OFFICE COPY

DRAINAGE INVESTIGATION AND REPORT

for

LOT 2D, BLOCK 3, SOUTH LOVELAND INDUSTRIAL PARK ADDITION, LOVELAND, COLORADO

MASTER METAL WORKS
204 12TH STREET S. E.
LOVELAND, COLORADO 80537

REVIEWED PLANS
REVIEWED PLANS ARE NOT APPROVED PLANS. FIELD INSPECTORS MAY REQUIRE CHANGES AS NECESSARY TO MEET ORDINANCE OR BUILDING CODE PROVISIONS ON THE JOB.

Prepared for:

MASTER METAL WORKS
204 12th Street S. E.
Loveland, Colorado 80537

PLEASE USE THE PERMIT NUMBER & ADDRESS WHEN CALLING FOR AN INSPECTION THANK YOU.

121467

INSPECTIONS REQUIRED
STORMWATER

August 2012

Project No. 1029 - GRD - 12

ACCEPTED - NO EXCEPTION TAKEN

AUG 2 0 2012

Prepared by:

DENNIS R. MESSNER, P. E.
1355 N. Cleveland Ave., Ste #1 Loveland, Colorado 80537 Telephone: (970) 461-3501

Dennis R. Messner, P. E.
Consulting Civil Engineer

Project No. 1029 - GRD - 12
August 13, 2012

Mary Shann
City of Loveland
Code Enforcement
500 E. 3rd Street
Loveland, Colorado 80537

Dear Ms. Shann,

Enclosed you will find three (3) copies of the Drainage Investigation Report for 204 - 12th Street S. E. for Stormwater's review and acceptance.

If you should have any questions, please feel free to contact this office.

Dennis R. Messner, P. E.
Consulting Civil Engineer

1355 N. Cleveland Ave., Ste #1 * Telephone: (970) 663-2221 * Loveland, Colorado 80537

Dennis R. Messner, P. E.

Consulting Civil Engineer

August 12, 2012
Project No. 1029-GRD-12

Mr. Kevin W. Gingery, P.E.
City of Loveland
Stormwater
410 E. 5th Street
Loveland, Colorado 80537

Re: **Drainage Investigation Report for MASTER METAL WORKS, 204 12th Street S. E., Loveland, Colorado 80537**

Dear Mr. Gingery:

I am pleased to submit for your review and acceptance, this Drainage Investigation Report for Lot 2D of the Replat of Lots 5 & 6, Block 1 and Lot 2, Block 3 of the South Loveland Industrial Park Addition, Loveland, Colorado.

The investigation and design within this report have been performed according to the criteria established in the City of Loveland's "Storm Drainage Criteria."

I sincerely appreciate your time and consideration in the review of this project. If you should have any questions, please feel free to contact this office.

Respectfully Submitted,

Dennis R. Messner, P. E.

cc: Master Metal Works

I hereby state that the attached **"Drainage Investigation Report for Lot 2D, Block 3 of the Relpat of Lot 5 & 6, Block 1 and Lot 2, Block 3 of the South Loveland Industrial Park Addition, Loveland, Colorado"** was prepared by me or under my direct supervision in accordance with the provisions of the City of Loveland Drainage Criteria for the owner thereof.

COLORADO REGISTERED DENNIS R. MESSNER 20109 PROFESSIONAL ENGINEER

Dennis R. Messner
Registered Professional Engineer
State of Colorado No. 20109

8-12-12

1355 N. Cleveland Ave., Ste#1 * Loveland, Colorado 80537 * Telephone: (970) 461-3501

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I. General Location and Description:

A. Location

1. The MASTER METAL WORKS facility is located in the Southwest Quarter of Section 24, Township 5 North, Range 69 West of the 6th P.M. in the City of Loveland, Larimer County, Colorado.

2. The site is more specifically located at 204 12th Street S. E. on the south side of 12th Street S. E. between South Garfield Avenue and South Cleveland Avenue. (Refer to the enclosed Vicinity Map.)

3. Several structures utilized for commercial and industrial activities border the site along its east boundary. 12th Street S. E. abuts the northern boundary of the site. The Century Link Maintenance Facility borders the site along its southern boundary. Commercial and industrial uses border the western boundary of the site.

B. Description of property

1. The MASTER METAL WORKS site contains approximately 0.58 acres. The site consists of a single story metal structure containing an office and product manufacturing and assembly facility. The open area consists of outside material storage, vehicle parking and material loading facilities.

2. The existing ground cover consists mainly of an asphalt pavement.

3. The "Soil Survey of Larimer County Area, Colorado" prepared by the U.S. Department of Agriculture, Soil Conservation Service, indicated that the surface soils consist of "Caruso clay loam." The soil typical of this series is described as level soil on low terraces and bottom lands. The "Soil Survey" identifies the runoff potential as slow, and the hazard of erosion from wind as slight and the erosion hazard from water as slight.

4. The site is generally considered flat with ground surface slopes ranging from 0.5% to 1.5%.

5. The existing structure on the Master Metal Works site has a building footprint of approximately 7,225 square feet. Landscaping and gravel surfaces consists of approximately 4,060 square feet. The balance of the site, approximately 13,960 square feet, is considered to be paved or hard surfaced. (Area based upon survey performed July 2012.)

II. Drainage Basins and Sub-basins:

A. Major Basin Description

1. The subject area is located on Lot 2D, Block 3 of the Replat of Lots 5 & 6, Block 1 and Lot 2, Block 3 of the South Loveland Industrial Park Addition to the City of Loveland, Colorado.

2. The site is shown to be in the HOLLOWELL CORNER BASIN 84-2004 as identified by the City of Loveland's Master Drainage Plan. The site is located within Basin Number 102 of the Hollowell Corner Basin. The site is located within the Big Thompson River flood fringe as shown on the FEMA Flood Insurance Rate Map Number 08069C1189F dated December 19, 2006.

B. Sub-basin Description

1. The drainage pattern of the property that was present prior the the re-construction of the paved parking and storage area is as follows:

a. At the south side of the site, a portion of the structures roof and the adjacent gravel surfaced open storage area drained overland to the southern boundary of the site. The flow was directed from west to east along the southern boundary to the southeast corner of the site. The flow then turned northerly and traveled along the eastern boundary of the site.

b. At the east side of the site, approximately half of the structures roof and the adjacent paved surfaced open storage area drained overland to the eastern boundary of the site. The flow was directed from south to north along the eastern boundary to 12th Street S. E. The flow enters a gutter pan in the Street and then was directed westerly in 12th Street S. E.

c. At the west side of the site, approximately half of the structures roof and the adjacent gravel surfaced open area drained overland to the western boundary of the site. The flow was directed from south to north along the western boundary to 12th Street S. E. The flow enters a gutter pan in the Street and then was directed easterly in 12th Street S. E.

d. At the north side of the site, the landscaped area and the paved parking and access drive area drained overland to the north to 12th Street S. E. The flow in the gutter pan in the Street drained from both the west and east to a cross-pan that flowed to the north.

The flow continues northerly in an open drainage swale and discharges into an abandoned gravel pit located approximately 600 feet north of 12th Street S. E. Overflow from the gravel pit flows directly to the Big Thompson River which is situated along the north side of the gravel pit.

situated along the north side of the gravel pit.

The specific area considered by this investigation is the eastern boundary of the site. The runoff flowed northerly along the eastern property line in an earthen and gravel surfaced drainage course that was poorly defined. Four structures are situated on the property to the east. The height of the floor levels of those structures varies with respect to the ground along the property line. The height varies from approximately ten inches at the southern most building to one inch at the northern most building. The area along the drainage course appears to have been poorly maintained. The ground cover consists mainly of weeds and numerous vehicles in various states of repair are stored in this area. The area directly south of 12th Street S.E. is paved. The asphalt pavement has been placed so that the southern edge is approximately level with the ground surface at the northeast corner of the site.

III. Drainage Design Criteria:

A. Development Regulations

1. Design criteria from the City of Loveland Storm Drainage Criteria (Addendum to the Urban Storm Drainage Criteria Manuals Volumes 1, 2 and 3) were utilized.

B. Development Criteria Reference and Constraints

1. The historic drainage pattern has been affected by the re-construction of the paved area on the site in that flows had been concentrated and channelized prior to the re-construction of the paved area on the site. Although the re-construction of the paved area has produced more runoff than the historic amount when this area was previously paved, The runoff from the re-constructed pavement is now confined to the site and does not drain to the eastern property boundary. The re-constructed improvements include curbing situated along the southern and eastern border of the paved area.

2. Runoff from the property will not negatively impact adjacent properties. Any drainage that previously flowed onto the property to the east will be intercepted by the curbing situated along the southern and eastern border of the paved area. The curbing directs the runoff from the site to the north and directly to 12th Street S. E.

3. The drainage impact of this site have been negated by the constructed improvements and will not adversely affect streets or utilities.

C. Hydrological Criteria

1. The Rainfall-Intensity-Duration curves for the City of Loveland were used in

conjunction with the Rational Method for determining peak flows at various concentration points.

2. The 2-year, 10-year and 100-year storms were analyzed in the design of the storm water management infrastructure in accordance with the City of Loveland Storm Drainage Criteria.

3. The storm runoff flows were determined using the Rational Method.

D. Hydraulic Criteria

1. Analysis of the flows is based upon use of the Manning Formula with cross section data taken for each surface material encountered.

a. The Manning s roughness coefficient for all open swale capacity calculations is 0.015 for paved surfaces and 0.027 for gravel surfaces as dictated in Section 4.4.1 of the City of Loveland Storm Drainage Criteria.

IV. Drainage Facility Design:

A. General Concept

In order to provide a reference of comparison, the Final Drainage Investigation & Erosion Control Report for Lot 5, Block 3 of South Loveland Industrial Park (Qwest Communications Construction & Maintenance Facility, 175 14th Street S. E., Loveland, Colorado 80537) was utilized. This investigation analyzed three cross-sections located along the eastern boundary of the subject site.

The cross-sections are referenced from Station 0+00 located at the Southeast property corner. The stationing increases from south to north along the eastern boundary.

The analysis performed considers the flows concentrating at each cross-section both prior to the reconstruction of the onsite paved area and after re-construction. The width and depth of flow at each cross-section was determined. The following is a chart comparing both the "pre" and "post" re-construction conditions.

Design Point	Prior Contributing Area (Acre)	Exist. Contributing Area (Acre)	Prior Percent (%) Imperviousness	Exist. Percent (%) Imperviousness	Prior Peak 2-Year (c.f.s.)	Exist. Peak 2-Year (c.f.s.)	Prior Peak 10-Year (c.f.s.)	Exist. Peak 10-Year (c.f.s.)	Prior Peak 100-Year (c.f.s.)	Exist Peak 100-Year (c.f.s.)
#1 (0+37.84)	0.57	0.51	59.56	60.81	0.61	0.56	1.28	1.17	2.51	2.29
#2 (0+93.10)	0.73	0.59	63.11	59.85	0.79	0.6	1.63	1.27	3.14	2.48
#3 (1+76.40)	0.98	0.7	66.94	59.41	1.11	0.69	2.24	1.48	4.22	2.9

V. Erosion & Storm Water Quality Control:

No Erosion Control or Storm Water Quality issues were considered as a part of this analysis and investigation.

VI. Conclusions:

A. Compliance with Standards

1. All drainage design conforms to the criteria and requirements of the City of Loveland Storm Drainage Criteria.

2.

B. Drainage Concept

1. The analysis of the re-constructed paved area improvements at 204 12th Street S. E. is effective for the control of storm water runoff without negatively impacting adjacent properties or structures.

VII. References:

A. City of Loveland Storm Drainage Criteria (Addendum to the Urban Storm Drainage Criteria Manuals Volumes I, II, and III.)

B. Urban Storm Drainage Criteria Manuals Volume I, II, and III

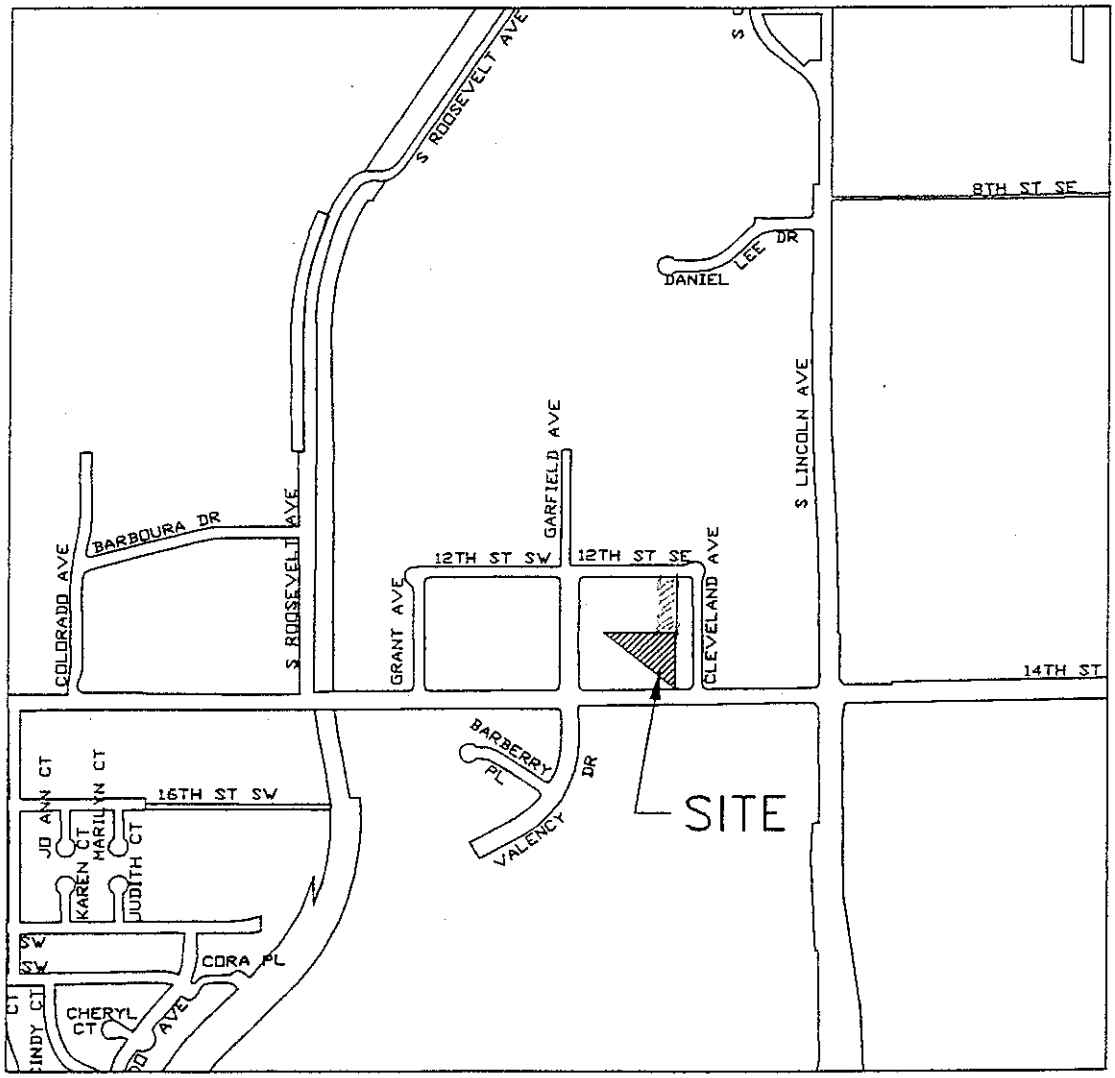
C. City of Loveland Master Drainage Plan

D. Soil Survey of Larimer County Area, Colorado

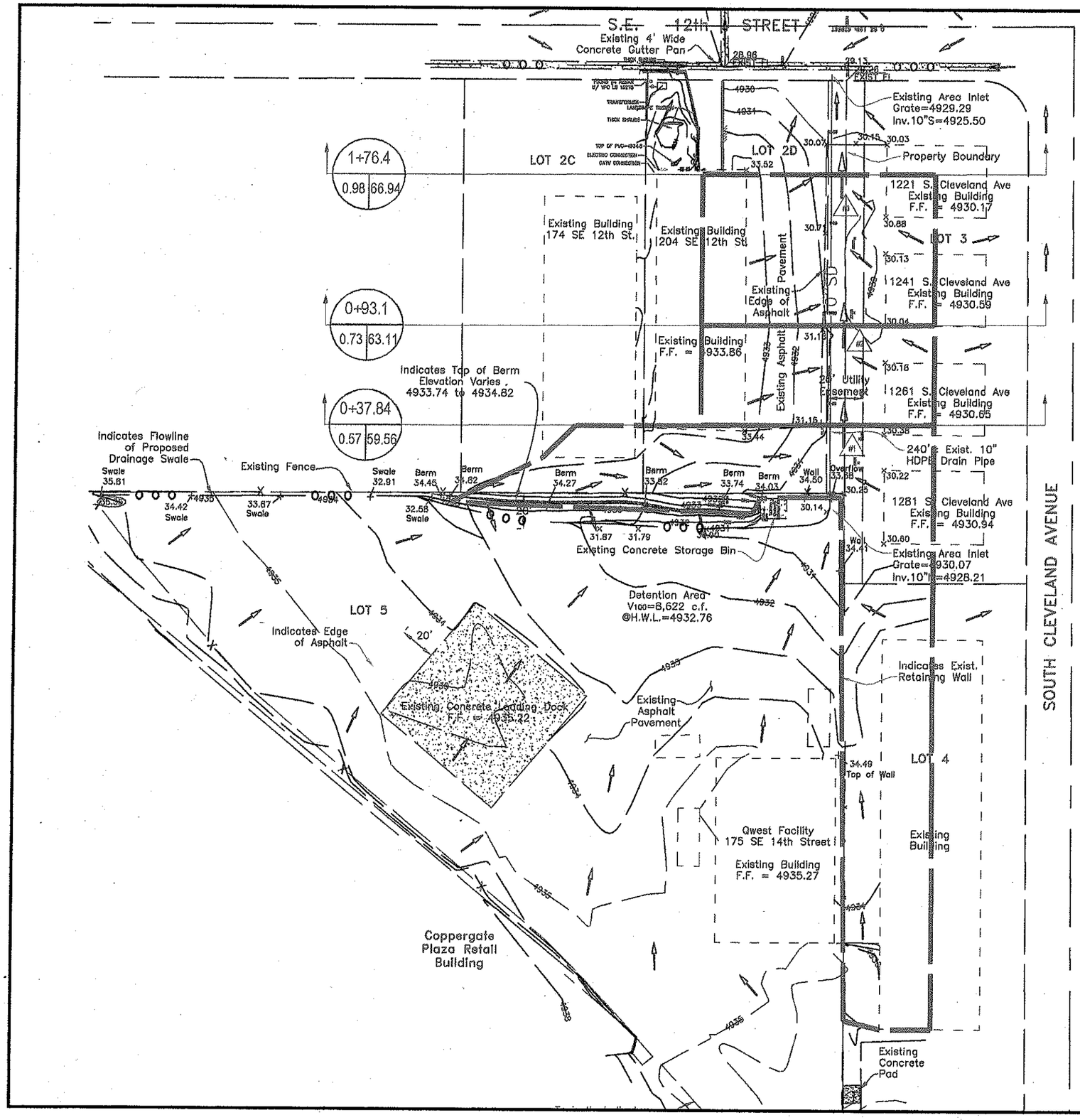
E. Final Drainage Investigation & Erosion Control Report for Lot 5, Block 3 of South Loveland Industrial Park (Qwest Communications Construction & Maintenance Facility, 175 14th Street S. E., Loveland, Colorado 80537) prepared by: Messner Engineering, Inc., dated: November 2003.

EXHIBITS

Vicinity Map



Scale: 1" = 1000'



"PRIOR" SUMMARY RUNOFF TABLE

Design Point	Contributing Basin(s)	Contributing Area (acres)	Peak 10-Year (cfs)	Peak 100-Year (cfs)
#1	0+37.84	0.57	1.28	2.51
#2	0+93.10	0.73	1.63	3.14
#3	1+76.40	0.98	2.24	4.22

LEGEND

- 5012 — Typically indicates Existing Ground Surface Contour
- Drainage Basin Limit Identifier
- Typically Indicates Drainage Flow Direction
- Concentration Point Identifier
- 'A' / B | I — A = Basin Designation, B = Area in Acres, I = % Imperviousness
- #1 — D = Design Point Designation

Dennis R. Messner, P.E.
Consulting Civil Engineer
114 East 5th Street
Loveland, Colorado 80537
Telephone: (970)663-2221

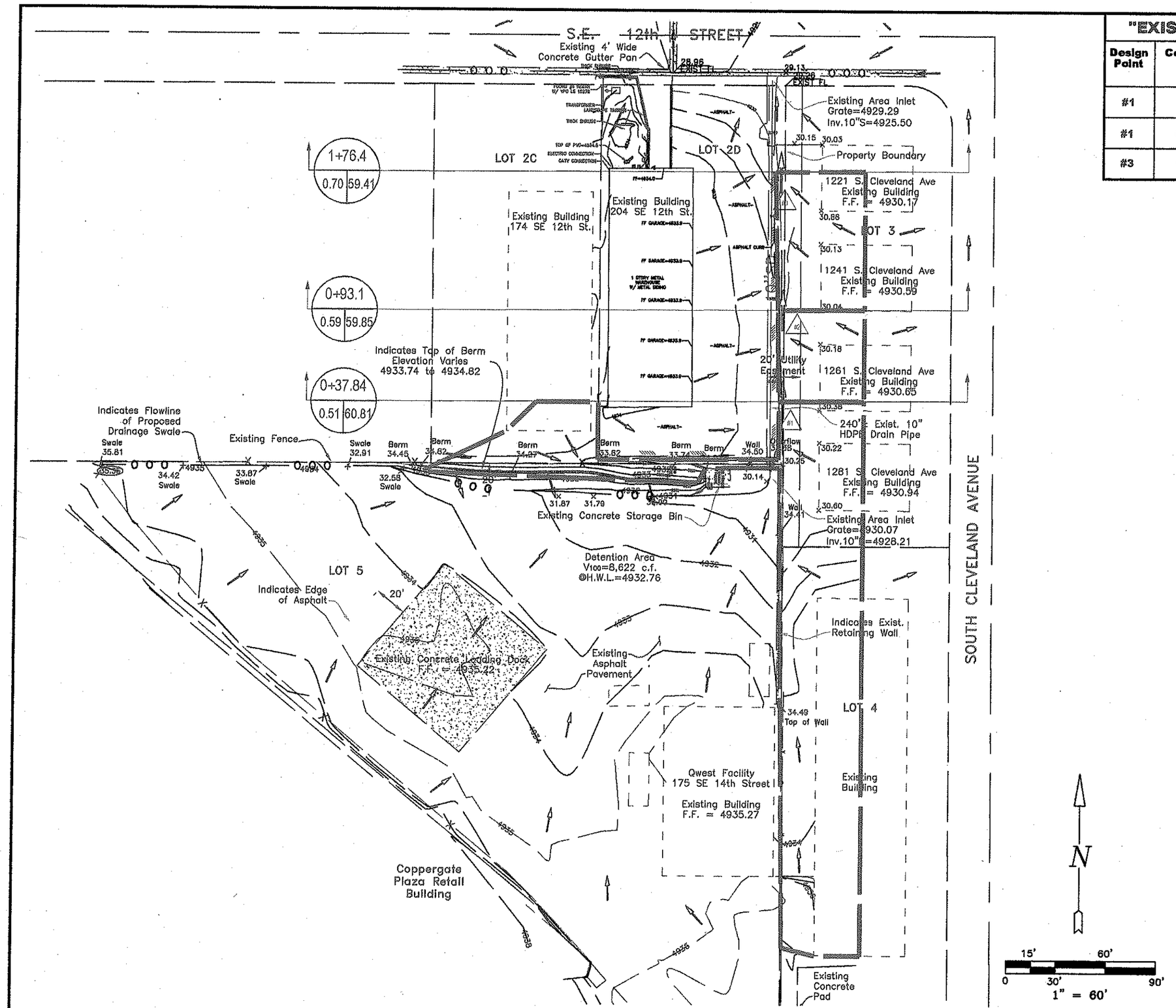
CLIENT: MASTER METAL WORKS

TITLE: Drainage Exhibit
Condition PRIOR to Parking Area Reconstruction
204 12th Street S. E.
Loveland, Colorado

DATE: Aug. 6, 2012
SCALE: As Noted
DRAWN: D.A.R.
CHKD: D.R.M

Project No. 1029-GRD-12

SHEET 1 of 2



"EXISTING" SUMMARY RUNOFF TABLE

Design Point	Contributing Basin(s)	Contributing Area (acres)	Peak 10-Year (cfs)	Peak 100-Year (cfs)
#1	0+37.84	0.51	1.17	2.29
#1	0+93.10	0.59	1.27	2.48
#3	1+76.40	0.70	1.48	2.90

LEGEND

- —5012— Typically Indicates Existing Ground Surface Contour
- Drainage Basin Limit Identifier
- Typically Indicates Drainage Flow Direction
- Concentration Point Identifier
- 'A' / B / I — A = Basin Designation, B = Area in Acres, I = % Imperviousness
- #1 — D = Design Point Designation

Dennis R. Messner, P.E.
Consulting Civil Engineer
114 East 5th Street
Loveland, Colorado 80537
Telephone: (970)663-2221

CLIENT: MASTER METAL WORKS

TITLE: Drainage Exhibit
Condition After Parking Area Reconstruction
204 12th Street S. E.
Loveland, Colorado

DATE: Aug. 6, 2012
SCALE: As Noted
DRAWN: D.A.R.
CHKD: D.R.M

Project No. 1029-GRD-12

SHEET 2 of 2

APPENDIX I

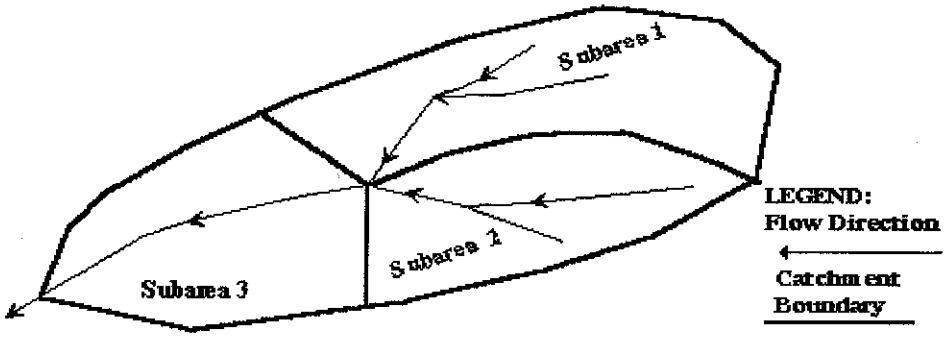
(CALCULATIONS)

CONDITION "PRIOR" TO RE-CONSTRUCTION

Area-Weighting for Runoff Coefficient Calculation

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition PRIOR to Re-Construction)

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres	Runoff Coeff.	Product
	A	C*	CA
input	input	input	output
Roof	8431.00	90.00	758790.00
Pavement	1063.00	100.00	106300.00
Gravel	15317.00	40.00	612680.00
Sum:	24811.00	Sum:	########

Area-Weighted Runoff Coefficient (sum CA/sum A) = 59.56

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

For catchments larger than 50 acres, CUHP hydrograph and routing are recommended.

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition PRIOR to Re-Construction) 2 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+37.84
Area = 0.57 Acres
Percent Imperviousness = 59.56 %
NRCS Soil Type = C A, B, C, or D

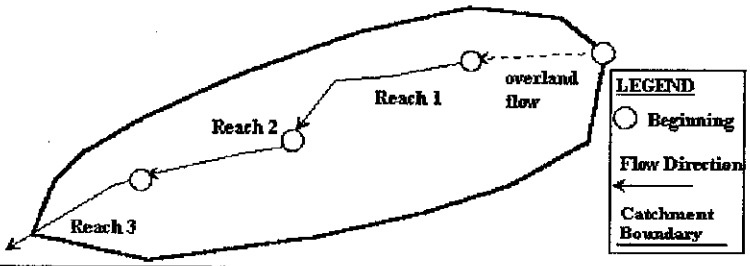
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	2 years	(input return period for design storm)
C1 =	28.50	(input the value of C1)
C2=	10.00	(input the value of C2)
C3=	0.786	(input the value of C3)
P1=	1.00 inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.40
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.45
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.45	N/A	0.13	6.68
1	0.0190	249		10.00	1.38	3.01
2	0.0034	38		10.00	0.59	1.08
3						
4						
5						
	Sum	338				

Computed Tc = 10.77
Regional Tc = 11.88
User-Entered Tc = 10.77

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	2.63 inch/hr	Peak Flowrate, Qp =	0.60 cfs
Rainfall Intensity at Regional Tc, I =	2.52 inch/hr	Peak Flowrate, Qp =	0.58 cfs
Rainfall Intensity at User-Defined Tc, I =	2.63 inch/hr	Peak Flowrate, Qp =	0.60 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition PRIOR to Re-Construction) 10 Year storm

I. Catchment Hydrologic Data

Catchment ID = 0+37.84
Area = 0.57 Acres
Percent Imperviousness = 59.56 %
NRCS Soil Type = C A, B, C, or D

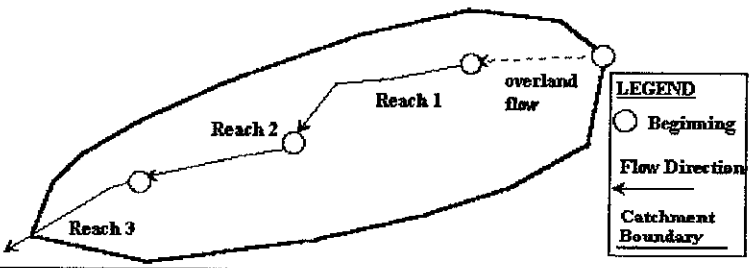
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 10 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.69 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.51
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.45
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.45	N/A	0.13	6.68
1	0.0190	249		10.00	1.38	3.01
2	0.0034	38		10.00	0.59	1.08
3						
4						
5						
	Sum	338				

Computed Tc = 10.77
Regional Tc = 11.88
User-Entered Tc = 10.77

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.44 inch/hr — Peak Flowrate, Qp = 1.28 cfs
Rainfall Intensity at Regional Tc, I = 4.26 inch/hr — Peak Flowrate, Qp = 1.23 cfs
Rainfall Intensity at User-Defined Tc, I = 4.44 inch/hr — Peak Flowrate, Qp = 1.28 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition PRIOR to Re-Construction) 100 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+37.84
Area = 0.57 Acres
Percent Imperviousness = 59.56 %
NRCS Soil Type = C A, B, C, or D

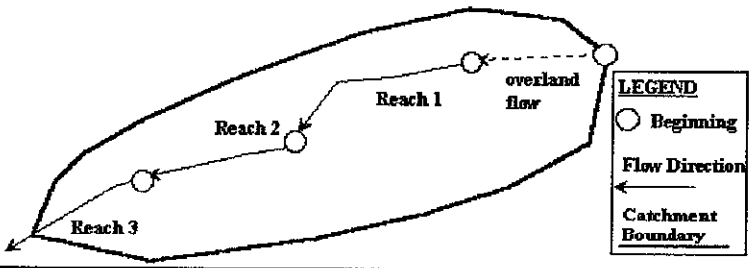
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.66 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.63
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.45
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.45	N/A	0.13	6.68
1	0.0190	249		10.00	1.38	3.01
2	0.0034	38		10.00	0.59	1.08
3						
4						
5						
	Sum	338				

Computed Tc = 10.77
Regional Tc = 11.88
User-Entered Tc = 10.77

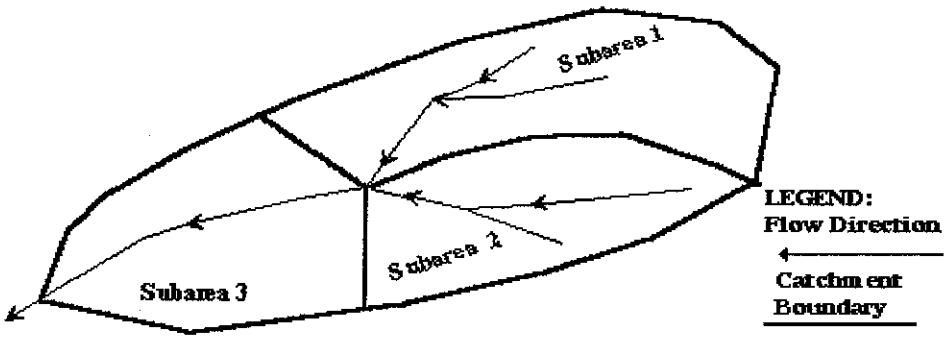
IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 6.99 inch/hr — Peak Flowrate, Qp = 2.51 cfs
Rainfall Intensity at Regional Tc, I = 6.71 inch/hr — Peak Flowrate, Qp = 2.41 cfs
Rainfall Intensity at User-Defined Tc, I = 6.99 inch/hr — Peak Flowrate, Qp = 2.51 cfs

Area-Weighting for Runoff Coefficient Calculation

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition PRIOR to Re-Construction)

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
Roof	10629.00	90.00	956610.00
Pavement	3398.00	100.00	339800.00
Gravel	17794.00	40.00	711760.00
Sum:	31821.00	Sum:	########

Area-Weighted Runoff Coefficient (sum CA/sum A) = 63.11

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

For catchments larger than 20 acres, UCHP hydrograph and routing are recommended.

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition PRIOR to Re-Construction) 2 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+93.1
Area = 0.73 Acres
Percent Imperviousness = 63.11 %
NRCS Soil Type = C A, B, C, or D

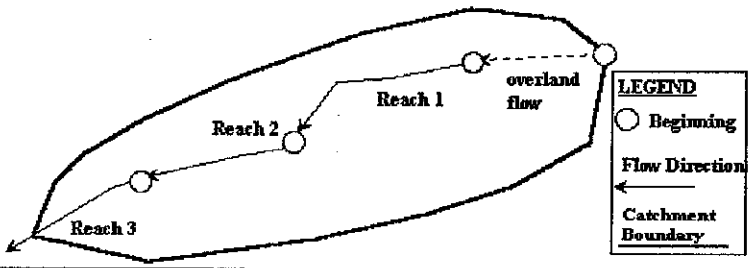
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 2 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.00 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.43
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.48
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.48	N/A	0.13	6.43
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3						
4						
5						
	Sum	393				

Computed Tc = 12.09
Regional Tc = 12.18
User-Entered Tc = 12.09

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.50 inch/hr — Peak Flowrate, Qp = 0.79 cfs
Rainfall Intensity at Regional Tc, I = 2.49 inch/hr — Peak Flowrate, Qp = 0.79 cfs
Rainfall Intensity at User-Defined Tc, I = 2.50 inch/hr — Peak Flowrate, Qp = 0.79 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition PRIOR to Re-Construction) 10 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+93.1
Area = 0.73 Acres
Percent Imperviousness = 63.11 %
NRCS Soil Type = C A, B, C, or D

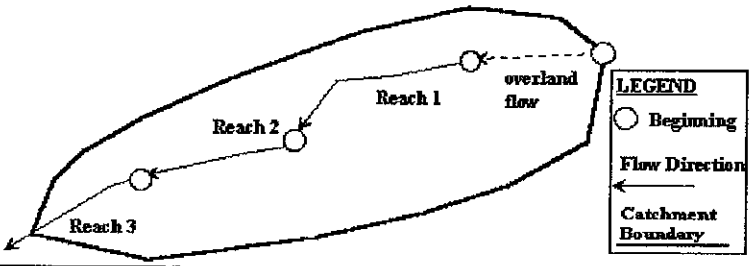
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 10 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.69 inches (input one-hr precipitation–see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.53
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.48
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.48	N/A	0.13	6.43
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3						
4						
5						
	Sum	393				

Computed Tc = 12.09
Regional Tc = 12.18
User-Entered Tc = 12.09

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.23 inch/hr — Peak Flowrate, Qp = 1.63 cfs
Rainfall Intensity at Regional Tc, I = 4.22 inch/hr — Peak Flowrate, Qp = 1.62 cfs
Rainfall Intensity at User-Defined Tc, I = 4.23 inch/hr — Peak Flowrate, Qp = 1.63 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition PRIOR to Re-Construction) 100 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+93.1
Area = 0.73 Acres
Percent Imperviousness = 63.11 %
NRCS Soil Type = C A, B, C, or D

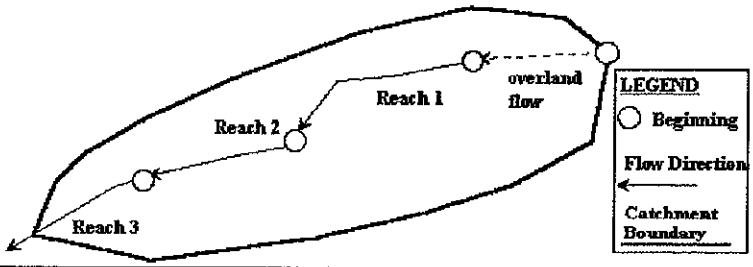
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100 years	(input return period for design storm)
C1 =	28.50	(input the value of C1)
C2=	10.00	(input the value of C2)
C3=	0.786	(input the value of C3)
P1=	2.66 inches	(input one-hr precipitation–see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.64
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.48
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.48	N/A	0.13	6.43
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3						
4						
5						
	Sum	393				

Computed Tc =	12.09
Regional Tc =	12.18
User-Entered Tc =	12.09

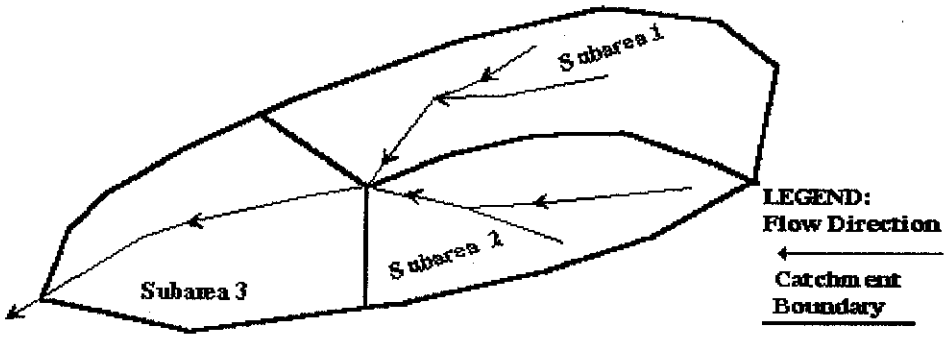
IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.66 inch/hr	Peak Flowrate, Qp =	3.14 cfs
Rainfall Intensity at Regional Tc, I =	6.63 inch/hr	Peak Flowrate, Qp =	3.13 cfs
Rainfall Intensity at User-Defined Tc, I =	6.66 inch/hr	Peak Flowrate, Qp =	3.14 cfs

Area-Weighting for Runoff Coefficient Calculation

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition PRIOR to Re-Construction)

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
Roof	14414.00	90.00	########
Pavement	7077.00	100.00	707700.00
Gravel	21025.00	40.00	841000.00
Sum:	42516.00	Sum:	########

Area-Weighted Runoff Coefficient (sum CA/sum A) = 66.94

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

For catchments larger than 50 acres, UHP hydrograph and routing are recommended.

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition PRIOR to Re-Construction) 2 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 1+76.4
Area = 0.98 Acres
Percent Imperviousness = 66.94 %
NRCS Soil Type = C A, B, C, or D

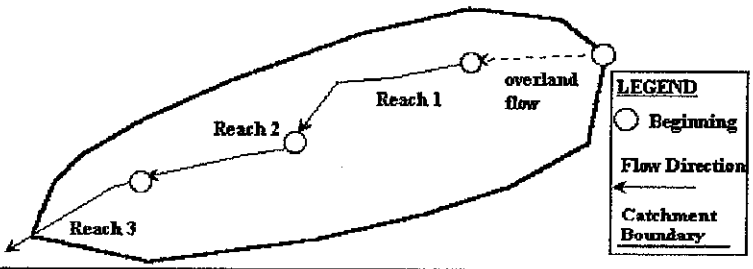
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 2 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.00 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.46
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.51
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.51	N/A	0.14	6.14
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3	0.0045	83		10.00	0.67	2.06
4						
5						
	Sum	476				

Computed Tc = 13.86
Regional Tc = 12.64
User-Entered Tc = 12.64

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.36 inch/hr — Peak Flowrate, Qp = 1.06 cfs
Rainfall Intensity at Regional Tc, I = 2.45 inch/hr — Peak Flowrate, Qp = 1.11 cfs
Rainfall Intensity at User-Defined Tc, I = 2.45 inch/hr — Peak Flowrate, Qp = 1.11 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition PRIOR to Re-Construction) 10 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 1+76.4
Area = 0.98 Acres
Percent Imperviousness = 66.94 %
NRCS Soil Type = C A, B, C, or D

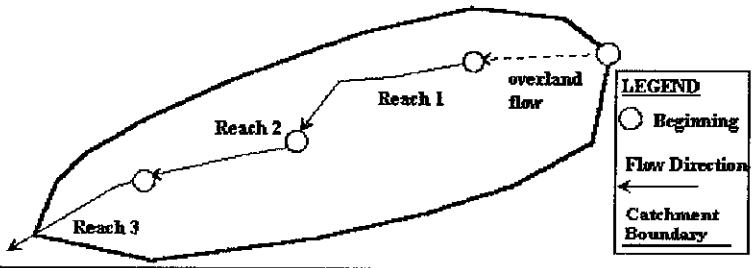
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 10 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.69 inches (input one-hr precipitation—see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.55
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.51
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.51	N/A	0.14	6.14
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3	0.0045	83		10.00	0.67	2.06
4						
5						
	Sum	476				

Computed Tc = 13.86
Regional Tc = 12.64
User-Entered Tc = 12.64

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 3.98 inch/hr — Peak Flowrate, Qp = 2.15 cfs
Rainfall Intensity at Regional Tc, I = 4.15 inch/hr — Peak Flowrate, Qp = 2.24 cfs
Rainfall Intensity at User-Defined Tc, I = 4.15 inch/hr — Peak Flowrate, Qp = 2.24 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition PRIOR to Re-Construction) 100 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 1+76.4
Area = 0.98 Acres
Percent Imperviousness = 66.94 %
NRCS Soil Type = C A, B, C, or D

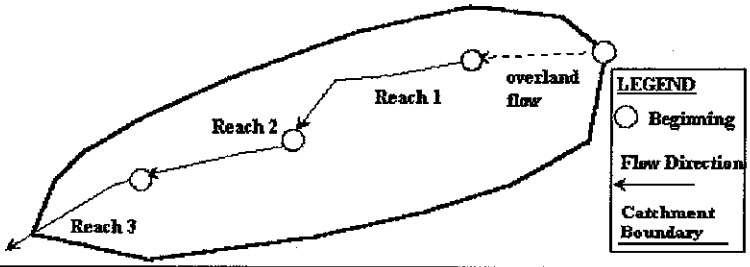
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.66	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.66
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.51
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.51	N/A	0.14	6.14
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3	0.0045	83		10.00	0.67	2.06
4						
5						
	Sum	476				

Computed Tc =	13.86
Regional Tc =	12.64
User-Entered Tc =	12.64

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.26 inch/hr	Peak Flowrate, Qp =	4.05 cfs
Rainfall Intensity at Regional Tc, I =	6.53 inch/hr	Peak Flowrate, Qp =	4.22 cfs
Rainfall Intensity at User-Defined Tc, I =	6.53 inch/hr	Peak Flowrate, Qp =	4.22 cfs

0+37.84 PRIOR to Reconstruction
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\mmw.fm2
Worksheet	0+37.84 PRIOR Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.004000	ft/ft
Elevation range: 4,930.15 ft to 4,933.80 ft.		

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,933.80	0.00	41.80	0.015
8.00	4,933.00	41.80	77.00	0.027
26.45	4,932.00			
41.80	4,931.15			
64.00	4,930.15			
77.00	4,930.35			

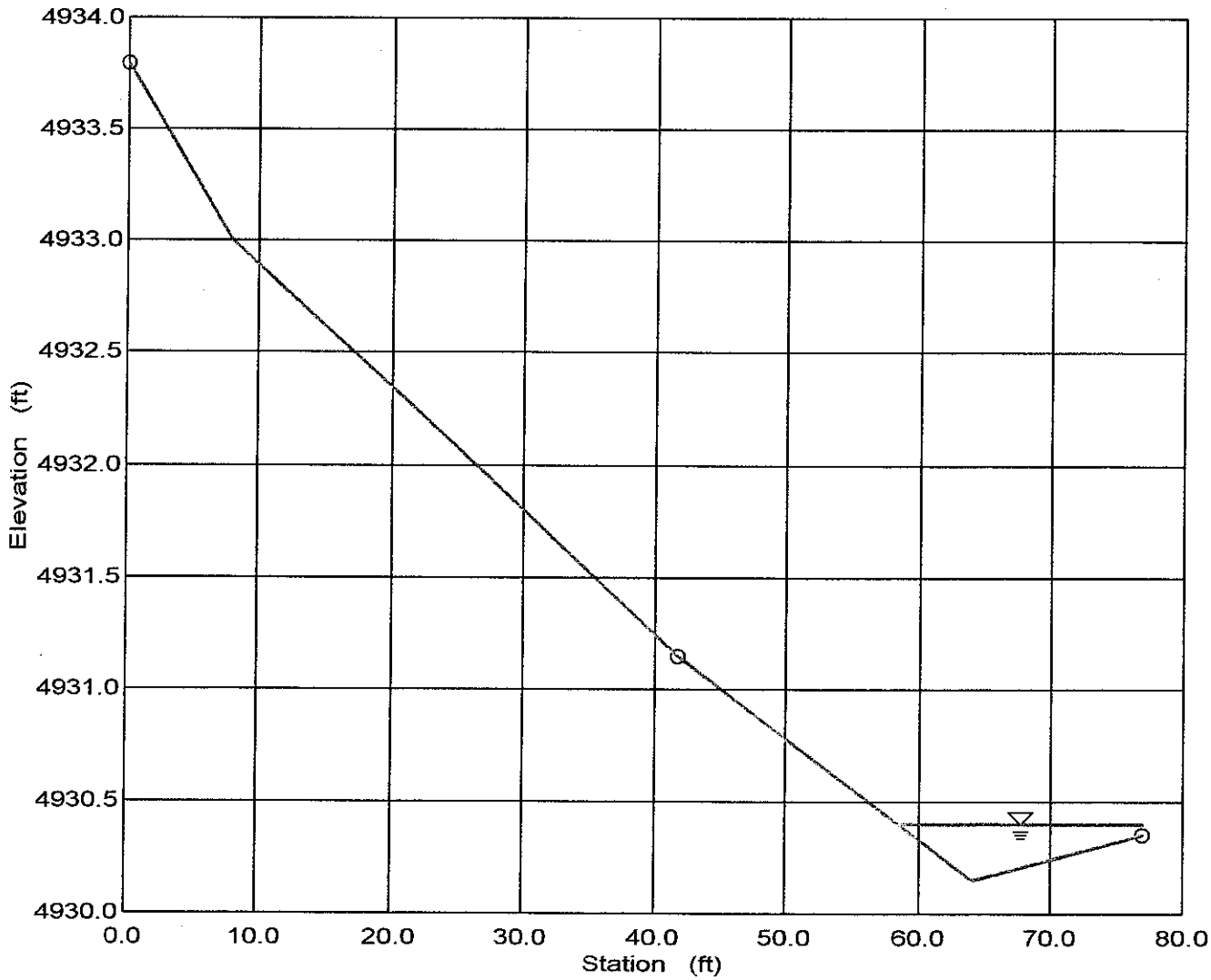
Discharge	2.51	cfs

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.40	ft
Flow Area	2.65	ft²
Wetted Perimeter	18.61	ft
Top Width	18.55	ft
Height	0.25	ft
Critical Depth	4,930.33	ft
Critical Slope	0.023579	ft/ft
Velocity	0.95	ft/s
Velocity Head	0.01	ft
Specific Energy	4,930.41	ft
Froude Number	0.44	
Flow is subcritical.		
Water elevation exceeds lowest end station by 0.05 ft.		

0+37.84 PRIOR 100 Year
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\mmw.fm2
Worksheet	0+37.84 PRIOR Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.40	ft
Discharge	2.51	cfs



0+93.1 PRIOR to Reconstruction
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\mmw.fm2
Worksheet	0+93.1 PRIOR Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

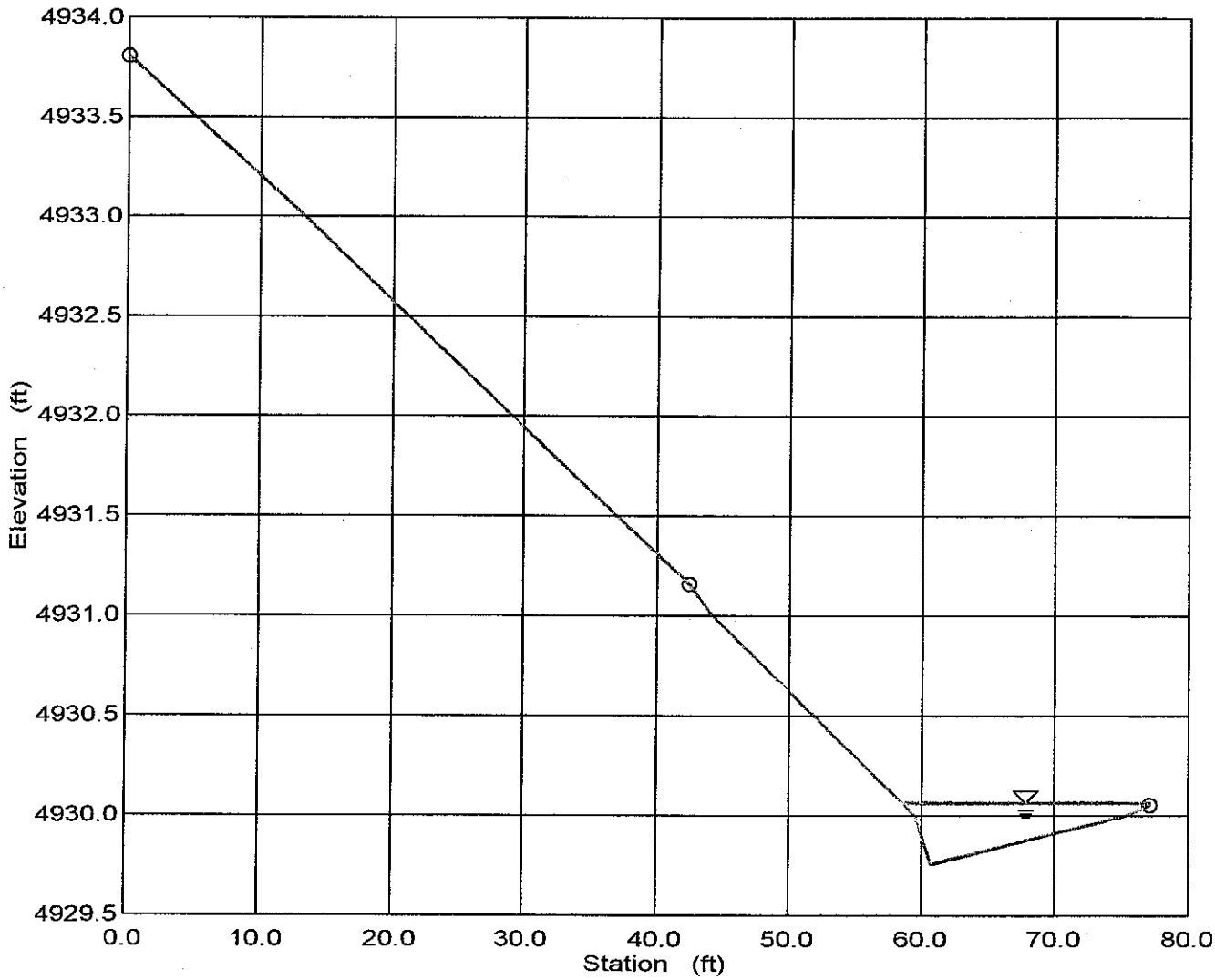
Input Data				
Channel Slope	0.004000 ft/ft			
Elevation range: 4,929.75 ft to 4,933.80 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,933.80	0.00	42.50	0.015
13.35	4,933.00	42.50	77.20	0.027
29.10	4,932.00			
42.50	4,931.15			
44.15	4,931.00			
59.50	4,930.00			
60.75	4,929.75			
75.30	4,930.00			
77.20	4,930.05			
Discharge	3.14 cfs			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.06	ft
Flow Area	3.03	ft^2
Wetted Perimeter	18.67	ft
Top Width	18.63	ft
Height	0.31	ft
Critical Depth	4,929.98	ft
Critical Slope	0.021964	ft/ft
Velocity	1.04	ft/s
Velocity Head	0.02	ft
Specific Energy	4,930.08	ft
Froude Number	0.45	
Flow is subcritical.		
Water elevation exceeds lowest end station by 0.01 ft.		

0+93.1 PRIOR 100 Year
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\mmw.fm2
Worksheet	0+93.1 PRIOR Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.06	ft
Discharge	3.14	cfs



1+76.4 PRIOR to Reconstruction
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\mmw.fm2
Worksheet	1+76.4 PRIOR Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.004000	ft/ft
Elevation range: 4,929.80 ft to 4,933.80 ft.		

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,933.80	0.00	44.00	0.015
7.45	4,933.00	44.00	77.10	0.027
21.20	4,932.00			
35.00	4,931.00			
44.00	4,930.03			
60.00	4,929.80			
77.10	4,930.40			

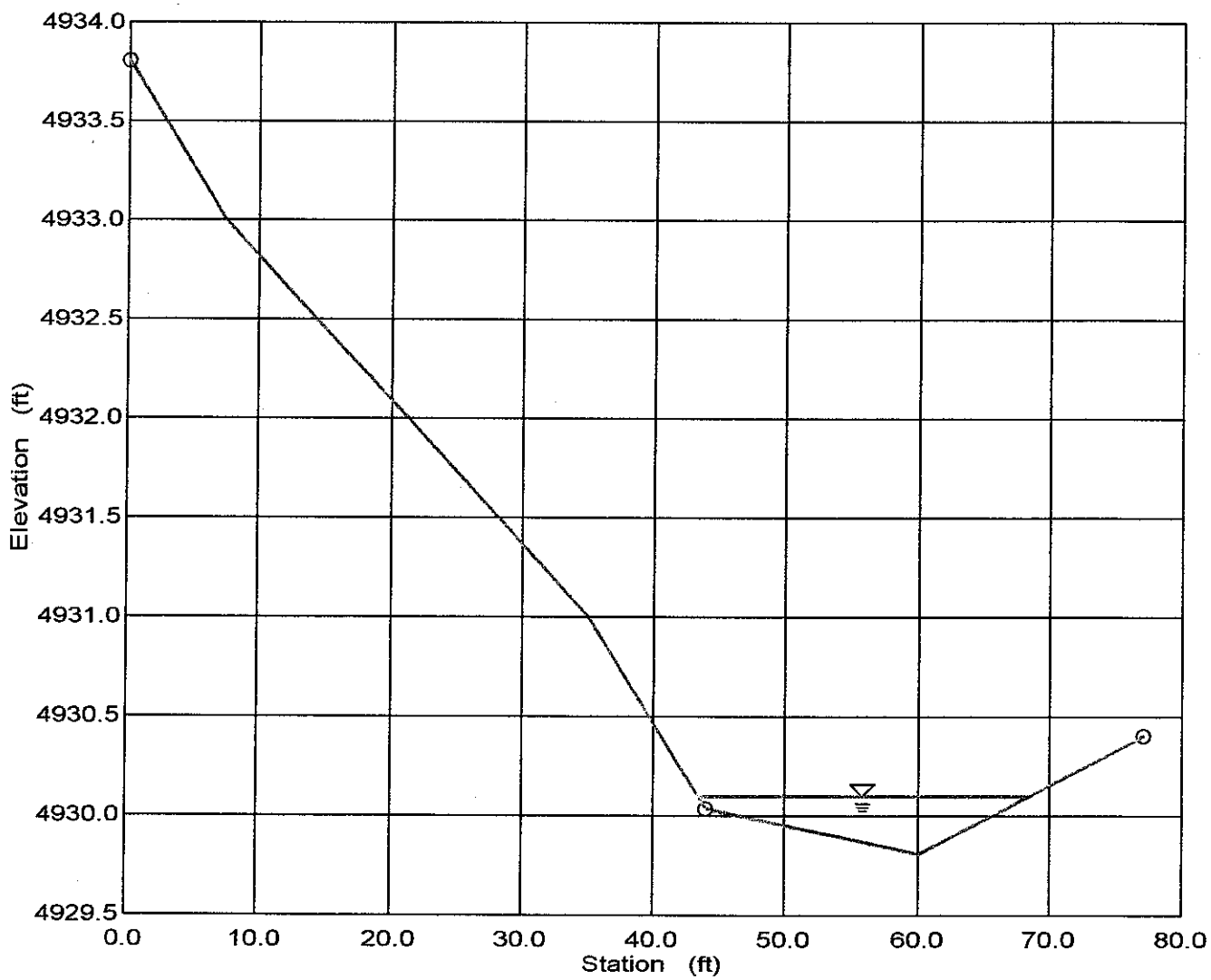
Discharge	4.22	cfs

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.09	ft
Flow Area	4.03	ft²
Wetted Perimeter	24.86	ft
Top Width	24.85	ft
Height	0.29	ft
Critical Depth	4,930.02	ft
Critical Slope	0.022345	ft/ft
Velocity	1.05	ft/s
Velocity Head	0.02	ft
Specific Energy	4,930.11	ft
Froude Number	0.46	
Flow is subcritical.		

1+76.4 PRIOR 100 Year
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\mmw.fm2
Worksheet	1+76.4 PRIOR Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.09	ft
Discharge	4.22	cfs

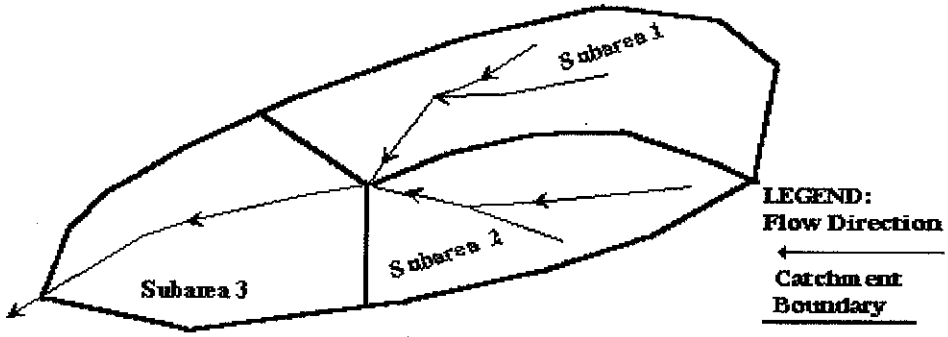


CONDITION "EXISTING" AFTER RE-CONSTRUCTION

Area-Weighting for Runoff Coefficient Calculation

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition EXISTING after Re-Construction)

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
Roof	8104.00	90.00	729360.00
Pavement	994.00	100.00	99400.00
Gravel	13244.00	40.00	529760.00
Sum:	22342.00	Sum:	########

Area-Weighted Runoff Coefficient (sum CA/sum A) = 60.81

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

For catchments larger than 50 acres, CUHP hydrograph and routing are recommended.

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition EXISTING after Re-Construction) 2 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+37.84
Area = 0.51 Acres
Percent Imperviousness = 60.81 %
NRCS Soil Type = C A, B, C, or D

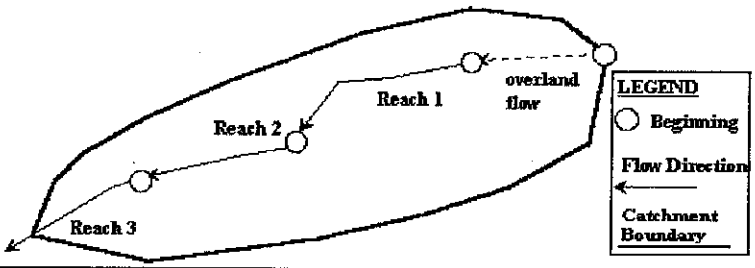
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 2 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.00 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.41
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.46
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.46	N/A	0.13	6.60
1	0.0190	249		10.00	1.38	3.01
2	0.0034	38		10.00	0.59	1.08
3						
4						
5						
	Sum	338				

Computed Tc = 10.69
Regional Tc = 11.88
User-Entered Tc = 10.69

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.63 inch/hr — Peak Flowrate, Qp = 0.56 cfs
Rainfall Intensity at Regional Tc, I = 2.52 inch/hr — Peak Flowrate, Qp = 0.53 cfs
Rainfall Intensity at User-Defined Tc, I = 2.63 inch/hr — Peak Flowrate, Qp = 0.56 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition EXISTING after Re-Construction) 10 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+37.84
Area = 0.51 Acres
Percent Imperviousness = 60.81 %
NRCS Soil Type = C A, B, C, or D

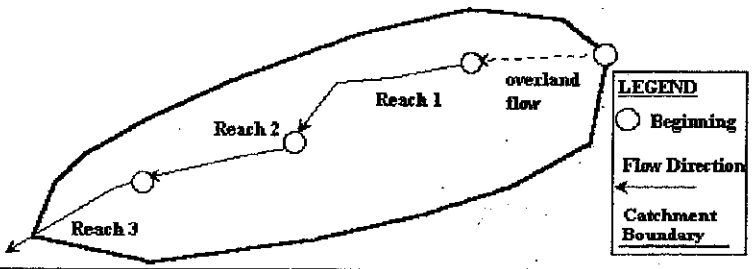
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 10 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.69 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.51
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.46
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.46	N/A	0.13	6.60
1	0.0190	249		10.00	1.38	3.01
2	0.0034	38		10.00	0.59	1.08
3						
4						
5						
	Sum	338				

Computed Tc = 10.69
Regional Tc = 11.88
User-Entered Tc = 10.69

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.45 inch/hr — Peak Flowrate, Qp = 1.17 cfs
Rainfall Intensity at Regional Tc, I = 4.26 inch/hr — Peak Flowrate, Qp = 1.12 cfs
Rainfall Intensity at User-Defined Tc, I = 4.45 inch/hr — Peak Flowrate, Qp = 1.17 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+37.84 (Condition EXISTING after Re-Construction) 100 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+37.84
Area = 0.51 Acres
Percent Imperviousness = 60.81 %
NRCS Soil Type = C A, B, C, or D

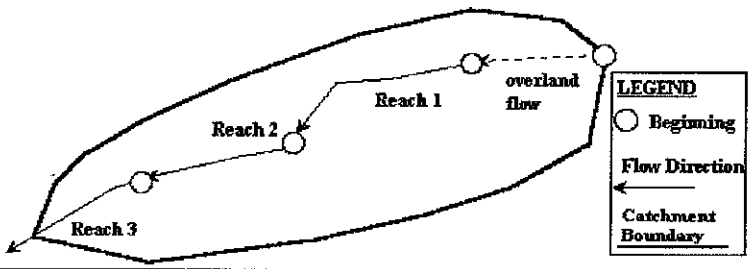
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.66 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.64
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.46
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.46	N/A	0.13	6.60
1	0.0190	249		10.00	1.38	3.01
2	0.0034	38		10.00	0.59	1.08
3						
4						
5						
	Sum	338				

Computed Tc = 10.69
Regional Tc = 11.88
User-Entered Tc = 10.69

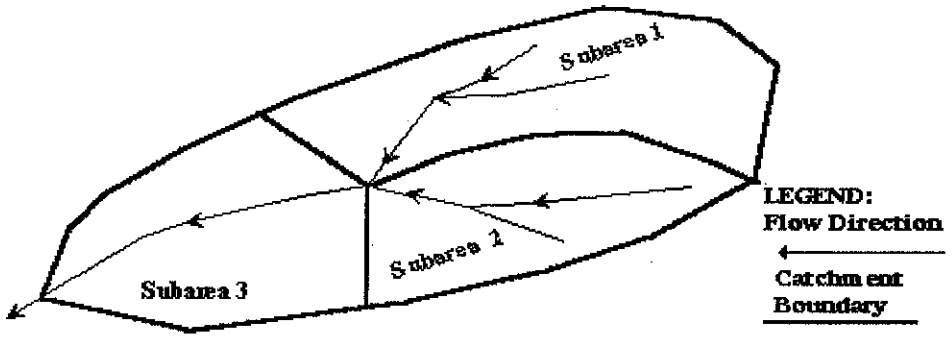
IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 7.01 inch/hr — Peak Flowrate, Qp = 2.29 cfs
Rainfall Intensity at Regional Tc, I = 6.71 inch/hr — Peak Flowrate, Qp = 2.19 cfs
Rainfall Intensity at User-Defined Tc, I = 7.01 inch/hr — Peak Flowrate, Qp = 2.29 cfs

Area-Weighting for Runoff Coefficient Calculation

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition EXISTING after Re-Construction)

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
Roof	9024.00	90.00	812160.00
Pavement	994.00	100.00	99400.00
Gravel	15721.00	40.00	628840.00
Sum:	25739.00	Sum:	########

Area-Weighted Runoff Coefficient (sum CA/sum A) = 59.85

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

For catchments larger than 30 acres, CUHP hydrograph and routing are recommended.

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition EXISTING after Re-Construction) 2 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+93.1
Area = 0.59 Acres
Percent Imperviousness = 59.85 %
NRCS Soil Type = C A, B, C, or D

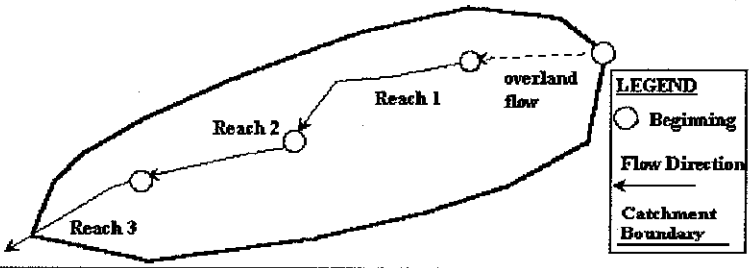
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 2 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.00 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.41
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.46
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.46	N/A	0.13	6.66
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3						
4						
5						
	Sum	393				

Computed Tc = 12.32
Regional Tc = 12.18
User-Entered Tc = 12.18

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.48 inch/hr — Peak Flowrate, Qp = 0.59 cfs
Rainfall Intensity at Regional Tc, I = 2.49 inch/hr — Peak Flowrate, Qp = 0.60 cfs
Rainfall Intensity at User-Defined Tc, I = 2.49 inch/hr — Peak Flowrate, Qp = 0.60 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition EXISTING after Re-Construction) 10 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+93.1
Area = 0.59 Acres
Percent Imperviousness = 59.85 %
NRCS Soil Type = C A, B, C, or D

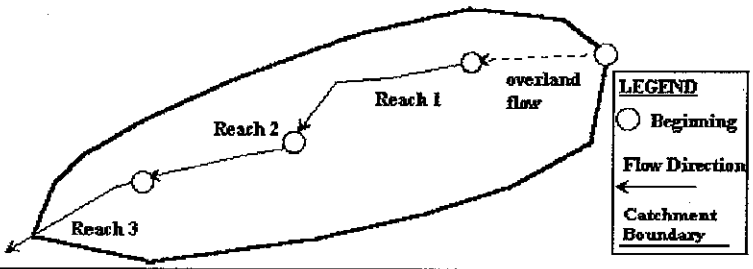
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 10 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.69 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.51
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.46
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.46	N/A	0.13	6.66
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3						
4						
5						
	Sum	393				

Computed Tc = 12.32
Regional Tc = 12.18
User-Entered Tc = 12.18

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.19 inch/hr — Peak Flowrate, Qp = 1.26 cfs
Rainfall Intensity at Regional Tc, I = 4.22 inch/hr — Peak Flowrate, Qp = 1.27 cfs
Rainfall Intensity at User-Defined Tc, I = 4.22 inch/hr — Peak Flowrate, Qp = 1.27 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 0+93.1 (Condition EXISTING after Re-Construction) 100 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 0+93.1
Area = 0.59 Acres
Percent Imperviousness = 59.85 %
NRCS Soil Type = C A, B, C, or D

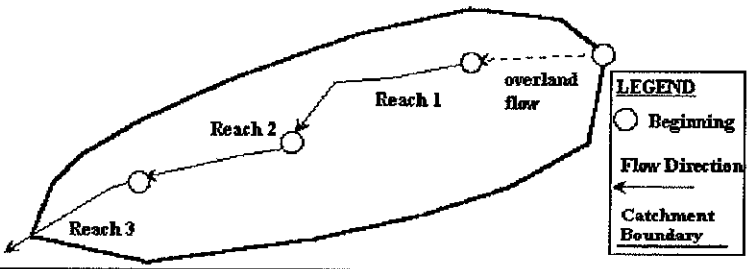
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100 years	(input return period for design storm)
C1 =	28.50	(input the value of C1)
C2=	10.00	(input the value of C2)
C3=	0.786	(input the value of C3)
P1=	2.66 inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.63
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.46
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.46	N/A	0.13	6.66
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3						
4						
5						
	Sum	393				

Computed Tc =	12.32
Regional Tc =	12.18
User-Entered Tc =	12.18

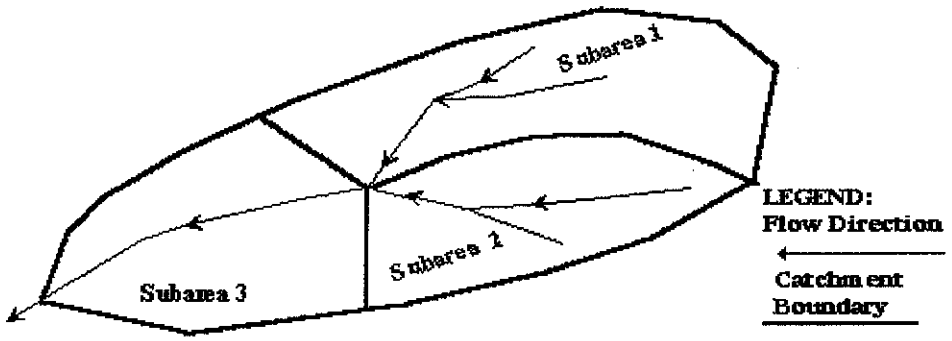
IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.60 inch/hr	Peak Flowrate, Qp =	2.47 cfs
Rainfall Intensity at Regional Tc, I =	6.63 inch/hr	Peak Flowrate, Qp =	2.48 cfs
Rainfall Intensity at User-Defined Tc, I =	6.63 inch/hr	Peak Flowrate, Qp =	2.48 cfs

Area-Weighting for Runoff Coefficient Calculation

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition EXISTING after Re-Construction)

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
Roof	10709.00	90.00	963810.00
Pavement	994.00	100.00	99400.00
Gravel	18952.00	40.00	758080.00
Sum:	30655.00	Sum:	########

Area-Weighted Runoff Coefficient (sum CA/sum A) = 59.41

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

For catchments larger than 50 acres, SCHP hydrograph and routing are recommended.

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition EXISTING after Re-Construction) 2 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 1+76.4
Area = 0.70 Acres
Percent Imperviousness = 59.41 %
NRCS Soil Type = C A, B, C, or D

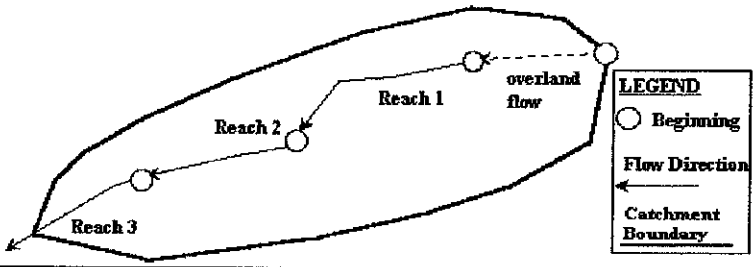
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 2 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.00 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.40
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.45
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.45	N/A	0.13	6.69
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3	0.0045	83		10.00	0.67	2.06
4						
5						
	Sum	476				

Computed Tc = 14.41
Regional Tc = 12.64
User-Entered Tc = 12.64

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.31 inch/hr — Peak Flowrate, Qp = 0.65 cfs
Rainfall Intensity at Regional Tc, I = 2.45 inch/hr — Peak Flowrate, Qp = 0.69 cfs
Rainfall Intensity at User-Defined Tc, I = 2.45 inch/hr — Peak Flowrate, Qp = 0.69 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition EXISTING after Re-Construction) 10 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 1+76.4
Area = 0.70 Acres
Percent Imperviousness = 59.41 %
NRCS Soil Type = C A, B, C, or D

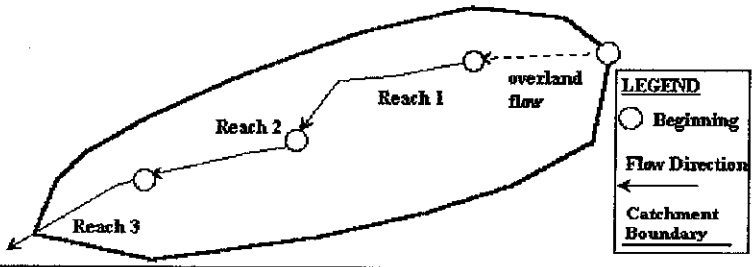
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 10 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.69 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.51
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.45
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.45	N/A	0.13	6.69
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3	0.0045	83		10.00	0.67	2.06
4						
5						
	Sum	476				

Computed Tc = 14.41
Regional Tc = 12.64
User-Entered Tc = 12.64

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 3.91 inch/hr — Peak Flowrate, Qp = 1.39 cfs
Rainfall Intensity at Regional Tc, I = 4.15 inch/hr — Peak Flowrate, Qp = 1.48 cfs
Rainfall Intensity at User-Defined Tc, I = 4.15 inch/hr — Peak Flowrate, Qp = 1.48 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: MASTER METAL WORKS - 204 12th Street SE
Catchment ID: 1+76.4 (Condition EXISTING after Re-Construction) 100 Year Storm

I. Catchment Hydrologic Data

Catchment ID = 1+76.4
Area = 0.70 Acres
Percent Imperviousness = 59.41 %
NRCS Soil Type = C A, B, C, or D

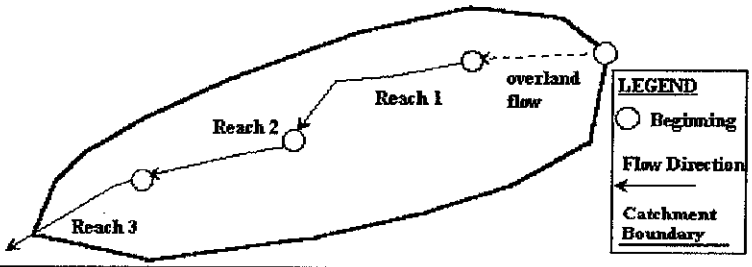
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.66 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.63
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.45
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0195	51	0.45	N/A	0.13	6.69
1	0.0190	249		10.00	1.38	3.01
2	0.0034	93		10.00	0.59	2.64
3	0.0045	83		10.00	0.67	2.06
4						
5						
	Sum	476				

Computed Tc = 14.41
Regional Tc = 12.64
User-Entered Tc = 12.64

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 6.15 inch/hr — Peak Flowrate, Qp = 2.73 cfs
Rainfall Intensity at Regional Tc, I = 6.53 inch/hr — Peak Flowrate, Qp = 2.90 cfs
Rainfall Intensity at User-Defined Tc, I = 6.53 inch/hr — Peak Flowrate, Qp = 2.90 cfs

0+37.84 EXISTING after Reconstruction
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	Sta. 0+37.84 EXISTING Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

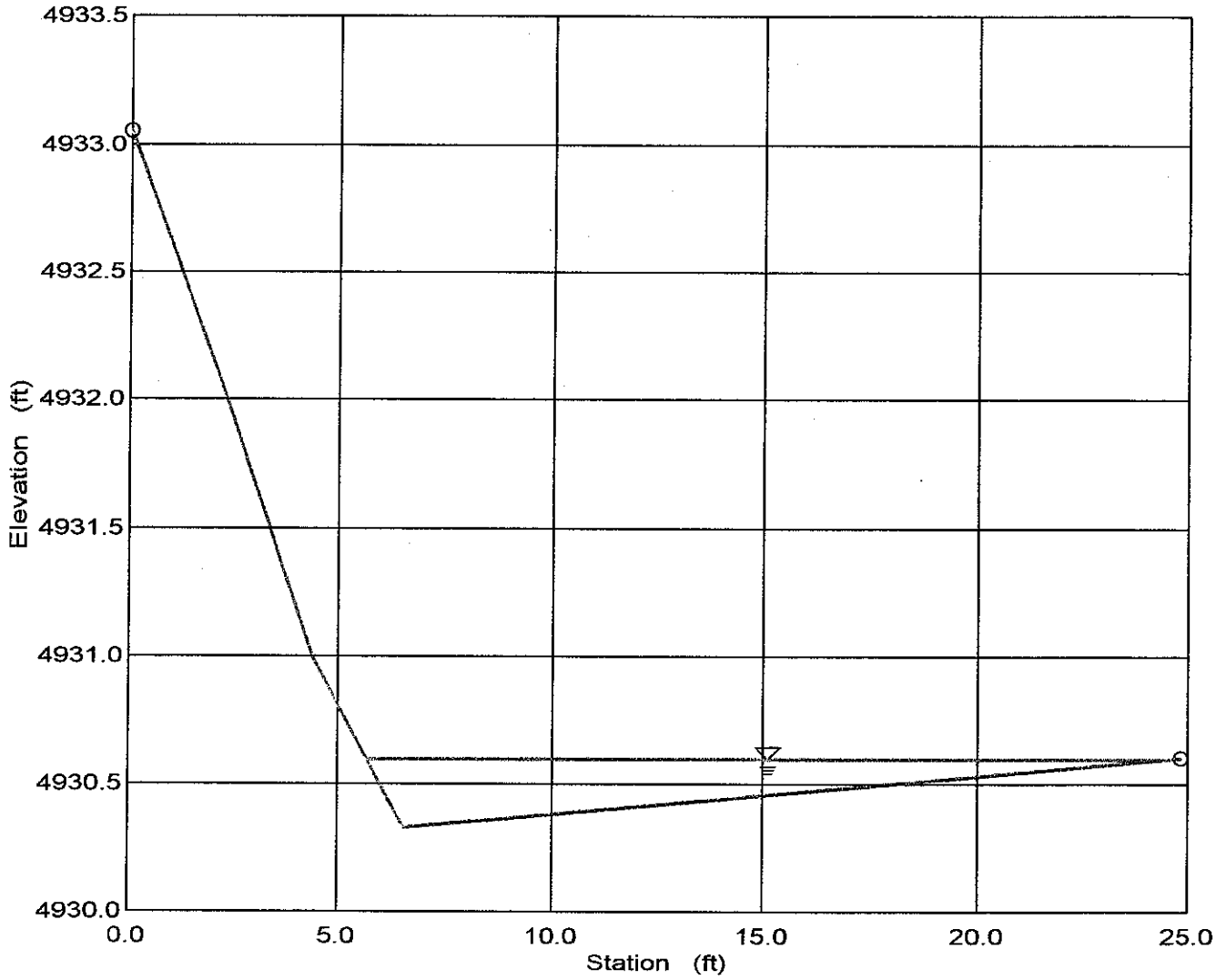
Input Data				
Channel Slope	0.004000 ft/ft			
Elevation range: 4,930.33 ft to 4,933.05 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,933.05	0.00	24.85	0.027
2.35	4,932.00			
4.35	4,931.00			
6.50	4,930.33			
24.85	4,930.60			
Discharge	2.29 cfs			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.60	ft
Flow Area	2.53	ft²
Wetted Perimeter	19.00	ft
Top Width	18.96	ft
Height	0.27	ft
Critical Depth	4,930.52	ft
Critical Slope	0.023287	ft/ft
Velocity	0.91	ft/s
Velocity Head	0.01	ft
Specific Energy	4,930.61	ft
Froude Number	0.44	
Flow is subcritical.		

0+37.84 EXISTING 100 YEAR
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	Sta. 0+37.84 EXISTING Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.60	ft
Discharge	2.29	cfs



0+37.84 EXISTING w/ Freeboard
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	Sta. 0+37.84 EXISTING w/ freeboard
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

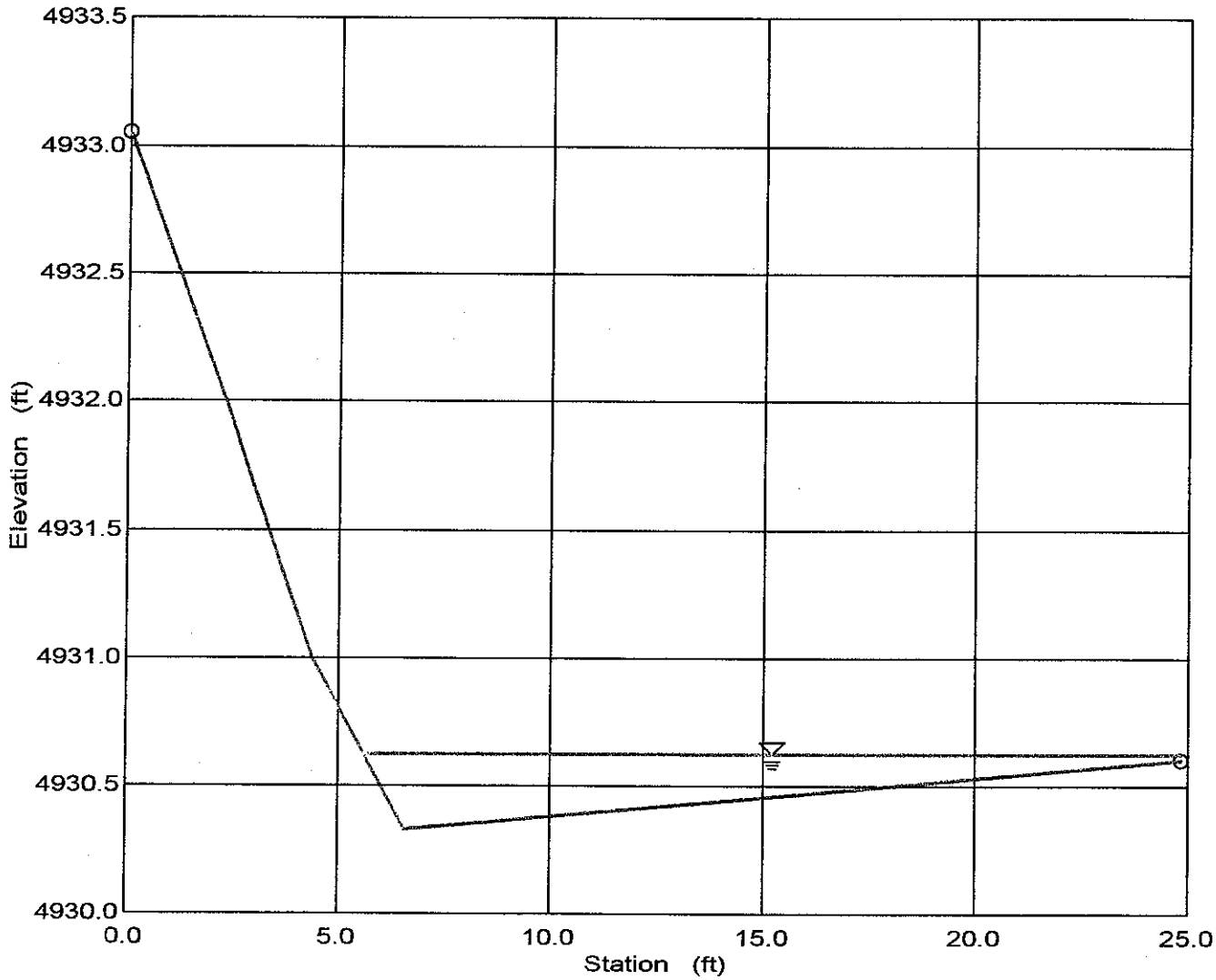
Input Data				
Channel Slope	0.004000 ft/ft			
Elevation range: 4,930.33 ft to 4,933.05 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,933.05	0.00	24.85	0.027
2.35	4,932.00			
4.35	4,931.00			
6.50	4,930.33			
24.85	4,930.60			
Discharge	3.05 cfs			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.62	ft
Flow Area	3.02	ft²
Wetted Perimeter	19.36	ft
Top Width	19.29	ft
Height	0.29	ft
Critical Depth	4,930.54	ft
Critical Slope	0.022417	ft/ft
Velocity	1.01	ft/s
Velocity Head	0.02	ft
Specific Energy	4,930.64	ft
Froude Number	0.45	
Flow is subcritical.		
Water elevation exceeds lowest end station by 0.02 ft.		

0+37.84 EXISTING 100 x 1.33
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	Sta. 0+37.84 EXISTING w/ freeboard
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.62	ft
Discharge	3.05	cfs



0+93.1 EXISTING after Reconstruction
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	0+93.1 EXISTING Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

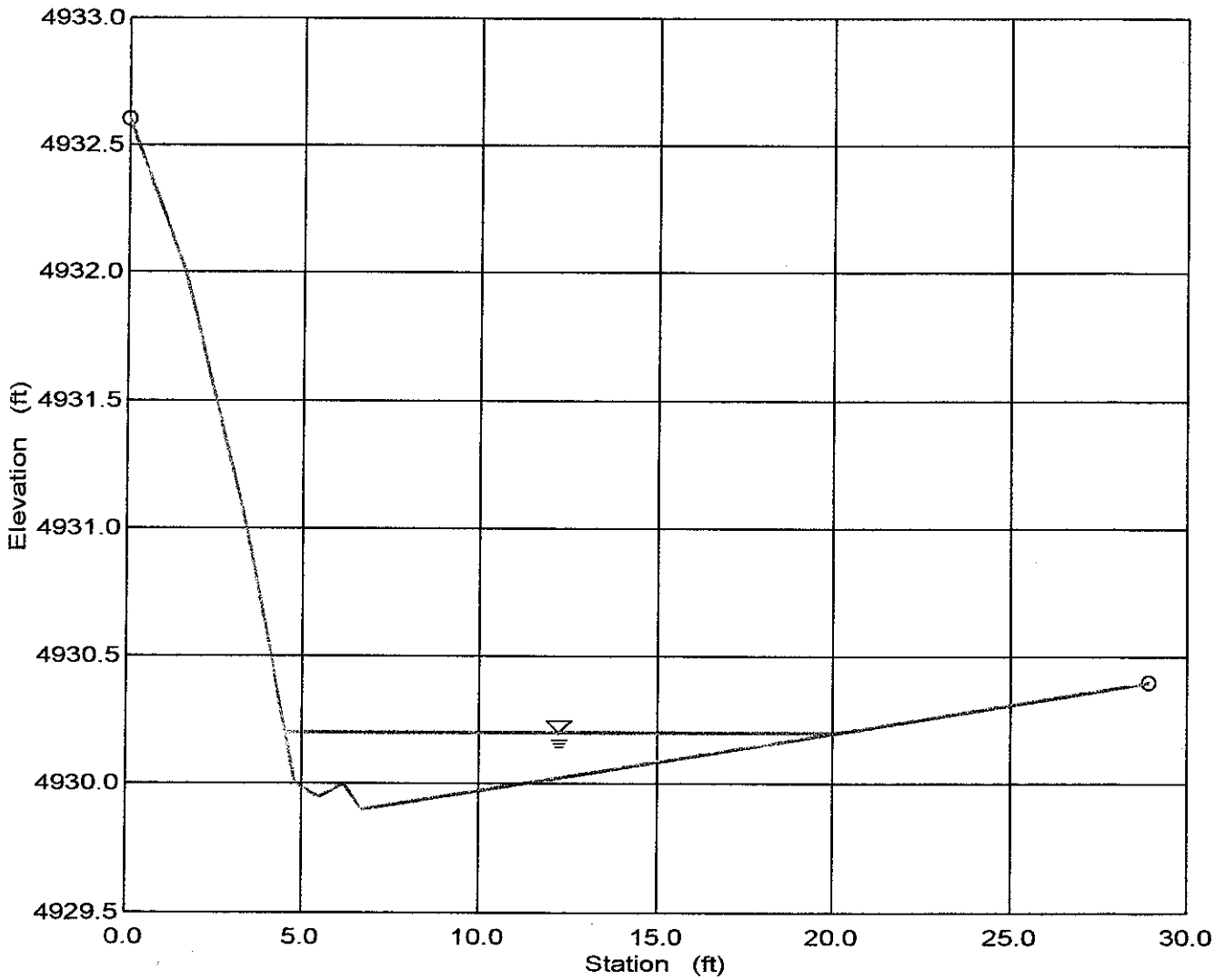
Input Data					
Channel Slope	0.004000 ft/ft				
Elevation range: 4,929.90 ft to 4,932.60 ft.					
Station (ft)	Elevation (ft)		Start Station	End Station	Roughness
0.00	4,932.60		0.00	28.95	0.027
1.60	4,932.00				
3.40	4,931.00				
4.80	4,930.00				
5.50	4,929.95				
6.20	4,930.00				
6.70	4,929.90				
28.95	4,930.40				
Discharge	2.48	cfs			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.20	ft
Flow Area	2.44	ft²
Wetted Perimeter	15.53	ft
Top Width	15.45	ft
Height	0.30	ft
Critical Depth	4,930.11	ft
Critical Slope	0.022131	ft/ft
Velocity	1.01	ft/s
Velocity Head	0.02	ft
Specific Energy	4,930.21	ft
Froude Number	0.45	
Flow is subcritical.		

0+93.1 EXISTING 100 Year
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	0+93.1 EXISTING Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.20	ft
Discharge	2.48	cfs



0+93.1 EXISTING w/ Freeboard
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	0+93.1 EXISTING w/ freeboard
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

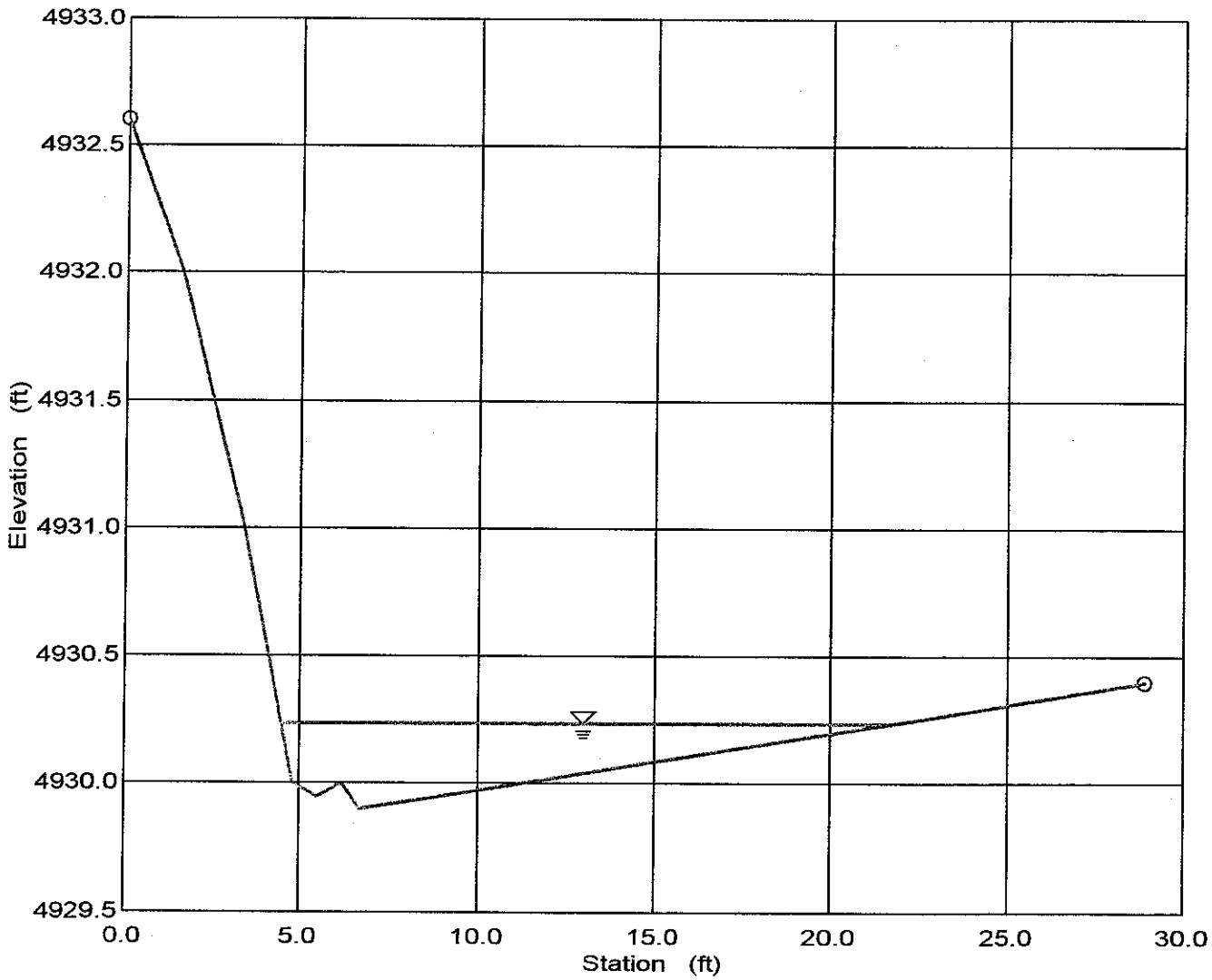
Input Data				
Channel Slope	0.004000 ft/ft			
Elevation range: 4,929.90 ft to 4,932.60 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,932.60	0.00	28.95	0.027
1.60	4,932.00			
3.40	4,931.00			
4.80	4,930.00			
5.50	4,929.95			
6.20	4,930.00			
6.70	4,929.90			
28.95	4,930.40			
Discharge	3.30 cfs			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,930.23	ft
Flow Area	3.02	ft²
Wetted Perimeter	17.17	ft
Top Width	17.08	ft
Height	0.33	ft
Critical Depth	4,930.14	ft
Critical Slope	0.021250	ft/ft
Velocity	1.09	ft/s
Velocity Head	0.02	ft
Specific Energy	4,930.25	ft
Froude Number	0.46	
Flow is subcritical.		

0+93.1 EXISTING 100 Year x 1.33
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	0+93.1 EXISTING w/ freeboard
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,930.23	ft
Discharge	3.30	cfs



1+76.4 EXISTING after Reconstruction
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	1+76.4 EXISTING Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

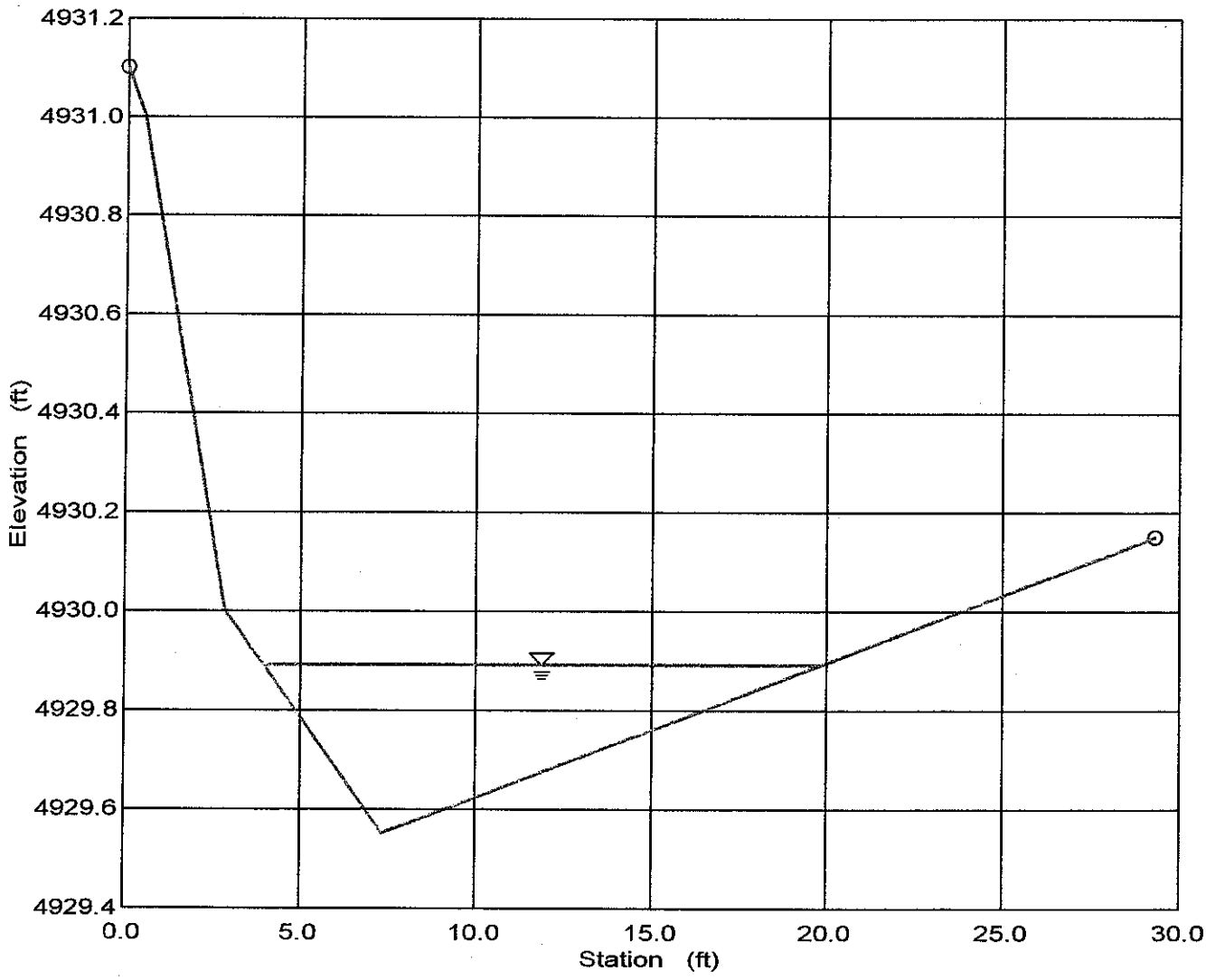
Input Data				
Channel Slope	0.004000 ft/ft			
Elevation range: 4,929.55 ft to 4,931.10 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,931.10	0.00	29.35	0.027
0.50	4,931.00			
2.85	4,930.00			
7.35	4,929.55			
29.35	4,930.15			
Discharge	2.90 cfs			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,929.89	ft
Flow Area	2.71	ft^2
Wetted Perimeter	15.93	ft
Top Width	15.91	ft
Height	0.34	ft
Critical Depth	4,929.80	ft
Critical Slope	0.021308	ft/ft
Velocity	1.07	ft/s
Velocity Head	0.02	ft
Specific Energy	4,929.91	ft
Froude Number	0.46	
Flow is subcritical.		

1+76.4 EXISTING 100 Year
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	1+76.4 EXISTING Condition
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,929.89	ft
Discharge	2.90	cfs



1+76.4 EXISTING w/ Freeboard
Worksheet for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	1+76.4 EXISTING w/ freeboard
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.004000	ft/ft
Elevation range: 4,929.55 ft to 4,931.10 ft.		
Discharge	3.85	cfs

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	4,931.10	0.00	29.35	0.027
0.50	4,931.00			
2.85	4,930.00			
7.35	4,929.55			
29.35	4,930.15			

Results		
Wtd. Mannings Coefficient	0.027	
Water Surface Elevation	4,929.93	ft
Flow Area	3.35	ft²
Wetted Perimeter	17.72	ft
Top Width	17.69	ft
Height	0.38	ft
Critical Depth	4,929.83	ft
Critical Slope	0.020518	ft/ft
Velocity	1.15	ft/s
Velocity Head	0.02	ft
Specific Energy	4,929.95	ft
Froude Number	0.46	
Flow is subcritical.		

1+76.4 EXISTING 100 x 1.33
Cross Section for Irregular Channel

Project Description	
Project File	c:\program files\haestad\academic\fmw\master m.fm2
Worksheet	1+76.4 EXISTING w/ freeboard
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.027	
Channel Slope	0.004000	ft/ft
Water Surface Elevation	4,929.93	ft
Discharge	3.85	cfs