

TECHNICAL DRAINAGE STUDY
ADDENDUM #1

Skye Canyon Infrastructure Phase 3B & 3C

City of Las Vegas, Nevada

Job No.: OLY1609.000

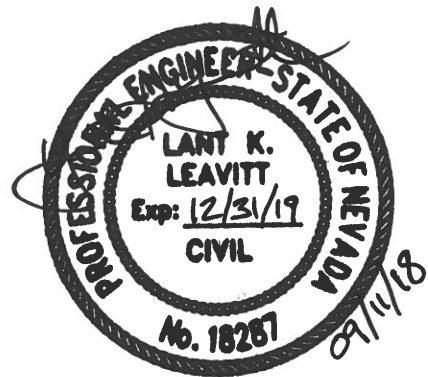
Date: September 2018

Prepared By:

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Prepared For:

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Lant Leavitt, P.E.
NV Professional Engineer No. 18287

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL
DRAINAGE STUDY INFORMATION FORM

Name of Development: Skye Canyon – Phase 3B, 3C Infrastructure Date: September 2018
Location of Development: a) Descriptive (Cross Streets): North/South: Skye Village Road
East/West: Iron Mountain Road
b) Section: 12 Township: 19 South Range: 59 East
c) APN: 126-12-101-002

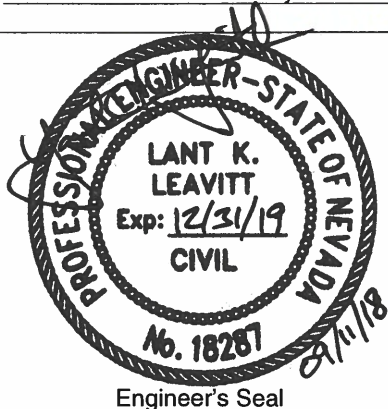
Name of Owner/Developer: M F Land, LLC / Ninety-Five Management, LLC
Telephone No.: 702-220-6565 Fax No.: 702-220-6566 E-mail Address: mbolduc@olympiacompanies.com
Address: 11411 Southern Highlands Parkway, Suite 300; Las Vegas, NV 89141

Contact Person – Name: Lant Leavitt, P.E. Telephone No.: 702-284-5300
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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: 20 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: 1800 acre +/-
6. Has the site drainage been evaluated in the past? ☒ Yes** ☐ No If yes, please identify documentation: Master Drainage Study for Skye Canyon Update #4 (SHG, DS4420)
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: Skye Village Road thru MOHU 0036
8. Briefly describe your proposed schedule for the subject project: ASAP Upon Substantial Completion of Detention Basin 2 Facilities and Phase 3A – Roadway Infrastructure.



Engineer's Seal

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**

Local Entity File No.	Revision	Date

REFERENCE: **SHG Job No. OLY1609.000**

STANDARD FORM 1

Updated 05/01/2008



OLY1609.000

September 10, 2018

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: Addendum No.1 to the Technical Drainage Study for Skye Canyon Infrastructure Phase 3B & 3C (CLV DS4953)

Dear Mr. Sung:

This letter is submitted in response to comments contained in the May 17, 2018 review memorandum, regarding the above referenced project. A copy of the City of Las Vegas (CLV) Department of Public Works comment letter has been provided in Appendix A.

The comments have been individually addressed as follows:

1. **Comment:** *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.*

Response: Noted. The study will be submitted for concurrence to CCRFCD upon conditional approval from the city.

2. **Comment:** *The subject Skye Canyon Phase 3B & 3C Infrastructure Drainage Study will not be approved prior to the final approval of the Skye Canyon Detention Basin 2 Technical Drainage Study and the Skye Canyon Phase 3A Infrastructure Technical Drainage Studies.*

Response: Noted. The Skye Canyon Detention Basin 2 TDS was approved by CLV on 01/11/18, CCRFCD on 07/16/18, and NDWR on 07/30/18. The Skye Canyon Phase 3A TDS was conditionally approved by CLV on 08/16/18, and is currently in review by CCRFCD.

3. **Comment:** *Skye Canyon Phase 3B & 3C onsite developments are to be flood protected by Detention Basin 2 and the Skye Canyon Phase 3A Infrastructure. No occupancy permits within onsite Phases 3B & 3C will be issued prior to the substantial completion of Detention Basin 2 with the outfall facility (from Detention Basin 2 in Iron Mountain Road to Skye Village Road) and the substantial completion of the Skye Canyon Phase 3A Infrastructure.*

Response: Noted.

4. **Comment:** *The future MPU facility within Skye Village Road north of the Skye Village/Grand Canyon/Iron Mountain intersection to the proposed MPU facility at the Kyle Canyon interchange area shall be substantially complete before occupancy of residential Units beyond Phases 3A, 3B and 3C. This includes residential development within Phases 4 & 6*

and the development of Phase 5 as shown on the Development Phasing Exhibit dated 12/4/2017.

Response: Noted.

5. **Comment:** *The implementation of the CCRFCD Master Plan for the Skye Canyon Master Development is being progressed with the recent 90% design submittal of the Moccasin Rd. CCRFCD Flood Control Facility - US95/Kyle Canyon Rd Interchange to Moccasin Rd. (Skye Canyon Developer Funded) and the Moccasin Rd. CCRFCD Flood Control Facility - Moccasin Rd to CCRFCD Facility LVUP 1076/1077(CCRFCD Funded). Once building permits are released for 75% of the Skye Canyon Development west of US-95 these critical facilities shall be substantially complete in accordance with the provisions of Title 19.02.130 D.*

Response: Acknowledged.

6. **Comment:** *The implementation of the CCRFCD Master Plan is being progressed with the recent bid opening of the NDOT US-95 facilities from the CC-215 interchange north to the Kyle Canyon interchange. Construction of the associated CCRFCD MPU facilities allows for the utilization of the existing MPU facilities constructed with the Horse Interchange. The development of Phases 3A, 3B and 3C west of US-95 shall maximize the flow collection into this facility prior to allowing flows to cross US-95 using the existing culvert system. Provide an Updated **Exhibit G** showing the Ultimate Condition & connection to the existing US-95 facilities. The Ultimate Condition will have the west side of these culvert systems removed, no longer having flows cross US-95 as per the CCRFCD Master Plan.*

Response: The ultimate condition drainage map, Exhibit G, is updated to show existing US 95 frontage road culvert removals, flows conveyed south along US 95, and connection to the US 95 regional storm drain facility.

7. **Comment:** *Revise Exhibit F to reflect the proposed interim MPU facility interception Berm/Levee shown on the Moccasin Rd. CCRFCD Flood Control Facility — US95/Kyle Canyon Rd Interchange to Moccasin Rd. (Skye Canyon Developer Funded) plans.*

Response: Exhibit F is revised to show the interim Moccasin RFCD Facility berm. Flow arrows and descriptions are added to clarify that once the berm is in place, all flow is diverted north along the berm.

8. **Comment:** *Flood Control understands that the new Skye Canyon Master Plan Amendment (MPA) is being included as a part of the 2018 MPU process. Any changes not incorporated in the 2018 MPU must be approved by City of Las Vegas and Clark County Regional Flood Control District (CCRFCD) and shall be adopted by the City of Las Vegas City Council prior to the final approval of the subject improvement plans.*

Response: Noted.

9. **Comment:** *The study shall show that the 10-year dry lane criteria has been addressed for Iron Mountain Road, Skye Canyon Park Drive, and Shaumber Road. Extend the storm drain system as necessary to meet the manual criteria. These are functional arterial roadways as identified in the Skye Canyon Master Plan.*

Response: 10-Yr dry lane criteria is met in all streets in the Phase 3B/3C area with right-of-way widths 80-ft or greater. The table below lists the street flow parameters for these streets and shows that 10-Yr dry lane criteria is met:

Interim Condition 10-Year Street Flow Summary							
Location	Q ₁₀ (cfs)	Slope (%)	Depth (ft)	Velocity (fps)	DxV	Dry Lane Width (ft)	Dry Lane Criteria Met?
Skye Canyon Park Drive	10	4.75	0.32	5.1	1.6	24.0	✓
Shaumber Road	8	1.00	0.37	2.8	1.0	15.0	✓
Iron Mountain Road	6	2.00	0.38	3.9	1.5	21.0	✓

10. **Comment:** *The provided WSPG analysis shows locations along Iron Mountain that exceed the allowable velocity of 25 fps. Review the system design to reduce the velocity and/or propose mitigation measures.*

Response: The existing slope of the Iron Mountain Road alignment exceeds 4% for extended distances, creating the potential for high velocities. To mitigate against velocities higher than 25 fps, an additional 1-inch sacrificial concrete between the storm drain invert and the reinforcing is proposed from Station “IMR” 119+36.99 to 114+06.33, and from Sta “IMR” 103+59.42 to 81+31.79. WSPGW model results included in Appendix D show storm drain velocities, and included plan/profile sheets call out 1-inch sacrificial concrete.

11. **Comment:** *Verify the headwater depths at the culverts will accommodate the HGL of the ultimate storm drain system design.*

Response: In the interim condition, the proposed storm drain stubs function as inlet control culvert entrances, and headwater depths are calculated assuming a ponded orifice condition. In the ultimate condition, storm drains within the parcels are proposed to connect directly to the infrastructure stub with the same size storm drain. The direct connection eliminates the large hydraulic losses associated with ponded water flowing into a culvert entrance, and therefore the interim condition HGL controls at these locations. The only exception to this is the storm drain stub in Iron Mountain Road at Station “IMR” 81+11.79. In this location, the ultimate condition HGL at the culvert entrance is approximately 0.4-ft higher than the proposed WSE, but both are still well below adjacent finished ground.

12. **Comment:** *The subject Phases 3B and 3C Infrastructure Drainage Study addresses the included street improvements of Iron Mountain Road, Skye Canyon Park Drive, Shaumber Road, culvert crossings and storm drain systems with the streets. Technical drainage studies will be required for the future onsite parcels as they develop.*

Response: Acknowledged. Future individual technical drainage studies will be provided with the development of each parcel.

13. **Comment:** *Since the streets network and the associated storm drain facilities will eventually be accepted by the **City of Las Vegas**, the engineer/developer must coordinate with City of Las Vegas Streets & Sanitation Department for their review and approval prior to the final approval of the improvement plans.*

Response: Noted.

14. **Comment:** *Structural plans for the storm drain improvements must be submitted for review by Flood Control and the Building Department. 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 improvement plans. The structural approval is also required to be submitted to CCRFCD prior to concurrence.*

Response: Noted. Structural plans will be submitted with improvement plan submittal.

15. **Comment:** *Phase 3A, 3B, and 3C include storm drain improvements that will be abandoned in the future. These abandoned facilities will impact the adjoining Phase 3B and 3C development parcels. The development of these parcels shall address the impact and removal of these improvements as well as include these items in the Maintenance Bond.*

Response: Phase 3A Infrastructure facilities that are planned to be abandoned are required to be in place until the Moccasin Regional Facility is constructed from the Upper Las Vegas Wash to west of the US 95 frontage road. If the Phase 3A removals are tied to the Phase 3B/3C project and the project is delayed, downstream properties would still experience larger storm flows even if the Moccasin Regional Facility is in place. Likewise, if the Phase 3B/3C project is constructed prior to completion of the Moccasin Regional facility, the facilities cannot be removed because flow patterns would be increased at Iron Mountain Road. It is suggested that removal of Phase 3A facilities be tied to either the Moccasin Regional project or adjacent individual parcel development.

16. **Comment:** *The project proposed to build temporary drainage facilities including drainage berms/swales over the Phases 3B, 3C site and along the west side of Shaumber Road. Prior to the final plans 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 facilities 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.

Response: Noted.

17. **Comment:** *Exhibit H: Clearly label all the street names on the exhibit.*

Response: Exhibit H is revised to clearly label streets.

18. **Comment:** *Exhibit H: Per Page 12 of the drainage study, Facility X13 is revised to 8'x4' RCB from a 60"-RCP as proposed in Phase 3A Infrastructure Drainage Study. Notice that the minimum height of an RCB shall be 5' per City requirements. Revise the facility size to show the minimum 5' RCB height and update the hydraulic calculations accordingly.*

Revise the proposed Facility P22 to per the updated calcs that show the 5' RCB height.

The Phase 3A Infrastructure Drainage Study and the Improvement plans must be revised accordingly.

Response: Existing (Phase 3A) and proposed (Phase 3B/3C) RCB facilities in Iron Mountain Road at Skye Village Road are revised to a 7'x5' RCB to meet CLV minimum height requirements. Revised improvement plans are included, a revised WSPGW model is included in Appendix D, and a revised Exhibit H is included in Appendix B.

19. **Comment:** *Provide maintenance access to all of the inlet and outlet structures. Include a typical access road section.*

Response: Maintenance access is provided to all inlet and outlet structures. A typical access road section is included in the improvement plans on Sheet DTL-01 of each plan set.

20. **Comment:** *Provide off-site grading permission for areas outside of the Skye Canyon Development impacted by these infrastructure improvements.*

Response: Discussions with off-site property owners impacted by grading are currently taking place. Request conditional approval of drainage study so that project can move forward while negotiations are taking place.

21. **Comment:** *The rip-rap sections need to be extended to a minimum depth of 1-foot above the normal depth.*

Response: Riprap sections are extended to 1-foot above WSE. The WSE for the Shaumber Road culvert at Sta 51+29 was too high to provide an additional 1-foot, so the pipe was upsized from 30-inch to 36-inch RCP to bring the WSE down and allow for providing an additional 1-foot vertical of riprap. Revised ponding depth calculation is included in Appendix C.

22. **Comment:** *Review the outlet velocities to verify rip-rap sizing.*

Response: Culvert outlet protection has been prepared in accordance with CCRFCD Manual Section 707.4 - Outlet Protection. Riprap sizing follows subsection 707.4.2 – Rock Size. Culvert outlet riprap sizing calculations are included in Appendix C.

23. **Comment:** *Provide nominal inlets along the arterial streets that do not exceed 660' maximum spacing.*

Response: The 3B/C infrastructure improvements are designed so that flows from developed parcels will be collected within the parcels and discharged to storm drain facilities via stubs. Due to this, the only stormwater anticipated in arterial streets is what rainfall lands in the street. In addition to this, the arterial streets within Skye Canyon are generally of a relatively high slope. These factors combine to produce relatively narrow arterial street flow spreads. In locations where no storm drain is currently proposed, the cost/benefit ratio of extending a storm drain system to collect what rainfall lands in the street is extremely high. Rather than propose this, the table below shows that minor flows have a minimal impact on the roadways and are not anticipated to be a nuisance to motorists or residents.

Interim Condition 10-Year Street Flow Information							
Location	Q ₁₀ (cfs)	Slope (%)	Depth (ft)	Velocity (fps)	DxV	Max. Flow Spread into Street (ft)	Max. Distance between Inlets (ft)
Skye Canyon Park Drive	10	4.75	0.32	5.1	1.6	7.2	1200
Shaumber Road	8	1.00	0.37	2.8	1.0	9.5	1600
Iron Mountain Road	Flow characteristics similar to Skye Canyon Park Drive, however, since a MPU facility is proposed in Iron Mountain Road, nominal drop inlets are provided at requested 660-ft spacing.						

24. **Comment:** *Provide drop inlets upstream of the roadway cross fall transitions to collect flow before it spills across the intersections.*

Response: This situation occurs at Shaumber Road approaching Iron Mountain Road. The plans are revised to include a future drop inlet south of the intersection on the west side of Shaumber Road to collect runoff upstream of the cross fall transition.

25. **Comment:** *Include utility crossings on the storm drain plans. Provide a complete set of Phases 3B and 3C improvement plans that include the Utility and Roadway plans for review to verify.*

Response: Utility crossings are shown on storm drain plans. A complete set of improvement plans is included.

26. **Comment:** *The interim channels adjacent to the infrastructure roadways are the Maintenance responsibility of the Master Developer.*

Response: Noted.

27. **Comment:** *Details show a proposed RCP-Tee section. Provide the location and purpose and/or provide a manhole at that location.*

Response: RCP-Tee section was originally considered for an interim collection scenario, but is no longer proposed and is removed from improvement plans.

28. **Comment:** ***Iron Mountain Road Improvement Plans:***

Sheet PP-01: *In conjunction with the review of Sheep Mountain Parkway Improvements Project, it was commented that why the intersection of Iron Mountain Road and Sheep Mountain Parkway is raised for a few feet above the existing grade. This caused substantial fill and 3:1 scarp in the adjacent properties to the north Iron Mountain Road. Address and revise the intersection design to match the existing grade as close as possible.*

The hydraulic grade line (HGL) of the existing 60"-RCP outfall was missing in the profile viewport.

Upsize the proposed 42"-RCP to 60"-RCP.

Sheet PP-03: *In the profile viewport, the storm drain and HGL upstream of SDMH #60 are missing. The existing and proposed finished grade of the centerline of Iron Mountain Road downstream of Sta. 106+97.04 are also missing. Review and revise accordingly in the next submittal.*

Sheet PP-04 to Sheet PP-07: *Offsite grading is proposed in the adjacent parcels to the north of Iron Mountain Road. The land parcels are owned by various private owners and the BLM. Obtain notarized letter of permission for grading from all the impacted owners and BLM prior to the final approval of the subject drainage study.*

For all impacted offsite properties, address how drainage is perpetuated at the bottom of the proposed scarps.

Sheet PP-04: *Provide a nominal drop inlet at approximately Sta. 100+00 on the south and a stub on the north.*

Sheet PP-05: *Provide maintenance access ramp to the sump condition pit. Label the length of the proposed drop inlet at Sta. 94+36.89.*

Sheet PP-06: *Provide a nominal drop inlet at approximately Sta. 88+00 on the south and a stub on the north.*

Sheet PP-07: *Provide a nominal drop inlet at approximately Sta. 82+00 on the south and a stub on the north.*

Sheet PP-08: *Provide a maintenance access ramp to the sump condition pit. Revise the RCB size to 8'x5'.*

Response:

Sheet PP-01: The Iron Mountain Road and Sheep Mountain Parkway intersection elevation was successfully coordinated with the Sheep Mountain Parkway project. The concept plans prepared by Horrocks set the profile for Sheep Mountain Parkway beyond the extents of Skye Canyon, and therefore are used to insure the Skye Canyon portion is compatible with other reaches. The concept plans have the intersection elevated to allow for a future crossing of Iron Mountain Road beneath Sheep Mountain Parkway. The issue of grading outside right-of-way was resolved by stopping the improvements short enough to allow room for the fill slope to touch down within right-of-way.

Iron Mountain Road plans are revised to show the missing 60" RCP hydraulic grade line.

The section of storm drain proposed as 42" RCP is sufficiently downstream of Detention Basin 2 to avoid negatively impacting the outfall hydraulics. Also, it meets hydraulic criteria, and matches the size proposed in the Master Drainage Study. Therefore, this reach is proposed to remain as a 42" RCP.

Sheet PP-03: Improvement plans are revised to show storm drain, HGL, and EG/FG.

Sheet PP-04 to PP-07: Discussions are taking place with impacted owners to obtain permissions to grade. This is anticipated to take some time. Conditional approval of the drainage study is requested to allow improvement plan process to move forward while this is taking place. There is an existing wash that passes through these parcels. Large offsite flows in this wash will be cut off by Skye Canyon Detention Basin 2 prior to construction of Phase 3B/3C. In the reach of existing wash impacted by the Iron Mountain Road alignment, the proposed roadway slope has been pulled back as much as possible to provide positive drainage along the toe of slope.

Sheet PP-04: Nominal drop inlet on south, and stub on north, provided at Station 100+75.89.

Sheet PP-05: Maintenance access ramp provided to sump. Length of proposed drop inlet at Sta. 94+36.89 is labeled.

Sheet PP-06: Nominal drop inlet on south, and stub on north, provided at Station 90+04.25.

Sheet PP-07: Nominal drop inlet provided on south at Station 80+59.39. Nominal drop inlet on south, and stub on north, provided at Station 80+07.63.

Sheet PP-08: Maintenance access ramp provided to sump. RCB size revised to 7'x5' to meet 5' minimum height criteria.

29. **Comment: Skye Canyon Park Drive Improvement Plans:**

Sheet PP-01: Show maintenance access to the culvert in Shaumber Road.

Sheet PP-02 and Sheet PP-03: The City requires nominal drop inlet at a maximum spacing of 600' in public right of ways. The distance between a proposed drop inlet in Skye Canyon Park Drive (see Sheet PP-03) and the Shaumber Road intersection is more than 1,200 feet. Extend the proposed 18" storm drain to approximately Sta. 46+00 with a nominal inlet on the north side and a stub to the south.

Sheet PP-04: Show the proposed 60"-RCP to the upstream end and provide maintenance access.

Sheet PP-05: Provide maintenance access to the 24"-RCP and a nominal inlet to the north curb of Skye Canyon Park Drive.

Sheet PP-06: Identify an existing regional facility and label with pipe size in Skye Village Drive.

Sheet PP-08: A proposed interim 54"-RCP is also denoted by a Storm Drain Note #5 which called out as a 30"-RCP. Review and revise accordingly.

The 54"-RCP appears to be a throw-away pipe in the future. Address the timeline of the construction of the future 60"-RCP in the next submittal.

Sheet GR-01: Provide maintenance access to both ends of the 54"-culvert.

Response:

Sheet PP-01: Maintenance access to the culvert in Shaumber Road is provided. See Shaumber Road improvement plans.

Sheet PP-02 and PP-03: See response to Comment No. 23.

Sheet PP-04: Matchlines are added to Sheet PP-04 and PP-07 to clarify location of 60" RCP upstream reach. Maintenance access is provided.

Sheet PP-05: Maintenance access is provided to 24" RCP. Nominal inlet at north curb is provided.

Sheet PP-06: Sheet revised to call out existing CCRFCD facility in Skye Village Drive.

Sheet PP-08: Note for RCP is revised from #5 to #8 to match proposed 54" size.

Future 60" RCP alignment shown is a potential future alignment, assuming developer receives approvals to fill in existing wash and convey flow in a storm drain system. The likelihood and potential timing of this scenario are unknown at this time.

Sheet GR-01: Maintenance access to the 54" RCP is now provided on upstream and downstream ends.

30. **Comment: Shaumber Road Improvement Plans:**

Sheet PP-01 and Sheet PP-09: Show the HGL of the existing 36" storm drain in the profile of Sheet PP-01.

Provide maintenance access to the riprap pad in Sheet PP-01.

As shown in the profile viewport of Sheet PP-09, a proposed connection of 60"-RCP to 42"-RCP results to a HGL less than 1-foot below grade which is unacceptable. Upsize the proposed 42"-RCP to 60"-RCP and re-run the hydraulic model to lower the HGL at least one foot below the finished grade. The City requires hinged and grated manholes where the HGL is less than 18-inches below grade. Revise the design accordingly.

Sheet PP-02: Provide 2-18" lateral stubs at approximately Sta. 29+00 on both sides of Shaumber Road.

Provide maintenance access to the riprap pads.

Sheet PP-03 and Sheet PP-04: Extend the storm drain at SDMH #20 to the south with an 18" pipe to approximately Sta. 36+00. Provide two stubs at the end of the 18"-storm drain.

Sheet PP-05: Provide maintenance access to the riprap pads.

Sheets PP-06 to PP-08: Extend the storm drain at SDMH #65 (in Sheet PP-08) to the south with an 18" pipe to approximately Sta. 56+00. Provide two stubs at the end of the 18" storm drain (Sheet PP-06) and another two stubs at approximately Sta. 62+00 (Sheet PP-07).

Response:

Sheet PP-01 and Sheet PP-09: HGL of existing 36" SD is now included in profile. See Appendix D for revised WSPGW model.

Maintenance access is provided to the riprap pad in Sheet PP-01.

Proposed 42" RCP to the west (see Sheet PP-09) is revised to a 54" RCP, see Appendix D for revised WSPGW model. This brings the HGL down to lower than 18-inches below finished grade. With this change, the HGL in the reach is now controlled by the HGL at the downstream junction, as evidenced by the relatively flat HGL from SDMH #8 back, and upsizing to a 60" RCP would not significantly lower the HGL.

Sheet PP-02: Stubs are provided at SDMH #9.

Sheet PP-03 and PP-04: See response to Comment No. 23.

Sheet PP-05: Maintenance access is provided to the riprap pads.

Sheet PP-06 to PP-08: See response to Comment No. 23.

The revised plan, profile and detail sheets adopting the revisions addressed in this letter are included with this submittal. 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

A handwritten signature in black ink, appearing to read 'Lant Leavitt', with a stylized, flowing script.

Lant Leavitt, P.E.
Flood Control Division

cc: Derick Yoro, P.E. – SHG
Mark Failla, P.E., CFM – SHG

APPENDIX

Appendix A CLV Comment Letter

Appendix B Revised Drainage Exhibits

Appendix C Surface Flow Hydraulic Computations

- Culvert Inlet Nomographs
- Culvert Outlet Protection Computations

Appendix D Storm Drain Analyses

- Iron Mountain Road
 - o Model "UIRM1" - Mainline
 - o Model "PIRM1-L3" – Interim Lateral at Skye Village Road
- Shaumber Road
 - o Model "USHA1" – South Mainline
 - o Model "SHA1-L" – DB1 Outfall Connection to Shaumber
 - o Model "USHA2B-L" – Lateral to Center Mainline

Appendix E CD of Electronic Files & Revised Improvement Plans

APPENDIX A

CLV Comment Letter

CITY OF LAS VEGAS			DATE:
INTER-OFFICE MEMORANDUM			May 17, 2018
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:		COPIES TO:
	Skye Canyon – Phases 3B & 3C Infrastructure		Slater Hanifan Group
Cross Streets:	NWC of Skye Village Road & Skye Canyon Park Drive		M F Land LLC / Ninety-Five Management LLC
File Number:	F:\Depot\DSMemos\DS4953A.doc		Bart Anderson, P.E., DevCo
Parcel Number:	126-12-101-002		CCRFCD
Zoning Action:			
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	2/8/2017	3/9/2018 & 5/15/2018	See Comments Below	\$400.00	493315: \$400
			TOTAL FEES (LDDRS):	\$400.00	----

REMARKS: Review also includes Master Plan Update #4 Supplemental information that was approved April 25, 2018.

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

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

1. 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.
2. The subject *Skye Canyon Phases 3B & 3C Infrastructure Drainage Study* will not be approved prior to the final approval of the *Skye Canyon Detention Basin 2* and the *Skye Canyon Phase 3A Infrastructure Technical Drainage Studies*.
3. *Skye Canyon Phases 3B & 3C* onsite developments are to be flood protected by *Detention Basin 2* and the *Skye Canyon Phase 3A Infrastructure*. No occupancy permits within onsite *Phases 3B & 3C* will be issued prior to the substantial completion of *Detention Basin 2 with the outfall facility (from Detention Basin 2 in Iron Mountain Road to Skye Village Road)* and the substantial completion of the *Skye Canyon Phase 3A Infrastructure*.
4. The future MPU facility within Skye Village Road north of the Skye Village/Grand Canyon/Iron Mountain intersection to the proposed MPU facility at the Kyle Canyon interchange area shall be substantially complete before occupancy of residential Units beyond Phases 3A, 3B and 3C. This includes residential development within Phases 4 & 6 and the development of Phase 5 as shown on the *Development Phasing Exhibit* dated 12/4/2017.

5. The implementation of the CCRFCD Master Plan for the Skye Canyon Master Development is being progressed with the recent 90% design submittal of the *Moccasin Rd. CCRFCD Flood Control Facility – US95/Kyle Canyon Rd Interchange to Moccasin Rd. (Skye Canyon Developer Funded)* and the *Moccasin Rd. CCRFCD Flood Control Facility – Moccasin Rd to CCRFCD Facility LVUP 1076/1077(CCRFCD Funded)*. Once building permits are released for 75% of the Skye Canyon Development west of US-95 these critical facilities shall be substantially complete in accordance with the provisions of Title 19.02.130 D.
6. The implementation of the CCRFCD Master Plan is being progressed with the recent bid opening of the NDOT US-95 facilities from the CC-215 interchange north to the Kyle Canyon interchange. Construction of the associated CCRFCD MPU facilities allows for the utilization of the existing MPU facilities constructed with the Horse Interchange. The development of Phases 3A, 3B and 3C west of US-95 shall maximize the flow collection into this facility prior to allowing flows to cross US-95 using the existing culvert system. Provide an Updated **Exhibit G** showing the Ultimate Condition & connection to the existing US-95 facilities. The Ultimate Condition will have the west side of these culvert systems removed, no longer having flows cross US-95 as per the CCRFCD Master Plan.
7. Revise Exhibit F to reflect the proposed interim MPU facility interception Berm/Levee shown on the *Moccasin Rd. CCRFCD Flood Control Facility – US95/Kyle Canyon Rd Interchange to Moccasin Rd. (Skye Canyon Developer Funded) plans*.
8. *Flood Control* understands that the new *Skye Canyon Master Plan Amendment (MPA)* is being included as a part of the 2018 MPU process. Any changes not incorporated in the 2018 MPU must be approved by *City of Las Vegas* and *Clark County Regional Flood Control District (CCRFCD)* and shall be adopted by the *City of Las Vegas City Council* prior to the final approval of the subject improvement plans.
9. The study shall show that the 10-year dry lane criteria has been addressed for *Iron Mountain Road, Skye Canyon Park Drive, and Shaumber Road*. Extend the storm drain system as necessary to meet the manual criteria. These are functional arterial roadways as identified in the Skye Canyon Master Plan.
10. The provided WSPG analysis shows locations along Iron Mountain that exceed the allowable velocity of 25 fps. Review the system design to reduce the velocity and/or propose mitigation measures.
11. Verify the headwater depths at the culverts will accommodate the HGL of the ultimate storm drain system design.
12. The subject *Phases 3B and 3C Infrastructure Drainage Study* addresses the included street improvements of *Iron Mountain Road, Skye Canyon Park Drive, Shaumber Road*, culvert crossings and storm drain systems with the streets. Technical drainage studies will be required for the future onsite parcels as they develop.
13. Since the streets network and the associated storm drain facilities will eventually be accepted by the **City of Las Vegas**, the engineer/developer must coordinate with *City of Las Vegas Streets & Sanitation Department* for their review and approval prior to the final approval of the improvement plans.
14. Structural plans for the storm drain improvements must be submitted for review by *Flood Control* and the *Building Department*. 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 improvement plans. The structural approval is also required to be submitted to CCRFCD prior to concurrence.

15. Phase 3A, 3B, and 3C include storm drain improvements that will be abandoned in the future. These abandoned facilities will impact the adjoining Phase 3B and 3C development parcels. The development of these parcels shall address the impact and removal of these improvements as well as include these items in the Maintenance Bond.
16. The project proposed to build temporary drainage facilities including drainage berms/swales over the *Phases 3B, 3C* site and along the west side of *Shaumber Road*. Prior to the final plans 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 facilities 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.

17. **Exhibit H:** Clearly label all the street names on the exhibit.
18. **Exhibit H:** Per Page 12 of the drainage study, *Facility X13* is revised to 8'x4' RCB from a 60"-RCP as proposed in Phase 3A Infrastructure Drainage Study. Notice that the minimum height of an RCB shall be 5' per City requirements. Revise the facility size to show the minimum 5' RCB height and update the hydraulic calculations accordingly.

Revise the proposed *Facility P22* to per the updated calcs that show the 5' RCB height.

The *Phase 3A Infrastructure Drainage Study* and the Improvement plans must be revised accordingly.

19. Provide maintenance access to all of the inlet and outlet structures. Include a typical access road section.
20. Provide off-site grading permission for areas outside of the Skye Canyon Development impacted by these infrastructure improvements.
21. The rip-rap sections need to be extended to a minimum depth of 1-foot above the normal depth.
22. Review the outlet velocities to verify rip-rap sizing.
23. Provide nominal inlets along the arterial streets that do not exceed 660' maximum spacing.
24. Provide drop inlets upstream of the roadway cross fall transitions to collect flow before it spills across the intersections.
25. Include utility crossings on the storm drain plans. Provide a complete set of Phases 3B and 3C improvement plans that include the Utility and Roadway plans for review to verify.
26. The interim channels adjacent to the infrastructure roadways are the Maintenance responsibility of the Master Developer.
27. Details show a proposed RCP-Tee section. Provide the location and purpose and/or provide a manhole at that location.

28. **Iron Mountain Road Improvement Plans:**

Sheet PP-01: In conjunction with the review of *Sheep Mountain Parkway Improvements Project*, it was commented that why the intersection of *Iron Mountain Road* and *Sheep Mountain Parkway* is

raised for a few feet above the existing grade. This caused substantial fill and 3:1 scarp in the adjacent properties to the north *Iron Mountain Road*. Address and revise the intersection design to match the existing grade as close as possible.

The hydraulic grade line (HGL) of the existing 60"-RCP outfall was missing in the profile viewport.

Upsize the proposed 42"-RCP to 60"-RCP.

Sheet PP-03: In the profile viewport, the storm drain and HGL upstream of SDMH #60 are missing. The existing and proposed finished grade of the centerline of *Iron Mountain Road* downstream of Sta. 106+97.04 are also missing. Review and revise accordingly in the next submittal.

Sheet PP-04 to Sheet PP-07: Offsite grading is proposed in the adjacent parcels to the north of *Iron Mountain Road*. The land parcels are owned by various private owners and the BLM. Obtain notarized letter of permission for grading from all the impacted owners and BLM prior to the final approval of the subject drainage study.

For all impacted offsite properties, address how drainage is perpetuated at the bottom of the proposed scarps.

Sheet PP-04: Provide a nominal drop inlet at approximately Sta. 100+00 on the south and a stub on the north.

Sheet PP-05: Provide maintenance access ramp to the sump condition pit.

Label the length of the proposed drop inlet at Sta. 94+36.89.

Sheet PP-06: Provide a nominal drop inlet at approximately Sta. 88+00 on the south and a stub on the north.

Sheet PP-07: Provide a nominal drop inlet at approximately Sta. 82+00 on the south and a stub on the north.

Sheet PP-08: Provide a maintenance access ramp to the sump condition pit. Revise the RCB size to 8'x5'.

29. Skye Canyon Park Drive Improvement Plans:

Sheet PP-01: Show maintenance access to the culvert in *Shaumber Road*.

Sheet PP-02 and Sheet PP-03: The City requires nominal drop inlet at a maximum spacing of 600' in public right of ways. The distance between a proposed drop inlet in *Skye Canyon Park Drive* (see Sheet PP-03) and the *Shaumber Road* intersection is more than 1,200 feet. Extend the proposed 18" storm drain to approximately Sta. 46+00 with a nominal inlet on the north side and a stub to the south.

Sheet PP-04: Show the proposed 60"-RCP to the upstream end and provide maintenance access.

Sheet PP-05: Provide maintenance access to the 24"-RCP and a nominal inlet to the north curb of *Skye Canyon Park Drive*.

Sheet PP-06: Identify an existing regional facility and label with pipe size in *Skye Village Drive*.

Sheet PP-08: A proposed interim 54"-RCP is also denoted by a Storm Drain Note #5 which called out as a 30"-RCP. Review and revise accordingly.

The 54"-RCP appears to be a throw-away pipe in the future. Address the timeline of the construction of the future 60"-RCP in the next submittal.

Sheet GR-01: Provide maintenance access to both ends of the 54"-culvert.

30. Shaumber Road Improvement Plans:

Sheet PP-01 and Sheet PP-09: Show the HGL of the existing 36" storm drain in the profile of Sheet PP-01.

Provide maintenance access to the riprap pad in Sheet PP-01.

As shown in the profile viewport of Sheet PP-09, a proposed connection of 60"-RCP to 42"-RCP results to a HGL less than 1-foot below grade which is unacceptable. Upsize the proposed 42"-RCP to 60"-RCP and re-run the hydraulic model to lower the HGL at least one foot below the finished grade. The City requires hinged and grated manholes where the HGL is less than 18-inches below grade. Revise the design accordingly.

Sheet PP-02: Provide 2-18" lateral stubs at approximately Sta. 29+00 on both sides of *Shaumber Road*.

Provide maintenance access to the riprap pads.

Sheet PP-03 and Sheet PP-04: Extend the storm drain at SDMH #20 to the south with an 18" pipe to approximately Sta. 36+00. Provide two stubs at the end of the 18"-storm drain.

Sheet PP-05: Provide maintenance access to the riprap pads.

Sheets PP-06 to PP-08: Extend the storm drain at SDMH #65 (in Sheet PP-08) to the south with an 18" pipe to approximately Sta. 56+00. Provide two stubs at the end of the 18" storm drain (Sheet PP-06) and another two stubs at approximately Sta. 62+00 (Sheet PP-07).

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

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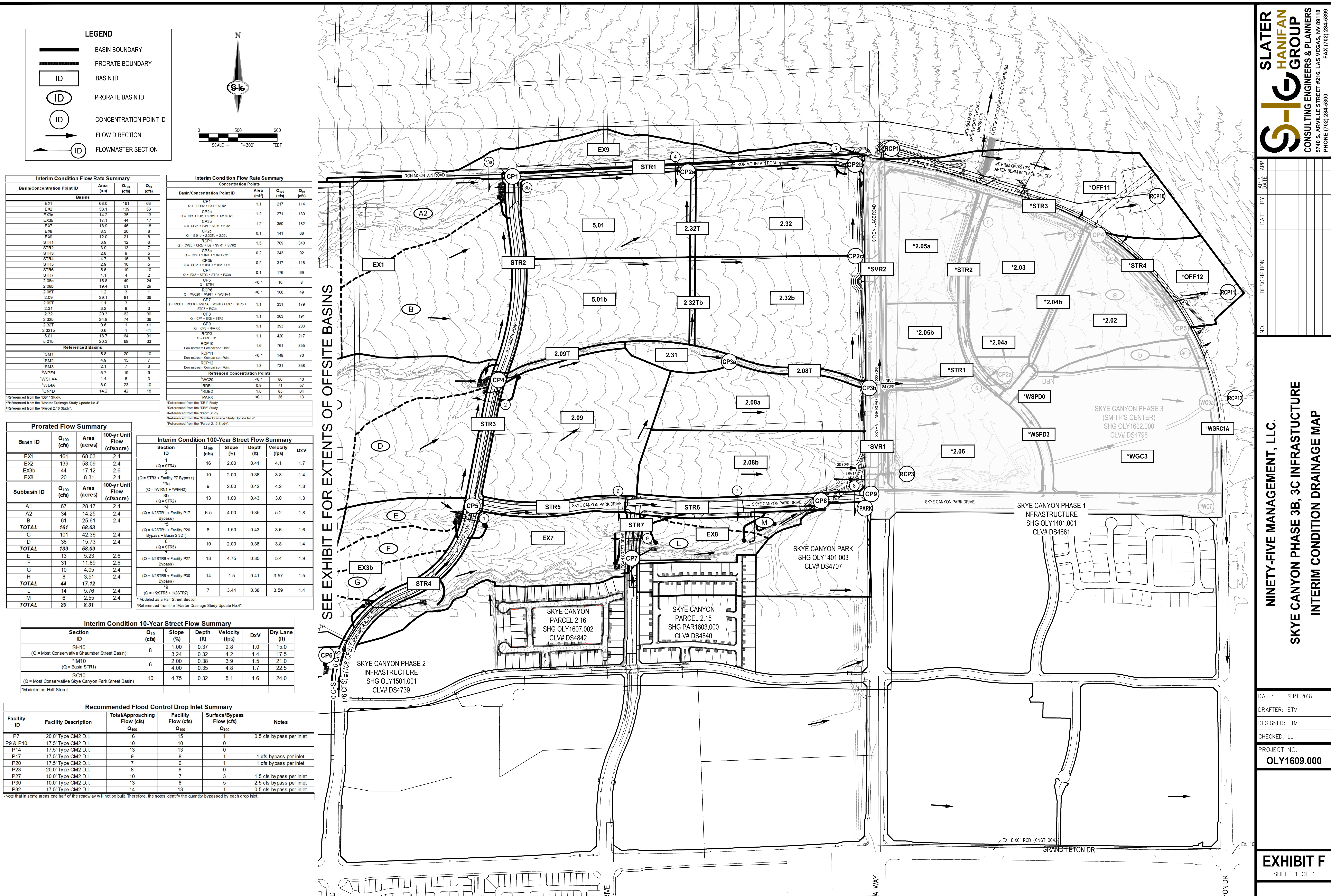
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AREA: F-12

APPENDIX B

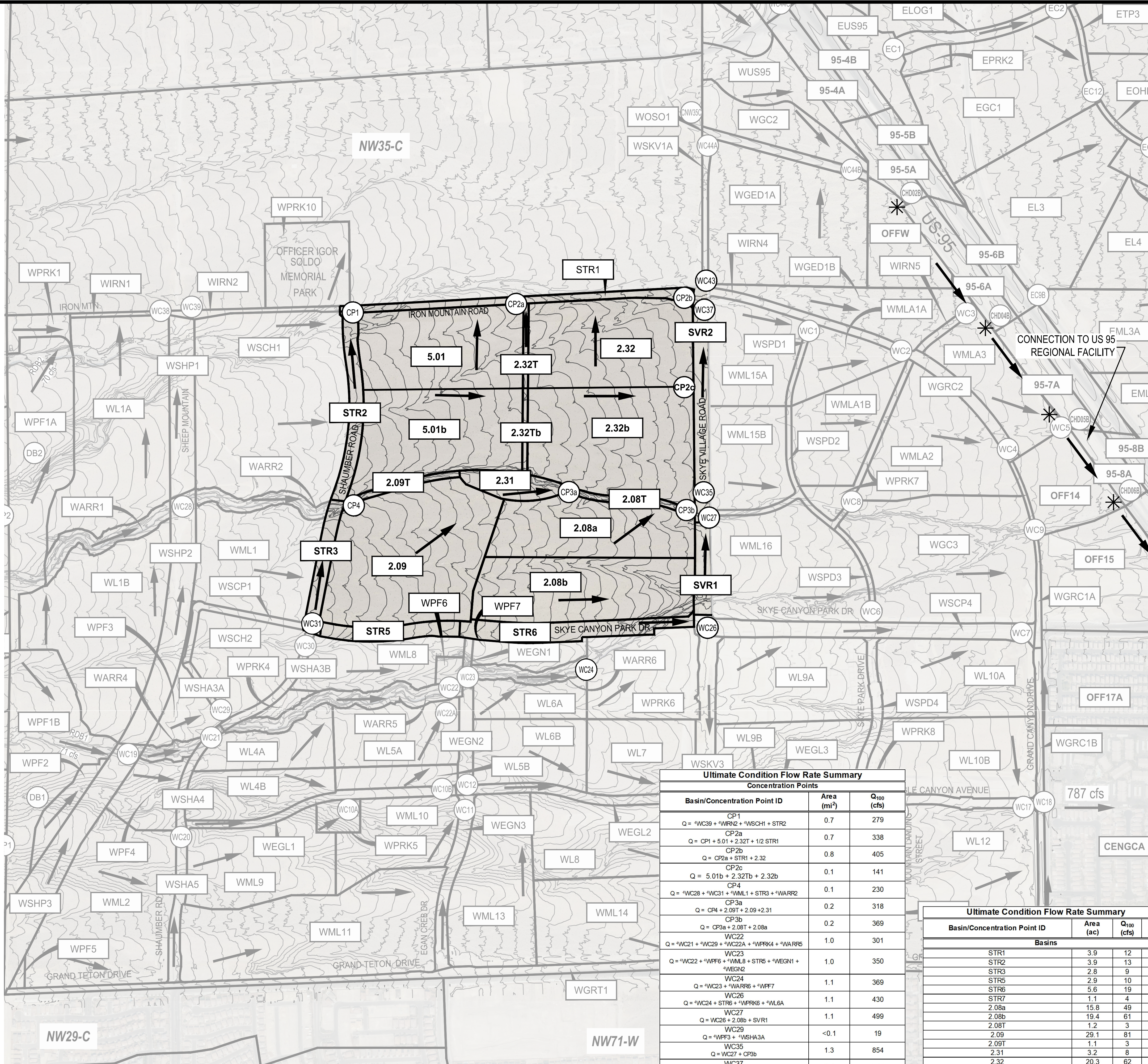
Revised Drainage Exhibits

\\s01609-000\skye_canyon_phase_3b_3c\drawings\phase_3b_3c\skye\addendum\figures\oly1609_000_exhibit_f_interim_condition_drainage_map.dwg 9/5/2018 3:00 PM Lant Levels



F:\01609-000_skye_canyon_phase_3b_3c_drainage\phase_3b_3c_study\addendum\figures\oly1609_000s exhibit 4 ultimate condition drainage map.dwg 9/4/2018 4:11 PM Lent Levitt

SEE REFERENCED EXHIBIT E FROM THE MASTER DRAINAGE STUDY UPDATE FOR EXTENTS OF ULTIMATE BASINS



NOTE:

- THE MAP VIEWPORT HAS ONLY INCLUDED THE MOST PERTINENT BASINS TO THE PROJECT SITE.
- BOLD CONCENTRATION POINTS HAVE BEEN UTILIZED FOR ULTIMATE CONDITION WSPW MODEL AND SIZING OF STORM DRAIN.
- BOLD CONCENTRATION POINTS LOCATED AT THE EAST SIDE OF THE PROJECT SITE HAVE BEEN UTILIZED AS COMPARISON POINTS TO THE MOST CURRENT MASTER DRAINAGE STUDY UPDATE.
- SEE REFERENCED ULTIMATE CONDITION EXHIBIT E FROM THE MASTER DRAINAGE STUDY UPDATE FOR THE FULL EXTENTS OF THE ULTIMATE CONDITION WATERSHED.

Ultimate Condition Flow Rate Summary			
Skye Canyon West Basins			
Basin/Concentration Point ID	Area (sq. mi)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
WARR1	3.6	9	4
WARR2	2.8	7	3
WARR3	7.1	17	7
WARR4	1.3	3	1
WARR5	8.0	18	8
WARR6	2.4	6	2
WARR7	8.3	24	11
WARR8	8.3	23	10
WARR9	30.4	95	47
WARR10	28.4	77	35
WARR11	11.5	33	16
WARR12	17.1	48	21
WARR13	18.3	49	22
WARR14	38.7	99	46
WARR15	31.4	84	38
WARR16	29.8	81	38
WARR17	28.0	79	36
WARR18	15.7	45	21
WARR19	24.9	69	32
WARR20	8.0	23	10
WARR21	8.9	27	12
WARR22	10.9	32	15
WARR23	12.5	36	17
WARR24	9.2	19	9
WARR25	10.6	30	14
WARR26	11.5	34	16
WARR27	17.4	48	22
WARR28	18.2	49	22
WARR29	14.4	39	18
WARR30	15.1	40	20
WARR31	11.6	38	19
WARR32	18.0	48	23
WARR33	15.1	40	20
WARR34	16.4	49	25
WARR35	19.2	59	29
WARR36	12.3	40	20
WARR37	11.2	34	17
WARR38	22.2	64	32
WARR39	27.4	78	38
WARR40	17.3	56	29
WARR41	25.1	77	38
WARR42	27.3	82	41
WARR43	20.5	64	32
WARR44	18.6	59	30
WARR45	10.3	34	17
WARR46	16.4	56	29
WARR47	6.5	20	10
WARR48	12.0	37	18
WARR49	30.4	95	47
WARR50	11.5	35	17
WARR51	20.2	59	29
WARR52	18.9	63	31
WARR53	3.1	10	5
WARR54	4.6	17	8
WARR55	4.5	14	7
WARR56	2.4	6	3
WARR57	10.0	19	8
WARR58	3.2	7	2
WARR59	1.8	4	2
WARR60	1.0	3	1
WARR61	2.0	5	2
WARR62	15.2	28	10
WARR63	3.0	8	2
WARR64	1.7	4	1
WARR65	0.5	1	0
WARR66	38.4	106	48
WARR67	11.5	37	18

Ultimate Condition Flow Rate Summary			
West Roadway Basins			
Basin/Concentration Point ID	Area (ac)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
WEGU1	3.4	12	6
WEGU2	3.3	12	7
WEGU3	4.8	16	9
WEGU4	0.5	2	1
WEGU5	2.1	2	1
WEGU6	3.3	10	6
WEGU7	1.3	4	2
WEGU8	3.2	10	5
WEGU9	11.7	16	10
WEGU10	0.8	2	1
WEGU11	2.2	7	4
WEGU12	1.3	5	3
WEGU13	2.7	9	5
WEGU14	0.7	3	2
WEGU15	1.3	5	2
WEGU16	2.2	8	3
WEGU17	1.5	6	3
WEGU18	3.0	11	6
WEGU19	3.5	13	7
WEGU20	7.8	25	14
WEGU21	2.3	6	2
WEGU22	1.6	5	2
WEGU23	0.7	3	1
WEGU24	1.6	6	3
WEGU25	1.4	5	3
WEGU26	2.4	8	3
WEGU27	1.1	3	1
WEGU28	2.3	6	2
WEGU29	2.4	8	3
WEGU30	2.3	6	2
WEGU31	0.6	1	<1
WEGU32	0.6	1	<1
WEGU33	18.7	64	31
WEGU34	20.3	68	33

Ultimate Condition Flow Rate Summary			
Referenced Basins			
Basin/Concentration Point ID	Area (ac)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
WARR1	2.7	10	5
WARR2	6.4	20	10

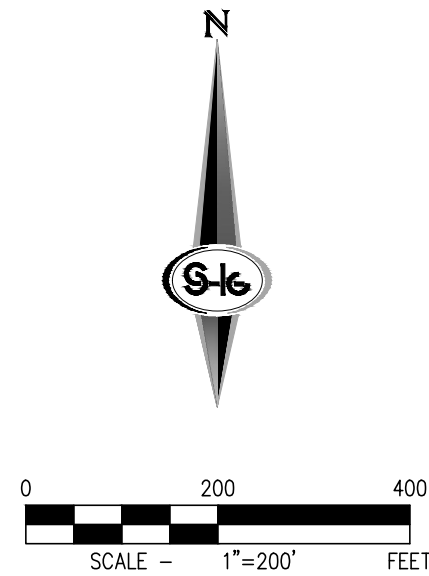
Ultimate Condition Flow Rate Summary			
Skye Canyon West Basins			
Basin/Concentration Point ID	Area (sq. mi)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
WARR1	3.6	9	4
WARR2	2.8	7	3
WARR3	7.1	17	7
WARR4	1.3	3	1
WARR5	8.0	18	8
WARR6	2.4	6	2
WARR7	8.3	24	11
WARR8	8.3	23	10
WARR9	30.4	95	47
WARR10	28.4	77	35
WARR11	11.5	33	16
WARR12	17.1	48	21
WARR13	18.3	49	22
WARR14	38.7	99	46
WARR15	31.4	84	38
WARR16	29.8	81	38
WARR17	28.0	79	36
WARR18	15.7	45	21
WARR19	24.9	69	32
WARR20	8.0	23	10
WARR21	8.9	27	12
WARR22	10.9	32	15
WARR23	12.5	36	17
WARR24	9.2	19	9
WARR25	10.6	30	14
WARR26	11.5	34	16
WARR27	17.4	48	22
WARR28	18.2	49	22
WARR29	14.4	39	18
WARR30	15.1	40	20
WARR31	11.6	38	19
WARR32	18.0	48	23
WARR33	15.1	40	20
WARR34	16.4	49	25
WARR35	19.2	59	29
WARR36	12.3	40	20
WARR37	11.2	34	17
WARR38	22.2	64	32
WARR39	27.4	78	38
WARR40	17.3	56	29
WARR41	25.1	77	38
WARR42	27.3	82	41
WARR43	20.5	64	32
WARR44	18.6	59	30
WARR45	10.3	34	17
WARR46	16.4	56	29
WARR47	6.5	20	10
WARR48	12.0	37	18
WARR49	30.4	95	47
WARR50	11.5	35	17
WARR51	20.2	59	29
WARR52	18.9	63	31
WARR53	3.1	10	5
WARR54	4.6	17	8
WARR55	4.5	14	7
WARR56	2.4	6	3
WARR57	10.0	19	8
WARR58	3.2	7	2
WARR59	1.8	4	2
WARR60	1.0	3	1
WARR61	2.0	5	2
WARR62	15.2	28	10
WARR63	3.0	8	2
WARR64	1.7	4	1
WARR65	0.5	1	0
WARR66	38.4	106	48
WARR67	11.5	37	18

Ultimate Condition Flow Rate Summary			
West Roadway Basins			
Basin/Concentration Point ID	Area (ac)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
WEGU1	3.4	12	6
WEGU2	3.3	12	7
WEGU3	4.8	16	9
WEGU4	0.5	2	1
WEGU5	2.1	2	1
WEGU6	3.3	10	6
WEGU7	1.3	4	2
WEGU8	3.2	10	5
WEGU9	11.7	16	10
WEGU10	0.8	2	1
WEGU11	2.2	7	4
WEGU12	1.3	5	3
WEGU13	2.7	9	5
WEGU14	0.7	3	2
WEGU15	1.3	5	2
WEGU16	2.2	8	3
WEGU17	1.5	6	3
WEGU18	3.0	11	6
WEGU19	3.5	13	7
WEGU20	7.8	25	14
WEGU21	2.3	6	2
WEGU22	1.6	5	2
WEGU23	0.7	3	1
WEGU24	1.6	6	3
WEGU25	1.4	5	3
WEGU26	2.4	8	3
WEGU27	1.1	3	1
WEGU28	2.3	6	2
WEGU29	2.4	8	3
WEGU30	2.3	6	2
WEGU31	0.6	1	<1
WEGU32	0.6	1	<1
WEGU33	18.7	64	31
WEGU34	20.3	68	33

Ultimate Condition Flow Rate Summary			
Referenced Basins			
Basin/Concentration Point ID	Area (ac)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
WARR1	2.7	10	5
WARR2	6.4	20	10

REFERENCE BASINS AND CONCENTRATION POINTS				
Ultimate Condition Flow Rate Summary				
Skye Canyon West Basins				
Basin/Concentration Point ID	Area (sq. mi)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)	
WARR1	3.6	9	4	
WARR2	2.8	7	3	
WARR3	7.1	17	7	
WARR4	1.3	3	1	
WARR5	8.0	18	8	
WARR6	2.4	6	2	
WARR7	8.3	24	11	
WARR8	8.3	23	10	
WARR9	30.4	95	47	
WARR10	28.4	77	35	
WGED18	11.5	33	16	
WL5A	17.1	48	21	
WL6	18.3	49	22	
WL11	38.7	99	46	
WL12	31.4	84	38	
WL13	29.8	81	38	
WL18	28.0	79	36	
WL2	15.7	45	21	
WL3	24.9	69	32	
WL4	8.0	23	10	
WL4B	8.9	27	12	
WL5	10.9	32	15	
WL5B	3.8	12	5	
WL6A	6.2	19	9	
WL6B	10.6	30	14	
WL7	11.5	34	16	
WL8	17.4	48	22	
WL9A	18.2	49	22	
WL9B	14.4	39	18	
WML1	15.1	40	20	
WML10	11.6	38	19	
WML11	18.0	48	23	
WML12	15.1	44	20	
WML13	16.4	49	25	
WML14	19.2	59	29	
WML15A	12.3	40	20	
WML15B	11.2	34	17	
WML16	22.2	64	32	
WML2	27.4	78	38	
WML3	17.3	56	28	
WML4	25.1	77	38	
WML5	27.3	82	41	
WML6	20.5	64	32	
WML7	18.3	59	30	
WML8	10.3	34	17	
WML9A	16.4	55	28	
WML9B	6.5	20	10	
WML18B	12.0	37	18	
WML2A	30.4	88	44	
WML3A	11.5	35	17	
WPF1A	20.2	59	29	
WPF1B	18.9	63	31	
WPF2	3.1	10	5	
WPF3	4.8	17	8	
WPF4	5.7	19	9	
WPF5	0.4	1	0	
WPF6	1.0	4	2	
WPF7	4.5	14	7	
WPF8	4.5	14	7	
WPRK1	2.4	6	2	
WPRK2	10.0	19	8	
WPRK3	1.8	4	2	
WPRK5	2.0	5	2	
WPRK6	13.2	28	10	
WPRK7	3.0	6	2	
WPRK8	4.7	4	2	
WPRK9	0.5	1	0	
WSCH1	89.4	108	48	
WSCH2	11.5	37	18	

Ultimate Condition Flow Rate Summary				
Skye Canyon West Concentration Points				
Basin/Concentration Point ID	Area (sq. mi)	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)	
Q = WML5A + WSPD1	0.02	43	21	
WC1	0.03	73	37	
Q = WC1 + WSRN4 + WMLA1A	0.05	109	54	
Q = WC2 + WSED2 + WMR5	0.08	135	67	
WC2	0.08	135	67	
Q = WPRK7 + WSED6 + WMLA2 + WGR2	0.09	170	83	
WC5	0.04	170	83	
Q = WC4 + WMLA3	0.04	68	33	
WC7	0.10	186	89	
Q = WC3 + WMLA + WML1 + WSPC4	0.12	37	15	
Q = WML18 + WSPD2	0.07	32	15	
WG9	0.17	322	155	
Q = WC7 + WC3 + WPRC3A + WG3	0.03	60	30	
WC10D	0.05	99	48	
Q = WC10A + WML8 + WEG11	0.07	127	61	
WC11	0.11	226	109	
Q = WML2 + WEG10	0.11	352	170	
WC12	0.24	485	236	
Q = WC12 + WML6 + WMT + WML13 + WEG12	0.24	485	236	
WC13	0.03	46	21	
Q = WC13 + WML4 + WML8 + WSRV3 + WSRV4	0.06	106	48	
WC15	0.37	695	331	
Q = WML6 + WSPD4	0.42	787	372	
WC16	0.90	94	70	
Q = WML11 + WPRK7 + WSPR3 + WMLT1	0.96	201	121	
WC17	0.05	67	43	
Q = WC14 + WML5 + WC16 + WEG13 + WL10B	1.01	282	189	
WC18	0.42	787	372	
Q = WC17 + WL12 + WGR18	0.90	94	70	
WC19	0.05	86	42	
Q = RB21 + WSPR2 + WPF2	0.96	201	121	
WC20	0.05	67	43	
Q = WPR5 + WSPR3 + WGR45	0.96	201	121	
WC21	0.05	67	43	
Q = WC19 + WC20 + WARR6 + WPF4 + WGR4A	1.01	282	189	
WC22A	0.05	67	43	
Q = WML4 + WML6 + WL15B	1.03	358	184	
WC23	0.01	16	8	
Q = WC17 + WML2A + WPRK4 + WARR10	1.08	412	217	
WC24	1.12	487	253	
Q = WC22 + WARR6 + WPF6 + WEDN1 + WEDN2	0.06	113	53	
WC25	0.04	62	29	
Q = WSPD2 + WPRK3	0.04	62	29	
WC26	0.04	62	29	
Q = WC26 + WARR6 + WPRK6 + WSPC3	0.04	68	33	
WC27	0.04	68	33	
Q = WC27 + WML1 + WSPR2	0.14	244	113	
WC28	0.23	404	191	
Q = WC28 + WML1 + WSGR2	0.34	876	436	
WC29	1.03	51	23	
Q = WML8 + WARR1 + WSPR2	1.03	51	23	
WC30	0.01	19	10	
Q = WPR5 + WMLA3A	0.04	62	29	
WC31	0.04	68	33	
Q = WC29 + WC30 + WMLA3B	0.07	321	170	
WC32	0.72	397	209	
Q = WC32 + WML2 + WSRV1B + WL3	0.62	139	84	
WC33	0.63	157	93	
Q = RB22 + WPRC1 + WPR1 + WL1A	0.07	112	50	
WC34	0.72	397	209	
Q = WC34 + WARR6 + WML1 + WML6	2.18	1325	648	
WC35	4.95	2130	950	
Q = WC35 + WARR6 + WML1 + WML6	4.95	2130	950	
WC36	0.18	250	97	
Q = WC36 + WML2 + WSGR1A	0.18	250	97	
WC37	0.18	250	97	
Q = WC37 + WML2 + WSGR1A	0.18	250	97	
WC38	0.18	250	97	
Q = WC38 + WML2 + WSGR1A	0.18	250	97	
WC39	0.18	250	97	
Q = WC39 + WML2 + WSGR1A	0.18	250	97	
WC40	0.18	250	97	
Q = WC40 + WML2 + WSGR1A	0.18	250	97	
WC41	0.18	250	97	
Q = WC41 + WML2 + WSGR1A	0.18	250	97	
WC42	0.18	250	97	
Q = WC42 + WML2 + WSGR1A	0.18	250	97	
WC43	0.18	250	97	
Q = WC43 + WML2 + WSGR1A	0.18	250	97	
WC44	0.18	250	97	
Q = WC44 + WML2 + WSGR1A	0.18	250	97	
WC45	0.18	250	97	
Q = WC45 + WML2 + WSGR1A	0.18	250	97	
WC46	0.18	250	97	
Q = WC46 + WML2 + WSGR1A	0.18	250	97	
WC47	0.18	250	97	
Q = WC47 + WML2 + WSGR1A	0.18	250	97	
WC48	0.18	250	97	
Q = WC48 + WML2 + WSGR1A	0.18	250	97	
WC49	0.18	250	97	
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WC50	0.18	250	97	
Q = WC50 + WML2 + WSGR1A	0.18	250	97	
WC51	0.18	250	97	
Q = WC51 + WML2 + WSGR1A	0.18	250	97	
WC52	0.18	250	97	
Q = WC52 + WML2 + WSGR1A	0.18	250	97	
WC53	0.18	250	97	
Q = WC53 + WML2 + WSGR1A	0.18	250	97	
WC54	0.18	250	97	
Q = WC54 + WML2 + WSGR1A	0.18	250	97	
WC55	0.18	250	97	
Q = WC55 + WML2 + WSGR1A	0.18	250	97	
WC56	0.18	250	97	
Q = WC56 + WML2 + WSGR1A	0.18	250	97	
WC57	0.18	250	97	
Q = WC57 + WML2 + WSGR1A	0.18	250	97	
WC58	0.18	250	97	
Q = WC58 + WML2 + WSGR1A	0.18	250	97	
WC59	0.18	250	97	
Q = WC59 + WML2 + WSGR1A	0.18	250	97	
WC60	0.18	250	97	
Q = WC60 + WML2 + WSGR1A	0.18	250	97	
WC61	0.18	250	97	
Q = WC61 + WML2 + WSGR1A	0.18	250	97	
WC62	0.18	250	97	
Q = WC62 + WML2 + WSGR1A	0.18	250	97	
WC63	0.18	250	97	
Q = WC63 + WML2 + WSGR1A	0.18	250	97	
WC64	0.18	250	97	
Q = WC64 + WML2 + WSGR1A	0.18	250	97	
WC65	0.18	250	97	
Q = WC65 + WML2 + WSGR1A	0.18	250	97	
WC66	0.18	250	97	
Q = WC66 + WML2 + WSGR1A	0.18	250	97	
WC67	0.18	250	97	
Q = WC67 + WML2 + WSGR1A	0.18	250	97	
WC68	0.18	250	97	
Q = WC68 + WML2 + WSGR1A	0.18	250	97	
WC69	0.18	250	97	
Q = WC69 + WML2 + WSGR1A	0.18	250	97	
WC70	0.18	250	97	
Q = WC70 + WML2 + WSGR1A	0.18	250	97	
WC71	0.18	250	97	
Q = WC71 + WML2 + WSGR1A	0.18	250	97	
WC72	0.18	250	97	
Q = WC72 + WML2 + WSGR1A	0.18	250	97	
WC73	0.18	250	97	
Q = WC73 + WML2 + WSGR1A	0.18	250	97	
WC74	0.18	250	97	
Q = WC74 + WML2 + WSGR1A	0.18	250	97	
WC75	0.18	250	97	
Q = WC75 + WML2 + WSGR1A	0.18	250	97	
WC76	0.18	250	97	
Q = WC76 + WML2 + WSGR1A	0.18	250	97	
WC77	0.18	250	97	
Q = WC77 + WML2 + WSGR1A	0.18	250	97	
WC78	0.18	250	97	
Q = WC78 + WML2 + WSGR1A	0.18	250	97	
WC79	0.18	250	97	
Q = WC79 + WML2 + WSGR1A	0.18	250	97	
WC80	0.18	250	97	
Q = WC80 + WML2 + WSGR1A	0.18	250	97	
WC81	0.18	250	97	
Q = WC81 + WML2 + WSGR1A	0.18	250	97	
WC82	0.18	250	97	
Q = WC82 + WML2 + WSGR1A	0.18	250	97	
WC83	0.18	250	97	
Q = WC83 + WML2 + WSGR1A	0.18	250	97	
WC84	0.18	250	97	
Q = WC84 + WML2 + WSGR1A	0.18	250	97	
WC85	0.18	250	97	
Q = WC85 + WML2 + WSGR1A	0.18	250	97	
WC86	0.18	250	97	
Q = WC86 + WML2 + WSGR1A	0.18	250	97	
WC87	0.18	250	97	
Q = WC87 + WML2 + WSGR1A	0.18	250	97	
WC88	0.18	250	97	
Q = WC88 + WML2 + WSGR1A	0.18	250	97	
WC89	0.18	250	97	
Q = WC89 + WML2 + WSGR1A	0.18	250	97	
WC90	0.18	250	97	
Q = WC90 + WML2 + WSGR1A	0.18	250	97	
WC91	0.18	250	97	
Q = WC91 + WML2 + WSGR1A	0.18	250	97	
WC92	0.18	250	97	
Q = WC92 + WML2 + WSGR1A	0.18	250	97	
WC93	0.18	250	97	
Q = WC93 + WML2 + WSGR1A	0.18	250	97	
WC94	0.18	250	97	
Q = WC94 + WML2 + WSGR1A	0.18	250	97	
WC95	0.18	250	97	
Q = WC95 + WML2 + WSGR1A	0.18	250	97	
WC96	0.18	250	97	
Q = WC96 + WML2 + WSGR1A	0.18	250	97	
WC97	0.18	250	97	
Q = WC97 + WML2 + WSGR1A	0.18	250	97	
WC98	0.18	250	97	
Q = WC98 + WML2 + WSGR1A	0.18	250	97	
WC99	0.18	250	97	
Q = WC99 + WML2 + WSGR1A	0.18	250	97	
WC100	0.18	250	97	
Q = WC100 + WML2 + WSGR1A	0.18	250	97	



- Storm drain facilities have been designed per the most conservative flow rate generated either in the interim or ultimate condition.

- Note that HEC-1 concentration points have been utilized to quantify flow at proposed facilities.

X' - Depicts an "Existing" Facility
P - Depicts a "Proposed" Facility
F - Depicts a "Future" Facility
S' - Depicts an "Interim Surp" Location

- Note that all ditches/berms have been designed utilizing the proposed condition layout.

[illegible]

NINETY-FIVE MANAGEMENT, LLC.

SKYKE CANYON PHASE 3B, 3C INFRASTRUCTURE

FACILITIES MAP

DATE: SEPTEMBER 2018
DRAFTER: ETM
DESIGNER: ETM
CHECKED: LL
PROJECT NO.
OLY1609.000

EXHIBIT H
SHEET 1 OF 1

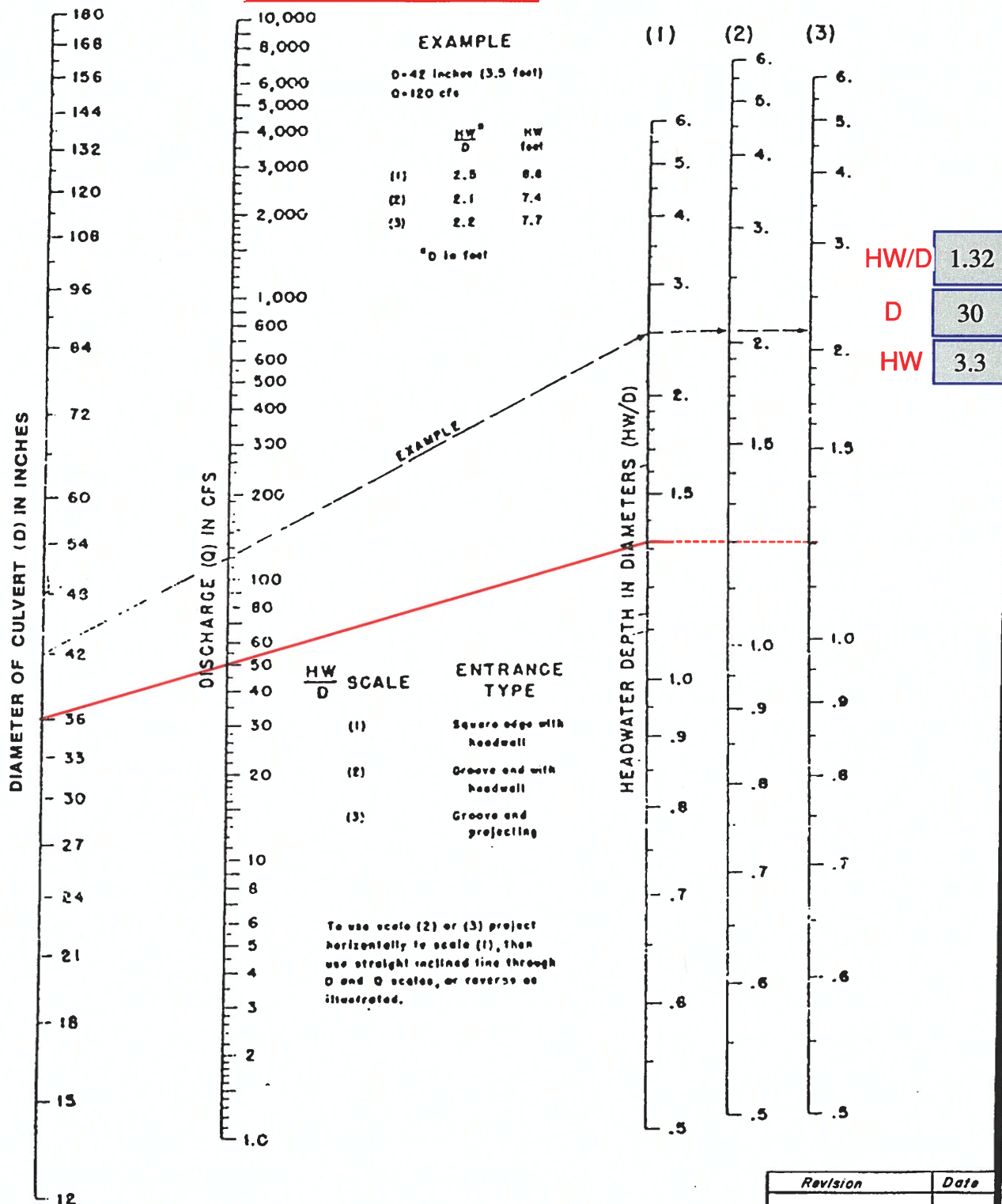
APPENDIX C

Surface Flow Hydraulic Computations

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

NOMOGRAPH - INLET CONTROL RCP

SUMP 2: Q= 51 CFS

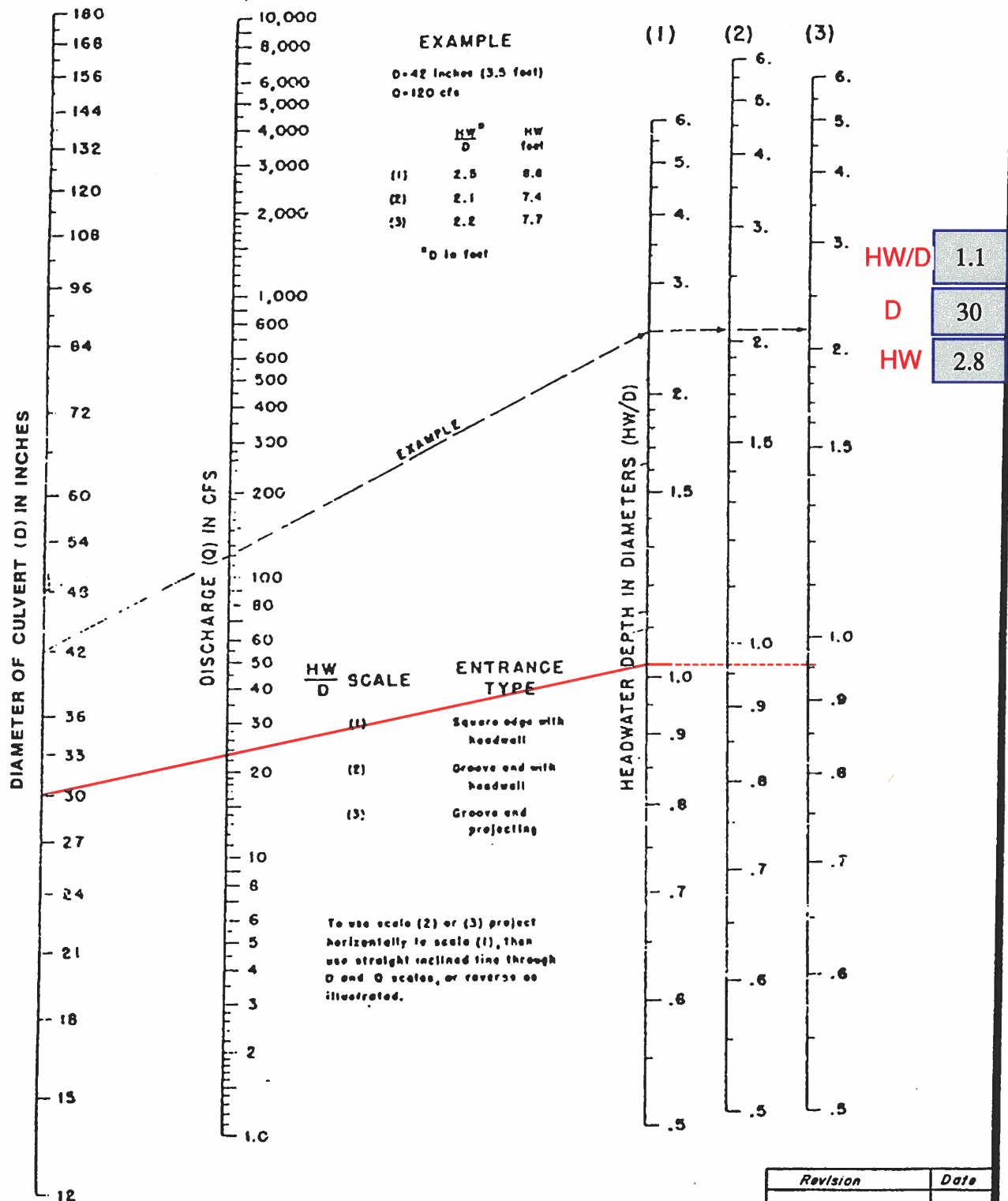


Revision	Date

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

NOMOGRAPH - INLET CONTROL RCP

SUMP 6: Q = 23 CFS

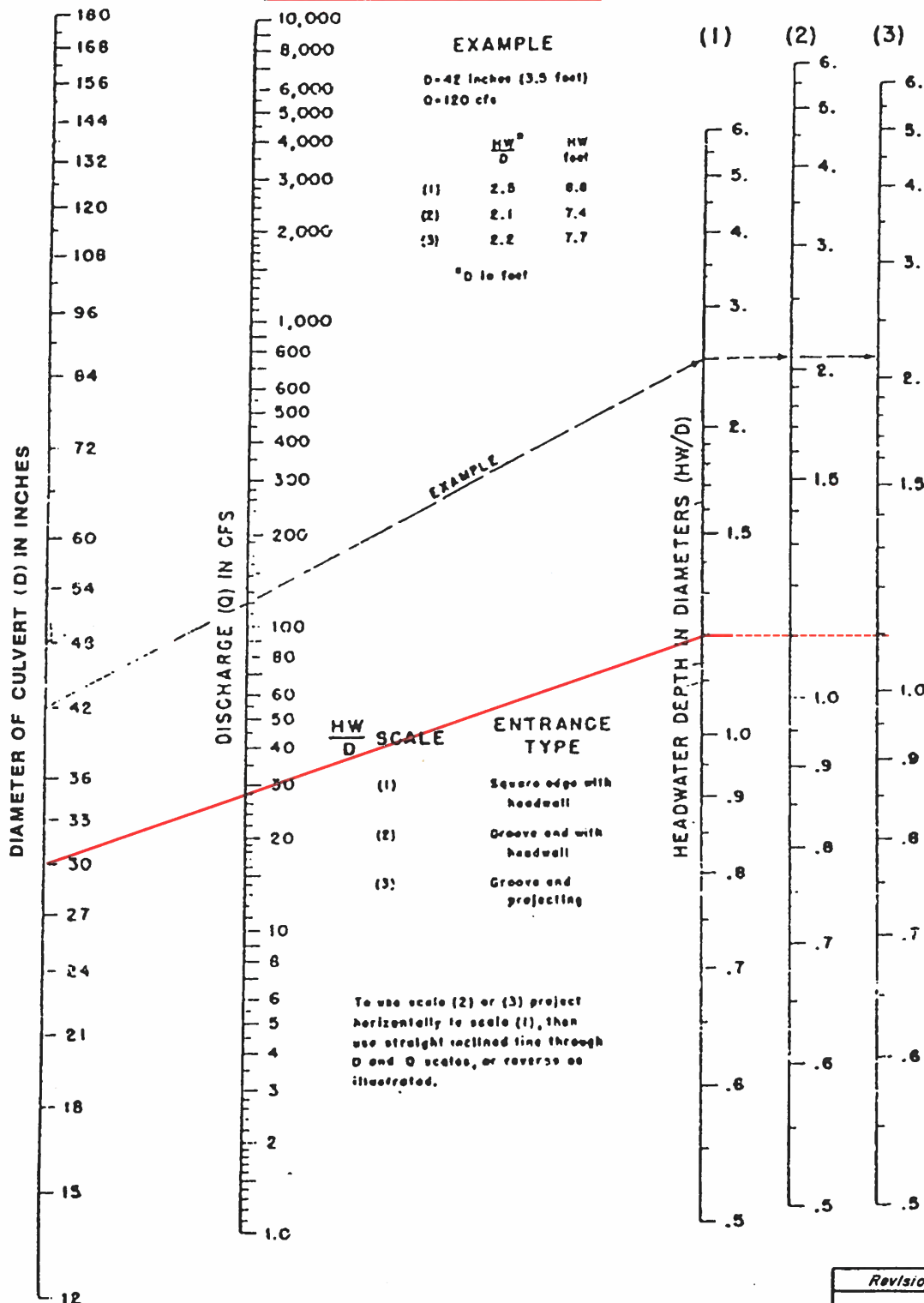


Revision	Date

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

NOMOGRAPH - INLET CONTROL RCP

SUMP 10: Q=28 CFS



HW/D	1.2
D	30
HW	3.0

Revision	Date

Pipe Culvert Outlet Protection Computation

FACILITY P3b

Project Name: **Skye Canyon Phase 3B 3C Infrastructure**
Project Number: **OLY1609.000**
Date: **9/10/2018**
By: **ETM**

Equations:

$(d_{50}/D) \cdot (Y_t/D)^{1.2} / (Q/D^{2.5}) = 0.023$	Equation 760*
$D_a = 1/2(D + Y_n)$ (used in place of D if $Fr > 1$)	Equation 762*
$L = (1/(2 \tan \phi)) (A_t/Y_t - W)$	Equation 764*
$A_t = Q/V$	Equation 765*

Known Information:

Q = 230	Flow (cfs)
D = 4.5	Diameter of Pipe (ft)
q = 20	Expansion angle of the culvert flow (typ=20°)
V = 5	Allowable downstream velocity (typ=5 ft/s)
Fr = 1.5	Froude Number (0 if full)
Y _n = 3.6	Normal Depth of flow in Pipe Culvert (ft)*
Y _t = 1.8	Tailwater Depth (Enter 0.4D if unknown)

Riprap Erosion Protection Check (Figure 712):

Applicable only if $Q/D^{2.5} \leq 6$

$Q/D^{2.5} = 5.35$	← See Figure 712 for Recommended Riprap Type
$Q/D^{1.5} = 24.09$	
$Y_t/D = 0.44$	

Solve For:

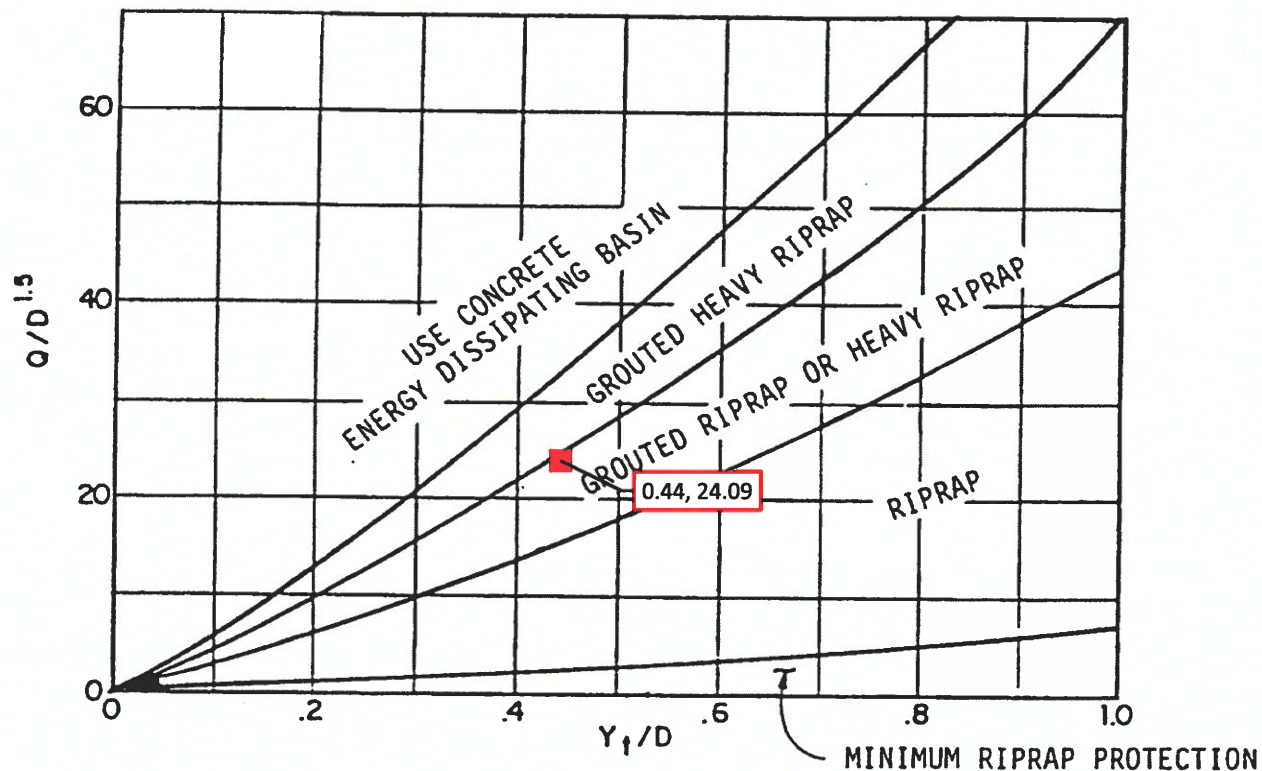
D₅₀ = 1.93	Average Size Riprap (ft)
D₅₀ = 23	Average Size Riprap (in)
A _t = 46.0	Req'd Area of flow at allowable velocity (ft ²)
Y _t = 1.80	Tailwater Depth (ft)
D _a = 4.1	only used if $Fr \geq 1$
L = 28.9	Length of Protection (ft)
*L = 28.9	*For: D<3.5-ft, L_{min}=3D. For: D>=3.5-ft, L_{min}>= 4D. L_{max(required)}=10D

Notes:

Provide D₅₀ = 24-inch riprap for a length of 30-ft

* Equations taken from the Clark County Regional Flood Control District - Hydrologic Criteria and Drainage Design Manual

RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of $3H$ downstream for 18" to 36" equivalent round pipe size and $4D$ downstream for 42" and larger equivalent round pipe size.

Revision	Date

Pipe Culvert Outlet Protection Computation

FACILITY P5

Project Name: **Skye Canyon Phase 3B 3C Infrastructure**
Project Number: **OLY1609.000**
Date: **9/10/2018**
By: **ETM**

Equations:

$(d_{50}/D) * (Y_t/D)^{1.2} / (Q/D^{2.5}) = 0.023$	Equation 760*
$D_a = 1/2(D + Y_n)$ (used in place of D if $Fr > 1$)	Equation 762*
$L = (1/(2 \tan q))(A_t/Y_t - W)$	Equation 764*
$A_t = Q/V$	Equation 765*

Known Information:

Q = 44	Flow (cfs)
D = 2.0	Diameter of Pipe (ft)
q = 20	Expansion angle of the culvert flow (typ=20°)
V = 5	Allowable downstream velocity (typ=5 ft/s)
Fr = 2.6	Froude Number (0 if full)
$Y_n = 1.5$	Normal Depth of flow in Pipe Culvert (ft)*
	* Not necessary if $Fr < 1$ (Enter 0 if unknown)
$Y_t = 0.8$	Tailwater Depth (Enter 0.4D if unknown)

Riprap Erosion Protection Check (Figure 712):

Applicable only if $Q/D^{2.5} \leq 6$

$Q/D^{2.5} = 7.78$	← Figure 712 Not Applicable
$Q/D^{1.5} = 15.56$	
$Y_t/D = 0.46$	

Solve For:

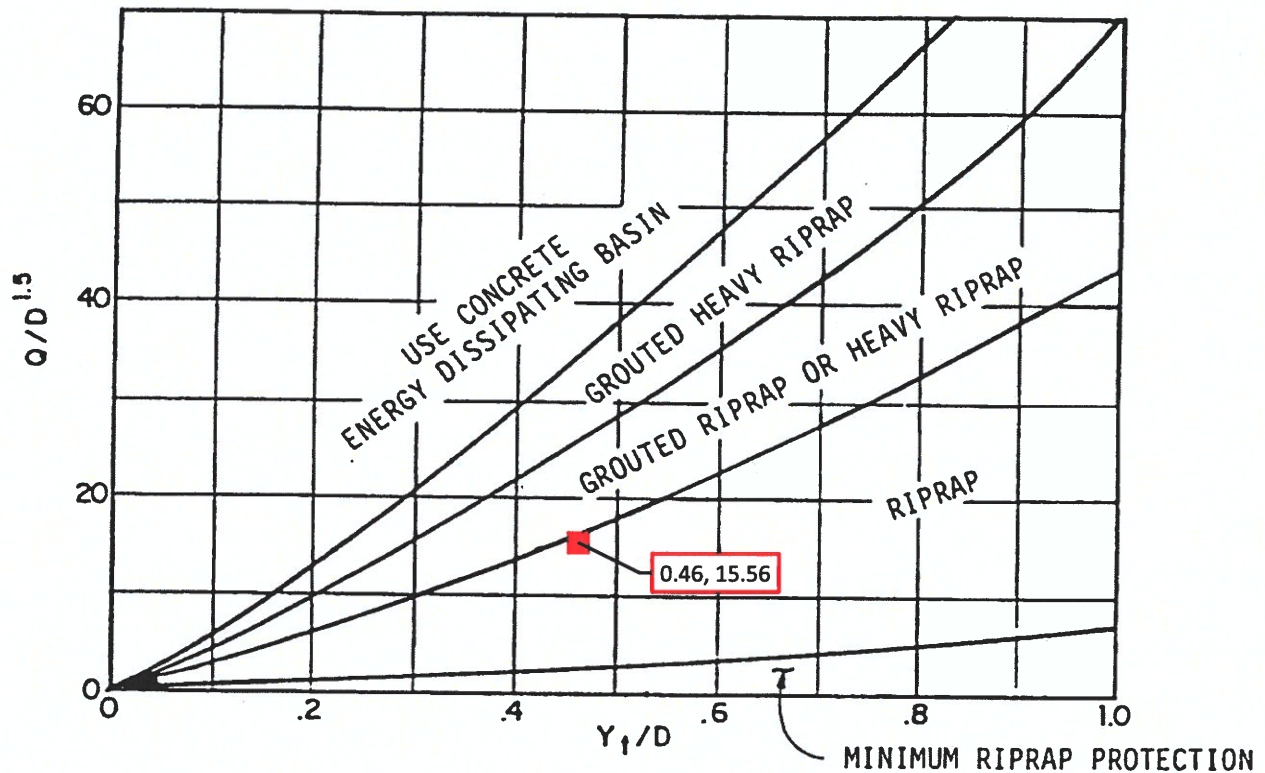
$D_{50} = 1.33$	Average Size Riprap (ft)
$D_{50} = 16$	Average Size Riprap (in)
$A_t = 8.8$	Req'd Area of flow at allowable velocity (ft ²)
$Y_t = 0.80$	Tailwater Depth (ft)
$D_a = 1.7$	only used if $Fr \geq 1$
L = 12.4	Length of Protection (ft)
*L = 12.4	*For: $D < 3.5$ -ft, $L_{min} = 3D$. For: $D \geq 3.5$ -ft, $L_{min} \geq 4D$. $L_{max(required)} = 10D$

Notes:

Provide $D_{50} = 16$ -inch riprap for a length of 13-ft

* Equations taken from the Clark County Regional Flood Control District - Hydrologic Criteria and Drainage Design Manual

RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of $3H$ downstream for 18" to 36" equivalent round pipe size and $4D$ downstream for 42" and larger equivalent round pipe size.

Revision	Date

Pipe Culvert Outlet Protection Computation

FACILITY P12

Project Name: **Skye Canyon Phase 3B 3C Infrastructure**
Project Number: **OLY1609.000**
Date: **9/10/2018**
By: **ETM**

Equations:

$(d_{50}/D) * (Y_t/D)^{1.2} / (Q/D^{2.5}) = 0.023$	Equation 760*
$D_a = 1/2(D + Y_n)$ (used in place of D if $Fr > 1$)	Equation 762*
$L = (1/(2 \tan q))(A_t/Y_t - W)$	Equation 764*
$A_t = Q/V$	Equation 765*

Known Information:

Q = 176	Flow (cfs)
D = 4.5	Diameter of Pipe (ft)
q = 20	Expansion angle of the culvert flow (typ=20°)
V = 5	Allowable downstream velocity (typ=5 ft/s)
Fr = 2.4	Froude Number (0 if full)
Y _n = 2.5	Normal Depth of flow in Pipe Culvert (ft)*
Y _t = 1.8	* Not necessary if Fr < 1 (Enter 0 if unknown)
	Tailwater Depth (Enter 0.4D if unknown)

Riprap Erosion Protection Check (Figure 712):

Applicable only if $Q/D^{2.5} \leq 6$

$Q/D^{2.5} = 4.10$	← See Figure 712 for Recommended Riprap Type
$Q/D^{1.5} = 18.44$	
$Y_t/D = 0.52$	

Solve For:

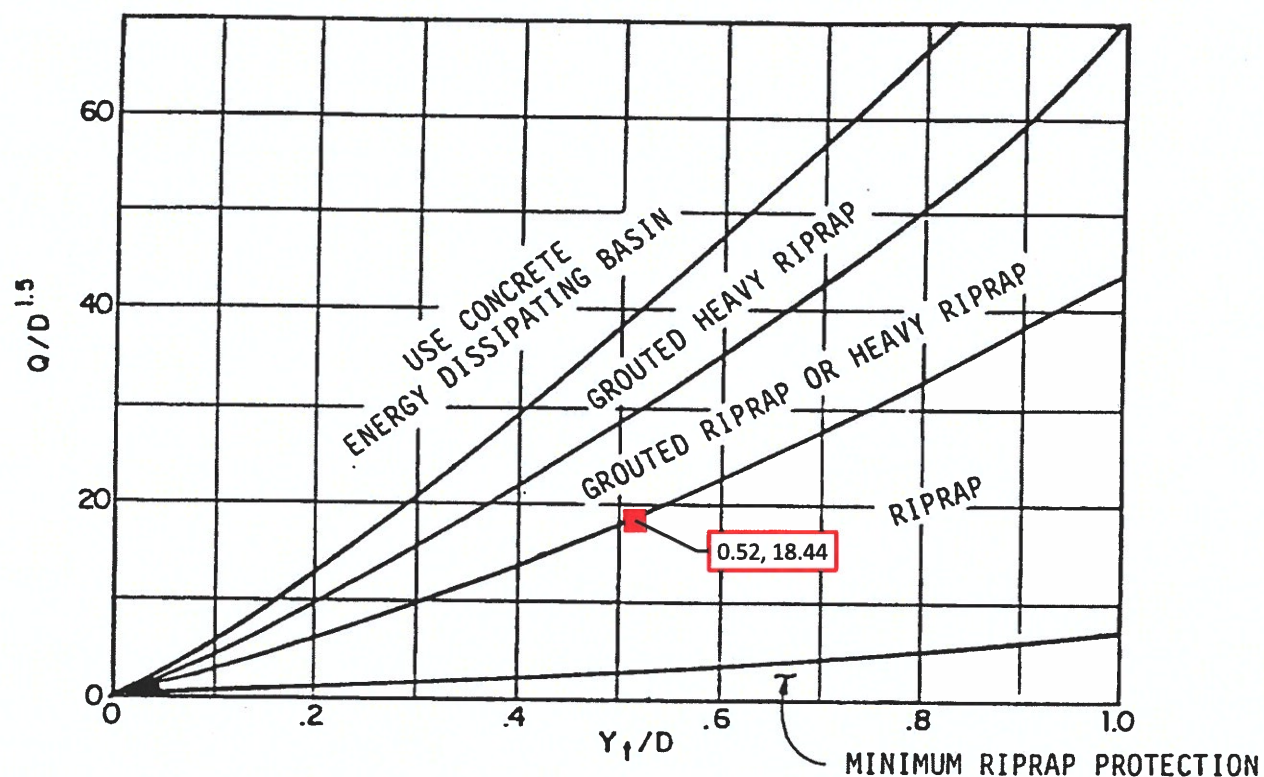
D₅₀ = 1.86	Average Size Riprap (ft)
D₅₀ = 22	Average Size Riprap (in)
A _t = 35.2	Req'd Area of flow at allowable velocity (ft ²)
Y _t = 1.80	Tailwater Depth (ft)
D _a = 3.5	only used if Fr ≥ 1
L = 20.7	Length of Protection (ft)
*L = 20.7	*For: D < 3.5-ft, L_{min} = 3D. For: D ≥ 3.5-ft, L_{min} ≥ 4D. L_{max(required)} = 10D

Notes:

Provide D₅₀ = 24-inch riprap for a length of 21-ft

* Equations taken from the Clark County Regional Flood Control District - Hydrologic Criteria and Drainage Design Manual

RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of $3H$ downstream for 18" to 36" equivalent round pipe size and $4D$ downstream for 42" and larger equivalent round pipe size.

Revision	Date

REFERENCE:

Pipe Culvert Outlet Protection Computation

FACILITY P26

Project Name: **Skye Canyon Phase 3B 3C Infrastructure**

Project Number: **OLY1609.000**

Date: **9/10/2018**

By: **ETM**

Equations:

$$(d_{50}/D) \cdot (Y_t/D)^{1.2} / (Q/D^{2.5}) = 0.023$$

Equation 760*

$$D_a = 1/2(D + Y_n) \text{ (used in place of } D \text{ if } Fr > 1)$$

Equation 762*

$$L = (1/(2 \tan q))(A_t/Y_t - W)$$

Equation 764*

$$A_t = Q/V$$

Equation 765*

Known Information:

Q = 321

Flow (cfs)

D = 4.5

Diameter of Pipe (ft)

q = 20

Expansion angle of the culvert flow (typ=20°)

V = 5

Allowable downstream velocity (typ=5 ft/s)

Fr = 2.8

Froude Number (0 if full)

Y_n = 3.1

Normal Depth of flow in Pipe Culvert (ft)*

* Not necessary if Fr < 1 (Enter 0 if unknown)

Y_t = 1.8

Tailwater Depth (Enter 0.4D if unknown)

Riprap Erosion Protection Check (Figure 712):

Applicable only if $Q/D^{2.5} \leq 6$

$$Q/D^{2.5} = 7.47$$

← **Figure 712 Not Applicable**

$$Q/D^{1.5} = 33.63$$

$$Y_t/D = 0.47$$

Solve For:

D₅₀ = 2.98

Average Size Riprap (ft)

D₅₀ = 36

Average Size Riprap (in)

A_t = 64.2

Req'd Area of flow at allowable velocity (ft²)

Y_t = 1.80

Tailwater Depth (ft)

D_a = 3.8

only used if Fr >= 1

L = 42.8

Length of Protection (ft)

*L = 42.8

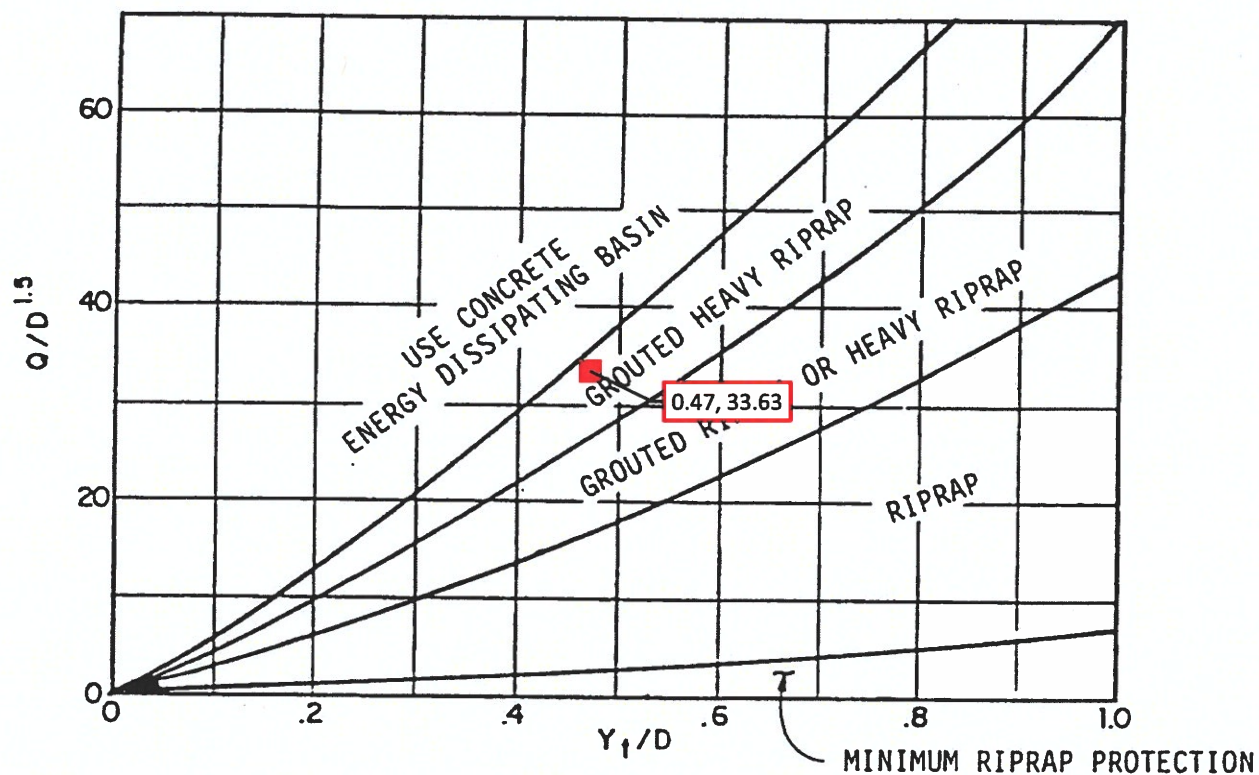
*For: D < 3.5-ft, L_{min} = 3D. For: D >= 3.5-ft, L_{min} >= 4D. L_{max(required)} = 10D

Notes:

Provide D₅₀ = 36-inch riprap for a length of 43-ft

* Equations taken from the Clark County Regional Flood Control District - Hydrologic Criteria and Drainage Design Manual

RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of $3H$ downstream for 18" to 36" equivalent round pipe size and $4D$ downstream for 42" and larger equivalent round pipe size.

Revision	Date

Pipe Culvert Outlet Protection Computation

FACILITY P28

Project Name: **Skye Canyon Phase 3B 3C Infrastructure**
Project Number: **OLY1609.000**
Date: **9/10/2018**
By: **ETM**

Equations:

$$(d_{50}/D) \cdot (Y_t/D)^{1.2} / (Q/D^{2.5}) = 0.023 \quad \text{Equation 760*}$$

$$D_a = 1/2(D + Y_n) \text{ (used in place of } D \text{ if } Fr > 1) \quad \text{Equation 762*}$$

$$L = (1/(2 \tan q)) (A_t/Y_t - W) \quad \text{Equation 764*}$$

$$A_t = Q/V \quad \text{Equation 765*}$$

Known Information:

Q = 4	Flow (cfs)
D = 1.5	Diameter of Pipe (ft)
q = 20	Expansion angle of the culvert flow (typ=20°)
V = 5	Allowable downstream velocity (typ=5 ft/s)
Fr = 6.0	Froude Number (0 if full)
Y _n = 0.3	Normal Depth of flow in Pipe Culvert (ft)*
Y _t = 0.6	* Not necessary if Fr < 1 (Enter 0 if unknown)
	Tailwater Depth (Enter 0.4D if unknown)

Riprap Erosion Protection Check (Figure 712):

Applicable only if $Q/D^{2.5} \leq 6$

$$\frac{Q/D^{2.5} = 1.27}{Q/D^{1.5} = 1.91} \quad \leftarrow \text{ See Figure 712 for Recommended Riprap Type}$$

$$Y_t/D = 0.67$$

Solve For:

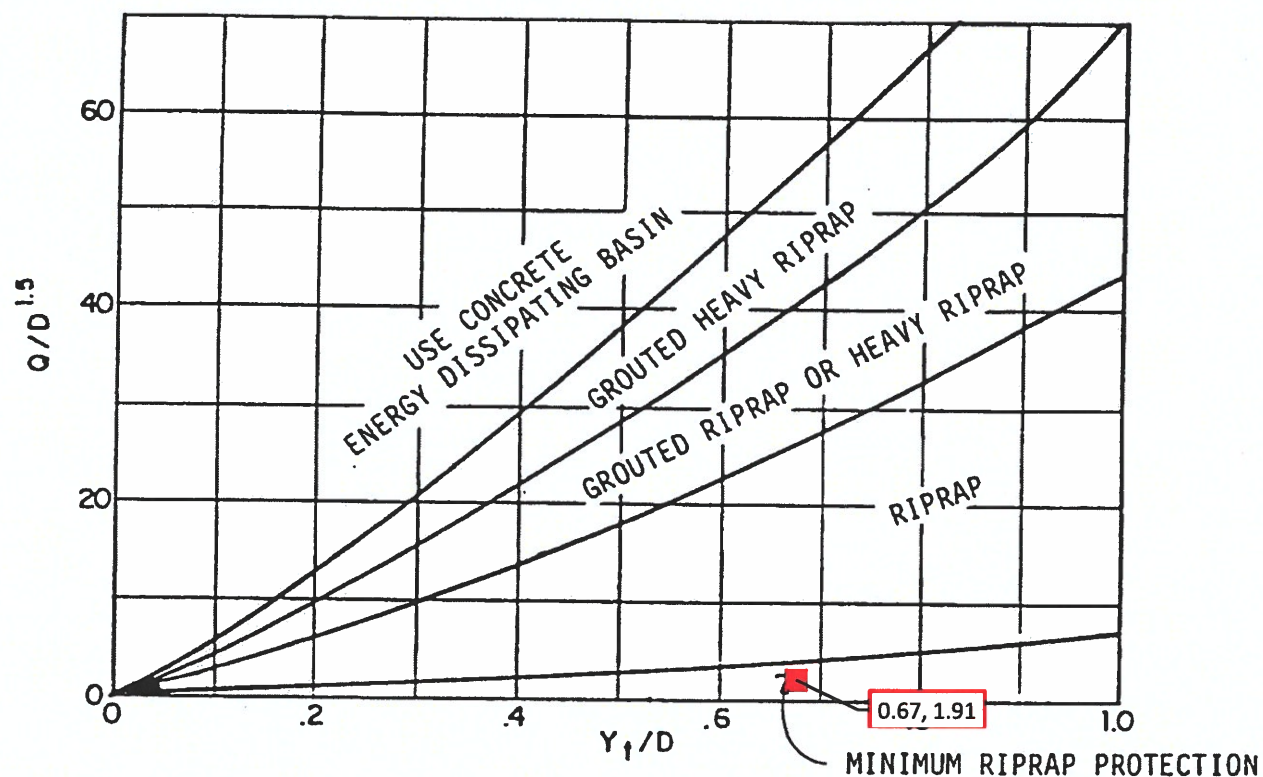
D ₅₀ = 0.29	Average Size Riprap (ft)
D ₅₀ = 3	Average Size Riprap (in)
A _t = 0.7	Req'd Area of flow at allowable velocity (ft ²)
Y _t = 0.60	Tailwater Depth (ft)
D _a = 0.9	only used if Fr ≥ 1
L = -0.5	Length of Protection (ft)
*L = 4.5	*For: D < 3.5-ft, L _{min} = 3D. For: D ≥ 3.5-ft, L _{min} ≥ 4D. L _{max(required)} = 10D

Notes:

Provide D₅₀ = 8-inch riprap for a length of 5-ft

* Equations taken from the Clark County Regional Flood Control District - Hydrologic Criteria and Drainage Design Manual

RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of $3H$ downstream for 18" to 36" equivalent round pipe size and $4D$ downstream for 42" and larger equivalent round pipe size.

Revision	Date

APPENDIX D

Storm Drain Analyses

Iron Mountain Road

Model “UIRM1” - Mainline

Ultimate Condition WSPG Summary								
Mainline in Iron Mountain Road along Northern Boundary of Project Site								
WSPG Station	Equivalent Roadway Station	Improvement Plan Sheet	Storm Drain Dimension	Invert Elevation (ft)	Q ₁₀₀ (cfs)	WSE (ft)	Velocity (ft/s)	HGL Check ¹
943.00	Existing SD	PP-08	7' x 5' RCB	2824.89	405	2835.80	11.57	2838.00 OK
954.00	Existing SD	PP-08	7' x 5' RCB	2825.59	405	2835.87	11.57	2838.10 OK
1023.24	Existing SD	PP-08	7' x 5' RCB	2830.16	405	2836.64	11.57	2839.30 OK
1037.24	Existing SD	PP-08	7' x 5' RCB	2830.23	405	2836.77	11.57	2839.50 OK
1116.09	Existing SD	PP-08	7' x 5' RCB	2830.64	405	2837.26	11.57	2840.28 OK
1118.40	80+07.63	PP-08	7' x 5' RCB	2830.64	389	2837.56	11.11	2840.28 OK
1221.97	81+11.79	PP-08	7' x 5' RCB	2832.20	389	2834.20	24.20	2842.02 OK
1234.00	81+23.88	PP-08	7' x 5' RCB	2832.39	339	2834.37	24.52	2842.23 OK
1242.00	81+31.79	PP-08	66" RCP	2832.60	339	2835.88	22.93	2842.37 OK
1368.40	82+58.64	PP-07	66" RCP	2833.37	339	2842.20	27.15	2845.87 OK
1368.40	82+58.64	PP-07	60" RCP	2833.87	339	2840.75	26.22	2845.87 OK
1713.01	86+04.25	PP-07	60" RCP	2844.81	339	2848.08	27.90	2857.03 OK
2113.01	90+04.25	PP-06	60" RCP	2860.30	339	2863.56	27.95	2872.78 OK
2313.01	92+04.25	PP-06	60" RCP	2868.30	339	2871.63	27.43	2880.79 OK
2524.65	94+15.89	PP-05	60" RCP	2876.27	339	2879.31	27.13	2889.27 OK
2524.65	94+15.89	PP-05	54" RCP	2876.77	279	2879.57	26.82	2889.27 OK
3184.64	100+75.89	PP-04	54" RCP	2903.15	279	2906.04	25.81	2915.70 OK
3468.17	103+59.42	PP-04	54" RCP	2914.35	279	2917.63	22.47	2926.93 OK
3751.34	106+42.59	PP-03	54" RCP	2922.56	279	2922.56	17.72	2934.64 OK
3751.34	106+42.59	PP-03	42" RCP	2923.56	173	2923.56	17.98	2934.64 OK
3855.40	107.46.33	PP-03	42" RCP	2925.64	173	2931.98	17.98	2935.95 OK
3855.40	107.46.33	PP-03	42" RCP	2925.64	157	2933.58	16.32	2936.66 OK
4334.07	112+25.00	PP-02	42" RCP	2933.93	157	2945.45	16.32	2955.88 OK
4630.98	115+21.91	PP-02	42" RCP	2939.07	157	2953.09	16.32	2972.06 OK
4961.97	118+52.90	PP-01	42" RCP	2964.23	157	2966.30	26.50	2985.15 OK
5077.69	119+36.99	PP-01	42" RCP	2973.02	157	2974.99	21.83	2984.43 OK

T1 SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C															
T2 BY OLYMPIA COMPANIES															
T3 IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT MODEL "UIRM1" (ULTIMATE CONDITION)															
SO	943.000	2824.890	1	.013	2835.800										
R	954.000	2825.590	1	.013											
R	1023.240	2830.160	1	.013	77.922 .000 0										
JX	1037.240	2830.230	1	.013	0.00	2830.230		00.0							
R	1116.090	2830.640	1	.013											
JX	1118.400	2830.640	1 24	18.013	8.0	8.0	2830.64	2834.14	45.0	45.0					
JX	1221.970	2832.200	1 30	.013	50.00	2834.480		45.0							
R	1234.000	2832.390	1	.013											
TS	1242.000	2832.600	66	.013											
R	1368.390	2833.370	66	.013											
JX	1368.390	2833.870	60	.013	0.00	2833.870		00.0							
R	1713.010	2844.810	60	.013	8.00 1										
R	2113.010	2860.300	60	.013	00.00 1										
R	2313.010	2868.300	60	.013	00.00 1										
R	2524.640	2876.270	60	.013	00.00 1										
JX	2524.640	2876.770	54 18 36	.013	6.0	54.0	2879.77	2878.27	45.0	45.0					
R	2924.640	2892.750	54	.013	00.00 1										
R	3184.640	2903.150	54	.013	00.00 1										
R	3468.170	2914.350	54	.013	00.00 1										
R	3751.340	2922.560	54	.013	00.00 1										
JX	3751.340	2923.560	42 36	.013	106.00	2924.060		45.0							
R	3855.400	2925.640	42	.013	00.00 1										
JX	3855.400	2925.640	42 18 18	.013	8.0	8.0	2927.64	2927.64	45.0	45.0					
R	4334.070	2933.930	42	.013	00.00 1										
R	4515.400	2937.070	42	.013	00.00 1										
R	4630.980	2939.070	42	.013	00.00 1										
R	4961.968	2964.228	42	.013	15.00 1										
R	4961.969	2964.229	42	.013	15.00										
R	4961.970	2964.230	42	.013	15.00										
R	5077.686	2973.196	42	.013											
JX	5077.687	2973.197	60	.013	0.00	2973.020		00.0							
R	5077.688	2973.198	60	.013	15.00										
R	5077.689	2973.199	60	.013	15.00										
R	5077.690	2973.020	60	.013	15.00										
R	5237.690	2978.540	60	.013											
SH	5237.690	2978.540	60	.013	2980.540										
CD	18	4	1	.000	1.500	.000	.000	.000	.00						
CD	24	4	1	.000	2.000	.000	.000	.000	.00						
CD	30	4	1	.000	2.500	.000	.000	.000	.00						
CD	36	4	1	.000	3.000	.000	.000	.000	.00						
CD	42	4	1	.000	3.500	.000	.000	.000	.00						
CD	48	4	1	.000	4.000	.000	.000	.000	.00						
CD	54	4	1	.000	4.500	.000	.000	.000	.00						
CD	60	4	1	.000	5.000	.000	.000	.000	.00						
CD	66	4	1	.000	5.500	.000	.000	.000	.00						
CD	72	4	1	.000	6.000	.000	.000	.000	.00						
CD	1	3	0	.000	5.000	7.000	.000	.000	.00						
Q	157.000 .0														

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Date: 9-10-2018 Time: 7:13:36

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SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT MODEL "UIRM1" (ULTIMATE CONDI

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt I.D.	No Wth Prs/Pip
L/Elem	Ch Slope					SE Dpth	HF				"N"	X-Fall	ZR Type Ch
943.000	2824.890	10.910	2835.800	405.00	11.57	2.08	2837.88	.00	4.70	7.00	5.000	7.000	.00 0 .0
11.000	.0637					.0062	.07	10.91	.91	1.79	.013	.00	.00 BOX
954.000	2825.590	10.278	2835.868	405.00	11.57	2.08	2837.95	.00	4.70	7.00	5.000	7.000	.00 0 .0
69.240	.0660					.0062	.43	.00	.91	1.77	.013	.00	.00 BOX
1023.240	2830.160	6.524	2836.684	405.00	11.57	2.08	2838.76	.00	4.70	7.00	5.000	7.000	.00 0 .0
JUNCT STR	.0050					.0062	.09	6.52	.91		.013	.00	.00 BOX
1037.240	2830.230	6.541	2836.771	405.00	11.57	2.08	2838.85	.00	4.70	7.00	5.000	7.000	.00 0 .0
78.850	.0052					.0062	.49	6.54	.91	4.48	.013	.00	.00 BOX
1116.090	2830.640	6.620	2837.260	405.00	11.57	2.08	2839.34	.00	4.70	7.00	5.000	7.000	.00 0 .0
JUNCT STR	.0000					.0057	.01	6.62	.91		.013	.00	.00 BOX
1118.400	2830.640	6.920	2837.560	389.00	11.11	1.92	2839.48	.00	4.58	7.00	5.000	7.000	.00 0 .0
JUNCT STR	.0151							6.92	.88		.013	.00	.00 BOX
1221.970	2832.200	2.001	2834.201	339.00	24.20	9.10	2843.30	.00	4.18	7.00	5.000	7.000	.00 0 .0
12.030	.0158					.0331	.40	2.00	3.02	2.59	.013	.00	.00 BOX
1234.000	2832.390	1.975	2834.365	339.00	24.52	9.34	2843.70	.00	4.18	7.00	5.000	7.000	.00 0 .0
TRANS STR	.0263					.0283	.23	1.98	3.07		.013	.00	.00 BOX
1242.000	2832.600	3.281	2835.881	339.00	22.93	8.17	2844.05	.00	4.97	5.40	5.500	.000	.00 1 .0
20.646	.0061					.0238	.49	3.28	2.44	5.50	.013	.00	.00 PIPE

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SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT MODEL "UIRM1" (ULTIMATE CONDI

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Height/Dia.-FT	Base Wt or I.D.	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR Type Ch
1262.646	2832.726	3.211	2835.937	339.00	23.53	8.60	2844.53	.00	4.97	5.42	5.500	.000	.00 1 .0
36.707	.0061					.0262	.96	3.21	2.54	5.50	.013	.00	PIPE
1299.352	2832.949	3.088	2836.038	339.00	24.68	9.46	2845.50	.00	4.97	5.46	5.500	.000	.00 1 .0
35.215	.0061					.0296	1.04	3.09	2.74	5.50	.013	.00	PIPE
1334.567	2833.164	2.971	2836.135	339.00	25.88	10.40	2846.54	.00	4.97	5.48	5.500	.000	.00 1 .0
33.823	.0061					.0336	1.14	2.97	2.95	5.50	.013	.00	PIPE
1368.390	2833.370	2.861	2836.231	339.00	27.15	11.44	2847.67	.00	4.97	5.50	5.500	.000	.00 1 .0
JUNCT STR	.0000					.0344	.00	2.86	3.17		.013	.00	PIPE
1368.390	2833.870	3.129	2837.000	339.00	26.22	10.67	2847.67	.00	4.79	4.84	5.000	.000	.00 1 .0
139.511	.0317					.0337	4.70	3.13	2.83	3.17	.013	.00	PIPE
1507.901	2838.299	3.091	2841.390	339.00	26.60	10.99	2852.38	.00	4.79	4.86	5.000	.000	.00 1 .0
205.109	.0317					.0365	7.49	3.09	2.89	3.17	.013	.00	PIPE
1713.010	2844.810	2.970	2847.780	339.00	27.90	12.08	2859.86	.00	4.79	4.91	5.000	.000	.00 1 .0
400.000	.0387					.0388	15.53	2.97	3.13	2.97	.013	.00	PIPE
2113.010	2860.300	2.965	2863.265	339.00	27.95	12.13	2875.39	.00	4.79	4.91	5.000	.000	.00 1 .0
200.000	.0400					.0380	7.60	2.97	3.13	2.94	.013	.00	PIPE
2313.010	2868.300	3.012	2871.312	339.00	27.43	11.68	2882.99	.00	4.79	4.89	5.000	.000	.00 1 .0
211.630	.0377					.0366	7.74	3.01	3.04	3.00	.013	.00	PIPE

Program Package Serial Number: 1704

Date: 9-10-2018 Time: 7:13:36

WATER SURFACE PROFILE LISTING

SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT MODEL "UIRM1" (ULTIMATE CONDI

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Height/ Dia.-FT	Base Wt or I.D.	No Wth Prs/Pip
L/Elem	Ch Slope					SE Dpth	HF				"N"	X-Fall	Type Ch
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
2524.640	2876.270	3.040	2879.310	339.00	27.13	11.43	2890.74	.00	4.79	4.88	5.000	.000	1 .0
JUNCT STR	.0000					.0380	.00	3.04	2.99		.013	.00	PIPE
2524.640	2876.770	2.800	2879.570	279.00	26.82	11.17	2890.74	.00	4.35	4.36	4.500	.000	1 .0
4.814	.0399					.0399	.19	2.80	3.06	2.80	.013	.00	PIPE
2529.454	2876.962	2.800	2879.763	279.00	26.82	11.17	2890.93	.00	4.35	4.36	4.500	.000	1 .0
395.186	.0399					.0396	15.64	2.80	3.06	2.80	.013	.00	PIPE
2924.640	2892.750	2.818	2895.568	279.00	26.62	11.00	2906.57	.00	4.35	4.35	4.500	.000	1 .0
260.000	.0400					.0377	9.81	2.82	3.02	2.80	.013	.00	PIPE
3184.640	2903.150	2.894	2906.044	279.00	25.81	10.34	2916.38	.00	4.35	4.31	4.500	.000	1 .0
146.476	.0395					.0344	5.04	2.89	2.87	2.81	.013	.00	PIPE
3331.116	2908.936	3.006	2911.942	279.00	24.71	9.48	2921.42	.00	4.35	4.24	4.500	.000	1 .0
83.839	.0395					.0308	2.58	3.01	2.67	2.81	.013	.00	PIPE
3414.954	2912.248	3.137	2915.385	279.00	23.56	8.62	2924.01	.00	4.35	4.14	4.500	.000	1 .0
53.216	.0395					.0275	1.46	3.14	2.45	2.81	.013	.00	PIPE
3468.170	2914.350	3.280	2917.630	279.00	22.47	7.84	2925.47	.00	4.35	4.00	4.500	.000	1 .0
124.558	.0290					.0246	3.07	3.28	2.25	3.14	.013	.00	PIPE
3592.728	2917.961	3.430	2921.392	279.00	21.45	7.14	2928.53	.00	4.35	3.83	4.500	.000	1 .0
70.259	.0290					.0222	1.56	3.43	2.05	3.14	.013	.00	PIPE

Program Package Serial Number: 1704

Date: 9-10-2018 Time: 7:13:36

WATER SURFACE PROFILE LISTING

SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT MODEL "UIRM1" (ULTIMATE CONDI

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Height Dia.-FT	Base or I.D.	Wt	ZL	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall		ZR	Type Ch
3662.987	2919.999	3.601	2923.600	279.00	20.45	6.49	2930.09	.00	4.35	3.60	4.500	.000	.00	1	.0
44.758	.0290					.0201	.90	3.60	1.85	3.14	.013	.00	.00		PIPE
3707.745	2921.296	3.794	2925.090	279.00	19.50	5.90	2930.99	.00	4.35	3.27	4.500	.000	.00	1	.0
29.118	.0290					.0185	.54	3.79	1.64	3.14	.013	.00	.00		PIPE
3736.863	2922.140	4.025	2926.166	279.00	18.59	5.37	2931.53	.00	4.35	2.77	4.500	.000	.00	1	.0
14.477	.0290					.0177	.26	4.03	1.41	3.14	.013	.00	.00		PIPE
3751.340	2922.560	4.351	2926.911	279.00	17.72	4.88	2931.79	.00	4.35	1.61	4.500	.000	.00	1	.0
JUNCT STR	.0000					.0236	.00	4.35	1.00		.013	.00	.00		PIPE
3751.340	2923.560	5.089	2928.649	173.00	17.98	5.02	2933.67	.00	3.44	.00	3.500	.000	.00	1	.0
104.060	.0200					.0296	3.08	5.09	.00	3.50	.013	.00	.00		PIPE
3855.400	2925.640	6.337	2931.977	173.00	17.98	5.02	2937.00	.00	3.44	.00	3.500	.000	.00	1	.0
JUNCT STR	.0000					.0270	.00	6.34	.00		.013	.00	.00		PIPE
3855.400	2925.640	7.943	2933.583	157.00	16.32	4.13	2937.72	.00	3.41	.00	3.500	.000	.00	1	.0
478.670	.0173					.0244	11.66	7.94	.00	3.50	.013	.00	.00		PIPE
4334.070	2933.930	11.516	2945.446	157.00	16.32	4.13	2949.58	.00	3.41	.00	3.500	.000	.00	1	.0
181.330	.0173					.0244	4.42	11.52	.00	3.50	.013	.00	.00		PIPE
4515.400	2937.070	12.998	2950.068	157.00	16.32	4.13	2954.20	.00	3.41	.00	3.500	.000	.00	1	.0
115.580	.0173					.0244	2.81	13.00	.00	3.50	.013	.00	.00		PIPE

Program Package Serial Number: 1704

WATER SURFACE PROFILE LISTING

Date: 9-10-2018 Time: 7:13:36

SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C
BY OLYMPIA COMPANIES

IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT MODEL "UIRM1" (ULTIMATE CONDI

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Height/Dia.-FT	Base Wt or I.D.	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR Type Ch
4630.980	2939.070	14.019	2953.089	157.00	16.32	4.13	2957.22	.00	3.41	.00	3.500	.000	.00 1 .0
105.349	.0760					.0244	2.57	14.02	.00	1.88	.013	.00	PIPE
4736.329	2947.078	8.745	2955.823	157.00	16.32	4.13	2959.96	.00	3.41	.00	3.500	.000	.00 1 .0
HYDRAULIC JUMP													
4736.329	2947.078	1.910	2948.988	157.00	29.23	13.27	2962.25	.00	3.41	3.49	3.500	.000	.00 1 .0
21.292	.0760					.0725	1.54	1.91	4.15	1.88	.013	.00	PIPE
4757.621	2948.696	1.914	2950.610	157.00	29.15	13.20	2963.81	.00	3.41	3.48	3.500	.000	.00 1 .0
140.858	.0760					.0680	9.58	1.91	4.13	1.88	.013	.00	PIPE
4898.479	2959.402	1.989	2961.391	157.00	27.80	12.00	2973.39	.00	3.41	3.47	3.500	.000	.00 1 .0
63.489	.0760					.0601	3.82	1.99	3.84	1.88	.013	.00	PIPE
4961.970	2964.230	2.070	2966.300	157.00	26.50	10.91	2977.21	.00	3.41	3.44	3.500	.000	.00 1 .0
10.656	.0775					.0555	.59	2.07	3.56	1.87	.013	.00	PIPE
4972.626	2965.055	2.090	2967.146	157.00	26.19	10.65	2977.79	.00	3.41	3.43	3.500	.000	.00 1 .0
34.019	.0775					.0516	1.75	2.09	3.49	1.87	.013	.00	PIPE
5006.645	2967.691	2.176	2969.867	157.00	24.97	9.68	2979.55	.00	3.41	3.39	3.500	.000	.00 1 .0
24.823	.0775					.0457	1.13	2.18	3.23	1.87	.013	.00	PIPE
5031.468	2969.615	2.267	2971.882	157.00	23.81	8.80	2980.68	.00	3.41	3.34	3.500	.000	.00 1 .0
19.049	.0775					.0406	.77	2.27	2.99	1.87	.013	.00	PIPE

Model “PIRM1-L3” – Interim Lateral at Skye Village Road

Proposed Condition WSPG Summary								
Lateral to the Mainline in Iron Mountain Road nearest Skye Village Road								
WSPG Station	Equivalent Roadway Station	Improvement Plan Sheet	Storm Drain Dimension	Invert Elevation (ft)	Q ₁₀₀ (cfs)	WSE (ft)	Velocity (ft/s)	HGL Check ¹
1000.00	80+07.63	LAT-01	30" RCP	2830.64	28.00	2833.60	5.70	OK
1037.10	80+32.5	LAT-01	30" RCP	2831.01	28.00	2833.77	5.70	OK
1088.40	N/A	LAT-01	30" RCP	2831.59	28.00	2834.09	5.70	N/A

T1 SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

T2 BY OLYMPIA COMPANIES

T3 IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT Lateral Stub "PIRM1-L3" (PROPOSED
CONDITION)

SO	1000.000	2830.640	30	.013				2833.600		
JX	1037.100	2831.010	30	.013	00.00			2831.010	00.0	
R	1117.100	2831.910	30	.013						45.00
SH	1117.100	2831.910	30	.013				2835.000		
CD	18	4	1	.000	1.500	.000	.000	.000	.00	
CD	24	4	1	.000	2.000	.000	.000	.000	.00	
CD	30	4	1	.000	2.500	.000	.000	.000	.00	
CD	36	4	1	.000	3.000	.000	.000	.000	.00	
CD	42	4	1	.000	3.500	.000	.000	.000	.00	
CD	48	4	1	.000	4.000	.000	.000	.000	.00	
CD	54	4	1	.000	4.500	.000	.000	.000	.00	
Q		28.000	.0							

Program Package Serial Number: 1704

Date: 9- 6-2018 Time: 3:19:33

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SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

IRON MOUNTAIN MAIN STORM DRAIN ALIGNMENT Lateral Stub "PIRM1-L3" (PROP

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Flow Top Dia.	Height or I.D.	Wt	ZL	No Wh
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall		ZR	Type Ch
1000.000	2830.640	2.960	2833.600	28.00	5.70	.51	2834.11	.00	1.80	.00	2.500	.000	.00	.00	1 .0
JUNCT STR	.0100					.0047	.17	2.96	.00		.013	.00	.00	.00	PIPE
1037.100	2831.010	2.763	2833.773	28.00	5.70	.51	2834.28	.00	1.80	.00	2.500	.000	.00	.00	1 .0
51.299	.0112					.0046	.24	2.76	.00	1.46	.013	.00	.00	.00	PIPE
1088.399	2831.587	2.500	2834.087	28.00	5.70	.51	2834.59	.00	1.80	.00	2.500	.000	.00	.00	1 .0
26.067	.0112					.0043	.11	2.50	.00	1.46	.013	.00	.00	.00	-

Shaumber Road

Model “USHA1” – South Mainline

Ultimate Condition WSPG Summary									
South Mainline in Shaumber Road along the West Boundary of Project Site									
WSPG Station	Equivalent Roadway Station	Improvement Plan Sheet	Storm Drain Dimension	Invert Elevation (ft)	Q ₁₀₀ (cfs)	WSE (ft)	Velocity (ft/s)	FG Elevation	HGL Check ¹
1000.00	N/A	LAT-01	54" RCP	2983.25	240.00	2987.04	16.81	N/A	N/A
1179.97	30+91.00	LAT-01	54" RCP	2985.92	240.00	2990.00	15.85	2997.67	OK
1179.98	30+91.00	LAT-01	54" RCP	2985.93	240.00	2990.04	15.77	2997.67	OK
1179.99	30+91.00	LAT-01	54" RCP	2985.94	240.00	2990.09	15.66	2997.67	OK
1180.00	30+91.00	LAT-01	54" RCP	2985.95	240.00	2990.19	15.45	2997.67	OK
1180.00	30+91.00	LAT-01	54" RCP	2985.95	221.00	2991.29	13.90	2997.67	OK
1342.91	29+32.87	PP-02	54" RCP	2987.58	221.00	2993.60	13.90	3002.76	OK
1510.28	27+70.39	PP-01	54" RCP	2989.25	221.00	2996.00	13.90	3006.58	OK
1733.24	25+53.65	PP-01	42" RCP	2992.47	108.00	3003.28	11.23	3010.29	OK
1733.25	25+53.65	PP-01	42" RCP	2992.48	108.00	3003.30	11.23	3010.29	OK
1733.25	25+53.65	PP-01	42" RCP	2992.98	76.00	3004.77	10.75	3010.29	OK
1854.73	24+35.56	PP-01	36" RCP	2996.48	76.00	3006.44	10.75	3009.44	OK
2040.73	23+50.00	PP-01	36" RCP	3000.30	76.00	3008.94	10.75	3011.15	OK
2090.73	23+00.00	PP-01	36" RCP	3001.13	76.00	3009.59	10.75	3011.74	OK

T1 SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

T2 BY OLYMPIA COMPANIES

T3 SHAUMBER SOUTH MAIN STORM DRAIN ALIGNMENT MODEL "USHA1" (ULTIMATE CONDITION)

SO	1000.0002983.250	54	.013		2987.75				
R	1179.9702985.920	54	.013					15.00	1
R	1179.9802985.930	54	.013					15.00	
R	1179.9902985.940	54	.013					15.00	
R	1180.0002985.950	54	.013					2.00	
JX	1180.0002985.950	54 24	.013	19.00	2988.450		45.0		
R	1342.9102987.580	54	.013					11.00	1
R	1510.2802989.250	54	.013					13.00	1
JX	1510.2802990.250	42 42	.013	113.00	2990.250		90.0		
R	1733.2402992.470	42	.013					15.00	1
R	1733.2502992.480	42	.013					3.00	
JX	1733.2502992.980	36 30	.013	32.00	2993.480		90.0		
R	1854.7302996.480	36	.013						1
R	2040.7303000.300	36	.013						1
R	2090.7303001.130	36	.013						
SH	2090.7303001.130	36	.013						
CD	18 4 1	.000	1.500	.000	.000	.000	.000	.00	
CD	24 4 1	.000	2.000	.000	.000	.000	.000	.00	
CD	30 4 1	.000	2.500	.000	.000	.000	.000	.00	
CD	36 4 1	.000	3.000	.000	.000	.000	.000	.00	
CD	42 4 1	.000	3.500	.000	.000	.000	.000	.00	
CD	48 4 1	.000	4.000	.000	.000	.000	.000	.00	
CD	54 4 1	.000	4.500	.000	.000	.000	.000	.00	
Q		76.000	.0						

Program Package Serial Number: 1704

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Date: 9-10-2018 Time:11: 4: 9

SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

SHAUMBER SOUTH MAIN STORM DRAIN ALIGNMENT MODEL "USHA1" (ULTIMATE COND

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Flow Top Dia.-FT	Height/ Base or I.D.	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	Type Ch
1000.000	2983.250	3.784	2987.034	240.00	16.81	4.39	2991.42	.00	4.24	3.29	4.500	.000	1 .0
67.573	.0148					.0141	.95	3.78	1.42	3.70	.013	.00	PIPE
1067.573	2984.252	3.834	2988.086	240.00	16.62	4.29	2992.38	.00	4.24	3.20	4.500	.000	1 .0
112.396	.0148					.0135	1.52	3.83	1.38	3.70	.013	.00	PIPE
1179.970	2985.920	4.075	2989.995	240.00	15.85	3.90	2993.90	.00	4.24	2.63	4.500	.000	1 .0
.010	1.0000					.0130	.00	4.08	1.16	1.06	.013	.00	PIPE
1179.980	2985.930	4.106	2990.036	240.00	15.77	3.86	2993.90	.00	4.24	2.54	4.500	.000	1 .0
.010	1.0000					.0130	.00	4.11	1.14	1.06	.013	.00	PIPE
1179.990	2985.940	4.146	2990.085	240.00	15.66	3.81	2993.90	.00	4.24	2.42	4.500	.000	1 .0
.010	1.0000					.0129	.00	4.15	1.10	1.06	.013	.00	PIPE
1180.000	2985.950	4.241	2990.190	240.00	15.45	3.71	2993.90	.00	4.24	2.10	4.500	.000	1 .0
JUNCT STR	.0000					.0128	.00	4.24	1.00		.013	.00	PIPE
1180.000	2985.950	5.337	2991.287	221.00	13.90	3.00	2994.29	.00	4.16	.00	4.500	.000	1 .0
162.910	.0100					.0126	2.06	5.34	.00	4.50	.013	.00	PIPE
1342.910	2987.580	6.023	2993.604	221.00	13.90	3.00	2996.60	.00	4.16	.00	4.500	.000	1 .0
167.370	.0100					.0126	2.11	6.02	.00	4.50	.013	.00	PIPE
1510.280	2989.250	6.746	2995.996	221.00	13.90	3.00	2998.99	.00	4.16	.00	4.500	.000	1 .0
JUNCT STR	.0000					.0121	.00	6.75	.00		.013	.00	PIPE

Model “SHA1-L” – DB1 Outfall Connection to Shaumber

Interim Condition WSPG Summary									
Lateral to the South Mainline in Shaumber Road along the West Boundary of Project Site									
WSPG Station	Equivalent Roadway Station	Improvement Plan Sheet	Storm Drain Dimension	Invert Elevation (ft)	Q ₁₀₀ (cfs)	WSE (ft)	Velocity (ft/s)	FG Elevation	HGL Check ¹
1000.00	27+70.39	PP-09	54" RCP	2990.25	113.00	3000.52	7.10	3006.58	OK
1164.50	27+71.92	PP-09	54" RCP	2991.88	113.00	3001.14	7.10	3005.00	OK
1164.51	27+71.92	PP-09	54" RCP	2991.89	113.00	3001.18	7.10	3005.00	OK
1164.52	27+71.92	PP-09	54" RCP	2991.90	113.00	3001.18	7.10	3005.00	OK
1164.52	27+71.92	PP-09	60" RCP	2991.90	113.00	3001.45	5.76	3005.00	OK
1283.45	27+27.44	PP-09	60" RCP	2995.40	113.00	3001.50	5.76	3005.00	OK

T1 SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

T2 BY OLYMPIA COMPANIES

T3 TIE-IN TO DB2 OUTFALL AND SHAUMBER ALIGNMENT; MODEL "SHA1-L"

SO	1000.000	2990.250	54	.013	3000.52					
R	1164.500	2991.880	54	.013					15.00	1
R	1164.510	2991.890	54	.013					15.00	
R	1164.520	2991.900	54	.013					1.00	
JX	1164.520	2991.900	60	.013						
R	1283.450	2995.400	60	.013						1
SH	1283.450	2995.400	60	.013						
CD	18	4	1	.000	1.500	.000	.000	.000	.00	
CD	24	4	1	.000	2.000	.000	.000	.000	.00	
CD	30	4	1	.000	2.500	.000	.000	.000	.00	
CD	36	4	1	.000	3.000	.000	.000	.000	.00	
CD	42	4	1	.000	3.500	.000	.000	.000	.00	
CD	48	4	1	.000	4.000	.000	.000	.000	.00	
CD	54	4	1	.000	4.500	.000	.000	.000	.00	
CD	60	4	1	.000	5.000	.000	.000	.000	.00	
Q				113.000	.0					

Program Package Serial Number: 1704

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Date: 9-10-2018 Time:11:21: 2

SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

BY OLYMPIA COMPANIES

TIE-IN TO DB2 OUTFALL AND SHAUMBER ALIGNMENT; MODEL "SHA1-L"

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Top Height Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch
1000.000	2990.250	10.270	3000.520	113.00	7.10	.78	3001.30	.00	3.13	.00	4.500	.000	.00	1 .0
164.500	.0099					.0033	.54	10.27	.00	2.45	.013	.00	.00	PIPE
1164.500	2991.880	9.261	3001.141	113.00	7.10	.78	3001.93	.00	3.13	.00	4.500	.000	.00	1 .0
.010	1.0000					.0033	.00	9.26	.00	.73	.013	.00	.00	PIPE
1164.510	2991.890	9.290	3001.180	113.00	7.10	.78	3001.96	.00	3.13	.00	4.500	.000	.00	1 .0
.010	1.0000					.0033	.00	9.29	.00	.73	.013	.00	.00	PIPE
1164.520	2991.900	9.283	3001.183	113.00	7.10	.78	3001.97	.00	3.13	.00	4.500	.000	.00	1 .0
JUNCT STR	.0000					.0026	.00	9.28	.00		.013	.00	.00	PIPE
1164.520	2991.900	9.549	3001.449	113.00	5.76	.51	3001.96	.00	3.03	.00	5.000	.000	.00	1 .0
118.930	.0294					.0019	.22							

Model “USHA2B-L” – Lateral to Center Mainline

Ultimate Condition WSPG Summary								
Lateral to the Center Mainline in Shaumber Road along the West Boundary of Project Site								
WSPG Station	Equivalent Roadway Station	Improvement Plan Sheet	Storm Drain Dimension	Invert Elevation (ft)	Q ₁₀₀ (cfs)	WSE (ft)	Velocity (ft/s)	HGL Check ¹
1000.00	51+28.97	LAT-01	36" RCP	2946.02	57.00	2951.58	11.61	OK
1051.79	51+10.89	LAT-01	36" RCP	2948.04	57.00	2952.04	11.61	OK
1051.79	51+10.89	LAT-01	36" RCP	2948.04	52.00	2952.38	10.59	OK
1087.95	N/A	LAT-01	36" RCP	2949.13	52.00	2952.60	10.59	N/A
1087.95	N/A	LAT-01	36" RCP	2949.13	52.00	2952.60	10.59	N/A

T1 SKYE CANYON INFRASTRUCTURE - PHASE 3B, 3C

T2 BY OLYMPIA COMPANIES

T3 SHAUMBER MID MAIN STORM DRAIN ALIGNMENT Lateral Stub "USHA2b-L" (ULTIMATE
CONDITION)

SO	1000.0002946.020	36	.013			2951.58			
R	1051.7902948.040	36	.013					9.50	1
JX	1051.7902948.040	36 36	.013	5.00		2948.040		90.0	
R	1087.9502949.130	36	.013						
SH	1087.9502949.130	36	.013						
CD	18 4 1	.000	1.500	.000	.000	.000	.000	.00	
CD	24 4 1	.000	2.000	.000	.000	.000	.000	.00	
CD	30 4 1	.000	2.500	.000	.000	.000	.000	.00	
CD	36 4 1	.000	3.000	.000	.000	.000	.000	.00	
CD	42 4 1	.000	3.500	.000	.000	.000	.000	.00	
CD	48 4 1	.000	4.000	.000	.000	.000	.000	.00	
CD	54 4 1	.000	4.500	.000	.000	.000	.000	.00	
Q		52.000	.0						

APPENDIX E

Cd of Electronic Files & Revised Improvement Plans
