

TECHNICAL DRAINAGE STUDY UPDATE

**Skye Canyon
(Phase 2 Infrastructure)**

City of Las Vegas, Nevada

Job No.: OLY1501.001

Date: April 2016

Prepared By:

Slater Hanifan Group, Inc.
5740 S. Arville Street, Suite 216
Las Vegas, Nevada 89118
Phone: 702-284-5300 • Fax: 702-284-5399

Prepared For:

Ninety-Five Management, LLC
11411 Southern Highlands Parkway, Suite 300
Las Vegas, NV 89141
Phone: 702-220-6565 • Fax: 702-220-6566



Stanley Okey Amadi, P.E.
NV Professional Engineer No. 21724

Assisted by: Erick Mata, E.I

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL
DRAINAGE STUDY INFORMATION FORM

Name of Development: Skye Canyon – Phase 2 Infrastructure Update Date: April 2016
Location of Development: a) Descriptive (Cross Streets): North/South: Hualapai Way
East/West: Grand Teton Drive
b) Section: 12 Township: 19 South Range: 59 East
c) APN: Portion of 126-12-000-001

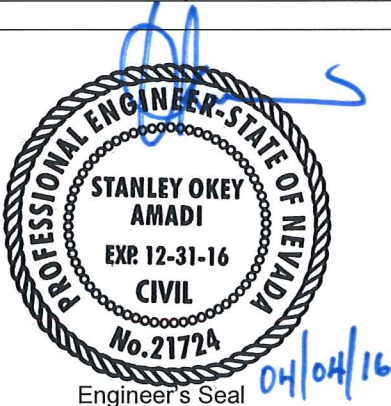
Name of Owner/Developer: Section 12, LLC / Ninety-Five Management, LLC
Telephone No.: 702-220-6565 Fax No.: 702-220-6566 E-mail Address: mbolduc@olympiacompanies.com
Address: 11411 Southern Highlands Parkway, Suite 300; Las Vegas, NV 89141

Contact Person – Name: Stanley Okey Amadi, P.E. Telephone No.: 702-284-5300
*E-mail Address: samadi@shg-inc.com Fax No.: 702-284-5399
Firm: Slater Hanifan Group
Address: 5740 S. Arville Street, Suite 216; Las Vegas, NV 89118

Type of Land Development/Land Disturbance Process:

☐ Rezoning	☐ Subdivision Map	☐ Clearing and grading Only
☐ Parcel Map	☐ Planned Unit Development	☒ Other (Please specify below)
☐ Large Parcel Map	☐ Building Permit	☐ Roadway & Storm Drain Infrastructure

1. Total Owned Land Area: At Site: 665 Acres Being Developed/Disturbed: 202 Acres +/-
2. Is a portion or all of the subject property located in a FEMA Flood Hazard Area? ☐ Yes** ☒ No
3. Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? ☒ Yes** ☐ No
4. Proposed type of development (Residential, Commercial, Etc.): Roadway & Storm Drain Infrastructure
5. Approximate upstream land area which drains to the subject site: 48 acre +/-
6. Has the site drainage been evaluated in the past? ☒ Yes** ☐ No If yes, please identify documentation: Master Drainage Study for Kyle Canyon (SHG, DS4420); Master Drainage Study for Kyle Canyon (GCW, DS4091)
Skye Canyon Phase 2 Infrastructure (SHG, DS4739)
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: Racel Street thru CCRFCD CNKC 0050,
And Minor flows to the CCRFCD Moccasin-Hualapai Branch alignment, Hualapai Way (MOHU 0118)
8. Briefly describe your proposed schedule for the subject project: ASAP Upon Substantial Completion of Detention Basin 1 Facilities
Phase 2 – Roadway Infrastructure per this TDS; Future Phase 2 Residential Subdivisions to follow by separate TDS.



Submit this form as part of the required drainage study to the local entity which has jurisdiction over The subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

***Newly Required Field**

**Review and concurrence of the Clark County Regional Flood Control District is required

Revision	Date

Local Entity File No. _____

REFERENCE: SHG Job No. OLY1501.001

STANDARD FORM 1

Updated 05/01/2008

OLY1501.001

April 4, 2016

Albert Sung, P.E.
Flood Control Project Engineer
City of Las Vegas Department of Public Works
333 N. Rancho Drive
Las Vegas, Nevada 89106

Subject: Technical Drainage Study Update for Skye Canyon Phase 2 Infrastructure

Dear Mr. Sung:

Submitted for your review is this *Technical Drainage Study Update for Skye Canyon Phase 2 Infrastructure*. The site had been previously analyzed and designed within a Technical Drainage Study (CLV DS4739), prepared by Slater Hanifan Group. The study was approved on January 11, 2016 and addressed the development of roadway and infrastructure improvements intended to support the development of approximately 202 acre portion of the Skye Canyon master planned community, identified hereinafter as *Phase 2 Study*. The approval letter has been included in Appendix A of this submittal.

This submittal addresses the proposed roadway widening by 2-ft total to Shaumber Road and Egan Crest Drive (1-ft on each side of the centerline) to increase the bike lane width from 4-ft to 5-ft. The street sections along Shaumber Road and Egan Crest Drive have been revised to account for the additional foot of bike lane to each side of the centerline. As a result the flow depth in the street remains unchanged. Note that there are flow depth differences of about 0.02-ft in certain sections. This is due to the adjustment to the Manning's n-value to reflect a 0.16 coefficient for the entire street section per the HCDDM. This update with revised street calculation also addresses condition No. 5 of the approval letter for the Phase 2 Infrastructure Study (DS4739C). As a result of the subject condition, Section ECA1 in Eagle Canyon Avenue has been revised and provided to show negligible change to the generated flow depth. All revised street sections have been provided in Appendix B and the previously approved street sections are also provided in Appendix A for reference. The updated Exhibit E has also been provided in Appendix C.

The revised improvement plans have been provided in Appendix D. If you have any questions or require additional information, please do not hesitate to contact us at 702-284-5300.

Respectfully Submitted,

SLATER HANIFAN GROUP


Erick T. Mata, E.I.
Flood Control Division

cc: Mark Failla, P.E., CFM – SHG
Stanley Okey Amadi, P.E. - SHG
Jerrold Ratcliffe - SHG

5740 S. Arville Street #216, Las Vegas, NV 89118 ph (702) 284-5300 fax (702) 284-5399

APPENDIX

Appendix A Technical Drainage Study for Skye Canyon Phase 2 Infrastructure

- Approval Letter
- Previously Approved Street Sections

Appendix B Revised Street Sections

Appendix C Updated Drainage Exhibit

Appendix D CD and Revised Improvement Plans

APPENDIX A

Technical Drainage Study for Skye Canyon Phase 2 Infrastructure (DS# 4739)

Approval Letter

Previously Approved Street Sections

CITY OF LAS VEGAS			DATE:	
INTER-OFFICE MEMORANDUM			January 11, 2016	
TO: Land Development Services Department of Building & Safety			FROM: Albert Sung, P.E. Flood Control Project Engineer Department of Public Works	
SUBJECT: Drainage Study for: Skye Canyon – Phase 2 Infrastructure			COPIES TO: Slater Hanifan Group, Inc.	
Cross Streets:	NWC of Grand Teton Blvd. & Hualapai Way		Section 12, LLC / Ninety Five Mgmt.	
File Number:	F:\Depot\DSMemos\DS4739C.doc		Bart Anderson, P.E., DevCo	
Parcel Number:	Portion of 126-12-000-001		CCRFCD	
Zoning Action:	TMP-58560			
FEMA Flood Zone	YES	NO	X	
Proposed Storm Drain	YES	X	NO	

HISTORY	DATE RECEIVED	DATE REVIEWED	COMMENTS	REVIEW FEES	FEES PAID Payment Trn #
1 st Submittal & Supplemental	6/18/2015, 8/4/2015	8/26/2015	See Comments Below	\$400.00	402578: \$400
2 nd Submittal	10/19/2015	11/02/2015	See Comments Below	\$400.00	419048: \$400
3 rd Submittal	11/19/2015 & Supplemental	1/7/2016	See Comments Below	\$400.00	419048: \$400
TOTAL FEES (LDDRS):				\$800.00	----

REMARKS: Supplemental impacts to study from the National Monument and the Detention Basin #1 study.

The Drainage Study for the subject project has been reviewed and:

	is approved subject to conformance to all City standards and the following conditions:
	must be resubmitted or supplemented including the following:
X	is conditionally approved subject to Clark County Regional Flood Control District concurrence.
	is conditionally approved subject to Clark County Public Works Department concurrence.

The City of Las Vegas will not allow further residential building permits for development outside of the limits of Phase I at this time based upon the current MPU impacts from the National Monument. This is a temporary hold of further residential building permits outside of Phase I until the National Monument Grant issues are resolved and/or alternative regional facilities are proposed and constructed to mitigate the development. Flood Control will continue to review the Infrastructure for Phase 2 and the Detention Basins; however Flood Control cannot issue final drainage study approvals until given clearance to do so. The City will work with the Developer and CCRFCD to help identify and alleviate these impacts.

1. The impacts to existing downstream neighborhoods of the long term discharge from the detention basin(s) without the associated regional outfall facilities is a major concern of both the City and the Clark County Regional Flood Control District. Flood Control understands that these impacts are being addressed with Skye Canyon Detention Basin #1. The proposed impact solution was included as a part of the Skye Canyon Detention Basin #1 improvements until the overall Skye Canyon MPU facilities are completed.

2. The drainage study for Phase 2 Infrastructure assumes that the project will be constructed in one phase. It was noted within this Addendum response that the developer desires to phase the construction of the improvements. If improvement plans are submitted to break the Phase 2 Infrastructure into separate phases, a drainage study update will be required for each phase addressing the interim condition.
3. The provided Phase 2 Infrastructure plans only show the proposed drainage facilities. The complete improvement plans will require additional review for impacts with other needed infrastructure; i.e. sanitary sewer, water, gas, etc. Any changes to the proposed storm drain system shall require a drainage study update.
4. The Storm Drain Plans have been revised to accommodate the proposed cross fall street sections and include added nuisance inlets at low points within the intersections.
5. Adjust the Manning N-value for all of the roadway sections to 0.016 per Section 906 of the Manual. Based upon the provided cross sections, revise the following sections: ECA-1, EGN2, EGN2 (10-Year), and SHA1 (10-Year).
6. The plans show preliminary mass grading with collection facilities within the parcels to intercept the flows prior to entering the infrastructure roadway improvements. It was noted that the inlet collection system needs to incorporate stormwater quality (SWQ) features and Best Management Practices (BMP's) at these interim collection points. This information will be provided and shown on the SWPPP, a copy of which shall be provided to Flood Control prior to permits. Additionally, the mass grading plan (Sheet GR-03) shows sheet flow from Basin ON2-1B discharging directly onto Hualapai Way without any interim collection. Revise to incorporate interim collection.
7. The site is adjacent to or crosses an existing or proposed *Clark County Regional Flood Control District* (CCRFCD) master planned facility. Therefore, CCRFCD concurrence is required prior to final approval of the drainage study.
8. Note that the ***Skye Canyon Master Drainage Study*** has not been approved in the current stage. The subject *Skye Canyon Infrastructure Phase 2* drainage study will not be approved prior to the final approval of the master drainage study.
9. The ***Skye Canyon Phase 2 Development*** is based on the sole protection of a planned ***Skye Canyon Detention Basin #1*** from major storm flood events. The subject drainage study will not be approved prior to the final approval of the Detention Basin #1 drainage study.
10. No Building Permits for onsite developments will be issued prior to the construction and substantial completion of the ***Skye Canyon Detention Basin #1***. The notice of Substantial Completion from the City of Las Vegas, Department of Public Works is required for the release of Building Permits.
11. All drainage facilities proposed in this ***Phase 2 Infrastructure Study*** are considered interim facilities and must be maintained by the Master Developer until the facilities are dedicated to and formally accepted by the *City of Las Vegas*.
12. Since the streets network and the associated storm drain facilities will eventually be accepted by the City, the engineer must coordinate with *City of Las Vegas Streets & Sanitation Department* for their review and approval prior to the final approval of the subject drainage study.
13. The provided WSPG Model shows that the storm drain in *Eagle Canyon Avenue* exceeds the maximum allowed velocity (25 fps) per the *CCRFCD Hydrologic & Hydraulic Design Manual*. A *Special Construction Note* has been added to the plan & profile sheets that call out the special construction requirement and the required special inspection for the additional sacrificial concrete.
14. Structural plans for the storm drain improvements must be submitted for review. Provide a soil report, structural calculations and specifications, wet stamped structural sets and a grading plan to the *City of Las Vegas Building Department* for processing (call *Building Department* to confirm their submittal requirements). The engineer must provide a copy of *Building Department* approval of the structures to *City Flood Control Section* prior to the final acceptance of the technical drainage study.

15. The project proposes to build temporary drainage berms/swales over the *Phase 2* site. Prior to final plan approval the developer must complete a ***Maintenance and Liability Agreement*** for the interim drainage improvements and post a minimum maintenance bond of \$50,000 or 50-percent of the construction cost for the improvements, whichever is greater. The engineer must submit an estimate of the quantities for construction the facility and an exhibit that adequately shows the location and limits of the drainage facility to *City Flood Control* for approval. Once the drainage study is conditionally approved, the engineer/developer should contact the *City's Land Development Section* (702-229-6371) to begin the agreement process.

In order for the maintenance bond to be released in the future, a drainage update/letter will be required to justify that the berms/swales are no longer necessary and can be removed.

16. Technical drainage studies are required for each of the future PODs. The technical drainage studies for the PODs may not be submitted until the conditional approval of the pertinent infrastructure drainage study is obtained. Final approval for the infrastructure study must be obtained prior to conditional approval of the impacted POD drainage studies.
17. No Building Permits for the homes within the individual PODs will be issued prior to the construction and substantial completion of the ***Skye Canyon Detention Basin #1***. Additionally, Building permits for the homes within the individual PODs will not be issued until construction of the streets and flood control infrastructure around the POD is substantially complete or interim protection is provided per the approved technical drainage study.
18. A note on the Grading Plans has been provided that "*Property Owner is responsible to maintain the best management practices such as but not limited to the removal of accumulated sediment and debris and care of the vegetation.*"
19. Provide numbering system for the manholes and inlets. It was noted in the response that the project may be divided into additional phases. The numbering system is still needed.
20. Show the size of all the proposed riprap areas. The rip-rap pads are shown on the GR-Sheets and some of the SD-Sheets include the pad size. Add the pad size to the grading plans and revise all pertinent plans and callouts accordingly.
21. Revise the pipe penetration detail to include a concrete collar with dowelled rebar connections. The detail has not been provided at this time and was noted that it will be a part of the Structural Details.
22. Provide details for the transition structure modifications to accommodate the 66"-RCP connection and the removal of the existing facilities to allow construction of the proposed improvements. The detail has not been provided at this time and was noted that it will be a part of the Structural Details.

NOTE: Please be advised that all land surface area disturbances over 1 acre or any area adjacent to a water way must submit to the *Nevada Division of Environmental Protection* a "Notice of Intent" to discharge that certifies a stormwater pollution prevention plan has been developed and is maintained on site; for inclusion in the Stormwater General Permit No. NVR100000. A phased construction unit in a contiguous subdivision is considered under construction until all stripped or disturbed surface areas have been covered by paving, building construction or planting. For more information, including forms and applications see <http://ndep.nv.gov/bwpc/storm01.htm> or call (775) 687-9429.

END OF REMARKS
AYS/PBJ

T/R/S: T19S/R59E/12
AREA F-12

Section - EGN1a

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1a
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.46 %
Discharge	4.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 1.18
Flow Area	1.4 ft ²
Wetted Perimeter	15.58 ft
Top Width	14.91 ft
Actual Depth	0.29 ft
Critical Elevation	0.33 ft
Critical Slope	0.82 %
Velocity	2.90 ft/s
Velocity Head	0.13 ft
Specific Energy	0.42 ft
Froude Number	1.68
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+65.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+26.00	0.65
0+26.01	0.73
0+26.25	1.04
0+26.42	1.06
0+32.50	1.18
0+38.58	1.06

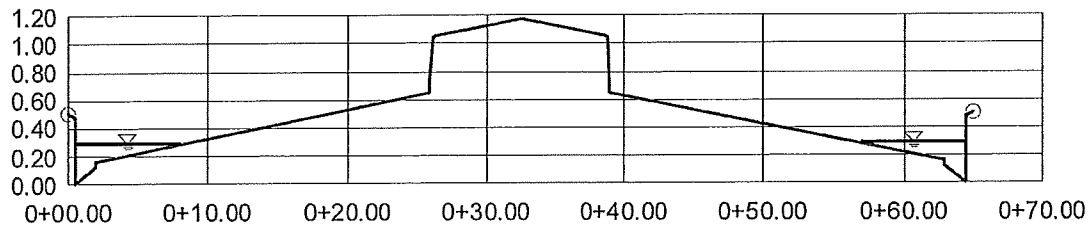
Section - EGN1a
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - EGN1a **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN1a
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.46 %
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 1.18
Discharge	4.00 cfs



V:10.0
H:1
NTS

Section - EGN1a (10-Year) Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1a (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.46 %
Discharge	2.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.24 ft
Elevation Range	0.00 to 1.18
Flow Area	0.8 ft ²
Wetted Perimeter	10.72 ft
Top Width	10.15 ft
Actual Depth	0.24 ft
Critical Elevation	0.28 ft
Critical Slope	0.89 %
Velocity	2.55 ft/s
Velocity Head	0.10 ft
Specific Energy	0.34 ft
Froude Number	1.62
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+65.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+26.00	0.65
0+26.01	0.73
0+26.25	1.04
0+26.42	1.06
0+32.50	1.18
0+38.58	1.06

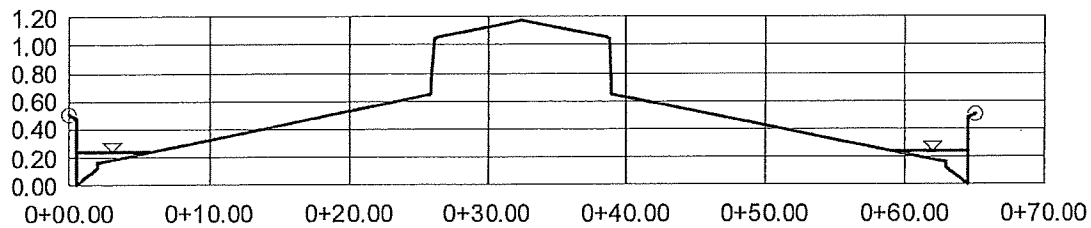
Section - EGN1a (10-Year) **Worksheet for Irregular Channel**

Natural Channel Points	
Station (ft)	Elevation (ft)
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - EGN1a (10-Year) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN1a (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.46 %
Water Surface Elevation	0.24 ft
Elevation Range	0.00 to 1.18
Discharge	2.00 cfs



V:10.0
H:1
NTS

Section - EGN1b

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1b
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	2.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.38 ft
Elevation Range	0.00 to 1.18
Flow Area	1.5 ft ²
Wetted Perimeter	12.21 ft
Top Width	11.79 ft
Actual Depth	0.38 ft
Critical Elevation	0.35 ft
Critical Slope	0.80 %
Velocity	1.64 ft/s
Velocity Head	0.04 ft
Specific Energy	0.42 ft
Froude Number	0.80
Flow Type	Subcritical

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+32.50	0+65.00	0.016

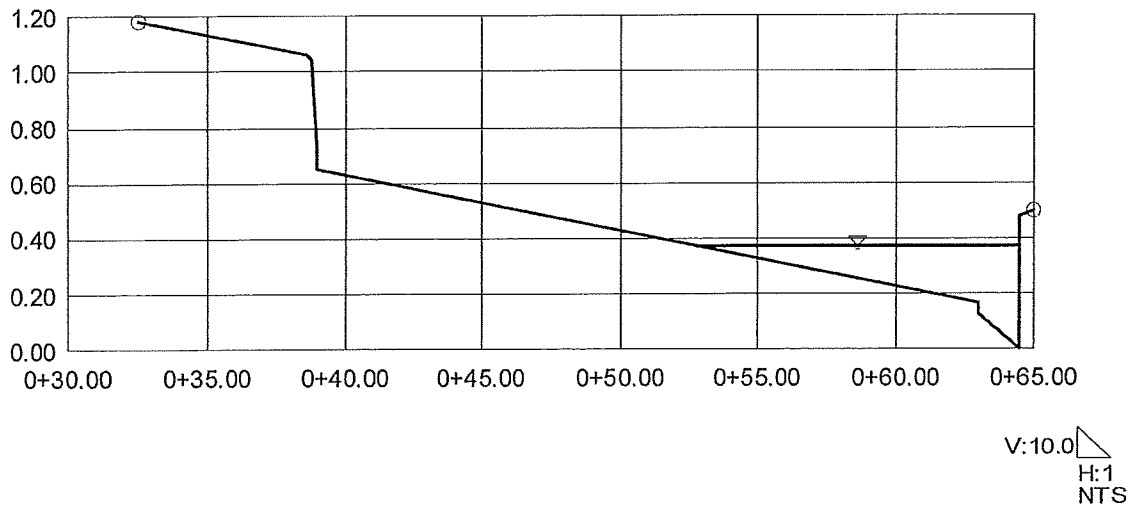
Natural Channel Points	
Station (ft)	Elevation (ft)
0+32.50	1.18
0+38.58	1.06
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - EGN1b

Cross Section for Irregular Channel

Project Description	
Worksheet	Section - EGN1b
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	0.50 %
Water Surface Elevation	0.38 ft
Elevation Range	0.00 to 1.18
Discharge	2.50 cfs



Section - EGN1b (10-Year) Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1b (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	1.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Flow Area	0.7 ft ²
Wetted Perimeter	8.18 ft
Top Width	7.84 ft
Actual Depth	0.30 ft
Critical Elevation	0.28 ft
Critical Slope	0.89 %
Velocity	1.33 ft/s
Velocity Head	0.03 ft
Specific Energy	0.32 ft
Froude Number	0.76
Flow Type	Subcritical

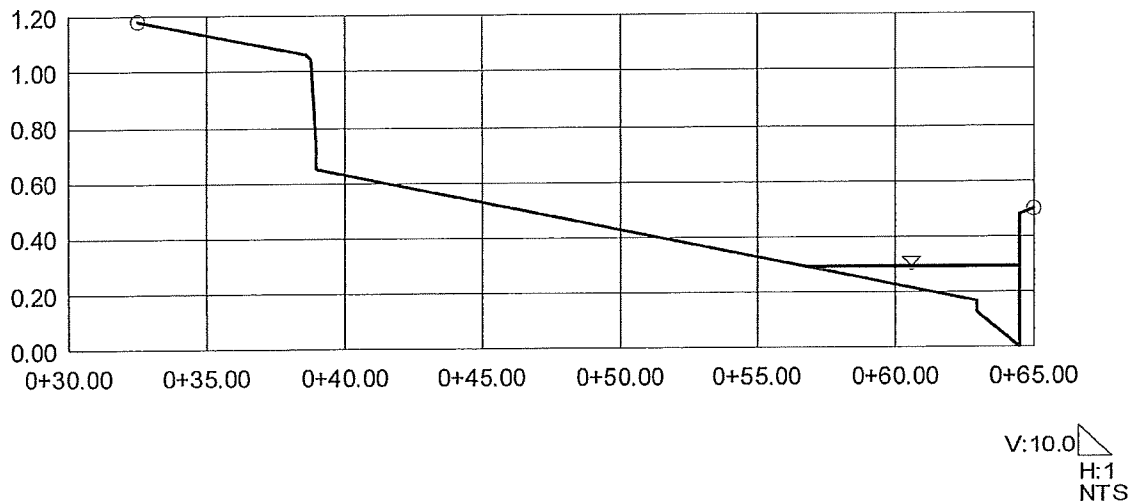
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+32.50	0+65.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+32.50	1.18
0+38.58	1.06
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - EGN1b (10-Year) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN1b (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	0.50 %
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Discharge	1.00 cfs



Section - EGN2

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.014
Water Surface Elevation	0.32 ft
Elevation Range	0.00 to 1.18
Flow Area	1.8 ft ²
Wetted Perimeter	18.36 ft
Top Width	17.64 ft
Actual Depth	0.32 ft
Critical Elevation	0.31 ft
Critical Slope	0.62 %
Velocity	1.64 ft/s
Velocity Head	0.04 ft
Specific Energy	0.36 ft
Froude Number	0.90
Flow Type	Subcritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+02.00	0.013
0+02.00	0+26.00	0.016
0+26.00	0+39.00	0.013
0+39.00	0+63.00	0.016
0+63.00	0+65.00	0.013

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+26.00	0.65
0+26.01	0.73

Section - EGN2
Worksheet for Irregular Channel

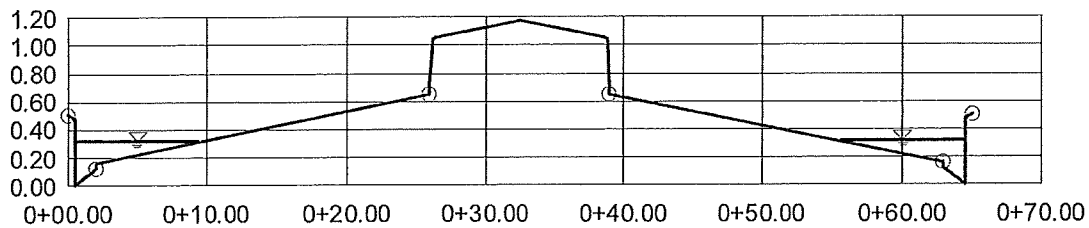
Natural Channel Points	
Station (ft)	Elevation (ft)
0+26.25	1.04
0+26.42	1.06
0+32.50	1.18
0+38.58	1.06
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - EGN2

Cross Section for Irregular Channel

Project Description	
Worksheet	Section - EGN2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.014
Channel Slope	0.50 %
Water Surface Elevation	0.32 ft
Elevation Range	0.00 to 1.18
Discharge	3.00 cfs



V:10.0
H:1
NTS

Section - EGN2 (10-Year) Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN2 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	2.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.013
Water Surface Elevation	0.28 ft
Elevation Range	0.00 to 1.18
Flow Area	1.3 ft ²
Wetted Perimeter	15.00 ft
Top Width	14.34 ft
Actual Depth	0.28 ft
Critical Elevation	0.28 ft
Critical Slope	0.62 %
Velocity	1.54 ft/s
Velocity Head	0.04 ft
Specific Energy	0.32 ft
Froude Number	0.90
Flow Type	Subcritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+02.00	0.013
0+02.00	0+26.00	0.016
0+26.00	0+39.00	0.013
0+39.00	0+63.00	0.016
0+63.00	0+65.00	0.013

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+26.00	0.65
0+26.01	0.73

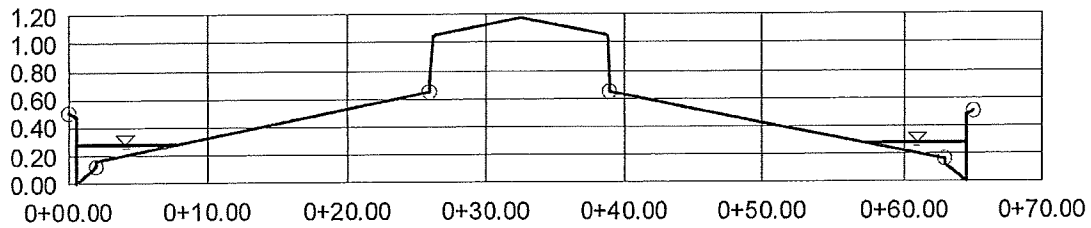
Section - EGN2 (10-Year)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+26.25	1.04
0+26.42	1.06
0+32.50	1.18
0+38.58	1.06
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - EGN2 (10-Year) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN2 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.013
Channel Slope	0.50 %
Water Surface Elevation	0.28 ft
Elevation Range	0.00 to 1.18
Discharge	2.00 cfs



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Section - SHA

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	2.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 0.53
Flow Area	0.8 ft ²
Wetted Perimeter	10.03 ft
Top Width	9.69 ft
Actual Depth	0.29 ft
Critical Elevation	0.34 ft
Critical Slope	0.82 %
Velocity	2.96 ft/s
Velocity Head	0.14 ft
Specific Energy	0.43 ft
Froude Number	1.77
Flow Type	Supercritical

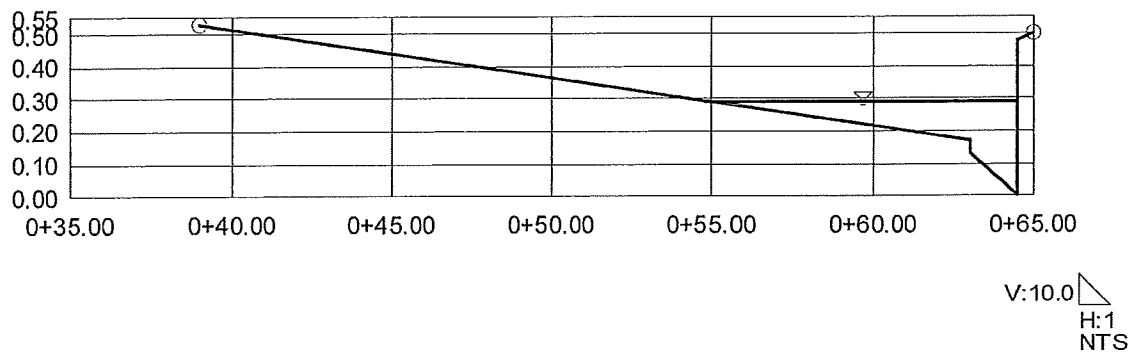
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+39.00	0+65.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.00	0.53
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - SHA Cross Section for Irregular Channel

Project Description	
Worksheet	Section - SHA
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 0.53
Discharge	2.50 cfs



Section - SHA (West Half Street) Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA (West Half Street)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	2.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 0.50
Flow Area	1.1 ft ²
Wetted Perimeter	19.89 ft
Top Width	19.59 ft
Actual Depth	0.26 ft
Critical Elevation	0.29 ft
Critical Slope	0.93 %
Velocity	2.25 ft/s
Velocity Head	0.08 ft
Specific Energy	0.34 ft
Froude Number	1.67
Flow Type	Supercritical

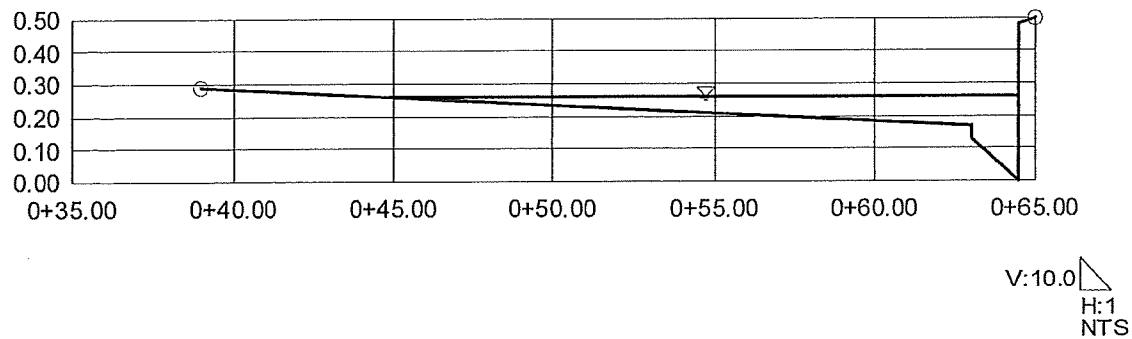
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+39.00	0+65.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.00	0.29
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - SHA (West Half Street) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - SHA (West Half Street)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 0.50
Discharge	2.50 cfs



Section - SHA1

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	5.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Flow Area	1.6 ft ²
Wetted Perimeter	16.86 ft
Top Width	16.16 ft
Actual Depth	0.30 ft
Critical Elevation	0.35 ft
Critical Slope	0.79 %
Velocity	3.17 ft/s
Velocity Head	0.16 ft
Specific Energy	0.46 ft
Froude Number	1.79
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+65.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+26.00	0.65
0+26.01	0.73
0+26.25	1.04
0+26.42	1.06
0+32.50	1.18
0+38.58	1.06

Section - SHA1
Worksheet for Irregular Channel

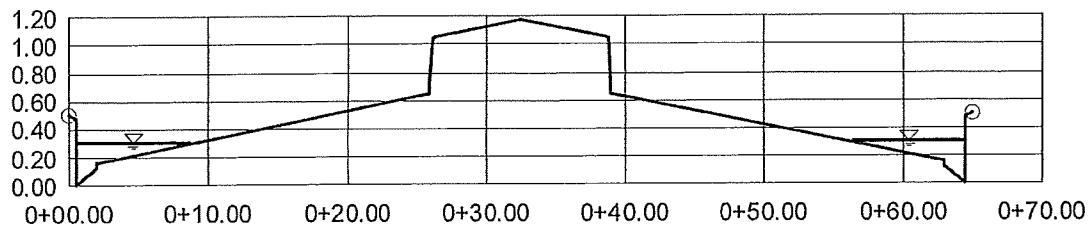
Natural Channel Points	
Station (ft)	Elevation (ft)
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - SHA1

Cross Section for Irregular Channel

Project Description	
Worksheet	Section - SHA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Discharge	5.00 cfs



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Section - SHA1 (10-Year) Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA1 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.015
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 1.18
Flow Area	1.0 ft ²
Wetted Perimeter	12.74 ft
Top Width	12.13 ft
Actual Depth	0.26 ft
Critical Elevation	0.31 ft
Critical Slope	0.77 %
Velocity	2.98 ft/s
Velocity Head	0.14 ft
Specific Energy	0.40 ft
Froude Number	1.83
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+02.00	0.013
0+02.00	0+26.00	0.016
0+26.00	0+39.00	0.013
0+39.00	0+63.00	0.016
0+63.00	0+65.00	0.013

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+26.00	0.65
0+26.01	0.73

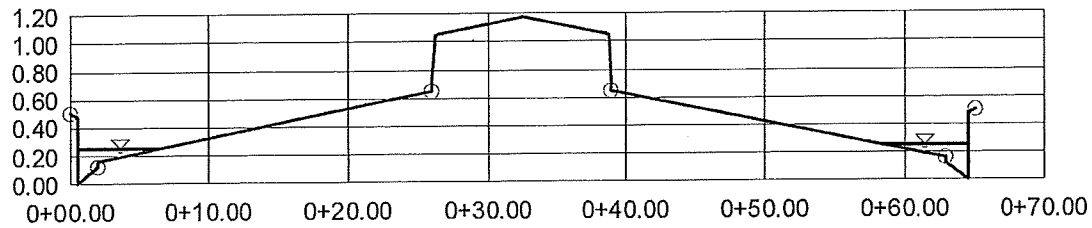
Section - SHA1 (10-Year)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+26.25	1.04
0+26.42	1.06
0+32.50	1.18
0+38.58	1.06
0+38.74	1.04
0+38.99	0.73
0+39.00	0.65
0+63.00	0.17
0+63.00	0.13
0+64.50	0.00
0+64.50	0.48
0+65.00	0.50

Section - SHA1 (10-Year) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - SHA1 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.015
Channel Slope	2.75 %
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 1.18
Discharge	3.00 cfs



V:10.0
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NTS

Section - ECA1

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - ECA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	4.90 %
Discharge	30.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.014
Water Surface Elevation	0.43 ft
Elevation Range	0.00 to 0.56
Flow Area	4.5 ft ²
Wetted Perimeter	30.10 ft
Top Width	29.14 ft
Actual Depth	0.43 ft
Critical Elevation	0.59 ft
Critical Slope	0.47 %
Velocity	6.64 ft/s
Velocity Head	0.69 ft
Specific Energy	1.12 ft
Froude Number	2.97
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+02.00	0.013
0+02.00	0+41.00	0.016
0+41.00	0+43.00	0.013

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+21.50	0.56
0+41.00	0.17
0+41.00	0.13
0+42.50	0.00

Section - ECA1
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+42.50	0.48
0+43.00	0.50

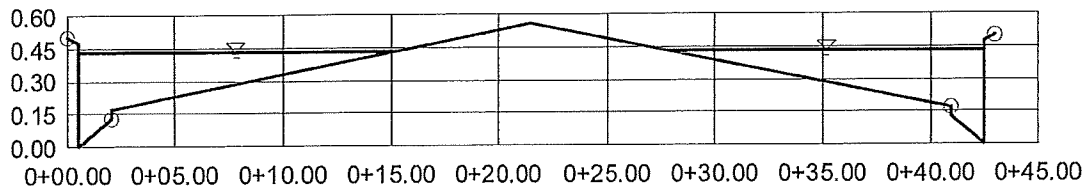
Notes: Q=30 cfs being ON3-I(A) Plus Half of EAGL1

Section - ECA1

Cross Section for Irregular Channel

Project Description	
Worksheet	Section - ECA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.014
Channel Slope	4.90 %
Water Surface Elevation	0.43 ft
Elevation Range	0.00 to 0.56
Discharge	30.00 cfs



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APPENDIX B

Revised Street Sections

Section - EGN1a

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1a
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.46 %
Discharge	4.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 1.18
Flow Area	1.4 ft ²
Wetted Perimeter	15.58 ft
Top Width	14.91 ft
Actual Depth	0.29 ft
Critical Elevation	0.33 ft
Critical Slope	0.82 %
Velocity	2.90 ft/s
Velocity Head	0.13 ft
Specific Energy	0.42 ft
Froude Number	1.68
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+27.00	0.67
0+27.01	0.73
0+27.25	1.04
0+27.42	1.06
0+33.50	1.18
0+39.58	1.06

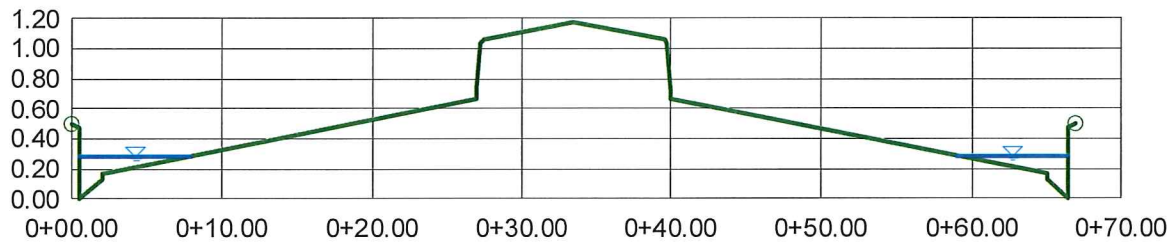
Section - EGN1a
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - EGN1a **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN1a
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.46 %
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 1.18
Discharge	4.00 cfs



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Section - EGN1a (10-Year)

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1a (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.46 %
Discharge	2.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.24 ft
Elevation Range	0.00 to 1.18
Flow Area	0.8 ft ²
Wetted Perimeter	10.72 ft
Top Width	10.15 ft
Actual Depth	0.24 ft
Critical Elevation	0.28 ft
Critical Slope	0.89 %
Velocity	2.55 ft/s
Velocity Head	0.10 ft
Specific Energy	0.34 ft
Froude Number	1.62
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+27.00	0.67
0+27.01	0.73
0+27.25	1.04
0+27.42	1.06
0+33.50	1.18
0+39.58	1.06

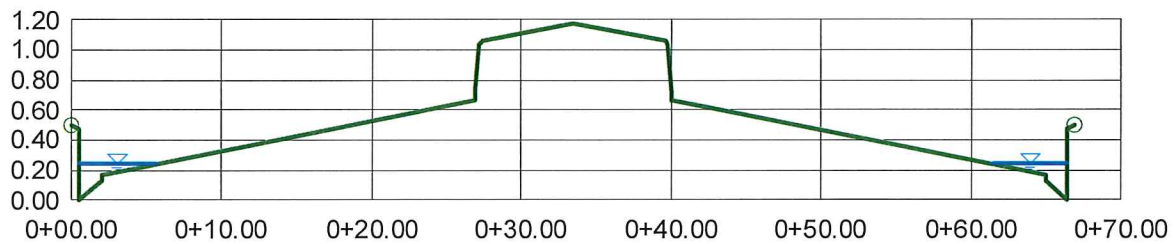
Section - EGN1a (10-Year)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - EGN1a (10-Year)
Cross Section for Irregular Channel

Project Description	
Worksheet	Section - EGN1a (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.46 %
Water Surface Elevation	0.24 ft
Elevation Range	0.00 to 1.18
Discharge	2.00 cfs



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NTS

Section - EGN1b

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1b
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	2.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.38 ft
Elevation Range	0.00 to 1.18
Flow Area	1.5 ft²
Wetted Perimeter	12.21 ft
Top Width	11.79 ft
Actual Depth	0.38 ft
Critical Elevation	0.35 ft
Critical Slope	0.80 %
Velocity	1.64 ft/s
Velocity Head	0.04 ft
Specific Energy	0.42 ft
Froude Number	0.80
Flow Type	Subcritical

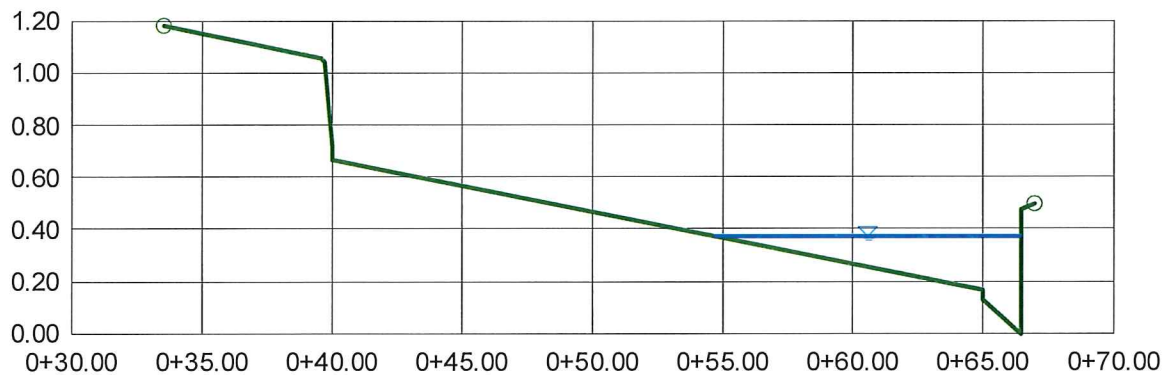
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+33.50	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+33.50	1.18
0+39.58	1.06
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - EGN1b **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN1b
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	0.50 %
Water Surface Elevation	0.38 ft
Elevation Range	0.00 to 1.18
Discharge	2.50 cfs



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Section - EGN1b (10-Year)

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN1b (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	1.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Flow Area	0.7 ft ²
Wetted Perimeter	8.18 ft
Top Width	7.84 ft
Actual Depth	0.30 ft
Critical Elevation	0.28 ft
Critical Slope	0.89 %
Velocity	1.33 ft/s
Velocity Head	0.03 ft
Specific Energy	0.32 ft
Froude Number	0.76
Flow Type	Subcritical

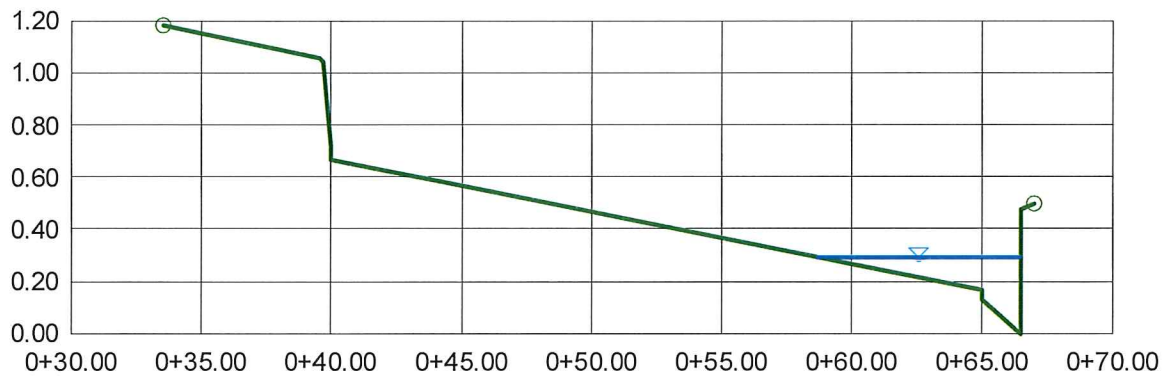
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+33.50	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+33.50	1.18
0+39.58	1.06
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - EGN1b (10-Year) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN1b (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	0.50 %
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Discharge	1.00 cfs



V:10.0
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NTS

Section - EGN2

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.33 ft
Elevation Range	0.00 to 1.18
Flow Area	2.1 ft ²
Wetted Perimeter	19.66 ft
Top Width	18.91 ft
Actual Depth	0.33 ft
Critical Elevation	0.31 ft
Critical Slope	0.85 %
Velocity	1.46 ft/s
Velocity Head	0.03 ft
Specific Energy	0.36 ft
Froude Number	0.78
Flow Type	Subcritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+27.00	0.67
0+27.01	0.73
0+27.25	1.04
0+27.42	1.06
0+33.50	1.18
0+39.58	1.06

Section - EGN2
Worksheet for Irregular Channel

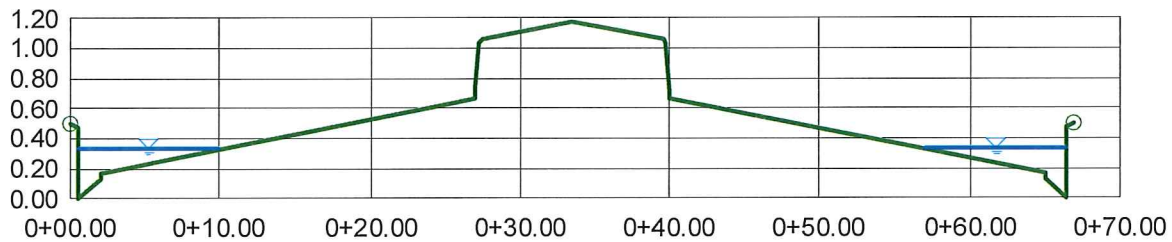
Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - EGN2

Cross Section for Irregular Channel

Project Description	
Worksheet	Section - EGN2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	0.50 %
Water Surface Elevation	0.33 ft
Elevation Range	0.00 to 1.18
Discharge	3.00 cfs



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NTS

Section - EGN2 (10-Year)

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - EGN2 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	0.50 %
Discharge	2.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Flow Area	1.5 ft²
Wetted Perimeter	16.36 ft
Top Width	15.68 ft
Actual Depth	0.30 ft
Critical Elevation	0.28 ft
Critical Slope	0.89 %
Velocity	1.33 ft/s
Velocity Head	0.03 ft
Specific Energy	0.32 ft
Froude Number	0.76
Flow Type	Subcritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+27.00	0.67
0+27.01	0.73
0+27.25	1.04
0+27.42	1.06
0+33.50	1.18
0+39.58	1.06

Section - EGN2 (10-Year)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - EGN2 (10-Year) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - EGN2 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	0.50 %
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Discharge	2.00 cfs



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Section - SHA

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	2.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 0.55
Flow Area	0.8 ft ²
Wetted Perimeter	10.03 ft
Top Width	9.69 ft
Actual Depth	0.29 ft
Critical Elevation	0.34 ft
Critical Slope	0.82 %
Velocity	2.96 ft/s
Velocity Head	0.14 ft
Specific Energy	0.43 ft
Froude Number	1.77
Flow Type	Supercritical

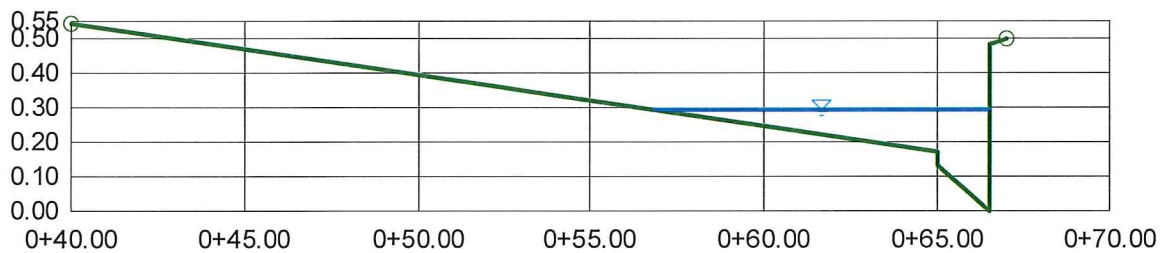
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+40.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+40.00	0.55
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - SHA **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - SHA
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 0.55
Discharge	2.50 cfs



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Section - SHA (West Half Street)

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA (West Half Street)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	2.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 0.50
Flow Area	1.1 ft ²
Wetted Perimeter	19.89 ft
Top Width	19.59 ft
Actual Depth	0.26 ft
Critical Elevation	0.29 ft
Critical Slope	0.93 %
Velocity	2.25 ft/s
Velocity Head	0.08 ft
Specific Energy	0.34 ft
Froude Number	1.67
Flow Type	Supercritical

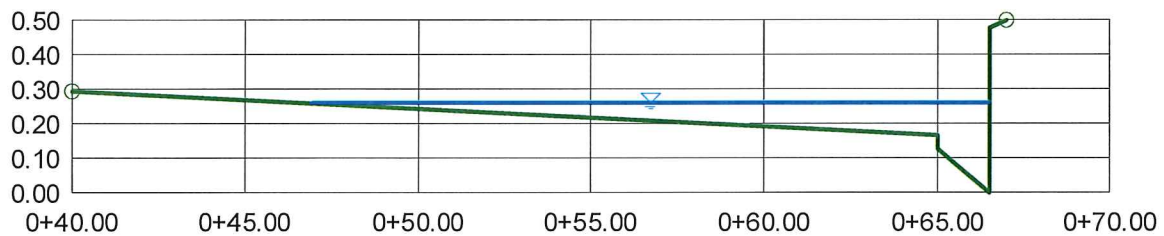
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+40.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+40.00	0.30
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - SHA (West Half Street) **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - SHA (West Half Street)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 0.50
Discharge	2.50 cfs



V:10.0
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NTS

Section - SHA1

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	5.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Flow Area	1.6 ft ²
Wetted Perimeter	16.86 ft
Top Width	16.16 ft
Actual Depth	0.30 ft
Critical Elevation	0.35 ft
Critical Slope	0.79 %
Velocity	3.17 ft/s
Velocity Head	0.16 ft
Specific Energy	0.46 ft
Froude Number	1.79
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+27.00	0.67
0+27.01	0.73
0+27.25	1.04
0+27.42	1.06
0+33.50	1.18
0+39.58	1.06

Section - SHA1
Worksheet for Irregular Channel

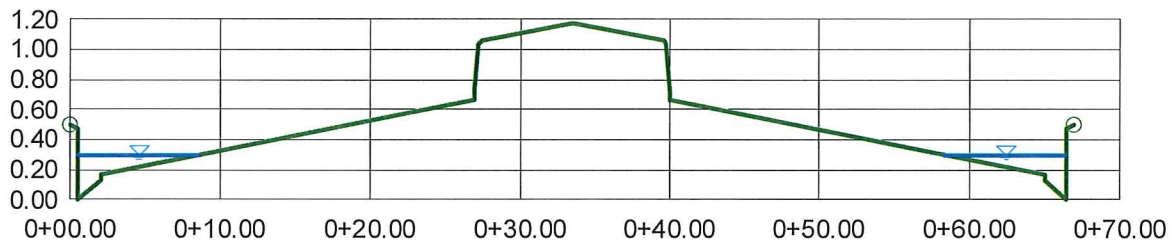
Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - SHA1

Cross Section for Irregular Channel

Project Description	
Worksheet	Section - SHA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.30 ft
Elevation Range	0.00 to 1.18
Discharge	5.00 cfs



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Section - SHA1 (10-Year)

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - SHA1 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	2.75 %
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 1.18
Flow Area	1.0 ft ²
Wetted Perimeter	13.10 ft
Top Width	12.48 ft
Actual Depth	0.26 ft
Critical Elevation	0.31 ft
Critical Slope	0.85 %
Velocity	2.86 ft/s
Velocity Head	0.13 ft
Specific Energy	0.39 ft
Froude Number	1.74
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+67.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+27.00	0.67
0+27.01	0.73
0+27.25	1.04
0+27.42	1.06
0+33.50	1.18
0+39.58	1.06

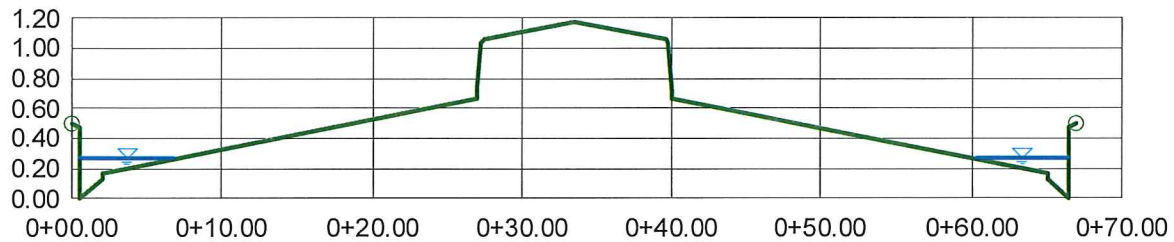
Section - SHA1 (10-Year)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
0+39.74	1.04
0+39.99	0.73
0+40.00	0.67
0+65.00	0.17
0+65.00	0.13
0+66.50	0.00
0+66.50	0.48
0+67.00	0.50

Section - SHA1 (10-Year)
Cross Section for Irregular Channel

Project Description	
Worksheet	Section - SHA1 (10-Year)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	2.75 %
Water Surface Elevation	0.26 ft
Elevation Range	0.00 to 1.18
Discharge	3.00 cfs



V:10.0
H:1
NTS

Section - ECA1

Worksheet for Irregular Channel

Project Description	
Worksheet	Section - ECA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	4.90 %
Discharge	30.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.45 ft
Elevation Range	0.00 to 0.56
Flow Area	5.0 ft ²
Wetted Perimeter	31.76 ft
Top Width	30.77 ft
Actual Depth	0.45 ft
Critical Elevation	0.59 ft
Critical Slope	0.62 %
Velocity	6.00 ft/s
Velocity Head	0.56 ft
Specific Energy	1.01 ft
Froude Number	2.62
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+43.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+21.50	0.56
0+41.00	0.17
0+41.00	0.13
0+42.50	0.00
0+42.50	0.48
0+43.00	0.50

Section - ECA1

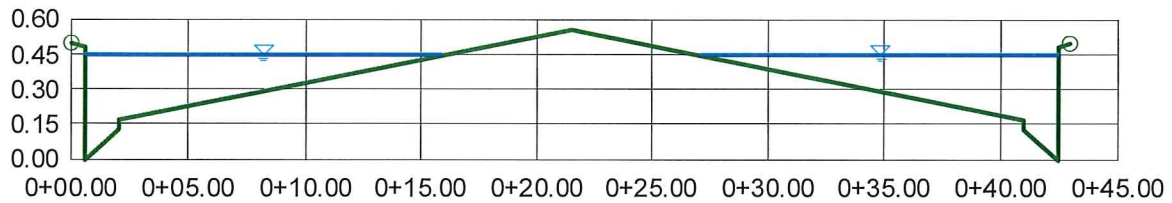
Worksheet for Irregular Channel

Notes: Q = 30 cfs being ON3-I(A) Plus Half of EAGL1

Section - ECA1 **Cross Section for Irregular Channel**

Project Description	
Worksheet	Section - ECA1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Channel Slope	4.90 %
Water Surface Elevation	0.45 ft
Elevation Range	0.00 to 0.56
Discharge	30.00 cfs



V:10.0
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APPENDIX C

Updated Drainage Exhibit

100-Year Ditch Flow Hydraulic Summary				
Cross Section ID	Slope (%)	Q ₁₀₀ (cfs)	Normal Depth (ft)	Description
1I	0.65	35	0.79	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
1I-1	3.70	11	0.24	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
2I	0.90	19	0.51	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
3I	1.90	32	0.55	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
6I	0.80	59	1.00	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
7I	1.50	85	0.60	Earthen Lined Trap. Channel: 26.5-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
8I	0.90	85	0.96	Earthen Lined Trap. Channel: 15-ft Bottom, 4:1&3:1 SS, Min. 2.0-ft Depth
9I	0.50	60	1.15	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.5-ft Depth
10I	0.50	35	0.85	Earthen Lined Trap. Channel: 10-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
11I	1.90	27.5	0.46	Earthen Lined Trap. Channel: 12-ft Bottom, 3:1 SS, Min. 2.0-ft Depth
12I	0.50	27.5	0.67	Earthen Lined Trap. Channel: 12-ft Bottom, 3:1 SS, Min. 2.0-ft Depth

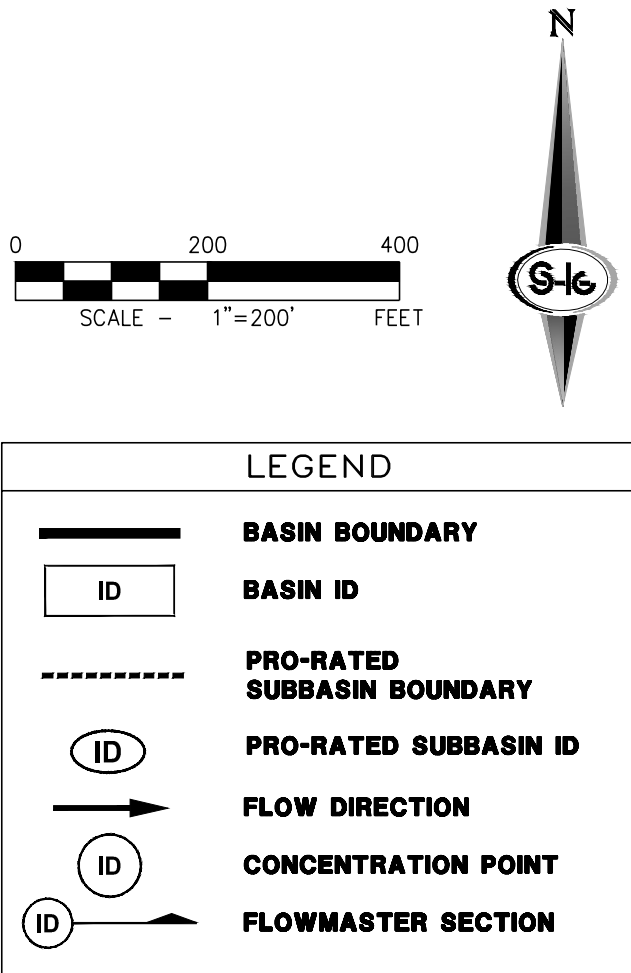
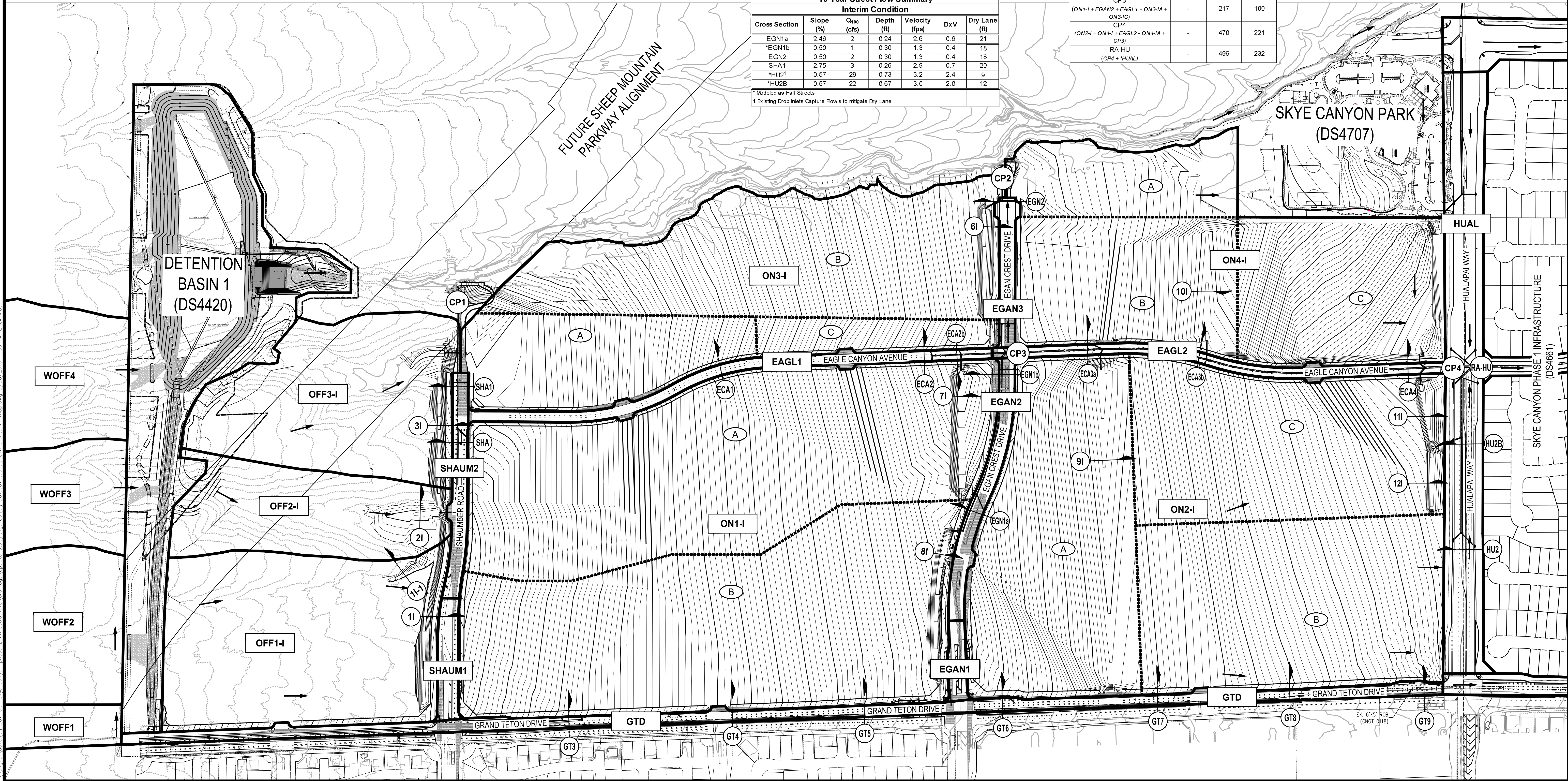
Interim Condition Prorated Flow Summary			
Basin	Q ₁₀₀ (cfs)	Area (acres)	Unit Flow (cfs/acre)
ON1-I	170	62.6	2.7
ON2-I	176	57.4	3.1
ON3-I	94	32.6	2.9
ON4-I	90	29.4	3.1
Subbasin	Q ₁₀₀ (cfs)	Area (acres)	Unit Flow (cfs/acre)
ON1-IA	85	31.4	2.7
ON1-IB	85	31.3	2.7
TOTAL	170	62.6	
ON2-IA	60	19.7	3.1
ON2-IB	61	19.8	3.1
ON2-IC	55	17.9	3.1
TOTAL	176	57.4	
ON3-IA	26	9.1	2.9
ON3-IB	59	20.4	2.9
ON3-IC	9	3.2	2.9
TOTAL	94	32.6	
ON4-IA	19	6.3	3.1
ON4-IB	35	11.3	3.1
ON4-IC	36	11.8	3.1
TOTAL	90	29.4	

100-Year Street Flow Summary					
Interim Condition					
Cross Section	Slope (%)	Q ₁₀₀ (cfs)	Depth (ft)	Velocity (fps)	DxV
ECA1	4.90	30	0.45	6.0	2.7
ECA2	4.90	43	0.50	6.5	3.2
ECA2b	2.00	13	0.40	3.5	1.4
ECA3a	4.94	5	0.28	4.0	1.1
ECA3b	4.94	42	0.49	6.5	3.2
ECA4	0.50	51	0.71	3.3	2.3
EGN1a	2.46	4	0.29	2.9	0.8
*EGN1b	0.50	2.5	0.38	1.6	0.6
EGN2	0.50	3	0.33	1.5	0.5
*SHA	2.75	2.5	0.29	3.0	0.9
*SHA (West Half)	2.75	2.5	0.26	2.3	0.6
SHA1	2.75	5	0.30	3.2	1.0
**GT3	3.80	10	0.40	5.6	2.2
***GT4	3.80	5	0.34	4.3	1.5
***GT5	4.30	3	0.30	4.1	1.2
**GT6	3.40	4	0.33	3.9	1.3
***GT7	3.50	2	0.27	3.5	0.9
***GT8	3.30	2	0.28	3.4	0.9
***GT9	3.60	2	0.27	3.5	0.9
*HU2	0.57	61	0.92	3.9	3.6
*HU2B	0.57	45	0.84	3.6	3.0
* Modeled as Half Streets					
** Basin GTD/3 + Bypass and/or Onsite Street Basin					
*** Basin GTD/9 +Bypass and/or Onsite Street Basin					

Basin Flow Rate Summary			
(Interim Condition)			
Basin/Concentration Point ID	Area (ac)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
ON1-I	62.6	170	78
ON2-I	57.4	176	83
ON3-I	32.6	94	44
ON4-I	29.4	90	43
OFF1-I	19.7	35	11
OFF2-I	8.8	19	6
OFF3-I	13.6	32	12
EAGL1	2.3	8	4
EAGL2	1.9	7	4
EGAN1	0.6	2	1
EGAN2	2.2	8	4
EGAN3	0.9	3	2
GTD	5.9	18	10
*HUAL	9.2	26	11
SHAUM1	1.0	4	2
SHAUM2	1.4	5	3
*REFERENCED FROM THE SKYE CANYON PHASE 1 STUDY.			

Concentration Points Summary			
(Interim Condition)			
Basin/Concentration Point ID	Area (ac)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
CP1 (OFF1-I + OFF2-I + OFF3-I + SHAUM)	-	92	32
CP2 (ON3-IB + EGAN3)	-	62	30
CP3 (ON1-I + EGAN2 + EAGL1 + ON3-IA + ON3-IC)	-	217	100
CP4 (ON2-I + ON4-I + EAGL2 - ON4-IA + CP3)	-	470	221
RA-HU (CP4 + *HUAL)	-	496	232

10-Year Street Flow Summary						
Interim Condition						
Cross Section	Slope (%)	Q ₁₀₀ (cfs)	Depth (ft)	Velocity (fps)	DxV	Dry Lane (ft)
EGN1a	2.46	2	0.24	2.6	0.6	21
*EGN1b	0.50	1	0.30	1.3	0.4	18
EGN2	0.50	2	0.30	1.3	0.4	18
SHA1	2.75	3	0.28	2.9	0.7	20
*HU2	0.57	29	0.73	3.2	2.4	9
*HU2B	0.57	22	0.67	3.0	2.0	12
* Modeled as Half Streets						
1 Existing Drop Inlets Capture Flow's to mitigate Dry Lane						



SLATER
HANIFAN
GROUP

CONSULTING ENGINEERS & PLANNERS

5740 S. ARVILLE STREET #216, LAS VEGAS, NV 89118
PHONE (702) 284-5300
FAX (702) 284-5300

DATE: APRIL 2016

DRAFTER: ETM

DESIGNER: ETM

CHECKED: SOA

PROJECT NO. OLY1501.001

EXHIBIT E

SHEET 1 OF 1

NINETY-FIVE MANAGEMENT, LLC.

SKYE CANYON - PHASE 2 INFRASTRUCTURE

INTERIM CONDITION DRAINAGE MAP

APPENDIX D

CD of Electronic Files & Revised Improvement Plans