Length of Bench	= 2560 ft
Slope of Bench	= 1-3 %
Velocity of flow	= 2 fps (Assumption)

$t_{c_1} = \frac{2560}{2}$
= 1280 seconds
= 0.355 hr

Length of Proposed Channel	= 2100 ft
Slope of Channel	7 %
Velocity of flow Assume	



$$V = \frac{1.49}{0.012}\left(\frac{4(1.0) + 2(1)^2}{4 + 2(1.0)\sqrt{5}}\right)^{2/3} 0.07^{1/2}$$

= 26.1 fps

$t_{c_2} = \frac{2100}{26.1}$
= 80.4 seconds
= 0.022 hr

SUBJECT Penelec - Conemaugh 1986 Stage II Const
Permanent Drainage Structures
BY MLA DATE 2/14/86 PROJ. NO. 86-167
CHKD. BY RFD DATE 3/4/86 SHEET NO. 27 OF 102

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T_c = 0.355 + 0.022
= 0.377 HR ≈ 0.38 HR

6. Peak Discharge:

i. At Point N 391,800 E 1,632,250 : Q_p = 100.1 cfs

SUBJECT Penelec - Conemaugh 1986 Stage II Const
BY MLA DATE 2/14/86 SHEET NO 28 OF 102
CHKD BY RFD DATE 3/4/86 PROJECT NO 86-147

EXECUTE CNTROL CARD OPERATION LIST

LISTING OF DATA IN CORE

0 PENELEC CONEMAUGH - WEST COLLECTION 4A CONSTRUCTIO

VELOCITY INCREMENT 0.2000

1 CTABLE

8	0.0000	0.0900	0.1300	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6650	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7350	0.7400	0.7500
8	0.7600	0.7750	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

	XSECTN NO.	DRAINAGE AREA
2 XSECTN	1	1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000

9 ENDTBL

TIME INCREMENT

4 DIMHYD

8	0.0000	0.0300	0.1000	0.1900	0.3500
8	0.4300	0.6500	0.8200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.6800	0.5600	0.4400	0.3900	0.3300
8	0.2900	0.2400	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0550	0.0470	0.0400	0.0340	0.0290
8	0.0250	0.0210	0.0180	0.0150	0.0130
8	0.0110	0.0090	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000

9 ENDTBL

COMPUTED PEAK K FACTOR = 484.00

TIME INCREMENT

SUBJECT *Penelec - Conemaugh 1986 Stage II Cont.*
BY *MLA* DATE *12/4/86* SHEET NO. *29* OF *102*
CHKD. BY *RFO* DATE *3/4/86* PROJECT NO. *86-147*

5 RAINFL 0.5000

8	0.0000	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1120	0.1250	0.1400	0.1560
8	0.1760	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5830	0.6240	0.6540	0.6820
8	0.7050	0.7270	0.7480	0.7670	0.7840
8	0.8000	0.8160	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9260	0.9360	0.9460	0.9550	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000

9 ENDTAL

TIME INCREMENT
5 RAINFL 2 0.0104

8	0.0000	0.0100	0.0205	0.0200	0.0300
8	0.0400	0.0500	0.0600	0.0700	0.0800
8	0.1000	0.1100	0.1300	0.1400	0.1700
8	0.1900	0.2200	0.2700	0.3500	0.4400
8	0.5200	0.6000	0.6300	0.6600	0.6900
8	0.7000	0.7200	0.7400	0.7600	0.7700
8	0.7900	0.8000	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9900	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000

9 ENDTAL

TIME INCREMENT
5 RAINFL 3 0.5000

8	0.0000	0.0053	0.0108	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0483	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1089	0.1203	0.1329	0.1467	0.1625
8	0.1809	0.2042	0.2351	0.2833	0.6632
8	0.7351	0.7724	0.7989	0.8197	0.8340
8	0.8538	0.8676	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9519	0.9589	0.9653	0.9717	0.9777
8	0.9836	0.9892	0.9947	1.0000	1.0000

9 ENDTAL

SUBJECT Pavelec - [illegible] 1986 Stage II Consol
BY MLA DATE 2/14/86 SHEET NO. 30 OF 102
CHKD. BY REP DATE 3/4/86 PROJECT NO. 86-167

```
STANDARD CONTROL INSTRUCTIONS

6 RUNOFF 1   1    X    0.5530    78.2000    0.3800L 1 1 0 0 0
  ENDATA

END OF LISTING
```

PASS= 5

EXECUT CONTROL CARD OPERATION INCREM, MAIN TIME INCREMENT 0.20
EXECUT CONTROL CARD OPERATION COMPUT, FROM XSEC TION 17 0 TO XSECTN/STRUCT 17 0
STARTING TIME= 0.00 RAIN DEPTH= 2.70 RAIN DURATI. 1.00 RAIN TABLE NO.= 3 SOIL CONDITION= 2
ALTERNATE NO.= 0 STORM NO.= 0

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.00 INPUT RUNOFF CURVE= 79.2 TIME OF CONCENTRATION= 0.14

FULL STRUCTURE...NO ELEVATIONS GIVEN
POINT IN PEAK - MAIN = 126

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS (RUNOFF)
12.10	27.517	

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.06

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.15	0.37	0.12	2.04	12.22
12.00	DISCHG	25.94	26.23	14.61	10.07	6.90	5.29	4.47	3.75	3.41	3.06
14.00	DISCHG	2.83	2.66	2.52	2.45	2.28	2.13	2.08	1.95	1.50	1.80
16.00	DISCHG	1.75	1.69	1.61	1.58	1.52	1.44	1.40	1.38	1.26	1.12
18.00	DISCHG	1.30	1.27	1.23	1.22	1.16	1.14	1.13	1.10	1.09	1.07
20.00	DISCHG	1.06	1.04	1.02	1.00	0.91	0.98	0.95	0.94	0.99	0.91
22.00	DISCHG	0.89	0.88	0.87	0.83	0.85	0.81	0.83	0.82	0.82	0.80
24.00	DISCHG	0.74	0.56	0.14	0.05	0.01	0.00				

ENDCMP

Peerless - Copenhagen 1986 Stage II Const.
MLL 3/10/86 3/A 102
REA 3/24/86 86-147

PASS= 2

EXECUTE RUNOFF CARD   OPERATION RUNOFF   FROM XSECT/STRUCT 17 0   TO XSECT/STRUCT 17 0
STARTING TIME= 0.00   RAIN DEPTH= 4.50   RAIN DURATION 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF   CROSS SECTION 1
AREA= 0.06   INPUT RUNOFF CURVE= 76.2   TIME OF CONCENTRATION= 0.18

NULL STRUCTURE,,,NO ELEVATIONS GIVEN
***** IN PEAK = MAXI = 121

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS (RUNOFF)
12.07	59.475	

HYDROGRAPH, TIME= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.06

TIME												
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.15	0.24	0.36
10.00	DISCHG	0.48	0.65	0.88	1.10	1.49	1.80	2.59	3.54	7.35	31.83
12.00	DISCHG	57.49	53.36	26.95	14.36	13.03	4.87	8.27	6.92	6.17	5.60
14.00	DISCHG	5.17	4.88	4.58	4.44	4.12	3.94	3.75	3.51	3.41	3.23
16.00	DISCHG	3.13	3.02	2.85	2.82	2.71	2.65	2.57	2.46	2.42	2.35
18.00	DISCHG	2.31	2.26	2.18	2.15	2.00	2.04	2.00	1.94	1.93	1.82
20.00	DISCHG	1.83	1.69	1.79	1.76	1.71	1.68	1.66	1.65	1.64	1.59
22.00	DISCHG	1.56	1.59	1.55	1.52	1.48	1.46	1.44	1.43	1.42	1.40
24.00	DISCHG	1.21	0.97	0.32	0.09	0.02	0.04	0.00			

ENDCMP

Fenelon - Conemaugh 1986 Stage II Const.
MLA 3/10/86   3/8 10C
BED 3/24/86   84-147

SUBJECT *Penneluc - Conemaugh 1986 Stage II Const*
BY *MLA* DATE *3/14/86* SHEET NO. *316* OF *702*
CHKD. BY *RFO* DATE *3/14/86* PROJECT NO. *86-147*

PASS= 1

EXECUTIVE CONTROL CARD   OPERATION INCREM,   MAIN TIME INCREMENT= 0.20
EXECUTIVE CONTROL CARD   OPERATION COMPUT,   FROM XSECTN/STRUCT 1/ 0   TO XSECTN/STRUCT 1/ 0
STARTING TIME= 0.00   RAIN DEPTH= 5.50   RAIN DURATION= 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF   CROSS SECTION 1
AREA= 0.05   INPUT RUNOFF CURVE= 74.2   TIME OF CONCENTRATION= 0.38

NULL STRUCTURE...NO ELEVATIONS GIVEN
***** IN PEAK - MAXI = 127

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.06	102.052	(RUNOFF)

HYDROGRAPH, TIMEDA 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.06

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.15
8.00	DISCHG	0.23	0.33	0.44	0.54	0.68	0.81	0.96	1.15	1.32	1.57
10.00	DISCHG	1.80	2.16	2.63	3.04	3.85	4.52	5.86	7.83	14.72	58.27
12.00	DISCHG	97.84	88.05	46.57	30.62	20.41	15.35	12.80	10.60	9.81	8.61
14.00	DISCHG	7.93	7.48	7.01	6.19	6.30	6.01	5.71	5.35	5.19	4.92
16.00	DISCHG	4.76	4.57	4.37	4.28	4.11	4.01	3.89	3.72	3.65	3.55
18.00	DISCHG	3.49	3.41	3.30	3.25	3.14	3.08	3.01	2.92	2.88	2.84
20.00	DISCHG	2.81	2.75	2.69	2.65	2.57	2.52	2.50	2.48	2.46	2.38
22.00	DISCHG	2.34	2.31	2.33	2.28	2.22	2.10	2.16	2.14	2.13	2.09
24.00	DISCHG	2.05	1.45	0.49	0.14	0.04	0.01	0.00			

ENDCMP

ENDJOB CARD ENCOUNTERED, END OF JOB.

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(2) HYDRAULICS

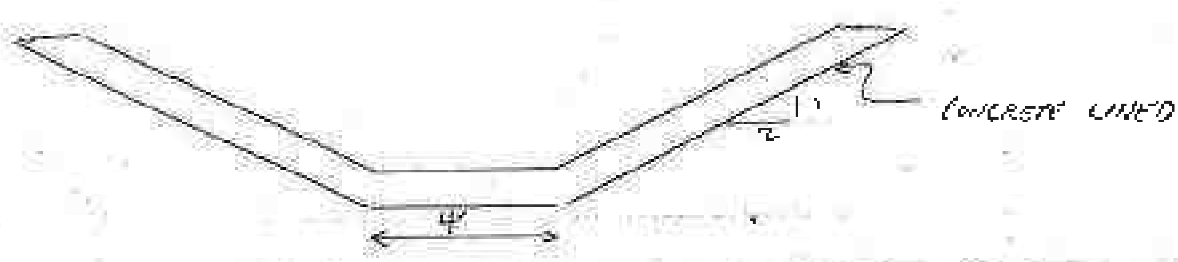
THE MAIN VALLEY WEST COLLECTION CHANNEL IS DESIGNED AS ONE CHANNEL. THE EXPECTED MAX DESIGN FLOW FOR THIS CHANNEL IS FROM THE STAGE II BENCHES AT THE ULTIMATE SITE CONFIGURATION, AS THE HYDROLOGY CALCS DEPICT.

CHARACTERISTICS:

- i THE CHANNEL EXTENDS FROM N 393,150 E 1,630,830 TO N 391,780 E 1,632,250
- ii THE DESIGN FLOW EQUALS 100 CFS (SHEET 31c)
- iii THE CHANNEL DRAINS FLOW FROM THE SLOPE BENCHES WEST OF THE HAUL ROAD DURING THE CONSTRUCTION OF STAGE II.
- iv THE SLOPE FOR THE CHANNEL RANGES FROM S = 1.3% TO 27.8%

DESIGN:

- i Q = 100 CFS
- ii S = 1.3 TO 27.8 %
- iii n = 0.012 CONCRETE LINED FOR IMPERMEABLE LINER
- iv CHANNEL DEPTH



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MINIMUM SLOPE = 1.3 %

$Qn / b^{8/3} S^{1/2} = 0.26$

$d/b = 0.31$

$d = 0.31 \times 4 = 1.24$ RECOMMEND 2.7 FT FOR FREEBOARD AND SUPERELEVATION (SEE SHEET 34)

v. MAXIMUM EXPECTED VELOCITY

$S = 27.8\%$ $d = 0.52$ FT

$$V = \frac{1.49}{0.012} \left(\frac{4(0.52) + 2(0.52)^2}{4 + 2(0.52)\sqrt{5}} \right)^{2/3} 0.278^{1/2}$$

= 36.4 FPS

vi. FREEBOARD AND SUPERELEVATION

$F.B. = 0.025 \, V d^{1/3}$
$= 0.025 (36.4 \text{ FPS})(0.52)^{1/3}$
$= 0.73$ FT

$S.E. = V^2 b / g R_c$

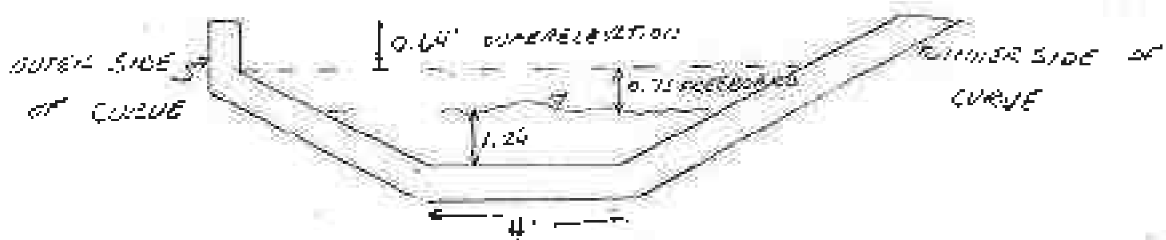
WHERE R_c IS THE RADIUS OF CURVATURE.

NOTE: SINCE THE WEST COLLECTION CHANNEL CURVES AROUND THE STAGE II TOE NEAR THE HLVL ROAD PRETTY TIGHTLY, SCOURING OF THE CHANNEL WILL OCCUR. THEREFORE, A PROTECTIVE MEASUREMENT SHOULD BE INCORPORATED

in the channel. In this channel, a vertical wall with a height equal to the super-elevation will be attached to the channel sidewall. See below for illustration.
The channel section that is analyzed for superelevation:

1. is 220 ft long
2. has an average slope of 16.7%
3. has a radius of curvature of 155 ft
4. has an average velocity of 30.5 fps

Required cross-section of channel in this area.



$$S.E. = \frac{30.5^2(4')}{(32.2)(155')}$$

$$= 0.74 \text{ ft}$$

$$d_{max} = 1.24 + 0.73 + 0.74$$

$$= 2.71 \text{ ft}$$

$$\approx 2.7 \text{ ft}$$

In straight sections of the channel, allowance for superelevation is not mandatory; therefore, the depth of the channel in relatively straight sections should be, at the minimum, 2 feet.

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Main Valley Collection Dissipator

(1) Hydrology

The design peak flow for the Main Valley collection dissipator occurs during the worst of two significant construction stages. These two stages will be analyzed to calculate which peak flow corresponding to these stages is the more significant for design purposes. The one stage is one of the last stages of the ultimate configuration of Stage II, (the stage that the Main Valley East collection channel was designed for), and the other stage occurs 4 years after the 1986 Stage II construction, just prior to the closing of Stage I.

I. Condition I - one of the last stages of the ultimate configurat

For the hydrology analysis for Condition I, the peak flows calculated for the Main Valley East and West collection channel design will be used. Even though the peak flow for the west collector was calculated for the ultimate stage, the difference between the peak flow in the west collector for the ultimate stage and Condition I is conservatively marginal. Also, the peak flows from each source are assumed to occur at the same time

Total flow:

Flow from Main Valley East Collection Channel = 525 cfs (see sheet 11)

Flow from Main Valley West Collection Channel = 100 cfs (see sheet 27)

Flow from Stilling Basin = 0.92 cfs ("Hydrology Study... Report," GAI, May 10, 1985, 82-134-11, Table 3 - Base Flow Summary, Condition IV, Leachate Only)

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Flow from the haul road gutter - The gutter collects the runoff from the haul road and drains west until it reaches the lower portion of the west collection channel. This runoff does not significantly affect the west collection channel; therefore, the additional flow was neglected in the west collection design.

Flow from incremental portions from the two lower bench drain overland to the west collection extension.

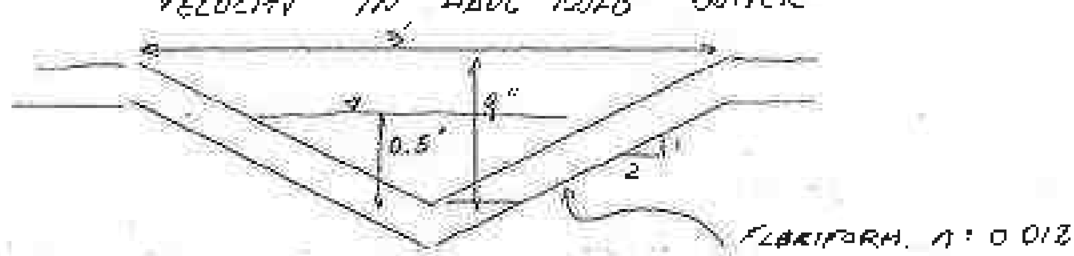
Input Data:

A. PPT: 5.5 inches - 100 yr, 4.0 inches - 10 yr, 2.7 inches - 2 yr.
B. AMC II
C. Hydrologic Soil Group C
D. Drainage Area

Length of haul road = 2800 ft
Width of haul road = 50' + 15' = 65'
Area = 2800' × 65' / 43,560 ft²/acre = 4.2 acres

E. Curve Number
Haul Road 85

F. Time of Concentration
i. Time in haul road gutter
Length of flow on haul road = 2800 ft
Slope of haul road = 10%
Velocity in haul road gutter:



$$V = \frac{1.49}{0.012}\left(\frac{2(0.5)}{2\sqrt{1+2^2}}\right)^{2/3} 0.10^{1/2}$$

$= 14.5$ fps

SUBJECT Penelec - Conemaugh 1986 Stage II Const
Permanent Drainage Structures

BY MLL DATE 2/17/86 PROJ NO. 86-167

CHKD BY RFD DATE 3/4/86 SHEET NO. 37 OF 102

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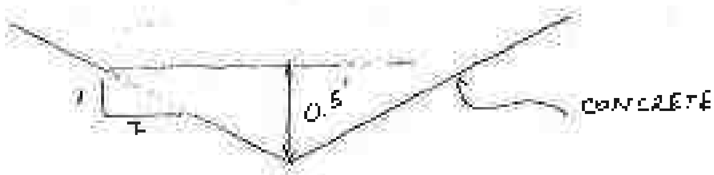
$t_{c_1} = 2800/14.5$

$= 193$ SECONDS

$= 0.054$ HR

ii. TIME IN CHANNEL

LENGTH OF CHANNEL = 40 FT
SLOPE OF CHANNEL = 11 %
VELOCITY OF FLOW
ASSUME



$V = \frac{1.49}{0.016}\left(\frac{2(0.5)}{2\sqrt{1+2^2}}\right)^{2/3} 0.11^{1/2}$
$= 15.2$ FPS

$t_{c_2} = 40/15.2$

$= 2.6$ SECONDS
$= 0.001$ HR

$T_c = 0.054 + 0.001$ HR
$= 0.055$ HR ≈ 0.06 HR

6. PEAK DISCHARGE

i. GUTTER ON HAUL ROAD = 16.5 CFS , FROM COMPUTER
ii. FLOW FROM FRONT BENCHES = 5 CFS (CONSERVATIVE ASSU
iii. TOTAL FLOW = 525 CFS + 100 CFS + 0.9 CFS + 16.5 + 5
= 647 CFS (CONDITION I)

SUBJECT Bunker-Conemaugh 1986 Stage II Cond
BY MLA DATE 2/17/86 SHEET NO. 38 OF 132
CHKD. BY RFD DATE 3/4/86 PROJECT NO. 86-167

EXEC CONTROL CARD OPERATION LIST

LISTING OF DATA IN CORE

0 CONEMAUGH - STAGE II 1986 - HAUL ROAD CONDITION 1

1 CTABLE

VELOCITY INCREMENT 0.2000

8	0.0000	0.0800	0.1800	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8800	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

2 XSECTN — XSECTN NO. 1 — DRAINAGE AREA 1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000

9 ENDTBL

4 DIMHYD

TIME INCREMENT

8	0.0000	0.0300	0.1000	0.1900	0.3100
8	0.4700	0.6600	0.8200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.6800	0.5600	0.4600	0.3900	0.3300
8	0.2800	0.2410	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0550	0.0470	0.0400	0.0340	0.0290
8	0.0250	0.0210	0.0180	0.0150	0.0130
8	0.0110	0.0090	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000

9 ENDTBL

COMPUTED PEAK R FACTOR = 484.00

TIME INCREMENT

SUBJECT Pennsauken? - Conemaugh 1986 Stage II Const
BY MLF DATE 2/11/86 SHEET NO. 31 OF 152
CHKD BY RFQ DATE 3/4/86 PROJECT NO. 86-167

5 RA 1 — 0.5000

8	0.0000	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1120	0.1260	0.1400	0.1560
8	0.1740	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5830	0.6240	0.6540	0.6820
8	0.7050	0.7270	0.7480	0.7670	0.7840
8	0.8000	0.8160	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9260	0.9360	0.9460	0.9550	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000

9 ENDTBL

5 RAINFL 2 — TIME INCREMENT 0.0700

8	0.0000	0.0100	0.0200	0.0250	0.0300
8	0.0400	0.0500	0.0600	0.0700	0.0800
8	0.1000	0.1100	0.1300	0.1400	0.1700
8	0.1900	0.2200	0.2700	0.3500	0.4400
8	0.5200	0.6000	0.6350	0.6600	0.6800
8	0.7000	0.7200	0.7400	0.7600	0.7700
8	0.7900	0.8000	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9800	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

5 RAINFL 3 — TIME INCREMENT 0.5000

8	0.0000	0.0053	0.0108	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0483	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1089	0.1203	0.1328	0.1467	0.1625
8	0.1808	0.2042	0.2351	0.2833	0.6632
8	0.7351	0.7724	0.7989	0.8157	0.8380
8	0.8538	0.8676	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9519	0.9588	0.9653	0.9717	0.9777
8	0.9836	0.9892	0.9947	1.0000	1.0000

9 ENDTBL

SUBJECT Penelec - Conemaugh 1980 Stage II Curves
BY MLA DATE 2/17/86 SHEET NO. 40 OF 122
CHKD. BY RFD DATE 3/4/86 PROJECT NO. 86-147

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1   E       1       0.0006     45.0000      0.00001 1 | 0 0 0
  ENDATA

END OF LISTING
```

SUBJECT Peebles – Commonwealth 1984 Stage II Const
BY MLS DATE 3/10/86 SHEET NO. ... OF 102
CHKD. BY RED DATE 3/14/86 JOB NO. 84-147

```
EXECUT    CONTROL CARD        OPERATION  INCREM.     MAIN TIME INCREMENT=  0.20
EXECUT    CONTROL CARD        OPERATION  COMPUT.     FROM XSEC    1  0      TO XSECTN/STRUCT   1  0
          STARTING TIME=  0.00    RAIN DEPTH=  2.70    RAIN DURAT.=   1.00    RAIN TABLE NO.= 1    SOIL CONDITION= 2
          ALTERNATE NO.= 0        STORM NO.= 0

SUBROUTINE RUNOFF    CROSS SECTION   1
          AREA=   0.02     INPUT RUNOFF CURVE=  85.0     TIME OF CONCENTRATION=  0.06

          NULL STRUCTURE,,,NO ELEVATIONS GIVEN
***** IN PEAK = MAXI =  122

          PEAK TIMES                PEAK DISCHARGES               PEAK ELEVATIONS
            11.93                        6.192                      (RUNOFF)
            12.31                        1.248                      (RUNOFF)
            12.91                        0.657                      (RUNOFF)
            13.43                        0.488                      (RUNOFF)
            13.91                        0.369                      (RUNOFF)
            14.31                        0.321                      (RUNOFF)
            14.90                        0.285                      (RUNOFF)
            15.31                        0.249                      (RUNOFF)
            15.90                        0.223                      (RUNOFF)
            16.31                        0.205                      (RUNOFF)

  TIME                               HYDROGRAPH, TZERO=   0.00        DELTA T= 0.20          DRAINAGE AREA=   0.01
  0.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  2.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  4.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  6.00    DISCHG      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.03
  8.00    DISCHG      0.00      0.00      0.00      0.00      0.01      0.04      0.02      0.03      0.04      0.05
 10.00    DISCHG      0.06      0.08      0.09      0.14      0.16      0.18      0.31      0.35      3.38      6.97
 12.00    DISCHG      5.83      1.17      1.39      0.66      0.61      0.54      0.46      0.46      0.37      0.36
 14.00    DISCHG      0.36      0.32      0.32      0.26      0.28      0.26      0.25      0.25      0.22      0.22
 16.00    DISCHG      0.22      0.20      0.20      0.19      0.19      0.19      0.17      0.17      0.17      0.17
 18.00    DISCHG      0.17      0.16      0.16      0.15      0.15      0.15      0.14      0.14      0.13      0.13
 20.00    DISCHG      0.13      0.13      0.13      0.12      0.12      0.12      0.12      0.12      0.11      0.11
 22.00    DISCHG      0.11      0.11      0.11      0.10      0.10      0.10      0.10      0.10      0.10      0.10
 24.00    DISCHG      0.10      0.00

 ENDCMP
```

PROBLEM - CONEMAUGH 1986 STAGE II CONT.
BY MLA DATE 3/10/86 ... 102
CHKD BY RFD DATE 3/24/86 ... 86-143

EXECUTIVE CONTROL CARD   OPERATION COMPUT,   FROM XSECTN/STRUCT 1   TO XSECTN/STRUCT 1
STARTING TIME= 0.00   RAIN DEPTH= 4.00   RAIN DURATION= 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF.   CROSS SECTION 1
AREA= 0.01   INPUT RUNOFF CURVE= 85.0   TIME OF CONCENTRATION= 0.06

WILL STRUCTURE... NO ELEVATIONS GIVEN
***** 1A PEAK - MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.52	10.953	(RUNOFF)
12.31	2.132	(RUNOFF)
12.40	1.106	(RUNOFF)
13.30	0.765	(RUNOFF)
13.90	0.615	(RUNOFF)
14.30	0.544	(RUNOFF)
14.90	0.472	(RUNOFF)
15.30	0.412	(RUNOFF)
15.50	0.374	(RUNOFF)
16.10	0.338	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.04
8.00	DISCHG	0.05	0.06	0.07	0.08	0.09	0.10	0.13	0.14	0.17	0.18
10.00	DISCHG	0.19	0.27	0.28	0.15	0.43	0.48	0.70	1.81	7.18	5.94
12.00	DISCHG	10.25	2.40	2.03	1.11	1.37	1.07	0.76	0.77	0.61	0.61
14.00	DISCHG	0.61	0.54	0.54	0.41	0.46	0.46	0.41	0.41	0.41	0.37
16.00	DISCHG	0.37	0.34	0.34	0.33	0.31	0.31	0.29	0.29	0.27	0.27
18.00	DISCHG	0.27	0.25	0.25	0.24	0.24	0.24	0.23	0.23	0.22	0.22
20.00	DISCHG	0.22	0.21	0.21	0.20	0.20	0.20	0.19	0.19	0.18	0.18
22.00	DISCHG	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.16	0.16
24.00	DISCHG	0.16	0.00								

ENDCMP

PASS= 1

```
EXEC      CONTROL CARD          OPERATION  INCREM,     MAIN TT     INCREMENT  0.20
EXECUTIVE CONTROL CARD          OPERATION  COMPUT,     FROM XS     TO STRUCT   1 0     TO XSECTN/STRUCT   1 0
          STARTING TIME=  0.00     RAIN DEPTH=  5.50     RAIN DURATION=  1.00     RAIN TABLE NO.= 3     SOIL CONDITION= 2
          ALTERNATE NO.= 0         STORM NO.= 0

SUBROUTINE RUNOFF     CROSS SECTION    1
           AREA=   0.01      INPUT RUNOFF CURVE=  85.0      TIME OF CONCENTRATION=  0.06

           NULL STRUCTURE...NO ELEVATIONS GIVEN
***** IN PEAK - MAXI =  122
```

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.92	16.546	(RUNOFF)
12.30	3.155	(RUNOFF)
12.90	1.627	(RUNOFF)
13.50	1.150	(RUNOFF)
13.90	0.898	(RUNOFF)
14.30	0.793	(RUNOFF)
14.90	0.687	(RUNOFF)
15.30	0.559	(RUNOFF)
15.90	0.504	(RUNOFF)
16.30	0.491	(RUNOFF)

HYDROGRAPH, TZERO=   0.00   DELTA T= 0.20   DRAINAGE AREA=   0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03
6.00	DISCHG	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.14
8.00	DISCHG	0.14	0.17	0.18	0.21	0.22	0.24	0.28	0.30	0.36	0.38
10.00	DISCHG	0.39	0.52	0.55	0.74	0.79	0.83	1.35	1.41	11.79	16.34
12.00	DISCHG	15.34	2.97	2.99	1.64	1.57	1.57	1.12	1.12	0.90	0.88
14.00	DISCHG	0.89	0.79	0.78	0.66	0.68	0.58	0.59	0.59	0.54	0.54
16.00	DISCHG	0.54	0.49	0.49	0.45	0.45	0.45	0.41	0.41	0.39	0.39
18.00	DISCHG	0.39	0.37	0.37	0.35	0.35	0.35	0.33	0.33	0.32	0.32
20.00	DISCHG	0.32	0.30	0.30	0.28	0.28	0.28	0.28	0.28	0.26	0.26
22.00	DISCHG	0.26	0.26	0.26	0.25	0.24	0.24	0.24	0.24	0.23	0.23
24.00	DISCHG	0.23	0.00								

ENDCMP

ENDJOB CARD ENCOUNTERED. END OF JOB.

JOB Penelec - Conemaugh 1986 Stage II Const.
BY MLA DATE 2/17/86 SHEET NO. 414 OF 432
CHKD BY RFQ DATE 3/4/86 PROJECT NO. 86-167

SUBJECT Penelec - Conemaugh 1986 Stage II Const
Permanent Drainage Structures
BY MLA DATE 2/18/86 PROJ. NO. 86-167
CHKD. BY RFD DATE 3/4/86 SHEET NO. 42 OF 102

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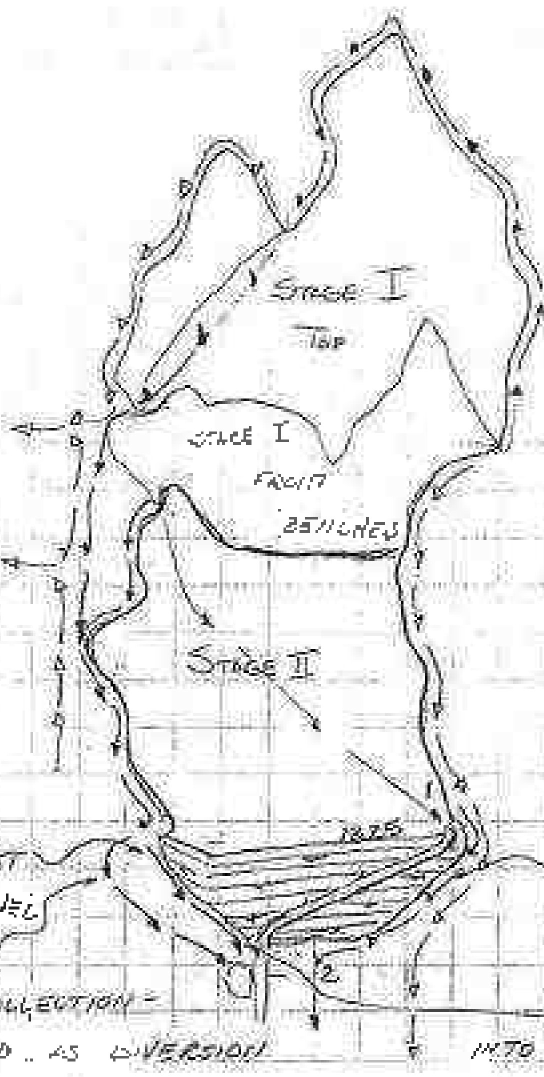
II. Condition II - 4 years after 1986 Stage II Construction, (199

For the hydrology analysis for Condition II, the majority of Stage I is assumed to be draining southwest to the natural channel that lies west of the site, travels south around Stage II and empties in the natural depression near the existing haul road. The other portion of Stage I drains to a channel that empties into the west valley. Stage II top bench (by 1990, benches are constructed up to elevation 1325) and a portion of the front face slopes drain to the east.
See diagram below and attached worksheets, 2A, 2B & 2C.



Darker boundary areas drain to the east collection channel

Note:
Stage II benches reach elevation 1325 at in 1990 construction
(Ref. Report, "Five Years of Development 1986 to 1990", 85-195-2, 4-10-85, GAI)

Permanent West Collection Channel

East Collection

Temporary Collection - to be used as diversion

Drainage from haul road empties into west channel near depression

SUBJECT Penelec - Conemaugh 1986 Stage II Cont.
Permanent Drainage Structures

BY MLA DATE 2/18/86 PROJ NO 86-167

CHKD. BY RFD DATE 3/4/86 SHEET NO 43 OF 102

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1. Main Valley East Collection

This channel collects runoff from a negligible portion of benches of Stage I, the top bench of Stage II, the front benches of Stage II east of the haul road, and incremental portions of offsite

Input Data.

A PPT = 5.5 inches - 100yr, 4.0 inches - 10yr, 2.7 inches - 2yr

B AMC II

C Hydrologic Soil Group C

D Drainage Area

		Area
i	Stage I front face bench	0.5 acres unit
ii	Stage II top bench	80.5 acres
iii	Stage II front benches	5.8 acres
iv	Offsite South of Stage II	1.7 acres (sheet

E Curve Numbers

		CN
i	Revegetated benches	78
ii	Active	85
iii	Revegetated benches	78
iv	Pasture offsite (soil stockpile)	80

F Time of Concentration

i To point 1

Stage II top bench

Length of swale	2710 ft
Slope of swale	1%
Velocity of flow	4 fps (assumption)

$T_c = \frac{712}{4}$

$= 178$ seconds

$= 0.189$ HR ≈ 0.19 HR

ii To point 2

Stage II Front Benches

Length of Bench	575 FT
Slope of Bench	1 - 3 %
Velocity of Flow	2 FPS (Assumption)

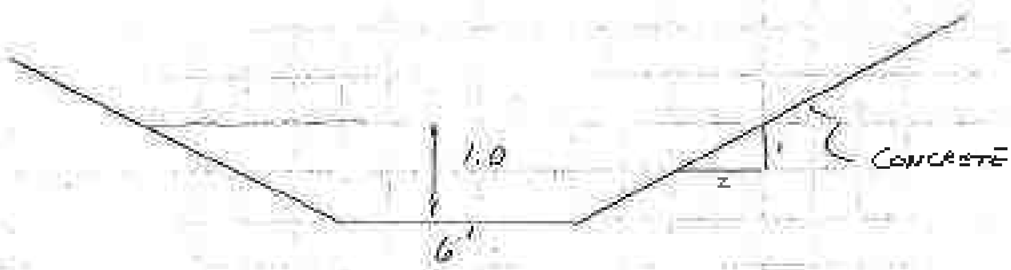
$t_{c_1} = 575/2$

$= 288$ seconds

$= 0.080$ HR

Length of Channel	715 FT
Slope of Channel	11 %
Velocity of Flow	

Assume



$$V = \frac{1.49}{0.012}\left(\frac{6(1.0) + 2(1.0)^2}{6 + 2(1.0)\sqrt{5}}\right)^{2/3} 0.11^{1/2}$$

$= 34.4$ FPS

$t_{c_2} = 715/34.4 \text{ FPS}$

$= 20.8$ seconds

$= 0.006$ HR

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T_c = 0.080 + 0.006
= 0.086 ≈ 0.09 HR

Offsite South of site. (Soil Stockpile)

T_c = 0.04 HR (see sheet 11)

Note: In routing flow from Pt 1 to Pt 2, length of channel equals 1380 ft. at 12% slope.

6. Peak Discharges

i. Point 1 Q_p = 292 cfs
ii. Point 2 Q_p = 314 cfs

SUBJECT Penelec - Conemaugh 1986 Stage II Const
BY MLA DATE 2/18/86 SHEET NO. 46 OF 102
CHKD BY REQ DATE 3/4/86 PROJECT NO 86-157

HEC-2 CONTROL CARD   OPERATION LIST

LISTING OF DATA IN CORE

0 CONEMAUGH - STAGE II 1986 - EAST COLLECTION CONDUIT

1 STAGE   VELOCITY INCREMENT 0.2000

8	0.0000	0.0800	0.1600	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

	XSECTN NO.	DRAINAGE AREA
2 XSECTN	1	1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000

9 ENDTBL

	XSECTN NO.	DRAINAGE AREA
3 XSECTN	2	1.0000

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000
8	1.0000	287.4000	6.0000
8	2.0000	1044.7000	20.0000

9 ENDTBL

4 DIMHYD   TIME INCREMENT

8	0.0000	0.0300	0.1000	0.1900	0.3100
8	0.4700	0.6600	0.8200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.6800	0.5600	0.4600	0.3900	0.3300
8	0.2800	0.2430	0.2070	0.1740	0.1470
8	0.1240	0.1070	0.0910	0.0770	0.0660
8	0.0550	0.0470	0.0400	0.0340	0.0290
8	0.0250	0.0210	0.0180	0.0150	0.0130

8	0.0110	0.0090	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000

9 ENDTBL

COMPUTED PEAK R FACTOR = 484.00

TIME INCREMENT
5 RAINFL 1 0.5000

8	0.0000	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1220	0.1250	0.1400	0.1560
8	0.1740	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5830	0.6240	0.6540	0.6820
8	0.7050	0.7270	0.7480	0.7670	0.7840
8	0.8000	0.8160	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9260	0.9360	0.9460	0.9550	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000

9 ENDTBL

TIME INCREMENT
5 RAINFL 2 0.0200

8	0.0000	0.0100	0.0200	0.0200	0.0300
8	0.0400	0.0500	0.0600	0.0700	0.0800
8	0.1000	0.1100	0.1300	0.1400	0.1700
8	0.1900	0.2200	0.2700	0.3500	0.4400
8	0.5200	0.6000	0.6300	0.6600	0.6800
8	0.7000	0.7200	0.7400	0.7600	0.7800
8	0.7900	0.8000	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9800	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

TIME INCREMENT
5 RAINFL 3 0.5000

8	0.0000	0.0053	0.0108	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0483	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1089	0.1203	0.1328	0.1467	0.1625
8	0.1808	0.2042	0.2351	0.2833	0.6632
8	0.7351	0.7724	0.7969	0.8197	0.8380
8	0.8538	0.8676	0.8803	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9448
8	0.9519	0.9588	0.9653	0.9717	0.9777
8	0.9836	0.9892	0.9947	1.0000	1.0000

9 ENDTBL

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1   1         1       0.3260      85.0000      0.1999 1 1 0 0 0 0
6 REACH  3   2    1    2    1330.0000       0.0000      0.0000 1 1 0 0 0 0
6 RUNOFF 1   2         3       0.0090      78.0000      0.5999 1 1 0 0 0 0
6 RUNOFF 1   2         4       0.0030      80.0000      0.0400 1 1 0 0 0 0
6 ADDHYD 4   2    3 4  5                                       1 1 0 0 0 0
6 ADDHYD 4   2    2 5  6                                       1 1 0 0 0 0
  ENDATA

END OF LISTING
```

Penelec - Conemaugh 1986 Stage II Calcs
MLA 3/10/86 SHEET NO. 4A OF 102
RFP 3/26/86 PROJECT NO. 86-147

EXECUTIVE CONTROL CARD   OPERATION INCREM,   MAIN TIME INCREMENT= 0.20
EXECUTIVE CONTROL CARD   OPERATION COMPUT,   FROM XSEC 1 TO XSEC 27 V   NO ASECT/STRUCT 27 0
STARTING TIME= 0.00   RAIN DEPTH= 2.10   RAIN DURATION= 1.00   RAIN TABLE NO.= 3   SOIL CONDITIONS 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF   CROSS SECTION 1
AREA= 0.13   INPUT RUNOFF CURVE= 85.0   TIME OF CONCENTRATION= 0.19
ERROR IN PEAK = MAXI = 123

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	136.691	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.13

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.02	0.11	0.21	0.35	0.48	0.63	0.83
10.00	DISCHG	0.99	1.40	1.65	2.11	2.63	4.23	5.20	6.33	24.04	78.60
12.00	DISCHG	102.51	42.01	24.11	19.64	12.72	12.15	9.98	8.78	8.20	7.03
14.00	DISCHG	6.94	6.31	6.16	5.92	5.39	5.35	4.85	4.71	4.50	4.30
16.00	DISCHG	4.28	3.98	3.89	3.61	3.64	3.63	3.34	3.13	3.28	3.17
18.00	DISCHG	3.17	3.06	2.97	2.92	2.83	2.80	2.67	2.63	2.61	2.57
20.00	DISCHG	2.57	2.46	2.44	2.49	2.31	2.30	2.27	2.27	2.23	2.14
22.00	DISCHG	2.13	2.10	2.10	2.07	2.00	2.00	1.97	1.96	1.94	1.90
24.00	DISCHG	1.89	0.43	0.03	0.00						

SUBROUTINE REACH   CROSS SECTION 2
LENGTH= 1380.00   INPUT COEFFICIENT= 0.0000   INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 35.950   AVERAGE ROUTING COEFF= 0.9544   NUMBER OF ROUTINGS= 0.05
ERROR IN PEAK = MAXI = 123

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	102.932	0.30

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.13

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.02	0.11	0.21	0.34	0.43	0.62	0.82
10.00	DISCHG	0.98	1.38	1.63	2.09	2.79	3.21	5.10	6.71	22.76	75.61
12.00	DISCHG	101.57	45.00	25.06	19.81	13.07	12.18	9.61	8.81	8.23	7.09
14.00	DISCHG	6.94	6.35	6.17	5.93	5.42	5.35	4.67	4.72	4.59	4.39
16.00	DISCHG	4.78	3.99	3.90	3.82	3.65	3.63	3.41	3.34	3.24	3.19
18.00	DISCHG	3.13	3.02	2.97	2.92	2.89	2.89	2.68	2.64	2.61	2.57
20.00	DISCHG	2.53	2.47	2.44	2.40	2.31	2.30	2.27	2.27	2.23	2.16
22.00	DISCHG	2.13	2.11	2.10	2.07	2.00	2.00	1.97	1.96	1.94	1.90
24.00	DISCHG	1.89	0.50	0.05	0.00						

SUBROUTINE RUNOFF   CROSS SECTION 2
AREA= 0.01   INPUT RUNOFF CURVE= 76.0   TIME OF CONCENTRATION= 0.09
ERROR IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	5.809	(RUNOFF)
12.91	0.591	(RUNOFF)
13.30	0.496	(RUNOFF)
13.91	0.395	(RUNOFF)

Perkins - Cavanaugh 1986 Stage II Curve
BY MLB DATE 3/10/86 SHEET NO. 50L OF 102
CHKD BY RFP DATE 3/10/86 JOB NO. 86-147

14.31	0.352	(RUNOFF)
14.91	0.309	(RUNOFF)
15.31	0.271	(RUNOFF)
15.91	0.248	(RUNOFF)
16.31	0.225	(RUNOFF)
16.91	0.212	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.03	0.00	0.02	0.04	0.11	0.15	1.71	4.81
12.00	DISCHG	5.64	1.35	1.22	0.71	0.66	0.67	0.49	0.49	0.41	0.39
14.00	DISCHG	0.39	0.35	0.35	0.31	0.30	0.30	0.27	0.27	0.25	0.25
16.00	DISCHG	0.25	0.22	0.22	0.21	0.21	0.21	0.19	0.19	0.19	0.19
18.00	DISCHG	0.18	0.17	0.17	0.16	0.16	0.16	0.15	0.15	0.15	0.15
20.00	DISCHG	0.15	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13
22.00	DISCHG	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11
24.00	DISCHG	0.11	0.00								

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.00 INPUT RUNOFF CURVE= 80.0 TIME OF CONCENTRATION 0.04
***** IN PEAK = MAXI = 121

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	2.266	(RUNOFF)
12.31	0.469	(RUNOFF)
12.91	0.250	(RUNOFF)
13.31	0.180	(RUNOFF)
13.91	0.149	(RUNOFF)
14.31	0.127	(RUNOFF)
14.91	0.111	(RUNOFF)
15.31	0.097	(RUNOFF)
15.91	0.089	(RUNOFF)
16.31	0.080	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.01	0.02	0.02	0.03	0.06	0.06	1.52	1.71
12.00	DISCHG	2.18	0.43	0.45	0.24	0.24	0.24	0.17	0.16	0.14	0.14
14.00	DISCHG	0.14	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.09	0.09
16.00	DISCHG	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.00	DISCHG	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
20.00	DISCHG	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
22.00	DISCHG	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
24.00	DISCHG	0.04									

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 3,4 OUTPUT HYDROGRAPH= 5
***** IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	8.075	0.00
12.31	0.941	0.00
12.31	0.476	0.00
13.31	0.337	0.00

SUBJECT Pueblo-Cavanaugh 1986 Stage II Cont
BY MLA DATE 3/19/86 SHEET NO. 5/A 182
CHKD. BY RFD DATE 3/20/86 PROJECT NO. 86-167

14.18	0.475	0.00
14.91	0.420	0.00
15.31	0.386	0.00
15.91	0.337	0.00
16.31	0.308	0.00
16.91	0.287	0.00

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.0.

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.01	0.02	0.04	0.07	0.13	0.24	2.75	5.81
12.00	DISCHG	7.81	1.68	1.07	1.05	0.90	0.91	0.66	0.66	0.55	0.53
14.00	DISCHG	0.53	0.47	0.47	0.42	0.41	0.41	0.36	0.36	0.34	0.33
16.00	DISCHG	0.33	0.30	0.30	0.29	0.28	0.28	0.26	0.26	0.25	0.25
18.00	DISCHG	0.25	0.23	0.23	0.22	0.22	0.22	0.21	0.21	0.20	0.20
20.00	DISCHG	0.20	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.17	0.17
22.00	DISCHG	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.15
24.00	DISCHG	0.15	0.00								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2.5 OUTPUT HYDROGRAPH= 6
ERROR IN PEAK - MAXT = 124

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	110.950	0.39

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.11

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.02	0.11	0.21	0.34	0.47	0.62	0.82
10.00	DISCHG	0.91	1.38	1.68	2.10	2.83	3.78	5.27	6.50	25.51	61.62
12.00	DISCHG	114.39	47.55	20.73	20.88	13.07	11.09	10.27	9.40	8.78	7.82
14.00	DISCHG	7.45	6.82	6.64	6.35	5.83	5.77	5.74	5.08	4.92	4.65
16.00	DISCHG	4.42	4.29	4.20	4.10	3.93	3.91	3.67	3.60	3.53	3.43
18.00	DISCHG	3.42	3.25	3.21	3.14	3.04	3.02	2.89	2.95	2.82	2.78
20.00	DISCHG	2.77	2.66	2.63	2.50	2.49	2.44	2.45	2.45	2.40	2.31
22.00	DISCHG	2.33	2.27	2.27	2.23	2.16	2.15	2.13	2.12	2.10	2.05
24.00	DISCHG	2.04	0.51	0.05	0.00						

ENDCMP

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
BY MLA DATE 3/19/86 SHEET NO. 79B OF 102
CHKD. BY RED DATE 3/24/86 PROJECT NO. 86-187

PASS= 2

EXECUTE RAINFALL TABLE OPERATION COMPUTE FROM XSEC 1/ 0 TO XSECTN/STRUCT 2/ 0
STARTING TIME= 0.00 RAIN DEPTH= 4.00 RAIN DURATION 1.00 RAIN TABLE NO.= 3 SOIL CONDITIONS 2
ALTERNATE NO.= 0 STORM NO.= 9

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.13 INPUT RUNOFF CURVE= 85.0 TIME OF CONCENTRATION= 0.19
***** IN PEAK = MAXI = 129

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	190.186	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.13

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.01	0.10	0.20	0.33	0.45	0.58	0.74
8.00	DISCHG	0.87	1.00	1.24	1.43	1.64	1.97	2.25	2.50	2.83	3.33
10.00	DISCHG	3.59	4.67	5.21	6.13	7.77	8.4[illegible]	12.47	14.94	51.48	152.98
12.00	DISCHG	164.62	74.66	41.19	34.59	21.52	20.46	15.94	14.73	13.73	11.75
14.00	DISCHG	11.58	10.52	10.25	9.83	8.95	8.84	8.03	7.80	7.57	7.11
16.00	DISCHG	7.07	6.56	6.47	6.28	6.00	5.97	5.57	5.48	5.39	5.21
18.00	DISCHG	5.20	4.94	4.81	4.78	4.60	4.54	4.37	4.31	4.27	4.20
20.00	DISCHG	4.20	4.02	3.98	3.90	3.76	3.75	3.70	3.64	3.63	3.56
22.00	DISCHG	3.47	3.42	3.41	3.36	3.28	3.24	3.20	3.19	3.15	3.08
24.00	DISCHG	3.06	0.70	0.05	0.03						

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 1300.00 INPUT COEFFICIENT 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 35.950 AVERAGE ROUTING COEFF= 0.9548 NUMBER OF ROUTINGS= 0.05
***** IN PEAK = MAXI = 124

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	187.268	0.65

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.13

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
6.00	DISCHG	0.00	0.00	0.00	0.01	0.09	0.26	0.32	0.44	0.56	0.73
8.00	DISCHG	0.87	1.01	1.21	1.42	1.68	1.66	2.23	2.49	2.81	3.30
10.00	DISCHG	3.58	4.62	5.20	6.09	7.69	8.38	12.65	14.93	49.67	147.91
12.00	DISCHG	183.20	80.27	43.03	33.79	22.13	20.53	16.43	14.79	13.74	11.85
14.00	DISCHG	11.59	10.58	10.26	9.85	9.06	8.84	8.07	7.81	7.58	7.13
16.00	DISCHG	7.07	6.58	6.43	6.29	6.01	5.97	5.60	5.48	5.39	5.22
18.00	DISCHG	5.20	4.95	4.87	4.79	4.61	4.57	4.38	4.31	4.27	4.21
20.00	DISCHG	4.20	4.03	3.98	3.91	3.77	3.75	3.71	3.69	3.63	3.49
22.00	DISCHG	3.47	3.43	3.41	3.36	3.26	3.24	3.20	3.19	3.16	3.08
24.00	DISCHG	3.06	0.82	0.09	0.09						

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.01 INPUT RUNOFF CURVE= 76.0 TIME OF CONCENTRATION= 0.09
***** IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	11.721	(RUNOFF)
12.40	1.202	(RUNOFF)
13.36	0.914	(RUNOFF)
13.91	0.722	(RUNOFF)
14.30	0.640	(RUNOFF)

SUBJECT Brambleton-Cavanaugh 1996 Stage II Const
BY MLA DATE 3/11/96 SHEET NO. 50B of 102
CHKD. BY JRF DATE 3/20/96 PROJECT NO. 86 167

14.90	0.556	(RUNOFF)
15.30	0.488	(RUNOFF)
15.90	0.446	(RUNOFF)
16.30	0.405	(RUNOFF)
16.90	0.378	(RUNOFF)

HYDROGRAPH, IZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.21

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.07
10.00	DISCHG	0.08	0.13	0.15	0.22	0.27	0.31	0.55	0.63	5.19	9.18
12.00	DISCHG	11.19	7.39	2.31	1.45	1.23	1.24	0.90	0.80	0.75	0.71
14.00	DISCHG	0.71	0.63	0.61	0.57	0.55	0.55	0.48	0.48	0.45	0.44
16.00	DISCHG	0.44	0.40	0.40	0.38	0.37	0.37	0.34	0.34	0.33	0.33
18.00	DISCHG	0.33	0.31	0.31	0.29	0.29	0.29	0.27	0.27	0.27	0.26
20.00	DISCHG	0.27	0.25	0.25	0.24	0.24	0.24	0.23	0.23	0.22	0.22
22.00	DISCHG	0.22	0.22	0.22	0.21	0.21	0.21	0.20	0.20	0.20	0.20
24.00	DISCHG	0.19	0.00								

SUBROUTINE RUNOFF CROSS SECTION 9
AREA= 0.00 INPUT RUNOFF CURVES 80.0 TIME OF CONCENTRATION= 0.06
***** IN PEAK = MAXI = 121

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.93	4.337	(RUNOFF)
12.31	3.061	(RUNOFF)
12.90	0.451	(RUNOFF)
13.30	0.321	(RUNOFF)
13.91	0.252	(RUNOFF)
14.30	0.224	(RUNOFF)
14.90	0.195	(RUNOFF)
15.30	0.170	(RUNOFF)
15.90	0.155	(RUNOFF)
16.30	0.140	(RUNOFF)

HYDROGRAPH, IZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04
10.00	DISCHG	0.04	0.06	0.07	0.11	0.12	0.13	0.21	0.25	2.53	3.52
12.00	DISCHG	4.10	0.80	0.62	0.49	0.43	0.44	0.31	0.31	0.25	0.25
14.00	DISCHG	0.25	0.22	0.19	0.19	0.19	0.19	0.17	0.17	0.15	0.15
16.00	DISCHG	0.15	0.13	0.14	0.13	0.11	0.11	0.12	0.12	0.11	0.11
18.00	DISCHG	0.11	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.09
20.00	DISCHG	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
22.00	DISCHG	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
24.00	DISCHG	0.07									

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 3,4 OUTPUT HYDROGRAPH= 5
***** IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	10.056	0.00
12.90	1.135	0.01
13.30	1.235	0.01
13.91	0.934	0.00
14.30	0.864	0.00

SUBJECT Pensacola-Conemaugh 1986 Stage II Const
BY MLA DATE 3/10/86 SHEET NO. 518 of 102
CHKD. BY KFD DATE 3/20/86 86-107

14.90	0.753	0.00
15.30	0.656	0.00
15.90	0.601	0.00
16.30	0.543	0.00
16.90	0.509	0.00

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.03	0.00	0.00	0.01	0.03	0.07	0.09	0.06	0.08	0.11
10.00	DISCHG	0.13	0.19	0.22	0.33	0.19	0.49	0.77	0.88	7.75	12.70
12.00	DISCHG	15.29	1.19	3.13	1.86	1.67	1.68	1.21	1.71	0.94	0.96
14.00	DISCHG	0.96	0.85	0.65	0.76	0.74	0.74	0.65	0.65	0.60	0.59
16.00	DISCHG	0.59	0.54	0.54	0.51	0.50	0.50	0.46	0.46	0.44	0.44
18.00	DISCHG	0.44	0.41	0.41	0.39	0.39	0.39	0.37	0.37	0.36	0.36
20.00	DISCHG	0.36	0.34	0.34	0.32	0.32	0.32	0.31	0.32	0.30	0.30
22.00	DISCHG	0.30	0.29	0.29	0.28	0.28	0.28	0.27	0.27	0.26	0.26
24.00	DISCHG	0.26	0.00								

SUBROUTINE ROUTING CROSS SECTION 9
INPUT HYDROGRAPHS= 2,5 OUTPUT HYDROGRAPHS 6
ERROR IN PEAK - MAXI = 120

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.95	203.164	0.71

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.14

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.01	0.09	0.20	0.32	0.44	0.58	0.73
8.00	DISCHG	0.67	1.07	1.23	1.43	1.69	1.88	2.27	2.54	2.89	3.41
10.00	DISCHG	3.73	4.81	5.41	6.41	8.01	8.82	13.42	15.71	57.17	160.51
12.00	DISCHG	198.49	83.47	40.14	35.07	23.19	22.21	17.38	16.00	14.78	12.81
14.00	DISCHG	12.55	11.45	11.12	10.68	9.75	9.02	8.72	6.46	6.18	5.73
16.00	DISCHG	7.67	7.12	6.97	6.19	6.51	6.88	6.26	5.95	5.84	5.66
18.00	DISCHG	5.64	5.36	5.20	5.16	5.00	4.87	4.74	4.61	4.63	4.56
20.00	DISCHG	4.55	4.37	4.32	4.23	4.09	4.07	4.02	4.01	3.93	3.76
22.00	DISCHG	3.76	3.72	3.71	3.64	3.54	3.52	3.43	3.46	3.42	3.35
24.00	DISCHG	3.33	0.82	0.05	0.00						

ENDCAF

SUBJECT Peveler - Copperhead 1986 Stage II Const
BY MLA DATE 2/10/86 SHEET NO. 190 OF 192
CHKD. BY RFD DATE 3/4/86 PROJECT NO. 86-107


```
EXECUTIVE CONTROL CARD        OPERATION  INCREM,     RAIN 1       INCREMENT= 0.20
EXECUTIVE CONTROL CARD        OPERATION  COMPUT,     FROM XS  INXSTRUCT  1/ 0     TO XSECTNXSTRUCT  2/ 0
     STARTING TIME=  0.00    RAIN DEPTH=  5.50    RAIN DURATION=  1.00    RAIN TABLE NO.= 1    SOIL CONDITION= 2
     ALTERNATE NO.= 0        STORM NO.= 0

SUBROUTINE RUNOFF    CROSS SECTION   1
        AREA=   0.13    INPUT RUNOFF CURVE=  85.0     TIME OF CONCENTRATION=  0.19
***** IN PEAK = NAXI =  124

        PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
          11.94                       291.899                    (RUNOFF)
```

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.13		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.27	0.43
6.00	DISCHG	0.58	0.75	0.91	1.09	1.30	1.47	1.74	1.94	2.17	2.47
8.00	DISCHG	2.67	3.07	3.31	3.65	4.14	4.39	5.11	5.58	6.05	6.95
10.00	DISCHG	7.32	9.31	11.19	11.70	14.56	15.41	23.07	26.21	86.92	263.57
12.00	DISCHG	281.49	111.78	61.73	49.25	31.67	30.98	23.17	21.57	20.09	17.18
14.00	DISCHG	16.91	15.35	14.55	14.33	13.04	12.32	11.68	11.33	11.00	10.33
16.00	DISCHG	10.27	9.52	9.31	9.10	8.69	8.65	8.06	7.93	7.60	7.94
18.00	DISCHG	7.52	7.14	7.04	6.91	6.65	6.67	6.31	6.22	6.17	6.07
20.00	DISCHG	6.06	5.83	5.73	5.63	5.42	5.40	5.34	5.32	5.23	5.01
22.00	DISCHG	4.99	4.93	4.92	4.84	4.69	4.67	4.60	4.59	4.54	4.43
24.00	DISCHG	4.41	1.05	0.06	0.00						

```
SUBROUTINE REACH     CROSS SECTION   2
        LENGTH=   1380.00    INPUT COEFFICIENT=  0.0000     INPUT ROUTINGS=  0.00

        AVERAGE WATER VELOCITY=  35.950       AVERAGE ROUTING COEFF= 0.9548       NUMBER OF ROUTINGS=  0.05
***** IN PEAK = NAXI =  124

        PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
          11.94                       297.876                     1.30
```

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.50			DRAINAGE AREA= 0.13		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.27	0.42
6.00	DISCHG	0.57	0.74	0.91	1.00	1.29	1.46	1.72	1.93	2.15	2.45
8.00	DISCHG	2.66	3.05	3.32	3.64	4.11	4.38	5.07	5.49	6.03	6.90
10.00	DISCHG	7.30	9.20	10.14	11.62	14.36	15.37	22.68	26.05	63.03	235.59
12.00	DISCHG	279.56	120.42	63.81	49.86	32.57	30.16	23.71	21.66	20.16	17.33
14.00	DISCHG	16.93	15.43	14.97	14.36	13.10	12.32	11.74	11.35	11.02	10.36
16.00	DISCHG	10.27	9.55	9.32	9.11	8.71	8.66	8.11	7.94	7.91	7.56
18.00	DISCHG	7.52	7.16	7.04	6.92	6.66	6.64	6.33	6.23	6.17	6.07
20.00	DISCHG	6.06	5.82	5.74	5.64	5.43	5.40	5.34	5.32	5.23	5.02
22.00	DISCHG	5.00	4.93	4.92	4.89	4.69	4.67	4.61	4.59	4.59	4.44
24.00	DISCHG	4.41	1.18	0.13	0.00						

```
SUBROUTINE RUNOFF    CROSS SECTION   2
        AREA=   0.01    INPUT RUNOFF CURVE=  70.0     TIME OF CONCENTRATION=  0.09
***** IN PEAK = NAXI =  122

        PEAK TIMES                 PEAK DISCHARGES            PEAK ELEVATIONS
          11.93                       19.079                     (RUNOFF)
          12.90                        1.988                     (RUNOFF)
          13.90                        1.348                     (RUNOFF)
          14.30                        0.980                     (RUNOFF)
```

SUBJECT Pensler, Cavanaugh 1986 Stage II Const
BY MLA DATE 2/18/86 SHEET NO. 504 OF 102
CHKD. BY RFO DATE 3/4/86 PROJECT NO. 86-167

14.90	0.851	(RUNOFF)
15.90	0.678	(RUNOFF)
16.90	0.573	(RUNOFF)
17.90	0.498	(RUNOFF)
18.90	0.439	(RUNOFF)
19.90	0.402	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03
8.00	DISCHG	0.04	0.06	0.07	0.10	0.11	0.13	0.17	0.18	0.23	0.26
10.00	DISCHG	0.29	0.34	0.43	0.58	0.66	0.71	1.29	1.31	9.98	15.71
12.00	DISCHG	18.00	3.77	3.62	2.26	1.92	1.92	1.58	1.38	1.15	1.09
14.00	DISCHG	1.09	0.97	0.97	0.86	0.84	0.84	0.74	0.74	0.69	0.67
16.00	DISCHG	0.67	0.61	0.61	0.57	0.57	0.57	0.52	0.52	0.50	0.49
18.00	DISCHG	0.49	0.46	0.46	0.44	0.44	0.44	0.41	0.41	0.40	0.40
20.00	DISCHG	0.40	0.39	0.38	0.36	0.36	0.36	0.35	0.35	0.33	0.33
22.00	DISCHG	0.33	0.33	0.33	0.31	0.31	0.31	0.30	0.30	0.30	0.29
24.00	DISCHG	0.29	0.00								

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.00 INPUT RUNOFF CURVE= 80.0 TIME OF CONCENTRATION= 0.06
***** IN PEAK = MAXI = 121

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.92	6.849	(RUNOFF)
12.30	1.326	(RUNOFF)
12.90	0.687	(RUNOFF)
13.30	0.408	(RUNOFF)
13.90	0.302	(RUNOFF)
14.30	0.338	(RUNOFF)
14.90	0.293	(RUNOFF)
15.30	0.256	(RUNOFF)
15.90	0.233	(RUNOFF)
16.30	0.210	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.00

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02
8.00	DISCHG	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.10	0.11
10.00	DISCHG	0.12	0.16	0.17	0.24	0.26	0.28	0.46	0.50	4.63	5.77
12.00	DISCHG	6.41	1.24	1.26	0.66	0.66	0.60	0.47	0.42	0.38	0.38
14.00	DISCHG	0.38	0.33	0.33	0.29	0.29	0.29	0.25	0.25	0.23	0.23
16.00	DISCHG	0.23	0.21	0.21	0.19	0.19	0.19	0.18	0.18	0.17	0.17
18.00	DISCHG	0.17	0.16	0.16	0.15	0.15	0.15	0.14	0.14	0.14	0.14
20.00	DISCHG	0.14	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.11	0.11
22.00	DISCHG	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
24.00	DISCHG	0.10									

SUBROUTINE ADDHYD CROSS SECTION 7
INPUT HYDROGRAPHS= 3,4 OUTPUT HYDROGRAPH= 5
***** IN PEAK = MAXI = 122

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.93	25.921	0.09
12.90	2.675	0.01
13.90	1.490	0.01
14.30	1.319	0.00

14.90	1.146	0.00
15.40	1.000	0.00
15.90	0.911	0.00
16.30	0.821	0.00
16.90	0.769	0.00
17.30	0.701	0.00

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.06
8.00	DISCHG	0.07	0.10	0.11	0.15	0.17	0.19	0.24	0.27	0.33	0.37
10.00	DISCHG	0.40	0.55	0.60	0.62	0.92	0.99	1.06	1.81	14.61	21.48
12.00	DISCHG	24.41	5.01	4.88	2.97	2.58	2.34	1.86	1.86	1.52	1.47
14.00	DISCHG	1.47	1.30	1.30	1.15	1.13	1.13	0.99	0.99	0.91	0.90
16.00	DISCHG	0.90	0.82	0.82	0.77	0.76	0.76	0.70	0.70	0.67	0.66
18.00	DISCHG	0.66	0.62	0.62	0.55	0.54	0.54	0.55	0.55	0.54	0.54
20.00	DISCHG	0.54	0.51	0.51	0.48	0.48	0.48	0.47	0.47	0.45	0.44
22.00	DISCHG	0.44	0.44	0.44	0.42	0.41	0.41	0.41	0.41	0.40	0.39
24.00	DISCHG	0.39	0.00								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,5 OUTPUT HYDROGRAPH= 6
IN PEAK = NALL = 124

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.94	313.574	1.03

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.14

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.27	0.42
6.00	DISCHG	0.57	0.74	0.91	1.06	1.29	1.43	1.73	1.95	2.19	2.51
8.00	DISCHG	2.73	3.14	3.43	3.76	4.28	4.57	5.31	5.75	6.36	7.27
10.00	DISCHG	7.70	9.76	10.74	12.44	15.28	16.35	24.34	27.86	98.45	251.07
12.00	DISCHG	303.97	125.43	68.49	52.76	35.14	32.75	25.57	23.52	21.69	18.80
14.00	DISCHG	18.40	16.73	16.27	15.57	14.23	14.05	12.73	12.34	11.93	11.26
16.00	DISCHG	11.17	10.37	10.14	9.58	9.47	9.42	8.81	8.64	8.48	8.22
18.00	DISCHG	8.18	7.78	7.66	7.34	7.25	7.21	6.88	6.78	6.71	6.61
20.00	DISCHG	6.59	6.37	6.25	6.12	5.91	5.88	5.81	5.80	5.68	5.47
22.00	DISCHG	5.44	5.37	5.35	5.20	5.10	5.08	5.02	5.00	4.94	4.83
24.00	DISCHG	4.80	1.18	0.13	0.00						

ENDCMP

ENDJOB CARD ENCOUNTERED, END OF JOB.

SUBJECT Penelec - Conemaugh 1986 Stage II Const
BY MLA DATE 8/18/86 SHEET NO. 512 OF 192
CHKD BY RFD DATE 8/19/86 PROJECT NO. 86-147

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2 Main Valley West Collection

This channel collects runoff from approximately 70% of Stage I top bench, Stage I exposed front benches, Offsite surrounding Stage I, offsite west of Stage II, and benches west of the haul road and the haul road cutter

Input Data:

a PPT = 5.5 inches - 100 yr, 4.0 inches - 10 yr, 2.7 inches - 2 yr
b AMC II
c Hydrologic Soil Group C
d Drainage Area

		Area
i	Stage I Offsite	104.0 acres
ii	Stage I Top Bench	81.7 acres
iii	Stage I benches + portion of Top Bench	48.2 acres
iv	Offsite West of Stage II	57.8 acres
v	Stage II benches	7.9 acres

e Curve Numbers

		CN
i	Wooded offsite Stage I	70
ii	Revegetated Top Bench (surface)	75
iii	Revegetated Benches (in process of stripping)	78
iv	Wooded offsite Stage II	70
v	Revegetated Benches	78

f Time of Concentration

i To point 3

STAGE I OFFSITE

LENGTH OF OVERLAND FLOW	2175 FT
SLOPE OF OVERLAND	7 %
VELOCITY OF FLOW	1.3 FPS

(SEE SHEET 7)

$t_{c1} = 2175/1.3$
$= 1673$ SECONDS
$= 0.465$ HR

LENGTH OF CHANNEL	1700 FT
SLOPE OF CHANNEL	0.3%
VELOCITY OF FLOW	

ASSUME
(REF: "PHASE II APPLICATION - COAL REFUSE DISPOSAL PERMIT", GAI, MODULE B, JULY 1985, STAGE I DITCH B)

$$V = \frac{1.49}{0.040}\left(\frac{12(2.5)+1.2(2.5)^2}{12+2(2.5)\sqrt{1+1.2^2}}\right)^{2/3} 0.003^{1/2}$$
$= 3.12$ FPS

$t_{c2} = \frac{1700}{3.12}$
$= 545$ SECONDS
$= 0.151$ HR

$T_c = 0.465 + 0.151$
$= 0.616$ HR ≈ 0.62 HR

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES

BY MLA DATE 2/19/86 PROJ. NO. 86-167

CHKD. BY RFD DATE 3/4/86 SHEET NO. 54 OF 102

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ii To point 4

STAGE I TOP BENCH

LENGTH OF OVERLAND FLOW	1910 FT
SLOPE OF OVERLAND	4 %
VELOCITY OF FLOW	1 FPS
	(SEE SHEET 7)

$t_i = 1910/1$
$= 1910$ SECONDS
$= 0.530$ HR

LENGTH OF CHANNEL	1700 FT
SLOPE OF CHANNEL	0.8 %
VELOCITY OF FLOW	3.12 FPS
	(SEE SHEET 53)

$t_{c2} = 1700/3.12$
$= 545$ SECONDS
$= 0.151$ HR

LENGTH OF CHANNEL	1520 FT
SLOPE OF CHANNEL	1.3 %
VELOCITY OF FLOW	

ASSUME

CLEAN, WEATHERED (JUST REVEGETATED) n = 0.030

(REF: "PHASE II APPLICATION COAL REFUSE DISPOSAL PERMIT", GAI, MODULE 13 JULY 1985, STAGE I DITCH 4)

$V = \frac{1.49}{0.030} \left(\frac{10(1.0) + 2(1.0)^2}{10 + 2(1.0)\sqrt{5}} \right)^{2/3} 0.013^{1/2}$

$= 5.00$ FPS

$t_{c3} = 1520/5.00$

$= 304$ SECONDS $= 0.084$ HR

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
Permanent Drainage Structures

BY MLA DATE 2/19/86 PROJ. NO. 86-167

CHKD BY RFO DATE 3/4/86 SHEET NO 55 OF 152

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$T_c = 0.530 + 0.151 + 0.084$
$= 0.765 \text{ HR} \approx 0.76 \text{ HR}$

Note: In routing flow from PT 3 to 4, length of channel equals 1520 FT

iii. To point 5

Stage I exposed front faces

Length of overland flow	1180 FT
Slope of overland	5%
Velocity of flow	1.2 FPS
	(See sheet 7)

$t_{c_1} = 1180/1.2$
$= 983 \text{ seconds}$
$= 0.273 \text{HR}$

Length of bench flow	2235 FT
Slope of bench	1-3%
Velocity of flow	2 FPS
	(Assumption)

$t_{c_2} = 2235/2$
$= 1118$
$= 0.310 \text{ HR}$

Length of channel	945 FT
Slope of channel	12%
Velocity in channel	

Assume

(Ref: "Phase II application - Coal Refuse Disposal Permit," GAI, Module 13, July 1985, Stage I Ditch 5)

SUBJECT Penelec – Conemaugh 1986 Stage II Const.
Permanent Drainage Structures

BY MLA DATE 2/21/86 PROJ. NO. 86-167

CHKD. BY REO DATE 3/4/86 SHEET NO. 56 OF 102

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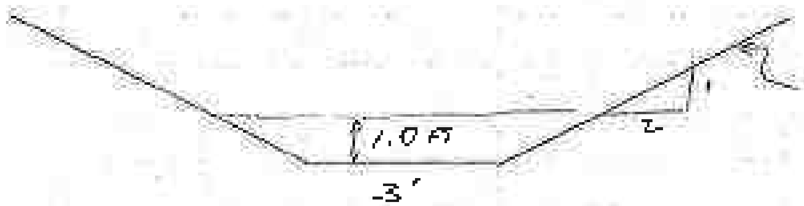


EARTHLINED, CLEAN, WEATHERED
EXCAVATED TO ROCK
n = 0.035

$$V = \frac{1.49}{0.035}\left(\frac{3(1.0) + 2(1.0)^2}{3 + 2(1.0)\sqrt{5}}\right)^{2/3} 0.12^{1/2}$$
$= 11.3$ FPS

$t_{c3} = 945/11.3$
$= 83.6$ SECONDS
$= 0.023$ HR

$T_c = 0.273 + 0.310 + 0.023$
$= 0.606$ HR ≈ 0.61 HR

vi To Point 6

Note: In routing flow from pt 4 to 6, length of V-notch channel with 2:1 sideslopes equals 1720 ft. at 6% slope

Note: In routing flow from pt 5 to 6, length of trapezoidal channel with 10' base and 2:1 sideslopes equals 1475 ft. at 0.8% slope

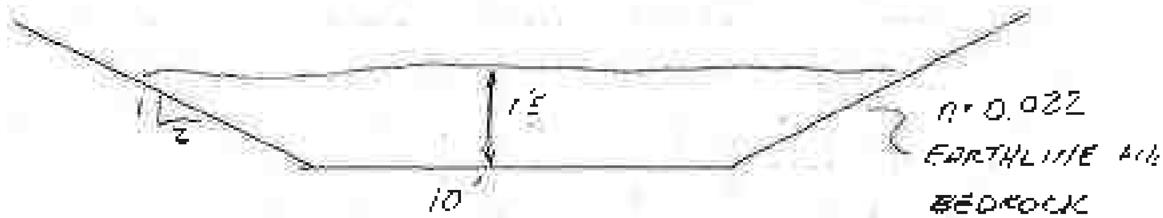
v To Point 7

Offsite West of Stage II

Length of overland flow	655 FT
Slope of overland	15 %
Velocity of overland (wooded)	2 FPS
	(see sheet 7)

$t_{c1} = 655/2$
$= 328$ seconds $= 0.091$ HR

Length of Channel (Pt 5 to Pt 7) 4350 ft
Slope of Channel 3%
Velocity of Flow
Assume



$$V = \frac{1.49}{0.022}\left(\frac{10(1.5) + 2(1.5)^2}{10 + 2(1.5)\sqrt{5}}\right)^{2/3} 0.03^{1/2}$$
$= 13.0$ fps

$t_{c_2} = 4350/13.0$
$= 335$ seconds
$= 0.093$ hr

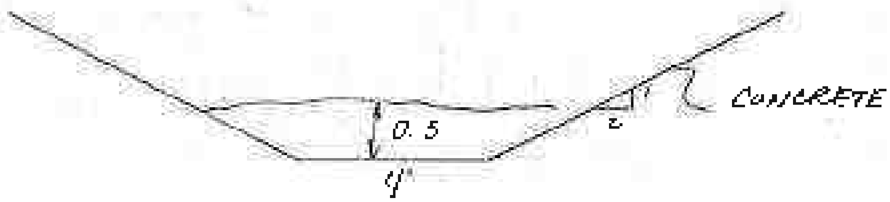
$T_c = 0.091\text{ hr} + 0.093\text{ hr}$
$= 0.184\text{ hr} \approx 0.18\text{ hr}$

a. To point 8
Stage II Benches West of Haul Road + Gutter
Length of Bench 1370 ft
Slope of Bench 1-3%
Velocity of Flow 2 fps

$t_{c_1} = 1370/2$
$= 685$ seconds
$= 0.190$ hr

Length of Channel 730 ft
Slope of Channel 14%
Velocity of Flow

ASSUME



$V = \frac{1.49}{0.012}\left(\frac{4(0.5)+2(0.5)^2}{4+2(0.5)\sqrt{5}}\right)^{2/3} 0.14^{1/2}$

$= 25.2$ FPS

$t_{c2} = 730/25.2$

$= 29.0$ SECONDS

$= 0.008$ HR

$T_c = 0.190 + 0.008$

$= 0.198$ HR ≈ 0.20 HR

NOTE: IN ROUTING FLOW FROM PT 6 TO 7, LENGTH OF CHANNEL EQUALS 2875 FT.
FLOW IN HAUL ROAD GUTTER = 7.8 CFS (SHEET 70)

6 PEAK FLOWS

i POINT 3 : Q_P = 160 CFS
ii POINT 4 : Q_P = 285 CFS
iii POINT 5 : Q_P = 99 CFS
iv POINT 6 : Q_P = 367 CFS
v POINT 7 : Q_P = 393 CFS
vi POINT 8 : Q_P = 24 CFS + (HAUL ROAD GUTTER) 7.8 CFS
vii IN DEPRESSION : Q_P = 408 CFS

SUBJECT Penelec - Conemaugh 1986 Stage II Conc
BY MLA DATE 2/21/86 SHEET NO. 57 OF 102
CHKD. BY RFD DATE 3/3/86 PROJECT NO. 86-167

EAST CONTROL CARD   OPERATION LIST

LISTING OF DATA IN CORE

0 CONEMAUGH - STAGE II 1986 - WEST COLLECTION COND. II

		VELOCITY INCREMENT			
1 CIABHG		0.2000			
8	0.0000	0.0800	0.1800	0.2500	0.3200
8	0.3700	0.4500	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8200
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300
9 ENDTBL					

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	1	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
9 ENDTBL				

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	2	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
8		1.0000	60.0000	12.0000
8		2.0000	205.7000	26.0000
8		3.0000	439.6000	46.0000
9 ENDTBL				

	XSECTN NO.	DRAINAGE AREA		
2 XSECTN	3	1.0000		
		ELEVATION	DISCHARGE	END AREA
8		0.0000	0.0000	0.0000
8		1.0000	19.4000	2.0000
8		2.0000	123.0000	8.0000
8		3.0000	363.2000	18.0000
9 ENDTBL				

		XSECTN NO.	DRAINAGE AREA		
2	XSECTN	4	1.0000		
			ELEVATION	DISCHARGE	END AREA
8			0.0000	0.0000	0.0000
8			1.0000	39.1000	12.0000
8			2.0000	134.8000	28.0000
8			3.0000	287.3000	48.0000
8			4.0000	502.6000	72.0000
9	ENDTBL				

		XSECTN NO.	DRAINAGE AREA		
2	XSECTN	5	1.0000		
			ELEVATION	DISCHARGE	END AREA
8			0.0000	0.0000	0.0000
8			1.0000	129.5000	12.0000
8			2.0000	426.3000	28.0000
8			3.0000	908.5000	48.0000
9	ENDTBL				

			TIME INCREMENT			
4	DIMHYD					
8		0.0000	0.0300	0.1000	0.1900	0.3100
8		0.4700	0.6600	0.8200	0.9300	0.9900
8		1.0000	0.9900	0.9300	0.8600	0.7800
8		0.6800	0.5600	0.4600	0.3900	0.3300
8		0.2800	0.2410	0.2070	0.1740	0.1470
8		0.1260	0.1070	0.0910	0.0770	0.0660
8		0.0550	0.0470	0.0400	0.0340	0.0290
8		0.0250	0.0210	0.0180	0.0150	0.0130
8		0.0110	0.0090	0.0080	0.0070	0.0060
8		0.0050	0.0040	0.0030	0.0020	0.0010
8		0.0000	0.0000	0.0000	0.0000	0.0000
9	ENDTBL					

COMPUTEJ PEAK K FACTOR = 484.00

			TIME INCREMENT			
5	RAINFL 1		0.5000			
8		0.0000	0.0080	0.0170	0.0260	0.0350
8		0.0450	0.0550	0.0650	0.0760	0.0870
8		0.0990	0.1120	0.1250	0.1400	0.1560
8		0.1740	0.1940	0.2190	0.2540	0.3030
8		0.5150	0.5830	0.6240	0.6540	0.6820
8		0.7050	0.7270	0.7480	0.7670	0.7840
8		0.8000	0.8160	0.8300	0.8440	0.8570
8		0.8700	0.8820	0.8930	0.9050	0.9160
8		0.9260	0.9360	0.9460	0.9550	0.9650
8		0.9740	0.9830	0.9920	1.0000	1.0000
9	ENDTBL					

			TIME INCREMENT			
5	RAINFL 2		0.0200			
8		0.0000	0.0100	0.0200	0.0200	0.0350

8	0.0400	0.0500	0.0600	0.0700	[illegible]
8	0.1000	0.1100	0.1300	0.1400	[illegible]
8	0.1900	0.2200	0.2700	0.3500	[illegible]
8	0.5200	0.6000	0.6300	0.6600	0.6800
8	0.7000	0.7200	0.7400	0.7600	0.7700
8	0.7900	0.8000	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9800	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

TIME INCREMENT
5 RAINFL 3 0.5000

8	0.0000	0.0053	0.0108	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0483	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1089	0.1203	0.1328	0.1467	0.1625
8	0.1808	0.2047	0.2351	0.2841	0.6612
8	0.7351	0.7724	0.7999	0.8197	0.8380
8	0.8516	0.8676	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9519	0.9588	0.9653	0.9717	0.9777
8	0.9836	0.9892	0.9947	1.0000	1.0000

9 ENDTBL

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1     1            1      0.1875     70.0000     0.62000 1 0 0 0 0
6 REACH  3     2     1      2   1520.0000      0.0000     0.00000 1 0 0 0 0
6 RUNOFF 1     2            3      0.1276     75.0000     0.76000 1 0 0 0 0
6 ADDHYD 4     2     2 3    4                                   1 1 0 0 0 0
6 REACH  3     3     4      5   1120.0000      0.0000     0.09000 1 0 0 0 0
6 RUNOFF 1     4            6      0.0753     78.0000     0.61000 1 0 0 0 0
6 REACH  3     4     6      7   1475.0000      0.0000     0.09000 1 0 0 0 0
6 ADDHYD 4     4     5 7    1                                   1 1 0 0 0 0
6 REACH  3     5     1      2   2875.0000      0.0000     0.03000 1 0 0 0 0
6 RUNOFF 1     5            3      0.0903     70.0000     0.19000 1 0 0 0 0
6 RUNOFF 1     5            4      0.0173     74.0000     0.20000 1 0 0 0 0
6 ADDHYD 4     5     2 3    5                                   1 1 0 0 0 0
6 ADDHYD 4     5     4 5    6                                   1 1 0 0 0 0
  ENDATA

END OF LISTING
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SUBJECT Penelec-Conemaugh 1986 Stage II Const
BY MLL DATE 8/21/86 SHEET NO. 62 OF 62
CHKD. BY RFO DATE 3/4/86 PROJECT NO. 86-767

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EXECUTIVE   TABL CARD       OPERATION  INCREM,      MAIN TIME INC   AREA=  0.20
EXECUTE     TABL CARD       OPERATION  COMPUT,      FROM XSEC       XSEC  1/ 3     TO XSECTN/STRUCT  5/ 0
    DRYING TIME=  0.00      RAIN DEPTH=  2.70      RAIN DURAT.      1.00      RAIN TABLE NO.= 3     SOIL CONDITION= 2
  ALTERNATE NO.= 0          STORM NO.= 0
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```
SUBROUTINE RUNOFF     CROSS SECTION   1
         AREA=   0.16      INPUT RUNOFF CURVE=  76.0      TIME OF CONCENTRATION=  0.62
***** 14 PEAK - MAXI =  130
```

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.29	29.673	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.16

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	2.90
12.00	DISCHG	14.85	24.36	27.16	21.17	16.96	12.29	9.82	6.16	7.09	6.23
14.00	DISCHG	5.56	5.15	4.84	4.60	4.38	4.15	3.98	3.77	3.61	3.47
16.00	DISCHG	3.34	3.23	3.11	3.01	2.92	2.84	2.77	2.66	2.60	2.54
18.00	DISCHG	2.49	2.44	2.38	2.33	2.28	2.24	2.19	2.14	2.09	2.06
20.00	DISCHG	2.04	2.01	1.98	1.94	1.90	1.86	1.84	1.82	1.80	1.78
22.00	DISCHG	1.74	1.71	1.70	1.64	1.66	1.63	1.61	1.60	1.59	1.57
24.00	DISCHG	1.54	1.36	0.99	0.44	0.20	0.09	0.19	0.07	0.01	0.00

```
SUBROUTINE REACH      CROSS SECTION   2
         LENGTH=   1520.00      INPUT COEFFICIENT=  0.0000      INPUT ROUTINGS=  0.00

         AVERAGE WATER VELOCITY=   5.000      AVERAGE ROUTING COEFF 0.7461      NUMBER OF ROUTINGS=  0.32
***** 14 PEAK - MAXI =  130
```

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.40	27.730	0.40

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.16

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	1.46
12.00	DISCHG	10.71	23.51	27.74	23.41	17.87	11.62	10.70	8.76	7.44	6.57
14.00	DISCHG	5.80	5.30	4.95	4.69	4.45	4.24	4.04	3.85	3.67	3.52
16.00	DISCHG	3.38	3.27	3.15	3.04	2.95	2.87	2.79	2.71	2.63	2.57
18.00	DISCHG	2.51	2.46	2.41	2.35	2.30	2.25	2.20	2.15	2.11	2.07
20.00	DISCHG	2.05	2.02	1.99	1.95	1.92	1.80	1.85	1.82	1.81	1.79
22.00	DISCHG	1.75	1.72	1.70	1.69	1.67	1.64	1.62	1.60	1.59	1.58
24.00	DISCHG	1.55	1.42	1.05	0.60	0.29	0.13	0.06	0.03	0.01	0.00

```
SUBROUTINE RUNOFF     CROSS SECTION   2
         AREA=   0.13      INPUT RUNOFF CURVE=  75.0      TIME OF CONCENTRATION=  0.76
***** 14 PEAK - MAXI =  132
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PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.38	31.364	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.13

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PROJECT Fowler - Cavanaugh 1986 Stage II Cross
BY MLA DATE 3/10/86 SHEET NO. 65A OF 192
CHKD BY RFD DATE 3/24/86 PROJECT NO. 86-167

2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.61	5.09
12.00	DISCHG	16.14	28.61	31.61	26.60	20.19	15.49	12.06	5.11	6.13	6.96
14.00	DISCHG	6.15	5.52	5.06	4.74	4.48	4.24	4.03	3.82	3.69	3.48
16.00	DISCHG	3.34	3.21	3.09	2.96	2.87	2.80	2.72	2.63	2.56	2.49
18.00	DISCHG	2.43	2.38	2.33	2.27	2.22	2.17	2.12	2.07	2.03	1.99
20.00	DISCHG	1.96	1.94	1.91	1.87	1.83	1.80	1.77	1.74	1.73	1.70
22.00	DISCHG	1.67	1.64	1.62	1.60	1.59	1.56	1.54	1.52	1.51	1.49
24.00	DISCHG	1.47	1.35	1.02	0.63	0.34	0.18	0.10	0.05	0.03	0.01
26.00	DISCHG	0.01	0.00								

SUBROUTINE ADDHYD CROSS SECTION 3
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
ARROW IN PEAK = MAXI = 132

PEAK TIMES 12.39 PEAK DISCHARGES 59.560 PEAK ELEVATIONS 0.99

HYDROGRAPH, TZEROM 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.29

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.69	7.05
12.00	DISCHG	26.91	55.14	59.55	50.06	38.05	29.07	22.76	18.46	15.57	13.50
14.00	DISCHG	11.95	10.82	10.04	9.41	8.94	8.48	8.07	7.67	7.31	7.00
16.00	DISCHG	6.72	6.48	6.25	6.03	5.84	5.67	5.52	5.36	5.19	5.06
18.00	DISCHG	4.94	4.84	4.73	4.62	4.52	4.42	4.33	4.23	4.14	4.06
20.00	DISCHG	4.01	3.96	3.90	3.83	3.75	3.67	3.61	3.57	3.54	3.49
22.00	DISCHG	3.42	3.37	3.32	3.29	3.25	3.20	3.16	3.12	3.10	3.07
24.00	DISCHG	3.02	2.77	2.08	1.23	0.63	0.31	0.16	0.08	0.04	0.01
26.00	DISCHG	0.01	0.00								

SUBROUTINE REACH CROSS SECTION 3
LENGTH 1720.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 12.190 AVERAGE ROUTING COEFF= 0.8650 NUMBER OF ROUTINGS= 0.16
ARROW IN PEAK = MAXI = 132

PEAK TIMES 12.42 PEAK DISCHARGES 58.430 PEAK ELEVATIONS 1.34

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.29

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	6.93
12.00	DISCHG	23.72	48.09	58.36	51.53	39.97	30.51	23.77	19.15	16.03	13.83
14.00	DISCHG	12.20	11.00	10.14	9.52	9.02	8.53	8.13	7.73	7.35	7.05
16.00	DISCHG	6.77	6.52	6.20	6.06	5.87	5.70	5.54	5.38	5.22	5.08
18.00	DISCHG	4.96	4.86	4.75	4.64	4.54	4.44	4.34	4.24	4.15	4.08
20.00	DISCHG	4.02	3.97	3.91	3.83	3.76	3.64	3.62	3.57	3.54	3.50
22.00	DISCHG	3.43	3.37	3.33	3.30	3.26	3.21	3.17	3.13	3.10	3.07
24.00	DISCHG	3.03	2.61	2.19	1.34	0.72	0.34	0.18	0.09	0.04	0.02
26.00	DISCHG	0.01	0.00								

BY MLB DATE 3/10/86 JOB NO. 694.102
CHKD. BY KRD DATE 3/12/86 PROJECT NO. 86-167

SUBJECT PENELEC-CONEMAUGH 1986 STAGE II CONST.
BY MLA DATE 3/10/86 15A-10-12
CHKD RFD DATE 3/20/86 EL-167

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.08 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION 0.61
***** IN PEAK - MAXI = 129

PEAK TIMES 12.25 PEAK DISCHARGES 29.101 PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.08

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.07	0.22	0.50	1.33	6.61
12.00	DISCHG	18.13	26.61	23.64	16.81	12.01	8.87	6.90	5.62	4.76	4.16
14.00	DISCHG	3.70	3.41	3.19	3.02	2.81	2.71	2.54	2.45	2.39	2.24
16.00	DISCHG	2.15	2.08	1.99	1.92	1.87	1.81	1.76	1.70	1.65	1.61
18.00	DISCHG	1.57	1.54	1.50	1.47	1.44	1.40	1.37	1.34	1.31	1.29
20.00	DISCHG	1.27	1.26	1.23	1.21	1.18	1.16	1.14	1.13	1.12	1.10
22.00	DISCHG	1.58	1.06	1.05	1.04	1.02	1.01	0.99	0.98	0.97	0.96
24.00	DISCHG	0.95	0.83	0.54	0.26	0.12	0.05	0.02	0.01	0.00	

SUBROUTINE REACH CROSS SECTION 4
LENGTH= 1475.00 INPUT COEFFICIENT 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 1.274 AVERAGE ROUTING COEFF= 0.6583 NUMBER OF ROUTINGS= 0.41
***** IN PEAK - MAXI = 129

PEAK TIMES 12.37 PEAK DISCHARGES 24.642 PEAK ELEVATIONS 0.03

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.08

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03
2.00	DISCHG	0.00	0.00	0.00	0.00	0.50	0.00	0.09	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.04	0.14	0.16	0.91	4.12
12.00	DISCHG	12.48	22.05	24.59	20.23	14.79	10.75	8.08	6.32	5.27	4.57
14.00	DISCHG	3.97	3.58	3.32	3.12	2.96	2.80	2.66	2.52	2.40	2.29
16.00	DISCHG	2.20	2.12	2.04	1.96	1.90	1.84	1.79	1.73	1.68	1.63
18.00	DISCHG	1.60	1.56	1.52	1.49	1.45	1.42	1.39	1.36	1.33	1.30
20.00	DISCHG	1.28	1.27	1.25	1.22	1.20	1.17	1.15	1.14	1.12	1.11
22.00	DISCHG	1.09	1.07	1.05	1.04	1.03	1.02	1.00	0.99	0.56	0.97
24.00	DISCHG	0.96	0.89	0.66	0.41	0.21	0.10	0.04	0.02	0.00	

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 6,7 OUTPUT HYDROGRAPH= 1
***** IN PEAK - MAXI = 112

PEAK TIMES 12.41 PEAK DISCHARGES 82.941 PEAK ELEVATIONS 1.46

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.37

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.05	0.14	0.40	1.50	10.35
12.00	DISCHG	46.20	70.33	62.95	31.77	54.76	41.76	31.86	25.54	21.30	16.35

SUBJECT
BY MLA DATE [illegible] SHEET NO. [illegible] OF [illegible]
CHKD. BY MED DATE [illegible] PROJECT NO. [illegible]

14.00	DISCHG	10.16	14.56	13.46	12.44	11.1	11.45	10.79	10.25	9.76	9.34
16.00	DISCHG	8.95	8.64	8.32	8.03		7.54	7.33	7.11	6.90	6.73
18.00	DISCHG	6.56	6.42	6.27	6.13		5.86	5.73	5.60	5.48	5.36
20.00	DISCHG	5.30	5.23	5.15	5.00		4.86	4.33	4.71	4.66	4.61
22.00	DISCHG	4.52	4.44	4.39	4.34	4.29	4.24	4.17	4.12	4.08	4.04
24.00	DISCHG	3.94	3.39	2.67	1.70	0.93	0.46	0.22	0.11	0.04	0.02
26.00	DISCHG	0.01	0.06								

SUBROUTINE REACH CROSS SECTION 5
LENGTH= 2675.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 10.358 AVERAGE ROUTING COEFF= 0.4540 NUMBER OF ROUTINGS= 0.33
ERROR IN PEAK = MAXI = 117

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.47	80.039	0.64

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.37

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.31	1.13	7.72
12.00	DISCHG	21.37	58.57	78.50	75.50	60.54	45.88	35.09	23.70	22.76	19.36
14.00	DISCHG	16.91	15.37	14.64	12.92	12.20	11.56	10.98	10.44	9.93	9.49
16.00	DISCHG	9.09	8.75	8.43	8.13	7.86	7.62	7.40	7.19	6.97	6.78
18.00	DISCHG	6.61	6.47	6.32	6.18	6.06	5.90	5.77	5.64	5.52	5.41
20.00	DISCHG	5.33	5.26	5.18	5.09	5.00	4.89	4.80	4.73	4.66	4.63
22.00	DISCHG	4.55	4.47	4.41	4.36	4.31	4.25	4.19	4.13	4.09	4.05
24.00	DISCHG	4.00	3.60	3.35	2.15	1.22	0.62	0.30	0.15	0.07	0.03
26.00	DISCHG	0.01	0.00								

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.09 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.18
ERROR IN PEAK = MAXI = 124

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.40	28.515	(RUNOFF)
16.30	1.549	(RUNOFF)
17.90	1.361	(RUNOFF)
19.91	1.126	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.09

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.27	19.11
12.00	DISCHG	28.57	12.80	8.74	7.00	4.66	4.57	3.50	3.39	3.17	2.75
14.00	DISCHG	2.74	2.50	2.41	2.37	2.16	2.14	1.97	1.93	1.88	1.78
16.00	DISCHG	1.78	1.65	1.61	1.60	1.53	1.54	1.47	1.41	1.39	1.35
18.00	DISCHG	1.35	1.29	1.27	1.29	1.21	1.21	1.15	1.64	1.13	1.12
20.00	DISCHG	1.12	1.07	1.07	1.05	1.05	1.01	1.00	1.05	0.98	0.94
22.00	DISCHG	0.94	0.93	0.53	0.12	0.89	0.89	0.88	0.58	0.87	0.06
24.00	DISCHG	0.85	0.17	0.00	0.00						

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.01 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.20
ERROR IN PEAK = MAXI = 123

SUBJECT ______ BY MLA DATE 3/10/86 ... 86-147
CHKD BY RED DATE 3/24/86

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.98	6.744	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.40	0.05
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.04	0.11	0.38	0.91	4.39
12.00	DISCHG	6.92	3.16	1.74	1.46	0.95	0.92	0.73	0.67	0.63	0.54
14.00	DISCHG	0.53	0.49	0.44	0.46	0.42	0.42	0.38	0.37	0.36	0.34
16.00	DISCHG	0.34	0.33	0.31	0.30	0.29	0.29	0.27	0.26	0.26	0.25
18.00	DISCHG	0.25	0.24	0.24	0.24	0.22	0.22	0.21	0.21	0.21	0.21
20.00	DISCHG	0.21	0.20	0.20	0.19	0.10	0.16	0.18	0.18	0.18	0.17
22.00	DISCHG	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.15
24.00	DISCHG	0.15	0.09	0.00							

SUBROUTINE ADDHYD CROSS SECTION 5
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 5
IN PEAK - HAAI = 177

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.46	67.549	0.70

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.45

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.30	0.00	0.00	0.00	0.00	0.03	0.11	0.31	1.25	19.33
12.00	DISCHG	55.84	71.36	66.19	62.56	65.21	50.45	32.66	31.04	25.93	22.11
14.00	DISCHG	19.65	17.63	16.31	15.29	14.38	13.14	12.96	12.37	11.81	11.26
16.00	DISCHG	10.07	10.00	10.36	9.17	9.39	9.55	8.83	8.60	8.36	8.11
18.00	DISCHG	7.92	7.75	7.60	7.43	7.25	7.11	6.93	6.79	6.65	6.51
20.00	DISCHG	6.45	6.33	6.29	6.15	6.05	5.91	5.80	5.73	5.66	5.57
22.00	DISCHG	5.49	5.40	5.34	5.27	5.20	5.14	5.07	5.01	4.96	4.90
24.00	DISCHG	4.85	3.97	3.16	2.15	1.22	0.62	0.30	0.15	0.07	0.03
26.00	DISCHG	0.01	0.00								

SUBROUTINE ADDHYD CROSS SECTION 6
INPUT HYDROGRAPHS= 4,5 OUTPUT HYDROGRAPH= 6
IN PEAK = HAAI = 132

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.45	69.145	0.72

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.47

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
8.00	DISCHG	0.00	0.00	0.00	0.01	0.06	0.00	0.00	0.00	0.00	0.06
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.07	0.22	0.49	2.26	23.03
12.00	DISCHG	62.71	74.52	66.57	63.98	60.17	53.36	39.14	31.75	26.56	22.65
14.00	DISCHG	20.19	18.12	16.16	15.75	14.80	14.16	14.33	12.74	12.17	11.60
16.00	DISCHG	11.21	10.71	10.36	10.02	9.67	9.43	9.10	8.88	8.62	8.38
18.00	DISCHG	8.22	7.99	7.83	7.65	7.47	7.34	7.19	7.08	6.86	6.70
20.00	DISCHG	6.65	6.53	6.44	6.33	6.19	6.09	5.98	5.91	5.84	5.74
22.00	DISCHG	5.63	5.57	5.51	5.44	5.36	5.30	5.22	5.17	5.12	5.06

BY MLA	DATE 3/10/86		LBL 102
CHKD BY RFD	DATE 3/27/86		86-107

EXECUTE FROM CARD   OPERATION COMPUT,   FROM XSECT   TO   TO ASECT/STRUCT 57 0
STARTING TIMES 0.00   RAIN DEPTH= 0.00   RAIN DURAT 1.00   RAIN TABLE NO.= 3   SOIL CONDITION= 2
ALTERNATE NO.= 0   STORM NO.= 0

SUBROUTINE RUNOFF   CROSS SECTION 1
AREA= 0.10   INPUT RUNOFF CURVE= 70.0   TIME OF CONCENTRATION= 0.67
IN PEAK + HALF = 140

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.25	63.827	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.16

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.12	0.49	1.26	4.02	19.76
12.00	DISCHG	55.47	62.72	73.58	52.76	48.38	26.09	21.85	17.79	15.09	13.18
14.00	DISCHG	11.88	10.76	10.36	9.55	9.05	8.55	8.15	7.72	7.36	7.06
16.00	DISCHG	5.77	6.54	6.28	6.07	5.88	5.71	5.55	5.37	5.21	5.08
18.00	DISCHG	4.56	4.66	4.74	4.63	4.53	4.42	4.33	4.22	4.13	4.07
20.00	DISCHG	4.01	3.96	3.89	3.81	3.74	3.65	3.60	3.56	3.53	3.47
22.00	DISCHG	3.40	3.34	3.31	3.20	3.21	3.17	3.13	3.30	3.08	3.04
24.00	DISCHG	2.99	2.64	1.72	0.65	0.39	0.18	0.08	0.04	0.01	0.00

SUBROUTINE REACH   CROSS SECTION 2
LENGTH= 1520.00   INPUT COEFFICIENT= 0.0000   INPUT ALLOWANCE= 0.00

AVERAGE WATER VELOCITY= 6.290   AVERAGE ROUTING COEFF= 0.7588   NUMBER OF ROUTINGS= 0.30
IN PEAK + HALF = 140

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.33	77.539	1.17

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.15

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.01	0.08	0.37	1.62	3.13	10.60
12.00	DISCHG	93.88	73.65	78.27	57.45	42.91	31.50	25.05	19.25	15.99	13.82
14.00	DISCHG	12.18	11.07	10.29	9.71	9.21	8.72	8.29	7.86	7.48	7.16
16.00	DISCHG	6.87	6.61	6.37	6.14	5.91	5.70	5.60	5.43	5.20	5.12
18.00	DISCHG	5.00	4.90	4.75	4.67	4.58	4.46	4.36	4.25	4.16	4.09
20.00	DISCHG	4.01	3.98	3.91	3.84	3.76	3.64	3.64	3.57	3.54	3.49
22.00	DISCHG	3.42	3.36	3.12	3.25	3.25	3.17	3.15	3.11	3.08	3.05
24.00	DISCHG	3.31	2.15	2.07	1.14	0.55	0.25	0.11	0.05	0.02	0.00

SUBROUTINE RUNOFF   CROSS SECTION 2
AREA= 0.13   INPUT RUNOFF CURVE= 75.0   TIME OF CONCENTRATION= 0.76
IN PEAK + HALF = 112

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.33	74.865	(RUNOFF)

HYDROGRAPH, TZERO= 0.00   DELTA T= 0.20   DRAINAGE AREA= 0.13

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SUBJECT
BY MGA   DATE 7/19/86   SHEET NO. 63B OF 102
CHKD BY RFD   DATE 7/24/86   PROJECT NO. 86-167

SUBJECT
BY MLA DATE 3/10/86 SHEET NO. [illegible] OF 702
CHKD. BY [illegible] DATE 3/20/86 JOB NO. 86-167

4.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.01
10.00	DISCHG	0.04	0.14	0.32	0.56	0.[illegible]	1.47	2.00	3.06	5.72	14.94
12.00	DISCHG	45.87	76.19	73.53	54.09	43.42	32.33	24.12	14.54	16.12	13.66
14.00	DISCHG	11.99	10.62	9.67	9.64	8.52	8.04	7.82	7.21	6.86	6.54
16.00	DISCHG	6.26	6.02	5.79	5.56	5.39	5.22	5.07	4.90	4.75	4.62
18.00	DISCHG	4.51	4.41	4.30	4.20	4.10	4.00	3.91	3.81	3.73	3.66
20.00	DISCHG	3.60	3.55	3.49	3.43	3.36	3.29	3.23	3.10	3.15	3.10
22.00	DISCHG	3.04	2.99	2.95	2.92	2.88	2.85	2.79	2.76	2.73	2.70
24.00	DISCHG	2.68	2.00	1.60	1.14	0.61	0.32	0.17	0.09	0.05	0.02
26.00	DISCHG	0.01	0.00								

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
***** IN PEAK = MAXI = 132

PEAK TIMES 12.33 PEAK DISCHARGES 152.402 PEAK ELEVATIONS 1.94

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.29

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
10.00	DISCHG	0.04	0.14	0.32	0.56	0.94	1.50	2.43	4.98	8.65	33.66
12.00	DISCHG	89.73	144.89	150.17	118.58	86.54	63.81	48.67	38.69	32.12	27.50
14.00	DISCHG	24.13	21.89	19.96	18.75	17.73	16.76	15.93	15.07	14.33	13.70
16.00	DISCHG	13.13	12.64	12.15	11.72	11.33	10.96	10.67	10.34	10.06	9.74
18.00	DISCHG	9.51	9.30	9.05	8.81	8.60	8.45	8.27	8.07	7.89	7.74
20.00	DISCHG	7.63	7.53	7.43	7.26	7.12	6.91	6.84	6.75	6.69	6.59
22.00	DISCHG	6.46	6.35	6.27	6.23	6.13	6.03	5.94	5.81	5.92	5.76
24.00	DISCHG	5.67	5.20	3.88	2.20	1.16	0.57	0.29	0.14	0.07	0.02
26.00	DISCHG	0.01	0.00								

SUBROUTINE REACH CROSS SECTION 3
LENGTH= 1720.00 INPUT COEFFICIENT= 0.3000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 15.496 AVERAGE ROUTING COEFF= 0.9011 NUMBER OF ROUTINGS= 0.10
***** IN PEAK = MAXI = 132

PEAK TIMES 12.36 PEAK DISCHARGES 149.953 PEAK ELEVATIONS 9.11

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.29

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	DISCHG	0.03	0.12	0.24	0.54	0.89	1.42	2.30	3.85	8.18	30.21
12.00	DISCHG	81.94	137.10	149.37	122.96	90.84	66.95	50.77	40.08	33.03	28.14
14.00	DISCHG	24.60	22.03	20.22	18.52	17.87	16.69	16.02	15.19	14.44	13.79
16.00	DISCHG	13.21	12.71	12.22	11.78	11.38	11.03	10.71	10.38	10.06	9.78
18.00	DISCHG	9.54	9.33	9.11	8.90	8.69	8.48	8.29	8.10	7.91	7.76
20.00	DISCHG	7.65	7.55	7.42	7.28	7.18	6.99	6.86	6.76	6.70	6.61
22.00	DISCHG	6.48	6.37	6.26	6.21	6.14	6.04	5.95	5.00	5.83	5.77
24.00	DISCHG	5.68	5.26	4.04	2.50	1.31	0.65	0.33	0.16	0.08	0.03
26.00	DISCHG	0.01	0.00								

SUBJECT ___ BY MLA DATE 3/10/86 SHEET NO. 45 B OF 102
CHKD. BY RBe DATE 3/10/86 PROJECT NO. 86-147

SUBROUTI... RUNOFF CROSS SECTION 4
AREA= 0.08 INPUT RUNOFF CURVE= 74.0 TIME OF ... CONCENTRATION= 0.61
... PEAK = PAAI = 130

PEAK TIMES 12.22 | PEAK DISCHARGES 56.598 | PEAK ELEVATIONS (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.08

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.17	0.79
10.00	DISCHG	0.12	0.58	0.74	1.34	1.37	1.78	2.14	1.25	5.34	19.25
12.00	DISCHG	41.98	58.47	49.21	33.92	21.17	27.12	13.13	10.54	8.85	7.48
14.00	DISCHG	6.79	6.25	5.62	5.51	5.22	4.92	4.09	4.62	4.21	4.03
16.00	DISCHG	3.48	3.13	3.57	3.35	1.36	3.24	3.14	3.09	2.44	2.47
18.00	DISCHG	2.80	2.74	2.87	2.51	2.55	2.40	2.43	2.37	2.32	2.26
20.00	DISCHG	2.25	2.22	2.10	2.13	2.09	2.04	2.01	1.98	1.97	1.95
22.00	DISCHG	1.89	1.85	1.64	1.02	1.79	1.76	1.74	1.72	1.70	1.69
24.00	DISCHG	1.65	1.45	0.94	0.46	0.21	0.09	0.04	0.02	0.01	0.00

SUBROUTINE REACH CROSS SECTION 4
LENGTH= 1475.00 INPUT COEFFICIENT= 0.0009 INPUT ROUTINGSA 0.00

AVERAGE WATER VELOCITY= 3.540 AVERAGE ROUTING COEFF= 0.6356 NUMBER OF ROUTINGS= 0.39
... IN PEAK - PAAI = 130

PEAK TIMES 12.33 | PEAK DISCHARGES 53.451 | PEAK ELEVATIONS 1.15

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.08

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.14	0.23
10.00	DISCHG	0.35	0.50	0.69	0.92	1.21	1.54	2.07	2.82	4.46	12.94
12.00	DISCHG	32.16	50.73	52.62	41.18	27.09	20.65	15.28	11.42	9.75	6.30
14.00	DISCHG	7.25	5.54	6.08	5.61	5.36	5.07	4.80	4.55	4.32	4.12
16.00	DISCHG	3.95	3.80	3.65	3.51	3.39	3.29	3.14	3.09	2.99	2.91
18.00	DISCHG	2.84	2.77	2.71	2.64	2.56	2.51	2.46	2.40	2.34	2.30
20.00	DISCHG	2.25	2.22	2.19	2.15	2.11	2.06	2.02	2.00	1.97	1.95
22.00	DISCHG	1.91	1.88	1.85	1.83	1.81	1.78	1.75	1.73	1.71	1.70
24.00	DISCHG	1.67	1.54	1.14	0.70	0.14	0.10	0.07	0.03	0.01	0.00

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 5,7 OUTPUT HYDROGRAPH= 1
... IN PEAK = PAAI = 132

PEAK TIMES 12.35 | PEAK DISCHARGES 203.290 | PEAK ELEVATIONS 2.95

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.37

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.13	0.73
10.00	DISCHG	0.35	0.62	0.44	1.40	2.10	3.00	4.37	6.67	12.65	43.16
12.00	DISCHG	114.37	197.91	201.74	164.14	119.95	47.01	60.05	52.03	42.70	36.44
14.00	DISCHG	31.45	27.37	26.27	24.69	24.21	21.95	20.83	19.74	18.76	17.91

SUBJECT ______
BY MLL DATE 3/10/86 SHEET NO. 66B OF 102
CHKD. BY [illegible] DATE 3/[illegible]/86 PROJECT NO. 85-147

16.00	DISCHG	15.18	16.51	15.67	15.29	14.2?	14.42	13.90	13.47	13.05	12.49
18.00	DISCHG	12.38	12.30	11.82	11.55	[illegible]	11.40	10.75	10.19	10.24	10.00
20.00	DISCHG	9.91	9.78	9.62	9.44	[illegible]	9.05	8.88	8.78	8.67	8.55
22.00	DISCHG	8.34	8.24	8.13	8.04	[illegible]	7.82	7.70	7.61	7.54	7.46
24.00	DISCHG	1.35	6.80	5.74	3.24	3.66	0.81	0.40	0.19	0.09	0.03
26.00	DISCHG	0.01	0.00								

SUBROUTINE REACH CROSS SECTION 5
LENGTH 2475.00 INPUT COEFFICIENTS 0.0000 INPUT ROUGHNESS= 0.00
AVERAGE WATER VELOCITY= 15.422 AVERAGE ROUTING COEFF= 0.6704 NUMBER OF ROUTINGS= 0.40
NOTE IN PEAK - MAXI = 129

PEAK TIMES 12.42 PEAK DISCHARGES 197.727 PEAK ELEVATIONS 1.24

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.37

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.11	0.26
10.00	DISCHG	0.34	0.55	0.67	1.33	1.90	7.12	3.45	5.46	10.80	33.74
12.00	DISCHG	92.15	165.43	197.51	175.78	133.64	97.60	72.75	56.37	45.65	38.41
14.00	DISCHG	33.28	29.59	26.96	25.11	21.66	22.30	21.18	20.08	19.46	18.18
16.00	DISCHG	17.39	16.71	16.63	15.47	14.94	14.46	14.03	11.61	13.18	12.80
18.00	DISCHG	12.47	12.19	11.58	11.62	11.15	11.08	10.83	10.57	10.31	10.19
20.00	DISCHG	9.96	9.82	9.61	9.49	9.11	9.11	8.93	8.80	8.70	8.59
22.00	DISCHG	8.44	8.29	8.18	8.07	7.98	7.86	7.74	7.60	7.56	7.49
24.00	DISCHG	7.38	6.97	5.72	3.80	2.14	1.08	0.53	0.26	0.12	0.05
26.00	DISCHG	0.02	0.00								

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.09 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.18
NOTE IN PEAK - MAXI = 124

PEAK TIMES 11.98 19.90 PEAK DISCHARGES 74.470 7.710 PEAK ELEVATIONS (RUNOFF) (RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.09

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00
10.00	DISCHG	0.00	0.00	0.00	0.00	0.09	0.32	1.03	3.78	33.55	47.54
12.00	DISCHG	73.94	30.04	16.49	15.29	10.07	9.76	7.59	1.13	6.65	5.34
14.00	DISCHG	5.10	5.18	5.09	4.80	4.47	4.45	4.02	3.93	3.62	3.60
16.00	DISCHG	3.59	3.33	3.29	3.21	3.07	3.07	2.66	2.82	2.78	2.69
18.00	DISCHG	2.69	2.56	2.53	2.48	2.40	2.49	2.28	2.25	2.24	2.20
20.00	DISCHG	2.20	2.11	2.04	2.05	1.90	1.94	1.96	1.95	1.92	1.84
22.00	DISCHG	1.84	1.82	1.81	1.79	1.73	1.71	1.70	1.70	1.64	1.65
24.00	DISCHG	1.49	0.33	0.02	0.00						

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.01 INPUT RUNOFF CURVE= 75.0 TIME OF CONCENTRATION= 0.20
NOTE IN PEAK - MAXI = 124

PEAK TIMES 11.96 PEAK DISCHARGES 10.307 PEAK ELEVATIONS (RUNOFF)

SUBJECT
BY MCA DATE 3/10/86 SHEET NO. 47a OF 102
CHKD BY RED DATE 3/20/86 PROJECT NO. 86-147

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.01		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.06	0.08
10.00	DISCHG	0.10	0.15	0.19	0.25	0.33	0.60	0.64	0.83	2.92	10.38
12.00	DISCHG	14.12	6.21	3.42	2.79	1.80	1.70	1.34	1.23	1.16	0.99
14.00	DISCHG	0.97	0.84	0.83	0.83	0.76	0.75	0.68	0.65	0.65	0.61
16.00	DISCHG	0.60	0.56	0.55	0.54	0.51	0.51	0.49	0.47	0.46	0.45
18.00	DISCHG	0.45	0.42	0.42	0.41	0.40	0.39	0.38	0.37	0.37	0.36
20.00	DISCHG	0.36	0.35	0.34	0.34	0.33	0.32	0.32	0.32	0.31	0.30
22.00	DISCHG	0.30	0.30	0.30	0.29	0.29	0.28	0.28	0.28	0.27	0.27
24.00	DISCHG	0.21	0.07	0.01	0.00						

SUBROUTINE ADDHYD CROSS SECTION 5
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 5
***** IN PEAK = MAXI = 132

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.39	215.996	1.30

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.46		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.33	0.20
10.00	DISCHG	0.34	0.55	0.87	1.38	1.95	3.06	4.97	7.74	21.35	61.70
12.00	DISCHG	165.17	195.06	216.00	191.07	143.71	107.42	80.35	63.49	52.30	44.15
14.00	DISCHG	38.96	34.77	33.87	29.99	25.13	26.81	25.20	24.01	22.78	21.78
16.00	DISCHG	20.99	20.04	19.35	18.65	18.01	17.53	16.90	16.43	15.96	15.49
18.00	DISCHG	15.16	14.75	14.93	14.10	13.74	13.47	13.30	12.83	12.57	12.32
20.00	DISCHG	12.16	11.93	11.76	11.54	11.25	11.09	10.89	10.75	10.61	10.43
22.00	DISCHG	10.23	10.10	9.98	9.80	9.71	9.59	9.44	9.34	9.24	9.13
24.00	DISCHG	9.02	7.30	5.74	3.83	2.14	1.06	0.53	0.26	0.12	0.05
26.00	DISCHG	0.02	0.00								

SUBROUTINE ADDHYD CROSS SECTION 5
INPUT HYDROGRAPHS= 4,5 OUTPUT HYDROGRAPH= 6
***** IN PEAK = MAXI = 137

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.38	219.519	1.14

TIME		HYDROGRAPH, TZERO= 0.00				DELTA T= 0.20			DRAINAGE AREA= 0.47		
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.17	0.28
10.00	DISCHG	0.44	0.70	1.06	1.50	2.29	3.41	5.02	8.54	24.27	91.66
12.00	DISCHG	180.24	201.21	219.42	193.85	145.55	109.14	81.69	64.15	51.45	45.19
14.00	DISCHG	39.95	35.66	32.93	30.09	28.48	27.56	25.88	24.67	23.53	22.38
16.00	DISCHG	21.59	20.60	19.89	19.21	18.52	18.04	17.38	16.90	16.42	15.59
18.00	DISCHG	15.61	15.11	14.65	14.52	14.14	13.67	13.48	13.70	12.93	12.69
20.00	DISCHG	12.52	12.28	12.10	11.88	11.61	11.44	11.21	11.09	10.94	10.73
22.00	DISCHG	10.58	10.40	10.27	10.15	9.99	9.87	9.72	9.67	9.52	9.40
24.00	DISCHG	9.29	7.11	5.75	3.83	2.14	1.06	0.53	0.26	0.12	0.05
26.00	DISCHG	0.02	0.00								

SUBJECT Panelec - Conemaugh 1986 Stage II Const
BY MLL DATE 2/21/86 SHEET NO. 636 OF 702
CHKD. BY BEP DATE 3/4/86 PROJECT NO. 86-467

PASS= 1

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EX  CONTROL CARD       OPERATION  INCREM,     RAIN      INCREMENT= 0.20
EX  CONTROL CARD       OPERATION  COMPUT,     FROM      IN/STRUCT   1/ 0     TO XSECTN/STRUCT   5/ 0
    STARTING TIME=  0.00   RAIN DEPTH=  5.50   RAIN DURATION=  1.00   RAIN TABLE NO.= 1   SOIL CONDITION= 2
    ALTERNATE NO.= 0       STORM NO.= 0
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SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.16 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.62
***** IN PEAK = MAXI = 131

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.23	160.076	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.16

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.19
10.00	DISCHG	0.46	0.83	1.34	1.96	2.79	3.85	5.37	7.60	14.22	46.64
12.00	DISCHG	516.09	159.16	136.11	91.93	67.10	48.67	37.31	30.05	25.27	21.94
14.00	DISCHG	19.37	17.78	16.59	15.68	14.86	14.02	13.35	12.61	12.01	11.50
16.00	DISCHG	11.02	10.63	10.21	9.84	9.53	9.24	8.59	8.68	8.41	8.20
18.00	DISCHG	8.00	7.84	7.63	7.45	7.28	7.10	6.95	6.77	6.62	6.52
20.00	DISCHG	6.43	6.35	6.27	6.10	5.97	5.84	5.74	5.68	5.63	5.53
22.00	DISCHG	5.41	5.33	5.27	5.22	5.14	5.05	4.98	4.93	4.89	4.81
24.00	DISCHG	4.75	4.19	2.74	1.35	0.62	0.28	0.13	0.05	0.02	0.01
26.00	DISCHG	0.00									

SUBROUTINE REACH CROSS SECTION 2
LENGTH= 1520.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 6.507 AVERAGE ROUTING COEFF= 0.7929 NUMBER OF ROUTINGS= 0.26
***** IN PEAK = MAXI = 131

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.28	152.080	1.61

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.16

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.16
10.00	DISCHG	0.39	0.73	1.20	1.79	2.57	3.57	4.93	6.99	12.46	39.51
12.00	DISCHG	98.14	147.73	142.15	105.89	74.57	53.61	40.36	32.00	26.56	22.44
14.00	DISCHG	20.06	18.20	16.91	15.95	15.08	14.25	13.53	12.81	12.17	11.64
16.00	DISCHG	11.15	10.71	10.32	9.94	9.61	9.32	9.05	8.76	8.48	8.25
18.00	DISCHG	8.06	7.88	7.69	7.50	7.31	7.15	6.94	6.82	6.66	6.54
20.00	DISCHG	6.45	6.37	6.25	6.13	6.01	5.87	5.77	5.70	5.64	5.56
22.00	DISCHG	5.45	5.35	5.28	5.23	5.16	5.07	5.00	4.94	4.90	4.85
24.00	DISCHG	4.77	4.34	3.12	1.12	0.82	0.47	0.17	0.08	0.03	0.01
26.00	DISCHG	0.00									

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.13 INPUT RUNOFF CURVE= 75.5 TIME OF CONCENTRATION= 0.76
***** IN PEAK = MAXI = 133

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.30	131.500	(RUNOFF)

SUBJECT Penelec-Conemaugh 1986 Stage II Const
BY MLA DATE 2/21/86 SHEET NO. 446 OF 482
CHKD. BY RFO DATE 3/4/86 PROJECT NO. 86-167

TIME		HYDROGRAPH, TZERO=	0.00			DELTA T= 0.20			DRAINAGE AREA=	0.13	
[illegible]	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
[illegible]	DISCHG	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.03	0.10	0.23	0.39	0.63	0.84	1.11	1.41
10.00	DISCHG	1.77	2.20	2.74	3.40	4.22	5.27	6.64	8.77	14.10	39.30
12.00	DISCHG	86.99	128.00	128.71	100.89	72.96	53.67	40.56	31.19	25.94	21.85
14.00	DISCHG	10.99	16.81	15.29	14.23	13.39	12.61	11.94	11.29	10.72	10.25
16.00	DISCHG	9.77	9.39	9.01	8.67	8.37	8.11	7.86	7.61	7.37	7.16
18.00	DISCHG	6.94	6.82	6.65	6.46	6.33	6.17	6.03	5.88	5.75	5.63
20.00	DISCHG	5.58	5.47	5.37	5.27	5.16	5.05	4.95	4.89	4.83	4.76
22.00	DISCHG	4.67	4.59	4.52	4.47	4.42	4.34	4.28	4.27	4.18	4.14
24.00	DISCHG	4.07	3.73	2.84	1.74	0.90	0.49	0.26	0.14	0.07	0.04
26.00	DISCHG	0.02	0.01	0.00							

SUBROUTINE ADDHYD CROSS SECTION 2
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 4
IN PEAK = MAXI = 133

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.29	295.287	2.34

TIME		HYDROGRAPH, TZERO=	0.00			DELTA T= 0.20			DRAINAGE AREA=	0.29	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.03	0.10	0.23	0.39	0.60	0.64	1.14	1.57
10.00	DISCHG	2.16	2.92	3.94	5.19	6.80	8.84	11.57	15.71	26.56	78.81
12.00	DISCHG	185.13	275.73	230.86	206.78	147.54	107.98	80.87	63.76	52.50	44.71
14.00	DISCHG	39.05	35.01	32.19	30.14	28.96	26.86	25.46	24.10	22.89	21.85
16.00	DISCHG	20.92	20.12	19.33	18.67	17.49	17.42	16.92	16.37	15.85	15.41
18.00	DISCHG	15.03	14.70	14.33	13.99	13.65	13.32	13.02	12.70	12.41	12.18
20.00	DISCHG	12.00	11.84	11.62	11.40	11.17	10.92	10.72	10.58	10.48	10.32
22.00	DISCHG	10.11	9.93	9.80	9.70	9.58	9.42	9.29	9.17	9.06	8.98
24.00	DISCHG	8.84	8.07	5.96	3.46	1.75	0.87	0.43	0.21	0.10	0.05
26.00	DISCHG	0.02	0.01	0.00							

SUBROUTINE REACH CROSS SECTION 3
LENGTH= 1720.00 INPUT COEFFICIENT= 0.0660 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 10.036 AVERAGE ROUTING COEFF= 0.9130 NUMBER OF ROUTINGS= 0.12
IN PEAK = MAXI = 133

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.32	276.137	7.64

TIME		HYDROGRAPH, TZERO=	0.00			DELTA T= 0.20			DRAINAGE AREA=	0.29	
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.03	0.09	0.21	0.37	0.57	0.81	1.10	1.52
10.00	DISCHG	2.09	2.83	3.62	5.04	6.60	8.60	11.24	15.21	25.24	72.88
12.00	DISCHG	192.26	264.16	271.45	214.54	154.75	117.15	86.03	65.38	53.56	45.65
14.00	DISCHG	39.73	35.50	32.54	30.41	28.67	27.05	25.63	24.26	23.03	21.98
16.00	DISCHG	21.04	20.22	19.43	18.70	18.06	17.49	16.98	16.43	15.93	15.46
18.00	DISCHG	15.08	14.74	14.39	14.03	13.69	13.36	13.05	12.74	12.45	12.21
20.00	DISCHG	12.02	11.86	11.65	11.43	11.20	10.95	10.75	10.60	10.49	10.34
22.00	DISCHG	10.14	9.96	9.87	9.71	9.59	9.44	9.29	9.10	9.09	9.00
24.00	DISCHG	8.86	8.16	6.21	3.16	1.96	0.97	0.49	0.24	0.12	0.05

27.	DISCHG	0.02	0.01	0.00

SUBROUTINE RUNOFF CROSS SECTION 4
AREA= 0.08 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.61
IN PEAK - MAXI = 130

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.21	98.917	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.08

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.09
8.00	DISCHG	0.17	0.27	0.36	0.50	0.64	0.79	0.95	1.14	1.35	1.59
10.00	DISCHG	1.86	2.19	2.61	3.13	3.80	4.60	5.67	7.43	11.69	36.33
12.00	DISCHG	77.62	98.90	81.21	55.13	36.14	27.14	20.59	16.45	13.73	11.67
14.00	DISCHG	10.46	9.61	8.94	8.45	7.99	7.53	7.15	6.75	6.43	6.15
16.00	DISCHG	5.89	5.68	5.44	5.24	5.07	4.91	4.77	4.61	4.46	4.35
18.00	DISCHG	4.24	4.15	4.04	3.94	3.85	3.75	3.67	3.57	3.49	3.43
20.00	DISCHG	3.39	3.34	3.27	3.21	3.14	3.07	3.02	2.98	2.95	2.90
22.00	DISCHG	2.84	2.79	2.76	2.73	2.69	2.64	2.61	2.58	2.56	2.53
24.00	DISCHG	2.48	2.17	1.40	0.66	0.31	0.14	0.06	0.03	0.01	0.00

SUBROUTINE REACH CROSS SECTION 4
LENGTH= 1475.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 4.196 AVERAGE ROUTING COEFF= 0.7112 NUMBER OF ROUTINGS= 0.35
IN PEAK - MAXI = 130

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.29	92.431	1.56

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.08

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06
8.00	DISCHG	0.14	0.23	0.33	0.45	0.58	0.74	0.86	1.06	1.26	1.49
10.00	DISCHG	1.75	2.05	2.45	2.93	3.53	4.27	5.24	6.72	9.99	26.67
12.00	DISCHG	61.01	89.63	87.54	65.66	45.35	31.84	23.47	18.23	14.89	12.66
14.00	DISCHG	11.05	9.90	9.22	8.66	8.18	7.77	7.31	6.92	6.57	6.26
16.00	DISCHG	5.99	5.76	5.54	5.32	5.14	4.96	4.83	4.67	4.52	4.39
18.00	DISCHG	4.28	4.19	4.08	3.98	3.89	3.79	3.70	3.61	3.53	3.46
20.00	DISCHG	3.41	3.36	3.30	3.24	3.17	3.10	3.04	3.00	2.97	2.92
22.00	DISCHG	2.87	2.81	2.77	2.75	2.71	2.66	2.62	2.59	2.57	2.54
24.00	DISCHG	2.50	2.29	1.71	0.96	0.47	0.21	0.10	0.04	0.02	0.00

SUBROUTINE ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 5,7 OUTPUT HYDROGRAPH= 3
IN PEAK - MAXI = 131

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.31	367.150	3.37

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= [illegible].37

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06
8.00	DISCHG	0.14	0.23	0.36	0.54	0.79	1.10	1.46	1.67	2.36	3.01

SUBJECT Conemaugh 1986 Stage II
BY MLL DATE 2/21/86 SHEET NO. 456 OF 102
CHKD. BY RFA DATE 3/1/86 PROJECT NO. 86-147

SUBJECT Penelec - Conemaugh 1986 Stage II Const
BY MLA DATE 2/21/86 SHEET NO. 160 OF 402
CHKD. BY KEO DATE 3/4/86 PROJECT NO. 86-167

[illegible]	DISCHG	3.03	4.88	6.21	7.97	[illegible]	12.87	16.46	21.93	35.24	99.15
[illegible]	DISCHG	233.27	354.39	350.99	290.15	[illegible]	143.99	107.48	64.01	64.75	58.31
[illegible]	DISCHG	50.78	45.48	41.76	39.06	[illegible]35	34.77	32.94	31.38	29.60	28.24
16.00	DISCHG	27.03	25.99	24.96	24.02	23.20	22.47	21.81	21.10	20.43	19.86
18.00	DISCHG	19.36	18.93	18.46	18.01	17.58	17.15	16.76	16.35	15.97	15.67
20.00	DISCHG	15.43	15.22	14.95	14.67	14.37	14.09	13.78	13.69	13.45	13.27
22.00	DISCHG	13.01	12.77	12.59	12.40	12.30	12.10	11.91	11.77	11.66	11.53
24.00	DISCHG	11.35	10.45	7.92	4.79	2.43	1.19	0.58	0.28	0.14	0.05
26.00	DISCHG	0.02	0.01	0.00							

SUBROUTINE REACH CROSS SECTION 5
LENGTH= 2875.00 INPUT COEFFICIENT= 0.0000 INPUT ROUTINGS= 0.00

AVERAGE WATER VELOCITY= 14.758 AVERAGE ROUTING COEFF= 0.6930 NUMBER OF ROUTINGS= 0.26
***** IN PEAK - MAXI = 113

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
12.38	358.329	1.77

HYDROGRAPH, IZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.37

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05
8.00	DISCHG	0.12	0.20	0.33	0.49	0.73	1.02	1.36	1.76	2.24	2.64
10.00	DISCHG	3.62	4.61	5.91	7.53	9.57	12.16	15.54	20.51	31.38	87.56
12.00	DISCHG	198.44	322.90	357.75	300.64	220.89	156.57	116.98	90.12	72.72	61.02
14.00	DISCHG	52.74	46.86	42.71	39.76	37.43	35.31	33.42	31.64	30.01	28.60
16.00	DISCHG	27.35	26.25	25.23	24.27	23.42	22.66	21.98	21.29	20.61	20.01
18.00	DISCHG	19.49	19.04	18.58	18.13	17.69	17.26	16.86	16.46	16.07	15.75
20.00	DISCHG	15.49	15.27	15.02	14.74	14.44	14.13	13.85	13.65	13.49	13.31
22.00	DISCHG	13.07	12.83	12.64	12.49	12.34	12.15	11.96	11.81	11.69	11.57
24.00	DISCHG	11.40	10.69	8.58	5.57	3.03	1.51	0.79	0.36	0.17	0.08
26.00	DISCHG	0.03	0.01	0.00							

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.09 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.18
***** IN PEAK - MAXI = 124

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
11.96	133.343	(RUNOFF)

HYDROGRAPH, IZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.09

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.15	0.36
10.00	DISCHG	0.47	0.47	1.32	1.82	2.62	3.15	5.40	6.80	29.01	99.12
12.00	DISCHG	135.08	52.57	31.61	25.65	16.92	16.32	12.65	11.64	11.01	9.49
14.00	DISCHG	9.40	6.53	8.35	8.00	7.31	7.24	6.36	6.41	6.22	5.66
16.00	DISCHG	5.84	5.40	5.31	5.19	4.97	4.46	4.03	4.56	4.48	4.34
18.00	DISCHG	4.31	4.11	4.07	3.99	3.85	3.84	3.65	3.61	3.58	3.53
20.00	DISCHG	3.52	3.37	3.34	3.28	3.16	3.10	3.17	3.11	3.05	2.99
22.00	DISCHG	2.93	2.89	2.84	2.89	2.75	2.74	2.71	2.70	2.57	2.61
24.00	DISCHG	2.60	0.52	0.03	0.00						

SUBROUTINE RUNOFF CROSS SECTION 5
AREA= 0.01 INPUT RUNOFF CURVE= 78.0 TIME OF CONCENTRATION= 0.20
***** IN PEAK - MAXI = 124

SUBJECT	Penelec - Conemaugh 1986 Stage II Const
BY MLK DATE 2/21/86	SHEET NO. 670 OF 702
CHKD. BY RED DATE 3/4/86	PROJECT NO. 86-147

PEAK TIMES 11.95 PEAK DISCHARGES 23.716 PEAK ELEVATIONS (XHROPH)

TIME HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.01

0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04
8.00	DISCHG	0.05	0.07	0.09	0.12	0.15	0.17	0.21	0.24	0.28	0.34
10.00	DISCHG	0.37	0.49	0.56	0.66	0.85	0.94	1.44	1.72	5.75	16.39
12.00	DISCHG	23.25	9.94	5.38	4.35	2.80	2.04	2.07	1.90	1.78	1.52
14.00	DISCHG	1.50	1.37	1.33	1.28	1.16	1.15	1.04	1.01	0.98	0.92
16.00	DISCHG	0.92	0.85	0.83	0.82	0.78	0.77	0.73	0.71	0.70	0.68
18.00	DISCHG	0.68	0.66	0.63	0.62	0.60	0.60	0.57	0.56	0.56	0.55
20.00	DISCHG	0.55	0.52	0.52	0.51	0.49	0.49	0.46	0.48	0.47	0.45
22.00	DISCHG	0.45	0.45	0.44	0.44	0.47	0.42	0.42	0.42	0.41	0.40
24.00	DISCHG	0.43	0.10	0.01	0.00						

SUBROUTINE ADDHYD CROSS SECTION 5
INPUT HYDROGRAPHS= 2,3 OUTPUT HYDROGRAPH= 5
00000 IN PEAK - MAXI = 133

PEAK TIMES 12.34 PEAK DISCHARGES 391.357 PEAK ELEVATIONS 1.89

TIME HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.94

0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05
8.00	DISCHG	0.12	0.20	0.33	0.49	0.73	1.02	1.36	1.78	5.39	3.20
10.00	DISCHG	4.39	5.59	7.34	9.35	17.19	15.31	20.94	27.11	60.80	161.67
12.00	DISCHG	333.52	375.47	389.35	326.49	237.81	174.89	120.63	101.95	83.33	70.51
14.00	DISCHG	62.14	55.39	51.08	43.77	44.74	42.59	39.98	38.05	36.23	34.45
16.00	DISCHG	33.18	31.66	30.54	29.46	28.39	27.62	26.60	25.84	25.09	24.35
18.00	DISCHG	23.82	23.35	22.65	22.12	21.54	21.10	20.51	20.07	19.65	19.27
20.00	DISCHG	19.02	18.65	18.36	18.02	17.61	17.29	16.97	16.76	16.55	16.25
22.00	DISCHG	16.00	15.72	15.52	15.33	15.09	14.90	14.67	14.51	14.36	14.18
24.00	DISCHG	14.00	11.21	8.61	5.47	3.03	1.51	0.74	0.36	0.17	0.08
26.00	DISCHG	0.03	0.01	0.00							

SUBROUTINE ADDHYD CROSS SECTION 5
INPUT HYDROGRAPHS= 4,5 OUTPUT HYDROGRAPH= 6
00000 IN PEAK - MAXI = 133

PEAK TIMES 12.33 PEAK DISCHARGES 399.012 PEAK ELEVATIONS 1.91

TIME HYDROGRAPH, TZERO= 0.00 DELTA T= 0.20 DRAINAGE AREA= 0.47

0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09
8.00	DISCHG	0.17	0.28	0.42	0.61	0.87	1.19	1.57	2.07	7.66	3.54
10.00	DISCHG	4.56	6.07	7.79	10.01	13.04	16.25	22.38	29.03	66.54	200.06
12.00	DISCHG	356.33	365.41	394.73	330.85	240.63	177.53	131.70	103.85	85.51	72.03
14.00	DISCHG	63.61	56.75	52.41	49.04	45.93	43.74	41.03	39.06	37.21	35.37
16.00	DISCHG	34.10	32.51	31.17	30.28	29.16	29.39	27.33	26.55	25.79	25.02
18.00	DISCHG	24.50	23.80	23.28	22.74	22.14	21.70	21.08	20.63	20.21	19.82
20.00	DISCHG	19.56	19.17	18.88	18.53	18.16	17.77	17.45	17.24	17.02	16.70
22.00	DISCHG	16.45	16.17	15.91	15.77	15.52	15.32	15.09	14.92	14.77	14.58
24.00	DISCHG	14.40	11.31	8.62	5.57	3.03	1.51	0.74	0.36	0.17	0.08

SUBJECT Penelec-Conemaugh 1986 Stage II Cont
BY MLF DATE 2/21/86 SHEET NO. 68 OF 102
CHKD. BY RED DATE 3/14/86 PROJECT NO. 86-167

0115CHG 0.03 0.01 0.00

ENDCAP

ENDJOB CARD ENCOUNTERED. END OF JOB.

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Environmental Specialists

3. Haul Road Collection

The runoff from the haul road drains into the haul road gutter and empties into the west collection channel near the depression located west of the existing haul road.

Input Data

A. PPT = 5.5 inches - 100YR, 4.0 inches - 10YR, 2.7 inches - 2YR
B. AMC II
C. Hydrologic Soil Group C
D. Drainage Area

Length of haul road = 1315 ft
Width of haul road = 50 + 15 = 65 ft
Area = 1315 x 65 / 43560 ft²/acre = 2.0 acres

E. Curve Number
Haul Road 85
F. Time of Concentration

Length of flow in gutter	1315 ft
Slope of gutter	10%
Velocity of flow	14.5 fps
	(see sheet 36)

t_{c1} = 1315/14.5
= 90.7 seconds
= 0.025 HR

Length of channel	≈ 40'
Slope of channel	11%
Velocity of channel	15.2 fps

t_{c2} = 0.001 HR (see sheet 37)

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Tc = 0.025 hr + 0.001 hr
= 0.026 hr ≈ 0.03 hr

6. Peak Discharge

i. Haul road: Qp = 7.8 cfs
ii. Front Benches ~ 5 cfs (assumed)

4. Base flow = 0.92 cfs (see sheet 35)

5. Total Flow

i. East Collection: Qp = 314 cfs
ii. West Collection: Qp = 400 cfs
iii. Haul Road: Qp = 7.8 cfs
iv. Base flow: Qp = 0.92 cfs
v. Incremental portion of front benches = 5 cfs
vi. Total = 727.7 cfs (Condition II)

Note: In adding peak flows together, it is assumed that the peak flows at the site collector occur at the same time, tp.

SUBJECT Penelec - Conemaugh 1986 Stage II Const
BY MLA DATE 2/22/86 SHEET NO. 11 OF 102
CHKD. BY RFO DATE 3/4/86 PROJECT NO. 86-147

EXEC CONTROL CARD OPERATION LIST

LISTING OF DATA IN CORE

0 CONEMAUGH - STAGE II 1986 + HAUL ROAD CONDITION II

VELOCITY INCREMENT 0.2000

1 CTABLE

8	0.0000	0.0800	0.1800	0.2500	0.3200
8	0.3700	0.4100	0.4500	0.4900	0.5100
8	0.5400	0.5700	0.5900	0.6100	0.6300
8	0.6500	0.6600	0.6700	0.6900	0.7000
8	0.7100	0.7200	0.7300	0.7400	0.7500
8	0.7600	0.7700	0.7700	0.7800	0.7900
8	0.7900	0.8000	0.8100	0.8100	0.8700
8	0.8200	0.8300	0.8300	0.8400	0.8400
8	0.8400	0.8500	0.8500	0.8600	0.8600
8	0.8600	0.8600	0.8700	0.8700	0.8700
8	0.8800	0.8800	0.8800	0.8900	0.8900
8	0.8900	0.8900	0.8900	0.8900	0.9000
8	0.9000	0.9000	0.9000	0.9000	0.9100
8	0.9100	0.9100	0.9100	0.9100	0.9100
8	0.9200	0.9200	0.9200	0.9200	0.9200
8	0.9200	0.9200	0.9200	0.9300	0.9300

9 ENDTBL

XSECTN NO. 1 DRAINAGE AREA 1.0000

2 XSECTN

	ELEVATION	DISCHARGE	END AREA
8	0.0000	0.0000	0.0000

9 ENDTBL

TIME INCREMENT

4 DIMHYD

0	0.0000	0.0300	0.1000	0.1900	0.3100
8	0.4700	0.6600	0.8200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.5800	0.5600	0.4600	0.3900	0.3300
8	0.2800	0.2410	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0550	0.0470	0.0400	0.0340	0.0290
8	0.0250	0.0210	0.0180	0.0150	0.0130
8	0.0110	0.0090	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000

9 ENDTBL

COMPUTED PEAK K FACTOR = 484.00

TIME INCREMENT

5 RAINFL 1		0.5000			
8	0.0000	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1120	0.1250	0.1400	0.1560
8	0.1740	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5930	0.6240	0.6540	0.6820
8	0.7050	0.7270	0.7480	0.7670	0.7840
8	0.8000	0.8150	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9260	0.9360	0.9460	0.9550	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000
9 ENDTBL					

		TIME INCREMENT			
5 RAINFL 2		0.0200			
8	0.0000	0.0100	0.0200	0.0200	0.0300
8	0.0400	0.0500	0.0600	0.0700	0.0800
8	0.1000	0.1100	0.1300	0.1400	0.1700
8	0.1900	0.2200	0.2700	0.3500	0.4400
8	0.5200	0.6000	0.6300	0.6600	0.6900
8	0.7000	0.7200	0.7400	0.7600	0.7700
8	0.7900	0.8000	0.8200	0.8300	0.8400
8	0.8500	0.8700	0.8800	0.8900	0.9000
8	0.9100	0.9200	0.9300	0.9400	0.9500
8	0.9567	0.9633	0.9700	0.9800	0.9900
8	1.0000	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

		TIME INCREMENT			
5 RAINFL 3		0.5000			
8	0.0000	0.0053	0.0108	0.0164	0.0223
8	0.0284	0.0347	0.0414	0.0483	0.0555
8	0.0632	0.0712	0.0797	0.0887	0.0984
8	0.1088	0.1203	0.1328	0.1467	0.1625
8	0.1808	0.2042	0.2351	0.2833	0.6632
8	0.7351	0.7724	0.7989	0.8197	0.8380
8	0.8538	0.8676	0.8801	0.8914	0.9019
8	0.9115	0.9206	0.9291	0.9371	0.9446
8	0.9514	0.9588	0.9653	0.9717	0.9777
8	0.9836	0.9892	0.9947	1.0000	1.0000
9 ENDTBL					

SUBJECT Peuelec - Conemaugh 1986 Stage II Const
BY MLA DATE 2/24/86 SHEET NO. 23 OF 102
CHKD. BY RPQ DATE 3/14/86 PROJECT NO. 86-167

```
                    STANDARD CONTROL INSTRUCTIONS

5 RUNOFF 1    1          5        0.0011      85.0000      0.03001 1 1 0 0 0
  ENDATA

END OF LISTING
```

BY MLA DATE 3/19/86 SHEET NO. 74A OF 122
CHKD. BY RGB DATE 7/29/86 PROJECT NO. 86-167


```
EXECUTIVE   MAIN CARD         OPERATION  RUNOFF,      MAIN TIME        HRS  0.20
EXECUTIVE   CONTROL CARD      OPERATION  COMPUTE,     FROM XSE    XSECT  17  0     TO XSECTN/STRUCT   17  0
            STARTING TIME  0.00   RAIN DEPTH  2.70    RAIN DURAT.   1.00    RAIN TABLE NO.= 3    SOIL CONDITION= 2
            ALTERNATE NO.= 0      STORM NO.= 6

SUBROUTINE RUNOFF      CROSS SECTION   1
            AREA   0.00      INPUT RUNOFF CURVE=  85.0      TIME OF CONCENTRATION  0.63

            NULL STRUCTURE...NO ELEVATIONS GIVEN
 ****  IN PEAK = NAXI =  121

            PEAK TIMES                PEAK DISCHARGES            PEAK ELEVATIONS
             11.93                       2.961                     (RUNOFF)
             12.31                       0.589                     (RUNOFF)
             12.90                       0.306                     (RUNOFF)
             13.30                       0.220                     (RUNOFF)
             13.91                       0.173                     (RUNOFF)
             14.30                       0.154                     (RUNOFF)
             14.90                       0.134                     (RUNOFF)
             15.30                       0.117                     (RUNOFF)
             15.90                       0.107                     (RUNOFF)
             16.33                       0.096                     (RUNOFF)
```

TIME			HYDROGRAPH, TZERO=	0.00		DELTA IS 0.20			DRAINAGE AREA=	0.00
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02
10.00	DISCHG	0.03	0.04	0.05	0.07	0.08	0.08	0.15	0.17	1.75	2.40
12.00	DISCHG	2.80	0.55	0.56	0.29	0.30	0.30	0.21	0.22	0.17	0.17
14.00	DISCHG	0.17	0.15	0.15	0.13	0.11	0.14	0.12	0.12	0.11	0.11
16.00	DISCHG	0.11	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.08
18.00	DISCHG	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06
20.00	DISCHG	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
22.00	DISCHG	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
24.00	DISCHG	0.05									

ENDCMP

```
                                                                                    PASS     2
EXECUT     RUNOFF CARD          OPERATION  CONTROL       FROM XSEC    DCT    17  0       TO XSEC/STRUCT    17  0
           STARTING TIME=  0.00     RAIN DEPTH=  4.00      RAIN DURAT     24.00      RAIN TABLE NO.= 1      SOIL CONDITION= 2
           ALTERNATE NO.= 0         STORM NO.= 0

SUBROUTINE RUNOFF    CROSS SECTION    1
           AREA=   0.00      INPUT RUNOFF CURVE=  85.0      TIME OF CONCENTRATION=  0.03

           ROUT STRUCTURE,,,NO ELEVATIONS GIVEN
***** IN PEAK - MAX =  121

           PEAK TIMES                  PEAK DISCHARGES              PEAK ELEVATIONS
              11.92                        5.205                       (RUNOFF)
              12.30                        1.006                       (RUNOFF)
              12.50                        0.520                       (RUNOFF)
              13.30                        0.370                       (RUNOFF)
              13.90                        0.289                       (RUNOFF)
              14.30                        0.256                       (RUNOFF)
              14.90                        0.227                       (RUNOFF)
              15.30                        0.194                       (RUNOFF)
              15.90                        0.176                       (RUNOFF)
              16.30                        0.159                       (RUNOFF)

    TIME                           HYDROGRAPH, TZERO=    0.00         VALUES AT 0.70        DRAINAGE AREA=   0.00
    0.00    DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    2.00    DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    4.00    DISCHG       0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    6.00    DISCHG       0.00      0.00      0.00      0.00      0.00      0.01      0.01      0.01      0.02      0.02
    8.00    DISCHG       0.02      0.03      0.03      0.04      0.04      0.05      0.06      0.06      0.08      0.09
   10.00    DISCHG       0.09      0.13      0.13      0.19      0.20      0.21      0.36      0.39      1.61      4.47
   12.00    DISCHG       4.86      0.94      0.95      0.50      0.50      0.54      0.36      0.36      0.28      0.28
   14.00    DISCHG       0.29      0.25      0.25      0.22      0.22      0.22      0.19      0.19      0.17      0.17
   16.00    DISCHG       0.17      0.16      0.16      0.15      0.15      0.15      0.13      0.13      0.13      0.13
   18.00    DISCHG       0.11      0.12      0.12      0.11      0.11      0.11      0.11      0.11      0.10      0.10
   20.00    DISCHG       0.10      0.10      0.10      0.09      0.09      0.09      0.09      0.09      0.09      0.09
   22.00    DISCHG       0.09      0.08      0.08      0.08      0.08      0.08      0.08      0.08      0.08      0.08
   24.00    DISCHG       0.08


    ENDCMP
```

MLA 3/10/86 248 of 102
BED 3/26/86 PROJECT NO. 86-167

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
BY MLA DATE 2/22/86 SHEET NO. 74C OF 102
CHKD. BY RED DATE 3/4/86 PROJECT NO. 85-147

```
                                                                                        PASS=  1
EXEC    CONTROL CARD          OPERATION  (COMPUTE,      MAIN 1       INCREMENT=  0.20
EXEC   E CONTROL CARD         OPERATION  COMPUT,        FROM X     /STRUCT   17  0      TO XSECTN/STRUCT   17  0
       STARTING TIME=  0.00     MAIN DEPTH=  5.50     MAIN DURATION=  1.00     MAIN TABLE NO.= 3     SOIL CONDITION= 2
       ALTERNATE NO.= 0         STORM NO.= 0

SUBROUTINE RUNOFF     CROSS SECTION    1
           AREA=   0.00      INPUT RUNOFF CURVE=  85.0      TIME OF CONCENTRATION=  0.03

           ROUL STRUCTURE,,,NO ELEVATIONS GIVEN
ERROR IN PEAK - MAXI =  121

           PEAK TIMES                     PEAK DISCHARGES                  PEAK ELEVATIONS
             11.91                             7.836                          (RUNOFF)
             12.30                             1.458                          (RUNOFF)
             12.90                             0.764                          (RUNOFF)
             13.30                             0.541                          (RUNOFF)
             13.90                             0.422                          (RUNOFF)
             14.30                             0.473                          (RUNOFF)
             14.90                             0.323                          (RUNOFF)
             15.30                             0.281                          (RUNOFF)
             15.90                             0.255                          (RUNOFF)
             16.30                             0.231                          (RUNOFF)

  TIME                                  HYDROGRAPH, ZERO=   0.00          DELTA T=  0.20           DRAINAGE AREA=   0.00
  0.00    DISCHG        0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
  2.00    DISCHG        0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
  4.00    DISCHG        0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.01     0.01     0.01
  6.00    DISCHG        0.02     0.02     0.02     0.03     0.03     0.04     0.05     0.05     0.06     0.06
  8.00    DISCHG        0.07     0.08     0.09     0.10     0.11     0.11     0.13     0.14     0.17     0.18
 10.00    DISCHG        0.19     0.25     0.26     0.36     0.37     0.39     0.64     0.67     5.94     6.62
 12.00    DISCHG        7.25     1.40     1.41     0.73     0.74     0.74     0.53     0.53     0.41     0.42
 14.00    DISCHG        0.42     0.37     0.37     0.37     0.32     0.32     0.28     0.28     0.25     0.25
 16.00    DISCHG        0.25     0.23     0.23     0.23     0.21     0.21     0.19     0.19     0.18     0.18
 18.00    DISCHG        0.19     0.17     0.17     0.16     0.16     0.16     0.15     0.15     0.15     0.15
 20.00    DISCHG        0.15     0.14     0.14     0.13     0.13     0.13     0.13     0.13     0.12     0.12
 22.00    DISCHG        0.12     0.12     0.12     0.11     0.11     0.11     0.11     0.11     0.11     0.11
 24.00    DISCHG        0.11

  ENDCMP

ENDJOB CARD ENCOUNTERED.  END OF JOB.
```

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES

BY MLA DATE 2/28/86 PROJ. NO. 86-167

CHKD. BY RPD DATE 3/14/86 SHEET NO. 75 OF 102

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

REVISION : MLA 3/26/86 RESPONSE TO CLIENT'S WISHES STATED IN MINUTES FROM PENELEC'S AND GAI'S MEETING ON MARCH 25, 1986.

SUMMARY :

A SUMMARY OF THE PEAK FLOWS FOR CONDITION I AND II ARE SHOWN BELOW:

CONDITION I

WEST COLLECTION + HAUL ROAD : Q_P : 116.5

EAST COLLECTION : Q_P : 525 CFS

INCREMENTAL BENCH FLOW : Q_P : 5 CFS

BASE FLOW : Q_P : 0.92 CFS

} Q_T = 648 CFS

CONDITION II

WEST COLLECTION + HAUL ROAD : Q_P : 407.8

EAST COLLECTION : Q_P : 314 CFS

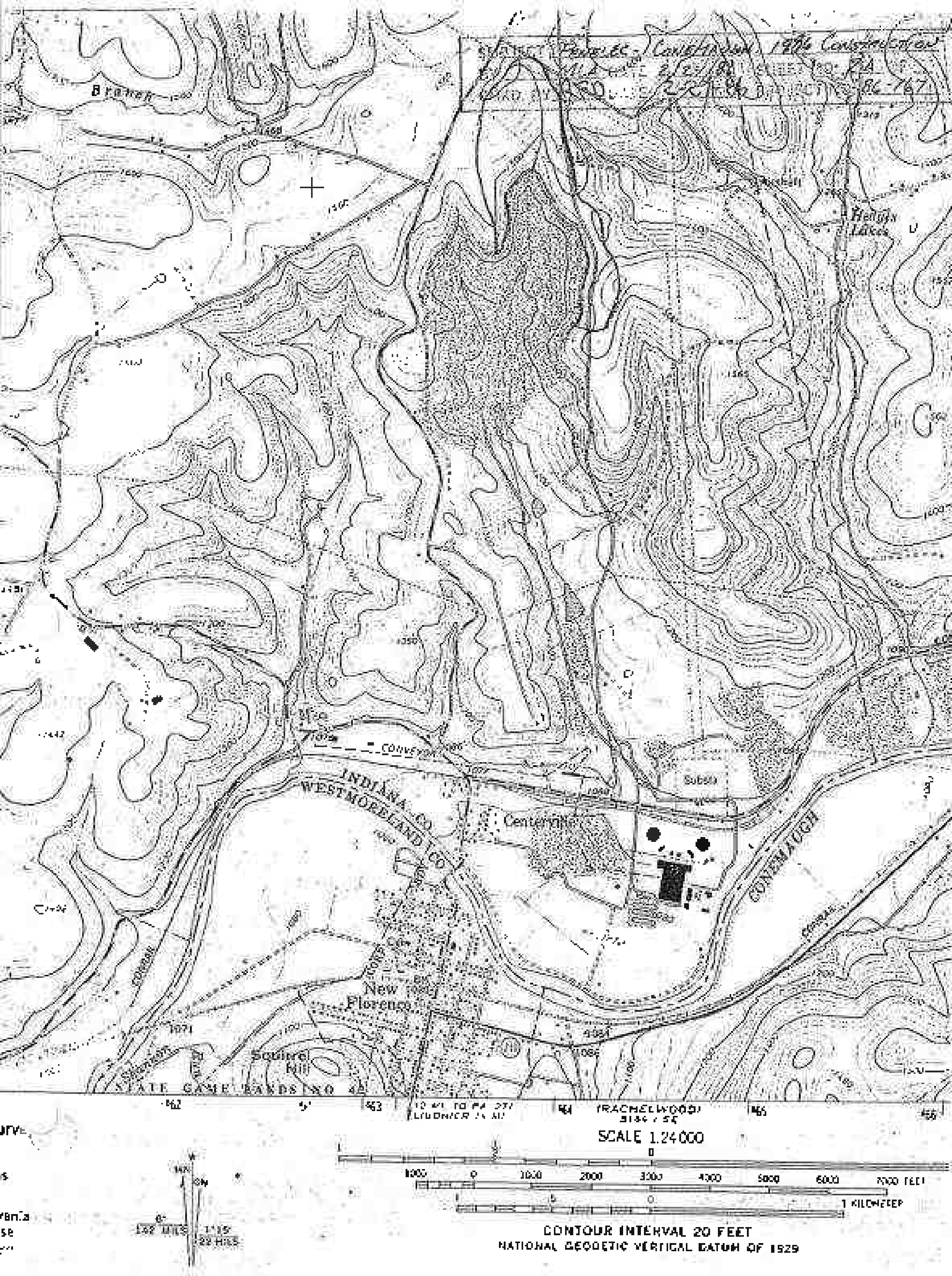
INCREMENTAL BENCH FLOW : Q_P : 5 CFS

BASE FLOW : Q_P : 0.92 CFS

} 728 CFS

NOTE: THE 2 AND 10YR FLOW SUMMARIES ARE ON SHEET 87+.

REVISION: CLIENT, LINUS SMITH FROM PENELEC, STATED THAT STAGE I WILL BE CLOSED AND WILL DRAIN INTO THE WEST VALLEY BY THE END OF 1987. IN RESPONSE TO LINUS' STATEMENT, THE MAIN VALLEY DISSIPATOR WILL BE DESIGNED FOR CONDITION I.



Centerville
New Florence
Squirrel Hill
INDIANA CO
WESTMORELAND CO
CONEMAUGH
CONVEYOR
STATE GAME LANDS NO 42
SCALE 1:24000
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONSTRUCTION
TEMPORARY DRAINAGE STRUCTURES

BY MLA DATE 4/24/86 PROJ. NO. 86-147
CHKD. BY DAY DATE 4/24/86 SHEET NO. 1 OF 1

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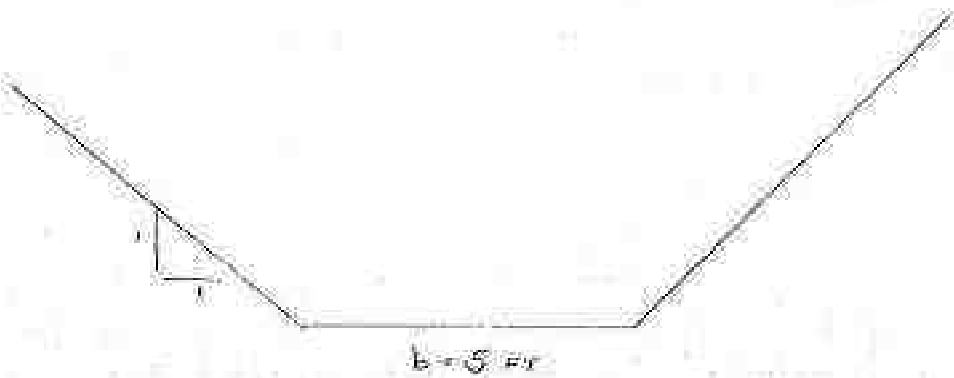
RELOCATING SMALL STRETCH OF WEST CHANNEL.

LENGTH OF CHANNEL RELOCATION = 300 - 400 FT
SLOPE OF CHANNEL = 0.5 %
LIFE OF CHANNEL = 3 YRS
DESIGN FOR 10 YR STORM
EXPECTED QPEAK = 60 CFS (SEE HYDROLOGY CALCS
+ 10 CFS FOR OFFSITE "PERMANENT DRAINAGE STRUCTURES"
= 70 CFS MLA, 2/10/86, SHEET 55+65B OF 102

CHANNEL IS EXPECTED TO BE CUT INTO BEDROCK n = 0.035



$Q n / b^{8/3} S^{1/2} = 70 (0.035) / 5^{8/3}\ 0.005^{1/2}$

$= 0.474$

$d/b = 0.48$

$d = 0.48 \times 5 = 2.4$ FT $\approx 3.0'$

(2) HYDRAULICS

IN THE HYDROLOGY CALCS (ON SHEET 35), THE DESIGN FOR THE SITE COLLECTOR SEEMS TO DEPEND ON THE TOTAL FLOW BEING EMITTED FROM THE COLLECTION CHANNELS INTO THE STILLING BASIN. THEREFORE, THE TOTAL MAXIMUM PEAK FLOW WAS CALCULATED FOR THE DURATION OF STAGE II LIFE SITE. HOWEVER, SINCE THE HIGHEST PEAK FLOW EQUALS 648 CFS AND SPACE FOR THE CONSTRUCTION OF THE STILLING BASIN DOESN'T SEEM TO BE A MAJOR FACTOR, OTHER HYDRAULIC FACTORS WILL BE CONSIDERED FOR THE STILLING BASIN DESIGN. SOME OF THE HYDRAULIC FACTORS THAT WILL BE CONSIDERED ARE:

1. EAST COLLECTION CHANNEL
   - A ENTRY CONDITIONS SUCH AS y_1, V_1, F_1, AND E_1 AND Q_P
   - B LENGTH OF JUMP, L_E
   - C HEIGHT OF SEQUENT DEPTH, y_2
   - D LOCATION OF JUMP, L_J
   - E EFFICIENCY OF JUMP

2. WEST COLLECTION CHANNEL
   - A EMTRY CONDITIONS SUCH AS y_1, V_1, F_1, AND E_1 AND Q_P
   - B LENGTH OF JUMP, L_W
   - C HEIGHT OF SEQUENT DEPTH, y_2
   - D LOCATION OF JUMP, L_d
   - E EFFICIENCY OF JUMP

THE LENGTH OF JUMP AND LOCATION OF THE JUMP WILL DICTATE THE LENGTH OF THE BASIN BOTTOM, AND THE CONJUGATE DEPTH WILL DICTATE THE HEIGHT OF THE BASIN WALLS.

SINCE THESE FACTORS ARE MORE IMPORTANT FOR DESIGN PURPOSES, THE MAXIMUM PEAK FLOW FOR DIFFERENT STORMS FOR EACH CHAN WILL BE USED TO CALCULATE THESE FACTORS.

SUBJECT Penelec - Conemaugh 1986 Stage II Const
Permanent Drainage Structures

BY MLA DATE 3/14/86 PROJ. NO. 86-167
CHKD. BY DAY DATE 4/24/86 SHEET NO. 77 OF 102

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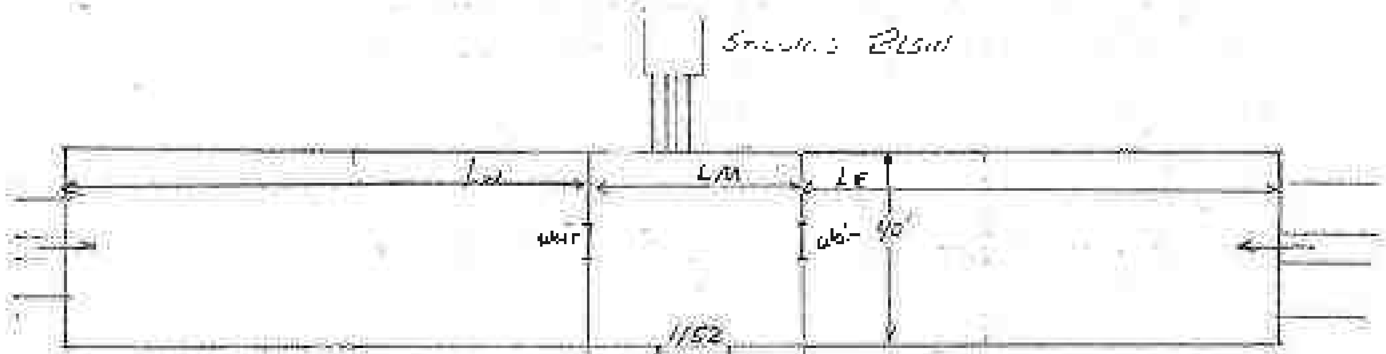
THE MAIN DISSIPATOR AND THE ENTRY CONDITIONS OF THE INCOMING CHANNELS ARE SHOWN BELOW.



West Collection
$S = 12.5\%$ (AVG)
Q_{100} = 121 cfs Condition I (+5 cfs from lower portion of benches)
= 413 cfs Condition II

Q_{10} = 74 cfs I (+4 cfs from lower portion of benches)
229 cfs II

Q_2 = 37 cfs I (includes small bench flow that flows overland to west extension. +3 cfs)
95 cfs II

East Collection Channel
$S = 10\%$ (AVG)
Q_{100} = 525 cfs I
314 cfs II

Q_{10} = 337 cfs I
203 cfs II

Q_2 = 181 cfs I
111 cfs II

Note: THE MAIN SITE COLLECTION DISSIPATOR IS A PERMANENT STRUCTURE, THEREFORE, IT WILL BE DESIGNED FOR A 100 YR STORM. HOWEVER, DOWNSTREAM OF THE DISSIPATOR, THERE WILL BE TWO DIFFERENT CASES THAT NEED ANALYZED.

CASE I - THIS CASE IS A TEMPORARY CASE WHICH INVOLVES AN ACCESS ROAD THAT CONTAINS A HI-LO WATER STRUCTURE. SINCE THIS SITUATION IS TEMPORARY, THE HI-LO STRUCTURE WILL BE DESIGNED FOR THE 10 YR STO[RM] AND SINCE THE HI-LO STRUCTURE WILL LAST TIL 19[..] THEN CONDITION II IS THE ONLY APPLICABLE CONDITION

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES

BY MCA DATE 3/17/86 PROJ. NO. 86-167
CHKD. BY DAY DATE 4/24/86 SHEET NO. 78 OF 102

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FOR DESIGN

CASE II - THIS CASE IS CONSIDERED PERMANENT. IT INVOLVES THE DISSIPATOR DRAINING INTO THE MAIN COLLECTION CHANNEL WITHOUT ANY OBSTRUCTION DOWNSTREAM. IN OTHER WORDS, THE ACCESS ROAD WILL BE REMOVED (1990). SINCE THIS CASE IS PERMANENT, THEN ALL STRUCTURES WILL BE DESIGNED FOR THE 100 YR STORM AND BOTH CONDITION I AND II WILL APPLY.

AS THE ILLUSTRATION ON SHEET 77 SHOWS, THE MAIN SITE COLLECTION DISSIPATOR IS SEPARATED INTO THREE BASINS, THE EAST, WEST AND MIDDLE. THE FLOW FROM EACH CHANNEL ENTERS INTO THEIR RESPECTIVE BASIN AND EMPTIES OVER A WEIR INTO A POOL LOCATED BETWEEN EACH BASIN. FROM THE POOL, THE FLOW EXITS INTO THE MAIN COLLECTOR CHANNEL.

THE EAST AND WEST BASINS ARE CONSIDERED ISOLATED STRUCTURES. THEREFORE, THEY WILL BE ANALYZED SEPARATELY, AND THEY SHOULD NOT AFFECT EACH OTHER.

THE MIDDLE BASIN CONNECTS THE EAST BASIN AND THE WEST BASIN. IT COLLECTS THE FLOW FROM THE EAST AND WEST WEIR (AND STILLING BASIN) AND EMPTIES THE FLOW INTO THE MAIN SITE COLLECTION CHANNEL.

ii EAST COLLECTION CHANNEL

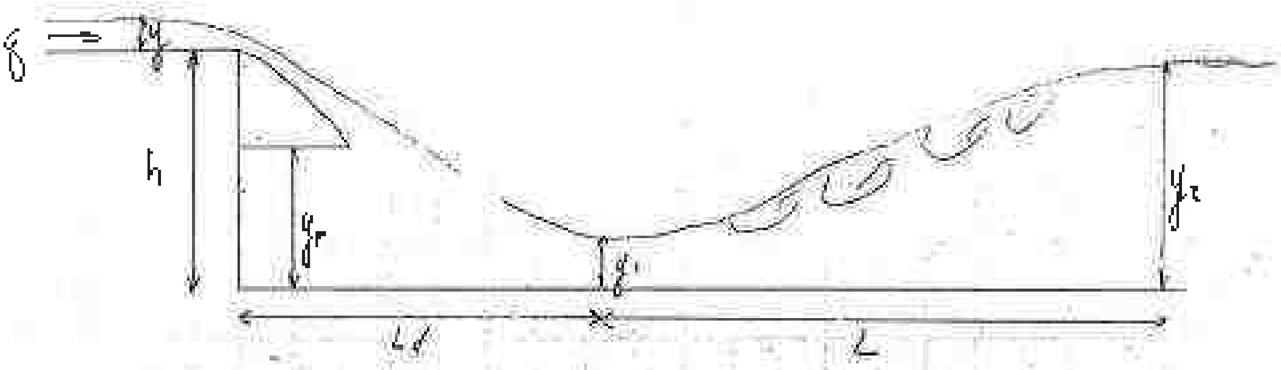
IN DESIGNING THE DIMENSIONS OF THE EAST BASIN, THE DROP NUMBER METHOD WILL BE USED.

(REF.: Open-Channel Hydraulics, Chow, 1959, pg 423)

IN DESIGNING THE DIMENSIONS OF THE WEIR, THE EQUATION FOR A BROADCRESTED WEIR IS USED.

(REF: Open-Channel Hydraulics, Chow, 1959, pg 53)

STRAIGHT DROP SPILLWAY



i. D = DROP NUMBER = q^2/gh^3 WHERE q = DESIGN FLOW/CHANNEL WI...
ii. L_d = BEGINNING OF JUMP = $4.30\,D^{0.27}h$
iii. y_p = POOL HEIGHT = $1.00\,D^{0.22}h$
iv. y_1 = INITIAL DEPTH = $0.54\,D^{0.425}h$
v. y_2 = SEQUENT DEPTH = $1.66\,D^{0.27}h$
vi. F_1 = FROUDE NUMBER OF JUMP ⇒ $y_2/y_1 = \frac{1}{2}\left(\sqrt{1+8F_1^2}-1\right)$ (PG. 427)
vii. L = LENGTH OF JUMP ⇒ USE F_1 AND FIGURE 15-4, PG 39...
viii. CHECK TAILWATER HEIGHT

SUBJECT: PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES

BY: MIA DATE: 3/18/86 PROJ NO: 86-167

CHKD BY: DAY DATE: 4/24/86 SHEET NO. 80 OF 102

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DESIGN STORM	CONDITION	Q_p (CFS)	y (CHANNEL)	h (FT)	D	L_j (FT)	y_p (FT)	y_1 (FT)	y_2 (FT)	F_1	L (FT)
2	I	181	0.84	10	0.028	16.38	4.56	1.19	6.34	4.10	37.0
2	I	111	0.60	10	0.011	12.61	3.68	0.78	4.87	4.76	23.1
10	I	387	1.14	10	0.098	22.96	6.00	2.01	8.86	3.45	49.0
10	II	203	0.87	10	0.036	17.46	4.80	1.31	6.74	3.98	37.0
100	I	525	1.44	10	0.238	29.18	7.29	2.93	11.86	3.05	57.9
100	I	314	1.08	10	0.095	22.10	5.81	1.89	8.53	3.53	47.8

NOTE: 1) y IS THE WATER DEPTH IN THE FIRST CHANNEL. IT WAS COMPUTED BY FINDING:

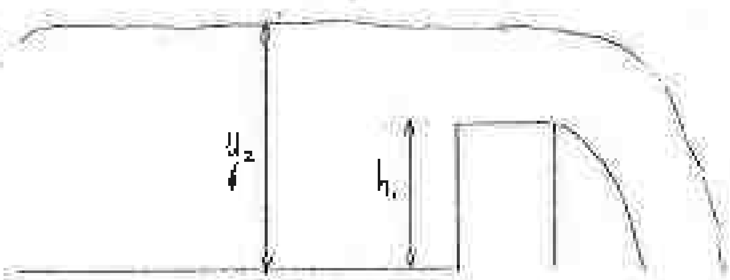
$$Qn / b^{8/3} S^{1/2}$$

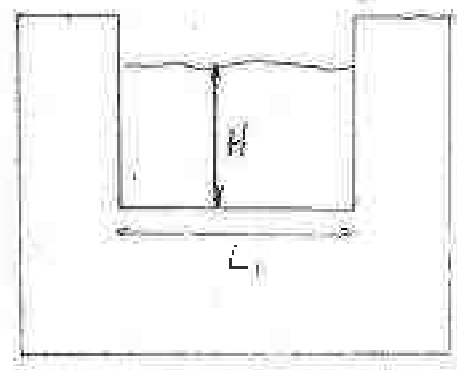
WHERE Q IS THE DESIGN FLOW
n IS THE MANNING'S n FOR CONCRETE = 0.012
b IS THE CHANNEL'S BOTTOM WIDTH = 6 FT
S IS THE CHANNEL'S SLOPE = 10%

AND, THEN, USING TABLE III-1 IN "HEC No. 14", DEC. 1975
y WILL BE USED TO CHECK IF THE JUMP WILL OCCUR IN THE BASIN OR UPSTREAM. SEE SHEET 81 AND 82

2) A JUMP WILL NOT OCCUR IN THE BASIN UNLESS THE TAILWATER IS GREATER THAN y_2 AND LESS THAN h+y. IF TW IS LESS THAN y_2, THE JUMP WILL MOST LIKELY OCCUR DOWNSTREAM OF THE BASIN. IF TW IS GREATER THAN h+y, THE THE JUMP WILL MOST LIKELY OCCUR UPSTREAM IN THE CHANN. THE TAILWATER FOR EACH CASE HAS BEEN COMPUTED AND COMPARED TO y_2 AND h+y. SEE SHEET 81.

Broadcrested Weir





$$q = Q/L_1 = 0.433\sqrt{2g}\left(\frac{y_2}{y_2+h_1}\right)^{1/2} H^{3/2}$$

Design Storm	Condition	Q_p (cfs)	$y+h$ (ft)	y_2 (ft)	L_1 (ft) (assumed)	h_1 (ft) (assumed)	H (ft)	$TW = H + h_1$ (ft)
2	I	181	10.84	6.34	10	5	3.65	8.65
2	II	111	10.60	4.87	10	5	2.74	7.74
10	I	337	11.14	8.86	10	5	5.28	10.28
10	II	203	10.87	6.74	10	5	3.90	8.90
100	I	525	11.44	11.26	10	5	6.91	11.91
100	II	314	11.08	8.53	10	5	5.06	10.06

Length of basin $L_E = L + L_d$ = 59.9 ft + 29.2 ft = 89.1 ft (min)
Height of basin H_E = 11.91 ft ≈ 12 ft (min)

SUBJECT: Penelec - Conemaugh 1986 Stage II Coast
Permanent Drainage Structures

BY: MLA DATE: 3/13/86 PROJ. NO: 86-167
CHKD. BY: DAY DATE: 4/24/86 SHEET NO. 82 OF 102

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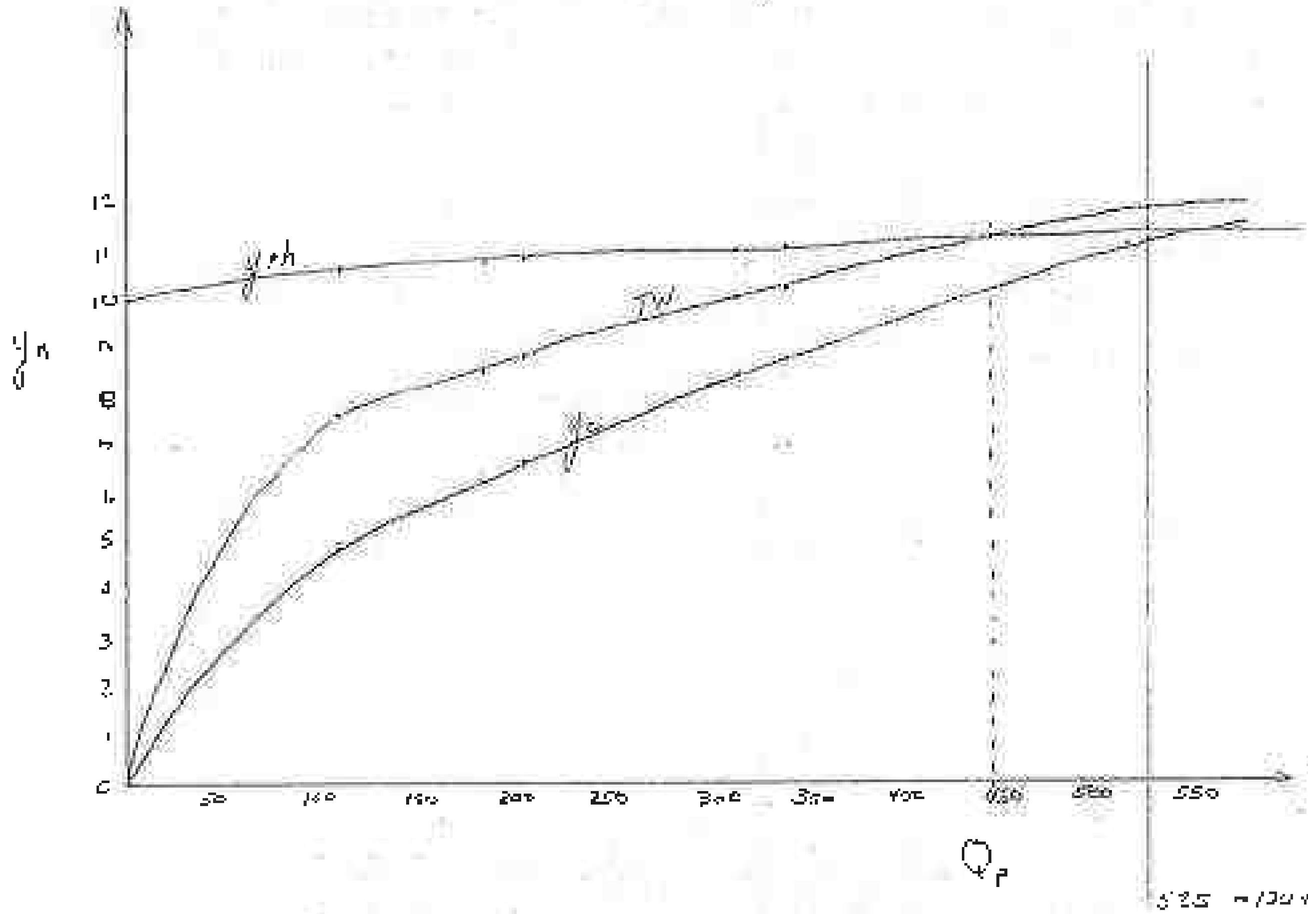
THE FOLLOWING GRAPH COMPARES $y+h$, y_2 AND TW



AT THE FLOW OF 445 CFS, THE TAILWATER STARTS TO BECOME LARGER THAN THE ENTERING CHANNEL'S HYDRAULIC DEPTH. HOWEVER, SINCE THE FLOW PRIOR TO THE WEIR IN THE BASIN IS NOT COMPLETELY QUIESCENT, THEN A SMALL PART OF THE FLOW'S TOTAL HEAD IS ATTRIBUTED TO A VELOCITY HEAD. WITH A SMALL VELOCITY HEAD, THE TAILWATER DECREASES SLIGHTLY WHICH WILL REDUCE THE CHANCES OF THE JUMP OCCURING UPSTREAM IN THE CHANNEL.

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
Permanent Drainage Structures

BY MLP DATE 3/18/86 PROJ. NO. 86-147

CHKD BY DAY DATE 4/24/86 SHEET NO. 83 OF 102

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Efficiency of Jump

$$\frac{E_2}{E_1} = \frac{(8F_1^2+1)^{3/2} - 4F_1^2 + 1}{8F_1^2(2+F_1^2)} \times 100\%$$

(Ref: Open-Channel Hydraulics, Chow, 1959, pg 396)

Design Storm	Condition	Q_p (cfs)	F_1	Efficiency (%)
2	I	191	4.10	59.7
2	II	111	4.76	54.6
10	I	[illegible]	3.45	67.8
10	II	202	3.98	61.1
100	I	525	3.05	73.6
100	II	314	3.53	66.7

SUBJECT: PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES

BY: MLA DATE: 3/26/86 PROJ. NO.: 86-167
CHKD. BY: DAY DATE: 4/24/86 SHEET NO.: 84 OF 102

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2. WEST COLLECTION CHANNEL

STRAIGHT DROP SPILLWAY:

DESIGN STORM	CONDITION *	Q_P (CFS)	y CHANNEL	h (FT)	D	L_d (FT)	y_p (FT)	y_1 (FT)	y_2 (FT)	F_1 (FT)	L (FT)
2	I	37	0.39	6	0.012	7.82	2.27	0.49	3.02	4.70	17.97
10	I	74	0.57	6	0.049	11.43	3.09	0.90	4.41	3.80	25.27
100	I	121	0.76	6	0.132	14.43	3.84	1.37	5.76	3.31	31.51

* SINCE LINUS SMITH FROM PENELEC STATED IN A MARCH 1986 MEETING THAT STAGE I SHOULD BE CLOSED AT THE END OF 1987, THE WEST CHANNEL AND WEST BASIN ARE DESIGNED FOR CONDITION I.

NOTE: y IS THE WATER DEPTH IN THE WEST CHANNEL BEFORE THE FLOW ENTERS THE WEST BASIN. IT WAS COMPUTED BY FINDING:

$$Qn / b^{8/3} S^{1/2}$$

WHERE Q IS THE DESIGN FLOW
n IS THE MANNING'S n FOR CONCRETE = 0.012
b IS THE CHANNEL'S BOTTOM WIDTH = 4 FT
S IS THE CHANNEL'S SLOPE = 12 %

AND, THEN USING TABLE III-1 IN "HEC No. 14" DEC. 1975

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES

BY MLA DATE 3/26/86 PROJ. NO. 86-167

CHKD BY DAY DATE 4/24/86 SHEET NO. 85 OF 122

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BROADCRESTED WEIR

$$\frac{Q}{L_1} = 0.433\sqrt{2g}\left(\frac{y_2}{y_2+h_1}\right)^{1/2} H^{3/2}$$

DESIGN STORM	CONDITION	Q_p (CFS)	$y+h$ (FT)	y_2 (FT)	L_1 (FT)	h_1 (FT)	H (FT)	$TW = H + h_1$ (FT)
2	I	37	6.39	3.02	10	4	1.38	5.38
10	I	74	6.57	4.41	10	4	2.05	6.05
100	I	121	6.76	5.76	10	4	2.74	6.74

LENGTH OF BASIN, $L_w = L + L_d = 31.51 + 14.93 = 46.44$ FT MIN
HEIGHT OF BASIN, $H_w = 6.74$ FT $\approx$ 7 FT (MIN)

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST.
PERMANENT DRAINAGE STRUCTURES
BY MLA DATE 3/20/86 PROJ. NO. 84-167
CHKD. BY DAY DATE 4/24/86 SHEET NO. 96 OF 102

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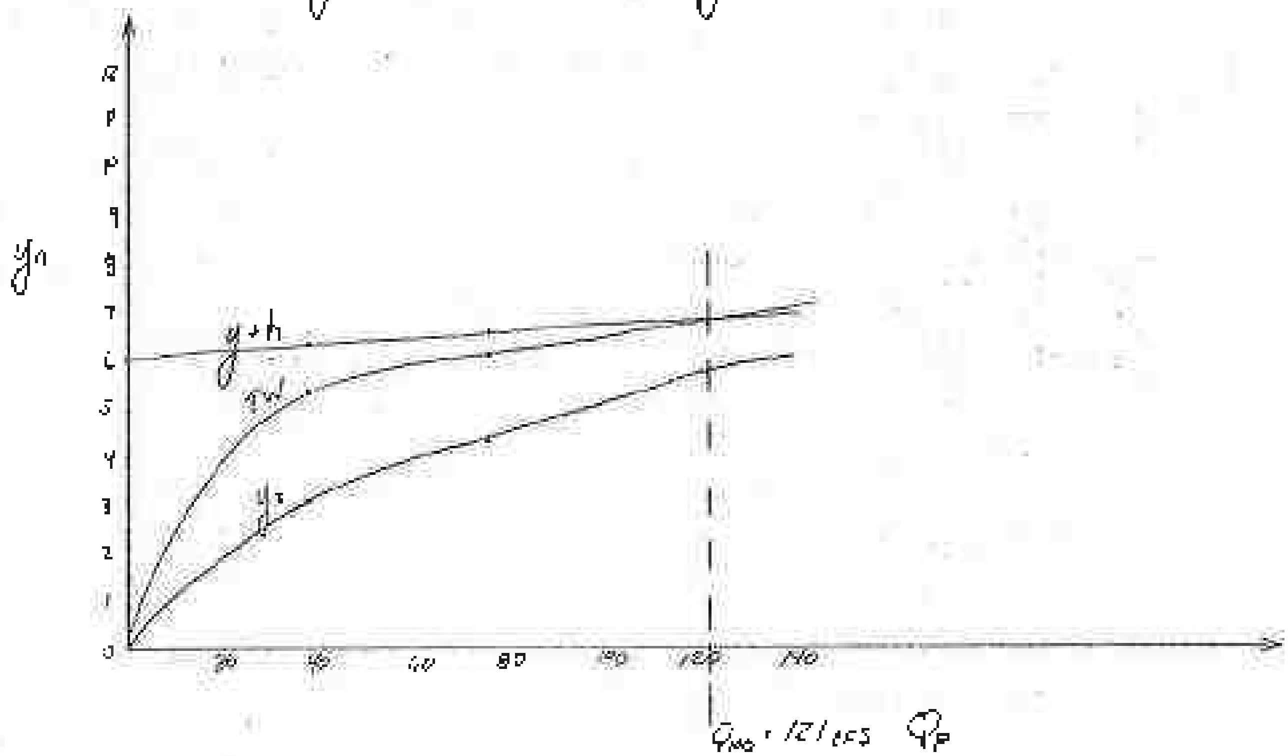
$y+h$ VS. TW. VS y_2



BY THE GRAPH, THE JUMP THEORETICALLY WILL OCCUR IN THE BASIN SINCE $y_2 < TW$ AND $TW < y+h$.

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EFFICIENCY OF JUMP

$$\frac{E_2}{E_1} = \frac{(8F_1^2 + 1)^{3/2} - 4F_1^2 + 1}{8F_1^2 (2 + F_1^2)} \times 100\,\%$$

Design Storm	Condition	Qp (cfs)	F_1	Efficiency (%)
2	I	37	4.70	53.6
10	I	74	3.80	63.2
100	I	121	3.31	69.7

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2 Middle Pool

The middle pool accepts the flow from the west weir, the east weir, and the stilling basin and empties into the main collector channel. The pool is affected by two cases that are influenced by downstream conditions. The two cases are described on sheets 77 and 78.

In analyzing the middle pool, the peak flows conducive to both cases will be studied for its effect on the structure, and the highest expected water elevation due to these peak flows will be calculated.

The outlet of the pool will be considered as a broad crested weir and will have the same shape as the downstream channel.

The total peak flows are summarized in the table below.

Design Storm	Condition	East Channel cfs	West Channel cfs	Stilling Basin cfs	Lower Benches cfs	Total Flow cfs
2	I	181	34	0.92	3	219
2	II	111	92	0.92	3	207
10	I	337	70	0.92	4	412
10	II	203	225	0.92	4	433
100	I	525	116	0.92	5	647 → Design Flow
100	II	314	408	0.92	5	728

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
Permanent Drainage Structures

BY MLA DATE 3/19/86 PROJ NO. 86-167
CHKD. BY DAY DATE 4/24/86 SHEET NO. 89 OF 102

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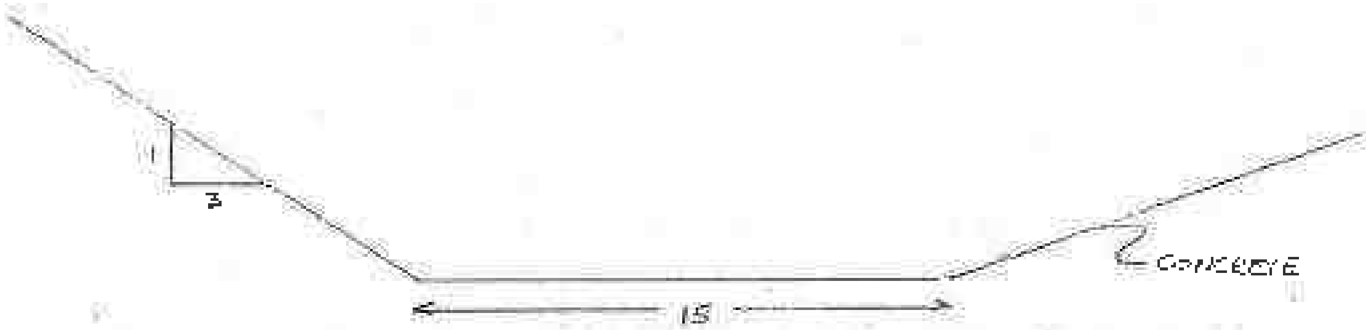
IN CASE 1, THE HIGHEST WATER ELEVATION DOWNSTREAM OF THE STRUCTURE IS EXPECTED TO BE THE TOP SURFACE ELEVATION OF THE HEAD DEVELOPED TO PASS THE 10 YR - 24 HR STORM THRU THE HIGH-LO STRUCTURE. THIS ELEVATION IS EXPECTED TO BE 1157.0 FT (SEE "HIGH-LO STRUCTURE DESIGN" CALCS, MLA, 3/14/86, 86-167).

IN CASE 2, THE HIGHEST WATER ELEVATION DOWNSTREAM OF THE STRUCTURE IS EXPECTED TO BE THE NORMAL HYDRAULIC DEPTH IN THE MAIN COLLECTOR CHANNEL.



$Qn / b^{8/3} S^{1/2}$ → WHERE $S = 0.5\%$

$128(0.012) / 15^{8/3}\, 0.005^{1/2} = 0.090$

$d/b = 0.165$

$d = 2.48$ FT

THE WORST CONDITION IS DURING CASE 1 WHERE THE MAXIMUM WATER ELEVATION IS 1157.0

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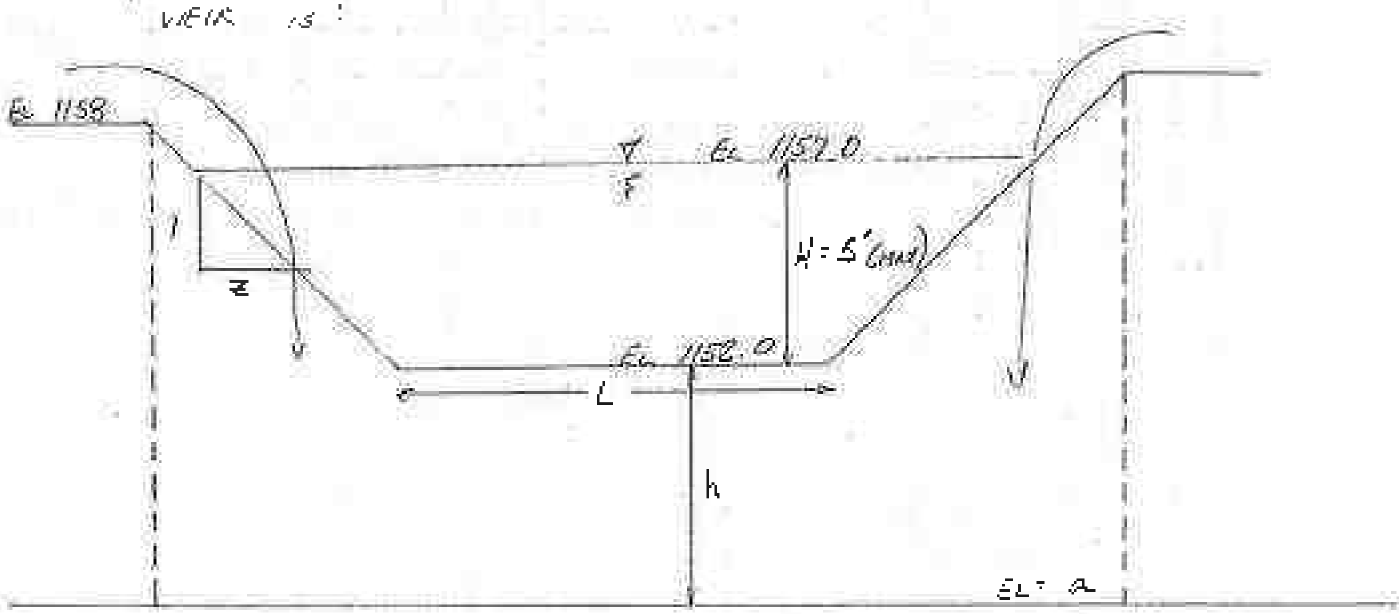
THE PERMISSIBLE HEAD PASSING THRU THE MIDDLE POOL WEIR IS:



USING BROADCRESTED WEIR EQUATION, FIND L, h, a, z

$$q = 0.433\sqrt{2g}\left(\frac{y_2}{y_2+h}\right)^{1/2} H^{3/2} \quad \text{WHERE } y_2 = h + H$$

DESIGN STORM	CONDITION	Q_T	y_2	L	h	H
2	I	219	10	20	5	2.46
2	II	207	10	20	5	2.36
10	I	412	10	20	5	3.75
10	II	433	10	20	5	3.88
100	I	647	10	20	5	5.06 → DESIGN DIMENSIO
100	II	728	10	20	5	5.48

SUBJECT

BY MLA DATE 4/4/86 PROJ NO 84-167

CHKD. BY DAY DATE 4/24/86 SHEET NO. 90A OF 102

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HYDRAULICS FOR ENERGY DISSIPATOR CONTINUE

PIPES ARE NEEDED TO DRAIN THE EAST AND WEST BASINS DURING LOW FLOW CONDITIONS SINCE THE SIDE WALL OF THE BASINS ARE NOT DESIGNED FOR ICE PRESSURES. THESE PIPES ARE TO BE AS LARGE AS POSSIBLE TO ACHIEVE EASY MAINTENANCE TO CLEAN ANY CLOGGED DEBRIS.

THE PIPES WILL BE LOCATED AT THE INVERT OF THE BASIN MAT AND WILL BE LOCATED ON THE WEIR WALL. THE FLOW WILL ACT AS AN ORIFICE FLOW AND WILL BE DESIGNED FOR VARIOUS FLOW VALUES, UPTO A 100 YEAR STORM.

SUBJECT ______

BY MLA DATE 4/14/86 PROJ. NO. 86-167
CHKD BY DAY DATE 4/24/86 SHEET NO. 90B OF 107

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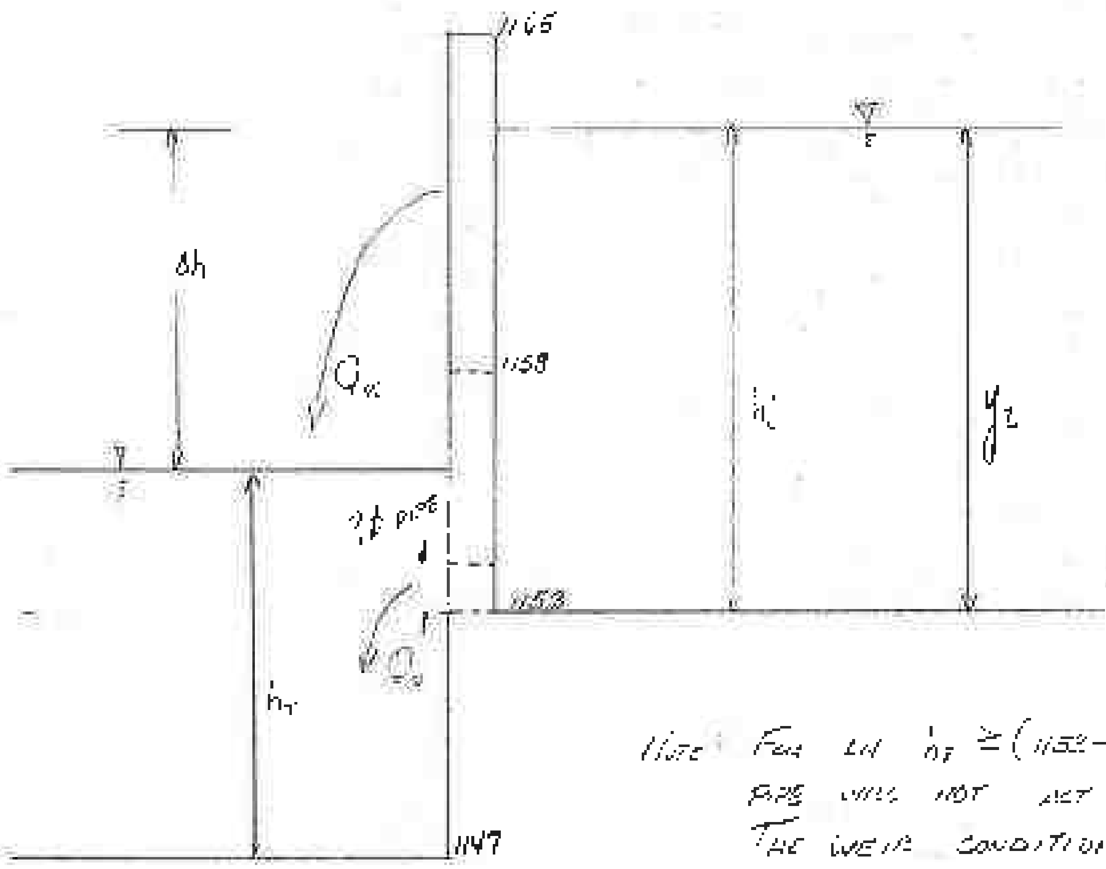
EAST BASIN:



NOTE: FOR AN $h_T \geq (1153 - 1147 + h_i)$, THE PIPE WILL NOT ACT AS AN ORIFICE. THE WEIR CONDITION WILL BE THE CONTROLLING FACTOR.

$Q_P = Q_o + Q_w$

ASSUME THAT 2 ONE FOOT DIAMETER PIPES WILL BE INCORPORATED INTO THE WALL. THIS WILL ACHEIVE ADEQUATE DRAINAGE OF THE BASIN AND EASY MAINTENANCE

CRITERIA: h_i CANNOT BE LESS THAN y_2 OR THE HYDRAULIC JUMP WILL NOT OCCUR IN THE BASIN.

FIND: Q_o AND THE NEW h_i DEVELOPED DUE TO THE DECREASE OF FLOW OVER THE WEIR. CHECK IF $h_{i\,NEW} \geq y_2$. IF h_i IS LESS THAN y_2, A SMALLER PIPE MUST BE USED.

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East Basin

Design Storm	Condition	Q_P (cfs)	y_2 (ft)	h_i estimate (ft)	h_T (ft)	Δh (ft)	Q_O (cfs)	$Q_W = Q_P - 2Q_O$ (cfs)	H_W (ft)	$h_{i\,new} = H_W + 5$ (ft)	$Q_{O\,new}$ (cfs)	$Q_O \approx Q_{O\,new}$	$h_{i\,new} \approx y_2$
2	I	181	6.34	8.65	7.96	7.19	10.14	160.72	3.37	8.37	9.94	YES	YES
2	II	111	4.87	7.74	7.36	6.38	9.55	91.90	2.42	7.42	9.31	YES	YES
10	I	337	8.86	10.28	8.75	7.53	10.38	316.24	5.06	10.06	10.22	YES	YES
10	II	203	6.74	8.90	8.88	6.02	9.28	184.44	3.66	8.66	9.09	YES	YES
100	I	525	11.26	11.91	10.06	7.95	10.60	503.80	6.72	11.72	10.47	YES	YES
100	II	314	8.53	10.06	10.48	5.58	8.93	296.14	4.86	9.86	8.77	YES	YES

Note: Condition II is ignored since Stage I is to be closed by the end of 1987.

Q_P, y_2, $h_i(TW)$ is taken from sheet 81 of 102

$h_T = h + H$ from sheet 90 of 102

$Q_{O(ORIF)} = CA\sqrt{2g\Delta h}$ where $C = 0.60$ and $A = \pi D^2/4$ $(D_O = 1\,ft)$
(Ref: Handbook of Hydraulics, Brater and King, 1976, pg 4.10)

$$H_W = \left[\frac{Q_W^2\,(y_2 + 5\,ft)}{0.433^2\,(2g)\,L^2\,\frac{y_2}{g}}\right]^{1/3}$$ → weir equation

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West Basin

Design Storm	Condition	Q_p (cfs)	y_c (ft)	h_1 estimate (ft)	h_T (ft)	Δh (ft)	Q_o (cfs)	$Q_w = Q_p - Q_o$ (cfs)	H_w (ft)	$H_{weir} = H_w + 4$ (ft)	Q_o new (cfs)	$Q_o \approx Q_{new}$	$H_{weir} > y_c$
2	I	37	3.02	5.38	7.46	4.92	8.39	20.22	0.92	4.92	7.99	YES	YES
10	I	74	4.41	6.05	8.75	4.30	7.84	58.32	1.75	5.75	7.56	YES	YES
100	I	121	5.76	6.74	10.06	3.68	7.25	106.5	2.52	6.52	7.03	YES	YES

Note: Condition II is ignored since Stage I is to be closed by the end of 1987.

Q_p, y_c, h_1 (est.) is taken from sheet 85

$h_T = h_1 + H$ from sheet 90

$Q_{o(new)} = CA\sqrt{2g\Delta h}$ where $C = 0.60$ and $A = \pi D^2/4$ ($D = 1$ ft)

$$H_w = \left[\frac{Q_w^2 (y_c + 4\text{ ft})}{0.433^2 (2g) L^2 y_c}\right]^{1/3}$$ → Broadcrested weir equation

Conclusion: 2 one foot diameter drains are adequate for draining the

MISCELLANEOUS HYDRAULIC STRUCTURE DESIGN

(1) WEST CHANNEL EXTENSION

THE WEST COLLECTION CHANNEL CONSIST OF TWO SECTIONS. THE FIRST SECTION STARTS AT COORDINATE N 393,150 E 1,630,820 AND ENDS AT THE DEPRESSION WEST OF THE HAUL ROAD, COORDINATE N 391,700 E 1,632,220. (SEE SHEETS 32 - 34 FOR DESIGN.) THE SECOND SECTION STARTS AT THE OUTLET END OF THE HAUL ROAD CULVERT, COORDINATE N 391,640 E 1,632,370, AND ENDS AT THE MAIN SITE COLLECTOR DISSIPATOR.

THE HYDROLOGY AND HYDRAULIC DESIGN FOR THE FIRST SECTION ARE DESCRIBED ON SHEETS 25 TO 34. THE HYDROLOGY FOR THE SECOND SECTION IS DESCRIBED ON SHEETS 75 AND 77. THE DIFFERENCE BETWEEN THE HYDROLOGY FOR SECTION ONE AND SECTION TWO IS DUE TO THE METHOD OF CONSTRUCTION AND DRAINAGE OF THE HAUL ROAD AND FRONT BENCHES OF STAGE II.

THE CALCS ON THE NEXT FEW PAGES CONSIST OF THE DESIGN OF SECTION 2 OF THE WEST COLLECTION CHANNEL, WEST CHANNEL EXTENSION.

SUBJECT PENELEC- CONEMAUGH 1986 STAGE II CONST
PERMANENT DRAINAGE STRUCTURES
BY MLA DATE 2/25/86 PROJ. NO. 86-167
CHKD. BY DBV DATE 4/24/86 SHEET NO. 92 OF 102

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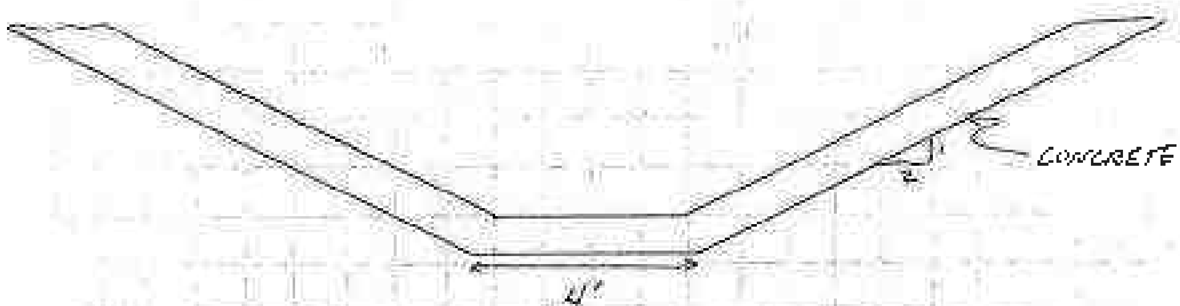
CHARACTERISTICS:

i THE CHANNEL EXTENDS FROM N391,440 E1,632,370 TO THE MAIN VALLEY DISSIPATOR.
ii THE DESIGN FLOW EQUALS 121 CFS (SHEET 77)
iii THE CHANNEL DRAINS RUNOFF FROM THE STAGE II BENCHES WEST OF THE HAUL ROAD, THE HAUL ROAD GUTTER AND SOME INCREMENTAL SECTIONS OF OFFSITE.
iv SLOPE RANGES FROM 5-6% TO 12.5%

DESIGN

i $Q = 121$ CFS
ii $S = 6$ TO 12.5 %
iii $n = 0.012$ CONCRETE LINED FOR IMPERMEABLE LINER
iv CHANNEL DEPTH



MINIMUM SLOPE = 6%

$Qn / b^{8/3} S^{1/2} = 0.147$

$d/b = 0.23$

$d = 0.92$ FT RECOMMEND 2.0 FT FOR FREEBOARD AND SUPERELEVAT(ION) (SEE SHEET 92)

v. Maximum expected velocity

$S \approx 12.5\%$ $d = 0.76$ ft

$$V = \frac{1.49}{0.012}\left(\frac{4(0.76) + 3(0.76)^2}{4 + 2(0.76)\sqrt{5}}\right)^{2/3} 0.125^{1/2}$$

$= 30.07$ fps

vi. Freeboard and superelevation

$F.B. = 0.025\, V\, d^{1/3}$
$= 0.025\,(30.1 \text{ fps})(0.76)^{1/3}$
$= 0.69$ ft

$S.E. = V^2 b / g R_c$

$= 0$ since channel is relatively flat

$d_{max} = 0.92 \text{ ft} + 0.69 \text{ ft} + 0$
$= 1.61$ ft ≈ 2 ft

SUBJECT Pennsylvania - Conemaugh 1986 Stage II Const.
Permanent Drainage Structures

BY MLA DATE 3/26/86 PROJ. NO. 86-11.7
CHKD. BY DAY DATE 3/25/86 SHEET NO. 94 OF 102

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Culvert Design

The culvert under the existing haul road is to be redesigned and relocated during the 1986 construction of Stage II. Its purpose is to carry runoff from the west collection channel, under the haul road and into the west channel extension that ultimately leads into the energy dissipator at the toe of Stage II. The culvert is designed to last during the life site of Stage II, therefore, it is designed for a 100 yr - 24 hour storm.

The design is based on methods described in HEC No 5 "Hydraulic Charts for the Selection of Highway Culverts". The design checks both inlet and outlet control.

The max peak flow expected to occur during the life site of Stage II is 116.5 cfs. (See sheet 95)

The culvert will be a circular culvert, CMP or RCP, with a square edge and a headwall.

The maximum head allowable for the culvert is 8.7 ft. This restriction on the allowable head prevents flooding of the haul road and excessive flooding in the surrounding area.

Note: The October, 1984 fly-over shows a 20 ft ± difference in elevation between the haul road and the depression. However, R&L filled in the depression with coal refuse and replaced the culvert at a higher elevation. Presently, Sam Englishes field notes dated March 25 states that there is only a 8.7 ft. drop between the haulroad and the invert of the culvert.

PROJECT: BG-117

DESIGNER: MLA

CHKD DMG 4/25/86 DATE: 3/31/86

HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = Q_{100} 116 CFS

Q_2 = ______

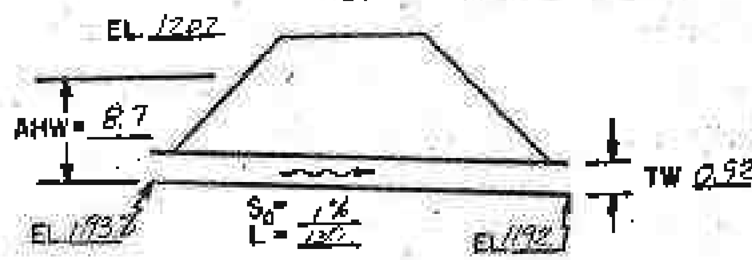
TW_1 = 0.92 (SEE SHEET 93)

TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ______



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

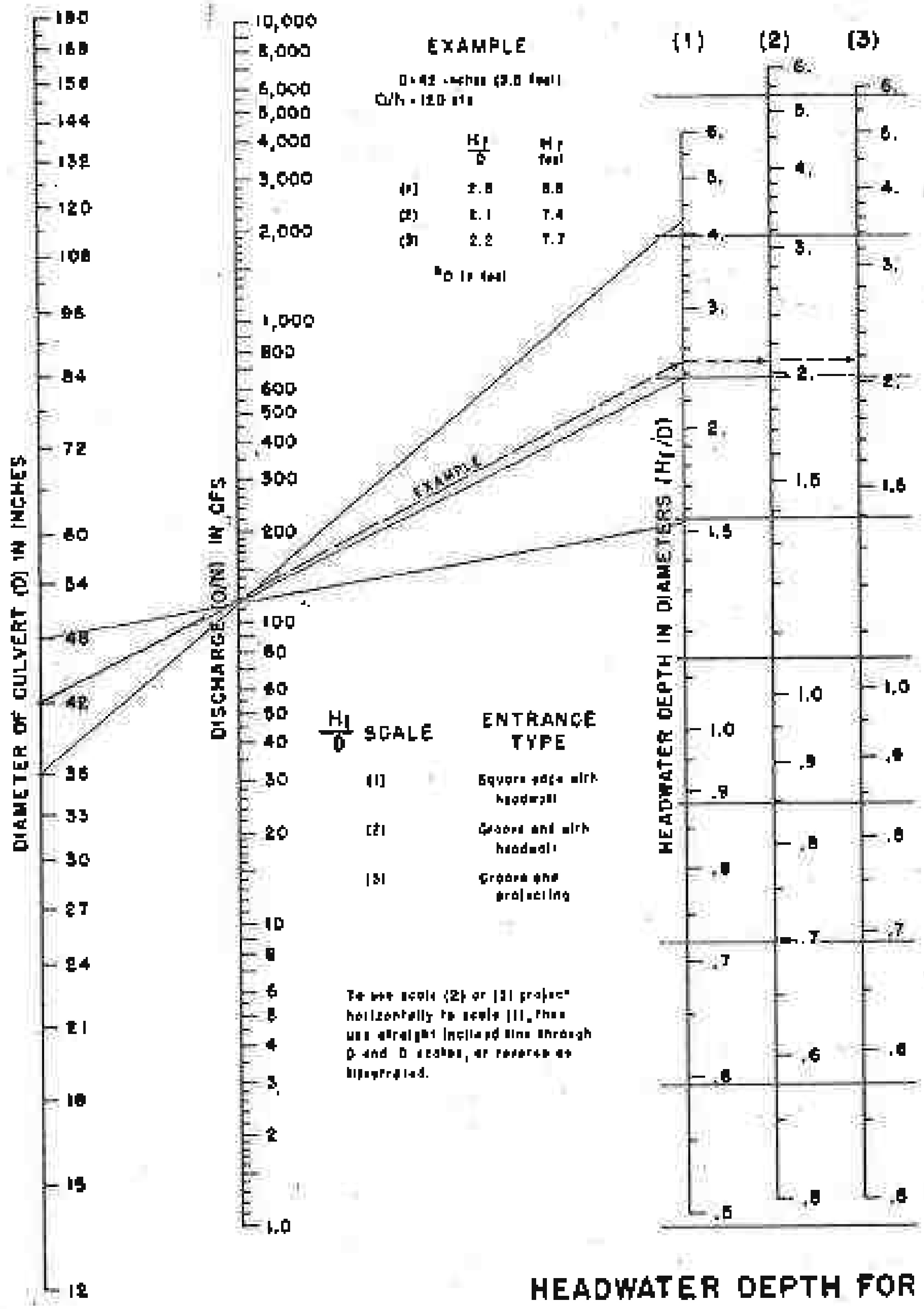
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
Concrete Pipe Square Edge w/ Headwall	116	36"	4.25	12.75												Head is too large
Concrete Pipe Square Edge w/ Headwall	116	42"	2.38	8.33	0.5	4.8	3.25	3.38	0.92	3.38	1.3	6.88	8.33			Inlet Control

SUMMARY & RECOMMENDATIONS:

Recommend 42" concrete pipe w/headwall

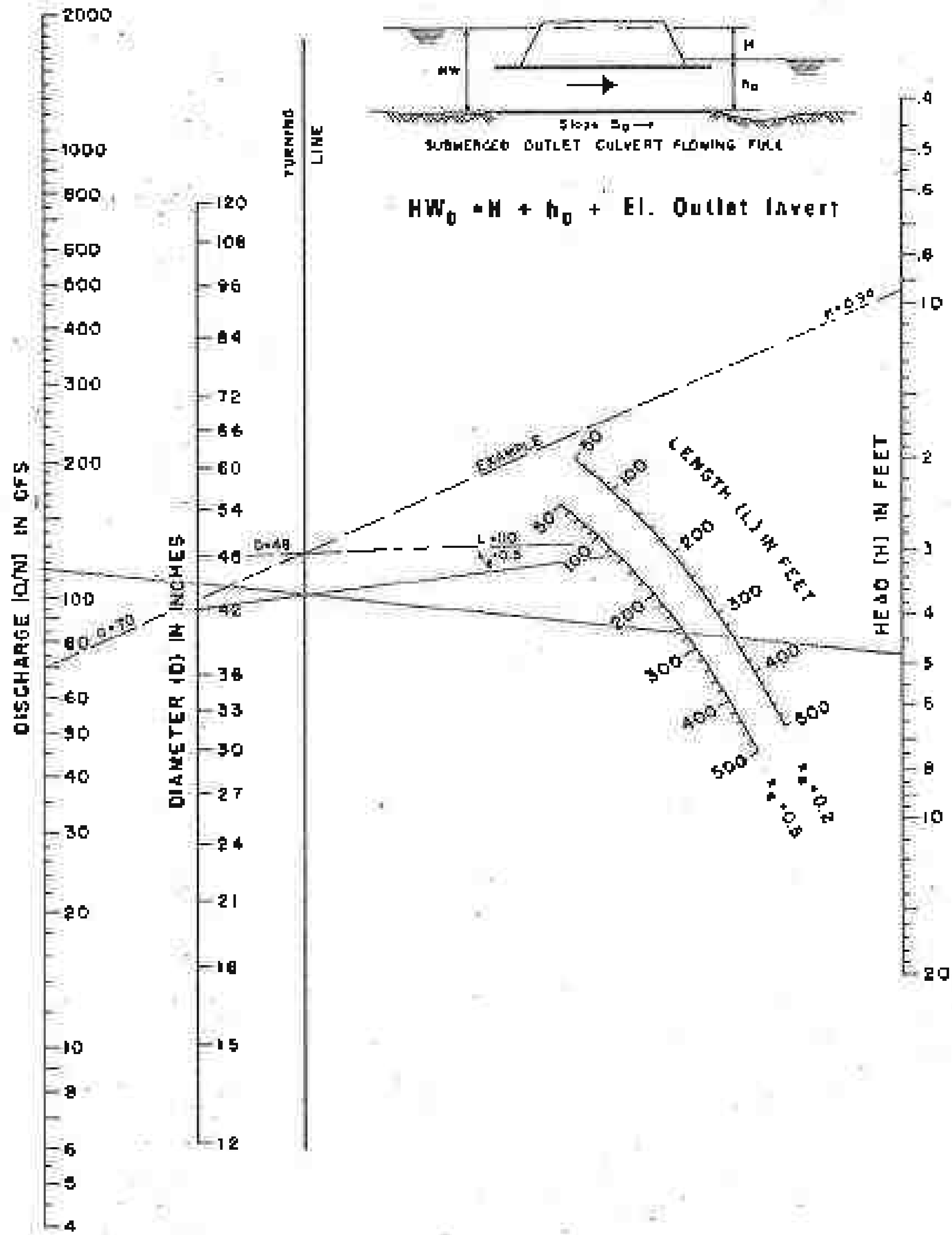
Figure 7

Chart 11



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Chart 2



HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL

$n = 0.012$

BUREAU OF PUBLIC ROADS JAN 1963

PROJECT: 86-147

CHKD DAH 4/25/86

DESIGNER: MLA

DATE: 3/31/86

HYDROLOGIC AND CHANNEL INFORMATION

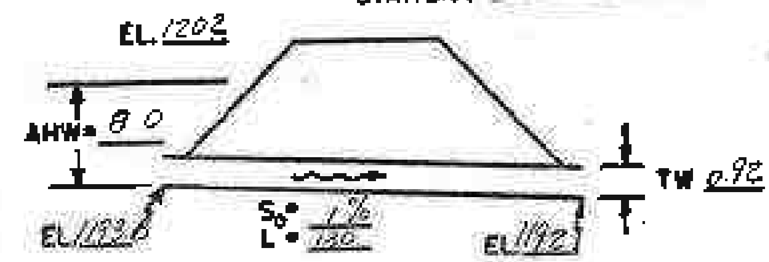
Q_1 = Q_{100} = 116 cfs TW_1 = 0.92

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ______



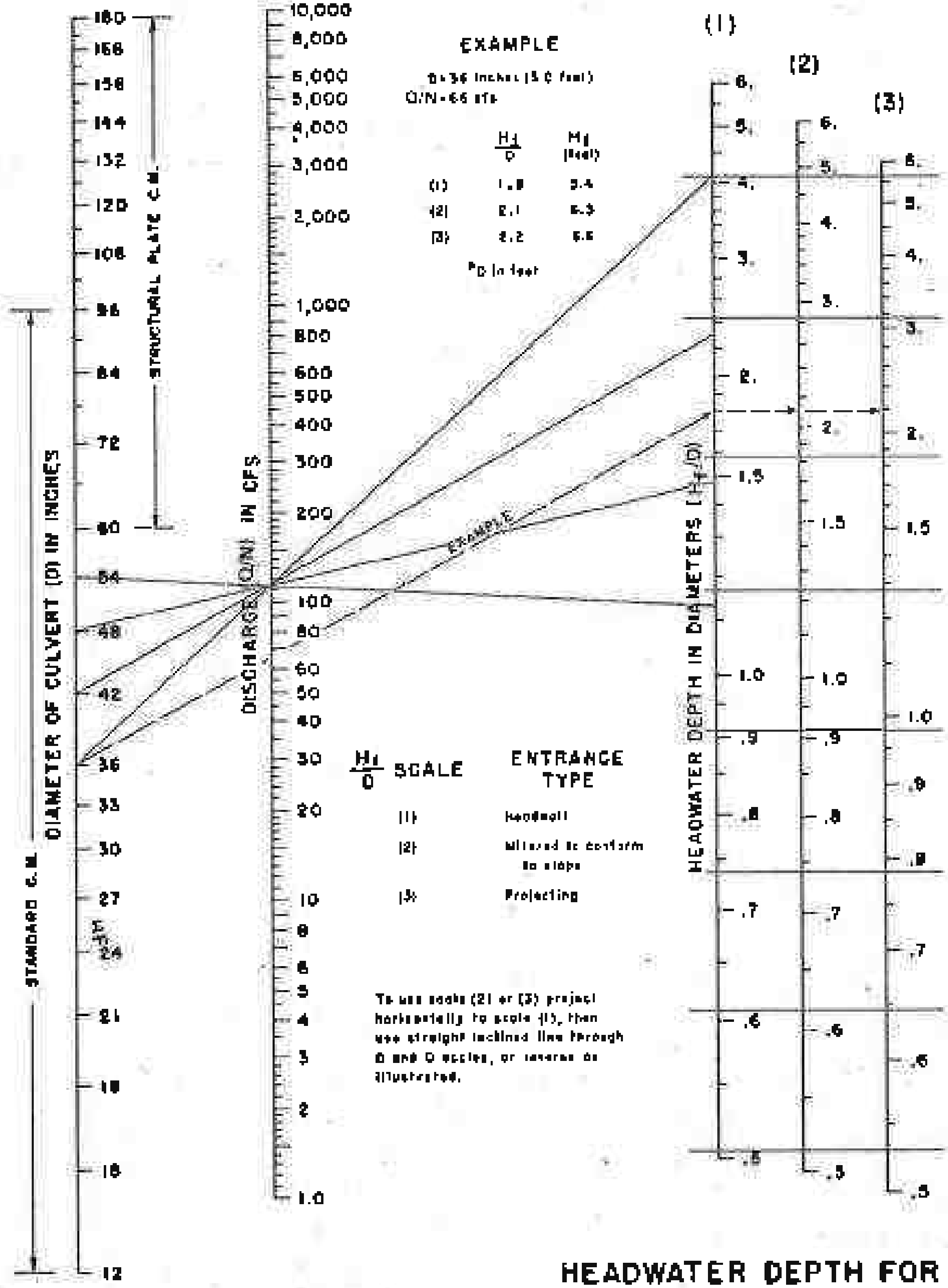
MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL $HW=H+h_o-LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
CMP w/ HEADWALL	116	36"	4.1	12.3												HEAD IS TOO HIGH
CMP w/ HEADWALL	116	42"	2.3	8.05	0.5	9.6	3.25	3.38	0.92	3.38	1.30	11.68	11.68			OUTLET CONTROL & HW IS TOO HIGH
CMP w/ HEADWALL	116	48"	1.48	5.92	0.5	4.8	3.2	3.6	0.92	3.6	1.30	7.1	7.1			OUTLET CONTROL
CMP w/ HEADWALL	116	54"	1.13	5.09	0.5	2.75	3.1	3.8	0.92	3.8	1.30	5.25	5.25			OUTLET CONTROL

SUMMARY & RECOMMENDATIONS:
USE 54" CMP; HOWEVER, USING A 42" CONCRETE SEEMS TO BE MORE ECONOMICAL

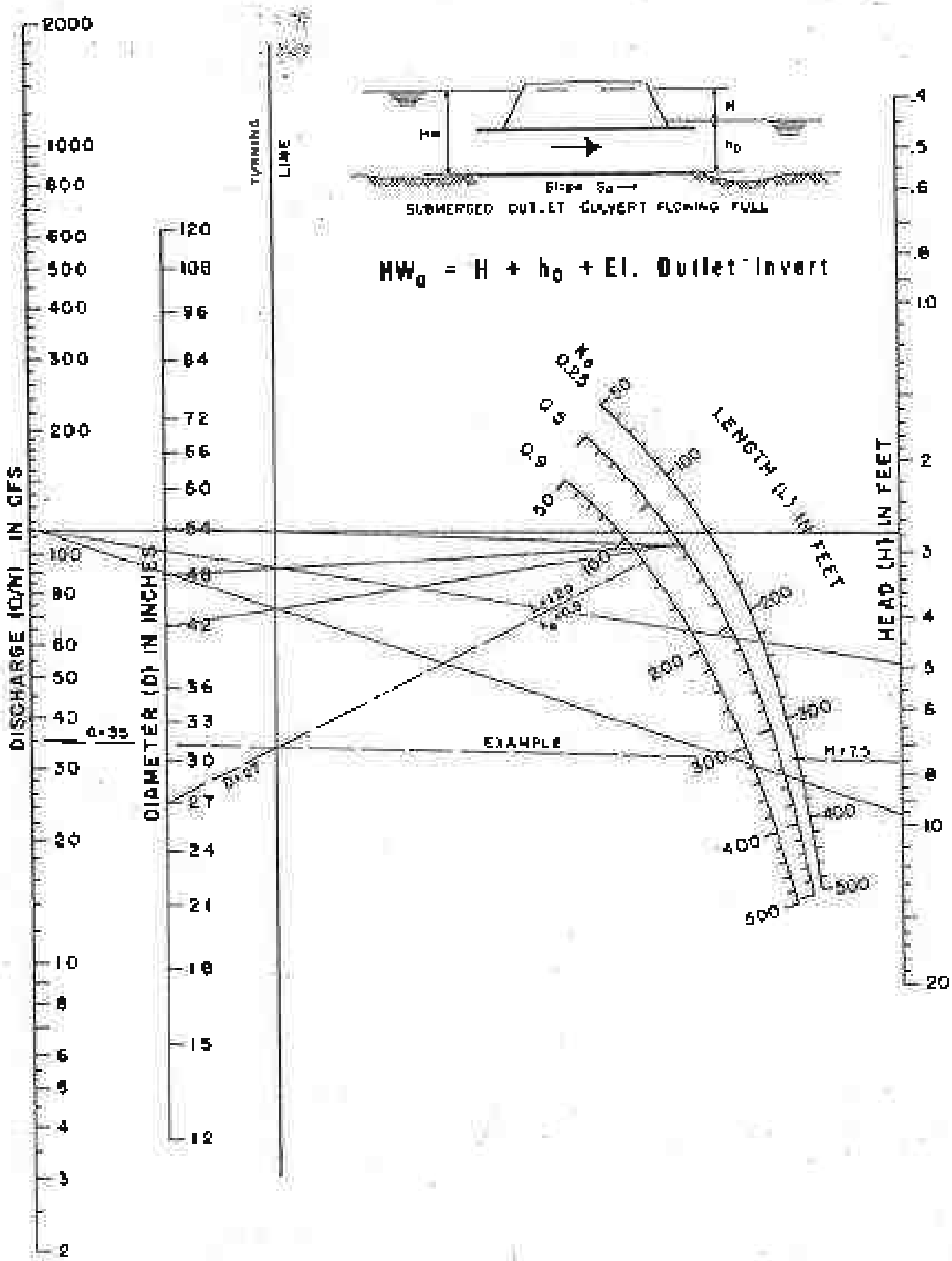
Figure 7

Chart 12



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

Chart 3



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

Table 1. - Entrance Loss Coefficients

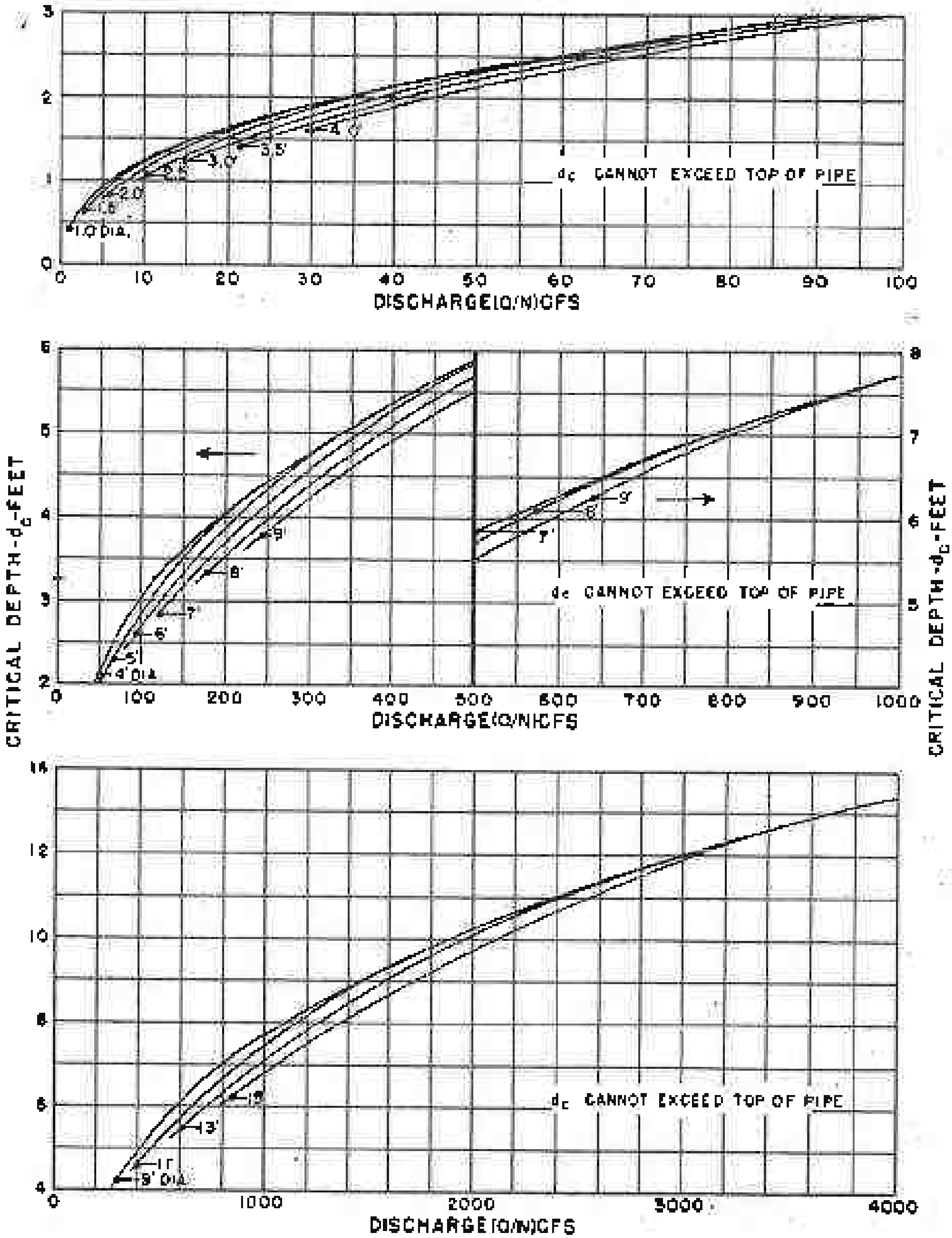
Coefficient k_e to apply to velocity head $\frac{V^2}{2g}$ for determination of head loss at entrance to a structure, such as a culvert or conduit, operating full or partly full with control at the outlet.

$$\text{Entrance head loss } H_e = k_e \frac{V^2}{2g}$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D).	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls	
Square-edge	0.5
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension	0.2
Wingwalls at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7

*Note: "End Section conforming to fill slope", made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the bevelled inlet, p. 5-13.

Chart 6



BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH CIRCULAR PIPE

(TYPE "K" CHANNEL)

SUBJECT PENELEC CONEMAUGH
SUPPLEMENTAL TO MODULE 13 STAGE II H&H STUDY

BY MLA DATE 9/20/85 PROJ. NO. 82-134-11

CHKD. BY DMK DATE 12/30/85 SHEET NO. 1 OF 1

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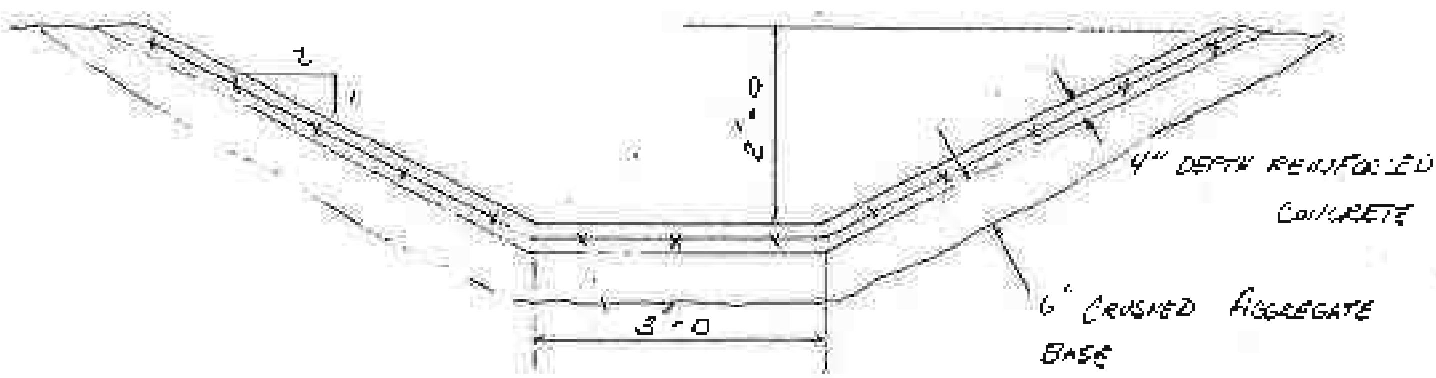
THE FOLLOWING CALC IS PERFORMED TO CHECK IF THE EXISTING CONCRETE CHANNEL THAT IS USED FOR THE EAST MAIN VALLEY DIVERSION IS SUFFICIENT TO HANDLE THE PEAK FLOW THAT WILL OCCUR FROM A 100 YR - 24 HR STORM.

CROSS SECTION OF EXISTING CHANNEL:



(REF: DWG No 82-134-F9, "CONEMAUGH STATION, L&H MINE REFUSE DISPOSAL SITE STAGE II 1983 CONSTRUCTION, DRAINAGE CHANNELS, DETAILS," RAC 7/3/83

DESIGN FLOW = 74.6 CFS (REF: CALCS, "PENELEC - CONEMAUGH, MODULE 13 STAGE II, H&H STUDY, 82-134-11, MLA 7-1-85, SHT 20 OF 24)

USE MANNING'S EQUATION
& CHANNEL DEPTH

MINIMUM SLOPE = 1% $n = 0.012$ (CHOW PG 111)

AS-BUILT DESIGN MINIMUM SLOPE = 7.3% ∴ 1% IS CONSERVATIVE

$Q_P = 74.6$ CFS $\longrightarrow \frac{74.6(0.012)}{3^{8/3}(.01)^{1/2}} = 0.478$

$d/b = 0.42$ (REF: HEC No. 14, DEC. 1975 PG III-18)

$d = 1.26$ USE $d = 2.0$ FOR FREEBOARD ∴ EXISTING CHANNEL IS ADEQUATE.

V_{max} @ SLOPE = 14% $d = 0.63$

$V = \frac{1.49}{0.012}\left(\frac{3(0.63)+2(0.63)^2}{\ldots}\right)^{2/3} 0.14^{1/2} = 27.7$ FPS

SUBJECT PENELEC - CONEMAUGH PERMITTING MODULE 14

EAST DIVERSION CHANNEL STAGE II

BY MLA DATE 5/15/86 PROJ. NO. 82-134-11

CHKD. BY TAG DATE 5/15/86 SHEET NO. 1 OF 2

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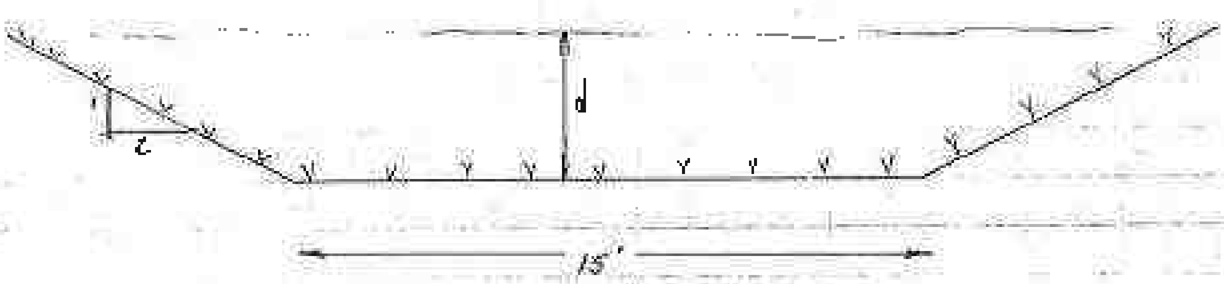
DESIGN THE EAST DIVERSION CHANNEL SO THAT IT WILL PASS THE EXPECTED 100 YR FLOW AND THAT IT WILL HAVE AN EASY TRANSITION TO GILBERT'S DESIGN WHICH STARTS AT COORDINATE N 390,766 E 1,633,200.

THE 100 YR FLOW IS CALCULATED TO BE 614 CFS. (SEE CALCS, "PENELEC CONEMAUGH, EAST VALLEY", KLF, 7/3/85, SHEET 3 OF 3).

GILBERT'S DESIGN FOR THE EAST DIVERSION CHANNEL CONSISTS OF A 15 FOOT BASE, 2:1 SIDESLOPES AND GRASS LINING.

THE MINIMUM AND MAXIMUM EXPECTED DESIGN SLOPES FOR THE CHANNEL IS 0.5% AND 2.0% RESPECTIVELY.

CHECK FOR THE DEPTH OF THE CHANNEL AND THE MAXIMUM VELOCITY.



USING MANNING'S EQUATION AND n = 0.035 FOR GRASS AND ENKAMAT

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

101.93 $$614\,cfs = \frac{1.49}{0.035}\left(15y + 2y^2\right)\left(\frac{15y + 2y^2}{15 + 2y\sqrt{5}}\right)^{2/3} S^{1/2}$$

$y = 4.2$ FOR $S = 0.005$ FT/FT

$y = 2.9$ FOR $S = 0.02$ FT/FT

SUBJECT PENELEC - CONEMAUGH PERMITTING MODULE 14

EAST DIVERSION CHANNEL STAGE II

BY MLA DATE 5/15/86 PROJ. NO. 82-194-11

CHKD. BY TAG DATE 5/15/86 SHEET NO. 2 OF 2

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TOTAL DEPTH FOR THE EAST DIVERSION CHANNEL SHOULD BE $d = 5 FT$ TO ALLOW FOR FREEBOARD.

$V_{MAX} = Q/A$

$= 614/(15(2.9) + 2(2.9)^2)$

$= 10.18$ FPS → THIS VELOCITY REQUIRES A ROCK LINING FOR EROSION PROTECTION

SINCE ON BORDERLINE - ROCK LINE OUTER SLOPE ONLY

$V_{MIN} = Q/A$

$= 614/(15(4.2) + 2(4.2)^2)$

$= 6.24$ FPS → THIS VELOCITY REQUIRES A GRASS LINING ACCOMPANIED WITH ENKAMAT.

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THESE CALCULATIONS WERE PERFORMED IN ORDER TO DETERMINE THE BUOYANCY OF THE ENERGY DISSIPATOR.

THE WEIGHT OF THE CONCRETE STRUCTURE MUST FIRST BE DETERMINED. ASSUME A UNIT WEIGHT OF CONCRETE = 150 PCF.

EAST BASIN:

BASE SLAB - AREA: 105'-3" x 40'-6" = 4,262.6 FT²
THICKNESS OF SLAB: 1'-0
VOLUME = 4,262.6 FT² x 1.0 FT x 1 YD³/27 FT³
= 157.9 YD³

WALLS = TWO WALLS @ 100' LENGTH x 10 1/2"
HEIGHT RANGES FROM: 1165 - 1153.25 = 11.75 FT TO
1165 - 1153 = 12.0 FT

AREA = 1/2 (11.75 + 12.0) (100') = 1,187.5 FT² (EACH WAL[L])
VOLUME = 2 WALLS x 1,187.5 FT² x 10.5/12 FT x 1 YD³/27 F[T³]
= 77.0 YD³

END WALL IS 31.75' x 11.75' x 10 1/2" WITH A CUT-OUT FOR DRAINAGE CHANNEL.

AREA OF WALL = 31.75 FT x 11.75 FT - 1/2 (6+18) 3
= 337.1 FT²
VOLUME = 337.1 FT² x 10 1/2/12 FT x 1 YD³/27 FT³
= 10.9 YD³

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VOLUME OF EAST BASIN = 157.9 + 77.0 + 10.9 = 245.8 YD^3

WEST BASIN :

BASE SLAB - AREA = 54'-0 x 28'-0 = 1,512 FT^2
THICKNESS OF SLAB = 1'-0
VOLUME = 1,512 FT^2 x 1.0 FT x $1 YD^3/27 FT^3$
= 56.0 YD^3

WALLS - TWO WALLS @ 50'-0 x 10"
HEIGHT RANGES FROM : 1162 - 1154.125 = 7.875 ft. TO
1162 - 1154 = 8 FT.

AREA = $\frac{1}{2}(7.875 + 8.0)(50)$ = 396.9 FT^2 (EACH WALL)
VOLUME = 2 WALLS x 396.9 FT^2 x 10/12 FT x $1 YD^3/27 FT^3$
= 24.5 YD^3

END WALL IS 21.67' x 8.875' x 10" WITH
A CUT-OUT FOR DRAINAGE CHANNEL.

AREA OF WALL = 21.67' x 8.875' - $\frac{1}{2}(4+16)3$
= 162.3 FT^2
VOLUME = 162.3 x 10/12 x $1 YD^3/27 FT^3$
= 5.0 YD^3

VOLUME OF WEST BASIN = 56.0 + 24.5 + 5.0 = 85.5 YD

SUBJECT PENELEC - CONEMAUGH
BUOYANCY OF ENERGY DISSIPATOR

BY DMK DATE 4/24/86 PROJ NO 86-167-14
CHKD. BY DAY DATE 4/29/86 SHEET NO 3 OF 9

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CENTRAL BASIN :

BASE SLAB - AREA = 32.3 IN² PLANIMETERED.
= 32.3 IN² × (1.0 FT / 1/8 IN)²
= 2,067.2 FT²
THICKNESS = 2'-0
VOLUME = 2,067.2 FT² × 2 FT × 1 YD³/27 FT³
= 153.1 YD³

NORTH WALL - 20'-6½" × 11'-0 × 1'-5½" WITH A 4×4' CUT-OUT FOR DRAINAGE CHANNEL.

VOLUME = [20'-6½ × 11'-0 − (4 × 4)] × 1'-5½"
= 209.96 FT² × 1.46' × 1 YD³/27 FT³
= 11.4 YD³

SOUTH WALL = 39' × 5' + 2 (½)(9.5)(9.5) = 285.3 FT²
VOLUME = 285.3 FT² × 1'-5½ × 1 YD³/27 FT³
= 15.4 YD³

EAST WALL - AREA = 31.75' × 18' WITH A 10' × 7' CUT-OUT FOR DRAINAGE CHANNEL.

AREA = 31.75 × 18 − 10 × 7 = 501.5 FT²
VOLUME = 501.5 FT² × 1'-8½" × 1 YD³/27 FT³
= 31.7 YD³

WEST WALL - AREA = 29'-2" × 15'-0 WITH A 10' × 4 CUT-OUT FOR DRAINAGE CHANNEL, PLUS A 9.125' × 8' SECTION.
AREA = 29'-2" × 15'-0 + 9.125' × 15' − 10 × 4
= 534.4 FT²

VOLUME = 534.4 FT² x 1'-8½" x 1 YD³/27 FT³
= 33.8 YD³

VOLUME OF CENTRAL BASIN = 153.1 + 11.4 + 15.4 + 31.7 + 33.8
= 245.4 YD³

TOTAL CONCRETE = 245.8 CY. + 85.5 CY. + 245.4 CY.
= 576.7 C.Y.

WEIGHT OF CONCRETE = 576.7 C.Y x 150 LB/FT³ x 27 FT³/YD
= 2,335,635 LBS.

THE BUOYANT FORCE EQUALS THE WEIGHT OF WATER DISPLACED.
EXAMINE CONDITION OF WATER TABLE AT GROUND SURFACE.

EAST BASIN - TOP OF WALL = 1165
GROUND SURFACE = 1164

VOLUME OF WATER DISPACED = VOLUME OVER BASE SLAB (INCLUDING SLAB) - MATERIAL OVER PROTRUDIN PORTION OF SLAB.

VOLUME OVER SLAB = 105.25' x 40.5' x 11'
= 46,889 FT³

UPWARD FORCE = 46,889 x 62.4 = 2,925,874 LB

SUBJECT PENELEC - CONEMAUGH
BUOYANCY OF ENERGY DISSIPATOR

BY DMK DATE 4/24/86 PROJ. NO 86-167-1A
CHKD. BY DAY DATE 4/29/86 SHEET NO 5 OF 9

AREA OF DOWNWARD FORCE = 2 x 105.25' x 4'-4½" + 31.75' x 4'-4½"
= 1,059.8 FT²

VOLUME OF SOIL + WATER = 1,059.8 x 12 = 12,718 FT³

ASSUME DRY UNIT WEIGHT OF AASHTO NO. 57 STONE = 130 PCF
POROSITY = 0.30

γ_{wet} AASHTO NO. 57 STONE = 130 PCF + 0.30 (62.4) = 148.7

USE γ_{wet} = 145 PCF.

DOWNWARD FORCE = 12,718 FT³ x 145 PCF (SOIL + WATER) + 245.8 x 150 x 27 (CONCRETE)
= 2,839,600 LBS.

NET BUOYANT FORCE = 2,925,874 - 2,839,600 = 86,274 LB.

THIS HIGH BUOYANT FORCE INDICATES THAT SUBGRADE DRAINS MUST BE INSTALLED TO LOWER THE WATER TABLE AROUND THE ENERGY DISSIPATOR.

EVALUATE THE BUOYANCY OF THE DISSIPATOR BY FINDING THE WEIGHT OF THE WATER DISPLACED.

EAST BASIN:

SECTION THROUGH WEST END -

SUBJECT: PENELEC - CONEMAUGH
BUOYANCY OF ENERGY DISSIPATOR

BY: DHK DATE: 4/28/86 PROJ. NO. 86-167-14
CHKD. BY: DAV DATE: 4/25/80 SHEET NO. 6 OF 9

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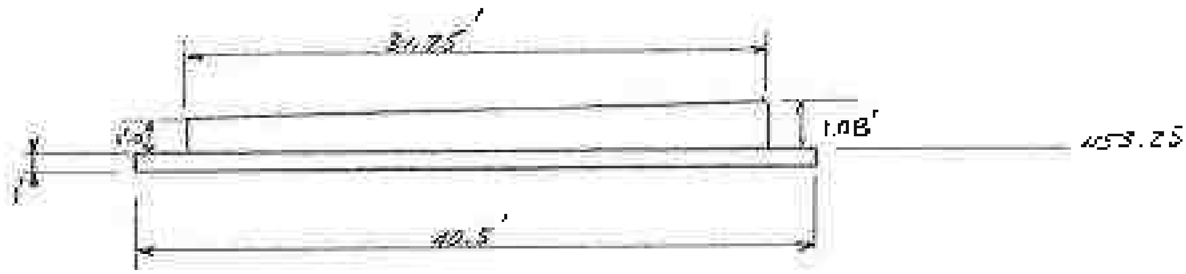
AREA = 40.5' x 1.0' + ½(1.0 + 1.58)(31.75') = 81.46 FT²

SECTION THROUGH EAST END -



AREA = 40.5' x 1.0' + ½(1.0 + 1.08)(31.75') = 73.52 FT²

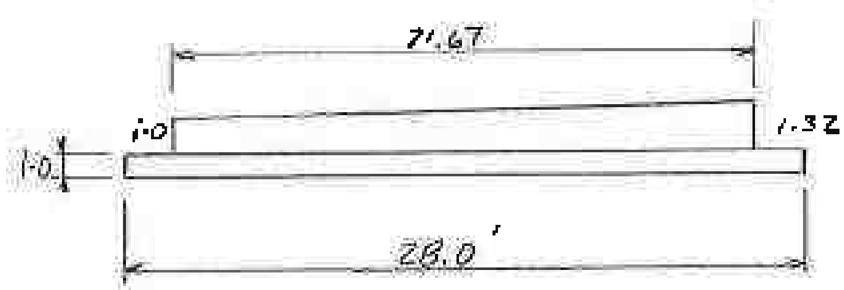
VOLUME = ½(81.46 + 73.52)(100.875') + 40.5 x 4.375 x 1.0

= 7,994 FT³

BUOYANT FORCE (EAST BASIN) = 7,994 FT³ x 62.4 PCF = 498,826 (

WEST BASIN :

SECTION THROUGH EAST END



AREA = 28.0' x 1.0' + ½(1.0 + 1.32)(21.67) = 53.14 FT²

SUBJECT PENELEC - CONEMAUGH
BUOYANCY OF ENERGY DISSIPATOR
BY DMK DATE 4/28/86 PROJ. NO. 86-167-14
CHKD BY DAY DATE 4/29/86 SHEET NO. 7 OF 9

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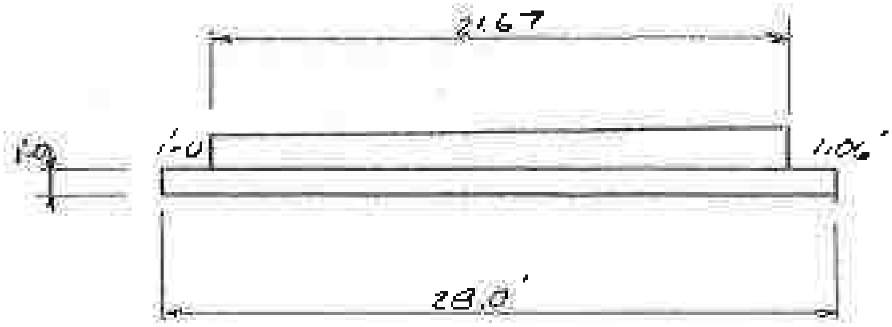
SECTION THROUGH WEST END.



AREA = 28.0 X 1.0 + ½ (1.0 + 1.06)(21.67) = 50.32 FT²

VOLUME = ½ (53.14 + 50.32)(50.83) + 3.17 X 28.0 X 1.0

= 2,718 FT³

BUOYANT FORCE (WEST BASIN) = 2,718 FT³ X 62.4 PCF = 169,603 LB.

CENTRAL BASIN:

AREA OF BASE SLAB = 2,067.2 FT² (SEE SHT. 3)
THICKNESS = 2'-0

VOLUME = 2,067.2 X 2.0 = 4,134 FT³

TOP OF BASE SLAB = 1147'
ASSUME THAT WATER TABLE MAY RISE TO 1156

AREA OF CENTRAL BASIN = 17.0 IN² X $\left(\frac{8\ FT}{1\ IN}\right)^2$ = 1088 FT²

VOLUME = 1,088 FT² X 9 FT = 9,792 FT³

TOTAL VOLUME = 4,134 + 9,792 = 13,926 FT³

SUBJECT PENELEC - CONEMAUGH
BUOYANCY OF ENERGY DISSIPATOR

BY DMK DATE 4/28/86 PROJ. NO. 86-167-14
CHKD BY DAY DATE 4/29/86 SHEET NO. 8 OF 9

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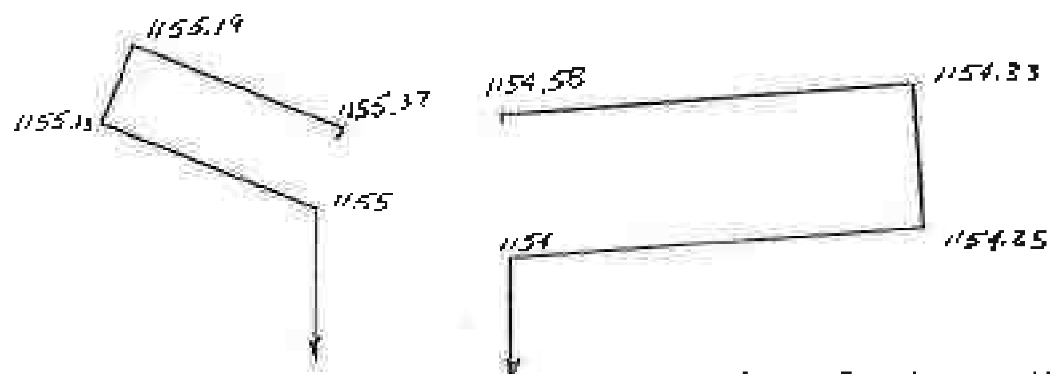
BUOYANCY FORCE (CENTRAL BASIN) = 13,926 $FT^3 \times 62.4$ pcf

= 868,982 LB.

TOTAL BUOYANCY FORCE = 498,826 + 169,603 + 868,982

= 1,537,411 LBS

THE DRAIN ELEVATIONS AS DESCRIBED BELOW WILL BE ADEQUATE TO KEEP THE BUOYANT FORCE LESS THAN THE WEIGHT OF THE STRUCTURE.



PIPES AROUND DISSIPATOR SLOPED AT 0.25%.

SUBJECT PENELEC- CONEMAUGH
BUOYANCY OF ENERGY DISSIPATOR

BY DMK DATE 4/23/86 PROJ NO 86-167-
CHKD BY DAV DATE 4/25/86 SHEET NO 9 OF 9

CHECK BUOYANCY OF EACH BASIN:

EAST BASIN:

VOLUME OF BASIN = 245.8 YD^3

WEIGHT OF BASIN = 245.8 YD^3 × 27 FT^3/YD^3 × 150 PCF

= 995,490 LBS.

BUOYANT FORCE = 478,824 LBS

EAST BASIN IS STABLE SINCE WEIGHT > BUOYANT FORCE.

WEST BASIN:

VOLUME OF BASIN = 85.5 YD^3

WEIGHT OF BASIN = 85.5 YD^3 × 27 FT^3/YD^3 × 150 PCF

= 346,275 LBS.

BUOYANT FORCE = 169,603 LBS.

WEST BASIN IS STABLE SINCE WEIGHT > BUOYANT FORCE

CENTRAL BASIN:

VOLUME OF BASIN = 245.4 YD^3

WEIGHT OF BASIN = 245.4 YD^3 × 27 FT^3/YD^3 × 150 PCF

= 993,870 LBS.

BUOYANT FORCE = 868,982 LBS.

CENTRAL BASIN IS STABLE SINCE WEIGHT > BUOYANT FORC

SUBJECT PENELEC - CONEMAUGH 1986 STAGE II CONST.
HIGH-LO STRUCTURE DESIGN

BY MLA DATE 3/10/86 PROJ NO 86-147-14
CHKD BY DAY DATE 4/24/86 SHEET NO. 1 OF 17

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HIGH-LO STRUCTURE

THE FOLLOWING CALCS INVOLVE THE DESIGN OF A HIGH-LO WATER STRUCTURE ON THE DELIVERY ROAD AT THE STAGE II TPE. THE HIGH-LO STRUCTURE WILL CONSIST OF A MULTI-PIPE OR BOX STRUCTURE THAT WILL PASS THE FLOW FROM A SMALL STORM EVENT (2 OR 5 YEAR) AND A DRAINAGE SWALE, ACTING AS A WEIR, THAT IS INCORPORATED IN THE ROAD THAT WILL PASS, WITH THE HELP OF THE MULTI-PIPES, A DESIGN FLOW FOR A 10 YR STORM.

THE HYDROLOGY FOR THE 10 YEAR STORM HAS ALREADY BEEN CALCULATED. REFERRING TO THE "PERMANENT DRAINAGE STRUCTURES, CONEMAUGH 1986 STAGE II CONST." CALCS, 86-147, 2/10/86, SHEET OF , THE 10 YEAR - 24 HOUR PEAK FLOW THAT IS EXPECTED TO AFFECT THIS AREA IS 428cfs. THIS FLOW IS THE FLOW FROM THE EAST COLLECTION CHANNEL, WEST COLLECTION CHANNEL, STILLING BASIN, AND HAUL ROAD DRAINAGE THAT DRAIN INTO THE MAIN SITE DISSIPATOR AND EXIT THE VALLEY BY THE MAIN COLLECTION CHANNEL. THE HIGH-LO STRUCTURE IS LOCATED BETWEEN THE MAIN SITE DISSIPATOR AND THE MAIN COLLECTION CHANNEL AND IS TO PASS THE PEAK FLOW WITHOUT BACKWATERING INTO THE STAGE II TPE. SEE THE ATTACHED WORKSHEET.

SUBJECT PENELEC – CONEMAUGH ABL STAGE II CONST
HIGH-LO STRUCTURE DESIGN
BY MLA DATE 3/10/86 PROJ. NO. 86-167
CHKD. BY DAY DATE 4/24/86 SHEET NO. 2 OF 17

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HYDROLOGY :

THE INPUT DATA TO RUN THE TR 20 COMPUTER PROGRAM IS SIMILAR FOR EACH STORM EVENT EXCEPT THE EXPECTED PRECIPITATION. THE STORM EVENT AND THE CORRESPONDING DESIGN FLOWS ARE LISTED BELOW. THE FLOWS ARE LISTED ON SHEET ___ OF ___.

STORM EVENT (YRS)	PPT (IN)	DESIGN FLOW (CFS) CONDITION I	CONDITION II
2	2.7	215	205
10	4.0	407	428
100	5.5	641	722

NOTE: CONDITION I AND CONDITION II ARE DESCRIBED IN THE "PERMANENT DRAINAGE STRUCTURE CALCS, 86-167, 2/19/86, SHEETS AND .

OTHER DESIGN CRITERIA, BESIDES THE PEAK FLOWS, THAT ARE IMPERATIVE IN DESIGNING THE HIGH-LO WATER STRUCTURE ARE:

1. RESTRICTIVE DEVELOPED HEAD, HIGHEST WATER SURFACE ELEVATION EQUALS 1156.8
2. USE OF CONCRETE HEADWALL AT INLET AND OUTLET
3. RESTRICTIVE SIZE OF CULVERT
   A. THICKNESS OF PIPE OR BOX
   B. HEIGHT OF COVER ON PIPE
      i. NOT NECESSARY ON BOX
      ii. IF USING A SMALL, HIGH STRENGTH CONCRETE PIPE, MINIMUM HEIGHT COVER IS 12 INCHES.
   C. RESTRICTIVE ELEVATION OF INVERT OF CULVERT, 1151.5 FT. THIS REQUIRES MINIMAL REGRADING OF THE MAIN SITE COLLECTOR.

SUBJECT Peneles - Conemaugh 1986 Stage II Const.
High-Lo Structure Design

BY MCA DATE 8/10/86 PROJ. NO 86-167
CHKD. BY DAY DATE 11/24/86 SHEET NO 3 OF 17

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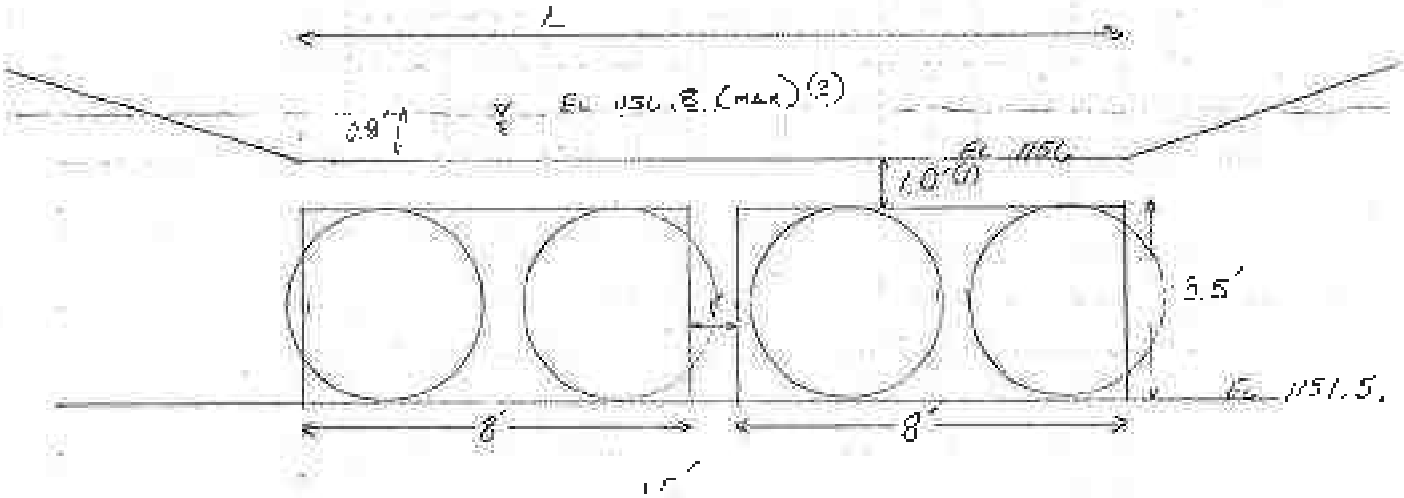
Cross-section at inlet of High-Lo Structure



Note: (1) 12" cover includes the depth of cover and the pipe's wall thickness. If a box culvert is used, the 12" is the box's wall thickness.

(2) Referring to DWG No 82-134-FB1, the headwater is restricted to elevation 1156.75 ≈ 1156.8 due to the prevention of having the water backflow into the pipes that empty into the stilling basin.

Channel slope downstream of culvert is approximately:

$$\frac{1151.1 - 1150}{360} \times 100\% = 0.3\% \rightarrow \text{Requires regrading}$$

Slope of culvert

$$\frac{1151.5 - 1151.1}{80} \times 100\% = 0.5\%$$

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
High - Lo Structure Design

BY MLA DATE 3/11/86 PROJ. NO 86-167

CHKD. BY DAY DATE 4/24/86 SHEET NO. 4 OF 17

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LO STRUCTURE

In designing the Lo structure, HEC No. 5 will be used. Pipes will be sized for each design flow from storm events 2 and 10 year. The attached charts illustrate the design process. (Test 10 year to see if weir is really needed. If weir is not needed, pipe or box may be higher than 3 feet)

Steps:

1. Find a pipe or box size that is circle 42" in height
2. Using the dimensions of the pipe, calculate HW/D

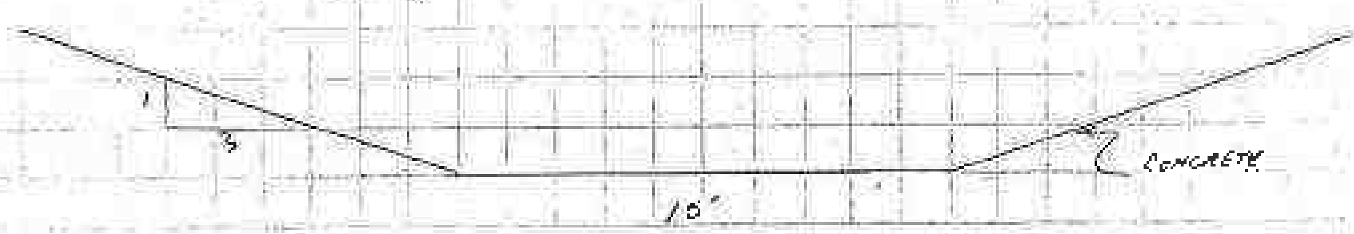
$$HW/D = \frac{\text{Height of water above the invert of the pipe}}{\text{Height of pipe}}$$

3. Draw a straight line through the D, Q and 1, 2, or 3 scales
4. Calculate or find the Q that the line passes thru
5. Calculate the number of pipes required

No. of pipes = Q_{design}/Q (Use a maximum of 3)

6. Test for outlet control

Tailwater, TW, is calculated for the 100yr storm for the main site collector.
(For dimensions of main site collector, see Coal Refuse Disposal Permit Application, 82-134-11, July 1985)



SUBJECT Keuzler - Conemaugh 1986 Stage II Const
High - Lo Structure Design

BY MLA DATE 3/11/86 PROJ. NO. 86-147

CHKD BY DAY DATE 4/24/86 SHEET NO. 5 OF 17

GAI CONSULTANTS, INC.
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$$Q_i = 428\ cfs \rightarrow \frac{428\,(0.012)}{15^{(8/3)}\,(0.003)^{1/2}} = 0.068$$

$$d/b = 0.14$$

$$d = 2.10\ FT$$

Table 1. - Entrance Loss Coefficients

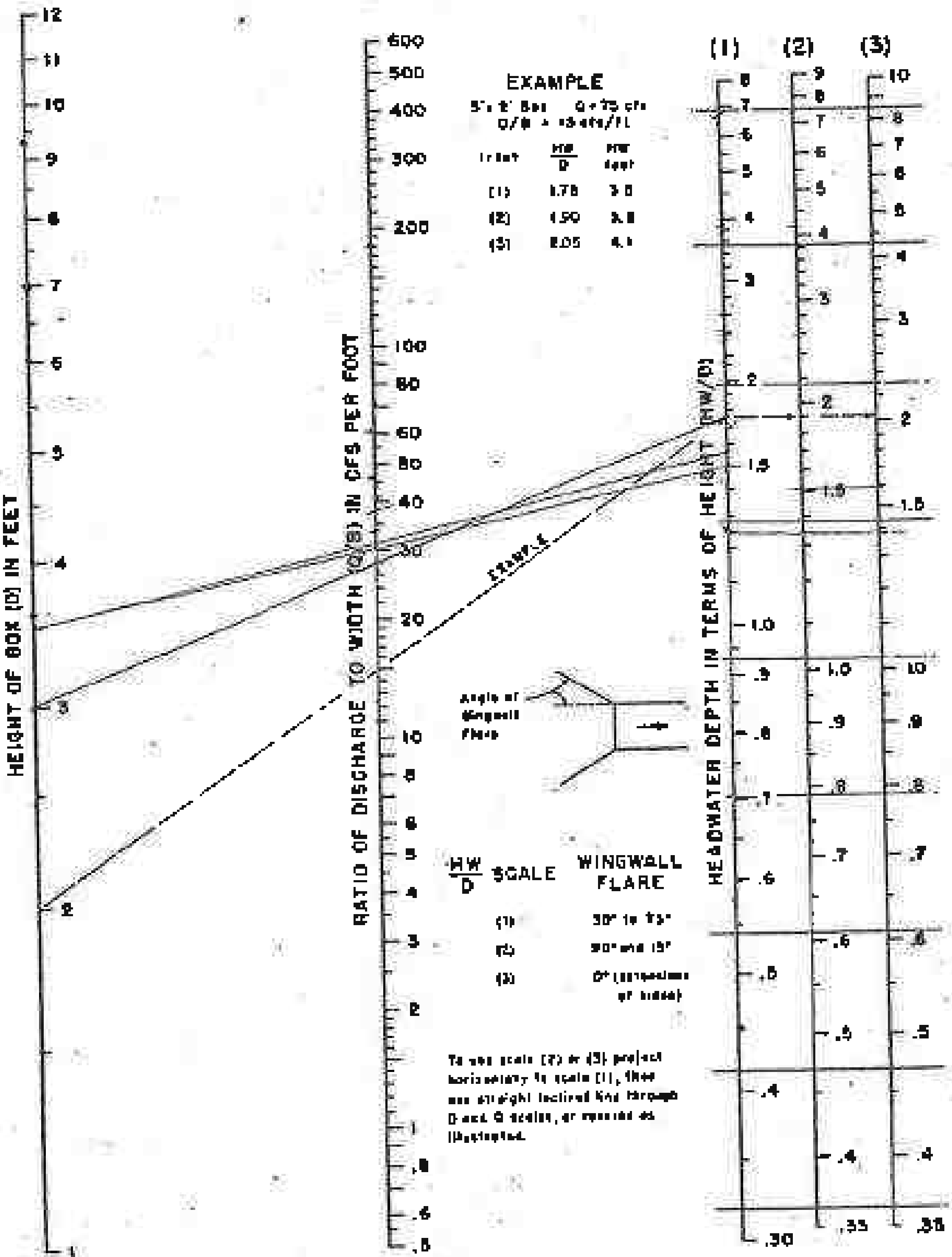
Coefficient k_e to apply to velocity head $\frac{V^2}{2g}$ for determination of head loss at entrance to a structure, such as a culvert or conduit, operating full or partly full with control at the outlet.

$$\text{Entrance head loss } H_e = k_e \frac{V^2}{2g}$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls	
Square-edge	0.5
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension	0.2
Wingwalls at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7

*Note: "End Section conforming to fill slope", made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the bevelled inlet, p. 5-13.

CHART I



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HW/D = (1151.8 - 1151.5) / 3.5 (HW)

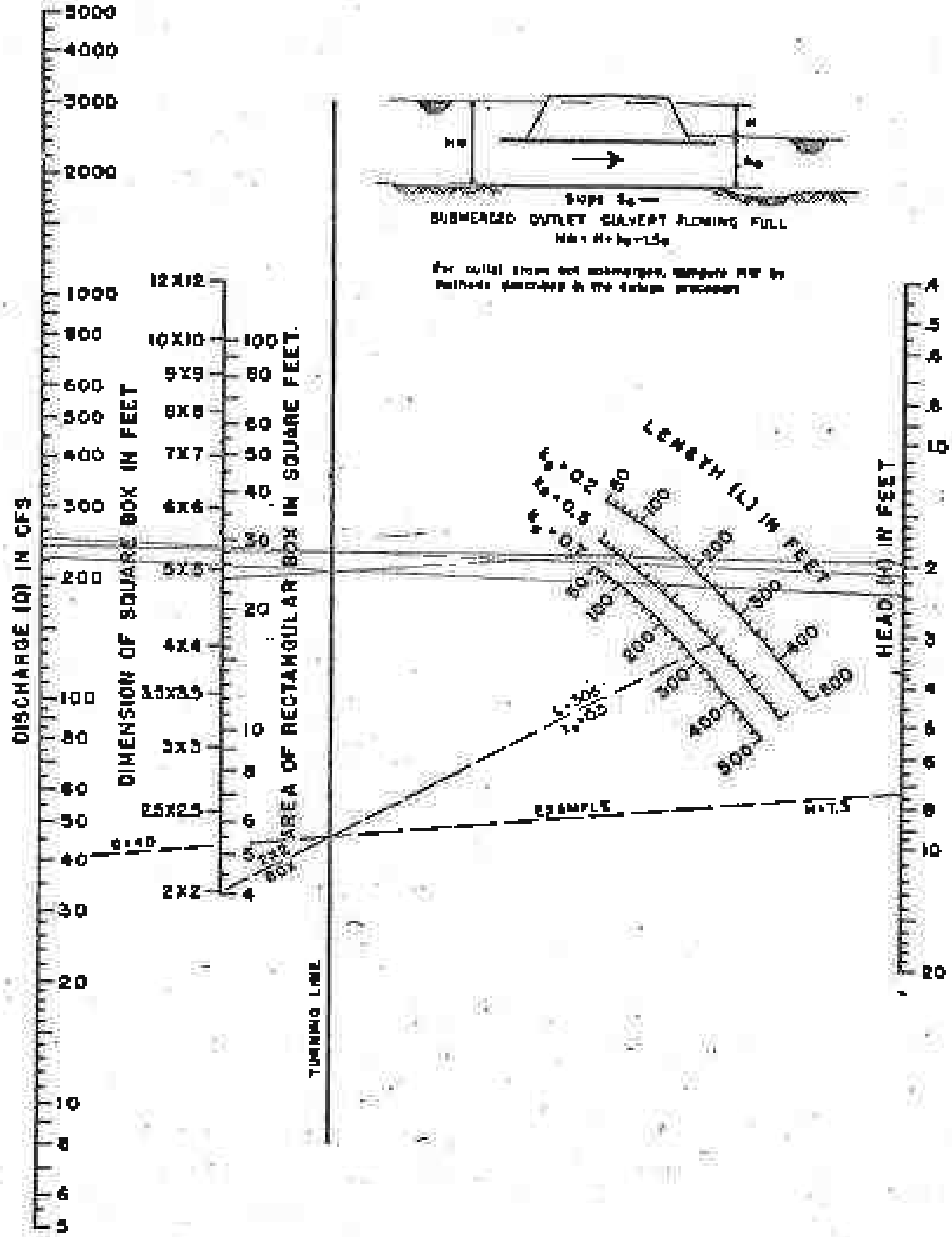
= 1.51

HW/D = 5.3/3

= 1.77

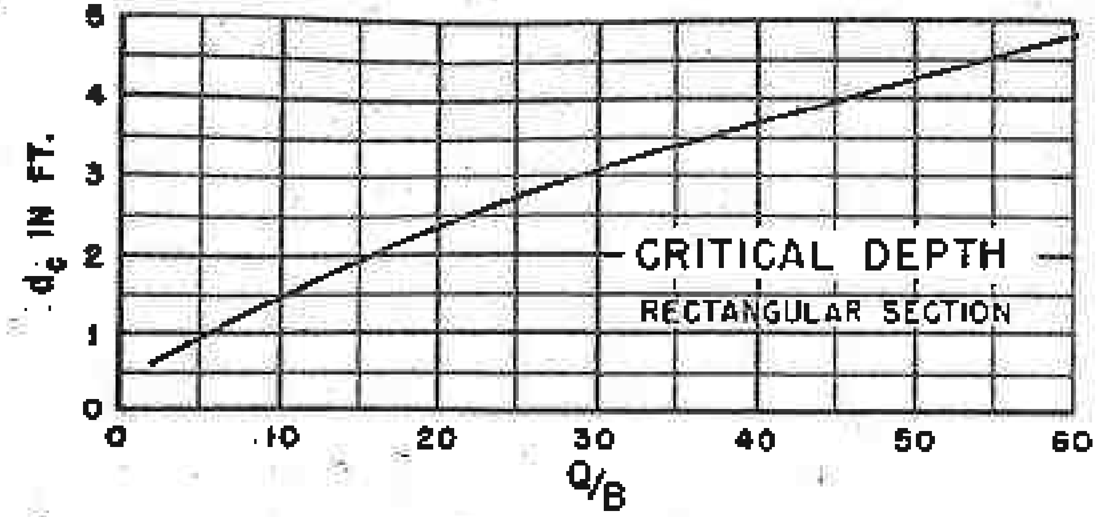
HW/D = 5.5/3.5

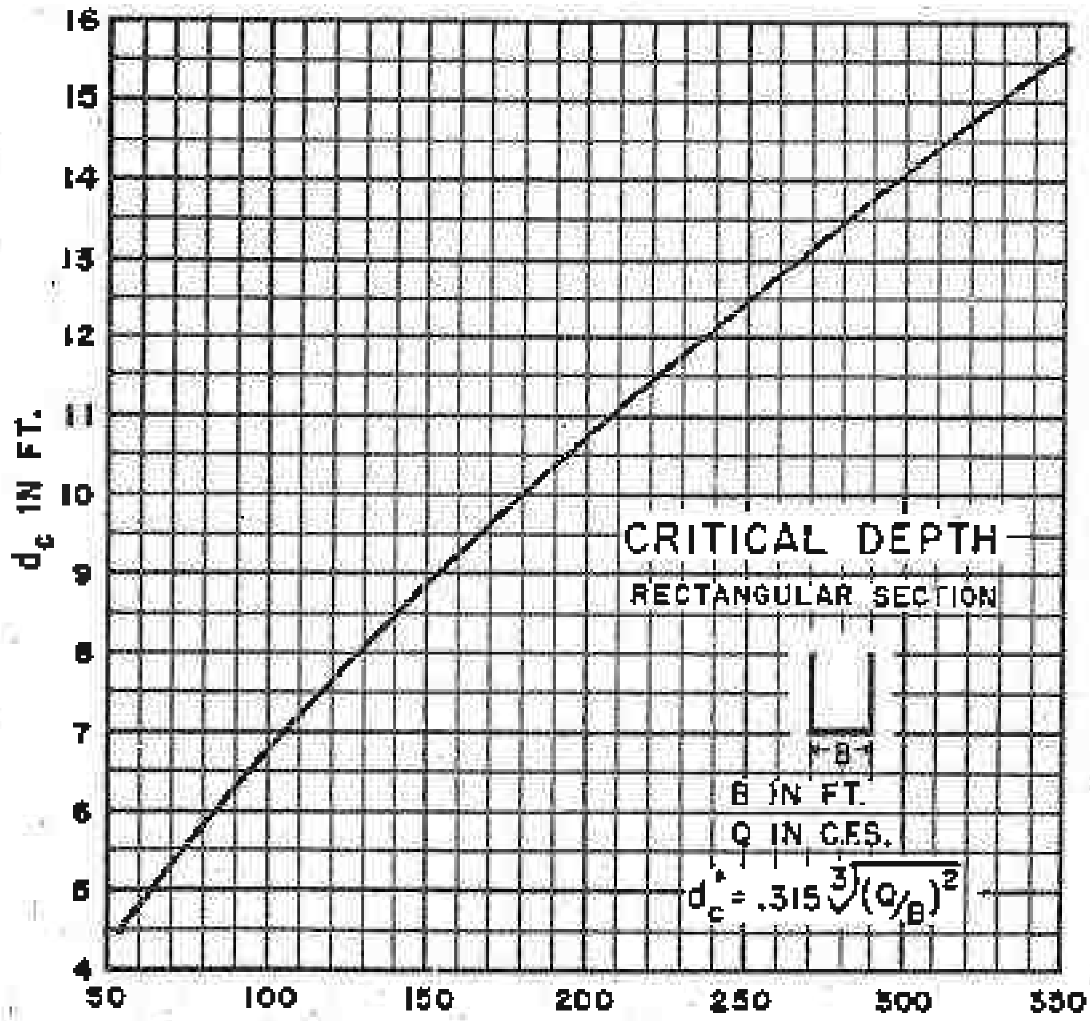
= 1.57



# HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963





*NOTE: d_c CANNOT EXCEED D

BUREAU OF PUBLIC ROADS JAN. 1963

PROJECT: BL-167	DESIGNER: MLA
	CHKD DAY [illegible] DATE: 3/11/86

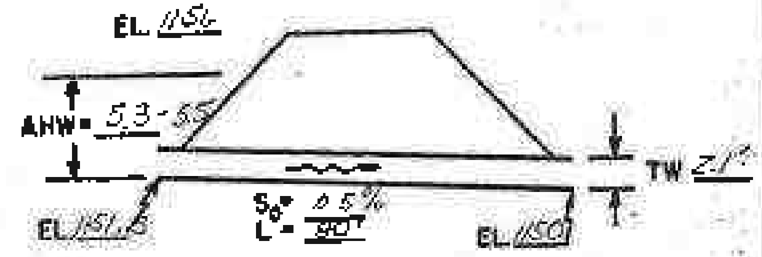
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = 203 2 YR TW_1 = 2.10
Q_2 = 428 10 YR TW_2 = 2.10

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ______



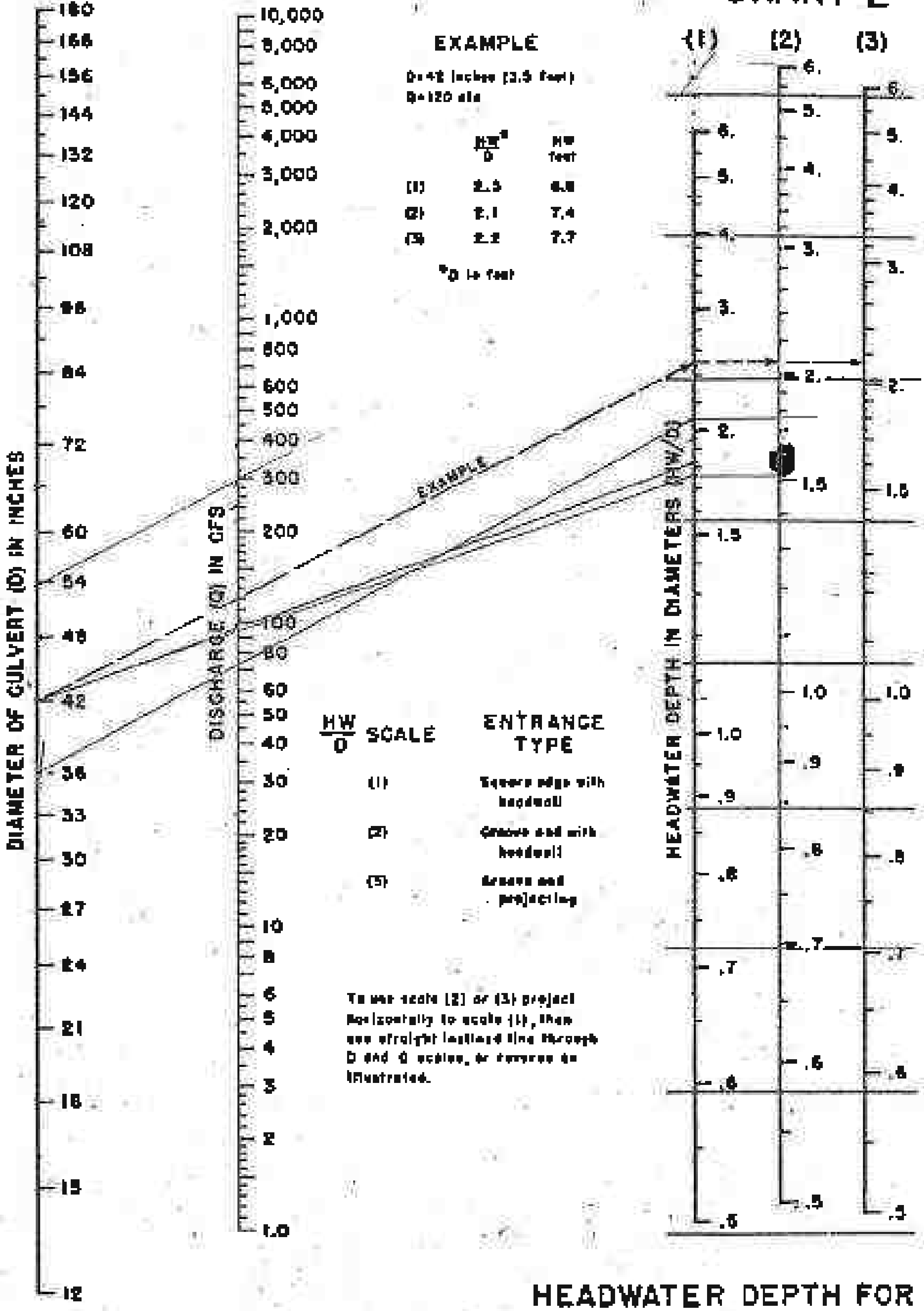
MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
Box Culvert w Headwall	240	3.5x8	1.51	5.3	0.4	2.0	3.1	3.3	2.1	3.3	0.4	4.9	5.3			INLET CONTROL
Wingwall Flare 30° to 75°																
"	224	3x8	1.77	5.3	0.4	2.4	2.9	3.0	2.1	3.0	0.4	5.0	5.3			INLET CONTROL
"	248	3.5x8	1.57	5.5	0.4	2.1	3.1	3.3	2.1	3.3	0.4	5.0	5.5			INLET CONTROL

SUMMARY & RECOMMENDATIONS:

Figure 7

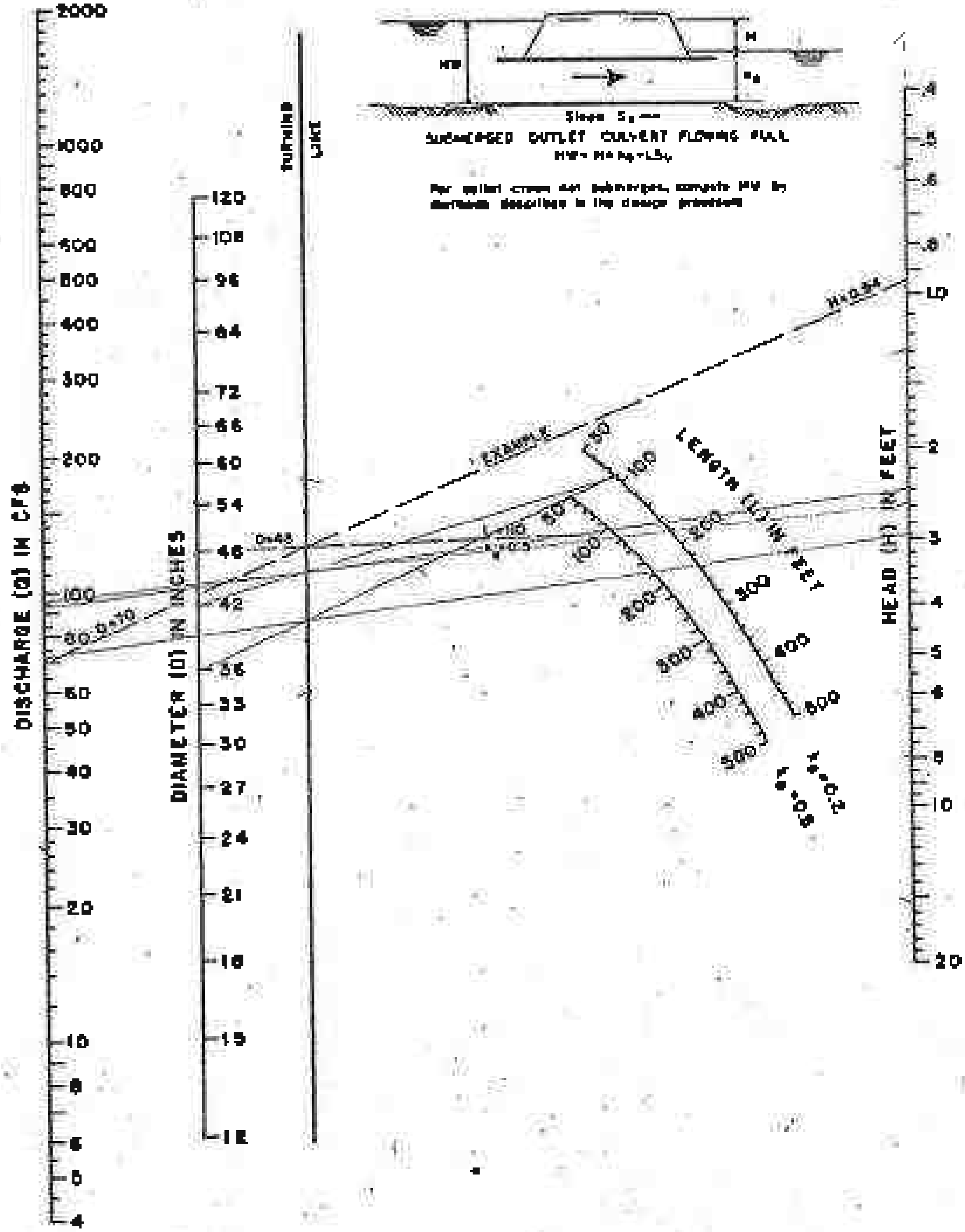
CHART 2



HEADWATER SCALES 2&3
REVISED MAY 1964

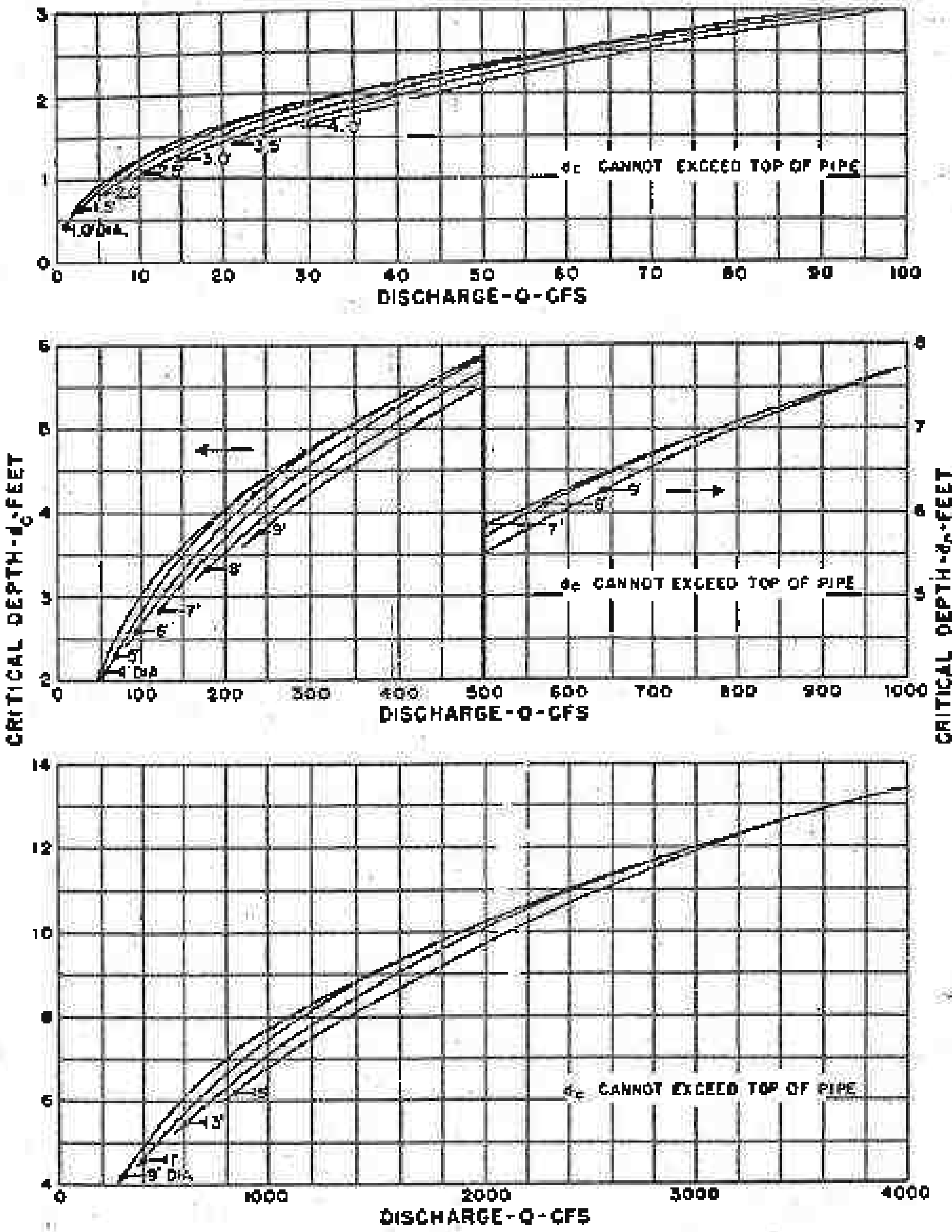
BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n=0.012

BUREAU OF PUBLIC ROADS JAN. 1963



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

PROJECT: Rl-167

DESIGNER: MLA

DATE: 3/17/86

4/21/86

HYDROLOGIC AND CHANNEL INFORMATION

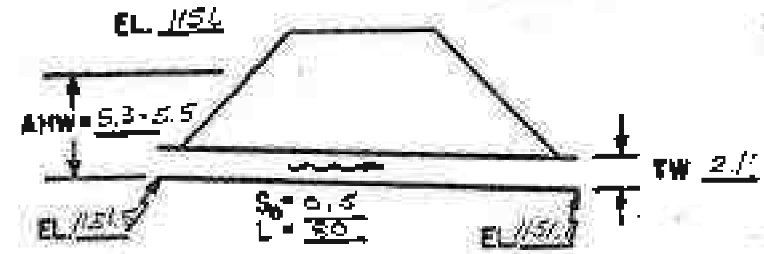
Q_1 = 203 TW$_1$ = 2.10

Q_2 = 428 TW$_2$ = 2.10

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ________



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
Concrete Pipe with Groove End and Headwall	216	3 36"	1.77	5.3	0.2	3.0	2.6	2.8	2.1	2.8	0.4	5.4	5.4			OUTLET CONTROL
"	292	3 42"	1.51	5.3	0.2	2.4	2.9	3.2	2.1	3.2	0.4	5.2	5.5			INLET CONTROL
"	288	3 42"	1.57	5.5	0.2	2.6	3.0	3.2	2.1	3.2	0.4	5.4	5.5			INLET CONTROL

SUMMARY & RECOMMENDATIONS:

Figure 7

SUBJECT Penelec - Conemaugh 1986 Stage II Const.
High - Lo Structure Design

BY MLA DATE 3/14/86 PROJ. NO. 86-167
CHKD. BY DAY DATE 4/24/86 SHEET NO. 15 OF 17

GAI CONSULTANTS, INC.
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Tabular Summary for Culverts

Design Storm	Design Flow	Max Developed Head	Type of Culvert					
			Concrete Box			Concrete Circular		
			Size	No.	Flow	Size	No.	Flow
2 yr	203	5.3 - 5.5	3.5' x 8'	1	240	3'	3	216
10 yr	428	5.3 - 5.5	3' x 8'	1	224	3.5'	3	282
100 yr	722	5.3 - 5.5	3.5' x 8'	1	218	3.5'	3	288

Note: For an option, the 2 year storm will pass thru the culverts without flooding the road.

The design flows listed above are from Condition II. The flows from condition I have been omitted since the access road will be removed by 1989 and will not exist during the time when Condition I occurs.

SUBJECT Conemaugh 1986 Stage II Const.
High-Lo Structure Design

BY MLL DATE 3/14/86 PROJ NO. 86-147
CHKD BY DAY DATE 4/6/86 SHEET NO. 16 OF 17

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High Structure

Using an equation for flow thru a broad-crested weir

$$Q/L = 0.433\sqrt{2g}\left(\frac{y_c}{y_c+h}\right)^{1/2} H^{3/2}$$

(Ref: Open-Channel Hydraulics Chow, 1959, pg 53)

Find L where Q = Qpeak for 10 year design - Q thru pipes
H = height of water above weir.
y_c = depth of water upstream of culvert
h = height of weir from inlet of the culvert

General Design				Type of Culvert							
				Concrete Box				Concrete Circular			
Q_{10} (cfs)	y_c (ft)	h (ft)	H (ft)	Size	No.	$Q_{10}-Q_c$	Length	Size	No.	$Q_{10}-Q_c$	Length
428	5.3	4.5	0.8	3.5x8	1	188	103	3	3	212	116
428	5.3	4.5	0.8	3x8	1	204	112	3.5	3	146	80
428	5.5	4.5	1.0	3.5x8	1	180	70	3.5	3	140	54

Conclusion: With the restriction of the grade of the access road (10% max), a shorter length weir would be a better option. Using the option of the 3 42" culverts with a 54 ft weir would require a 10% grade. Any option with a wider weir would require a grade greater than 10%.

SUBJECT Penelec - Conemaugh 1986 Stage II Const
High - Lo Structure Design

BY MAL DATE 3/14/86 PROJ. NO 86-167
CHKD. BY DAY DATE 4/21/86 SHEET NO 17 OF 17

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Using 3 42" pipes and 2 54 ft weir:

Disadvantages: 1) Regrading of the main site collector is required

2) The height of water above the weir, H, has to be 1 ft or higher which causes, at least, 0.2 ft (1157.0 - 1156.8) of flooding above the restricting elevation, 1156.8, in the stilling basin

Advantages 1) A 10% or less grade can be acheived on the access road

2) Regrading of main site collector channel is minimized

3) Weir will have only a foot of water on the road for a 10 year storm which will still allow trucks to pass without minor problems.

4) Backwatering into the pipes in the stilling basin is minimized

5) Backwatering into the main site dissipator (plunge pool) is minimized.

6) Channel width changes from the upstream channel to the high-lo structure and from the high-lo structure to the downstream channel do not require as much channel length to acheive a smooth transition.

7) Reduces the amount of concrete required to pave the haul road and construct the headwalls.

SUBJECT Conemaugh Station
1987 Construction Design
BY TRY DATE 3/6/87 PROJ. NO 84-267-32
CHKD. BY ______ DATE ______ SHEET NO. ______ OF ______

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Index Channel Hydraulics

	Index No.
1. East Peripheral Diversion	1 – 45
2. East Collector	46
3. West Collector	47 – 48
4. Main Collector	–
~~5. Energy Dissipator~~	
~~Sump Diversion Channel~~	

THESE CALCULATIONS WERE PERFORMED TO COMPUTE A CHANNEL SECTION FOR A PROPOSED NEW SECTION OF THE EAST DIVERSION DITCH AT THE CONEMAUGH ASH / MINE REFUSE DISPOSAL AREA. THE MAXIMUM FLOW AND CHANNEL SECTION WAS PREVIOUSLY COMPUTED BY MAC USING THE GRAPHICAL SOLUTION IN TR-55 BUT RESULTED IN A HIGH DESIGN FLOW RATE AND A LARGE SECTION. THESE CALCULATIONS USE THE TABULAR SOLUTION PRESENTED IN TR-55, "URBAN HYDROLOGY FOR SMALL WATERSHEDS" BY THE SCS.

FROM THE ATTACHED TOPO WORKSHEET, 6 SUBAREAS WERE DEVELOPED. AREAS A, C & D WERE PLANIMETERED FROM DWG. NO. 42-D-0429, REV. 0. THE OTHER AREAS (OUTLINED IN BLUE) WERE PLANIMETERED FROM THE 1" = 400' MAPPING.

RESULTS FOLLOW

NOTE: WORKSHEETS NOT LOCATED, 6 SUBAREAS WERE REDEVELOPED DURING CHECKING AND AREAS WERE FOUND TO BE COMPARABLE.

SUBAREA	AREA	AREA
A	16.8 AC	0.02625 $(MILE)^2$
B	18.1	0.02828
C	10.3	0.01609
D	9.3	0.01453
E	15.9	0.02484
F	5.6	0.00875

FIND TRAVEL TIME (T_t) AND TIME OF CONCENTRATION (T_c) FOR EACH SUBAREA. (BASED ON EXISTING CONDITIONS, ANTICIPATED TO REMAIN SIMILAR)

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DETERMINE TRAVEL TIMES AND TIME OF CONCENTRATION FOR THE DRAINAGE AREAS A, C, B-D, E, AND F.

SUB-AREA A

T_c: 930 FT OVER TOP OF PILE, SLOPE $\frac{1512 - 1460}{930} \sim 5.6\%$
FROM ATTACHED FIG. 8, USING CURVE 2
VELOCITY ~ 1.2 FPS

1340 FT IN SWALE, FROM SHT. 7 OF DESIGN PARAMETERS OUTLINE; VELOCITY = 2 TO 4 FPS

SAY 4 FPS

$$T_c = \frac{930 \text{ FT}}{1.2 \text{ FPS}} + \frac{1340 \text{ FT}}{4 \text{ FPS}} = 1110 \text{ SEC} \sim 0.31 \text{ H}$$

SAY 0.3 H

T_t: 1250 FT IN DITCH WITH S = 0.18 PERCENT

ASSUME CHANNEL IS TRAP w/ 5' BASE, 2:1 SS, n=0.0
FROM "DESIGN CHARTS FOR OPEN-CHANNEL FLOW" BY FHA, REPRINTED IN DEC. 1980

ENTER CHART 18 WITH SLOPE = 0.0018 FT/FT
DEPTH = 3 FT.

VEL. = 3.1 FPS

T_t = 1250 FT ÷ 3.1 FPS ~ 403 SEC ~ 0.11 HR

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~400 FT IN SLOPE PIPE, HIGH VELOCITY
THIS COMPONENT OF T_t IS NEGLIGIBLE.

~ 1,000 FT IN DITCH WITH S = 0.18 PERCENT

AGAIN USE VEL. FROM SHT 2. OF 3.1 FPS

T_t = 1000 FT ÷ 3.1 FPS = 323 SEC ~ 0.09 HR.

~ 1,060 FT IN THE NEW CHANNEL
SLOPE IS 12.5% TO 16.67%.

DUE TO STEEP SLOPE, ASSUME 20 FPS

T_t = 1,060 FT ÷ 20 FPS = 53 SEC ~ 0.01 HR

NOW ADD TO GET T_t

T_t = 0.11 + 0.09 + 0.01 ~ 0.21 HR

∴ FOR SUBAREA A - USE T_c = 0.30 HR
T_t ~ 0.20 HR

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SUBAREA C

T_c : 1,570 FT ALONG 1345 BENCH
FROM SHT. 7 OF DESIGN PARAMETERS OUTLINE
VELOCITY OF BENCH FLOW = 2 FPS $T_c = \frac{1570}{2} \sim 785$
0.22 HR

T_t : 600 FT IN EXISTING TYPE II CHANNEL
SLOPE IS ABOUT 5/160 ~ 0.031 FT/FT

ASSUME VEL. = 4 FPS

T_t = 600 ÷ 4 = 150 SEC ~ 0.04 HR

1000 FT. IN DITCH WITH S = 0.18 PERCENT,
FROM SHT. 3 T_t = 0.09 HR

1,060 FT IN NEW CHANNEL WITH SLOPE FROM
12.5 % TO 16.67 %

FROM SHT. 3 , T_t ~ 0.01 HR

T_t = 0.04 + 0.09 + 0.01 ~ 0.14 HR

∴ FOR SUBAREA C - USE T_c = 0.20 HR (MUST INTERP)
T_t = 0.14 HR

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SUBAREA B

T_c : 600 FT. OVERLAND THROUGH WOODS SLOPE IS (1518 - 1450)/600 = 11.3 %

FROM FIG. B (ATTACHED) USE CURVE 1
VEL. = 0.85 FPS

T_c = 600/0.85 = 706 SEC ~ 0.20 HR.

T_t : T_t FOR AREA B CAN BE TAKEN AS THE SAME T_t AS FOR AREA A
T_t = 0.20 HR.

∴ FOR SUBAREA B USE T_c = 0.20 HR
T_t = 0.20 HR

SUBAREA D

T_c : 430 FT OVERLAND THROUGH WOODS

SLOPE : (1445 - 1315) ÷ 430 ~ 30 %

FROM FIG. B USING CURVE NO. 1
FOR A 30 % SLOPE, VEL. ~ 1.4 FPS

T_c = 430 FT ÷ 1.4 FPS ~ 307 SEC 0.09 HR.

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T_t: USE THE LAST TWO COMPONENTS OF T_t FOR SUBAREA A (SHT. 3)

1,000 FT IN CHANNEL WITH S = 0.18% T_t = 0.0

1,060 FT IN NEW CHANNEL T_t ~ 0.01 HR

T_t = 0.09 + 0.01 ~ 0.10 HR

∴ FOR SUBAREA D - USE T_c ~ 0.10 HR
T_t ~ 0.10 HR (MUST INTERPO

SUBAREA E

T_c: 890 FT. OVERLAND THROUGH WOODS, SLOPE = (1470 - 1320) ÷ 890 ~ 16.9 %

FROM FIG. 8 USING CURVE NO. 1 AND S = 17%
VEL. ~ 1.0 FPS

T_c = 890/1 = 890 SEC ~ 0.25 HR

890 FT. IN CHANNEL SLOPED AT 0.18%

AGAIN USE VELOCITY FOR S = 0.18% FROM SHT.
OF 3.1 FPS

T_c = 890 FT ÷ 3.1 FPS = 287 SEC ~ 0.08 HR

T_c = 0.25 + 0.08 = 0.33 HR. SAY 0.30 HR

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T_t: CONSISTS OF T_t IN NEW SECTION FROM SHT. 3, T_t ESTIMATED AT 0.01 HR

SAY 0

∴ FOR SUBAREA E - USE T_c = 0.30 HR
T_t = 0

SUBAREA F

T_c: 600 FT OVERLAND THROUGH FOREST
SLOPE = (1457 - 1315)/600 ~ 0.24 FT/FT

FROM FIG. 8, CURVE 1 WITH S = 0.24
VEL = 1.2 FPS

T_c = 600 FT ÷ 1.2 FPS = 500 SEC = 0.14 HR

1,060 FT IN NEW CHANNEL
T_c HAS PREVIOUSLY BEEN COMPUTED AS 0.01 HR

T_c = 0.18 + 0.01 = 0.19 HR SAY 0.20 HR.

T_t. T_t = 0

∴ FOR SUBAREA F - USE T_c = 0.15 HR
T_t = 0

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FIND VALUES FOR TABULAR DISCHARGE (CSM/in) FROM TABLE 5-3 IN TR-55. INTERPOLATE WHERE NECESSARY.

	TABULAR DISCHARGE (CSM/in)					
SUBAREA	11.8	11.9	12.0	12.1	12.2	12.3
A	118.4	224.4	354.8	475.8	521.6	479.2
B	174.6	316	463.4	567.2	550.6	422.8
C	274.9	460	516.7	524.2	458.9	347.0
D	650.6	578.4	536.6	414.2	309.6	224.8
E	324	586	658	535	372	251
F	750	771	559	329	199	151

NOW, COMPUTE RUNOFF FOR EACH SUBAREA BASED ON DESIGN STORM AND CURVE NO.

FROM SHT. 6 OF DESIGN PARAMETERS OUTLINE, DESIGN STORM OF 100 YR, 24 HR STORM YIELDS 5.5 INCHES

CURVE NOS. ARE FROM SHT. 7 OF THE OUTLINE (SEE BELOW)

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SUBAREA	DESCRIPTION	CURVE NO.	RUNOFF
A	TOP OF PILE - REVEG'D	75	2.85
B	WOODS -	70	2.42
C	BENCH FACES - REVEGED	78	3.15
D	WOODS	70	2.42
E	WOODS	70	2.42
F	WOODS	70	2.42

USE TABLE 2-1 IN TR-55 TO OBTAIN RUNOFF (INCHES)

NOW, USE THE FOLLOWING EQUATION TO COMPUTE PEAK FLOWS FOR EACH TIME.

$$q = q_p \times DA \times Q$$

WHERE q = HYDROGRAPH COORDINATE DISCHARGE (CFS)
q_p = CSM/in
DA = DRAINAGE AREA (SQ MI.)
Q = RUNOFF (INCHES)

TIME 11.8

q_A = (118.4)(.02625)(2.85) = 8.9 CFS
q_B = (174.6)(.02828)(2.42) = 11.9 CFS
q_C = (274.9)(.01609)(3.15) = 13.9 CFS
q_D = (650.6)(.01453)(2.42) = 22.9 CFS
q_E = (324)(.02484)(2.42) = 19.5 CFS
q_F = (750)(.00875)(2.42) = 15.9 CFS

93.0 CFS

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TIME 11.9

q_A = (224.4)(.02625)(2.85) = 16.8 CFS
q_B = (316)(.02828)(2.42) = 21.6
q_C = (460)(.01609)(3.15) = 23.3
q_D = (578.4)(.01453)(2.42) = 20.3
q_E = (586)(.02484)(2.42) = 35.2
q_F = (771)(.00875)(2.42) = 16.3

133.5 CFS

TIME 12.0

q_A = (354.8)(.02625)(2.85) = 26.5 CFS
q_B = (463.4)(.02828)(2.42) = 31.7
q_C = (516.7)(.01609)(3.15) = 26.2
q_D = (536.6)(.01453)(2.42) = 18.9
q_E = (658)(.02484)(2.42) = 39.6
q_F = (557)(.00875)(2.42) = 11.8

154.7 CFS

TIME 12.1

q_A = (475.8)(.02625)(2.85) = 35.6 CFS
q_B = (567.2)(.02828)(2.42) = 38.8
q_C = (524.2)(.01609)(3.15) = 26.6
q_D = (414.2)(.01453)(2.42) = 14.6
q_E = (535)(.02484)(2.42) = 32.2
q_F = (329)(.00875)(2.42) = 7.0

154.8 CFS

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TIME 12.2

$Q_A = (521.6)(.02625)(2.85) = 39.0$ CFS

$Q_B = (550.6)(.02828)(2.42) = 37.7$

$Q_C = (458.9)(.01609)(3.15) = 23.3$

$Q_D = (309.6)(.01453)(2.42) = 10.9$

$Q_E = (372)(.02484)(2.42) = 22.4$

$Q_F = (151)(.00875)(2.42) = 3.2$

134.5 CFS

∴ PEAK FLOW OCCURS AT TIME 12.1 = 154.8 CF

SAY 160 CFS

NOW, DESIGN TWO SECTIONS

ONE SECTION, THE INITIAL 100 TO 200 FT, WILL BE SLOPED AT 1%.

TRY A TRAPEZOIDAL SECTION WITH b = 10'
SS = 2:1
GRASS LINED
(n = 0.045)

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{160\,(0.045)}{(10)^{8/3}\,(.01)^{1/2}} = 0.155$$

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FROM TABLE III-1 (ATTACHED)

$d/b = 0.235$

$d = 0.235b = 0.235(10) = 2.35$ FT.

SAY 3.0 FT WITH FREEBOARD.

UPPER 100 TO 200 FT.
TRAPEZOIDAL
2:1 SIDESLOPES
BASE = 10 FT
DEPTH = 3 FT
GRASS-LINED
SLOPE = 1%

CHECK VELOCITY:

$A = db + zd^2 = 2.35(10) + 2($

$= 34.5$ FT²

$V = Q/A = \frac{160}{34.5} = 4.6$ FP

OK FOR GRASS

2ND SECTION, FLOW = 160 CFS
TRAPEZOIDAL
SLOPES 12.5 TO 16.67 %
BASE = 6 FT
2:1 SIDESLOPES
LINING (CONC. OR GROUTED ROCK)

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TRY GROUTED ROCK LINING, $n = 0.025$

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(160)(0.025)}{(6)^{8/3}(0.125)^{1/2}} = 0.095$$

FROM TABLE III-1,

$d/b \sim 0.18$

$d = 0.18b = 0.18(6) = 1.08$ FT.

$A = db + zd^2 = 1.08(6) + 2(1.08)^2 = 8.8$ FT^2

$V = Q/A = 160 / 8.8 \sim 18.2$ FPS
OK FOR GROUTED ROCK.

CHECK THE $S = 16.67\%$

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(160)(0.025)}{(6)^{8/3}(.1667)^{1/2}} \sim 0.082$$

FROM TABLE III-1

$d/b \sim 0.165$

$d = 0.165(6) \sim 0.99$ FT

$A = db + zd^2 = 0.99(6) + 2(.99)^2 \sim 7.90$ FT^2

$V = Q/A = 160 / 7.90 \sim 20.3$ FPS

I WOULD THINK GROUTED ROCK IS OK.

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A. FOR 2ND SECTION

TRAPEZOIDAL
2:1 SIDESLOPES
BASE = 6 FT
DEPTH = 2.5 FT (≥1.5 FT FREEBOARD)
GROUTED ROCK LINING
SLOPE 12.5 TO 16.67%

DEPTHS ASSUME NO TURNS, IF CHANNELS HAVE ABRUPT TURNS SUPERELEVATION MAY BE REQUIRED.

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WHAT IF INITIAL 100 - 200 FT OF CHANNEL HAS B = 6 FT
VELOCITY LIMITED TO 5 FPS

$V = Q/A = 5$

$A = Q/V = 160/5 = 32 \text{ FT}^2$

$A = db + zd^2$

$32 = d(6) + 2(d)^2$

$32 = 6d + 2d^2$

$d^2 + 3d - 16 = 0$

NO EXACT SOLUTION
BY QUADRATIC FORMULA

$d \quad \dfrac{-3 \pm \sqrt{3^2 - 4(1)(-16)}}{2} = \dfrac{-3 \pm \sqrt{73}}{2}$

$d = 2.77$ FT.

FIND BOTTOM SLOPE

$d = 2.77$

$d/b = 2.77/6.0 = 0.462$

FROM TABLE III-1, $\dfrac{Qn}{b^{8/3}S^{1/2}} \approx 0.5792$

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n = 0.045 GRASS

$$0.5792 = \frac{160\,(.045)}{(6)^{8/3}\;S^{1/2}}$$

$$0.5792 = \frac{0.0605708}{S^{1/2}}$$

$$S^{1/2} = 0.1045767$$

$$S = 0.0109 \quad \text{OR} \quad 1.09\,\%$$

CHECK 1.1 % → OK

∴

SLOPE = 1.1 %
BASE = 6 FT
DEPTH = 3.5 FT (INCLUDING FREEBOARD)
SIDESLOPES = 2:1
GRASS-LINED.

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DESIGN A SECTION FOR THE TYPE II CHANNEL (EXISTING ON-SITE DIVERSION CHANNEL) WHICH ACCEPTS FLOW FROM SUBAREAS C & D.

FIND THE MAXIMUM FLOW FROM SHEETS 9, 10, OR 11.

TIME	Σ Q_{C+D}
11.8	36.8 CFS
11.9	43.7
12.0	45.1 ← MAX. FLOW = 45.1 CFS
12.1	41.2
12.2	34.2

TRY A TRAPEZOIDAL SECTION
BASE = 3 FT
SS = 2:1 (z=2)
SLOPE = 0.5 %
GRASS-LINED n = 0.045

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(45.1)(.045)}{(3)^{8/3}(0.005)^{1/2}} \sim 1.533$$

FROM TABLE III-1

$d/b \sim 0.74$

$d = 0.74(3) \sim 2.22$ (MAKE DEPTH 3' w/ FREEBOARD

$A = bd + zd^2 = 3(2.22) + 2(2.22)^2 \sim 16.52 \text{ FT}^2$

$V = Q/A = 45.1/16.52 = 2.7$ FPS ∴ GRASS IS OK

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∴ CHANNEL SECTION SHOULD BE :

TRAPEZOIDAL
BASE = 3 FT
DEPTH = 3 FT
SS = 2:1
SLOPE = 0.5%
GRASS-LINED

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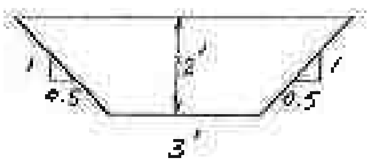
WHAT SLOPE MUST THE EXISTING TYPE II CHANNEL BE CONSTRUCTED AT TO MATCH THE FOLLOWING SECTION.



$d = 1.5$ FT - PROVIDE 6" FREEBOARD

$b = 3.0$ FT

$d/b = 1.5/3 = 0.50$ FT

$z = 0.5$

FROM TABLE III-1, FOR $d/b = 0.50$ AND $z = 0.5$

$\frac{Qn}{b^{8/3} S^{1/2}} \sim 0.411$

$Q = 45.1$ CFS

$n = 0.045$ GRASS

$\frac{(45.1)(0.045)}{(3)^{8/3} S^{1/2}} = 0.411$

$\frac{0.10841}{S^{1/2}} = 0.411$

$S = 0.0696 \sim 0.07$

$S = 7.0\%$

FIND V:

$A = db + zd^2 = (1.5)(3) + 0.5(1.5)^2$

$A = 5.625$

$V = Q/A = 45.1 / 5.625$

$V = 8.0$ FPS

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∴ TO USE SECTION AT EXISTING OUTLET,

SLOPE = 7.0 %
VELOCITY = 8.0 FPS

WHAT IF FLOW DEPTH IS 2.25 FT (PROVIDE 0.75 FT. FREEBOARD TO MAKE CHANNEL DEPTH 3.0 FT)

$d = 2.25$ FT
$b = 3.0$ FT

$d/b = 2.25/3.0 \sim 0.75$

FROM TABLE III-1, FOR $d/b \sim 0.75$ w/ $z = 1/2$

$$\frac{Qn}{b^{8/3} S^{1/2}} \sim 0.8115$$

$$\frac{(45.1)(0.045)}{(3)^{8/3} \; S^{1/2}} \sim 0.8115$$

$S = 0.018 = 1.8\%$

FIND V

$A = db + zd^2 = 2.25(3) + 0.5(2.25)^2 = 9.28 \text{ FT}^2$

$V = Q/A = 45.1 / 9.28 = 4.9$ FPS

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∴ FOR A FLOW DEPTH OF 2.25'
CHANNEL DEPTH = 3.0 FT
SLOPE = 1.8%
VELOCITY = 4.9 FPS

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MODIFY THE PORTION OF THE CHANNEL PRIOR TO THE NEW CONSTRUCTION (FROM a TO b) ^SEE SHT. 29 ALONG THE 1320 BENCH. CHANNEL IS PRESENTLY SLOPED AT 0.18 %

DESIGN FOR THE 100-YR, 24-HR. STORM :

CHANNEL MUST BE DESIGNED TO ACCEPT FLOW FROM SUBAREAS A → E.

CHANNEL TO BE : TRAPEZOIDAL
BASE : 6 FT
SS = 2:1
SLOPE = 0.5 %
GRASS-LINED n = 0.045

FLOW ($\Sigma q_A \to q_E$) SHTS. 9, 10 & 11	TIME	
77.1 CFS	11.8	
117.3	11.9	
142.9	12.0	
147.7	12.1	* MAX. q
133.3	12.2	

Q DESIGN = 147.7 CFS

FROM TABLE III-1 :

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(147.7)(0.045)}{(6)^{8/3}(0.005)^{1/2}} \sim 0.791$$

$d/b \sim 0.54$

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$d = 0.54b = 0.54(6) = 3.24$ FT

$A = db + zd^2 = 3.24(6) + 2(3.24)^2 \sim 40.4$ FT^2

$V = Q/A = 147.7 / 40.4 = 3.7$ FPS

∴ @ S = 0.5%
DEPTH MUST BE 4.0 FT (INCLUDING FREEBOARD)

INVESTIGATE THE 10-YR STORM.

RAINFALL = 4.0 INCHES, TR55 C-2

COMPUTE RUNOFF FOR EACH SUBAREA BASED ON THE PROPER CURVE NOS.

SUBAREA	CURVE NO.	RUNOFF	
A	75	1.67 INCHES	
B	70	1.33	
C	78	1.89	SCS TABLE 2-1
D	70	1.33	TR55
E	70	1.33	

NOW, FOR TIME 12.1 FIND FLOW (SIMILAR TO PROCEDURE ON SHT. 10

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1/19/87 PROJ. NO. RG-267-32

CHKD. BY TRV DATE 3/4/87 SHEET NO. 24 OF. 39

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$Q_A = (475.8)(.02625)(1.67) = 20.9$ CFS
$Q_B = (567.2)(.02828)(1.33) = 21.3$ CFS
$Q_C = (524.2)(.01609)(1.89) = 15.9$
$Q_D = (414.2)(.01453)(1.33) = 8.0$
$Q_E = (535)(.02484)(1.33) = 17.7$
83.8 CFS

FROM THE DER EROSION AND SEDIMENTATION CONTROL MANUAL, A TEMPORARY DITCH MUST BE SIZED TO PASS 1.6 CFS/ACRE.

Σ AREAS A→E = 16.8 + 18.1 + 10.3 + 9.3 + 15.9 = 70.4 AC

FLOW = 70.4 AC X 1.6 CFS/AC ~ 113 CFS

SIZE DITCH FOR THE 10-YR, 24-HR STORM:

Q = 83.8 CFS
TRAPEZOIDAL
b = 6 FT
2:1 SS
SLOPE = 0.5 %
GRASS-LINED (n = 0.045)

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(83.8)(0.045)}{(6)^{8/3}(.005)^{1/2}} \sim 0.449$$

$d/b \sim 0.41$

$d = 0.41b = 0.41(6) \sim 2.46$ FT

$A = db + zd^2 = 2.46(6) + 2(2.46)^2 \sim 26.9$ FT^2

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1/19/87 PROJ. NO. 86-267-32

CHKD. BY TRV DATE 3/4/87 SHEET NO 25 OF 39

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$V = Q/A = 83.8/26.9 \sim 3.1$ FPS GRASS OK

∴ FOR 10-YR, 24-HR STORM
DEPTH = 3 TO 3.5 FT @ S = 0.5%

NOW, SIZE DITCH FOR 1.6 CFS/AC

Q = 113 CFS

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(113)(.045)}{(6)^{8/3} (0.005)^{1/2}} \sim 0.605$$

$d/b \approx 0.47$

$d = 0.47\,b = 0.47(6) \approx 2.82$ FT

∴ DEPTH SHOULD BE 3.5 FT W/ FREEBOARD.

FROM SHT. 17, SIZE EXISTING TYPE II CHANNEL FOR THE 1.6 CFS / ACRE REQUIREMENT

FROM SHT 17, CHANNEL ACCEPTS FLOW FROM AREAS C + D.

$\Sigma A_{C+D} = 10.3 + 9.3 = 19.6$ AC

Q = 19.6 AC x 1.6 CFS/AC = 31.4 CFS

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1/19/87 PROJ NO 86-267-32

CHKD BY TRV DATE 3/4/87 SHEET NO. 26 OF 39

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KEEP THE SAME SECTION
TRAPEZOIDAL
b = 3 FT
2:1 SS
SLOPE = 0.5 %
GRASS - LINED.

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(31.4)(.045)}{(3)^{8/3}\,(.005)^{1/2}} \sim 1.067$$

$d/b \sim 0.62$

$d = 0.62(3) = 1.86$ FT

∴ CHANNEL COULD BE 2.5 FT DEEP w/ FREEBOARD

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1/21/87 PROJ. NO. 86-267-32

CHKD. BY TRV DATE 3/4/87 SHEET NO 27 OF 39

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CHANNEL a-6 , SEE SHT. 29

THE BOTTOM WIDTH OF THE CHANNEL MUST BE INCREASED FROM 6 FT TO 8 FT. ALSO, INVESTIGATE THE POSSIBILIT. OF USING A CONCRETE CHANNEL LINING WITH A ROUGH FINISH

FLOW = 160 CFS (SHT 12)
TRAPEZOIDAL
SLOPE : 12.5 TO 16.67 %
BASE : 8 FT.
2:1 SIDESLOPES
LINING - i. GROUTED ROCK $n = 0.025$
ii. CONCRETE (ROUGH FINISH) $n = 0.017$

i. $\frac{Qn}{b^{8/3}S^{1/2}} = \frac{(160)(0.025)}{(8)^{8/3}(0.125)^{1/2}} \sim 0.044$

$d/b \sim 0.115$

$d = 0.115(8) = 0.92$ FT

FLOW DEPTH = 0.92 FT GROUTED ROCK

CHECK VELOCITY : $\frac{Qn}{b^{8/3}S^{1/2}} = \frac{(160)(0.025)}{(8)^{8/3}(.1667)^{1/2}} \sim 0.038$

$d/b \sim 0.11$

$d = 0.11(8) \sim 0.88$

$A = db + zd^2 = (0.88)(8) + 2(.88)^2 = 8.59$ FT²

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1/21/87 PROJ NO 86-267-32

CHKD. BY TRY DATE 3/4/87 SHEET NO. 28 OF 39

GAI CONSULTANTS, INC

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V = Q/A = 160/8.59 = 18.6 FPS ∴ OK FOR GROUTED RR.

ii, TRY CONCRETE:

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(160)(0.017)}{(8)^{8/3}(.125)^{1/2}} \sim 0.030$$

$d/b \sim 0.095$

$d = 0.095(8) = 0.76$ FT

FLOW DEPTH = 0.76 FT

ADD 3/4' TO CHANNEL FOR FREEBOARD, DEPTH = 1.5'

CHECK VELOCITY:

$$\frac{Qn}{b^{8/3} S^{1/2}} = \frac{(160)(.017)}{(8)^{8/3}(.1667)^{1/2}} \sim 0.026$$

$d/b = 0.085$

$d = 0.085(8) = 0.68$ FT

$A = db + zd^2 = 0.68(8) + 2(0.68)^2 = 6.36$ FT²

V = Q/A = 160/6.36 = 25 FPS

SUBJECT CONEMAUGH - EAST DIVERSION

BY DHK DATE 1-22-87 PROJ. NO. 810-267-32

CHKD BY TBV DATE 3/4/87 SHEET NO. 28A OF 39

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CHANNEL a-b

CHANNEL a-b WILL CONTAIN A CURVE WITH A RADIUS OF 500 FT.

ESTIMATE SUPERELEVATION:

FROM "OPEN-CHANNEL HYDRAULICS" BY CHOW, 1959, EQUATION (16-11) GIVES

$$\Delta h = \frac{V_c^2 b}{g\, r_c}$$

WHERE

Δh = SUPERELEVATION

b = WIDTH OF CHANNEL (TOP SURFACE OF FLOW)

g = 32.2 FT/S²

r_c = RADIUS OF CURVATURE

V = VELOCITY

V = 25 FPS (SHT 28, V_{max} @ SLOPE = 16.67%)

b = 8 FT + 2(2)(0.68) = 10.72 FT (8 FT BASE, 2:1 SS, DEPTH = 0.

r_c = 500 FT

$$\Delta h = \frac{\left(25 \frac{FT}{S}\right)^2 (10.72\ FT)}{\left(32.2 \frac{FT}{S^2}\right)(500\ FT)} = \frac{0.42\ FT^2 \cdot FT \cdot S^2}{S^2\ FT \cdot FT}$$

0.42 FT

INCREASE TO 1.0 FT FOR CROSS WAVES, SPLASH.

SUBJECT CONEMAUGH - EAST DIVERSION

BY DHK DATE 1/22/87 PROJ. NO 86-267-32

CHKD. BY TRV DATE 3/4/87 SHEET NO. 28B OF 39

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WHAT IF RADIUS IS REDUCED TO 270 FT WITH THE SAME 25 FPS VELOCITY.

$$\Delta h = \frac{V_c^2 b}{g r_c} = \frac{(25)^2(10.72)}{(32.2)(270)} = 0.77 \text{ FT}$$

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1-20-87 PROJ. NO. 86-267-32

CHKD. BY TRV DATE 3/4/87 SHEET NO. 29 OF 39

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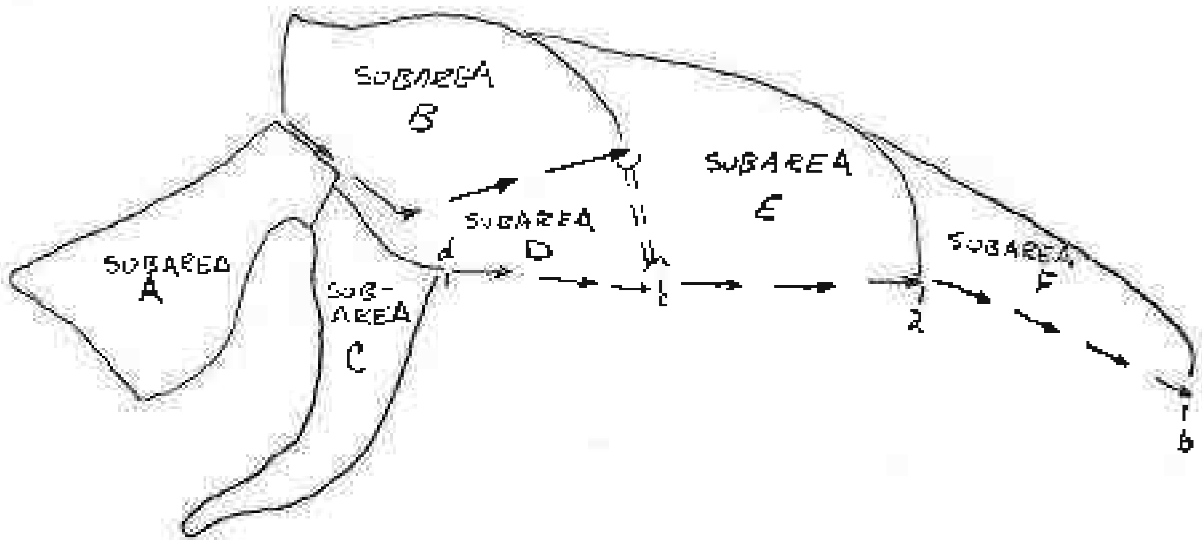
SUMMARY OF CHANNEL DESIGN

THE DECISIONS MADE DURING THE PREVIOUS CALCULATIONS ARE SUMMARIZED ON THE FOLLOWING SHTS. ORIGINALLY, ALL CHANNELS WERE TO BE DESIGNED TO CARRY THE PEAK FLOW FROM THE 100-YR, 24-HR STORM. HOWEVER, SOME OF THE CHANNELS WILL ONLY HAVE A USEFUL LIFE OF ~ 3 YRS. THE FOLLOWING SKETCH SHOWS THE CHANNELS.



CHANNEL a-b: THIS CHANNEL HAS A LIFE EQUAL TO THAT OF STAGE II, THEREFORE IT WAS DESIGNED TO CARRY THE PEAK FLOW FROM THE 100-YR, 24-HR STORM. THE CHANNEL RUNS ALONG VALLEY BROOK ROAD. THE DESIGN SECTION FOLLOWS.

TRAPEZOIDAL Q = 160 CFS (SEE SHT. 27)

BASE = 8 FT

DEPTH = 1.5 FT (WITH ALMOST 0.75 FT. OF FREEBOARD)

2:1 SIDESLOPES

SLOPE = 12.5 TO 16.67 %

ROUGH FINISH CONC. LINING

SUPERELEVATION IN 500' RADIUS CURVE TO BE + 1 FT.

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SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1-20-87 PROJ. NO 86-267-32
CHKD. BY TEV DATE 3/4/87 SHEET NO. 30 OF 39

CHANNEL c-a: THIS CHANNEL INVOLVES MODIFICATION OF AN EXISTING DIVERSION CHANNEL ALONG THE 1320 BENCH. THE CHANNEL RUNS FROM THE ROUGH FINISH CONC. CHANNEL (CHANNEL a-b) TO THE CONCRETE OUTLET BOX. THE USEFUL LIFE OF THE CHANNEL IS ~ 3 YEARS. DUE TO THE SHORT LIFE, A DISCUSSION WITH F. STRAW (PENELEC) LEAD TO SELECTING THE TEMPORARY CHANNEL DESIGN FLOW RATE CONTAINED IN THE DER EROSION AND SEDIMENTATION CONTROL MANUAL OF 1.6 CFS/ACRE. SEE SHTS. 24 & 25 FOR DESIGN.

THE DESIGN SECTION FOLLOWS:

TRAPEZOIDAL Q = 113 CFS
BASE: 6 FT.
DEPTH: 3.5 FT. (WITH ~ 3/4 FT OF FREEBOARD)
2:1 SIDESLOPES
SLOPE = 0.5 %
GRASS LINING

CHANNEL d-c: THIS CHANNEL INVOLVES MODIFICATION OF AN EXISTING "TYPE II CHANNEL" (AN ON-SITE DIVERSION DITCH) ALONG THE SAME 1320 BENCH AS CHANNEL c-a, BUT ABOVE THE CONCRETE OUTLET BOX. THE CHANNEL ACCEPTS FLOW FROM A PORTION OF THE STAGE I FACE. THE USEFUL LIFE OF THE CHANNEL IS ~ 3 YEARS, AS INDICATED ABOVE, THE CHANNEL WAS DESIGNED TO CARRY A FLOW OF 1.6 CFS/ACRE. SEE SHTS. 25 & 26 FOR DESIGN.

THE CHANNEL SECTION FOLLOWS:

SUBJECT CONEMAUGH - EAST DIVERSION

BY DMK DATE 1-20-87 PROJ. NO 86-267-32

CHKD. BY TRV DATE 2/4/87 SHEET NO. 31 OF 39

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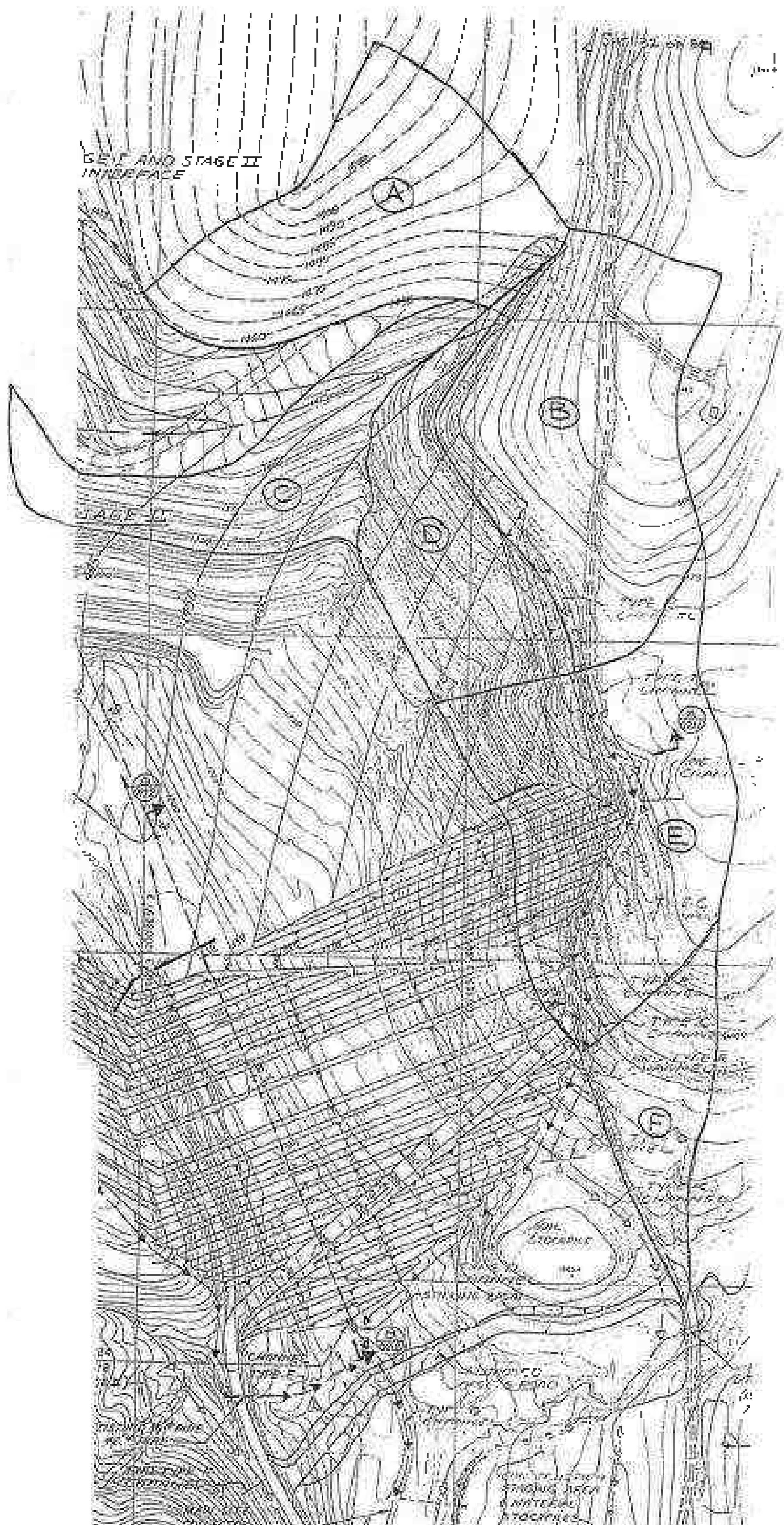
TRAPEZOIDAL Q = 31.4 CFS
BASE = 3 FT
DEPTH = 2.5 FT. (WITH ~ 3/4 FT OF FREEBOARD)
2:1 SIDESLOPES
SLOPE = 0.5%
GRASS LINED


BELF AND STAGE II
INTERFACE
A
B
C
D
E
F
STAGE II
SOIL STOCKPILE
SCALE 1" = 200'

INTRA-OFFICE MEMO

GAI CONSULTANTS
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Environmental Specialists

To: File

From: EHK

Subject: Meeting on Conemaugh & Keystone Hydrology

Project No. 85-195, 85-205

Date: 2/21/85

☑ For Information Only ☐ For Your Action

☐ For Review and Reply ☐ Non-Project File No.

Meeting between Ellen Kucharik, Tim Kyper and Anne Brendel was held to attain some kind of consistency between Conemaugh and Keystone hydrology.

Curve Numbers for certain areas were decided on as follows:

Revegetated pile - top surface	75	ii
" " - bench faces	78	iii
Off-site - fair pasture or range	80	iv
Off-site - woods	70	i
Active disposal	85	viii
Bench faces in process (seeded but not fully vegetated)	82	vi
Paved haul road (If large enough area to separate)	90	ix
Haul Road on pile	85	vii
Top Surface in process (seeded but not fully vegetated)	80	v

Time of concentration determinations will be ba...

Distribution: ASB, TNK, EHK, GFB, DB, HCP, File, JRL

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To:
From:
Subject:
Project No. ☐ For Information Only ☐ For Your Action
Date: ☐ For Review and Reply ☐ Non Project File No.

on the attached graph as follows: (velocities)

Active pile - Curve ⑤
Pile in process - Curve ③ (seeded but not fu
Revegetated pile - " ②
Off-site pasture - " ③
" woods - " ①

Velocities in channels will be estimated base on experience and checked with a quick channel design after flows are received from TR 20. TR2 will be rerun if the assumed velocity and the velocity from the channel design differ greatly.

Tim gave a quick review of the TR20 progra 3 levels of detail are possible from th program.

1. "Detailed" Analysis
2. Addition of runoff hydrographs for each s area
3. Considering area as one "gross" wat

Distribution:

100 Year 24 hr Storm 5.5 inch precipitation.

DC-272-413-015 6/22

Sub Area	Surface Area	Runoff (1) Curve CN	Drainage Area Acres	Drainage Area Mi^2	(Y) Sub area slope %	Runoff (2) Depth inches	OVERLAND FLOW: Greatest flow length in ft (l)	OVERLAND FLOW: (L) Lag in Hours (3)	OVERLAND FLOW: Tc (4) hr	OPEN CHANNEL: length ft	OPEN CHANNEL: estimated velocity f/sec	OPEN CHANNEL: Travel time thru Reach hr	T_t HRS	Rounded Numbers used in Calcs. T_t	Rounded Numbers used in Calcs. T_c
I	Wood Forest - Good Cover	70	63.15	0.099	12.5	2.4	1600	0.174	0.29	—	—	0.00	0.304	0.25	0.3
II	" "	70	49.26	0.077	31.2	2.4	900	0.070	0.117	1600	4	0.111	0.193	0.25	0.1
III	" "	70	37.91	0.059	22.2	2.4	1000	0.093	0.155	1600	4	0.111	0.193	0.25	0.2
IV	" "	70	31.08	0.048	43.7	2.4	500	0.037	0.062	1800	6	0.083	0.110	0	0.1
V	Grass Cover - Fair	70	22.00			3.2									[illegible]
VI	Grass Cover - Fair Cond	79	48.40	0.076	14.5	3.2	2000	0.150	0.250	1400	7	0.055	0.055	0	0.3
VII	" "	79	34.92	0.054	9.4	3.2	2400	0.215	0.358	500	8	0.020	0.035	0	0.3
VIII	" "	79	15.18	0.024	4.5	3.2	1000	0.154	0.257	1000	8	0.035	0	0	0.3
			301.90												

(1) Page 2-5 Table 2.2 TR55

(2) TR55 - Page 2-3 Table 2-1 (interpolated values)

(3) TR55 - Eq. 3-2 page 3.6 $L = \frac{l^{0.8}(S+1)^{0.7}}{1,900\, Y^{0.5}}$; $S = \frac{1000}{CN} - 10$

(4) TR-55 - Eq 3-1 page 3.5 $L = 0.6\, T_c \Rightarrow T_c = 1.67\, L$

DC-277-4/3-015 7/22

	T_σ	T_t	11.0	11.5	11.6	11.7	11.8	11.9	12	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0
I	0.3	0.25	17	31	35	43	67	134	279	461	559	530	428	318	234	179	143	116	97
	$A_{total} \times RD_{in}$ =	0.2376	4.04	7.36	8.32	10.22	15.92	31.84	66.29	109.53	132.82	125.93	101.69	75.55	55.60	42.53	33.98	27.56	23.04
II	0.1	0.25	20	38	42	66	140	327	626	680	546	364	236	169	137	117	97	83	75
		= 0.1848	3.70	7.02	7.76	12.10	25.87	60.43	115.68	125.66	100.90	67.27	43.61	31.23	25.32	21.62	17.92	15.34	13.86
III	0.2	0.25	18	34	39	49	91	196	419	603	607	486	341	235	173	138	114	96	83
		= 0.1416	2.54	4.81	5.52	6.94	12.88	27.75	59.33	85.38	85.95	68.82	48.28	33.27	24.50	19.54	16.14	13.59	11.75
IV	0.1	0	24	51	173	299	954	746	477	233	152	132	121	111	85	74	70	68	65
		= 0.1152	2.76	5.87	19.93	34.44	109.90	85.93	54.95	26.84	17.51	15.21	13.94	12.79	9.79	8.52	8.06	7.83	7.49
V	0.3	0																	
	(22 Arm)	= 0.11088	3.33	4.77	7.43	15.63	35.92	64.97	72.96	59.32	41.25	27.72	20.41	16.41	13.75	11.31	9.53	8.53	7.67
VI	0.3	0	21	43	67	141	324	586	658	535	372	250	184	148	124	102	86	77	71
		= 0.2432	5.11	10.46	16.29	34.29	78.80	142.51	160.02	130.11	90.47	60.80	44.75	35.99	30.16	24.81	20.91	18.73	17.27
VII	0.3	0																	
		= 0.1728	3.63	7.43	11.58	24.36	55.99	101.26	113.70	92.45	64.28	43.20	31.79	25.57	21.43	17.62	14.86	13.30	12.27
VIII	0.3	0																	
		= 0.0768	1.61	3.30	5.14	10.83	24.88	45.00	50.53	41.09	28.57	19.20	14.13	11.37	9.52	7.83	6.60	5.91	5.45
						148.91	360.16	559.69	693.46	670.38	561.75	428.15	318.60	[illegible]	190.07				

Gilbert/Commonwealth
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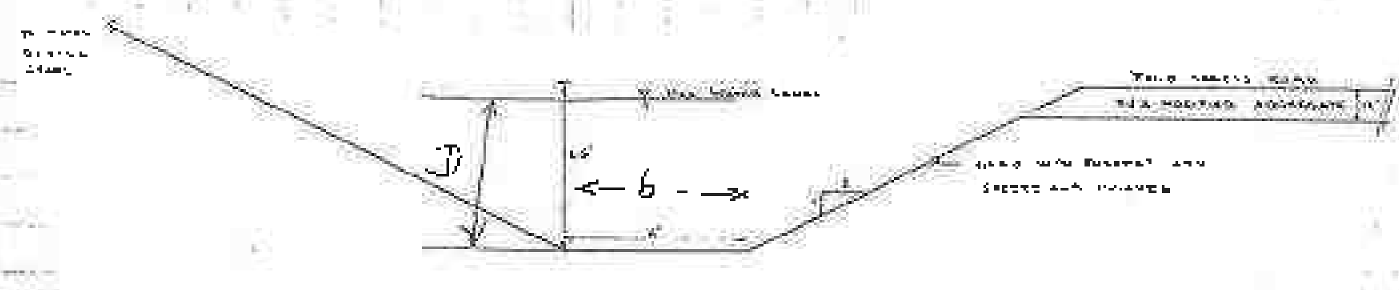
CALCULATION

SUBJECT	IDENTIFIER	PAGE
East Valley Div. Channel	DC-272-413-015	8 OF 22 PAGES

REV.	0	1	2	3
MICROFILMED				
ORIGINATOR	WAKANIK			
DATE	DEC 84			

(2) CHANNEL DESIGN



$S = 0.0111$

$Q = 700$ cfs

578 cfs Feb 1/85

Enkamat lining provided by American Enka Company North Carolina 704-657-7713

(In accordance to "Erosion Control Instruction Manual – Bulletin Nr EM-1 – Dec 82 - ENKA)

Enkamat conditions	n
Bare	0.04
Partial Silt	0.03
Full Silt	0.02
Vegetated (3" grass)	0.04
Vegetated (6" grass)	0.05

Use $0.045 = n$

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Div. Channel			IDENTIFIER DC-272-413-015	PAGE 5 OF 22 PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR W.A. HANIC				
	DATE Apr 84				

In accordance to table 77 of Ref 3

$$\frac{Qn}{b^{8/3} S^{1/2}} = K' = \frac{Q \times 0.045}{6^{8/3} \times \sqrt{0.0111}} = 0.00359\, Q$$

Q	K'	D/b	Depth ft	A ft²	V fps	$\frac{V^2}{2g}$
200	0.718	0.515	3.09	37.64	5.31	
400	1.439	0.715	4.29	62.55	6.39	
600	2.156	0.865	5.19	85.01	7.06	
700	2.515	0.925	5.55*	94.90	7.37	0.84

*(If n = 0.040 ; K' = 2.236 ⇒ D/b = 0.875 ∴ D = 5.25 ft ; V = 8.08 fps)

Let's calculate critical depth (table 109 Ref 3)

$$K' = \frac{700}{6^{2.5}} = 7.938$$

$D_c/b = 0.70$

$D_c = 4.20$ ft

$V = 11.57$ fps

∴ Flow is subcritical

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East valley Dr. Chan		IDENTIFIER DC-272-413-011	PAGE 10 OF 22 PAGES
	REV. 0	1	2	3
	MICROFILMED			
	ORIGINATOR WAHMK			
	DATE Dec 84			

(3) CHUTE and STILLING BASIN

for $Q = 700$ cfs.

chute width = 12.00 ft

$n = 0.015$

– Critical Depth $= d_c = 0.31433\, q^{0.666}$

for $q = \frac{700}{12} = 58.33$ cfs and $b = 12$ ft

$$\left\{\begin{array}{l} d_c = 4.72 \text{ ft} \\ V_c = 12.35 \text{ fps} \\ \frac{V^2}{2g} = 2.37 \text{ ft} \\ E_c = 7.09 \text{ ft} \end{array}\right.$$

Flow depth in 12' wide chute

$$S = \frac{\Delta h}{L} = \frac{1115 - 1092}{115} = \frac{23}{115} = 0.20$$

$$\frac{Qn}{\sqrt{S}\; b^{8/3}} = K' = \frac{Q \times 0.015}{\sqrt{0.2}\; 12^{2.666}}$$ (Ref (3) page 97)

$K' = 4.4438 \times 10^{-5} \times (Q_{cfs})$

for 700 cfs ; $K' = 0.031 \Rightarrow \frac{D}{b} = 0.105 \therefore D = 1.26$ ft.

Water depths in chute when flow is 700 cfs

Chute width = 12.0 ft.

F = 1.04

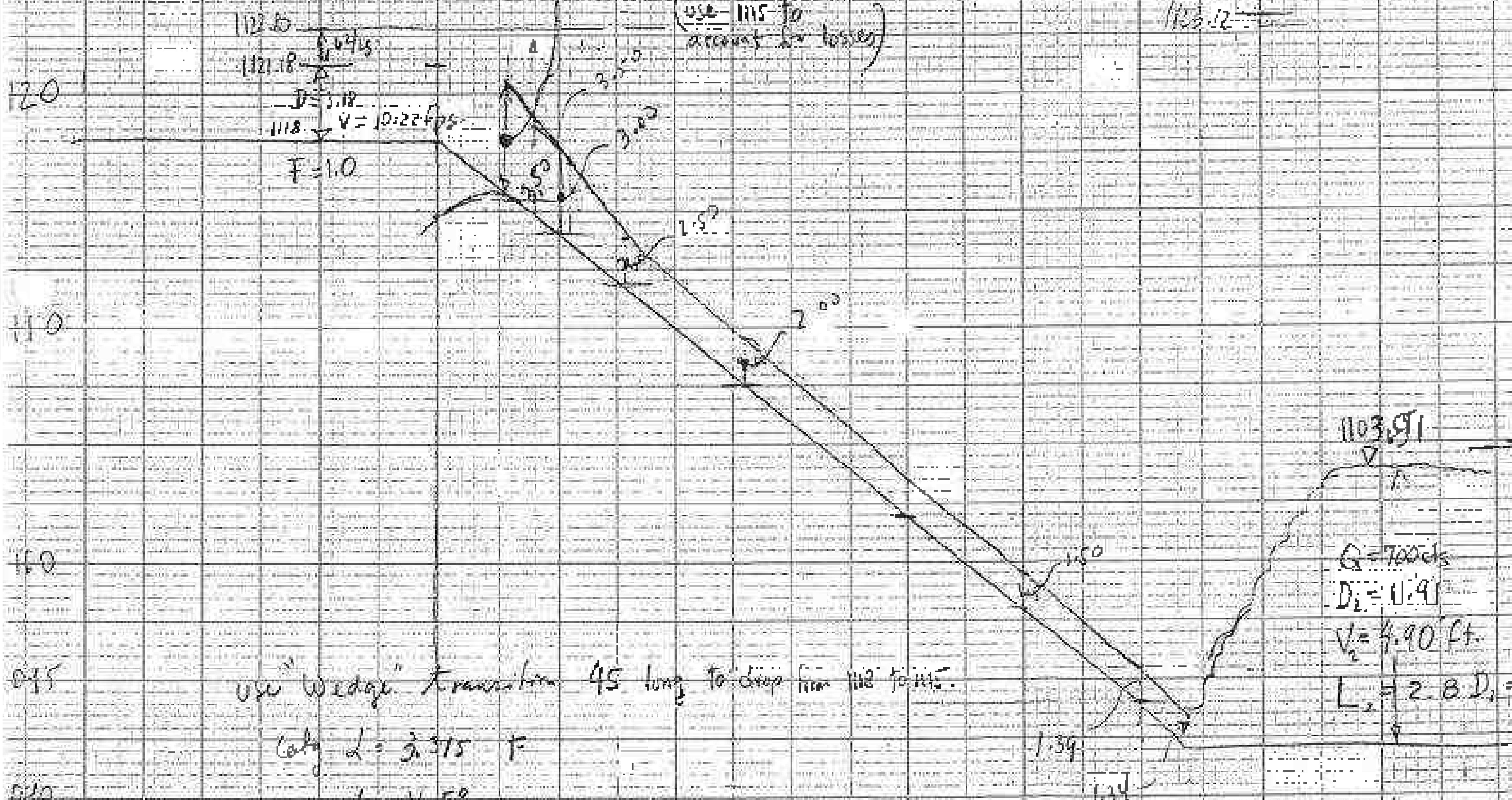
D = 4.60 ft

V = 12.68 fps

h_v = 2.50

Bottom = 1115.75 (without head losses)

(use 1115 to account for losses)



Q = 700 cfs

D_2 = 11.91

V_2 = 4.90 ft.

L_2 = 2.8 D_2 = 33.35 ft. (use 35 ft)

Use "Wedge" transition 45 long to drop from 1118 to 1115.

Calc α = 3.375 F

α = 16.5°

Use α = 15° on each side

$$F = \frac{V}{\sqrt{gd}} = \frac{43.53}{\sqrt{32.2 \times 1.34}} = 6.63 \; ; \; D_2 = \frac{D_1}{2}\left(\sqrt{1+8F^2} - 1\right) = 11.91$$

12' Chute

Depth	V	$V^2/2g$	E	1122.80 − E
→ 1.34	43.53	29.43	30.77	1092.03
1.39	41.97	27.35	28.74	1094.06
1.40	41.66	26.96	28.35	1094.44
1.50	38.89	23.48	24.98	1097.86
2.00	29.17	13.21	15.21	1107.59
2.50	23.33	8.45	10.95	1111.85
3.00	19.44	5.87	8.87	1113.93
3.50	16.67	4.31	7.81	1114.99
4.00	14.58	3.30	7.30	1115.50
4.25	13.72	2.92	7.17	1115.62
4.50	12.96	2.61	7.10	1115.69
→ 4.60	12.02	2.50	7.10	1115.70
5.00	11.67	2.11	7.11	1115.68
6.00	9.72	1.46	7.47	1115.33
7.00	8.33	1.08	8.08	1114.72

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT: East Valley Div. Chanl			IDENTIFIER: DC-292-413-015	PAGE 12 OF 22 PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR: WAHANIK				
	DATE: DEC 84				

In accordance to Pages 27, 35 & 37 Ref (4) the stilling basin needed is the Burec Type III dissipator. The blocks dimensions are:

$$L_{III} = 2.8 \times 11.91 = 33.35 \text{ ft} \quad (\text{use } 35')$$

$$h_3 = 1.7 \times 1.34 = 2.28 \text{ ft} \quad (\text{use } 3')$$

$$h_4 = 1.2 \times 1.34 = 1.61 \text{ ft} \quad (\text{use } 2')$$

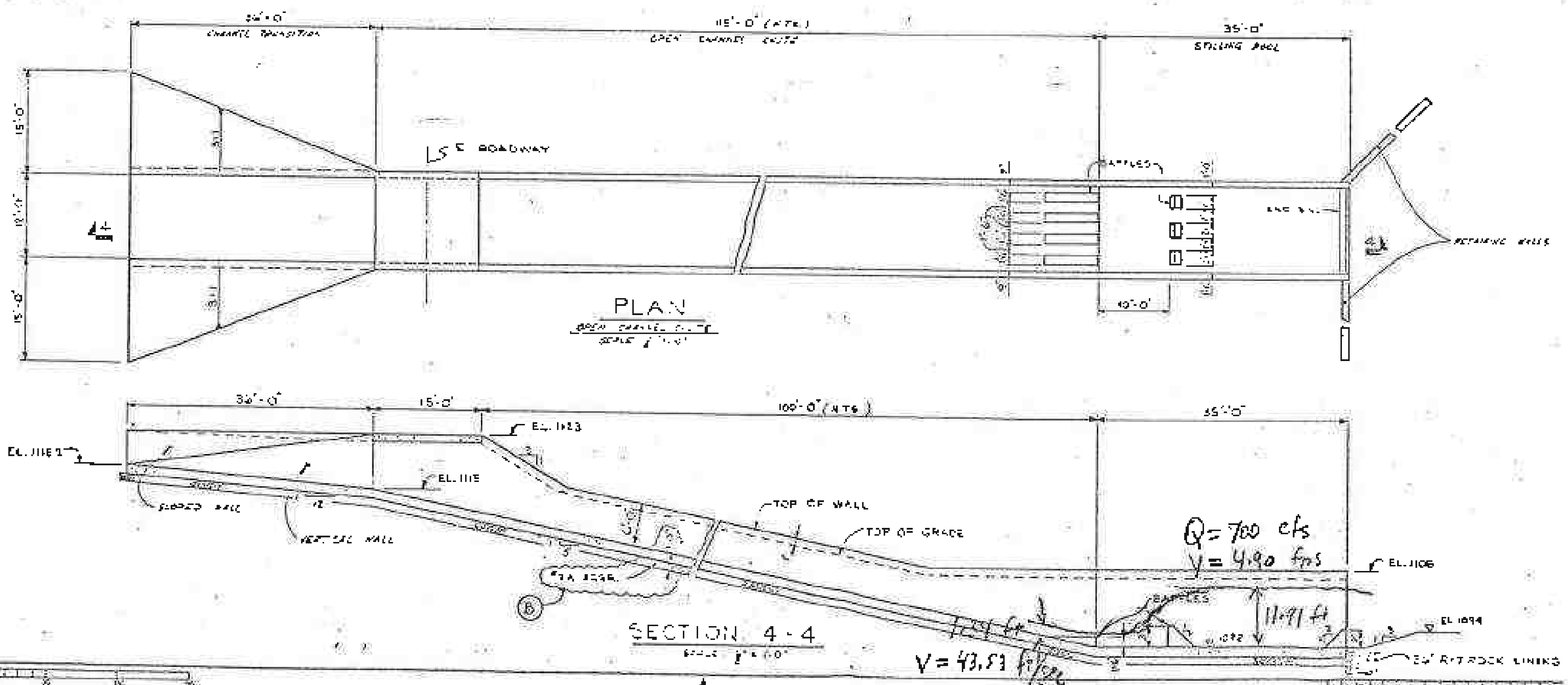
$$0.8\, D_2 = 0.8 \times 11.91 = 9.53 \text{ ft} \quad (\text{use } 10')$$

Top of stilling basin side walls should be at Elev <u>1106.0 ft</u>

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Diversion Channel			IDENTIFIER DC-282-413-015	PAGE 14 OF 22 PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR WAAANIK				
	DATE MARCH 85				

FORCE ON BAFFLE PIERS AND END SILL – DRAG ANALYSIS

The dimensions of the baffle piers and of the end sill are shown below



Reference: Dwg. G/C E-282-039

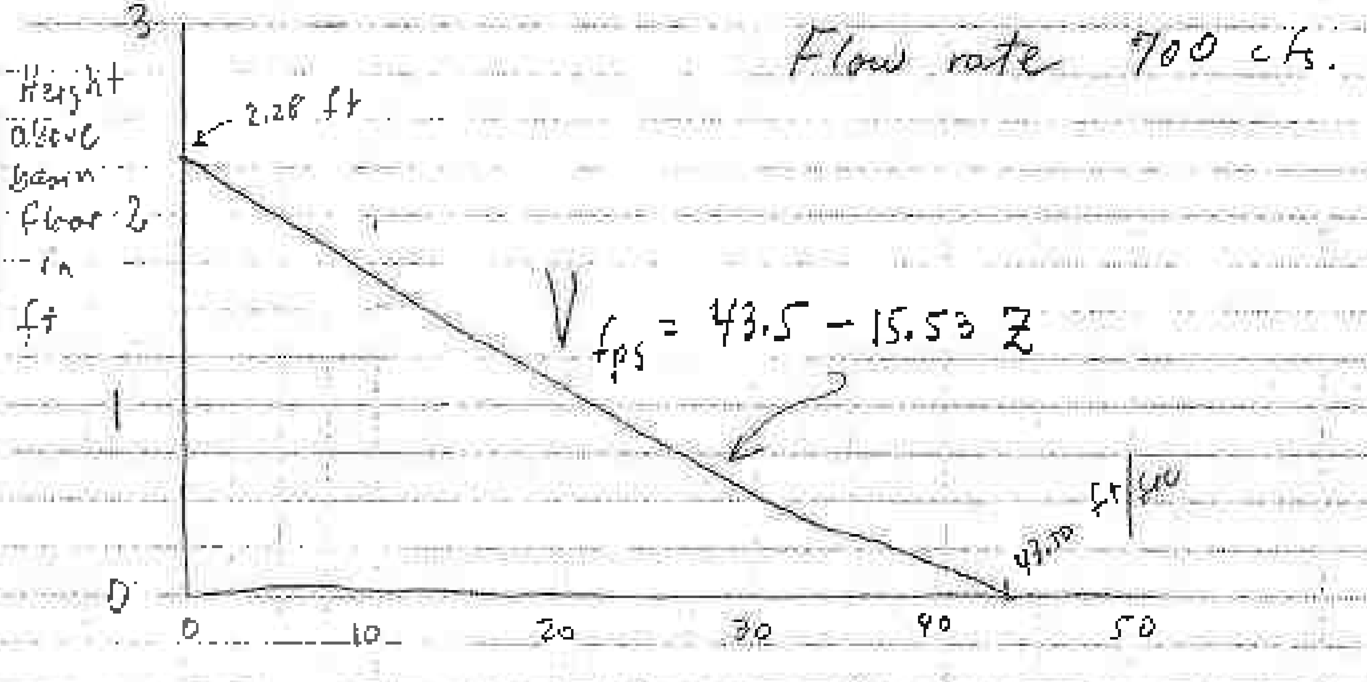
Gilbert/Commonwealth
ENGINEERS/CONSULTANTS
CALCULATION

SUBJECT	IDENTIFIER	PAGE
East valley Div. Channel	DC-292-413-015	15 OF 22 PAGES

REV.	0	1	2	3
MICROFILMED				
ORIGINATOR	WA HAMIR			
DATE	March 83			

Intermediate Baffle Piers

Let's assume that the actual water depth before the baffle is 2.28 ft (see value at h_3 in page 12 of this calcs.) and that the velocity profile at that point is:



$\frac{43.50}{2.8} = 15.53.$

Since the velocity in the stilling basin is not uniform, V will be approximated by the Root-Mean-Square velocity

$$V_{RMS}^2 = \int_0^{2.28} \frac{(43.5 - 15.53\,z)^2\,dz}{A}$$

$$= \int_0^{2.28} \frac{\left[(43.5)^2 - 2(43.5 \times 15.53\,z) + (15.53\,z)^2\right] dz}{A}$$

$$= \frac{(43.5^2 \times 2.28) - \left[43.5 \times 15.53 \times (2.28)^2\right] + \left(15.53^2 \times \frac{2.28^3}{3}\right)}{2.28}$$

$$V_{RMS}^2 = 929.74$$

$$\therefore \quad V_{RMS} = 30.5 \text{ fps}$$

Drag force exerted on submerged body in a uniform velocity field is given by

$$F_D = \frac{C_D\,\rho\,A\,V^2}{2}$$

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT: East Valley Div Channel		IDENTIFIER: DC-272-413-115	PAGE 17 OF 22 PAGES
	REV. 0	1	2	3
	MICROFILMED			
	ORIGINATOR DAHANIR			
	DATE March 85			

$R = VD/\nu$

R = Reynolds number
D = depth
ν = kinematic viscosity
V = velocity

$V = 30.5$

$D = 2.00$

$\nu_{70°F} = 1.06 \times 10^{-5}\ Ft^2/sec$

$$R = \frac{30.5 \times 2.00}{1.06 \times 10^{-5}} = 5.75\ E^{6}$$

Reference: Rouse, H., Engineering Hydraulics, John Wiley & Sons Inc., N.Y. 1950 Page 126

For $R > 10^3$, C_D for a rectangular plate with a length/width ratio of $3/2 = 1.5$ is equal to 1.16

THUS

$$F_D = 1.16 \cdot \frac{\rho A V_{RMS}^2}{2}$$

ρ = density @ 70°F = 1.94 Slug/Ft³

$A = 3 \times 2 = 6\ Ft^2$

$V^2_{RSM} = 929.74\ Ft^2/sec^2$

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Divers. Channel		IDENTIFIER K-272-413-415	PAGE 18 OF 22 PAGES
	REV. 0	1	2	3
	MICROFILMED			
	ORIGINATOR WAHANIK			
	DATE March 85			

$$F_D = \frac{1.16 \times 1.94 \times 6 \times 929.74}{2}$$

$$F_D = 6277 \text{ Pounds.}$$

Line of action:

$$\bar{Z} = \frac{C_D \frac{\rho_1}{2} \int_0^{2.28} \frac{(43.5 - 15.53 Z)^2 Z\,dZ}{2.28}}{6277}$$

$$\bar{Z} = \frac{\frac{1.16 \times 1.94}{2} \int_0^{2.28} \left(\frac{43.5^2 - 2(43.5)(15.53 Z) + (15.53 Z)^2}{3} \right) \frac{Z^2}{2}}{6277}$$

$\bar{Z} = 0.33$ ft from base of baffle pier

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Div. channel		IDENTIFIER DC-292-413-015	PAGE 19 OF 22 PAGES
	REV. 0	1	2	3
	MICROFILMED			
	ORIGINATOR WAHANIK			
	DATE March 85			

For Drag on Sides:

Assume the sides of the baffle pier can be approximated by smooth flat plate of average length 4.0 ft and average height of 2 ft

Ref: Vennard J. K., Fluid Mechanics, John Wiley and Sons Inc., New York 1962 Page 509

$R_x = \frac{V x}{\nu}$ where x = length of plate

$R_x = \frac{30.5 \times 4}{1.06 \times 10^{-5}} = 1.15 \times 10^{7}$

$C_f = 0.0025$ (Turbulent Boundary Layer)

$D_x = \text{Drag} = C_f \frac{\rho A V^2}{2}$

D_x (two sides of plate)

$= 0.0025 \times 1.94 \times 8 \times 929.44$

$D_x = 36$ lbs

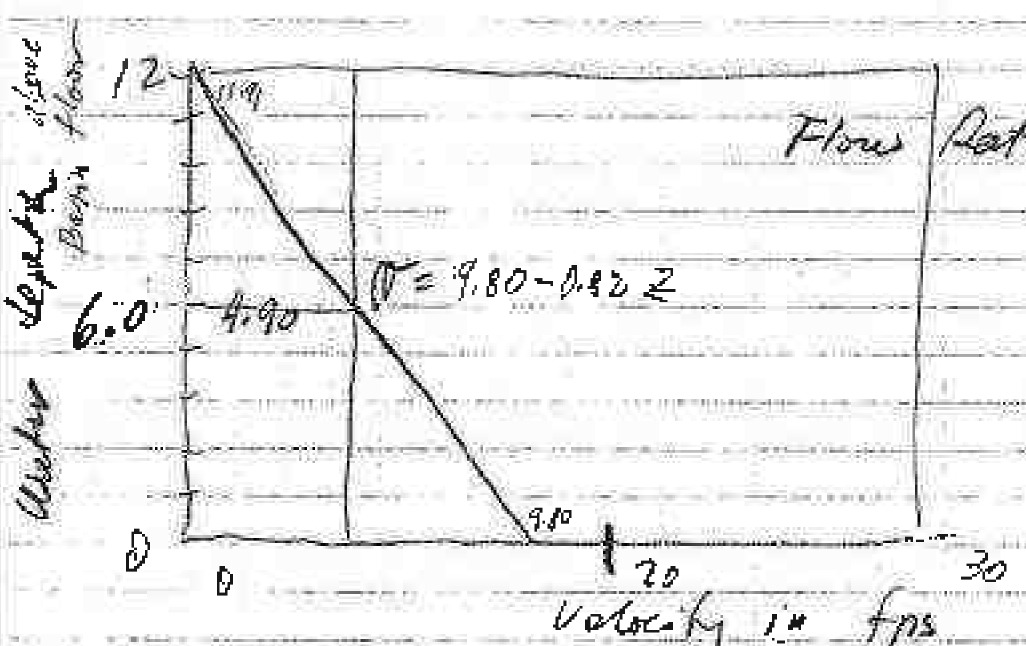
Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Div. Channel			IDENTIFIER DC-272-V13-011	PAGE 20 OF 22 PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR MAHONE				
	DATE March 85				

the drag force on the sides of the baffle piers is small compared to the drag forces on the face of the piers.

thus the total force acting on the baffle is 6277+36 = 6313 lbs = 6.3 KIPS

END SILL FORCES

velocity profile before end sill



Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Diversion Channel	IDENTIFIER DC-277-413-015	PAGE 21 OF 26 PAGES
	REV. 0 / 1 / 2 / 3		
	MICROFILMED		
	ORIGINATOR WAHAMK		
	DATE March 85		

The end sill is assumed to be a rectangular place of infinite length

From Rouse page 126 for $R > 10^3$; $C_D = 1.90$

for 900 cfs $R = \frac{9.8 \text{ fps} \times 1.91}{1.66 \times 10^{-5}} = 1.10 \times 10^7$

thus $C_D = 1.90$

$$F_{D_{\text{Pr...}}} = \frac{1.90\, \rho A v^2}{2} = \frac{1.90 \times 1.94}{2} \times 2 \times v^2 = 3.686\, V^2 / \text{linear ft}$$

lets determine the velocity in front of the end sill using the Root Mean Square velocity method

$$\bar{V}^2 = \frac{(9.8^2 \times 2) - (9.8 \times 0.82 \times 2^2) + (0.82^2 \times \frac{2^3}{3})}{2}$$

$\bar{V}^2 = 80.86$; 8.99 fps.

$\therefore F_D = 3.686 \times 80.86 = 298$ lbs/linear ft $= 0.3 \frac{\text{kips}}{\text{ft}}$

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT East Valley Diversion Channel		IDENTIFIER DC-271-43-015	PAGE 22 OF 22 PAGES
	REV. 0	1	2	3
	MICROFILMED			
	ORIGINATOR W. Ahrentil			
	DATE March 85			

and the line of action

$$\bar{Z} = \left(\frac{1.90 \times 1.94}{2} \times 80.86 \times \frac{4}{2}\right) \div 298$$

$\bar{Z}$ = 1.00 ft from base of end sill

SUMMARY IMPACT FORCES

Intermediate baffle piers — F = 6.3 Kips PER BAFFLE acting 0.33 ft. from base of BAFFLE.

End sill — F = 0.3 $\frac{\text{Kips}}{\text{FT of sill}}$

acting 1.0 ft. from Base of Sill.

Note: For heel (beginning of Stilling basin) use a horizontal force in the direction of flow = 3.0 Kips per Block (EACH)

PROPRIETARY INFORMATION OF GILBERT/COMMONWEALTH - FOR INTERNAL USE ONLY
THIS IS A PERMANENT RECORD DO NOT DESTROY

Rather than modify the existing concrete channel at the equalization pond spillway, design new channel to bypass the structure.

We were to pick up GAI Consultants, Inc. east valley channel from the existing flow channel at N 390,750, with their channel being a 15 ft wide bottom trapezoidal channel at [illegible].

Instead, we will assume that they will change the routing of the last 300 ft. of their channel to run from approx. N 390,990 and E 1,633,060 to approx. N 390,770 and E 1,633,260, and sloped the same as our portion.

Total run in question

N 390,770 }
E 1,633,260 } invert 1157.6

to — ℄ length = 1016'

N 390,100 }
E 1,633,410 } invert 1140.5

slope = (1157.6 − 1140.5) / 1016' = 0.0173%

Invert at match point ≅ 1152.4 { N 390,770 ; E 1,633,260 }

Design bypass channel configuration

Q_{peak} = 575 cfs per GAI Cons. Inc. 1/28/85 report

slope = 0.0173 %

use trapezoidal shape - maintain 14 ft. bottom width - 2:1 side slopes.

determine depth required

Assume lined with Enkamat and permanent vegetation —
n value = 0.022 to 0.033 for short grass with few weeds
to 0.080 to 0.120 for unmaintained channel with weeds and brush uncut – dense weeds, high as flow depth

(Ref. Open Channel Hydraulics, V.T. Chow, McGraw-Hill, 1959, Table 5-6)

also

(Ref. Enkamat Erosion Control Instruction Manual, American Enka Co., 1983, Table A-1)

Estimated n value for Enkamat channel lining with medium growth vegetation = 0.03 to 0.04

Since flow is very likely to exceed height of grass, the 2nd range from Chow would be too conservative

∴ use average value of 0.035 from Enkamat

Ref. H.D.S. #3, Design Charts for Open-Channel Flow, U.S. DOT, 1961

For 14 ft. wide bottom w/ 2:1 side slopes, S = 0.0173,
Qn = 578 × 0.035 = 20.23
Vn = 0.327 → V = 9.3 fps, d = 3.1 ft

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT Conemaugh Ash Site East Valley Diversion Channel	IDENTIFIER BC-272-413-015	PAGE 22C OF PAGES 22
	REV. 0 / 1 / 2 / 3		
	MICROFILMED		
	ORIGINATOR [signature]		
	DATE 8/6/85		

For 16 ft wide bottom w/ 2:1 side slopes, S = 0.0373,

Qn = 578 × 0.035 = 20.23

$V_n = 0.325 \rightarrow V = 9.3$ fps, d = 3.0 ft

Since these values are so close for the two bottom widths, averaging is not even necessary for the 15 ft wide bottom.

∴ Use 15 ft wide bottom at S = 0.0373 w/ 2:1 side slopes and minimum depth of 3.5 ft. Line w/ Enkamat and permanent vegetation.

No transition will be necessary at match with GAI Con'd, Inc. channel section, but a transition will be required when tying into the original east valley diversion channel.

Per Chow reference, p. 310, the optimum maximum angle between the channel axis and a line connecting the channel sides between entrance and exit sections is 12.5°.

New channel width = 15', existing design east valley diversion channel = 6', then each side must taper 4.5'. A 12.5° transition is equivalent to a 4.5:1 taper, thus transition length =

$$\frac{4.5}{1} = \frac{d}{4.5} \rightarrow d = 20.25'$$

Round up to 25 ft. length

POWER AND INDUSTRIAL SYSTEMS DIVISION – READING

DESIGN INPUT RECORD

PROJECT	W.O.	IDENTIFIER
Conemaugh ST.	04-4479-170	DC-272-415-015

SUBJECT: East Valley Diversion Channel

DEPT./SECTION: Structural / Civil / 0415 — PAGE 1 OF 2

REVISION	0	1	2	3
ITEM(S) REVISED	X			
ORIGINATOR	R. WAHANIK			
DATE	Dec 84			
PROJECT ENGINEER REVIEW	D. J. [illegible]			
DATE	2/28/85			
SECTION MANAGER APPROVAL	D. [illegible]			
DATE	3/1/85			
FUTURE CONFIRMATION REQUIRED?	~~NO~~ YES*			
MICROFILMED/DATE				

* NEED FINAL PLAN DATA

INSTRUCTIONS: USE "N/A" FOR ITEMS NOT APPLICABLE. IDENTIFY ITEMS REQUIRING FUTURE CONFIRMATION BY CIRCLE OR CLOUD. IDENTIFY REVISED INFORMATION BY VERTICAL LINE IN RIGHT MARGIN AND REVISION NUMBER. USE ADDITIONAL SHEETS AS NECESSARY.

1. SCOPE OF THIS DIR; BASIC FUNCTIONS OF SYSTEM, STRUCTURE, OR COMPONENT:

Hydraulic analysis and design of the East Valley Diversion Channel for the Conemaugh Coal Ash/Mine Refuse disposal site.

CONTINUED PAGE ___

2. CLASSIFICATION, DESIGN CODE(S) AND STANDARD(S):

Non Safety

CONTINUED PAGE ___

3. PERFORMANCE REQUIREMENTS AND SOURCE:

CONTINUED PAGE ___

4. DESIGN MARGINS OR SAFETY FACTORS:

N.A.

CONTINUED PAGE ___

DESIGN INPUT RECORD

IDENTIFIER	
PAGE 2 OF	

5. DESIGN CONDITIONS AND SOURCE:

CONTINUED PAGE ___

6. OPERATING CONDITIONS AND SOURCE:

CONTINUED PAGE ___

7. AMBIENT CONDITIONS AND SOURCE:

CONTINUED PAGE ___

8. MATERIAL(S):

CONTINUED PAGE ___

9. OTHER REQUIREMENTS:

CONTINUED PAGE ___

10. REFERENCES:

See attached Page 2

CONTINUED PAGE ___

DISTRIBUTION RECORD

REV.	DISCIPLINE ENGINEERS								OTHERS				
	BSVC	CHEM	ELEC	I/C	LO/MOD	MECH	PIPING	STRUC	RECORDS	PM	RESPON. SM		
REVIEW													
0									X				
1									X				
2									X				
3									X				

Gilbert/Commonwealth

THIS IS A PERMANENT DESIGN RECORD   DO NOT DESTROY

Gilbert/Commonwealth ENGINEERS/CONSULTANTS DESIGN IMPUT RECORD	SUBJECT East Valley Diversion Channel	IDENTIFIER DC-782-913-015	PAGE 2 OF 2 PAGES
	REV. 0 / 1 / 2 / 3		
	MICROFILMED		
	ORIGINATOR WAHAMIC		
	DATE Dec. 1984		

Conemaugh Coal Ash / Mine Refuse Disposal Site

REFERENCES

1) Letter from H.C. Pedersen and J.A. Lesnik (General Analytics) to S.J. Novotny (Penelec) dated Nov 9, 1984

2) Letter from H.C. Pedersen (General Analytics) to S.J. Novotny (Penelec) dated Nov 16, 1984

3) Handbook of Hydraulics by H.W. King - 4th Edition

4) Hydraulic Design of Stilling Basins and Energy dissipators - US Dept of Interior - Bureau of Reclamation

5) Design of small canal structures - U.S. Dept of the Interior - Bureau of Reclamation.

6) Civil Engineering Hydraulics by Featherstone & Nalluri Granada Press - London - New York.

7) Urban Hydrology for Small Watersheds - 1975 Technical Release No 55 - SCS - US Dept of Agric

8) SCS - US Dept of Agriculture - April 1978 "NETSC TECHNICAL NOTE - Engineering 20, Rev. 2"

9) GAI Consultants Drwg. 82-134-E42 Rev 0

10) G/C drawings D-782-032 Rev [illegible]; E-782-033 Rev A and D-782-472 Rev 7

DC-272-413-015

Date: 04-22-1986

Project: CONEMAUGH ASH VALLEY

Description: EAST VALLEY DIVERSION CHANNEL
DEPTH CHECK FOR FLOW CHANGES

** Open Channel Flow - Trapezoidal Cross Section **

Side slope (H/1V)= 2

	Discharge (cfs)	Ave. Vel. (ft/s)	Depth (ft)	Area (sq ft)	Top Width (ft)	Froude No.	Slope (ft/ft)	n Value	Bottom Width (ft)
①	649	7.23	5.37	89.79	27.46	0.70	.01111	.0450	6.00
②	686	7.33	5.50	93.53	28.00	0.71	.01111	.0450	6.00
③	703	7.38	5.57	95.34	28.26	0.71	.01111	.0450	6.00

① Flow rate used this DC, p. 22A, provided by GAI Consultants, Inc, 1/21/85 report, plus 71 cfs* accumulated to the end of the channel.

② Revised flow rate per S.J.N.-F.G.N. 3/25/86 telecon, plus 71 cfs* accumulated to the end of the channel.

③ Revised flow rate from GAI Consultants, Inc, 5/10/85, plus 71 cfs* accumulated to the end of the channel.

* From p. 4a/22 this DC.

FILE ____________

GILBERT ASSOCIATES, INC.

TELEPHONE AND CONFERENCE MEMORANDUM

DATE March 25, 1986

BY: Gregory Nadeau

G/C, Inc. WORK ORDER NO 04-4479-170

GDE PROJECT WORK ORDER NO. C0014

PENELEC WORK ORDER NO. C367

TELEPHONE CALL [X] CONFERENCE [ ]

WITH: Steve Novotny

COMPANY: Penelec

SUBJECT: Conemaugh - Ash Disposal Leachate Treatment System

Steve requested that G/C, Inc. perform the following tasks:

1. Transmit the mylar for the new stockpile area by Federal Express to Don Newman at Schneider Consulting Engineers.

2. GAI Consultants, Inc. have submitted new flows to Penelec for the three channels. The following ditches have a higher flow rate
   a) Check the capacity of the Main Valley West Diversion Channel for a flow rate of 225 cfs.
   b) Check the capacity of the East Valley Diversion Channel for a flow rate of 614 cfs at North Coordinate 389,840.*

3. GAI Consultants, Inc. have designed a concrete lining for the Main Valley Site Collector Channel. Steve requested that I submit to him the reasons for using a PVC liner with riprap cover instead of concrete.

F. G. Nadeau

Not Sent

FGN:bmb

cc: S. J. Novotny
K. W. Eshbaugh
T. C. Frank
T. E. Strittmatter
D. R. Erail/F. G. Nadeau
E. J. Zinn, Jr.
P. K. Shewchuk
O. G. Boarder

*N 389,840 is approximately the beginning of the 6' wide bottom.

REF (9)

REF (9)

Channel	Minimum Flow Area	Minimum Flow cfs	Maximum Flow Area	Maximum Flow cfs		
East valley	67	110 (1.64)	323	560 (1.73)	344	1015 (2.57)
Site collection	526	1007				
West side	33.2	75 (2.26)	341	602 (1.76)		

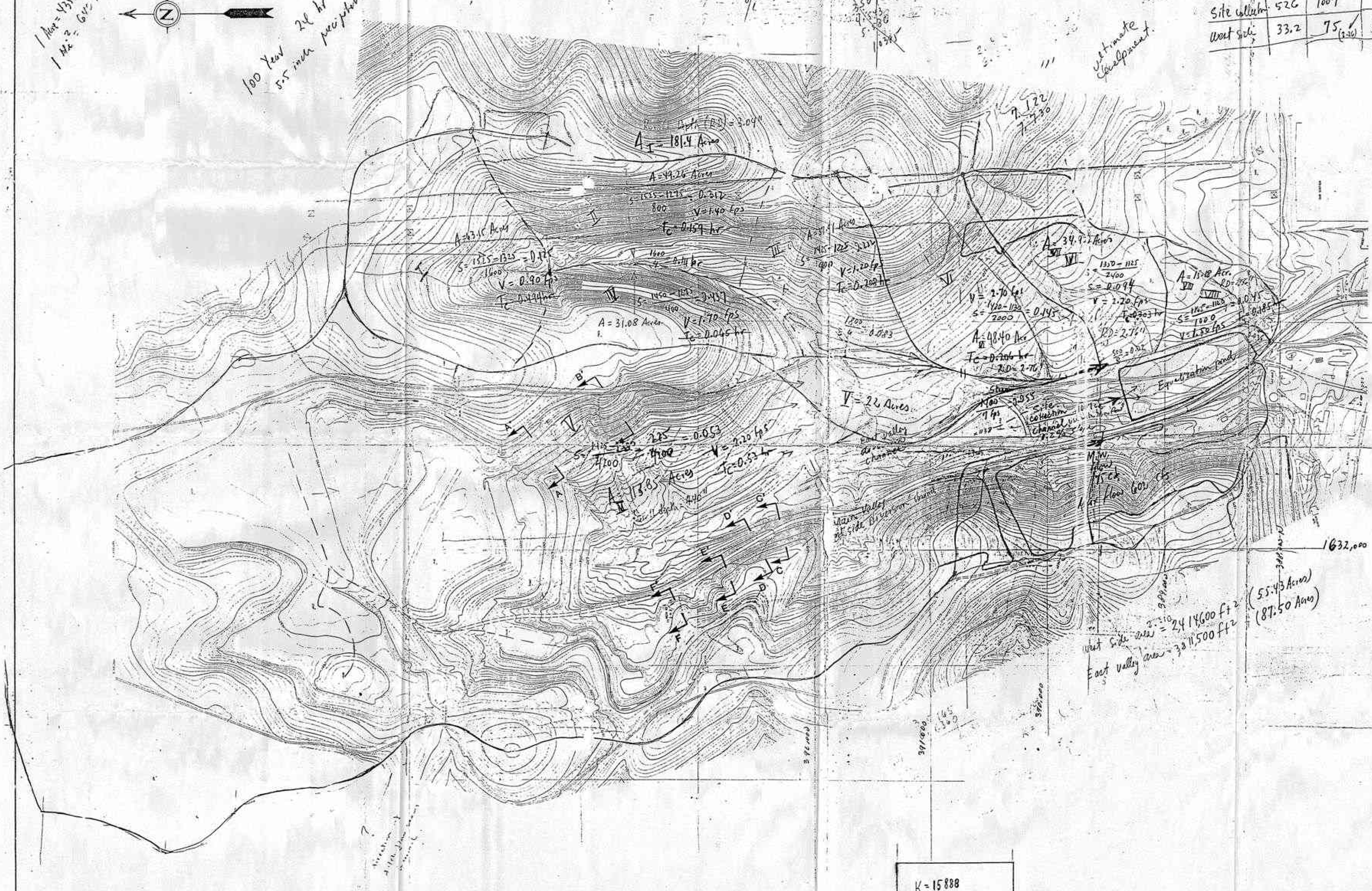
1 Acre = 43560 ft²
1 Mi² = 640 Acres

100 Year 24 hr Storm
5.5 inch precipitation

1.271
4.000

2,167,917 sq.ft
49.77 Acres
S. 2400 ft.
Slope = (1310 − 1125)/2400 = 0.09375
pasture

5.514
7.079
1,243,236 ft²
28.545 Acres



K = 15888
1000 ft.
10000 sq.ft.
1000 ft.

OCT 22 1984

FIGURE 1

GAI CONSULTANTS, INC.	PROJ. NO. 82-134
	DWG. NO. 82-134-E42

JOHNSTOWN PENNA.

PENNSYLVANIA ELECTRIC COMPANY
GENERATION DIV. ENG'R.

PENELEC

STATION
CONEMAUGH STATION
ASH/MINE REFUSE DISPOSAL SITE STAGE II
SECTIONS A - A' THRU F - F'
LOCATION PLAN

DRAFTING MADE	DRAFTING CHECKED	ARCH	CIVIL	ELEC	MECH	APP'D DEPT HD
GEL	HSC					
DATE 10/22/84	10/22/84					

SCALE	WORK ORDER	DRAWING NUMBER	REV.
1" = 400'			0

REVISIONS: NO. | DATE | MADE | CHECKED | APPROVED

POWER AND INDUSTRIAL SYSTEMS DIVISION – READING
CALCULATION

Gilbert Commonwealth Companies

PROJECT: Conemaugh Station

IDENTIFIER: DC-272-413-027

SUBJECT: MAIN VALLEY WEST DIVERSION CHANNEL

CLASSIFICATION:

SECTION NAME AND NUMBER: STRUCTURAL/CIVIL/0413

W.O. 04-4479-170

REVISION	0	1	2	3
ITEM(S) REVISED		Pg 16, 16a, 31a, 25		
ORIGINATOR	[signature]	[signature]		
DATE	Feb 85	6/18/85		
REVIEWER/VERIFIER	D. I [signature]	[signature]		
DATE	4/2/85	6-18-85		
APPROVAL	D. [signature]	D. [signature]		
DATE	3/1/85	6/19/85		
ASSUMPTIONS/PRELIMINARY DATA	YES	NO		
PAGES REFERENCE				

THIS CALCULATION REQUIRES ☑ REVIEW PER E-1 NO. 9 RESULTS ARE NOTED BELOW. ☐ VERIFICATION PER DCP 2.05

THE REVIEW OF THE CALCULATION INCLUDED EVALUATION AGAINST THE FOLLOWING QUESTIONS:	REMARKS	REMARKS	REMARKS	REMARKS
WERE INPUTS, INCLUDING CODES, STANDARDS, AND REGULATORY REQUIREMENTS, CORRECTLY SELECTED AND APPLIED?	Yes	Yes		
ARE ASSUMPTIONS REASONABLE AND ADEQUATELY IDENTIFIED?	Yes	YES		
HAVE APPLICABLE CONSTRUCTION AND OPERATING EXPERIENCES BEEN CONSIDERED?	Yes	Yes		
WAS AN APPROPRIATE CALCULATION METHOD USED?	Yes	Yes		
IS THE OUTPUT REASONABLE COMPARED TO INPUTS?	Yes	YES		

The Main Valley West diversion channel analysis and design is presented in four parts:

1- Additional Drainage Area runoff flow determination.

2- Channel design

3 - Culvert design

4 - Energy Dissipator

FLOW DATA

In accordance to Ref 2, the west valley diversion channel at station N 389000 carries a maximum peak flow of 203 cfs (100 Year 24 hr Storm, 5.5 inch precipitation for a Drainage Area of ___ Acres

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT: West Division		IDENTIFIER: DC-272-VG-027		PAGE 3 OF 33 PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR Walter K.				
	DATE Feb 85				

I — RUNOFF DETERMINATION

Methodoly

The calculations performed to estimate the time of concentration and the total time for each subarea are as follows:

Sub Area = Subdrainage area as identified in attached reference 10 drawing

Surface cover = land use description

Runoff curve CN = the runoff curve numbers given use for a Type C hydrologic soil group (see table 2-2 Page 2.5 Ref. 7)

Drainage Area = Drainage area corresponding to each subarea

Y = average watershed land slope in percent

Runoff depth in inches = interpolated values using table 2-1 of page 2-3 (Reference 7) and shown graphically in Page 5 of this calc.

Greatest flow length = l = hydraulic length of watershed in feet where OVERLAND flow occurs.

L = lag in hours (equation 3-2 page 3-6 Ref 7)

$$L = \frac{l^{0.8}(S+1)^{0.7}}{1900\,Y^{0.5}} = \frac{\left[\left\{\left[\left(\frac{1000}{CN}\right)-10\right]+1\right\}^{0.7} * (l)^{0.8}\right]}{(1900 * \sqrt{Y})}$$

$$S = \frac{1000}{(CN)} - 10$$

(Where (CN) is the retardance factor and is equivalent to the runoff curve number shown in Fig 2.2 Pag 2.6 Ref 7)

T_c = Overland flow Concentration Time (for each Subarea) in hours = 1.667 L

(this equation was derived from Eq 3-1 Page 3-5 Ref 9 which reads $L = 0.6\, T_c$)

T_{tr} = Total travel Time for each routing reach in hours.

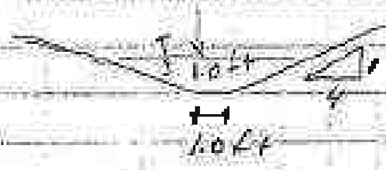
Open channel length = as measured in Ref 10

Channel velocity = See table below for overland channel

concentration travel Time thru channel = (Channel length) ÷ (channel velocity)

Channel velocity determination

lets assume that the natural channels have the following cross section:



with n = 0.040

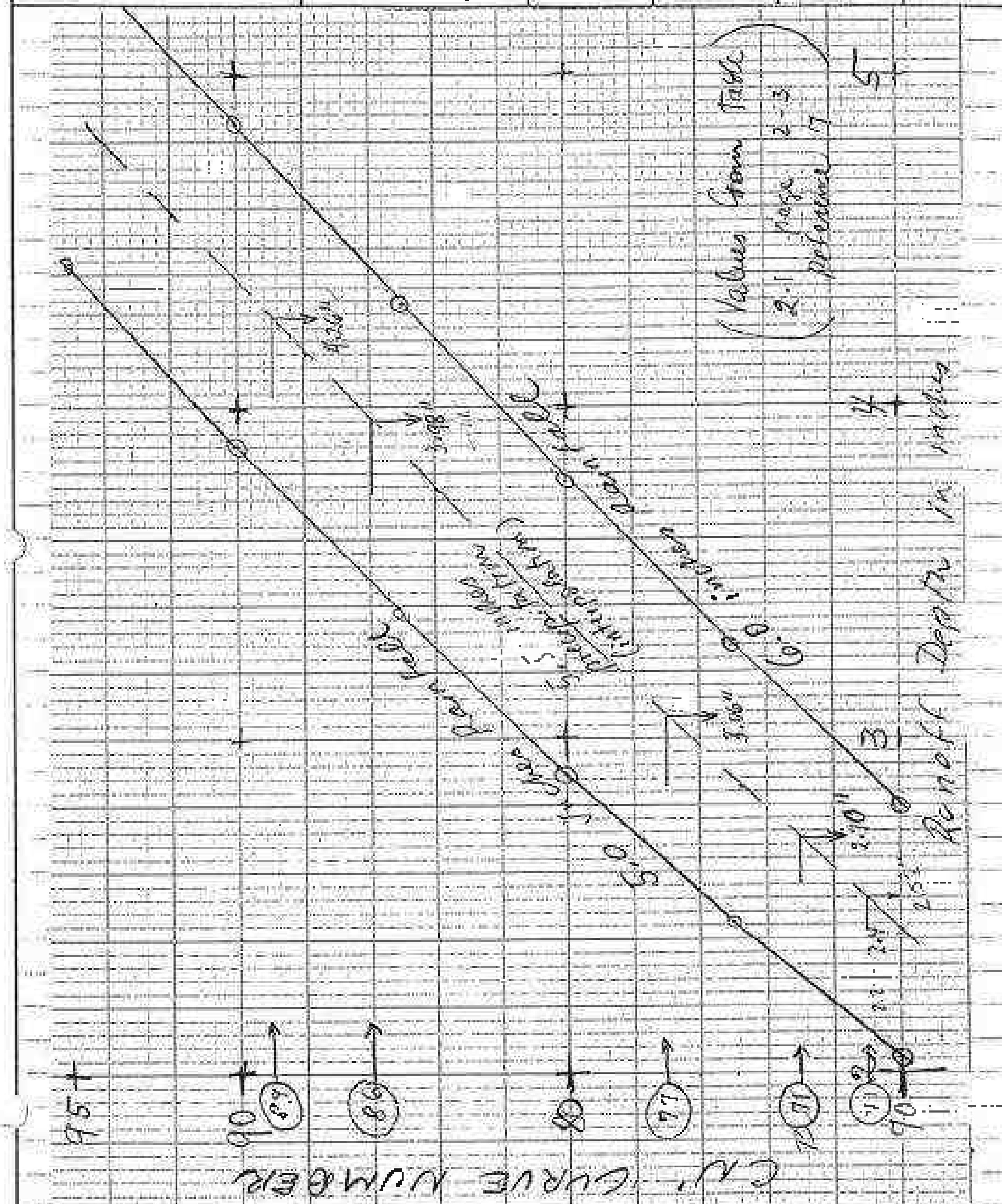
have from table 96 of Ref 3 for D/d = 1.0 ;

$$Q_{cfs} = \frac{4.93}{0.04} \times 1 \times \sqrt{S} = 123.25\sqrt{S}$$

$$V_{fps} = \frac{Q}{A} = \frac{123.25\sqrt{S}}{5\ ft^2} = 24.65\sqrt{S}$$

Slope	0.10	0.05	0.04	0.03	0.02	0.01
Velocity	7.80	5.50	4.90	4.30	3.50	2.50

Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT West [illegible]		IDENTIFIER DC-272-4?-017	PAGE 5 OF 33 PAGES
	REV. 0	1	2	3
	MICROFILMED			
	ORIGINATOR Wohan K.			
	DATE Feb 85			



Gilbert/Commonwealth
ENGINEERS/CONSULTANTS
CALCULATION

SUBJECT	IDENTIFIER	PAGE
West [illegible]	[illegible]-272-413-027	6 OF 33 PAGES

REV.	0	1	2	3
MICROFILMED				
ORIGINATOR	[illegible]			
DATE	Feb 85			

DRAINAGE AREA CALCULATION

[illegible]

Identification: Section	Sub Section	Cover	Planimeter Readings: begin	end	Difference	Area Acres	
I	~	asphalt road	6.218	6.904	0.686	0.6844	
II	~	Grass	5.438	5.713	0.275	0.2744	
III	~	Grass	5.094	5.255	0.161	0.1606	0.2284
		"	0.360	0.428	0.068	0.0678	
IV	~	Grass	6.247	6.672	0.425	0.4240	
V	a	Grass	6.802	7.270	0.468	0.4669	0.8021
V	b	Grass	7.921	8.257	0.336	0.3352	
VI	~	Grass	9.756	10.539	0.783	0.7812	
VII	a & b	Grass	0.428	0.984	0.556	0.5547	7.6003
		~~Grass~~	~~0.360~~	~~0.428~~	~~0.068~~	~~0.0678~~	
	c	Grass	0.984	1.188	0.204	0.2035	
	d	Grass	1.921	2.545	0.624	0.6226	
	e	WOODED	3.268	4.827	1.559	1.5554	
	f	Grass	2.039	2.409	0.370	0.3691	
	g	Grass	10.032	10.365	0.333	0.3322	
	h	Grass	9.678	10.032	0.354	0.3532	
	i	WOODED	7.165	10.060	2.895	2.8883	
	J	Grass	2.545	3.268	0.723	0.7213	

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Gilbert/Commonwealth
ENGINEERS/CONSULTANTS
CALCULATION

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MICROFILMED				
ORIGINATOR	Wolbanic			
DATE	Feb 85			

Planimeter Rdg

Section	Sub Section	cover	begin	end	difference	Area Acres	
VIII	a	Grass	3.665	4.147	0.482	0.4809	1.2920
VIII	b	Grass	6.153	6.248	0.095	0.0948	
VIII	c	WOODED	6.248	6.717	0.469	0.4679	
VIII	d	Grass	2.409	2.658	0.249	0.2484	
IX	a	Grass	4.147	5.300	1.153	1.1503	3.3652
IX	b	Grass	6.717	7.195	0.478	0.4769	
IX	c	WOODED	7.195	8.727	1.532	1.5285	
IX	d	Grass	7.856	8.066	0.210	0.2095	

TOTAL DRAINAGE AREA —— 15.452 Acres

conversion factors used:

1 Sq. Mile = 640 Acres

1 Acre = 43560 ft²

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SUB AREA	SURFACE COVER	Runoff curve CN	Drainage Area Acres	Drainage Area sq. mi (DA)	(Y) Land slope %	Runoff Depth inches (RO)	OVERLAND FLOW: Greatest flow length ℓ in ft	Lag (L) Hours	Time of concentration Tc Hours (1.667 L)	OPEN CHANNEL: Reach length ft	Estimated Velocity fps	Tt Travel time thru reach Hours	(DA) x (RO)	DA x RO
I	Asphalt Road and shoulder	89	0.6846	0.00107	3	4.26	60	0.01412	0.02353	—			0.00456	
II	Poor condition range land	86	0.2744	0.00043	40	3.98	70	0.00490	0.00817	—			0.00171	
III	" " " "	86	0.2284	0.00036	40	3.98	40	0.00313	0.00522	—			0.00143	
IV	" " "	86	0.4240	0.00066	50	3.98	50	0.00335	0.00558	—			0.00263	
V	Meadow	71	0.8021	0.00125		2.70	500	0.08380	0.13967	—			0.00338	
VI	Meadow	77	0.7812	0.00122	10	2.70	200	0.03601	0.06002	250 at 2%	3.50	0.01984	0.00329	
VII (a+b+c)	Meadow	77	0.7582	0.00118	12	2.70	60	0.01255	0.02092	250 at 2%	3.50	0.01984	0.00319	
VII (d)	Meadow	71	0.6226	0.00097	40	2.70	80	0.00865	0.01442	250 at 1%	2.50	0.02778	0.05262	
VII (e)	Forest land	77	1.5554	0.00243	27.5	3.06	410	0.03253	0.05422	—			0.05744	0.01163
VII (f)	Meadow	71	0.3691	0.00058	4	2.70	180	0.05234	0.08723	—			0.00157	
VII (g)	"	71	0.3322	0.00052	4	2.95	200	0.05694	0.09490	—			0.00141	
VII (h)	"	71	0.3532	0.00055	27.5	2.70	350	0.03398	0.05663	—			0.00149	0.01995
VII (i)	Forest land	77	2.8883	0.00451	27.5	3.06	500	0.03812	0.06353	—			0.01380	
VII (j)	Meadow	71	0.7213	0.00113	40	2.70	80	0.00865	0.01442	350 at 3%	4.30	0.02267	0.00305	
										160 at 10% (Collects VII d-j wtg)	7.80	0.00570		

Sub Area	Surface Cover	Runoff curve CN	Drainage Area Acres	Drainage Area Sq. mi (DA)	Slope % (Y)	Runoff depth inches (RO)	Overland Flow: Greatest flow length	Overland Flow: Lag (L) Hours	Overland Flow: Time Concentration Tc overland Hours	Open Channel: Reach length ft	Open Channel: Estimated velocity fps	Open Channel: Time Concentration Tc channel	DA x RO	DA x RO
VIII (a)	Meadow	71	0.4809	0.00075	20	2.70	210	0.00703	0.01172	420 at 4%	4.90	0.02381	0.00203	
VIII (b)	"	71	0.0948	0.00015	40	2.70	80	0.00865	0.01442	—			0.00041	
VIII (c)	Forest land	77	0.4679	0.00073	27.5	3.06	390	0.03125	0.05208	—			0.00223	0.00572
VIII (d)	Meadow	71	0.2484	0.00039	4	2.70	180	0.05234	0.08723	—			0.00105	
IX (a)	Meadow	71	1.1503	0.00180	25	2.70	50	0.00751	0.01252	500 at 5%	5.50	0.02525	0.00486	
IX (b)	"	71	0.4769	0.00075	40	2.70	90	0.00951	0.01585	—			0.00203	0.01507
IX (c)	Forest land	77	1.5285	0.00239	27.5	3.06	360	0.02931	0.04885	—			0.00731	
IX (d)	Meadow	71	0.2095	0.00033	4	2.70	180	0.05234	0.08723	—			0.00089	

T_C & T_T

VI
0.0[illegible] = Tc
0.01960 = Tt

VII abc
0.02072 = Tc
0.01984 = Tt

VII def
0.06[illegible]
0.05422
0.01442
Tc = 0.15587
Tt = 0.02198

VII ghij
0.09410
0.05083
0.06[illegible]
0.04442
Tc = 0.22948
Tt = 0.0220

VIII abcd
0.08723
0.05208
0.01442
0.01172
Tc = 0.16545
Tt = 0.02381

IX abcd
0.08723
0.04885
0.01585
0.01252
Tc = 0.16445
Tt = 0.02525

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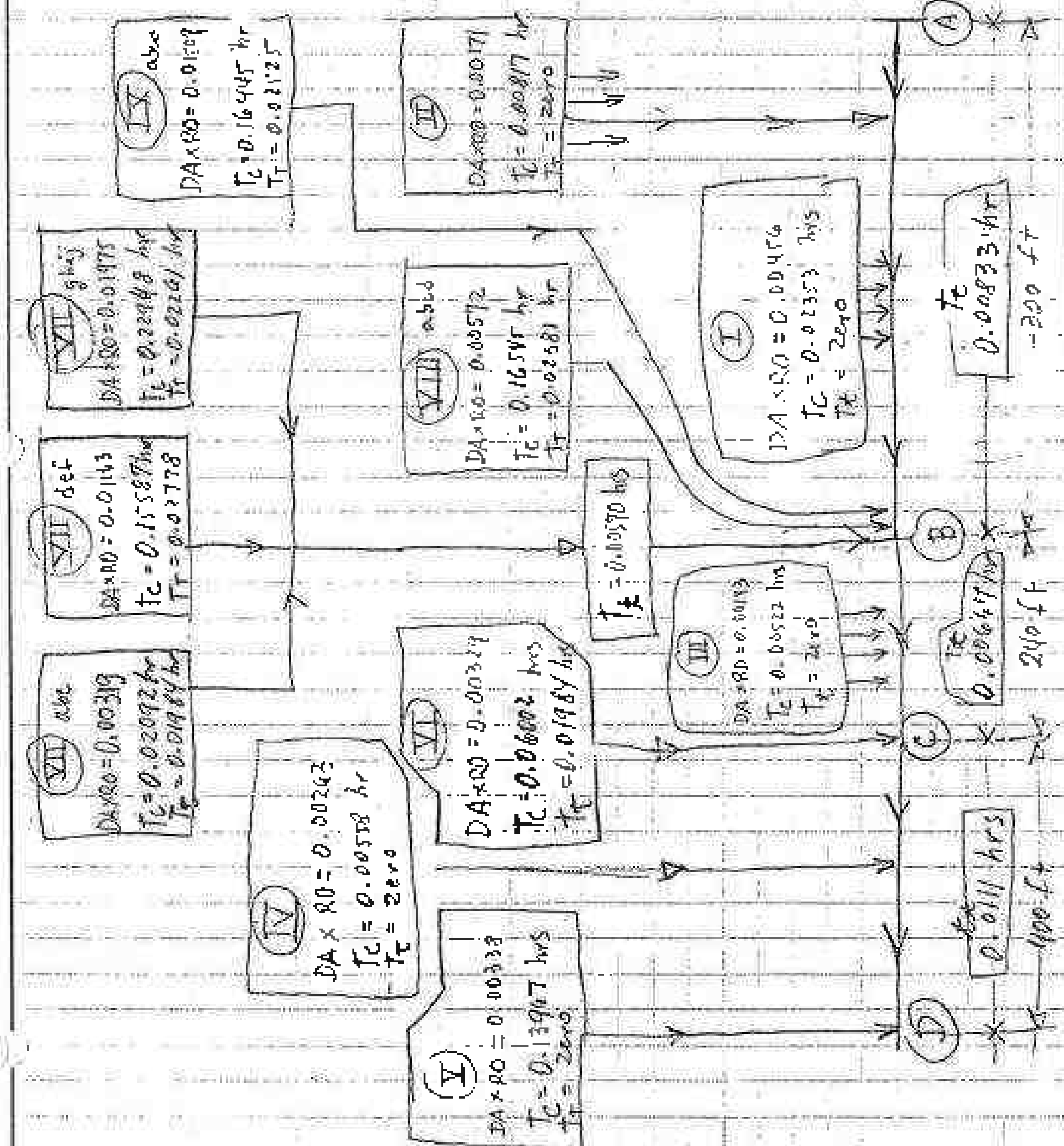
FLOW DIAGRAM

the concentration time in hrs and the product (DA×RO) for each subarea are shown in the diagram below



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From the foregoing flow diagram we can deduce that;

Firstly: T_T for practical purposes can be assumed to ZERO

Second the value of Tc for each Subarea is given below.

	Subarea	DA × RO	actual Tc hours	Tc Value to be used in computations
	I	0.00456	0.02353	0.1
	II	0.00171	0.00817	0.1
	III	0.00143	0.00522	0.1
	IV	0.00263	0.00558	0.1
	V	0.00338	0.13967	0.2
	VI	0.00329	0.06002	0.1
a b c	VII	0.00319	0.02092	0.1
d e f	VII	0.01163	0.15578	0.2
g h i j	VII	0.01975	0.22948	0.2
	VIII	0.00572	0.16545	0.2
	IX	0.01509	0.16445	0.2

and for calculation purposes we will use de following CONSOLIDATED sub-drainage area values

Tc	Sub-Areas included	Σ (DA × RO) mi²·inch
0.1	I + II + III + IV + VI + VII abc	0.01681
0.2	V + VII def + VII ghij + VIII + IX	0.05558

the runoff flows will be calculated using table 4 (1 and 2 of 19) of ref 8 which gives ft^3/mi^2 per inch of runoff. Together with the value of $\Sigma(DA \times RO)$ for each category.

the runoff is calculated with equation

$$\underset{cfs}{Q} = \left(q \; \frac{ft^3}{mi^2} / inch\right) \times \left(\underset{mi^2}{DA}\right) \times \left(\underset{inches}{RO}\right)$$

DA = drainage Area in sq. miles.
RO = Runoff in inches
(Page 5-3 Ref 7)

	$T_T = 0.0$, $T_C = 0.1$		$T_T = 0.0$, $T_C = 0.2$		
Hydrograph time hrs	$q\left(\frac{ft^3}{mi^2}\right)$/inch (A)	$Q_{0.0681}$ cfs	$q\left(\frac{ft^3}{mi^2}\right)$/inch (B)	$Q_{0.05558}$ cfs	ΣQ cfs
11.	24		22		1.63
11.5	51		47		3.47
11.6	173		94		8.13
11.7	299		202		16.59
11.8	954		509		44.33
11.9	746		796		56.78
12.	477		641		43.64
12.1	233		424		27.48
12.2	152		245		16.17
12.3	132		170		11.67
12.4	121		138		9.70
12.5	111		121		8.59
12.6	85		104		7.21
12.7	74		85		5.97
12.8	70		75		5.34
12.9	68		71		5.09
13.	65		68		4.87
13.1	56		62		4.39
13.2	52		56		3.99

ZC-272-413-027

	$T_T = 0.0$, $T_C = 0.1$		$T_T = 0.0$, $T_C = 0.2$		Page 14/33
Hydrograph Time hr	$q_{0.1}$ (A)	$Q_{0.01681}$	$q_{0.2}$ (B)	$Q_{0.03558}$	ΣQ cfs
13.4	49		51		3.66
13.6	43		47		3.33
13.8	41		42		3.02
14.	39		40		2.88
14.2	35		36		2.60
14.4	34		34		2.46
14.6	31		33		2.35
14.8	30		30		2.17
15.	29		29		2.10
15.2	27		27		1.95
15.4	26		26		1.88
15.6	25		26		1.86
15.8	24		24		1.74
16.	24		24		1.74
16.5	22		22		1.59
17.	20		20		1.45
17.5	19		19		1.35
18	18		18		1.30
18.5	17		17		1.23

	$T_I = 0.0$, $T_C = 0.1$		$T_I = 0.0$, $T_C = 0.2$		
Hydrograph Time hr	$q_{0.1}$ (A)	$Q_{0.01681}$	$q_{0.2}$ (B)	$Q_{0.05553}$	ΣQ cfs
19.	16		16		1.16
19.5	15		15		1.08
20.	14		14		1.01
21.	13		13		0.94
22.	12		12		0.87
23	11		11		0.80
24	11		11		0.80
25	0		0		0.00

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ORIGINATOR	W. Hamik	I.E. Fonyes		
DATE	Feb 85	6/18/85		

AND THEREFORE THE TOTAL FLOW BEFORE THE CULVERT WILL BE THE SUM OF THE CALCULATED FLOW AND THE FLOWS CALCULATED BY GAI AND SHOWN IN PAGE 6 OF 17 OF Ref 2

TIME hr	INCOMMING FLOW (GAI)	D.A. contribution cfs	TOTAL FLOW
11.	7	1.6	8.6
11.5	15	3.5	18.5
11.7	33	16.6	49.6
11.8	~~68~~ 100	44.3	144.3 ~~112.3~~
11.9	~~135~~ 159	56.8	215.6 ~~179.8~~
12.	~~177~~ 217	43.6	260.6 ~~220.6~~
12.1	~~203~~ 244	27.5	271.5 ~~230.5~~
12.2	~~194~~ 270	16.2	286.2 ~~210.2~~
12.3	~~162~~ 252	11.7	263.7 ~~193.7~~
12.4	~~127~~ 203	9.7	136.7
12.5	99	8.6	107.6
12.6	79	7.2	86.2
12.7	65	6.0	71.0
12.8	53	5.3	58.3
12.9	45	5.1	50.1
13.	38	4.9	42.9
13.2	31	4.0	35.0
13.5	23	3.5	26.5
14.	18	2.9	20.9
14.5	15	2.4	17.4
15.	13	2.1	15.1
16.	10	1.7	11.7
18.	7	1.3	8.3
20.	6	1.0	7.0
⋮			⋮
32.3 hr	0		0

(Revision clouds marked with triangle 1; note: "2/12, NAYS 385"; "per ..." [illegible])

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pg 16a

CHECK DEPTH OF CHANNEL WITH NEW PEAK FLOW (286.4) cfs 3% FROM PAGE 16 DUE TO GAI'S NEW INCOMMING FLOW OF 270 CFS,

Date: 06-17-1985

Project: CONEMAUGH - EQUALIZATION POND

Description: MAIN VALLEY WEST DIVERSION CHANNEL
FLOW IN 3% SECTION

** Open Channel Flow - Trapezoidal Cross Section **

Side slope (H/1V)= 2

Discharge (cfs)	Ave. Vel. (ft/s)	Depth (ft)	Area (sq ft)	Top Width (ft)	Froude No.	Slope (ft/ft)	n Value	Bottom Width (ft)
286	11.00	2.74	25.99	14.96	1.47	.03000	.0320	4.00
286	11.54	2.66	24.78	14.64	1.56	.03000	.0300	4.00
286	10.29	2.86	27.77	15.43	1.35	.03000	.0350	4.00

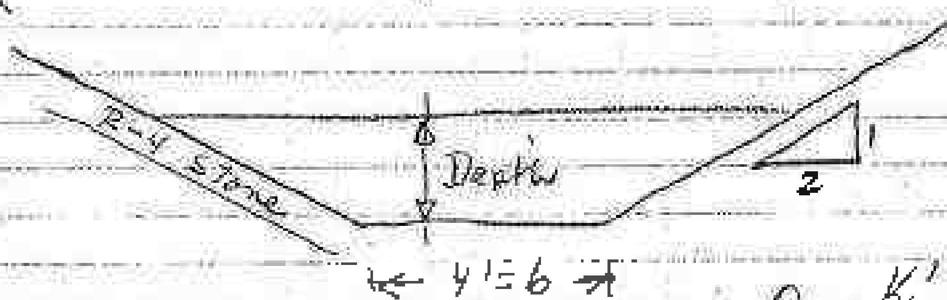
n VARIED FOR WORST CONDITION → MAX. DEPTH = 2.86' < 3' O.K.

VELOCITY REMAINS THE SAME AS BEFORE, THEREFORE

RIPRAP SIZE IS ALL RIGHT

2- CHANNEL DESIGN

CHECK WEST DIVERSION CHANNEL SECTION FOR PEAK FLOW (as shown in page 7 of 15) OF 230.5 cfs



S = 0.03

n = 0.032

Area flow = (4 + 2D) D

Area flow = 2D (2 + D)

$$Q = \frac{K'}{0.032} (4^{8/3}) \times \sqrt{0.03}$$

$$Q = 218.22\ K' \quad \text{(Ref 3, Table 47)}$$

$$Vel = \frac{Q}{A} = \frac{218.22\ K'}{2D(2+D)} = 109.11 \frac{K'}{D(2+D)}$$

D/b	Depth ft	K'	V fps	Q cfs
0.2	0.8	0.1163	5.66	25.38
0.3	1.2	0.248	7.05	54.12
0.4	1.6	0.434	8.22	94.71
0.45	1.8	0.549	8.76	119.80
0.50	2.0	0.679	9.26	148.17
0.55	2.2	0.826	9.75	180.25
0.58	2.32	0.922	10.04	201.20
0.60	2.40	0.990	10.23	216.04
0.61	2.44	1.020	10.27	222.58
0.62	2.48	1.060	10.41	231.31 ← $Q_{100 year}$
0.63	2.52	1.100	10.54	240.04

3 - CULVERT DESIGN

4 - ENERGY DISSIPATOR

General

Construction of the west diversion channel of following characteristics:

channel base = 4 ft
side slopes = 2H : 1V
bed slope = 3 %
bottom elevation at N 389000 and E 1,633,132 } = 1131.75 ft

will result in a channel bottom elevation at the road intersection of

1131.75 − (940 × 0.03) = 1103.55 before culvert

and if the slope is continued thru culvert to the other side of road

1103.55 − (110 × 0.03) = 1100.25 ' after culvert

which is higher than (1100.25 − 1098 = 2.25 ft) the existing channel bed (see pg 10 attached)

However the culvert exit velocity if we use one 60" diameter culvert at 3% slope -

will be: (if outlet control is assumed!)

: 60" ø culvert outlet velocities calculated using tables 84 and 100 of Ref. 3

Pipe	Q cfs	n	K' *	D/B	D ft	A ft²	V fps
Concrete	231	0.013	0.237	0.51	2.55	10.07	22.93
Corrugated Metal	231	0.024	0.438	0.77	3.85	16.22	14.24

$$* \; K' = \frac{231\,n}{(5^{8/3})\sqrt{0.03}} = 18.24\,n$$

Culvert outlet velocities are high and will require anti-erosive protection measures after the outlet.

lets check the west channel profile and the existing ground surface before and after the culvert (in order to select the culvert size, culvert slope and determine if there is need for an energy dissipator)

Gilbert/Commonwealth
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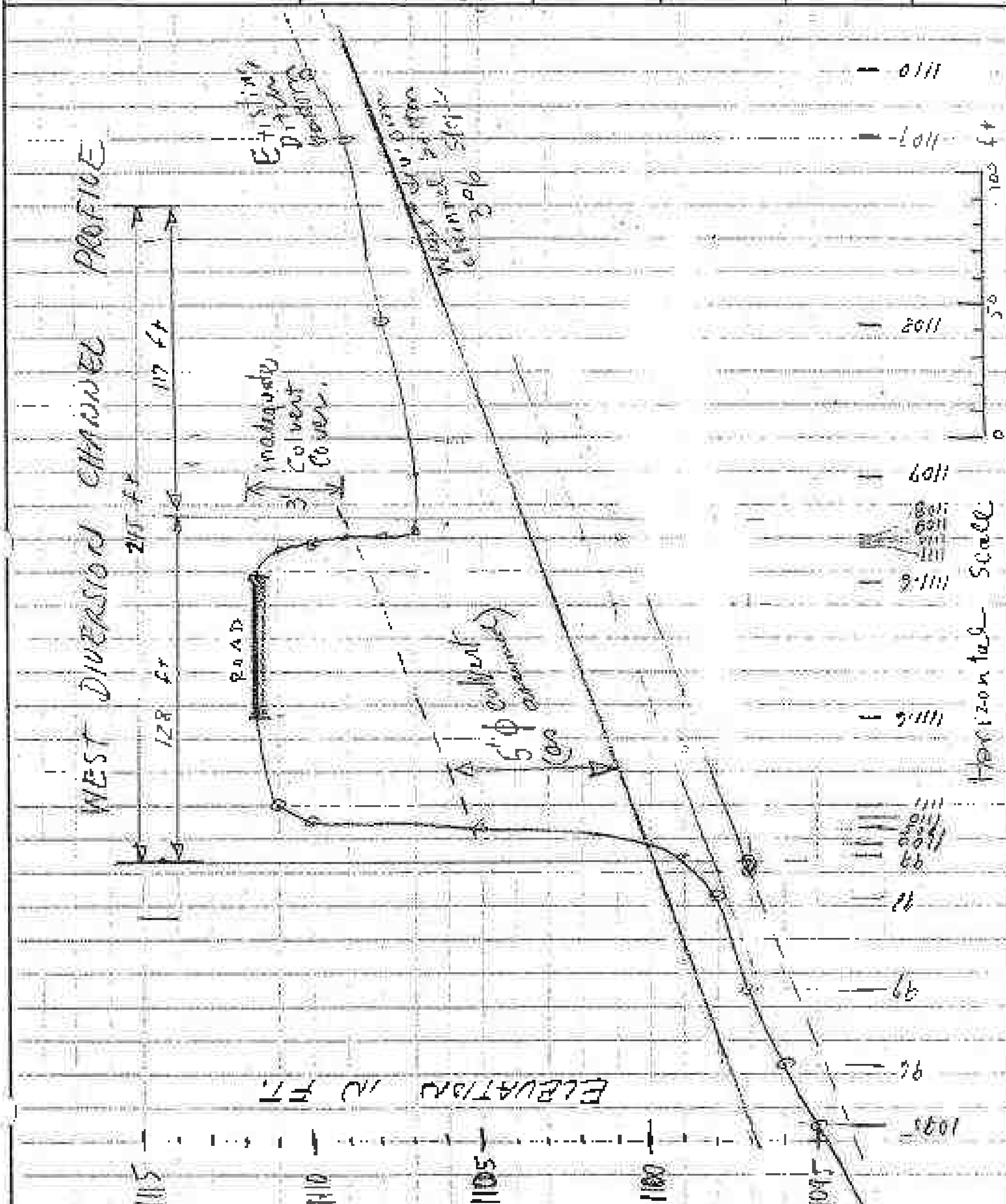
ORIGINATOR	Wehauk			
DATE	Feb 85			



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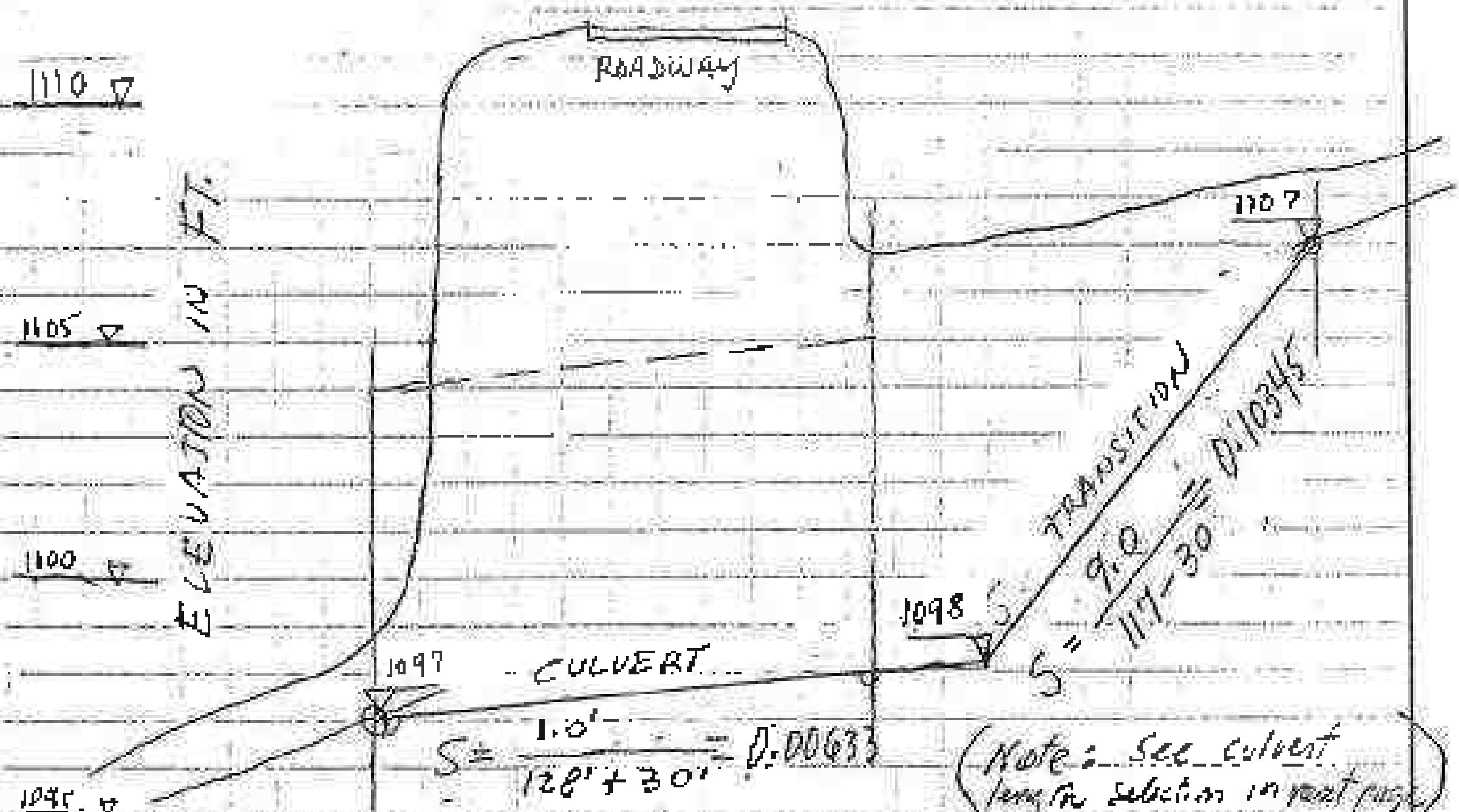
From the profile shown in the preceding page it can be concluded that the culvert outlet has to be dropped to elevation 1097 ft in order to meet the existing ground surface and the bottom of the extension of the West diversion channel outlet junction (as well as provide adequate cover requirements)

The design of the culvert will be influenced by
- Approach velocity, Velocity thru culvert,
- outlet velocity and need for energy dissipation.



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	DATE Feb 85				

The total culvert length needed, using pipe sections that are 6, 8, 10, 12 or 16 ft long shall be at least 120 ft. The pipe sections are:

84" ⌀ Pipe section length	Number of Sections	Total length to be supplied
6	20	120 ft
12	10	120 ft
8	15	120 ft
8	16	128 ft
16	8	128 ft
10	12	120 ft

Lets assume that pipes will be delivered in 16 ft sections, therefore the total culvert length to be used is 128 ft.

Determination of inlet approach water velocity at end of upstream transition

$Q = 231$ cfs

base of channel $b = 4.0$ ft with (2H:1V) slopes

$n = 0.032$

$S = 0.10345$

$$Q = \frac{K'}{0.032} \times \left(4^{8/3}\right) \times \sqrt{0.10345} = 405.25\,K'$$

$$\therefore K' = \frac{231.0}{405.25} = 0.570$$

$D/b = 0.46$; table 77 Ref 3

$\therefore$ Depth $= 1.84$ ft

$$V = \frac{231 \text{ cfs}}{2 \times 1.84\,(2 + 1.84)} = \frac{231}{14.13} = 16.35 \text{ fps}$$

hence $F = \frac{V}{\sqrt{gd}} = \frac{16.35}{\sqrt{32.2 \times 1.84}} = 2.12$

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A Froude number of 2.12 indicates that we have an undular hydraulic jump along the culvert which can cause vibrations in the culvert itself and further, the wave motion will be transmitted downstream of the culvert. To eliminate this possibility it is recommended that the excessive energy of the incomming flow be destroy by installing a RING CHAMBER ENERGY DISSIPATOR inside of the culvert

The Ring Chamber Dissipator will be design using the criteria presented in Ref 6

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	ORIGINATOR Wohrank	R.A. [illegible]			
	DATE Feb 85	6/19/85			

Ring chamber diameter and spacing

the diameter needed to ensure proper energy dissipation D_o

$$\left[\frac{Q^2}{3.22}\right]^{1/5} < D_o < \left[\frac{Q^2}{1.468}\right]^{1/5}$$

$$6.98\text{ ft} < D_o < 8.21\text{ ft}$$

(corrected to: 7.6 < D_o < 8.96)

USE 7.0 ft = 84" Φ

WITH Q=285 CFS PER [illegible] MAY '93 THE 7' Φ RING CHAMBER IS STILL ACCEPTABLE BECAUSE THE 285 cfs IS THE PEAK FLOW FOR THE 100YR-24HOUR STORM & IS CONSERVATIVE, ALSO RING CHAMBERS ARE USED FOR VEL ≥ 20 FPS [illegible] AT OUTLET [illegible] IS USED ∴ 7' Φ RING CHAMBER IS ACCEPTABLE

Dissipator Ring size length K

$$0.1 < \frac{K}{D_o} < 0.15$$

$$0.7 < K < 1.05$$

USE K = 12 inches

and the ring spacing L

$$1.5 < \frac{L}{D_o} < 2.5$$

$$10.5 < L < 17.5$$

USE L = 12.0 ft

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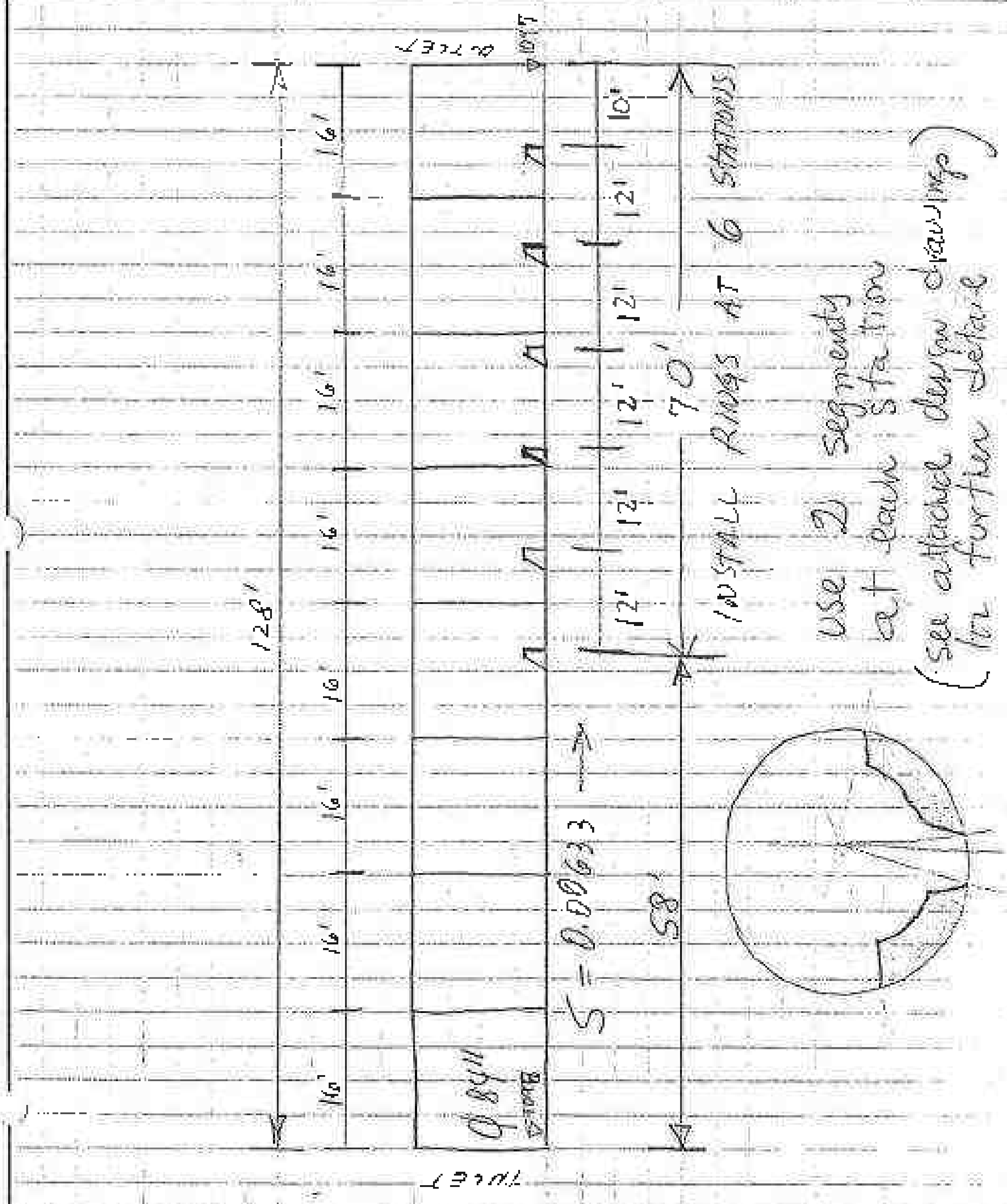
	ORIGINATOR			
	DATE Feb 85			



Gilbert/Commonwealth ENGINEERS/CONSULTANTS CALCULATION	SUBJECT West Diversion			IDENTIFIER DC-272-413-027	PAGE 27 of 33 PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR Wahoud				
	DATE Feb 85				

Determination of flow depth in 7' Ø pipe without rings

$Q = 231$ cfs

$n = 0.013$

$S = 0.00633$

lets calculate flow depth and velocity using tables 84 and 100 of Ref 3

$$Q = \frac{K'}{0.013}\left(7^{2.667}\right)\sqrt{0.00633} = 1098.08Q$$

$$K' = \frac{231}{1098.08} = 0.210$$

$\frac{D}{diam} = 0.475$ hence Depth $= 3.325$ ft

$$Vel = \frac{231}{0.3657 \times 49} = 12.89 \text{ fps}$$

Determination of critical depth and velocity in 7' Ø pipe used for culvert without Ramp.

$Q = 231$ cfs

$D = 7$ ft

$Q = K_c' \, d^{5/2} = 129.64 \, K_c'$ {Table 114, Ref 3

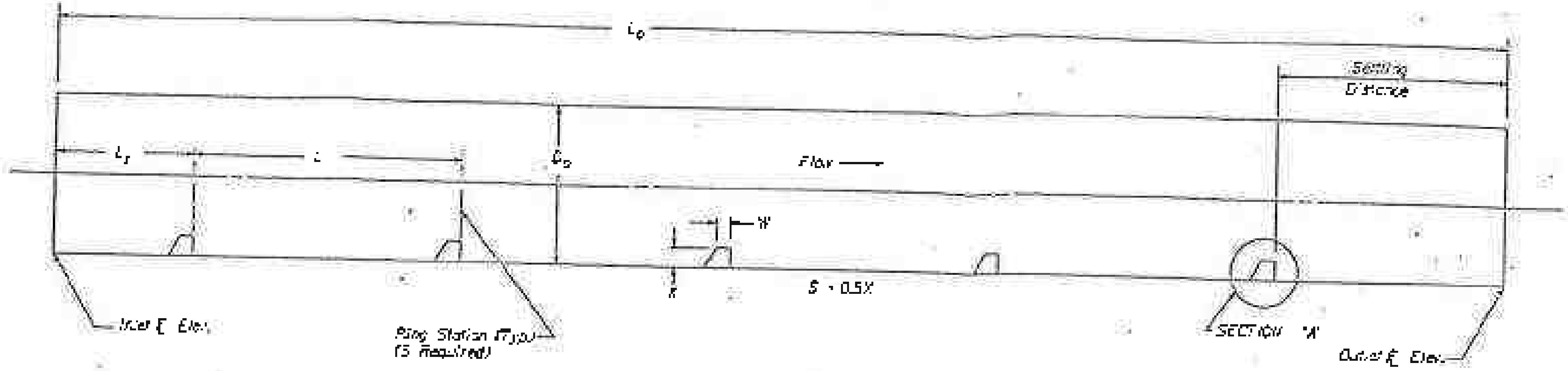
$K_c' = \frac{231}{129.64} = 1.782$ ✓

$\frac{D_c}{d} = 0.57 \Rightarrow D_c = 3.99$ ft.

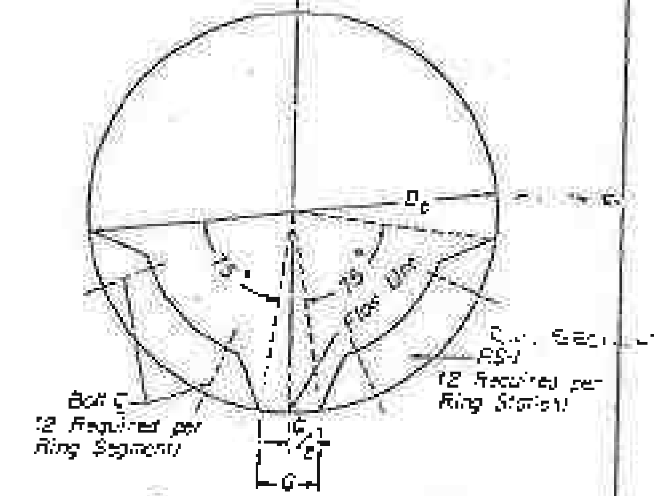
$V_c = \frac{231}{0.462 \times 49} = \frac{231}{22.64} = 10.20$ fps {Table 58, Ref 3

Note that this velocity is very close to the 10.4 fps velocity calculated for the West diversion channel with a slope of 3%.

DC-272-413-027



RING CHAMBER PROFILE

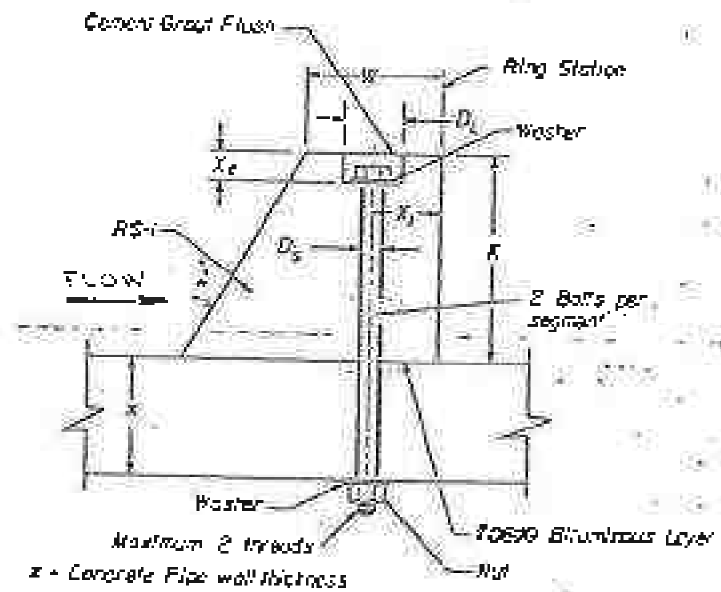


RING CHAMBER STATION (Typ.)

TABLE OF RING CHAMBER DATA FOR EACH PIPE SIZE (Do)

D_o	K	W	D_S	D_L	X_1	X_2	G	Bolt Size	L_o	(1) 8'-Sections		(1) 6'-Sections	
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Feet	L_1 Feet	L Feet	L_1 Feet	L Feet
36	4	4	0.625	1.5	2.00	1.00	4	0.50	40	3	6	3	6
42	5	5	0.625	2.0	2.50	1.00	4	0.50	40		6		6
48	6	6	0.750	2.0	3.00	1.25	5	0.625	49		8		8
54	7	7	1.000	3.0	3.50	1.50	5	0.750	48		6		8
60	7	7			3.50		6		46		8	3	8
66	8	8			4.00				50		9	7	3
72	8	9	1.000		4.00			0.750	56	3	9	7	9
78	10	8	1.250	3.0	4.00	1.50	6	1.00	72	7	12	8	12
84	12	9	1.625	4.0	4.50	2.00	8	1.250	72	7	12	8	12
90							8		72	7	12	8	12
96							12		96	6	16	5	15
102													
108	12												
114	14												
120	14	9	1.625		4.50	2.50		1.250	96	6	16	5	15
126	15	10	1.750		5.00	2.50		1.50	112	7	20	9	15
132	15								112	7	20	9	15
138	18						12		112	7	20	9	13
144							16		126	6	24	7	24
150							16						
156	18	10		4.0	5.00		24						
162	20	12	1.750	5.0	6.00	2.50	24	1.50	126	6	24	7	24

USE →



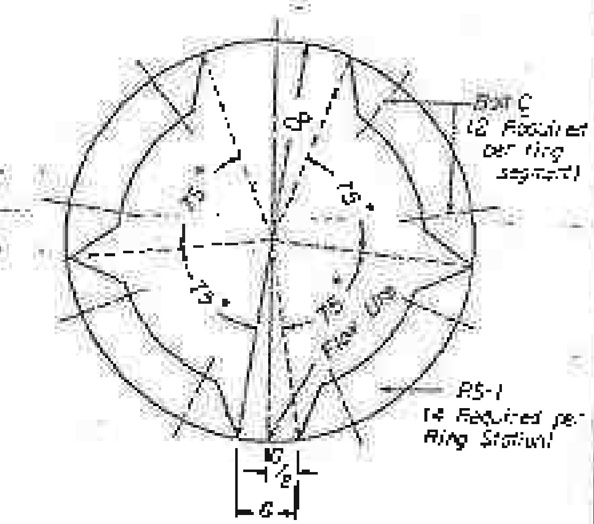
SECTION "A" @ BOLT ℄ (Typical)

DETAIL "A"

NOTES:

The Ring Chamber is to be made from the strength and size of concrete pipe specified in the plans. The Ring segments shall be precast according to RS-1 and assembled into pipe sections according to its standard at the precast facility. A 705[illegible] Bituminous coat will be placed between each Ring Segment and the pipe section. Each bolt head cavity must be grouted flush with cement grout. All bolts, nuts and washers must be galvanized as per section 711.02. The bolt lengths "K" permit full engagement of all threads of the nuts (minimum). The Ringed Sections must be delivered to the Project marked as needed and ready to lay similar to any other concrete pipe section.

(1) These L_1 and L dimensions are to be used when 8' or 6' long pipe sections are delivered respectively.



TYPE "B"
RING CHAMBER STATION (Typ.)

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OHIO DEPARTMENT OF TRANSPORTATION

RING CHAMBERS

DATE 3/28/83

RC-1

Designed	Checked	Graphics	Revised
C.S.P.	C.S.P.	F.B.C.	

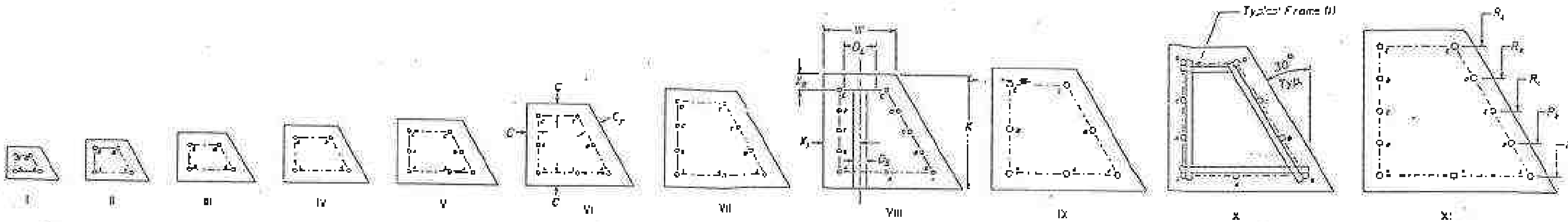
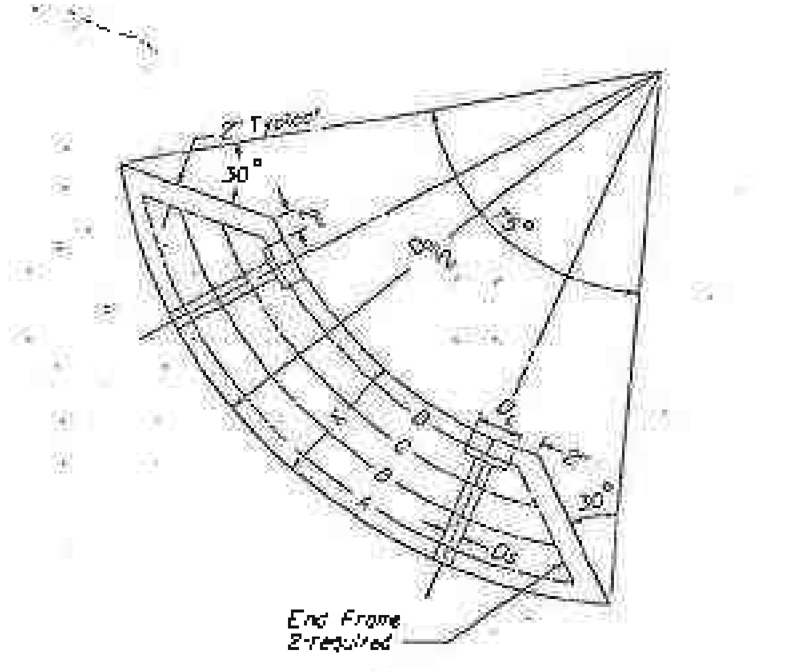


TABLE OF RING SEGMENT DATA FOR EACH PIPE SIZE (D_0)

D_0 Inches	K Inches	W Inches	D_S Inches	D_L Inches	X_1 Inches	X_2 Inches	A Length Inches	B Length Inches	C Length Inches	D Length Inches	E Length Inches	R_A Radius Inches	R_B Radius Inches	R_C Radius Inches	R_D Radius Inches	R_E Radius Inches	Number of Frames	C Inches	C_r Inches	Reinforcing Bar Size	Section Number
36	4	4	0.625	1.5	2.00	1.00	17.10	12.17	0.00	0.00	0.00	17.00	15.00	0.0	0.0	0.0	3	1.0	1.5	#4	I
42	5	5	0.625	2.0	2.50	1.00	21.03	13.63	0.00	0.00		20.00	17.00	0.0	0.0		3	1.0			II
48	6	6	0.750	2.0	3.00	1.25	23.72	16.33	0.00	0.00		22.50	19.50	0.0	0.0		3	1.5			III
54	7	7	1.000	3.0	3.50	1.50	27.65	17.79	0.00	0.00		25.50	21.50	0.0	0.0		3				IV
60	7	7	1.000		3.50	1.50	31.57	21.72	0.00	0.00		28.50	24.50	0.0	0.0		3		1.5		IV
66	8	8	1.000		4.00	1.50	35.50	29.34	23.78	0.00		31.50	29.00	26.50	0.0		4		2		V
72	9	8	1.000		4.00	1.50	39.42	33.77	27.11	0.00		34.50	32.00	29.50	0.0		4				V
78	10	8	1.250	3.0	4.00	1.50	43.36	34.73	28.14	0.00		37.50	34.00	30.50	0.0		4				VI
84	12	9	1.625	4.0	4.50	2.00	47.29	39.89	32.50	25.17		40.50	37.50	34.50	31.50		5				VII
90							51.21	43.92	36.43	29.04		43.50	40.50	37.50	34.50		5				VII
96							55.14	47.75	40.35	32.96		46.50	43.50	40.50	37.50		5				VII
102							59.06	51.57	44.28	36.89		49.50	46.50	43.50	40.50		5				VII
108	12						62.99	55.40	48.21	40.82	0.0	52.50	49.50	46.50	43.50	0.0	5	1.5			VII
114	14						65.65	59.53	53.37	47.21	41.05	55.00	52.50	50.00	47.50	45.00	5	2			VII
120	14	9	1.625		4.50	2.00	69.61	63.45	57.29	51.14	44.98	58.00	55.50	53.00	50.50	48.00	5			#4	VII
126	15	10	1.750		5.00	2.50	73.54	59.99	46.44	0.0	0.0	61.00	55.50	50.00	0.0	0.0	6			#6	IX
132	15						77.47	63.92	50.37	0.0		64.00	58.50	53.00	0.0		6				IX
138	16						81.39	69.90	58.40	46.90		67.00	62.33	57.67	53.00		6				X
144							85.32	73.92	62.33	50.82		70.00	65.33	60.67	56.00		6				X
150							89.25	77.75	66.25	54.76		73.00	68.33	63.67	59.00		7				X
156	18	10		4.0	5.00		93.17	81.38	70.18	58.65	0.0	76.00	71.33	66.67	62.00	0.0	7				X
162	20	12	1.750	5.0	6.00	2.50	97.10	87.25	77.39	67.54	57.93	79.00	75.00	[illegible]	67.00	63.00	7	2	2	#6	XI



RING SEGMENT PROFILE

Ring Segments are to be precast from class C Concrete per 706.13.

(1) Frames of Item 709 reinforcing must be wired or resistance welded to the curved bars to form a cage. A frame must be placed at each end face. Frame bars must be made of the same size bars as the curved bars to form. Ex. Frames are to be evenly spaced but may be adjusted to avoid the block out for the bolt holes. Frames may be made from a single bent bar rather than four individual bars as shown. The bars of diameter D_0 may be reduced to obtain a proper fit with the inside diameter of the pipe section.

BUREAU OF LOCATION AND DESIGN
OHIO DEPARTMENT OF TRANSPORTATION

RING SEGMENTS

RS-1

Designed	Checked	Graphics	Revised
C.G.P.	C.G.P.	F.E.C.	

Gilbert Associates, Inc. Reading, Pennsylvania CALCULATION	SUBJECT West Diversion		CSID DC-272-413-027		PAGE 31 OF PAGES 33
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR WAHAIK				
	DATE Feb 85				

RIPRAP PROTECTION SIZE

a- West diversion channel

Q = 231 cfs   slope = 3%   V = 10.4 fps

USE R-5 Riprap (Pendot Form 408)
(2' THICK LAYER)

b) transition

Q = 231   slope = 10.3%   V = 16.35 fps

USE R-8 Riprap...(Pendot Form 408)
(4' THICK LAYER)

Ref: Fig 165, Pag 209 Ref K

CC-272-413-027

CHECK RIPRAP PROTECTION SIZE WITH THE NEW PEAK FLOW (286cfs) FROM PAGE 16 DUE TO GAI'S NEW INCOMING FLOW OF 270 CFS.

31 / 33

Date: 06-17-1985

Project: CONEMAUGH - EQUALIZATION POND

Description: MAIN VALLEY WEST DIVERSION CHANNEL
FLOW IN THE 10.3% SECTION

** Open Channel Flow - Trapezoidal Cross Section **

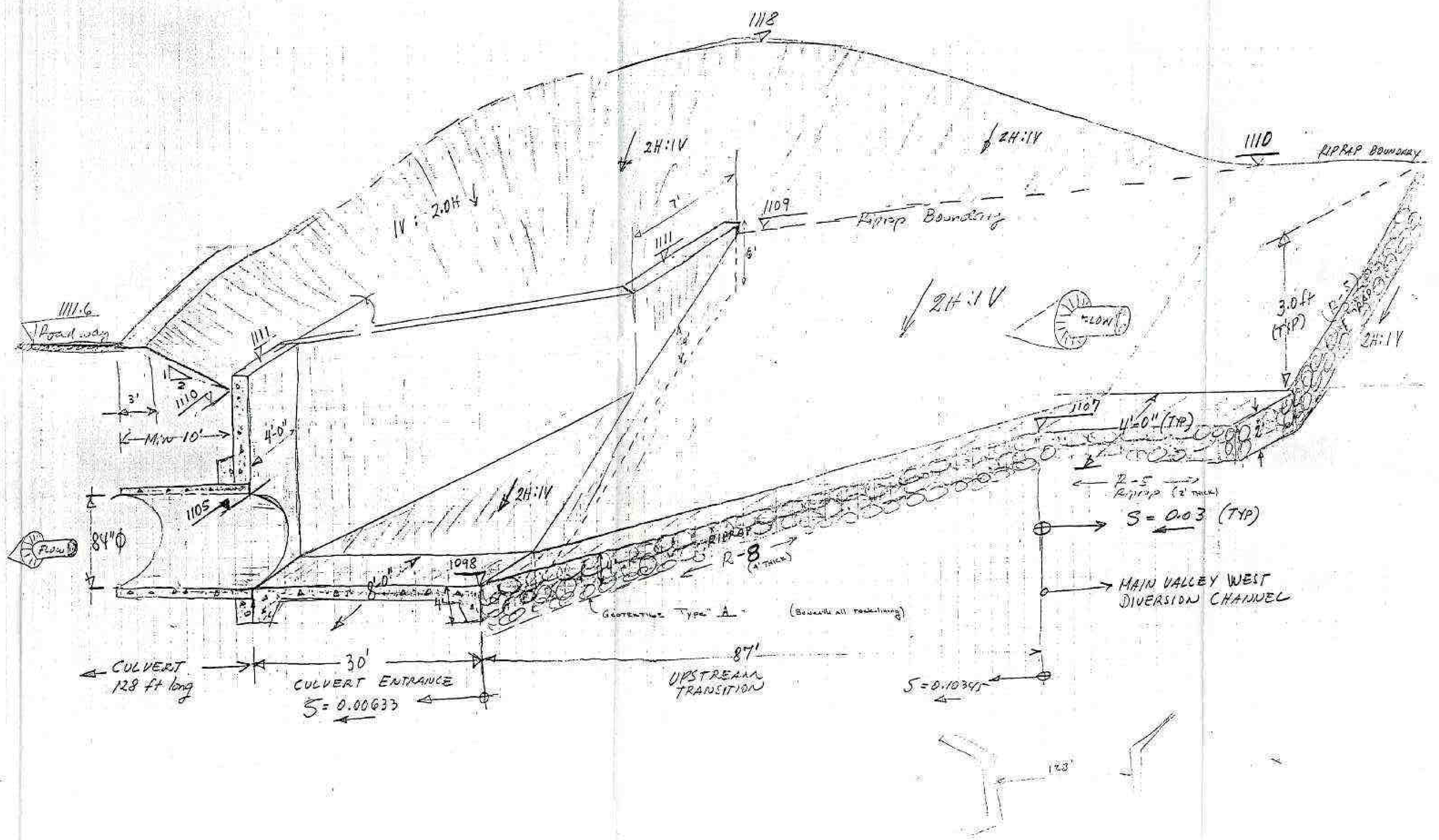
Side slope (H/1V)= 2

Discharge (cfs)	Ave. Vel. (ft/s)	Depth (ft)	Area (sq ft)	Top Width (ft)	Froude No.	Slope (ft/ft)	n Value	Bottom Width (ft)
286	16.24	2.13	17.62	12.53	2.42	.10300	.0350	4.00
286	14.71	2.27	19.43	13.09	2.13	.10300	.0400	4.00

n VARIED FOR WORST CONDITION ⇒ MAX VEL. = 16.24 FPS

VEL. USED IN ORIGINAL DESIGN = 16.35 FPS > 16.24 FPS O.K.

R-8 RIPRAP ACCEPTABLE


1118
1110
RIPRAP BOUNDARY
2H:1V
2H:1V
1V : 2.0H
1109
Riprap Boundary
1111
6'
1111.6
Roadway
1111
1110
3'
Min 10'
4'-0"
2H:1V
FLOW
3.0 ft (TYP)
2H:1V
1107
4'-0" (TYP)
R-5 Riprap (2' thick)
S = 0.03 (TYP)
1105
84"ϕ
FLOW
2H:1V
1098
R-8
RIPRAP
Geotextile Type "A"
MAIN VALLEY WEST DIVERSION CHANNEL
CULVERT 128 ft long
30'
CULVERT ENTRANCE
S = 0.00633
87'
UPSTREAM TRANSITION
S = 0.10345

POWER AND INDUSTRIAL SYSTEMS DIVISION – READING

DESIGN INPUT RECORD

PROJECT	W.O.	IDENTIFIER
Conemaugh Stn	04-4479-110	X-272-413-027

SUBJECT: MAIN VALLEY WEST DIVERSION CHANNEL

DEPT./SECTION: Structural / Civil / 0413

PAGE 1 OF 3

REVISION	0	1	2	3
ITEM(S) REVISED	X			
ORIGINATOR	R. Wolenik			
DATE	Feb 85			
PROJECT ENGINEER REVIEW	[signature]			
DATE	2/20/85			
SECTION MANAGER APPROVAL	D. [signature]			
DATE	3/1/85			
FUTURE CONFIRMATION REQUIRED?	YES *			
MICROFILMED/DATE				

* Need final flow data

INSTRUCTIONS: USE "N/A" FOR ITEMS NOT APPLICABLE. IDENTIFY ITEMS REQUIRING FUTURE CONFIRMATION BY CIRCLE OR CLOUD. IDENTIFY REVISED INFORMATION BY VERTICAL LINE IN RIGHT MARGIN AND REVISION NUMBER. USE ADDITIONAL SHEETS AS NECESSARY.

1. SCOPE OF THIS DIR; BASIC FUNCTIONS OF SYSTEM, STRUCTURE, OR COMPONENT:

Hydraulic Analysis and design of the WEST diversion channel of the main valley for the Conemaugh Coal Ash/Mine refuse disposal site

CONTINUED PAGE ___

2. CLASSIFICATION; DESIGN CODE(S) AND STANDARD(S):

Non Safety

CONTINUED PAGE ___

3. PERFORMANCE REQUIREMENTS AND SOURCE:

CONTINUED PAGE ___

4. DESIGN MARGINS OR SAFETY FACTORS:

NA

CONTINUED PAGE ___

Gilbert/Commonwealth

GAI-520 3-83

THIS IS A PERMANENT DESIGN RECORD DO NOT DESTROY

APPENDIX B
Stage III Form I Calculations

Worksheets

1.0 INTRODUCTION

The existing and proposed drainage features for Stage III at the Conemaugh Station Ash/Refuse Disposal Site are to be designed for the peak flow from either a 25-year 24-hour storm event or a 100-yr 24-hour storm event. Stage III will be constructed in five (5) intermediate phases, or sub-stages, during landfill development. The five Stage lll phases are called Phase A, B, C, D, and E, herein. Temporary channels and culverts that are to be constructed during the intermediate phases are designed for the 25-year 24-hour storm event. The permanent culverts and perimeter channels which are constructed during the intermediate landfill phasing are designed for either the intermediate phase which produces the largest 25-yr peak flow, or for the final vegetated condition using the 100-yr peak flow, whichever is greatest. ***Since the 25-year storm is the design event for PaDEP Solid Waste, all features are to be sized for the 25-yr peak flow with a minimum freeboard of 25% of the flow depth or 6 inches, whichever is greatest. Features designed for the 100-yr peak flow are to be compared to the 25-yr peak flow plus freeboard, and the deepest resulting channel will be used.***

The following calculations present the culverts and portions of the channels which will be constructed as part of a particular Stage lll phase, and by doing so, the culverts and channels are designed to accommodate a range of slopes and peak flows. Site hydrology was analyzed for all intermediate phases of construction in order to determine the maximum flows used to design each channel and culvert.

The channels were analyzed using the computer program Hydraflow Hydrographs 2004 (Hydraflow), and the outputs are included in later sections. A separate drainage network was developed for each construction phase within Hydraflow to acquire a true representation of the watershed and resulting peak flows. Input and output values from the program are summarized in this calculation set.

The permanent perimeter channels were previously designed in Form I of the May 1997 Major Permit Modification (1997 Permit Modification), and approved November 4, 1998. The same naming convention of these channels is used in the Stage III design, where possible. However, the naming convention of all temporary and permanent channels in this calculation set does not follow that of the 1997 Permit Modification. Therefore the calculations within this calculation set will state the relationship between the naming convention used in this calculation set and in the 1997 Permit Modification (for permanent channels only). The proposed concrete channel linings in the 1997 Permit Modification are to be replaced with concrete-filled, Uniform Section Mat (USM) channel linings. The capacities of the original designs (now using USM) were then analyzed, verified, and modified if needed.

The culverts were analyzed using the Federal Highway Administration computer program HY-8. The locations of culverts are included on the plan drawings provided with this permit modification package. For these locations, estimates were made of the ground surface elevations at culvert inlet and outlet locations. These elevations, in conjunction with the required cover over the culvert to maintain structural integrity, the pipe diameter, and the requirements of headwater and tailwater depths, were used to provide the inlet and outlet invert elevations. In some instances, the required inlet and outlet elevations necessitate special structures or construction measures in order to meet the elevations of inlet or outlet points. These measures might include the steepening of the upstream channel in order to provide extra headwater depth at the culvert, or the installation of culvert inlet drop structures as noted in the calculations.

The Stage III Development Plan and Phasing drawings can be used to locate and identify the channels and culverts, primarily Drawings E-728-1181 and E-728-1182

2.0 HYDROLOGY INPUT DATA

2.1 PRECIPITATION

The April, 2013 precipitation data (below) is the same as for the 2013 Chapter 105/Section 404 Joint Permit Application for the Conemaugh Stage III Expansion Stream Relocation and Wetlands Mitigation Project, and was used throughout the Hydraflow software analysis for this major permit modification application.

NOAA Atlas 14, Volume 2, Version 3
Location name: New Florence, Pennsylvania, US*
Coordinates: 40.3867, -79.0630
Elevation: 1089 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.319 (0.289-0.353)	0.381 (0.346-0.422)	0.461 (0.418-0.510)	0.525 (0.474-0.579)	0.608 (0.546-0.670)	0.674 (0.603-0.741)	0.741 (0.659-0.814)	0.812 (0.718-0.891)	0.911 (0.799-0.998)	0.988 (0.861-1.08)
10-min	0.496 (0.449-0.548)	0.595 (0.540-0.658)	0.717 (0.649-0.793)	0.810 (0.731-0.894)	0.930 (0.835-1.02)	1.02 (0.914-1.12)	1.12 (0.992-1.23)	1.21 (1.07-1.33)	1.34 (1.18-1.47)	1.44 (1.25-1.57)
15-min	0.608 (0.551-0.672)	0.728 (0.660-0.805)	0.880 (0.797-0.974)	0.997 (0.899-1.10)	1.15 (1.03-1.27)	1.26 (1.13-1.39)	1.39 (1.23-1.52)	1.51 (1.33-1.66)	1.67 (1.47-1.83)	1.80 (1.57-1.97)
30-min	0.804 (0.729-0.889)	0.974 (0.883-1.08)	1.21 (1.09-1.33)	1.38 (1.25-1.53)	1.62 (1.46-1.79)	1.81 (1.62-1.99)	2.00 (1.78-2.20)	2.20 (1.95-2.41)	2.48 (2.17-2.71)	2.70 (2.35-2.95)
60-min	0.982 (0.890-1.09)	1.20 (1.08-1.32)	1.51 (1.37-1.67)	1.76 (1.59-1.94)	2.10 (1.89-2.32)	2.38 (2.13-2.62)	2.68 (2.38-2.94)	2.98 (2.64-3.28)	3.43 (3.00-3.75)	3.79 (3.30-4.14)
2-hr	1.16 (1.05-1.28)	1.40 (1.27-1.55)	1.78 (1.61-1.96)	2.08 (1.88-2.29)	2.52 (2.28-2.76)	2.87 (2.57-3.15)	3.26 (2.90-3.57)	3.68 (3.25-4.02)	4.29 (3.75-4.68)	4.80 (4.18-5.24)
3-hr	1.25 (1.13-1.38)	1.51 (1.37-1.67)	1.91 (1.73-2.10)	2.23 (2.01-2.46)	2.69 (2.42-2.96)	3.09 (2.75-3.38)	3.51 (3.11-3.84)	3.97 (3.49-4.33)	4.65 (4.04-5.07)	5.22 (4.50-5.69)
6-hr	1.51 (1.36-1.68)	1.82 (1.64-2.03)	2.28 (2.07-2.53)	2.66 (2.40-2.95)	3.21 (2.88-3.54)	3.67 (3.28-4.04)	4.17 (3.70-4.59)	4.73 (4.15-5.19)	5.54 (4.81-6.07)	6.24 (5.37-6.82)
12-hr	1.83 (1.67-2.04)	2.20 (2.01-2.45)	2.73 (2.48-3.04)	3.18 (2.88-3.52)	3.84 (3.46-4.24)	4.40 (3.94-4.85)	5.02 (4.46-5.52)	5.70 (5.01-6.25)	6.73 (5.83-7.37)	7.60 (6.52-8.31)
24-hr	2.17 (2.00-2.36)	2.59 (2.40-2.82)	3.19 (2.95-3.48)	3.71 (3.41-4.03)	4.46 (4.08-4.84)	5.10 (4.63-5.52)	5.80 (5.22-6.27)	6.57 (5.86-7.10)	7.70 (6.77-8.34)	8.67 (7.53-9.40)

The curve number values below are from Form I, Appendix I-1-A of the 1997 Permit Modification.

Woods	70
Revegetated Top	75
Revegetated Bench	78
Pasture	80
Active Surface	85

2.2 WATERSHED DELINEATION AND COMPOSITE CURVE NUMBERS

2.2.1 PHASE A (called Stage IIIA on drawings)

PHASE A (A pile Active - Bottom 3 benches of Stage II Pile Vegetated)							
WC1/2	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	1.18	0.00	2.76	3.94	83
Z/Y/E	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	18.84	0.00	0.00	18.84	78
HR1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.00	0.00	3.94	3.94	85
EC1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.00	0.00	21.12	21.12	85
R/D	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	7.52	0.00	8.78	16.30	82
ED1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	1.29	0.00	0.00	0.00	0.00	1.29	70
ED2	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	2.52	0.00	0.00	0.00	0.00	2.52	70

2.2.2 PHASE B (called Stage IIIB on drawings)

PHASE B (Vegetated Phase A portion - Stage II fully Vegetated)							
WC3	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.00	0.00	6.42	6.42	85
Z/Y/E	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	6.93	0.00	0.00	6.93	78
HR1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.00	0.00	6.60	6.60	85
EC1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	23.18	0.00	42.69	65.87	83
WD1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	22.26	0.00	0.00	2.47	0.00	24.73	71
ED1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	1.29	0.00	0.00	0.00	0.00	1.29	70
ED2	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	2.36	0.00	0.00	0.00	0.00	2.36	70

2.2.3 PHASE C (called Stage IIIC on drawings)

PHASE C (Vegetated Phase B portion)

Basin	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	Area (Ac)						
WC6	1.53	0.00	0.00	0.00	0.00	1.53	70
SD2	0.00	0.00	0.00	0.00	8.60	8.60	85
WC5	0.00	0.00	4.92	0.00	7.45	12.37	82
EC1	0.00	0.00	17.44	0.00	1.12	18.56	78
HR1	0.00	0.00	2.12	0.00	8.77	10.89	84
HR2	0.00	0.00	0.00	0.00	1.44	1.44	85
HR3	0.00	0.00	0.00	0.00	14.02	14.02	85
SD1	0.00	0.00	0.94	0.00	3.56	4.50	84
SD4	0.00	0.00	11.89	0.00	0.00	11.89	78
WD2/1	6.34	0.00	0.00	0.00	0.00	6.34	70
WD4	3.41	0.00	0.00	0.00	0.00	3.41	70
ED1	1.29	0.00	0.00	0.00	0.00	1.29	70
ED2	2.36	0.00	0.00	0.00	0.00	2.36	70

2.2.4 PHASE D (called Stage IIID on drawings)

PHASE D (Vegetate Phase C further upslope)							
	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
WC6	1.53	0.00	0.00	0.00	0.00	1.53	70
SD2	0.00	0.00	0.00	0.00	8.60	8.60	85
WC5	0.00	0.00	11.14	0.00	1.23	12.37	79
WC7	0.00	0.00	0.00	1.92	1.28	3.20	82
EC1	0.00	0.00	15.80	0.00	1.06	16.87	78
EC2	0.00	0.00	0.00	0.00	19.12	19.12	85
EC3	0.00	0.00	0.00	0.00	0.42	0.42	85
HR1	0.00	0.00	6.30	0.00	4.59	10.89	81
HR2	0.00	0.00	1.25	0.00	0.19	1.44	79
HR3	0.00	0.00	1.19	0.00	12.83	14.02	84
SD1	0.00	0.00	3.39	0.00	1.11	4.50	80
SD4	0.00	0.00	11.89	0.00	0.00	11.89	78
WD2/1	6.34	0.00	0.00	0.00	0.00	6.34	70
WD4	3.41	0.00	0.00	0.00	0.00	3.41	70
ED1	1.14	0.00	0.00	0.00	0.00	1.14	70
ED2	2.36	0.00	0.00	0.00	0.00	2.36	70
ED3	2.09	0.00	0.00	0.00	0.00	2.09	70

2.2.5 PHASE E (WORST CASE)

PHASE E (Largest Active Top)

Subarea	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	Area (Ac)						
WC6	1.53	0.00	0.00	0.00	0.00	1.53	70
SD2	0.00	0.00	8.60	0.00	0.00	8.60	78
WC9	0.00	0.00	0.00	0.00	12.60	12.60	85
SD3	0.00	0.00	1.27	0.00	11.76	13.03	84
WC8	0.00	0.00	16.43	0.00	0.00	16.43	78
HR5	0.00	0.00	6.01	0.00	5.15	11.17	81
HR4	0.00	0.00	0.00	0.00	5.83	5.83	85
SD1 / Culvert 3	0.00	0.00	0.82	0.00	3.18	4.00	84
SD1	0.00	0.00	9.96	0.00	0.00	9.96	78
SD4	0.00	0.00	11.89	0.00	0.00	11.89	78
EC1	0.00	0.00	22.01	0.00	6.70	28.71	80
EC2	0.00	0.00	5.69	0.00	0.00	5.69	78
EC3	0.00	0.00	0.42	0.00	0.00	0.42	78
ED1	1.14	0.00	0.00	0.00	0.00	1.14	70
ED2	2.36	0.00	0.00	0.00	0.00	2.36	70
ED3	2.09	0.00	0.00	0.00	0.00	2.09	70
WD3	8.56	0.00	0.00	0.00	0.00	8.56	70
WD4	3.41	0.00	0.00	0.00	0.00	3.41	70

2.2.6 PHASE E (FULLY VEGETATED)

PHASE E (Fully Vegetated)							
WC6	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	1.53	0.00	0.00	0.00	0.00	1.53	70
WC9	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	1.08	0.00	0.00	1.08	78
SD3	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	18.23	0.00	0.00	18.23	78
WC8	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	16.43	0.00	0.00	16.43	78
HR5	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.00	0.00	2.28	2.28	85
HR4	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.00	0.00	5.83	5.83	85
SD1 / Culvert 3	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	15.95	0.00	0.00	15.95	78
SD1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	9.96	0.00	0.00	9.96	78
SD4	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	11.89	0.00	0.00	11.89	78
EC1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	27.38	0.00	0.00	27.38	78
EC2	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	5.69	0.00	0.00	5.69	78
EC3	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	0.00	0.00	0.42	0.00	0.00	0.42	78
ED1	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	1.14	0.00	0.00	0.00	0.00	1.14	70
ED2	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	2.36	0.00	0.00	0.00	0.00	2.36	70
ED3	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	2.09	0.00	0.00	0.00	0.00	2.09	70
WD3	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	8.56	0.00	0.00	0.00	0.00	8.56	70
WD4	Area (Ac)						
	Woods	Revegetated Top	Revegetated Bench	Pasture	Active Surface	TOTAL	CN
	3.41	0.00	0.00	0.00	0.00	3.41	70

2.3 TIME OF CONCENTRATION

2.3.1 PHASE A

PHASE A (A pile Active - Bottom 3 benches of Stage II Pile Vegetated)

WC1/2

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

HR1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

EC1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Active Top	
Manning's Roughness Coefficient, n (table 3-1)	0.011	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.01	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0359**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1435	
Flow Length, L	1193	ft
Watercourse Slope, s	0.01	ft/ft
Average Velocity, $V = C*s^{0.5}$	1.27	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.2610**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0359	
Shallow Concentrated Flow T_t	0.2610	
Channel Flow T_t		
Time of Concentration, T_c	**0.2969**	**hrs**
	17.81	**min**

PHASE A (A pile Active - Bottom 3 benches of Stage II Pile Vegetated)

Z/Y/E

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.15	
Flow Length, L........	21	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.57	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0136**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.011	
Manning's Roughness Coefficient, n........	0.045	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	2.17	ft/sec
Flow Length, L........	1844	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.2366**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0136	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.2366	
Time of Concentration, T_c........	**0.2502**	**hrs**
	15.01	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE A (A pile Active - Bottom 3 benches of Stage II Pile Vegetated)

R/D

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	32	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0201**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	918	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.1227**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0201	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.1227	
Time of Concentration, T_c	**0.1428**	**hrs**
	8.57	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

ED1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

PHASE A (A pile Active - Bottom 3 benches of Stage II Pile Vegetated)

ED2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	42	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.17	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0851**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.1435	16.1435	
Flow Length, L	43	203	ft
Watercourse Slope, s	0.35	0.14	ft/ft
Average Velocity, $V = C*s^{0.5}$	9.53	6.00	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0013**	**0.0094**	**hrs**

Channel Flow

Segment ID	Interface	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	2.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	4.47	
Hydraulic Radius, $r = a / p_w$	0.45	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.90	ft/sec
Flow Length, L	734	ft
Travel Time, $T_t = (L) / (3600*V)$		**hrs**

Time of Concentration

Sheet Flow T_t	0.0851	
Shallow Concentrated Flow T_t	0.0107	
Channel Flow T_t		
Time of Concentration, T_c	**0.0958**	**hrs**
	5.75	**min**

2.3.2 PHASE B

PHASE B (Vegetated Phase A portion - Stage II Vegetated)

WC3

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Act. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.011	
Flow Length, L........	18	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0016**	**hrs**

Channel Flow

Segment ID	Act. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	3.12	ft/sec
Flow Length, L........	929	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.0828**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0016	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.0828	
Time of Concentration, T_c........	**0.0843**	**hrs**
	5.06	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE B (Vegetated Phase A portion - Stage II Vegetated)

Z/Y/E

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	21	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.57	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0136**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.011	
Manning's Roughness Coefficient, n	0.045	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.17	ft/sec
Flow Length, L	1844	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.2366**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0136	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.2366	
Time of Concentration, T_c	**0.2502**	**hrs**
	15.01	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE B (Vegetated Phase A portion - Stage II Vegetated)

HR1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Act. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.011	
Flow Length, L........	29	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0023**	**hrs**

Channel Flow

Segment ID	Act. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	3.12	ft/sec
Flow Length, L........	666	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.0593**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0023	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.0593	
Time of Concentration, T_c........	**0.0616**	**hrs**
	3.70	**min**

*** Minimum Time of concentration of 5 minutes was used**

PHASE B (Vegetated Phase A portion - Stage II Vegetated)

EC1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Active Top	
Manning's Roughness Coefficient, n (table 3-1)........	0.011	
Flow Length, L........	100	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.01	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0296**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)........	Unpaved	
Surface Description Coefficient, C........	16.1435	
Flow Length, L........	1128	ft
Watercourse Slope, s........	0.01	ft/ft
Average Velocity, $V = C*s^{0.5}$........	1.27	ft/sec
Travel Time, T_t = (L) / (3600*V)........	**0.2468**	**hrs**

Channel Flow

Segment ID	Interface	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$........	2.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	4.47	
Hydraulic Radius, $r = a / p_w$........	0.45	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	2.90	ft/sec
Flow Length, L........	734	ft
Travel Time, T_t = (L) / (3600*V)........	**0.0702**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0296	
Shallow Concentrated Flow T_t........	0.2468	
Channel Flow T_t........	0.0702	
Time of Concentration, T_c........	**0.3466**	**hrs**
	20.79	**min**

PHASE B (Vegetated Phase A portion - Stage II Vegetated)

WD1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Woods	
Manning's Roughness Coefficient, n (table 3-1)........	0.4	
Flow Length, L........	70	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.01	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.3946**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)........	Unpaved	Unpaved	
Surface Description Coefficient, C........	16.1435	16.1435	
Flow Length, L........	132	220	ft
Watercourse Slope, s........	0.12	0.38	ft/ft
Average Velocity, $V = C*s^{0.5}$........	5.62	9.98	ft/sec
Travel Time, $T_t = (L) / (3600*V)$........	**0.0065**	**0.0061**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.3946	
Shallow Concentrated Flow T_t........	0.0127	
Channel Flow T_t........		
Time of Concentration, T_c........	**0.4073**	**hrs**
	24.44	**min**

PHASE B (Vegetated Phase A portion - Stage II Vegetated)

ED1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

ED2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	42	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.17	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0851**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.1435	16.1435	
Flow Length, L	43	203	ft
Watercourse Slope, s	0.35	0.14	ft/ft
Average Velocity, $V = C*s^{0.5}$	9.53	6.00	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0013**	**0.0094**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0851	
Shallow Concentrated Flow T_t	0.0107	
Channel Flow T_t		
Time of Concentration, T_c	**0.0958**	**hrs**
	5.75	**min**

2.3.3 PHASE C

PHASE C (Vegetated Phase B portion)

WC6

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Woods	
Manning's Roughness Coefficient, n (table 3-1)........	0.4	
Flow Length, L........	100	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.03	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.3383**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)........	Unpaved	
Surface Description Coefficient, C........	16.1435	
Flow Length, L........	17	ft
Watercourse Slope, s........	0.09	ft/ft
Average Velocity, $V = C*s^{0.5}$........	4.80	ft/sec
Travel Time, $T_t = (L) / (3600*V)$........	**0.0010**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.3383	
Shallow Concentrated Flow T_t........	0.0010	
Channel Flow T_t........		
Time of Concentration, T_c........	**0.3392**	**hrs**
	20.35	**min**

PHASE C (Vegetated Phase B portion)

SD2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Act. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.011	
Flow Length, L........	25	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0020**	**hrs**

Channel Flow

Segment ID	Act. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	3.12	ft/sec
Flow Length, L........	1102	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.0982**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0020	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.0982	
Time of Concentration, T_c........	**0.1002**	**hrs**
	6.01	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE C (Vegetated Phase B portion)

WC5

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.15	
Flow Length, L........	27	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0176**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	2.08	ft/sec
Flow Length, L........	711	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.0950**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0176	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.0950	
Time of Concentration, T_c........	**0.1126**	**hrs**
	6.75	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE C (Vegetated Phase B portion)

EC1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.15	
Flow Length, L........	41	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0245**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	2.08	ft/sec
Flow Length, L........	909	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.1215**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0245	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.1215	
Time of Concentration, T_c........	**0.1460**	**hrs**
	8.76	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE C (Vegetated Phase B portion)

HR1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	26	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0170**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	678	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0906**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0170	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.0906	
Time of Concentration, T_c	**0.1076**	**hrs**
	6.46	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

HR2

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

PHASE C (Vegetated Phase B portion)

HR3

Sheet Flow

	Segment ID	1	
Surface Description (Table 3-1)		Act. Bench	
Manning's Roughness Coefficient, n (table 3-1)		0.011	
Flow Length, L		28	ft
Two-year 24-hour Rainfall, P_2		2.59	in
Land Slope, s		0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$		**0.0022**	**hrs**

Channel Flow

	Segment ID	Act. Bench	
Section Base, b		0	
Section Depth, d		1	
Section Side Slope, z		10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$		10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$		20.10	
Hydraulic Radius, $r = a / p_w$		0.50	
Channel Slope, s		0.010	
Manning's Roughness Coefficient, n		0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$		3.12	ft/sec
Flow Length, L		1412	ft
Travel Time, $T_t = (L) / (3600*V)$		**0.1258**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0022	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.1258	
Time of Concentration, T_c	**0.1280**	**hrs**
	7.68	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

SD1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

PHASE C (Vegetated Phase B portion)

SD4

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)........	0.15	
Flow Length, L........	26	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.0170**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b........	0	
Section Depth, d........	1	
Section Side Slope, z........	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$........	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$........	20.10	
Hydraulic Radius, $r = a / p_w$........	0.50	
Channel Slope, s........	0.010	
Manning's Roughness Coefficient, n........	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$........	2.08	ft/sec
Flow Length, L........	1503	ft
Travel Time, $T_t = (L) / (3600*V)$........	**0.2008**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.0170	
Shallow Concentrated Flow T_t........		
Channel Flow T_t........	0.2008	
Time of Concentration, T_c........	**0.2179**	**hrs**
	13.07	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

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PHASE C (Vegetated Phase B portion)

WD2/1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Woods	
Manning's Roughness Coefficient, n (table 3-1)........	0.4	
Flow Length, L........	70	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.01	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.3946**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)........	Unpaved	Unpaved	
Surface Description Coefficient, C........	16.1435	16.1435	
Flow Length, L........	132	220	ft
Watercourse Slope, s........	0.12	0.38	ft/ft
Average Velocity, $V = C*s^{0.5}$........	5.62	9.98	ft/sec
Travel Time, $T_t = (L) / (3600*V)$........	**0.0065**	**0.0061**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.3946	
Shallow Concentrated Flow T_t........	0.0127	
Channel Flow T_t........	0.0000	
Time of Concentration, T_c........	**0.4073**	**hrs**
	24.44	**min**

PHASE C (Vegetated Phase B portion)

WD4

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	70	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.04	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2205**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1435	
Flow Length, L	156	ft
Watercourse Slope, s	0.14	ft/ft
Average Velocity, $V = C*s^{0.5}$	6.06	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0071**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2205	
Shallow Concentrated Flow T_t	0.0071	
Channel Flow T_t		
Time of Concentration, T_c	**0.2276**	**hrs**
	13.66	**min**

PHASE C (Vegetated Phase B portion)

ED1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

ED2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	42	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.17	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0851**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Channel Slope, s	0.010		
Manning's Roughness Coefficient, n	0.03		(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.90		ft/sec
Flow Length, L	734		ft
Travel Time, $T_t = (L) / (3600*V)$			**hrs**

Time of Concentration

Sheet Flow T_t	0.0851	
Shallow Concentrated Flow T_t	0.0107	
Channel Flow T_t		
Time of Concentration, T_c	**0.0958**	**hrs**
	5.75	**min**

2.3.4 PHASE D

PHASE D (Vegetate Phase C further upslope)

WC6

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.03	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.3383**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1435	
Flow Length, L	17	ft
Watercourse Slope, s	0.09	ft/ft
Average Velocity, $V = C*s^{0.5}$	4.80	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0010**	**hrs**

Time of Concentration

Sheet Flow T_t	0.3383	
Shallow Concentrated Flow T_t	0.0010	
Channel Flow T_t		
Time of Concentration, T_c	**0.3392**	**hrs**
	20.35	**min**

PHASE D (Vegetate Phase C further upslope)

SD2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Act. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.011	
Flow Length, L	25	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0020**	**hrs**

Channel Flow

Segment ID	Act. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	3.12	ft/sec
Flow Length, L	1102	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0982**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0020	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.0982	
Time of Concentration, T_c	**0.1002**	**hrs**
	6.01	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE D (Vegetate Phase C further upslope)

WC5

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	29	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0186**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	1048	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.1400**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0186	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.1400	
Time of Concentration, T_c	**0.1586**	**hrs**
	9.52	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

WC7

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

PHASE D (Vegetate Phase C further upslope)

EC1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)................	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)................	0.15	
Flow Length, L................	41	ft
Two-year 24-hour Rainfall, P_2................	2.59	in
Land Slope, s................	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$................	**0.0245**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b................	0	
Section Depth, d................	1	
Section Side Slope, z................	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$................	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$................	20.10	
Hydraulic Radius, $r = a / p_w$................	0.50	
Channel Slope, s................	0.010	
Manning's Roughness Coefficient, n................	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$................	2.08	ft/sec
Flow Length, L................	909	ft
Travel Time, $T_t = (L) / (3600*V)$................	**0.1215**	**hrs**

Time of Concentration

Sheet Flow T_t................	0.0245	
Shallow Concentrated Flow T_t................		
Channel Flow T_t................	0.1215	
Time of Concentration, T_c................	**0.1460**	**hrs**
	8.76	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE D (Vegetate Phase C further upslope)

EC2

Sheet Flow

	Segment ID	1	
Surface Description (Table 3-1)		Act. Top	
Manning's Roughness Coefficient, n (table 3-1)		0.011	
Flow Length, L		100	ft
Two-year 24-hour Rainfall, P_2		2.59	in
Land Slope, s		0.02	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$		**0.0224**	**hrs**

Shallow Concentrated Flow

	Segment ID	2	3	
Surface Description (Paved / Unpaved)		Unpaved	Unpaved	
Surface Description Coefficient, C		16.1435	16.1435	
Flow Length, L		528	14	ft
Watercourse Slope, s		0.02	0.50	ft/ft
Average Velocity, $V = C*s^{0.5}$		2.28	11.42	ft/sec
Travel Time, $T_t = (L) / (3600*V)$		**0.0642**	**0.0003**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0224	
Shallow Concentrated Flow T_t	0.0646	
Channel Flow T_t		
Time of Concentration, T_c	**0.0870**	**hrs**
	5.22	**min**

EC3

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

PHASE D (Vegetate Phase C further upslope)

HR1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	90	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.18	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0696**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	980	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.1309**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0696	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.1309	
Time of Concentration, T_c	**0.2006**	**hrs**
	12.03	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE D (Vegetate Phase C further upslope)

HR2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	27	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0176**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	712	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0951**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0176	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.0951	
Time of Concentration, T_c	**0.1127**	**hrs**
	6.76	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE D (Vegetate Phase C further upslope)

HR3

Sheet Flow

	Segment ID	1	
Surface Description (Table 3-1)		Act. Bench	
Manning's Roughness Coefficient, n (table 3-1)		0.011	
Flow Length, L		28	ft
Two-year 24-hour Rainfall, P_2		2.59	in
Land Slope, s		0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$		**0.0022**	**hrs**

Channel Flow

	Segment ID	Act. Bench	
Section Base, b		0	
Section Depth, d		1	
Section Side Slope, z		10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$		10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$		20.10	
Hydraulic Radius, $r = a / p_w$		0.50	
Channel Slope, s		0.010	
Manning's Roughness Coefficient, n		0.03	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$		3.12	ft/sec
Flow Length, L		1412	ft
Travel Time, $T_t = (L) / (3600*V)$		**0.1258**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0022	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.1258	
Time of Concentration, T_c	**0.1280**	**hrs**
	7.68	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

SD1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

PHASE D (Vegetate Phase C further upslope)

SD4

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	26	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0170**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	1503	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.2008**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0170	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.2008	
Time of Concentration, T_c	**0.2179**	**hrs**
	13.07	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)

PHASE D (Vegetate Phase C further upslope)

WD2/1

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)........	Woods	
Manning's Roughness Coefficient, n (table 3-1)........	0.4	
Flow Length, L........	70	ft
Two-year 24-hour Rainfall, P_2........	2.59	in
Land Slope, s........	0.01	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$........	**0.3946**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)........	Unpaved	Unpaved	
Surface Description Coefficient, C........	16.1435	16.1435	
Flow Length, L........	132	220	ft
Watercourse Slope, s........	0.12	0.38	ft/ft
Average Velocity, $V = C*s^{0.5}$........	5.62	9.98	ft/sec
Travel Time, $T_t = (L) / (3600*V)$........	**0.0065**	**0.0061**	**hrs**

Time of Concentration

Sheet Flow T_t........	0.3946	
Shallow Concentrated Flow T_t........	0.0127	
Channel Flow T_t........	0.0000	
Time of Concentration, T_c........	**0.4073**	**hrs**
	24.44	**min**

PHASE D (Vegetate Phase C further upslope)

WD4

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	70	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.04	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2205**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1435	
Flow Length, L	156	ft
Watercourse Slope, s	0.14	ft/ft
Average Velocity, $V = C*s^{0.5}$	6.06	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0071**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2205	
Shallow Concentrated Flow T_t	0.0071	
Channel Flow T_t		
Time of Concentration, T_c	**0.2276**	**hrs**
	13.66	**min**

PHASE D (Vegetate Phase C further upslope)

ED1

Time of Concentration, T_c	**0.0833**	**hrs**
	5.00	**min**

* Minimum Time of concentration of 5 minutes was used

ED2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	42	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.17	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0851**	**hrs**

Shallow Concentrated Flow

Segment ID	2	3	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.1435	16.1435	
Flow Length, L	43	203	ft
Watercourse Slope, s	0.35	0.14	ft/ft
Average Velocity, $V = C*s^{0.5}$	9.53	6.00	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0013**	**0.0094**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0851	
Shallow Concentrated Flow T_t	0.0107	
Channel Flow T_t		
Time of Concentration, T_c	**0.0958**	**hrs**
	5.75	**min**

PHASE D (Vegetate Phase C further upslope)

ED3

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.10	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2090**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1435	
Flow Length, L	20	ft
Watercourse Slope, s	0.10	ft/ft
Average Velocity, $V = C*s^{0.5}$	5.11	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0011**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2090	
Shallow Concentrated Flow T_t	0.0011	
Channel Flow T_t		
Time of Concentration, T_c	**0.2101**	**hrs**
	12.60	**min**

2.3.5 PHASE E (WORST CASE)

PHASE E (Largest Active Top)

WC6

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.03	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.3383**	**hrs**

Shallow Concentrated Flow

Segment ID	2	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1435	
Flow Length, L	17	ft
Watercourse Slope, s	0.09	ft/ft
Average Velocity, $V = C*s^{0.5}$	4.80	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0010**	**hrs**

Time of Concentration

Sheet Flow T_t	0.3383	
Shallow Concentrated Flow T_t	0.0010	
Channel Flow T_t		
Time of Concentration, T_c	**0.3392**	**hrs**
	20.35	**min**

PHASE E (Largest Active Top)

SD2

Sheet Flow

Segment ID	1	
Surface Description (Table 3-1)	Rec. Bench	
Manning's Roughness Coefficient, n (table 3-1)	0.15	
Flow Length, L	25	ft
Two-year 24-hour Rainfall, P_2	2.59	in
Land Slope, s	0.50	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0165**	**hrs**

Channel Flow

Segment ID	Rec. Bench	
Section Base, b	0	
Section Depth, d	1	
Section Side Slope, z	10	Note 1
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.0	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	20.10	
Hydraulic Radius, $r = a / p_w$	0.50	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.045	(assumed)
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	2.08	ft/sec
Flow Length, L	1102	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.1472**	**hrs**

Time of Concentration

Sheet Flow T_t	0.0165	
Shallow Concentrated Flow T_t		
Channel Flow T_t	0.1472	
Time of Concentration, T_c	**0.1638**	**hrs**
	9.83	**min**

Note 1: Side slope shown averages the two slopes (20H:1V & 2H:1V)