

Las Vegas Wash Central, Cedar Avenue Channel **Preliminary Design Report**

June 22, 2015

Prepared for **City of Las Vegas, Nevada**



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June 22, 2015

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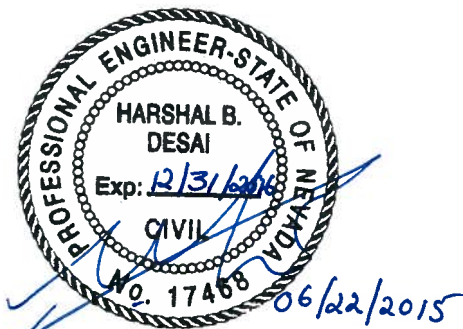
RE: Preliminary Design Report for Las Vegas Wash Central, Cedar Avenue Channel

Dear Ms. Cortez,

Transmitted herewith are the Preliminary Design Report and the 30% Design Plan Submittal for the Las Vegas Wash Central, Cedar Avenue Channel Project (Cedar Avenue Channel).

Please feel free to contact me if you have any questions.

Sincerely,



Harshal Desai, PE, CFM
Project Manager

Executive Summary

This Preliminary Design Report (PDR) has been prepared to describe the 30% design and analysis of the Las Vegas Wash Central, Cedar Avenue Channel project (hereafter referred to as the CAC). The project improvements extend from the Las Vegas Wash at the downstream end to the intersection of Pecos Road and Stewart Avenue at the upstream end. The regional facilities encompassed in this project are described in the 2013 Las Vegas Valley Flood Control Master Plan Update (MPU) as facility numbers CACH 0000 through 0148 and CACN 0001.

The project involves expanding the existing Cedar Avenue Channel from a trapezoidal channel to a rectangular channel ranging from 25 to 36 feet wide and from 6 to 17 feet deep. The project also involves installing approximately 2,000 feet of RCB storm drain upstream of the channel that varies in size from a 12' x 6' RCB to an 18' x 4' RCB. The proposed storm drain facilities will extend from the upstream end of the Cedar Avenue Channel to the intersection of Pecos Road and Stewart Avenue. The project entails the construction of these facilities and associated collection system including, but not limited to: laterals, drop inlets, manholes, and all necessary appurtenances to complete the Cedar Avenue Channel improvements.

It should be noted that the original Scope of Services previously provided for this project assumed that the storm drain improvements would extend west in Stewart Avenue from Pecos Road to Mojave Road and in Pecos Road south of Stewart Avenue to Sunrise Avenue. However, due to preliminary hydrologic/hydraulic analysis and coordination with the City, the project extents were shifted downstream in order to design channel improvements that will increase the limited capacity of the existing Cedar Avenue Channel.

Hydrologic analysis has been performed using the HEC-1 computer program to develop 100-year design flows for the CAC. These design flows were subsequently used in the hydraulic analysis to size the conveyance facilities accordingly. Hydraulic calculations for the storm drain were based on normal depth calculations and WSPG modeling, while the open channel portion of the project was analyzed using HEC-RAS.

The 30% Design Plans are provided with this PDR submittal. Other important aspects of the 30% design effort are presented in this PDR, including geotechnical investigations, survey summary, required permits, right-of-way information, and utility conflicts.

The overall, estimated construction cost of the project is **\$16,652,193**, which includes a 15-percent contingency to offset the level of detail provided at this submittal phase.

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- Appendix C-1: Draft Geotechnical Data Report
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- Cedar Avenue Channel Capacity Analysis
- Hydrologic/Hydraulic Models
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- PDF version of the Preliminary Design Report
- PDF version of the 30% Design Plans

1. Introduction

1.1. Purpose

The purpose of this Preliminary Design Report (PDR) is to describe the criteria, parameters, considerations, assumptions, and methodology used in the preliminary design and analysis of the Las Vegas Wash Central, Cedar Avenue Channel (hereafter referred to as CAC). This PDR includes pertinent aspects of the project explored to date and facilitates review of the design by the City of Las Vegas (the City), the Clark County Regional Flood Control District (CCRFCD), and other stakeholders.

It is important to note that the proposed drainage system and the associated analysis presented in this PDR is still a work in progress and represents the latest information corresponding to the 30% milestone submittal. Thus, the analysis, design, and information presented herein are subject to amendments, additions, and revisions in the future as comments are received and more analyses are completed throughout the detailed design phase. The content presented herein will later be updated as necessary and incorporated into the Draft Final Design Report at the 70% milestone.

1.2. Project Description and Location

The scope of services to be provided under the terms of the project contract includes the design and preparation of contract drawings, special provisions, cost estimates, and reports for the CAC. The project improvements extend from the Las Vegas Wash at the downstream end to the intersection of Pecos Road and Stewart Avenue at the upstream end. The regional facilities encompassed in this project are described in the 2013 Las Vegas Valley Flood Control Master Plan Update (MPU) as facility numbers CACH 0000 through 0148 and CACN 0001.

The project involves expanding the existing Cedar Avenue Channel from a trapezoidal channel to a rectangular channel ranging from 25 to 36 feet wide and from 6 to 17 feet deep. At this phase of the design the intent is to preserve all of the existing bridge crossings along the channel and make improvements to the channel section only. The project also involves installing approximately 2,000 feet of RCB storm drain upstream of the channel that varies in size from a 12' x 6' RCB to an 18' x 4' RCB. The proposed storm drain facilities will extend from the upstream end of the Cedar Avenue Channel to the intersection of Pecos Road and Stewart Avenue. The project entails the construction of these facilities and associated collection system including, but not limited to: laterals, drop inlets, manholes, and all necessary appurtenances to complete this project.

There will also be drop inlet facilities and lateral storm drains required on the north and south of Stewart Avenue, just west of Pecos Road, to collect runoff from the street and convey it to the main storm drain facility. Detailed sizes, location, and alignments of the proposed storm drain facilities are shown on the 30% Design Plans that accompany this report and will be described later in this PDR.

The project site is located in the area referred to as the "Central Watershed" in the 2013 MPU, within Sections 31 and 32 of Township 20S, Range 62E and Section 36 of Township 20S, Range 61E. The general project location is shown on a vicinity map in **Figure 1**. **Figure 2** is a reproduction of Figure F-26 and Table F-26 from the 2008 MPU that show the original alignment and geometry of the proposed system. **Figure 3** shows the general location (alignment) of the CAC.

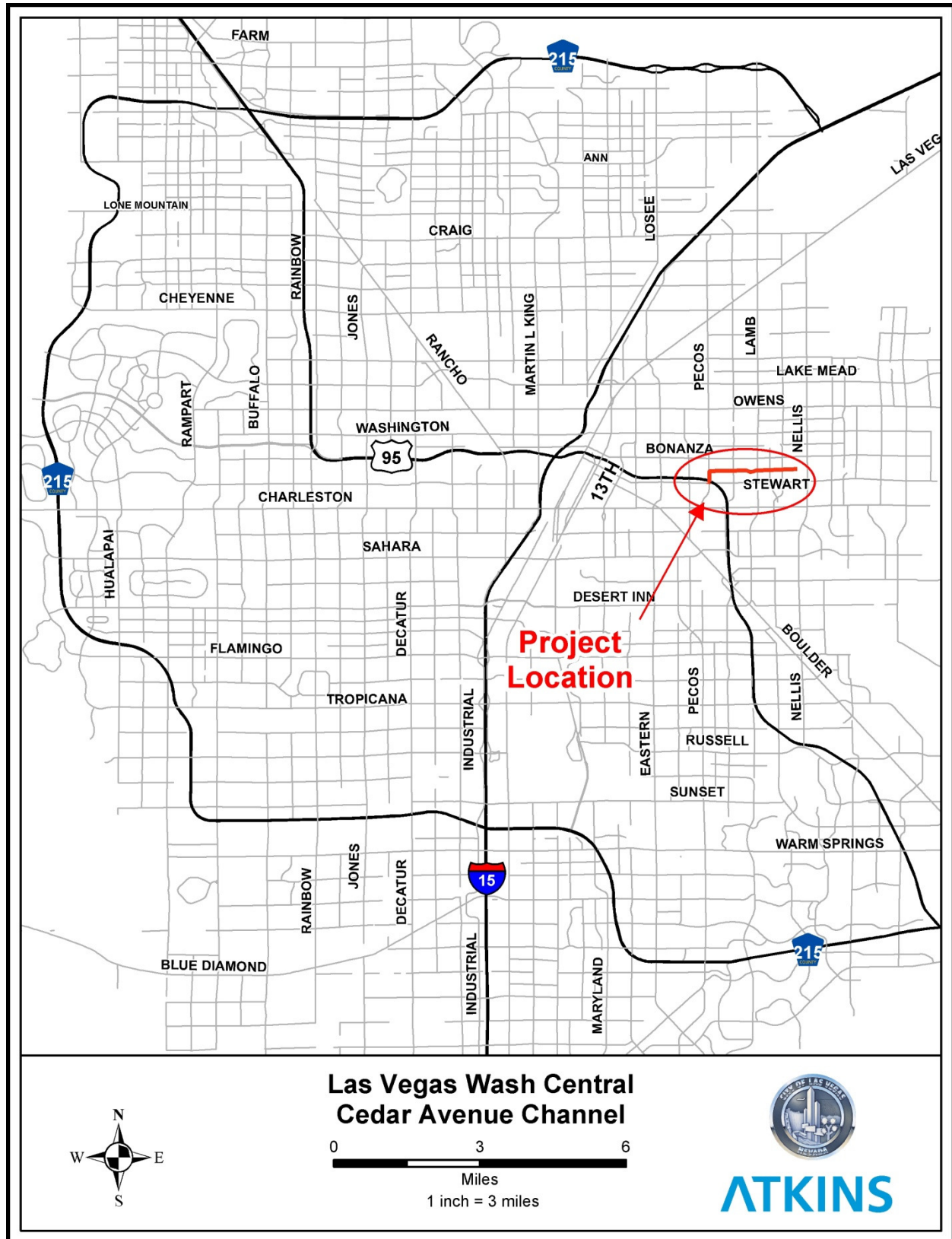
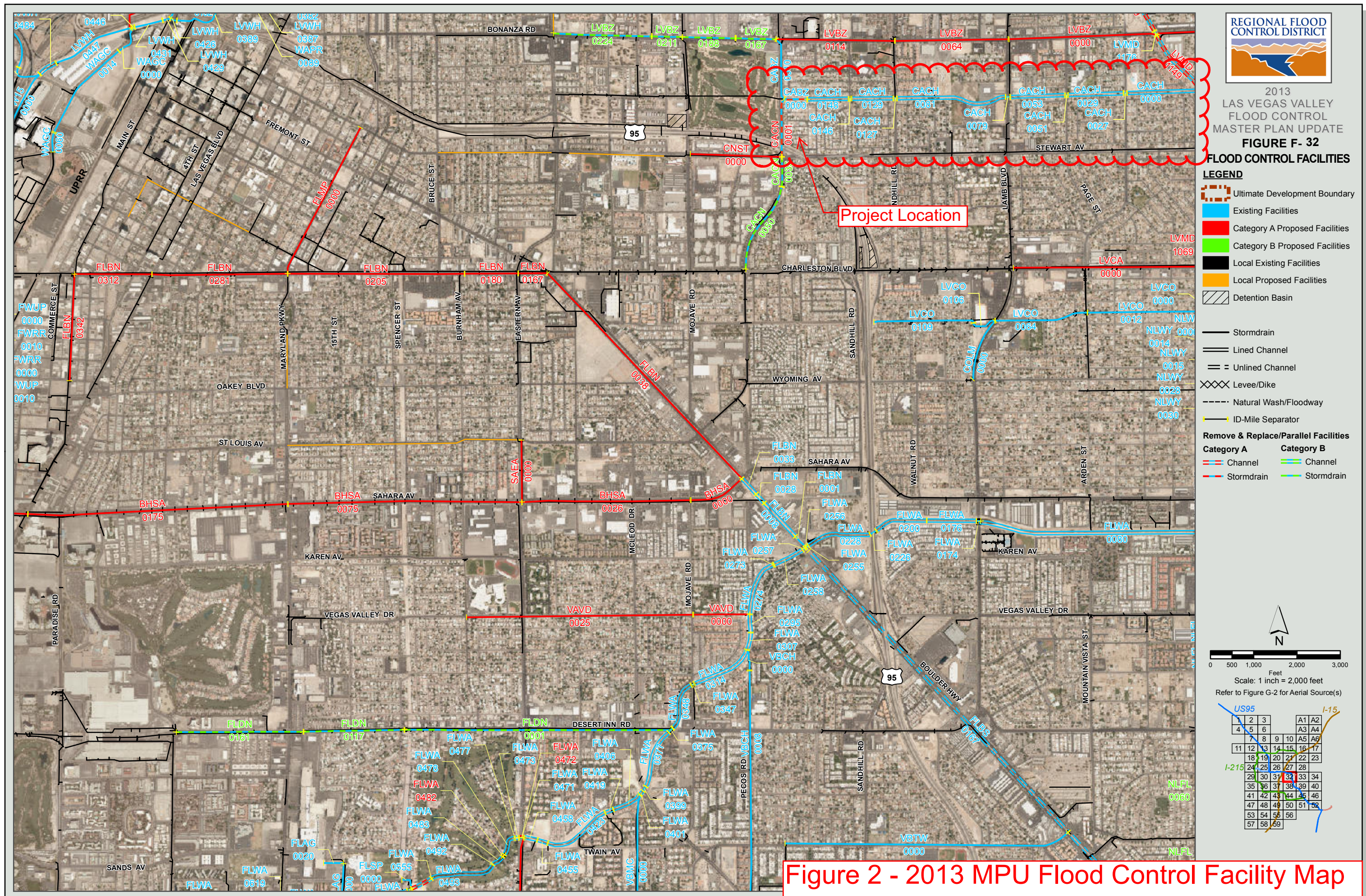


Figure 1. Cedar Avenue Channel Project Vicinity Map



ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
BHSA		BOULDER HIGHWAY SAHARA AVENUE						
0000	P2	14' X 10' RCB	1350	3837	CSA13*	SW3	7.93	0.50
0026	P1	14' X 11' RCB	4000	3837	CSA13*	SW3	7.93	1.30
0075	P1	12' X 11' RCB	5280	3837	CSA13*	SW3	7.93	2.11
0175	P1	14' X 14' RCB	6000	3837	CSA13	SW3	7.93	0.67
CABZ		CEDAR AVENUE - BONANZA						
0000	E	72" RCP	525					0.30
0014	E	84" RCP	450					0.50
CACH		CEDAR AVENUE CHANNEL						
0000	E	Conc Chnl 10"W 8'D 1.5:1 SS	1681	1544	CCA10-C	SW3	1.81	0.20
0027	E	2: 15'X5' RCBC @ Marion	82	1544	CCA10-C	SW3	1.81	0.35
0029	E	Conc Chnl 10"W 8'D 1.5:1 SS	1284	1544	CCA10-C	SW3	1.81	0.37
0051	E	2: 15'X5' RCBC @ Page	64	1544	CCA10-C	SW3	1.81	0.38
0053	E	Conc Chnl 10"W 6'D 1.5:1 SS	1275	1544	CCA10-C	SW3	1.81	0.38
0079	E	2: 12' X 6' RCBC @ Lamb	100	1387	CCA08-C	SW3	1.61	0.38
0081	E	Conc Chnl 12"W 6'D 1.5:1 SS	2562	1387	CCA08-C	SW3	1.61	0.20
0127	E	3: 12'X4' RCBC @ Sandhill	80	1387	CCA08-C	SW3	1.61	0.20
0129	E	Conc Chnl 10"W 8'D 1.5:1 SS	971	1387	CCA08-C	SW3	1.61	0.26
0146	E	2: 12' X 5.5' RCBC @ Honolulu	62	1387	CCA08-C	SW3	1.61	0.53
0148	E	Conc Chnl 10"W 8'D 1.5:1 SS	959	1387	CCA08-C	SW3	1.61	0.53
CACN		CEDAR AVENUE - CHARLESTON						
0000	E	72" RCP (Replace w/ CACN0001)	1867	933	CCA05	SW3	0.96	0.41
0001	P1	10' X 9' RCB (Replaces CACN0000)	1867	933	CCA05	SW3	0.96	0.41
0034	E	2: 18' X 8' RCBC @ Mojave	80	7195	CFW30B	FLAM5B	21.25	0.94
0035	P0	6' X 6' RCB (Replaces CACN0034)	685	254	CA05	SW3	0.24	0.30
0049	E	66" RCP (Replace w/ CACN0050)	2146	254	CA05	SW3	0.24	0.60
0050	P0	6' X 5' RCB (Replaces CACN0049)	2146	254	CA05	SW3	0.24	0.60
CNST		CEDAR AVENUE CHANNEL - STEWART						
0000	P1	8' X 7' RCB	2120	690	CCA04	SW3	0.72	0.90
COLM		COLORADO / LAMB						
0000	E	72" RCP	1500	470	CCH94	SW3	0.63	0.87
FLAG		FLAMINGO WASH - ALGONQUIN						
0000	E	72" RCP	1080	513	FW21	FLAM3A	0.47	0.50
0020	E	66" RCP	460	513	FW21	FLAM3A	0.47	1.00
FLBN		FLAMINGO - BOULDER HIGHWAY NORTH						
0001	E	5: 10' X 6' RCB	350	4784	CCFR03	BOULDER4	11.13	0.58
0008	E	3: 14' X 12' RCB	1055	4784	CCFR03	BOULDER4	11.13	0.20
0028	E	3: 14' X 12' RCB	275	4784	CCFR03	BOULDER4	11.13	0.20
0033	E	3: 14' X 12' RCB	500	4784	CCFR03	BOULDER4	11.13	0.20
0038	P1	15' X 10' RCB	6600	2448	CFR03	SW3	3.46	0.59
0167	P1	2: 10' X 6' RCB	700	2046	CCH68-C	SW3	2.86	1.14
0180	P1	2: 10' X 6' RCB	1300	1799	CCCH67-C	SW3	2.55	1.31
0205	P1	10' X 6' RCB	4000	1461	CCH63-C	SW3	1.88	2.30
0281	P1	10' X 7' RCB	3100	1259	CCH56	SW3	1.64	1.33
0312	P1	7' X 4' RCB	1800	555	CCH52	SW3	0.55	4.20
0342	P1	7' X 4' RCB	2500	555	CCH52	SW3	0.55	4.20
FLBS		FLAMINGO - BOULDER HIGHWAY SOUTH						
0000	E	Unlined Median Chnl 0"W 6.5'D 4.5:1 SS	4060	945	CB4	FLAM3A	1.38	1.30
0167	E	Unlined Median Chnl 0"W 3.5'D 9:1 SS	8850	452	CB4N	FLAM3A	0.63	0.90
FLDN		DESERT INN DRAIN EAST						
0000	E	60" RCP (Replace w/ FLDN0001)	6160	1267	CFW30AW	FLAM3A	2.12	1.22
0001	P0	12' X 6' RCB (Replaces FLDN0000)	6160	1267	CFW30AW	FLAM3A	2.12	1.22
0116	E	54" RCP (Replace w/ FLDN0117)	2330	1178	CFW29	FLAM3A	1.82	1.77
0117	P0	10' X 6' RCB (Replaces FLDN0116)	2330	1178	CFW29	FLAM3A	1.82	1.77
0160	E	48" RCP (Replace w/ FLDN0160)	2950	906	CFW28	FLAM3A	1.51	1.28
0161	P0	10' X 6' RCB (Replaces FLDN0161)	2950	906	CFW28	FLAM3A	1.51	1.28

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
FLMP		FLAMINGO WASH-MARYLAND PARKWAY SYSTEM						
0000	P1	8' X 6' RCB	3800	492	CCH60A-C	SW3	0.75	0.49
FLSP		FLAMINGO WASH - SPENCER						
0000	E	48" RCP	420	513	FW21	FLAM3A	0.47	1.10
FLWA		FLAMINGO WASH						
0000	E	Grass Chnl 107"W 5'D 2:1 SS (Replace w/ FLWA0001)	4570	10952	CFW36*	FLAM5B	36.14	0.40
0001	P1	Conc Chnl 100"W 7.5'D 1:1 SS (Replaces FLWA0000)	4570	10952	CFW36*	FLAM5B	36.14	0.40
0078	E	3 Span Bridge 108.25"W 5.5'D @ Nellis	120	10952	CFW36	FLAM5B	36.14	0.70
0080	E	Conc Chnl 50"W 8.5'D 1:1 SS	5080	10952	CFW36	FLAM5B	36.14	1.20
0174	E	9: 10' X 6' RCBC @ Lamb	110	10822	CFW34	FLAM5B	35.66	1.40
0176	E	Conc Chnl 60"W 9'D 1:1 SS	1180	10822	CFW34	FLAM5B	35.66	0.70
0200	E	Conc Chnl 70"W 8'D to 12'D w/ Pier 0:1 SS	1245	10822	CFW34	FLAM5B	35.66	0.50
0226	E	Free Span Bridge 100"W 10'D @ I-515	170	10822	CFW34	FLAM5B	35.66	0.80
0228	E	Conc Chnl 70"W 8'D to 12'D 0:1 SS	1500	10788	CFW33	FLAM5B	35.36	0.80
0255	E	2 Span Bridge 150"W 9'D @ Boulder Hwy	60	8146	CFW33W	FLAM5B	24.23	1.00
0256	E	Conc Chnl 60"W 7.5'D 0:1 SS	40	8146	CFW33W	FLAM5B	24.23	1.00
0257	E	2 Span Bridge 150"W 9'D @ Boulder Hwy	60	8146	CFW33W	FLAM5B	24.23	1.00
0258	E	Conc Chnl 60"W 7.5'D 0:1 SS	750	8146	CFW33W	FLAM5B	24.23	0.44
0273	E	Free Span Bridge 60"W 9'D @ MMMHP	20	8146	CFW33W	FLAM5B	24.23	0.40
0274	E	Conc Chnl 60"W 8.1'D 0:1 SS	1370	8146	CFW33W	FLAM5B	24.23	1.00
0295	E	Conc Chnl 60"W 8.1'D 0:1 SS	430	7669	CFW31	FLAM5B	22.62	0.80
0307	E	Conc Chnl 60"W 8.1'D 2:1 SS	410	7669	CFW31	FLAM5B	22.62	0.70
0314	E	Conc Chnl 60"W 8.1'D 2:1 SS	1500	7195	CFW30B	FLAM5B	21.25	0.90
0347	E	5: 10' X 8' RCBC @ Mojave	80	7195	CFW30B	FLAM5B	21.25	0.94
0348	E	Conc Chnl 30"W 12'D 1:1 SS	1150	7195	CFW30B	FLAM5B	21.25	0.70
0375	E	5: 10' X 8' RCBC @ Desert Inn	140	7102	CFW30A	FLAM5B	20.96	2.70
0377	E	Conc Chnl 50"W 9.5'D 0:1 SS	1372	6964	CFW23	FLAM5B	19.36	1.04
0399	E	Free Span Bridge 60"W 16'D @ McLeod	120	6964	CFW23	FLAM5B	19.36	0.50
0401	E	Conc Chnl 50"W 11.5'D 0:1 SS	123	6964	CFW23	FLAM5B	19.36	0.50
0406	E	Conc Chnl 33"W 11.5'D 0:1 SS	690	6964	CFW23	FLAM5B	19.36	1.01
0419	E	Conc Chnl 33'-50"W 9.8'D 0:1 SS	200	6964	CFW23	FLAM5B	19.36	2.00
0423	E	Conc Chnl 50"W 9.8'D 0:1 SS	1686	6964	CFW23	FLAM5B	19.36	0.76
0455	E	Conc Chnl 50'-75"W 9.8'D 0:1 SS	169	6964	CFW23	FLAM5B	19.36	1.83
0458	E	Conc Chnl 75'-80"W 9.8'D 0:1 SS	347	6964	CFW23	FLAM5B	19.36	1.01
0471	E	5: 10' X 8' RCBC @ Eastern	110	5781	CFW22W	FLAM5B	14.95	1.30
0472	P1	Add 1: 22' X 8' RCBC @ Eastern	110	5781	CFW22W	FLAM5B	14.95	0.50
0473	E	Grass Chnl 60"W 15'D 2:1 SS	100	5781	CFW22W	FLAM5B	14.95	0.47
0477	E	3 Span Bridge 47"W 15'D	10	5781	CFW22W	FLAM5B	14.95	0.80
0478	E	Grass Chnl 60"W 15'D 2:1 SS	520	5781	CFW22W	FLAM5B	14.95	0.47
0481	E	3: 90" CMAP @ Tioga (Replace w/ FLWA0482)	60	5781	CFW22W	FLAM5B	14.95	0.87
0482	P1	4: 20' X 8' RCBC @ Tioga (Replaces FLWA0481)	60	5781	CFW22W	FLAM5B	14.95	0.87
0483	E	Grass Chnl 60"W 15'D 2:1 SS	300	5781	CFW22W	FLAM5B	14.95	0.63
0492	E	3 Span Bridge 47"W 15'D	10	5781	CFW22W	FLAM5B	14.95	0.50
0493	E	Grass Chnl 60"W 15'D 2:1 SS	1520	5781	CFW22W	FLAM5B	14.95	0.46
0555	E	3 Span Bridge 47"W 15'D	10	5701	CFW21	FLAM5B	14.55	0.50
0556	E	Earth Chnl 60"W 15'D 2:1 SS (Replace w/ FLWA0557)	520	5701	CFW21	FLAM5B	14.55	0.54
0557	P1	Gabion Chnl 30"W 10.5'D 2:1 SS (Replaces FLWA0556)	520	5701	CFW21	FLAM5B	14.55	0.54
LVBS		LAS VEGAS WASH - BONANZA						
0000	P1	2: 12' X 7' RCB	3400	1636	CBN15-C	SW3	2.40	0.40
0064	P1	2: 12' X 6' RCB	2630	1449	CBN12-C	SW3	2.12	0.40
0114	P1	2: 12' X 6' RCB	2740	1266	CBN10-C	SW3	1.79	0.40
0166	E	54" RCP (Replace w/ LVBZ0167)	1095	1051	CBN09	SW3	1.54	0.45
0167	P0	10' X 9' RCB (Replaces LVBZ0166)	1095	1051	CBN09	SW3	1.54	0.45
0187	E	48" RCP (Replace w/ LVBZ0188)	1235	1051	CBN09	SW3	1.54	0.71
0188	P0	9' X 9' RCB (Replaces LVBZ0187)	1235	1051	CBN09	SW3	1.54	0.71
0210	E	42" RCP (Replace w/ LVBZ0211)	704	911	CBN08	SW3	1.30	1.37
0211	P0	8' X 7' RCB (Replaces LVBZ0210)	704	911	CBN08	SW3	1.30	1.37
0223	E	36" RCP (Replace w/ LVBZ0224)	2275	722	CBN03	SW3	1.09	0.72
0224	P0	8' X 7' RCB (Replaces LVBZ0223)	2275	722	CBN03	SW3	1.09	0.72

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
LVCA		LAS VEGAS WASH - CHARLESTON						
0000	P1	12' X 9' RCB	4600	1104	CCH77-C	SW3	1.34	0.30
LVCO		COLORADO AVENUE SYSTEM						
0000	E	18' X 8' RCB	610	1015	CNEL06	SW3	1.30	0.24
0012	E	14' X 8' RCB	2560	1015	CNEL06	SW3	1.30	0.24
0064	E	10' X 8' RCB	2165	827	CCH94	SW3	0.98	0.24
0106	E	10' X 8' RCB	590	394	CCH92-C	SW3	0.35	0.24
0109	E	10' X 5' RCB	2350	394	CCH92-C	SW3	0.35	0.67
LVMD		LAS VEGAS WASH - MIDDLE						
1032	E	Earth Chnl 75W 10'D 1:1 SS (Replace w/ LVMD1033)	715	15156	CNLWY	CLVWASH5	118.28	0.30
1033	P1	Conc Chnl 75W 11'D 1:1 SS (Replaces LVMD1032)	739	15156	CNLWY	CLVWASH5	118.28	0.30
1045	E	5 Span Bridge 75W 10'D 1:1 SS (Replace w/ LVMD1046)	120	15156	CNLWY	CLVWASH5	118.28	0.52
1046	P1	Bridge 75W 9.5'D 1:1 SS @ Nellis (Replaces LVMD1045)	120	15156	CNLWY	CLVWASH5	118.28	0.52
1047	E	Earth Chnl 80W 8'D 2:1 SS (Replace w/ LVMD1048)	340	15083	CCNEL06	CLVWASH5	117.81	0.50
1048	P1	Conc Chnl 120W 8'D 0:1 SS (Replaces LVMD1047)	340	15083	CCNEL06	CLVWASH5	117.81	0.50
1053	E	Earth Chnl 80W 8'D 2:1 SS (Replace w/ LVMD1054)	860	14811	CNEL04-2	CLVWASH5	116.51	0.50
1054	P1	Conc Chnl 120W 8'D 0:1 SS (Replaces LVMD1053)	860	14811	CNEL04-2	CLVWASH5	116.51	0.50
1068	E	5 Span Bridge 90W 6'D 2:1 SS (Replace w/ LVMD1069)	120	14438	CCST03-C	CLVWASH5	114.87	0.50
1069	P1	5 Span Bridge 110W 8'D 2:1 SS (Replaces LVMD1068)	120	14438	CCST03-C	CLVWASH5	114.87	0.50
1070	E	Earth Chnl 90W 10.5'D 1:1 SS (Replaces w/ LVMD1071)	2587	14438	CCST03-C	CLVWASH5	114.87	0.43
1071	P1	Conc Chnl 90W 9.5'D 1:1 SS (Replaces LVMD1070)	2587	14438	CCST03-C	CLVWASH5	114.87	0.43
1119	E	5 Span Bridge 90W 12'D 2:1 SS @ Stewart	120	14354	CCCA10-C	CLVWASH5	114.40	0.20
1120	E	Earth Chnl 90W 12'D 1:1 SS (Replace w/ LVMD1121)	1400	14354	CCCA10-C	CLVWASH5	114.40	0.20
1121	P1	Conc Chnl 90W 10.5'D 1:1 SS (Replaces LVMD1120)	1400	14354	CCCA10-C	CLVWASH5	114.40	0.20
1148	E	Earth Chnl 70W 18' 20"D 1.5:1 SS (Replace w/ LVMD1149)	1675	13944	CCBN15-C	CLVWASH5	112.59	0.41
1149	P1	Conc Chnl 70W 10'D 1.5:1 SS (Replaces LVMD1148)	1675	13944	CCBN15-C	CLVWASH5	112.59	0.41
1176	E	5 Span Bridge 110W 20'D 2:1 SS @ Bonanza	120	12690	CLVW04-C	CLVWASH5	108.80	0.57
1178	E	Earth Chnl 90W 18' 20"D 2:1 SS (Replace w/ LVMD1179)	1500	12690	CLVW04-C	CLVWASH5	106.80	0.57
1179	P1	Conc Chnl 60W 9.5'D 2:1 SS (Replaces LVMD1178)	1500	12690	CLVW04-C	CLVWASH5	106.80	0.57
LVNE		LAS VEGAS WASH - NELLIS						
0000	P1	2: 13' X 10' RCB	4675	2303	CNEL02-C	WEST3	3.39	0.20
LVOE		OWENS AVENUE - EAST						
0345	P1	13' X 11' RCB	1685	2369	DLVOE	SW5	22.79	0.60
LVWH		WASHINGTON AVENUE CHANNEL						
0389	E	12' X 8' RCB	2110	1607	(1/2) CV1-C	SW5SC	15.16	0.90
0426	E	16' X 8' RCB	150	1607	(1/2) CV1-C	SW5SC	15.16	1.08
0429	E	Splitter Structure (2: 12' X 8' RCB)	190	2870	DLCL21	SW5	22.79	1.90
0431	E	3: 14.33' X 10' RCB	665	2870	DLCL21	SW5	22.79	0.15
0446	E	Junction Structure	69	2870	DLCL21	SW5	22.79	0.15
0447	E	3: 14.33' X 10' RCB	1955	4978	CCAL93	SW5	22.19	0.15
NLFL		NELLIS FLAMINGO STORM DRAIN						
0028	P0	Add 1: 7' X 6' RCB	1530	338 ^A	CM3 ^A	FLAM3A	1.27	0.39
0029	E	76" & 48" RCP	1530	391 ^A	CM3 ^A	FLAM3A	1.27	0.39
0059	E	60" RCP	1370	143 ^A	CM3 ^A	FLAM3A	1.27	0.30
0060	P0	Add 1: 12' X 6' RCB	1370	586 ^A	CM3 ^A	FLAM3A	1.27	0.34
0084	E	48" RCP	2490	79 ^A	CM2 ^A	FLAM3A	0.98	0.30
0085	P0	Add 1: 11' X 6' RCB	2490	505 ^A	CM2 ^A	FLAM3A	0.98	0.30
0131	E	42" RCP	650	350	M1	FLAM3A	0.51	0.23
0144	E	36" RCP	620	350	M1	FLAM3A	0.51	0.20
NLWY		NELLIS - WYOMING CHANNEL						
0000	E	Conc Chnl 8'W 4'D 1.3:1 SS	260	338	FW35	FLAM3A	0.47	1.71
0004	E	15' X 6' RCAC	80	338	FW35	FLAM3A	0.47	1.30
0006	E	Conc Chnl 8'W 4'D 1.3:1 SS	400	338	FW35	FLAM3A	0.47	0.38
0014	E	12' X 4' RCBC @ Winterwood	70	338	FW35	FLAM3A	0.47	0.40
0015	E	Conc Chnl 8'W 4'D 1.3:1 SS	720	338	FW35	FLAM3A	0.47	0.38
0028	E	12' X 4' RCBC @ Wyoming	90	338	FW35	FLAM3A	0.47	0.80
0030	E	Conc Chnl 8'W 4'D 1.3:1 SS	250	338	FW35	FLAM3A	0.47	0.38
SAEA		SAHARA AVENUE - EASTERN LATERAL						
0000	P1	10' X 8' RCB	1440	564	CFR02	SW3	0.66	0.20

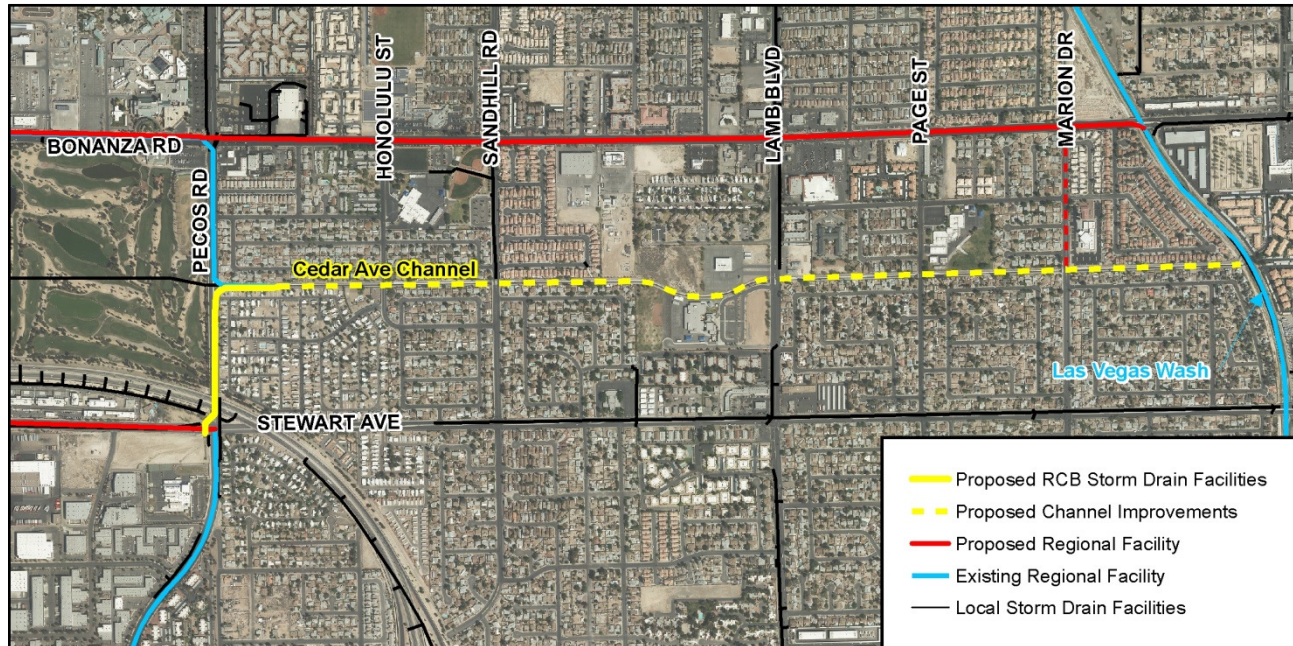


Figure 3. Cedar Avenue Channel Project Alignment

1.3. Inventory of the Existing Condition

The watershed area impacting the CAC encompasses approximately 3.5-square-miles of urbanized area in the central portion of the City. The watershed is generally bounded by Maryland Parkway on the west, Bonanza Road on the North, Charleston Boulevard on the south, and the Las Vegas Wash on the east. The overall drainage pattern in the study area is from west to east, with surface runoff being conveyed on surface streets and in local channels and minor storm drain facilities.

Panel 32003C2186F and 32003C2187F of Federal Emergency Management Agency's (FEMA's) Flood Insurance Rate Maps (FIRMs) shows the majority of the project area is not within a Special Flood Hazard Area. A small reach at the end of the proposed channel lies within a Zone AE flood zone. FIRMettes showing the flood zone boundaries in the study area is included in **Appendix A**.

During early phases of the project, field investigations were performed by Atkins in the study area to assess drainage patterns, confirm design data that was collected, and evaluate the current condition of the project site and tributary areas. Detailed topography, aerial photos, and previously completed drainage studies were also reviewed and relevant information extracted in order to inventory the existing condition and understand constraints and design considerations in the study area. In addition, photos were taken during field investigations and compiled in a photo library included in **Appendix A**.

A few observations regarding the existing condition are summarized in the following paragraphs.

The intersection of Stewart Avenue and Pecos Road is the main collection point for the proposed storm drain facilities. The flows impacting this intersection come primarily from the west on the surface of Stewart Avenue. There are existing drop inlets and lateral storm drains on the north and south side of Pecos Road that collect a small portion of the surface flow. There is also a drainage swale that runs from south to north along the west side of Pecos Road that connects to a headwall under Stewart Avenue. The flow collected at the headwall and in the drop inlets is conveyed through local storm drains to an existing 72" RCP in Pecos Road that drains north and eventually discharges to the Cedar Avenue Channel. These facilities are undersized and do not have adequate capacity to convey the 100-year flow impacting the intersection.

South of Stewart Avenue, Pecos Road has relatively minor surface flows on the street because the majority of the flow in the area is already conveyed in the existing 66" RCP (which transitions to dual 48" RCPs) in Pecos Road and in local, on-site storm drains that convey flow through parking lots and commercial areas immediately west of Pecos Rd. The drainage facilities in Pecos Road are adequately sized and will connect to proposed storm drain facilities constructed with this project. More detailed information regarding the drainage patterns and hydrology in this area is included in Section 2.

Any flow that is not collected by drop inlets on Stewart Avenue will bypass the intersection and continue east on Stewart Avenue. There is an existing low point further downstream on Stewart Avenue, west of Marion Drive, where flow will pond up during storm events. This project will help alleviate or reduce some of the flooding problems occurring downstream on Stewart Avenue.

The Cedar Avenue Channel collects flow from the 72" RCP in Pecos Road, as well as another 72" RCP that brings flow into the channel from the Desert Pines Golf Course area and Bonanza Road. The channel conveys this flow eastward under 5 bridge structures at Honolulu Street, Sandhill Road, Lamb Boulevard, Page Street, and Marion Drive until eventually discharging to the Las Vegas Wash at the downstream end. Additional flow comes into the channel via drop inlets at each of the bridge structures. During an early progress meeting on the project, the City stated that the Cedar Avenue Channel was limited in capacity and has experienced overtopping at Lamb Boulevard in the past. Atkins performed normal depth and HEC-RAS analysis and confirmed that the channel had limited capacity to convey the project design flows in the existing condition.

The overall intent of the project is to collect as much of the 100-year flow as possible at Stewart Avenue and Pecos Road and to increase the conveyance capacity of the Cedar Avenue Channel, thereby improving flood protection in this area.

1.4. Existing Facilities and Adjacent Completed Projects Summary

There are completed and ongoing projects and storm drain facilities in the study area that are related to this project and may impact the storm drain design considerations/constraints. The major projects and facilities are described below.

1.4.1. Pecos Road Storm Drain

There is a 66" RCP storm drain in Pecos Road that conveys flow north from Charleston Boulevard. The pipe transitions to dual 48" RCPs north of Sunrise Avenue in order to cross over a 36" sewer line. After crossing the sewer and Stewart Avenue, the dual 48" RCP transitions to a large 72" RCP that continues north and then east until discharging to the Cedar Avenue Channel. The 72" RCP will be replaced and upsized with this

project, while the dual 48" RCP and 66" RCP will remain in place and connect with proposed storm drain facilities constructed with this project.

1.4.2. Stewart Avenue Storm Drain

There is a 24" RCP storm drain in Stewart Avenue that extends from just west of Mojave Road to Pecos Road. This storm drain collects flow from existing drop inlets on Stewart Avenue and eventually connects to the 72" RCP in Pecos Road. The 24" RCP facility will connect with proposed storm drain facilities constructed with this project.

1.4.3. Desert Pines Golf Course Storm Drain

The Desert Pines Golf Course, located east of Pecos Road and north of US 95, has a 60" RCP storm drain running from west to east through the middle of the golf course. This facility collects flow from Cedar Avenue and the golf course and conveys it to Pecos Road. At Pecos Road, it combines with another 60" RCP that comes from the north (from Bonanza Road), and then continues as a 72" storm drain that eventually discharges to the upstream end of the Cedar Avenue Channel.

1.4.4. BOMO Force Main – Phase 2

This ongoing sewer project has a proposed alignment in Pecos Road and Stewart Avenue in the immediate vicinity of the proposed storm drain improvements. Coordination with this project is ongoing. Atkins reviewed the preliminary layout of the BOMO system at the 70% design level to resolve potential conflicts. Coordination with this project should continue through final design.

1.4.5. Multi-Family Residential Development (APN 140-31-501-021)

There is an ongoing land development project for a multi-family residential site that is located just north of the Cedar Avenue Channel and west of Lamb Boulevard. Coordination with the City and the design engineer (L.R. Nelson) has occurred and will continue as necessary. The development intends to discharge runoff directly to the Cedar Avenue Channel, so coordination on hydrology/hydraulics as well as the trail widths and easements in this area will be needed going forward.

1.4.6. Las Vegas Wash Project

The Las Vegas Wash project is ongoing at the downstream end of the Cedar Avenue Channel. At the downstream end of the channel, the Las Vegas Wash project proposed to convey all flow in the Cedar Avenue Channel within an 18' x 12' RCB confluence (based on the 100% QA/QC set, not for construction). Atkins has coordinated with the City the design consultants on several occasions and it was agreed that the proposed RCB should be widened to 22 – 25 feet, instead of 18 feet as was shown on the preliminary plans. This will improve the hydraulics of the channel and make it possible to potentially bring more flow into the channel from Bonanza Road in the future. However, this Las Vegas Wash project at the downstream end of the channel is currently on hold, so the design at the confluence has not been finalized. For the purpose of this preliminary design report and per the direction of the City, it was assumed that the confluence will be at least 22 feet wide. Further information regarding the channel design and confluence at the downstream end of the channel is available in **Section 4**.

1.4.7. Cedar Drainage Trail

The Cedar Drainage Trail was constructed along the north side of the Cedar Avenue Channel, extending from Pecos Road to the pedestrian bridge at the Las Vegas Wash. The project also included installation of light poles and landscaping. The wider channel improvements completed with this project will preserve a functional trail, although the trail width will be reduced in several locations.

1.5. Report Organization

The technical information compiled and presented in this report will facilitate review of the drainage analysis/design and is based on best available data at the time of the 30% milestone submittal. The report has been organized into five main sections: Section 1 serves as an overall introduction; Section 2 and 3 contain detailed information about the hydrologic and hydraulic (H&H) analysis, respectively; Section 4 includes summaries of several other design works and activities, including general design considerations, the geotechnical investigations, survey summary, right-of-way summary, etc.; Section 5 summarizes the utility conflicts and utility coordination effort that has taken place to date; Section 6 is the final section and includes the construction cost estimate.

A technical appendix is included at the end of the report with all supporting documentation and analysis. In addition, an electronic Data CD is also provided at the end of report with a pdf version of the entire report, the 30% design plans in pdf format, and other electronic files related to this submittal. The 30% design plans also accompany this report and include pertinent information for review, such as proposed facility sizes, horizontal/vertical alignments, utility conflicts, lateral locations, etc.

2. Hydrologic Analysis

2.1. General

This section includes information about the criteria and methodology used in the hydrologic analysis of the CAC. The criteria, methodology, and analyses are generally consistent with the Clark County Regional Flood Control District's (CCRFCD) Hydrologic Criteria and Drainage Design Manual (hereafter referred to as the Design Manual). Any deviations from the Design Manual are discussed in more detail later in this section.

2.2. Previous and/or Related Drainage Studies

Several drainage studies, hydrologic models, and reports were reviewed in conjunction with this project. May of the drainage studies were provided to Atkins by the City for small or local developments in the study area. These were all reviewed and incorporated as necessary. The more significant or major drainage studies used as a reference included:

- **2008 Las Vegas Valley Flood Control Master Plan Update**, prepared by PBS&J, September 2008. This study was reviewed and used as a reference for the hydrologic analysis and parameterization (CN methodology, land use, soils, routing, lag time, etc.). The 2008 MPU HEC-1 model developed for the Central Watershed was used as a base model for this project.
- **Central Neighborhood Flood Control Master Plan** prepared by PBS&J, March 2005. This study was used as a reference and to check the overall watershed boundary and to estimate the interim condition flow in the 72-inch RCP in Pecos Road

2.3. Technical Memorandums

After performing data collection, field investigations, survey, and preliminary H&H analysis, Atkins compiled two different technical memorandums to summarize the analysis, results, channel capacities, and recommended drainage plan and assumptions that were used in developing this PDR and the 30% design plans. These memorandums were submitted and reviewed by the City and CCRFCD, who agreed on the overall design concepts and design flows. The two memorandums include:

- **Preliminary Drainage Memorandum.** Atkins submitted the Preliminary Drainage Memorandum on May 5, 2014 to estimate peak flows impacting the intersection of Stewart Ave and Pecos Rd, to determine if revisions to the storm drain extents were warranted, and to make storm drain facility recommendations.
- **Cedar Avenue Channel Capacity Analysis.** Atkins submitted the Cedar Avenue Channel Capacity Analysis on June 13, 2014 to determine the existing channel conveyance capacity and to understand potential project impacts on the downstream channel and adjacent properties.

A copy of both memorandums is provided on the **Data CD** as a reference and to provide background information related to design alternatives that were investigated and decisions that have been made to date.

2.4. Topography Data and Survey

Detailed 1-foot aerial topography data was obtained for the study area with this project. In general, the 1-foot topography data extends to Charleston Boulevard on the south, Maryland Parkway on the west, Pecos Road on the east, and Cedar Avenue on the north. An additional corridor along the Cedar Avenue Channel was also obtained for that portion of the project area. 5-ft contour data from Clark County was used for watershed areas outside of the detailed topography extents.

Detailed field survey (and manhole dipping) was also performed to determine accurate horizontal and vertical information for the manholes, sanitary sewers, storm drains, and other utilities.

2.5. Hydrologic Design Scenarios

Atkins performed hydrologic analysis to determine the peak 100-year design flows in the study area in the ultimate condition. The hydrologic analysis and the storm drain recommendations described in this memo are based on the ultimate condition, which assumes that the project watershed is fully developed and that all proposed regional facilities are built and functioning. This is the condition represented in the HEC-1 model and fully described in this PDR that will be used as the design basis throughout the project.

The main difference between the watershed today and the ultimate condition is the assumption that the proposed regional facility in Bonanza Road (LVBZ0000-0014) will be complete, which will convey the 100-year flow from Bonanza Road to the Cedar Avenue Channel at Marion Drive (see **Section 2.9** for more information about this alternate alignment).

Since the watershed area is more than 95% developed, any other changes in land use, impervious areas, and flow rates between the existing and ultimate (future) condition are considered negligible.

Throughout early design phases of this project, an interim condition model was developed in order to support alternative analysis and decision making, especially with regards to the Cedar Avenue Channel. The interim condition model is identical to the ultimate condition model except that the Bonanza Regional system does not bring flow into the channel at Marion Drive as described above. The interim condition model is provided on the **Data CD** for reference purposes if needed.

Qualitative assessments of the existing condition flow in the Cedar Avenue Channel have also been made based on the Central Neighborhood Study and assumptions that the inflow facilities into the channel are at full flow capacity (normal depth calculations), but detailed HEC-1 modeling of the existing condition was not required for this project.

2.6. Hydrologic Analysis and Parameterization

The methodology used to develop the hydrologic model and input parameters is discussed in detail in **Appendix A** with all supporting information and tables. A brief description of methods is provided as a summary below:

2.6.1. Subbasin Delineation

The 2008/2013 MPU and Central Neighbourhood Flood Control Master Plan (CNS) subbasin delineations were used as a starting point and were modified and subdivided

as necessary based on field investigations, aerial photos, drainage studies, and the detailed 1-ft topography data that was obtained for the project. The subbasins used in this design project were more refined than the MPU subbasins in order to analyze and evaluate detailed roadway drainage patterns, storm drain sizes, and street flow capacities. The subbasins used in the HEC-1 model are shown on the Hydrologic Summary Map (**Figure 6**) at the end of this section of the report.

2.6.2. Hydrologic Parameters

- **Rainfall** – The 6-hour, 100-year and 10-year precipitation depth were used in the model based on the McCarran Airport Rainfall Area from the Design Manual. The SDN3 storm distribution was used since the watershed area is less than 8 square miles.
- **Depth-Area Reduction Factor** – The depth-area reduction factors (DARFs) from Table 503 in the Design Manual were applied to the rainfall depths in the HEC-1 models at each subbasin and concentration point based on upstream tributary area.
- **Soils** – Soils data in the hydrologic analysis was based on the same soils information that was used in the 2008 MPU, which is the Soil Survey of the Las Vegas Valley Area by the National Conservation Resources Service (NRCS), dated July 1985. It should be noted that NRCS has updated the available soils data since that time; however, in an effort to be consistent with the MPU and other design projects that have been completed in the area, the 2008 MPU soils data was used in the CAC hydrologic analysis.
- **Land Use** – Land use data was based on the 2008 MPU and updated as needed. Minor updates and revisions were made to the land use data based on aerial imagery to reflect changes that have occurred or to better represent actual land use conditions in the watershed.
- **Curve Numbers** – Rainfall losses due to soil infiltration, depression storage, and other factors are computed using the NRCS curve number (CN) method described in the Design Manual. Curve number information was compiled for each subbasin using GIS polygon processing of subbasin delineations, soil map unit delineations, and land use layers.
- **Lag Time** – All subbasins within the project watershed are less than 0.5 square miles. The time of concentration for subbasins of this size is computed with the time of concentration equation (velocity method) from the CCRFCD Design Manual.
- **Routing** – The routings in the HEC-1 model through streets or storm drains were performed using the Muskingum-Cunge method for floodwave routing to be consistent with the 2008 MPU.

Detailed summary tables and supporting calculations for all parameters listed above are provided in **Appendix A**.

2.6.3. Computer Modeling

HEC-1 Version 4.1 (dated June 1998) was used for the CAC hydrologic modeling in order to be consistent with the MPU process. Descriptive information has been included in the HEC-1 input file on the “ID” and “KM” cards. The HEC-1 model is included in **Appendix A** and electronic model files are also provided on the Data CD that accompanies this report.

2.6.4. Concentration Points

Peak flows were combined in HEC-1 using concentration points that were inserted into the HEC-1 model. Several concentration points are located at the Pecos/Stewart intersection and along the Cedar Avenue Channel (as shown in **Figure 6** and **Figure 7**) since these are the main design locations in the study area.

2.6.5. Referenced Portions of the Model (Flow Diversions)

There are a few portions of the model that are based on reference studies/models:

At the intersection of Pecos Road and Charleston Boulevard, 206 cfs is conveyed north in an existing 66” RCP that collects flow from Charleston Boulevard and turns north in Pecos Road (see HEC-1 node CCHAR). The flow of 206 cfs is based on a referenced model from the Central Neighborhood Flood Control Master Plan. It is assumed that this flow of 206 cfs is the same in the interim and ultimate condition, since subbasin CH70-C will still drain to Charleston Boulevard, and there will be still be some bypass flow on Charleston Boulevard even when the future regional facility is built in Boulder Highway. A small inflow hydrograph (see HEC-1 node CHAR) was added to the model to represent existing flow on Charleston Boulevard from upstream watersheds in order to have a total peak flow of 206 cfs at the intersection of Pecos Road and Charleston Boulevard.

In order to account for flows that will enter the Cedar Avenue Channel from Bonanza Road area, portions of the 2008 MPU Central Watershed model (SW3) were copied and included directly in the HEC-1 model. The referenced portions of the model establish the 100-year peak flows in Bonanza Road. At the intersection of Pecos Road and Bonanza Road, the HEC-1 model has a diversion (DBN09) to represent the 202 cfs that is conveyed south in the existing 60” RCP toward the Cedar Avenue Channel (based on full flow capacity normal depth calculations).

Similarly, at Marion Street and Bonanza Road, the referenced 2008 MPU model (at HEC-1 node CBN15-C) represents the flow that will be conveyed south in Marion Drive in the ultimate condition. Refer to **Section 2.9** or the 2008 MPU model for more details if necessary.

Also, it should be noted that the 2008 MPU assumes that the existing 60” RCP in Pecos Road south of Bonanza Road will be abandoned (see **Figure 4**). However, the Cedar Avenue Channel has been designed to accommodate this flow. Therefore, in the future, the 60” RCP can remain in place without any adverse impacts on the channel, which may reduce the size of the future regional facility in Bonanza. This assumption will need to be confirmed during the design of the Bonanza Road regional facility.

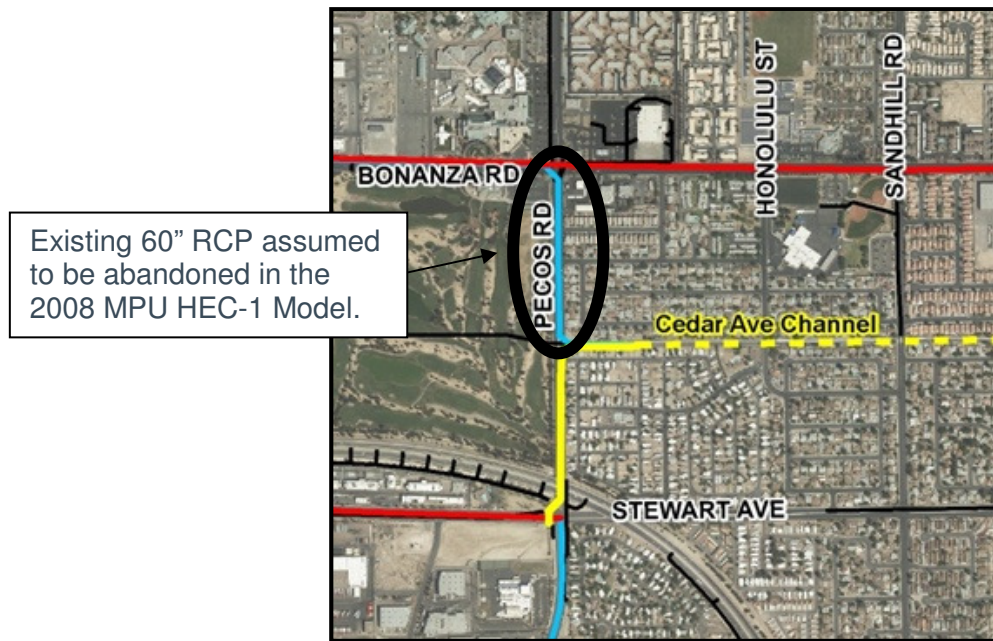


Figure 4. Existing 60" RCP in Pecos Rd

2.7. Hydrologic Analysis Results

The 100-year peak flows from the ultimate condition HEC-1 model for the subbasins, diversions, and combination points are summarized on the Hydrologic Summary Map (**Figure 6**) at the end of this section. **Table 1** below summarizes the main design flows at key locations. The table also includes the MPU Flows from the 2008 MPU for comparison purposes.

Table 1. Summary of Design Flows at Key Locations

Location	HEC-1 Combo Point	Ultimate Flow (cfs)	MPU Flow (cfs)
Pecos/Stewart intersection (total flow in the proposed SD)	CCA05	702	-
Outlet of 2:72" RCP's (at upstream end of channel)	CCA06	1085	1170
Honolulu Street	CCA08	1136	-
Sandhill Road	CCA09	1172	-
Red Bandana Street	CCA10	1196	-
Lamb Blvd	CCA11	1266	1387
Page Street	CCA12	1314	-
Marion Drive (Upstream)	CCA13a	1364	-
Marion Drive (Downstream)	CCA13	2885	-
Las Vegas Wash	CCA14	2916	1544

2.8. Stewart Avenue Collection and Bypass Flow

After the initial HEC-1 model was run, it was subsequently modified through an iterative process in order to represent the flow collected in the proposed drop inlets and storm drains at the intersection of Stewart Avenue and Pecos. In other words, initial hydrologic results were used in the hydraulic analysis to size collection facilities, and then the hydrologic model was updated afterward to divert flows to proposed storm drain facilities and determine the remaining bypass flow on the streets. This provides consistency between the hydrologic and hydraulic analysis and results in a model that is representative of the post-project condition.

As shown in **Figure 7**, 745 cfs flows east on Stewart Avenue towards Pecos road. A portion of that flow (approximately 445 cfs) is collected and conveyed in proposed drop inlets/laterals as well as the existing 24" RCP in Stewart Avenue. An additional 55 cfs enters the storm drain system from the drainage swale and headwall south of Stewart Avenue, for a total peak 100-year flow in the storm drain of 502 cfs (HEC-1 node CCA05-2a).

The existing dual 48" RCP on Pecos Road conveys 210 cfs and will connect with the proposed storm drain system north of Stewart Avenue, resulting in a combined total flow of 688 cfs (HEC-1 node CCA05-4). Some minor existing storm drains will connect to the system downstream of this point and add an additional 14 cfs which increases the total flow in the system to 702 cfs (HEC-1 node CCA05).

When timing is accounted for, the flow bypassing the proposed storm drain system on Stewart Avenue is approximately 315 cfs. There is an additional 79 cfs in the street on Pecos Road that is bypassed east on Stewart Avenue. Thus, the total bypass flow on Stewart Avenue is 357 cfs (HEC-1 node CSTEWB).

While this is a significant improvement compared to the existing condition, there will still be a flow conveyed eastward on the surface of Stewart Avenue. According to the Central Neighborhood Flood Control Master Plan, there is an additional 300 cfs that drains to Stewart Avenue from tributary areas north of Stewart Avenue between Pecos Road and the Las Vegas Wash. This flow will combine with the bypass flow of 357 cfs at the low point in Stewart Avenue west of Marion Drive, resulting in more than 500 cfs at this location. The existing 48" RCP in Stewart Avenue does not have adequate capacity to convey the flow to the Las Vegas Wash and thus ponding will occur. Atkins recommends that this area be reviewed in more detail and a proposed regional facility in Stewart Avenue (between the low point and the Las Vegas Wash) be considered for inclusion in the Las Vegas Valley MPU.

2.9. Marion Drive Confluence

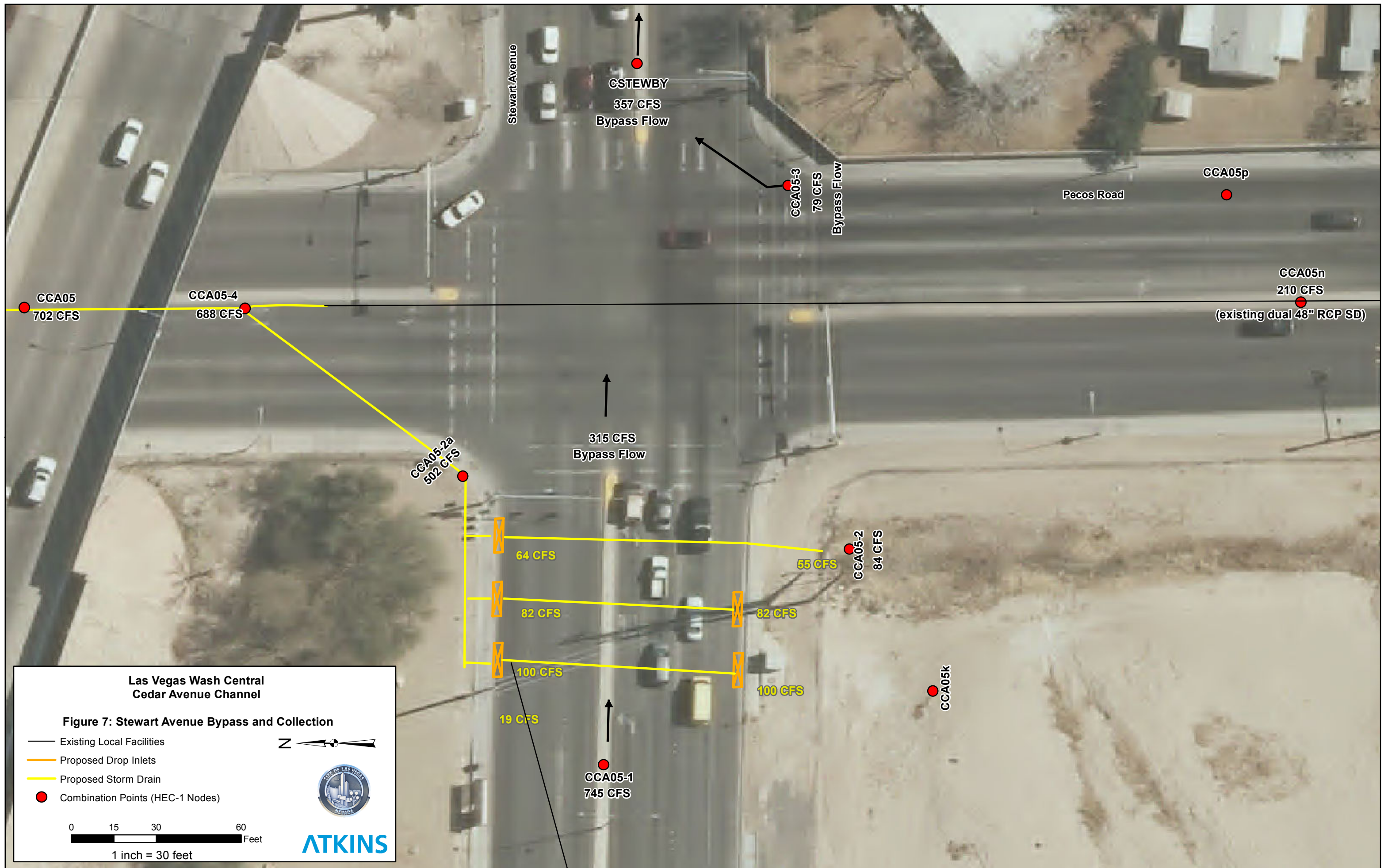
The Las Vegas Wash CMAR project determined that connecting the proposed regional facility in Bonanza Road to the Las Vegas Wash would be difficult because of the bridge configuration, right-of-way, and other design constraints. As a result, they proposed to re-route the proposed regional facility down Marion Drive to the Cedar Avenue Channel instead of connecting directly to the Las Vegas Wash. This results in increased flow in the Cedar Avenue Channel and a need for a major confluence structure and a larger channel to accommodate the combined flow.

As described previously, this alternative alignment and future regional facility in Marion Drive has been incorporated into the ultimate condition HEC-1 model using the 2008 MPU as a reference. The resulting flows in the area are shown on **Figure 5**.



Figure 5. Future Bonanza Regional Facility and Marion Drive Confluence

As shown above, the 100-year ultimate condition flow in the Bonanza Road regional facility is around 1,783 cfs, while the channel has a 100-year flow of 1,208 cfs. This results in a combined total flow of 2,875 cfs to be conveyed in the Cedar Avenue Channel downstream of Marion Drive. The design of the channel and future confluence to accommodate this increased flow will be described in the next section.



3. Hydraulic Design and Analysis

3.1. General

This section includes information about the proposed design of the storm drain and channel facilities. It also presents the hydraulic analysis, criteria, and methodology that were used to develop the 30% design of the Cedar Avenue Channel.

3.2. Proposed Design

For the purpose of organizing the information presented in this Section, the project improvements are grouped into two categories: (1) the storm drain system improvements (from Pecos Road/Stewart Avenue to the existing Cedar Avenue Channel and (2) the channel improvements (from the upstream end of the Cedar Avenue Channel to the Las Vegas Wash). The overall design concepts are described below:

3.2.1. Pecos/Stewart Storm Drain System

The proposed storm drain system has been designed to collect as much flow as possible from Stewart Avenue to alleviate downstream flooding.

The proposed storm drain system is comprised of new drop inlets and laterals on Stewart Avenue that collect surface flow and connect to a mainline storm drain on the north side of Stewart Avenue. The mainline storm drain consist of an 18' x 4' RCB north of Stewart Avenue and west of Pecos Road that transitions into a dual 8'X4' RCB at the Pecos Road/Stewart Avenue intersection in order to cross over an existing 36" sewer. After crossing the sewer, the dual 8' x 4' RCB transitions into an 18' x 4' RCB north of the intersection. At this same location, the existing dual 48" RCPs in Pecos Road will connect to the 18' x 4' RCB. The storm drain then transitions to a 12' x 6' RCB that continues north in Pecos Road before turning east and eventually discharging to the Cedar Avenue Channel. The proposed storm drain facilities are shown in a schematic in **Figure 8**.

The above mentioned design of the storm drain system is driven by several constraints:

- There is an existing 36" sewer running through the Pecos Road/Stewart Avenue intersection. The sewer line is not very deep and limits the storm drain to be short and shallow. There is not enough room to cross the sewer line using a mega box (18' x 4' RCB) with a thicker slab. Therefore, the transition of an 18' x 4' RCB to a dual 8' x 4' RCB is required. The total capacity of the storm drain is controlled by the capacity of the dual 8' x 4' RCB, which is around 500 cfs.
- Several alternatives were investigated to relocate the sewer, but the feasibility and costs did not result in suitable alternatives. Additional information is described in project meeting minutes.
- The mainline storm drain is also constrained by the existing invert at the downstream connection point in the Cedar Avenue Channel. Therefore, the slope is relatively flat and governed by crossing over the sewer and tying into the channel.

3.2.2. Cedar Avenue Channel

As discussed in the Cedar Avenue Channel Capacity Analysis, the channel is limited in capacity and has experienced overtopping in the existing condition. Similarly, it does not have adequate capacity to convey the ultimate condition flows. The proposed design is intended to increase the conveyance capacity of the channel in order to improve the existing conveyance and to accommodate the design flows that will be discharged to the channel after the proposed storm drain is complete. From upstream to downstream, the proposed channel improvements include:

- **Upstream of Honolulu Street:** For this section of the channel, no changes have been proposed. The channel will remain a trapezoidal channel with a 10' bottom width, 1.5:1 side slopes, and around 8.25' of depth. The bridge crossing (dual 12' x 5.5' RCB) at Honolulu Street will remain in place.

Honolulu Street to Sandhill Road: The new channel section between Honolulu Street and Sandhill Road is proposed to be a 25' wide rectangular channel. It will transition to a 36 feet wide channel just upstream of Sandhill Road Crossing. The bridge crossing at Sandhill Road (1: 12' x 4' RCB and 1: 11' x 4' RCB) will remain in place.

Sandhill Road to Lamb Boulevard: For about 1,200 feet downstream of Sandhill Road, the new channel section is proposed as a 36' wide rectangular section. At this location, it transition into a 30' wide rectangular section, which is necessary because the right-of-way constricts from 60 feet wide to 50 feet wide in this area. Contracting the channel allows for minimum trail widths to be maintained (see **Section 4.1.2**). The 30' wide rectangular channel section then continues for another 1,300 feet where it transitions again down to a 25' wide rectangular channel in order to tie into the dual 12' x 6' RCB culvert crossing at Lamb Boulevard. By doing this, additional RCBs at Lamb are not needed.

In addition, a 1-foot tall vertical wall on the north side of the channel is proposed to extend 1,500 feet upstream from Lamb Boulevard to provide additional freeboard (see Section 3.4 for freeboard analysis).

- **Lamb Boulevard to Page Street:** In this section the proposed channel expands to be a 31' wide rectangular channel downstream of Lamb Blvd. It remains the same throughout the section.

Page Street to Marion Drive: The proposed channel is a 31' wide rectangular channel downstream of Page Street. It remains the same throughout the section.

- **Downstream of Marion Drive:** Downstream of Marion Drive, the proposed 31' rectangular channel continues for approximately 200 feet. At this point, there is a channel transition which will accommodate future flow from the Bonanza regional facility while dropping 7 feet in elevation and narrowing into a 22' wide rectangular section. The rectangular channel will be deep (ranging from 15' to 17' deep) and extend at 0.2% slope until connecting to the Las Vegas Wash.

The design of the channel section downstream of Marion Drive assumes that the alternative alignment for the Bonanza Road regional facility will be used as described in Section 2. It was assumed that the future regional facility in Marion Drive would be approximately 20 feet wide in order to accommodate the 100-year flow from Bonanza Road of 1,785 cfs. The future facility will combine with the Cedar Avenue Channel downstream of Marion Drive bridge (which can likely remain in place).

In order to maintain the Cedar Drainage Trail, the future 20 feet wide regional facility coming into the channel from Marion Drive will need to consist of dual, 10-ft wide boxes (or similar geometry with a center pier) in order for the trail to be feasible (i.e., span cannot be 20 feet wide for structural integrity purposes). This conceptual confluence layout is included in the design plans and is subject to review and revision during future design phases.

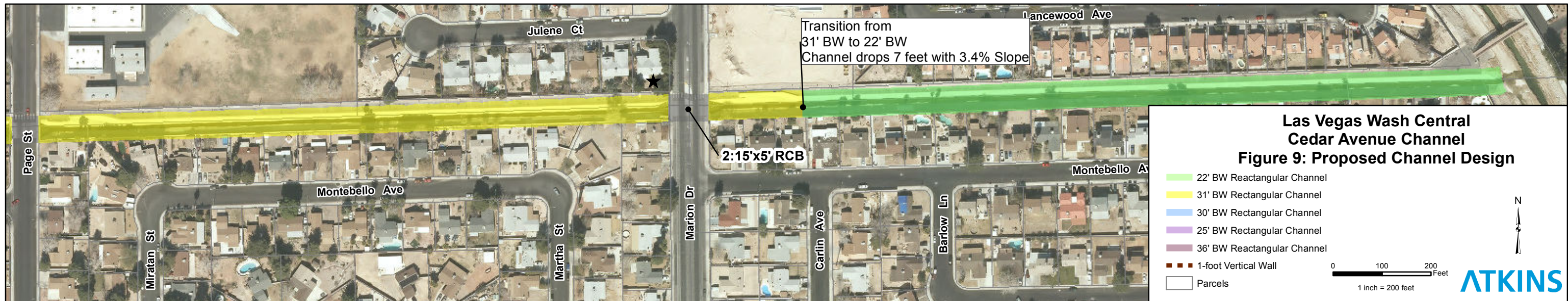
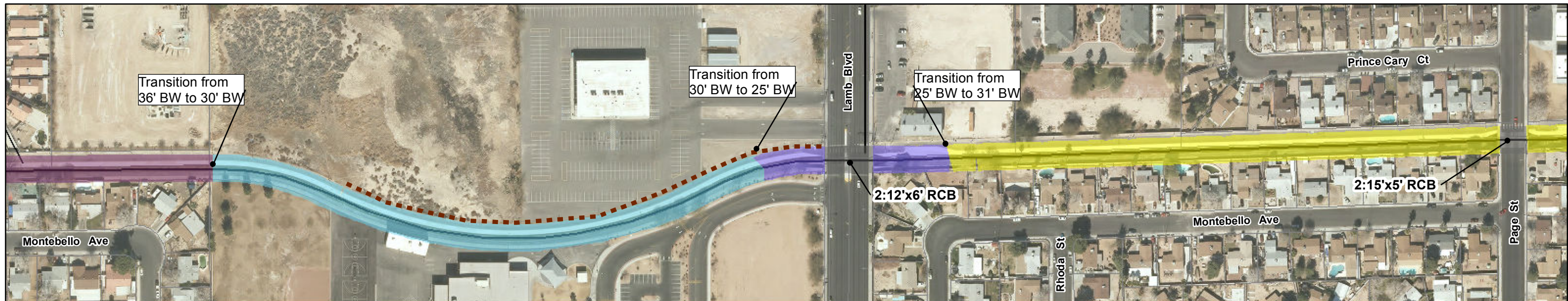
Figure 9 summarizes the proposed design for the Cedar Avenue Channel.

The channel design was driven by several constraints which are listed below:

- The Cedar Drainage Trail runs alongside the entire length of the channel, making it difficult to widen the channel and still accommodate the trail and access ramps.
- The existing channel profile is very flat and does not provide topographic relief or option to steepen the channel to increase conveyance capacity
- The design intent was to maintain the existing crossings/bridges at the cross street to avoid costs associated replacing the culvert crossings and disturbing traffic.
- Between Sandhill Road and Lamb Boulevard, the right-of-way constricts from 60 feet to 50 feet limiting the corridor even further.
- The downstream end of the channel (past Marion Drive) was constrained by the proposal to bring in more flow from Bonanza Road and by the constraint to tie into the proposed, narrow confluence structure proposed as part of the Las Vegas Wash CMAR project.
- Constructability of the channel in a narrow corridor with the above constraints will require specialized construction methods and caution. Refer to **Section 4.2** for additional information.

Atkins worked with the City during various workshops and progress meetings in order to review alternatives and develop the proposed design described above. The proposed design is the result of the coordination that occurred in order to come up with cost-effective, feasible design concepts that provide maximum flood control in accordance with the regional master plan in the area. The proposed design is still in the process of being reviewed and optimized and is subject to revision as the design phase continues.





**Las Vegas Wash Central
Cedar Avenue Channel
Figure 9: Proposed Channel Design**

- 22' BW Rectangular Channel
- 31' BW Rectangular Channel
- 30' BW Rectangular Channel
- 25' BW Rectangular Channel
- 36' BW Rectangular Channel
- 1-foot Vertical Wall
- Parcels

0 100 200 Feet
1 inch = 200 feet



3.3. Hydraulic Analysis Methodology and Results

3.3.1. Pecos/Stewart Storm Drain System

WSPG Model and Facility Sizing

The Pecos/Stewart Storm Drain mainline was analyzed and sized using the Water Surface Pressure Gradient (WSPG) computer program. The computational procedure used in WSPG is based on solving Bernoulli's equation for the total energy at each section and Manning's equation for friction losses between sections in a reach. The program accounts for energy losses at junctions, angle points, and transitions and uses basic hydraulic principles to calculate hydraulic data such as flow area, wetted perimeter, critical depth, hydraulic grade line, Froude number, momentum, etc. The geometry, slopes, and sizes of the mainline were input into WSPG along with the design flows, and the model was run in order to ensure that the hydraulic grade line (HGL) or depth of flow remained at least 1 foot below final grade at all locations. The mainline WSPG model is included in **Appendix B**.

The hydraulic grade line can be seen for the entire storm drain system on the submitted 30% Design Plans.

At this phase of design, the lateral storm drains and other minor facilities were sized using normal depth calculations. All facilities will be analyzed in WSPG prior to the 70% design submittal.

3.3.2. Cedar Avenue Channel

HEC-RAS Model and Facility Sizing

The hydraulic analysis for Cedar Avenue Channel was performed using the steady state routines within the HEC-RAS computer model, Version 4.1.0 (USACE, 2010) based on the 100-year peak flows for the ultimate condition. A preliminary, existing condition scenario was also analyzed in HEC-RAS to evaluate the current water surface profile today. The parameters used in the hydraulic analysis are described below:

- **Channel Geometry:** Channel geometry is based on detailed field survey obtained by Atkins at several channel cross sections as well as upstream and downstream of all of the bridge crossings. The HEC-RAS 'XS Interpolation' tool was also used to interpolate cross sections every 50 feet between the surveyed cross sections. Detailed 1-foot topography was also obtained and used as necessary in the modeling effort in locations where survey was not available. Channel geometry for cross sections upstream and downstream of structures are provided in **Appendix B**.
- **Manning's Roughness:** Manning's roughness of 0.015 is used for the entire channel reach.
- **Downstream Boundary Condition:** The HEC-RAS model is executed for the subcritical flow regime based on steady-state flow routines. The model utilizes a normal depth boundary condition at the downstream and upstream ends based on the proposed channel design slopes.

- **Expansion and Contraction Coefficients:** Default values of 0.1 and 0.3 for the contraction and expansion coefficients, respectively, are utilized for cross-sections with gradual transitions. However, these coefficients are increased to 0.3 and 0.5 in the vicinity of each structure.
- **Hydraulic Structures:** The five crossings (Honolulu, Sandhill, Lamb, Page and Marion) are modelled as bridges based on the detailed field survey obtained by Atkins. The geometry and hydraulic parameters for each structures were incorporated into the model using 'Bridge Editor' in HEC-RAS.

Results from HEC-RAS can be found in **Appendix B**. The complete HEC-RAS model, which consists of existing and proposed channel geometries, is included on the Data CD. **Figure 10** below summarizes shows the channel profile and WSE and compares the proposed channel invert with the existing channel invert elevation. The proposed channel design is adequate to convey interim and ultimate condition flows.

The hydraulic grade line for the channel can be seen on the 30% Design Plans. Note that 30% Design Plan stations do not match the HEC-RAS stations. Appendix B provides the correlation between 30% Design Plan stations and HEC-RAS stations.

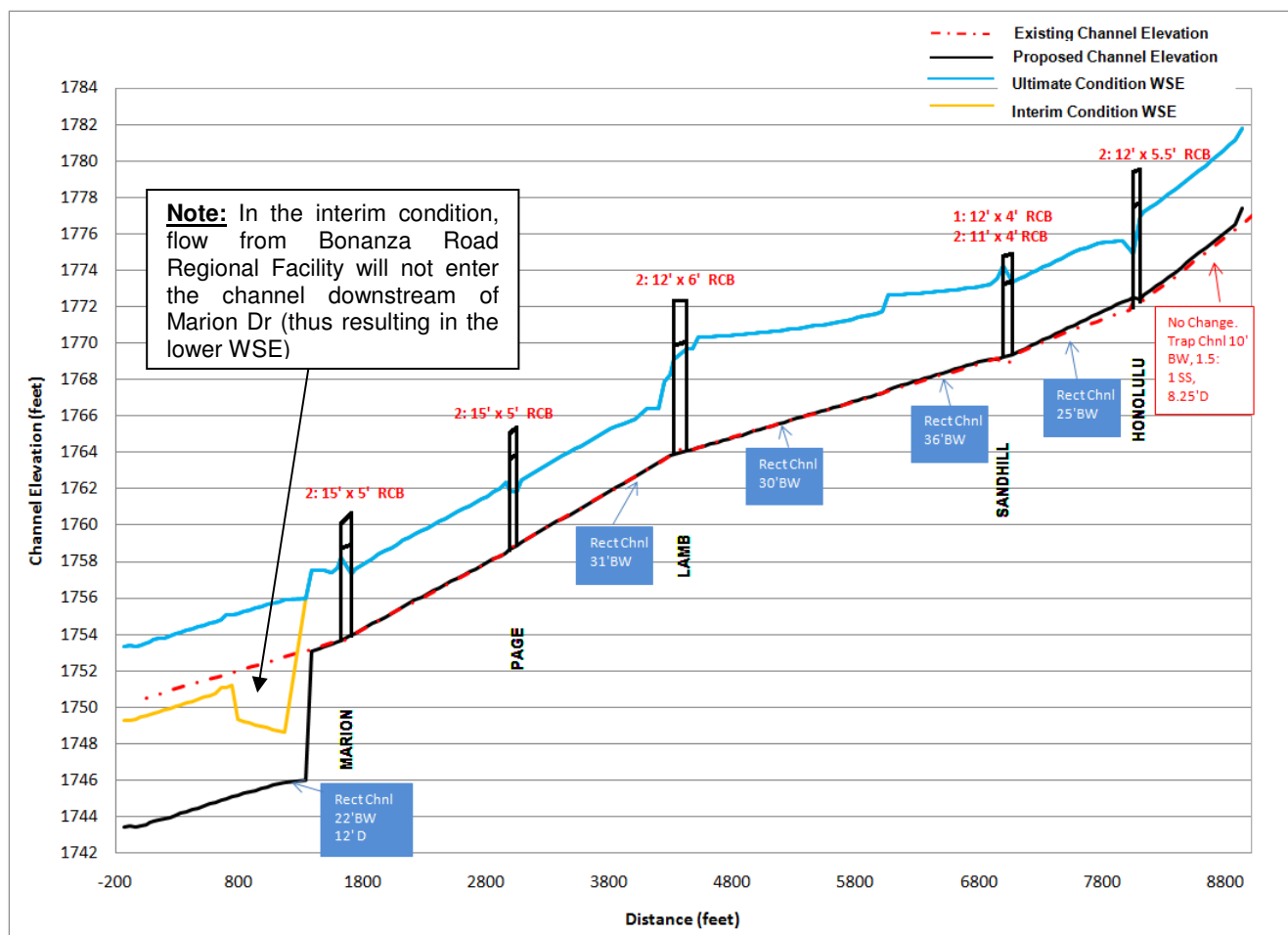


Figure 10. HEC-RAS Profile - Water Surface Elevation (WSE)

The proposed channel design was analyzed to verify if the freeboard criteria presented in HCDDM is met at all model cross sections. The proposed channel has adequate capacity to convey the design flow plus freeboard and an extra tolerance for super-elevation at most channel locations. For a short section upstream of Lamb Blvd, adequate freeboard was not available because the channel transitions from 36 foot wide to 30 foot wide and ultimately to 25 foot wide just upstream of Lamb Blvd. To address this issue, Atkins proposes a 1-foot tall wall along the north side of the channel segment. The proposed 1-foot tall vertical wall provides extra freeboard; however, there will still be a short section where CCRFCD freeboard criteria is not met, but more than a foot of freeboard is available. Detailed freeboard calculations and a summary table are provided in **Appendix B**.

Freeboard criteria is met at every bridge except for the downstream face of Sandhill Road and the upstream face of Lamb Boulevard. However, in both of these cases, the available freeboard is greater than 1 foot.

3.4. Drop Inlets

During the 30% design phase, cursory drop inlet analysis and assessment has been performed to get an overall understanding of the potential inlet locations and capacities. The preliminary drop inlet analysis was done at this phase of the project to identify major obstacles/utility conflicts and to identify impacts on the overall design concept or the main line. Atkins has proposed five drop inlets on Pecos/Stewart intersection based on preliminary analysis. Detailed drop inlet sizing calculations have not been performed nor included in this report, but they will be developed during the 70% design phase and submitted with the Draft Final Design Report.

4. Other Design Works and Considerations

This section has been included in the PDR to summarize key considerations and factors that influenced the 30% design of the CAC. This information has been provided for reference and also to aid with decision making during future design phases. This section also includes a summary of other activities that were performed during the 30% design phase. Pertinent aspects of the project explored to date are included below.

4.1. General Design Considerations

The following is a summary of several design considerations that are pertinent to the overall design of the project now and into the future.

4.1.1. Future Facility in Stewart Avenue

Upstream of the proposed improvements, there is approximately 675 cfs on Stewart Avenue at Mojave Road (see combination point CCA04 in the HEC-1 model). This flow is conveyed east on the surface of Stewart Avenue until it reaches the proposed drop inlets and storm drain at the intersection of Stewart Avenue and Pecos Road.

In the future, the proposed regional facility CNST 0000 should be constructed on Stewart Avenue, upstream of the current project between Pecos Road and Mojave Road. This facility will reduce surface flow on Stewart Avenue in order to meet dry lane criteria and can tie into the upstream end of the 18' x 4' RCB installed with this project (north of Stewart Avenue and west of Pecos Road).

A lateral storm drain extending a quarter-mile to the south in Mojave Road could also be installed to collect surface flow in this area. The proposed regional facility and potential lateral storm drain are shown in **Figure 11**.



Figure 11. Future Regional Facility in Stewart Avenue

4.1.2. Cedar Drainage Trail

The Cedar Drainage Trail width was kept as wide as possible with the intent to match existing trail widths. The revised trail widths for each section are described below:

- **Honolulu Street to Sandhill Road:** Original trail width maintained
- **Sandhill Road to channel bend:** The trail has been reduced to 8 feet to allow for channel width and for constructability reasons. This also allows the existing trail lighting to be protected-in-place. This section of the trail will not be drivable.
- **Channel bend to Lamb Boulevard:** The channel width is narrower through this section which allows the trail to remain very similar to existing condition with a 10-foot wide trail in spot locations and at the trail light poles.
- **Lamb Boulevard to Page Street:** The trail was reduced but still maintains 13 feet of width.
- **Page Street to Marion Drive:** The trail was reduced but still maintains 12 feet of width.
- **Marion Drive to Las Vegas Wash:** The existing trail width has been maintained. In the future, the trail will need to be shifted to north adjacent to the right-of-way boundary from Marion Drive to the end of the access ramp in order to accommodate the future regional facility that will convey flow from Bonanza Road. The trail would be reduced to 10 feet in the future for that particular section.

4.1.3. Cedar Avenue Channel Access Ramps

Because of proposed widening of the Cedar Avenue channel, the new access ramps into the wider channel section will encroach further into the trail and reduce the existing trail width in these already narrow sections. Effort has been made to provide as much width as possible while still maintaining the required channel and access ramp widths. The minimum amount of trail width remaining adjacent to the access ramps is shown in **Table 2** and a cross-section of the channel/ramp/trail is shown in **Figure 12**. The table and figure are referenced directly from the 30% design plans so refer to those for more information.

Table 2. Minimum Trail Widths at Channel Access Ramps

Access Ramp Location	Paved Trail Width (Adjacent to Access Ramp)
Honolulu Street	8
Sandhill Road	4.58
Lamb Boulevard	10
Page Street	8
Marion Drive	8

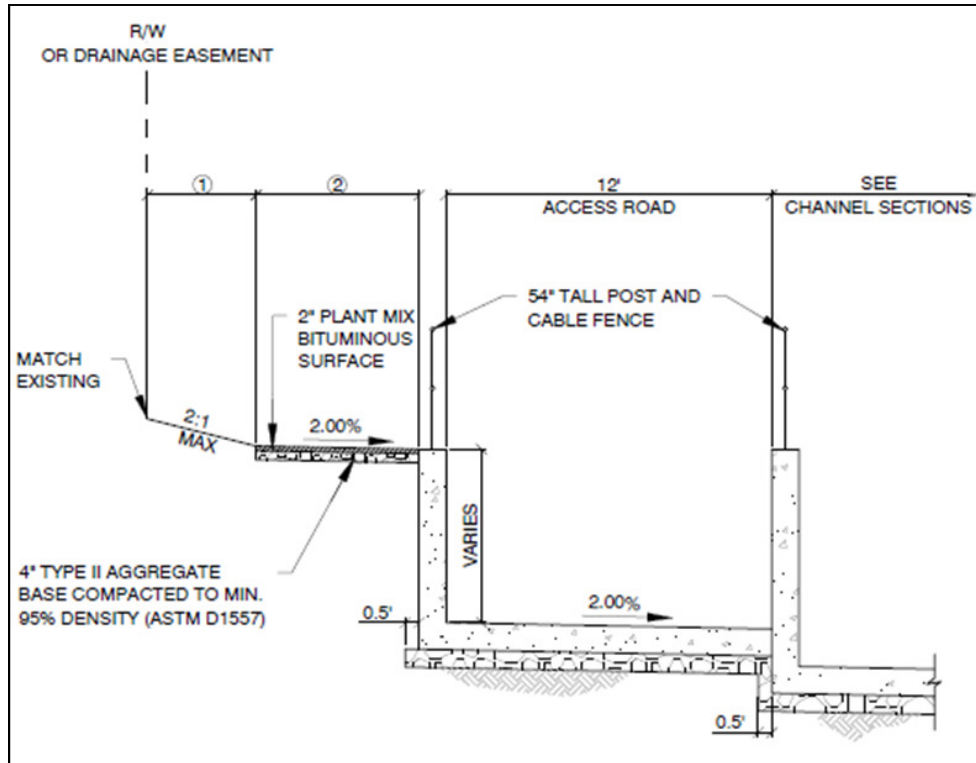


Figure 12. Channel Cross-Section Schematic at Access Ramps

Because of the narrow trail width, an alternate location for the Sandhill Road access ramp is being investigated by Atkins and the City. One potential location is on the south side of the channel on the school property west of Lamb Boulevard. This ramp location will continue to be reviewed and finalized as the design progresses.

4.2. Constructability

4.2.1. RCB Storm Drain Constructability

- There will be minimal cover (about 1 foot) over the dual 8' x 4' RCBs and the junction structure in Pecos Road just north of Stewart Avenue due to crossing over the existing 36" sewer. There will be 6" minimum clearance over the sewer line.
- Installation of the 18'x4' RCB storm drain will require the use of forklifts to set pre-cast boxes or cast-in-place construction under I-515/US 95 due to the existing bridge over Pecos Road.
- Installation of the RCB once it exits Pecos Road and continues east toward the connection point with the channel will require shoring and careful construction as to not impact the existing wall and property on the south side.
- Per the geotechnical report, there is groundwater in the vicinity of the storm drain and when plotted it rises above the invert. Dewatering will likely be required. Refer to geotechnical report for additional constructability considerations related to dewatering. Please refer to Section 4.3.

4.2.2. Concrete Channel Constructability

- Construction on the south side of the channel will be very close to existing fencing and block walls. Typically, there is around 5 to 7 feet of clearance, which will be a small width to excavate the channel and meet OSHA requirements. Additionally, there are some swimming pools adjacent to some of these sections in the backyards of residences. At Sandhill Road and Page Street, construction will be 2.5 – 4 feet away from existing right-of-way boundaries. In all of these areas temporary retaining wall systems, such as driven piles, or permanent retaining walls that can be constructed without impacting the existing properties, will be required. Additional survey is recommended along the south side of the channel to confirm existing tie-ins and verify constructability.
- East of Marion Drive to the end of the channel improvements, the channel becomes very deep (17 feet) and will require the use of a temporary retaining wall, such as driven piles, in order to excavate and construct the channel.
- The entire construction corridor is narrow, and the existing channel is sloping at 0.20%. Constructing the channel at such a flat slope will be difficult.
- Per the geotechnical report, there is groundwater in the area and when plotted it rises above or is at subgrade in the upstream section of the channel and at the downstream section of the channel. Dewatering will likely be required. Refer to geotechnical report for additional constructability considerations related to dewatering. Please refer to Section 4.3.
- Channel wall heights are bound by the existing improvements on each side of the channel.

4.2.3. Project Phasing

The following recommendations were agreed upon with the City with regard to project phasing:

- It is assumed that the Cedar Avenue Channel improvements described in this report will not be installed until the Las Vegas Wash CMAR is complete at the downstream end of the channel. This includes the Cedar Avenue Channel/Las Vegas Wash confluence structure that will be designed and constructed outside of this project.
- It was assumed that once the Las Vegas Wash improvements are complete, the Cedar Avenue Channel will be constructed from the downstream end to the upstream end. In other words, the storm drain proposed in this project should not be built prior to the downstream channel improvements in order to avoid any adverse impacts on properties adjacent to the channel.
- There will be some variability in the future depending on final design configurations and decisions made with respect to the Las Vegas Wash and the alternative alignment of the Bonanza Regional Facility. A Master Plan Amendment will be required to finalize the regional flood control plan for the area.

4.3. Geotechnical Investigations

Ninyo & Moore completed geotechnical investigations during the 30% design phase. The results of these investigations are summarized in the Draft Geotechnical Data Report, Draft Geotechnical Interpretive Report, and Hydrogeologic Aquifer Testing Report. The main sections of these reports are provided in **Appendix C**. All of the supporting data and appendix material is only included on the PDF versions of the reports on the Data CD.

The Geotechnical Data Report includes the findings of the field exploration and laboratory testing, while the Geotechnical Interpretive Report includes the findings of the geologic review, the results of the field exploration and laboratory testing programs, and presents recommendations for design and construction of the proposed project. The Hydrogeologic Aquifer Testing Report includes results of hydrogeologic aquifer testing and a summary of hydrogeologic and groundwater conditions along the project.

It is anticipated that groundwater dewatering will be required in some areas during construction. Based on the Hydrogeologic Aquifer Testing Report, the dewatering flow rate is expected to be lower than the 250 gpm threshold limit for a *DeMinimis* discharge permit. It is anticipated that the construction dewatering groundwater might be discharged to the CLV sanitary sewer system. This will be further coordinated with the City during the next design phase.

During future design phases, additional coordination and planning for dewatering can occur in order to obtain approval from the City's Environmental Division for dewatering and to prepare an application for approval.

4.4. Record of Survey

The Record of Survey (ROS) establishes a record alignment of the project to be used as a basis to assist in locating existing monuments during the field/construction phase of the project. Research of available record information, parcel maps, subdivisions maps, and other records of survey was performed to create the ROS for this project.

The ROS was formally submitted for approval to the City of Las Vegas Surveyor on June 11, 2015, as directed in the project scope. At the time of this 30% design submittal, approval from the City Surveyor has not been received and is still pending. Once approval is received in writing, then the ROS will be submitted to the Clark County Recorder for recordation.

The Record of Survey is included in **Appendix D**.

4.5. Summary of Permits

A draft summary of the permits and approvals needed for this project has been compiled into a summary matrix shown in **Table 3**. This list is preliminary and may be revised as the project moves forward. Further coordination and effort will be required in future design phases to complete permit applications and assist the City in obtaining required permits for the project.

Table 3. Summary Matrix of Required Permits

Permit	Issuing Agency	Regulated Activity	Phase
City of Las Vegas - Excavation Permit	CLV Department of Public Works Land Development Services	Underground construction on private property or within CLV ROW	Construction
City of Las Vegas - Soils Report Submittal	CLV Department of Public Works Land Development Services	Soils associated with construction activity within CLV ROW (required for off-site construction projects)	Construction
City of Las Vegas - Construction Permit	CLV Department of Public Works Land Development Services	Off-site improvements within a City of Las Vegas ROW	Construction
City of Las Vegas - Grading Permit	CLV Department of Building and Safety	On-site grading activities	Construction
City of Las Vegas - Temporary Stock Pile Permit	CLV Department of Building and Safety	Temporary stock piling of earth materials on private or BLM parcels not covered by grading permit	Construction
City of Las Vegas - Traffic Barricade Plan Approval	CLV Construction Services	Traffic barricade plan associated with construction or discharge activity impacting a CLV ROW	Construction
Dust Control Permit	Clark County Department of Air Quality Management (DAQM)	In accordance with DAQM Regulations, dust control permit required for grading or other land-disturbance activities in Clark County.	Construction
NPDES General Storm Water Permit for Construction	NDEP Bureau of Water Pollution Control	Activity that disturbs 1 acre or greater and discharges storm water runoff from the construction site into a municipal separate storm water sewer system, or "waters of the US" as defined by Section 404 of the CWA.	Construction
NPDES Discharge Permit	NDEP Bureau of Water Pollution Control	Point source discharge to surface water, i.e. natural channel, roadway or storm drain. Required for dewatering during construction.	Design
NDOT ROW Encroachment Permit	Nevada Department of Transportation (NDOT)	NDOT requires this permit for construction activities in NDOT ROW.	Design
CCRFCD Section 8 Resource Screening Analysis	Clark County Regional Flood Control District	U.S. BLM requires each new regional facility be reviewed to ensure full compliance with environmental regulatory requirements	Design
OTHER AGENCY APPROVALS AND COORDINATION:			
Entity	Issuing Agency	Regulated Activity	Phase
City of Las Vegas Department of Public Works Flood Control Section	City of Las Vegas	Design Plan/Drainage Study Review/Approval	Design
Clark County Regional Flood Control District	Clark County Regional Flood Control District	Design Plan/Drainage Study Review/Approval, also check of Federal Emergency Management Agency (FEMA) maps	Design
Utility Services Coordination	Various (Refer to Section 5 of this PDR for more information)	Coordination required with utilities and agencies having facilities within the limits of or adjacent to the project. Identify and resolve potential utility conflicts.	Design

4.6. Right-of-Way Summary

Atkins performed a review of the existing right-of-way in the study area and possible acquisition requirements based on the proposed alignment and facilities identified in this report.

Figure 13 and **Figure 14** show the existing right-of-way conditions based on research of available records, including Clark County Assessor Maps, Parcel Maps, and Record of Surveys. The majority of the proposed alignment is contained within the existing public right-of-way located in the jurisdiction of City of Las Vegas. A portion of the project on Pecos Road will be under US95 and within Nevada Department of Transportation (NDOT) right-of-way.

The start of the mainline construction is located on City of Las Vegas owned property. A permanent drainage easement will be required to construct and maintain the facility in the proposed location.

Additionally, a small permanent drainage easement will be required to construct and maintain the 5' x 3' RCB stormdrain and headwall on the south side of Stewart Avenue in APN 139-36-710-019 owned by the School Board of Trustees. There is an existing drainage easement on the School Board property, but it stops short of the Stewart Avenue right-of-way.

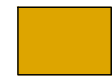
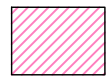
A small 5-foot wide permanent drainage easement on the south side of the channel right-of-way at Lamb Boulevard is required for the 5' manway. The easement would be located in parcel 140-31-602-001, which is owned by the School Board of Trustees. At APN 140-32-103-002, owned by the Las Vegas VOA Elderly Housing, 30' of channel right-of-way is required. Currently, records only show that 30' as a trail easement.

The limits of the proposed easements and right-of-way are shown on **Figure 13** and **Figure 14**. At this time it does not appear that any Authorization to Enter Property (AEP) easements will be required. AEP easements will be further evaluated between the 30% and 70% submittals and will be added if required.

Coordination with NDOT and an NDOT Encroachment Permit will be required under US95 in order to construct the proposed facilities within NDOT right-of-way. It is intended that this permit be prepared and submitted with the 90% submittal. In addition, Atkins will coordinate with NDOT after the 30% design submittal has been reviewed by the City and CCRFCD. This coordination will introduce the design to NDOT and provide them with a copy of the 30% plans and PDR and also discuss any changes to the design that resulted from the City and CCRFCD review. Input on the design from NDOT will be requested.

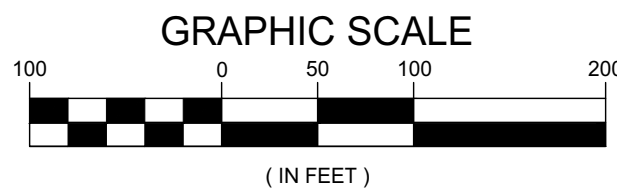
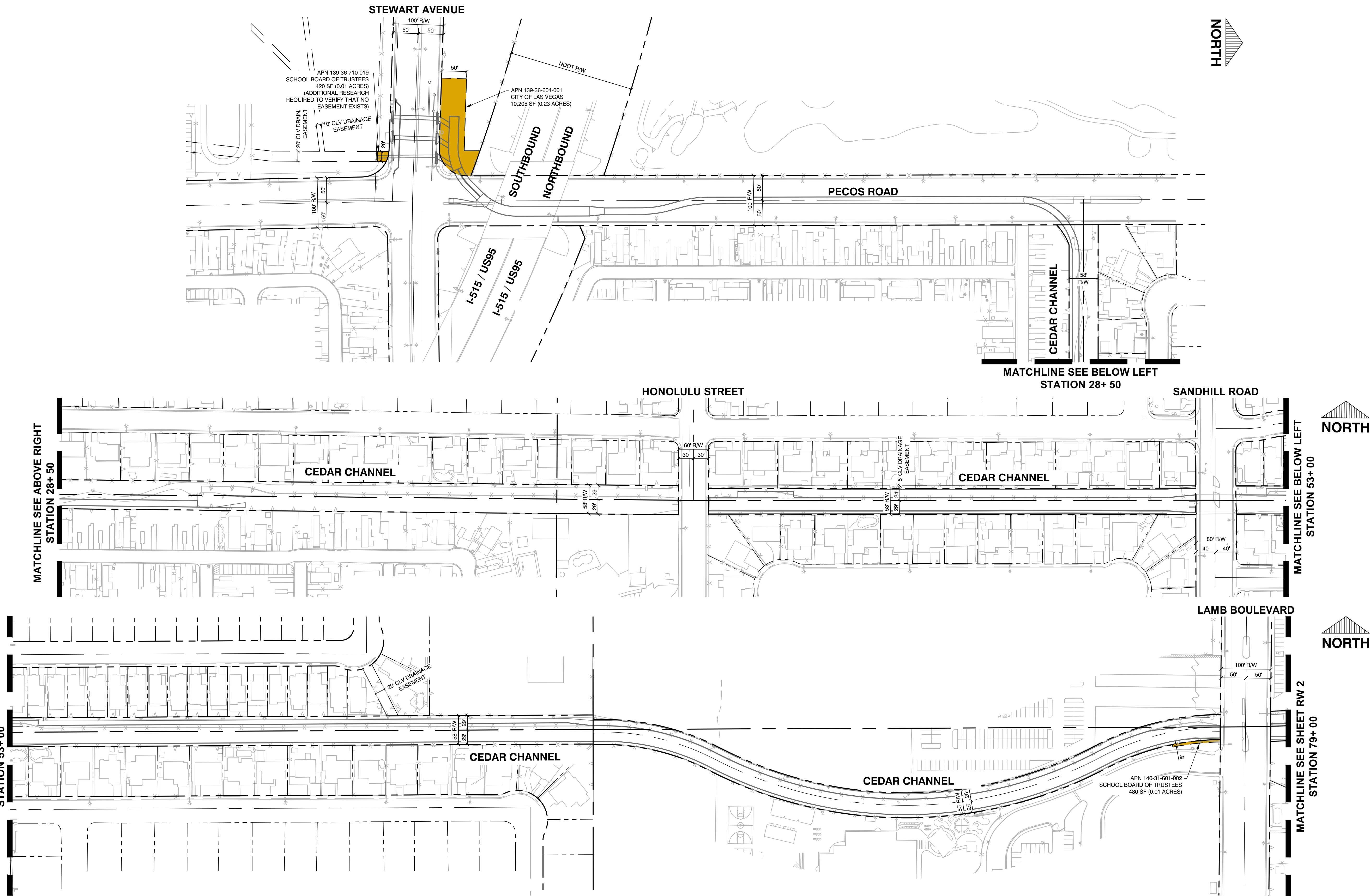
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LEGEND

- | | | | |
|---|-----------------------------|---|---------------------------------|
|  | PERMANENT RIGHT OF WAY |  | AUTHORIZATION TO ENTER PROPERTY |
|  | PERMANENT DRAINAGE EASEMENT |  | LVVWD EASEMENT |

MATCHLINE SEE ABOVE RIGHT
STATION 53+ 00

MATCHLINE SEE ABOVE RIGHT
STATION 28+ 50



CALL BEFORE CONSTRUCTION 		
BEFORE YOU DIG	USA NORTH	811 OR 800-227-2600
	F.A.S.T.	702-432-5300
BEFORE YOU UNDERGROUND	CLARK COUNTY TRAFFIC OPERATIONS	702-455-7511
	CITY OF LAS VEGAS T.E.F.O.	702-229-6611
BEFORE YOU OVERHEAD	NV ENERGY	702-227-2929

TITLE

LAS VEGAS WASH CENTRAL
CEDAR AVENUE CHANNEL

SHEET

RIGHT OF WAY PLAN 1
FIGURE 13

SHEET

RW 1
1 OF 2
DRAWING NO.
XXX-XXXX

PREPARED FOR

CITY OF LAS VEGAS

H# H48866

DATE: 6/19/2015

SUBMITTAL STAGE:

30% - PRELIMINARY

BID# XX-XXXX

DESIGNED BY: SMB

DRAWN BY: MM

CHECKED BY: HD

PREPARED BY



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NO. DATE REVISIONS

5. Utility Issues and Conflicts Summary

5.1. Utility Data Collection and Conflicts

This section includes discussion regarding the utility research and coordination and recommended test hole locations. The proposed project alignment runs through a well-established area mainly consisting of the existing Cedar Avenue Channel corridor and collector and arterial streets.

Research of the underground utilities was based on survey of surface features, dipping manholes, aerial photography, and obtaining and reviewing design and as-built drawings from utility companies and the City of Las Vegas, which dated as far back as the mid 1950s. As a result, potential utility conflicts identified herein are preliminary and more detailed determination of the location and depth of the existing underground services will continue throughout final design by means of conventional potholing (test holes) and additional coordination with the impacted entities.

The following utilities and agencies were contacted:

- Zayo (formerly American Fiber Systems, Inc.)
- AT&T Cable Maintenance
- Century Link
- City of Las Vegas
- Cox Communications
- Extenet Systems, Inc
- Freeway Arterials System of Transportation (FAST)
- Kern River Gas Transmission Company
- Kinder Morgan Energy Partners
- Level 3 Communications, LLC
- Las Vegas Valley Water District (LVVWD)
- NV Energy (Distribution)
- NV Energy (Transmission)
- Southern Nevada Water Authority (SNWA)
- Southwest Gas Corporation
- Sprint LD
- Sprint Nextel Engineering
- TWT Telecom
- Verizon Business Communications

Existing utilities have been identified from the agencies above and are shown on the 30% design plans. Colored linework is used on the design plans to identify the SUE quality (A, B, C, or D). Please refer to the design plans for detailed information.

The following is an inventory of existing utilities that are anticipated to be in conflict with the proposed storm drain and channel facilities. For the purpose of organizing the information below, the utility conflicts are discussed either by the main trunk line, channel segment or the individual street segment it corresponds to.

Main Trunk Line – Pecos Road north of Stewart Avenue to Cedar Channel

- Existing 60"x38" HE RCP SD will need to be removed for the installation of the proposed 18'x4' RCB SD and the dual 8'x4' RCB SD.
- Existing underground power conduit running north from the intersection near the west side Pecos right-of-way is anticipated to be in conflict with the proposed dual 8'x4' RCB storm drain and will require relocation. The depth of the conduit is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing streetlight conduit running north from the intersection near the west side Pecos right-of-way is anticipated to be in conflict with the proposed dual 8'x4' RCB storm drain and will require relocation. The depth of the conduit is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing 2" ITS conduit running north from the intersection near the west side Pecos right-of-way is anticipated to be in conflict with the proposed dual 8'x4' RCB storm drain and will require relocation. The depth of the conduit is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing 10" HP Steel Gas running north/south in Pecos Road on the west side of the street is anticipated to be in conflict with the proposed dual 8'x4' RCB storm drain and will require relocation. The depth conduit is currently unknown but test hole data received from the CLV from the BOMO project shows the line to be 5.38' below existing grade on the south side of the Stewart/Pecos intersection. This is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing 36" RCP SS running north/south in Pecos Road is not anticipated to be in conflict based on survey data of the upstream and downstream manholes. Based on the manhole data there will be 6" of clearance between the existing pipe and the proposed dual 8'x4' RCB SD. It is recommended that a test hole be performed to verify the clearance.
- Existing ITS conduits crossing Pecos Road north of Stewart Avenue are anticipated to be in conflict with the proposed dual 8'x4' RCB SD and will require relocation. The depth of the conduits is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing 72" RCP SD that runs north/south to the Cedar Channel will need to be removed for the installation of the proposed junction structure, 18'x4' RCB SD and the 12'x6' RCB SD.

Channel – Honolulu Drive to Sandhill Road

- Existing trail lighting conduit runs east/west near the north Cedar Channel right-of-way. It is not anticipated that this conduit will be in conflict with the proposed channel access ramp but it is recommended a test hole be performed to verify the horizontal location and clearance from the access ramp.

Channel – Sandhill Road to Lamb Boulevard

- Existing trail lighting conduit runs east/west near the north Cedar Channel right-of-way. It is anticipated that this conduit will be in conflict with the proposed channel access ramp excavation and will need to be removed and replaced.
- Existing 4" underground power conduit runs east/west on the north side of the existing channel starting near Sta 59+50 and continuing to Lamb Boulevard. It is not anticipated that that this conduit will be in conflict with the proposed channel but is recommended a couple test holes be performed to verify the horizontal location of the conduit.

Channel – Lamb Boulevard to Page Street

- Existing 4" underground power conduit runs east/west on the north side of the existing channel from Lamb Boulevard to Page Street. It is not anticipated that that this conduit will be in conflict with the proposed channel but is recommended a test hole be performed to verify the horizontal location of the conduit near the proposed access ramp to verify the horizontal location.

Channel – Page Street to Marion Drive

- Existing 4" underground power conduit runs east/west on the north side of the existing channel from Page Street to Marion Drive. It is not anticipated that that this conduit will be in conflict with the proposed channel but is recommended a test hole be performed to verify the horizontal location of the conduit near the proposed access ramp to verify the horizontal location.

Channel – Marion Drive to Las Vegas Wash

- Existing 6" and 8" SS that crosses the proposed channel near Sta 118+75 will be in conflict with the proposed channel and will need to be relocated.

Stewart Laterals – Stewart Avenue west of Pecos Road

- Existing 18" ACP waterlines will need to be relocated to provide the required horizontal clearance from the proposed drop inlets. The line is not anticipated to be in conflict vertically with the proposed 7'x3' and 5'x3' RCB SDs based on test hole data received from CLV from the BOMO project which shows the line 7.97' from existing grade at the southwest corner of the intersection of Stewart and Pecos. It is recommended that a test hole be performed to verify the horizontal and vertical location.
- Existing traffic signal conduit running east/west in the middle of Stewart Avenue is anticipated to be in conflict with the proposed 7'x3' and 5'x3' RCB SDs based on test hole data received from the CLV from the BOM project which shows the line 2.66 below

existing grade at the west side of the intersection. The conduit will require relocation. It is recommended that test holes be performed at the location of the proposed lateral to verify the relocation will be required.

- Existing streetlight conduit running east/west in the middle of Stewart Avenue is anticipated to be in conflict with the proposed 7'x3' and 5'x3' RCB SDs and will require relocation. The depth of the conduit is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing ITS conduit running east/west in the middle of Stewart Avenue is anticipated to be in conflict with the proposed 7'x3' and 5'x3' RCB SDs and will require relocation. The depth of the conduit is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed.
- Existing 8" SS will be in conflict with the proposed 7'x3' and 5'x3' RCB SDs and will require relocation.
- Existing underground power conduit running east/west on the north side of Stewart Avenue is anticipated to be in conflict with the proposed 7'x3' and 5'x3' RCB SDs and will require relocation. The depth of the conduit is currently unknown but is a recommended test hole location. Relocation will be verified once a test hole is performed

The remaining existing utilities, other than those identified above, do not appear to be in conflict with the proposed storm drain system and channel. However, existing underground utilities are required to be protected during the excavation for the placement of the proposed storm drain system. Additionally, more utilities may be identified for relocations as the final design proceeds and as potholes are completed. A complete list of utility crossings is included in **Appendix E**.

5.2. Utility Potholing

Currently, no test holes have been performed on the project. Following the submittal of the 30% design plans and after addressing any comments received, a pothole plan will be submitted to the City for approval and the first round of potholes will be performed. A total of 50 potholes are anticipated to be performed for this project.

6. Construction Cost Estimate

It is estimated that the project will have a total construction cost of **\$16,652,193**.

All of the improvements are shown to be funded by the Clark County Regional Flood Control District.

A 15-percent contingency has been added to the cost estimate to offset the level of detail that has been provided at this stage.

The detailed cost estimate and associated quantities are shown in **Appendix F**.

Appendix A

Hydrologic Analysis

- Appendix A-1: FEMA FIRMette
- Appendix A-2: Existing Condition Photo Library
- Appendix A-3: HEC-1 Model
- Appendix A-4: CCRFD Design Manual Tables
- Appendix A-5: Hydrologic Parameters
- Appendix A-6: Land Use Map and Soils Map

Appendix A-1

FEMA FIRMette

[illegible]

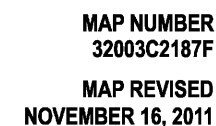
PANEL 2187F

FIRM
FLOOD INSURANCE RATE MAP
CLARK COUNTY,
NEVADA
AND INCORPORATED AREAS

PANEL 2187 OF 4090
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

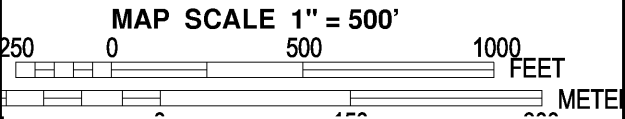
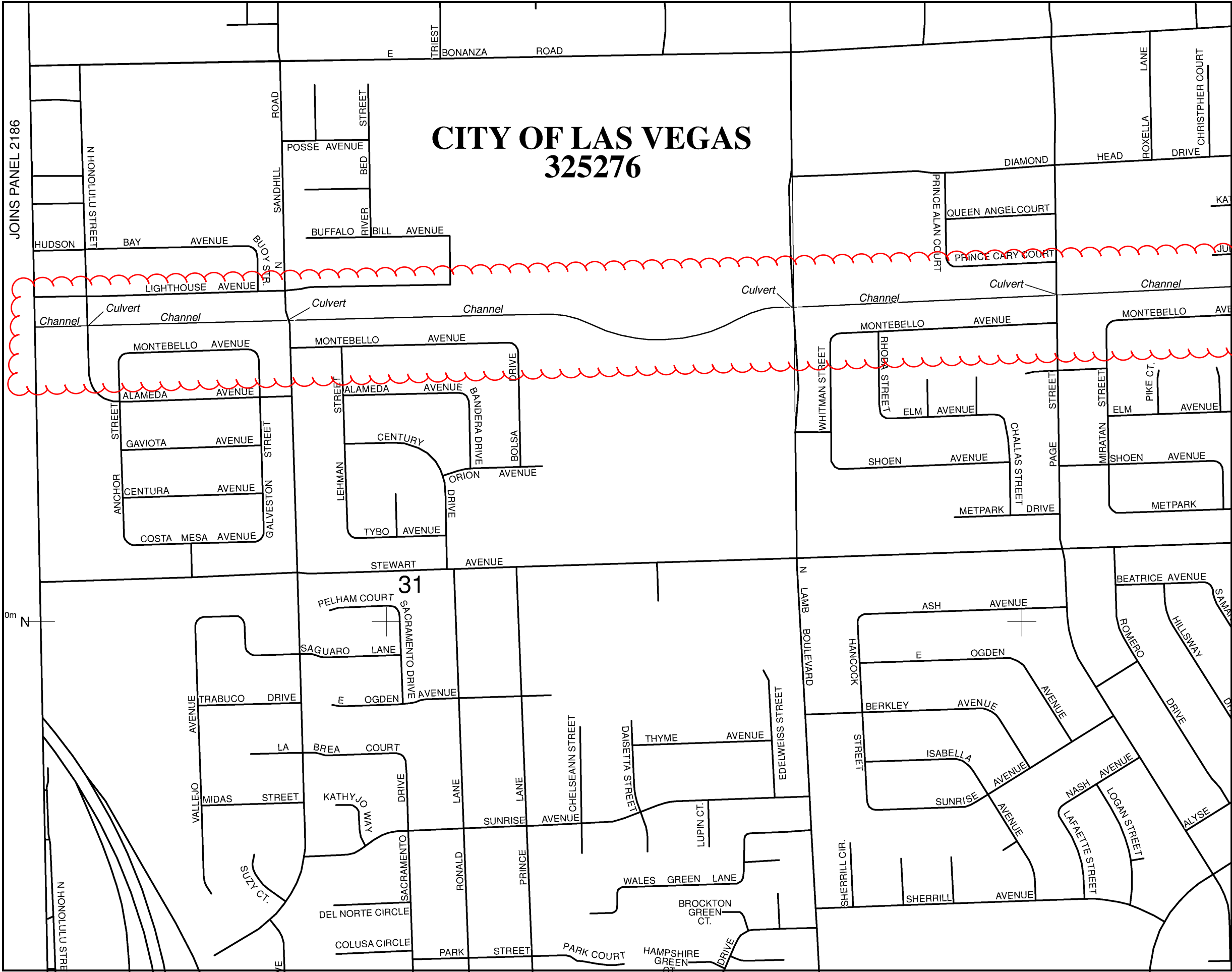
<u>CONTAINS:</u>	<u>NUMBER</u>	<u>PANEL</u>	<u>SUFFIX</u>
CLARK COUNTY	320003	2187	F
LAS VEGAS, CITY OF	325276	2187	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



PANEL 2187F

FIRM
FLOOD INSURANCE RATE MAP
CLARK COUNTY,
NEVADA
AND INCORPORATED AREAS

PANEL 2187 OF 4090
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLARK COUNTY	32003	2187	F
LAS VEGAS, CITY OF	325276	2187	F

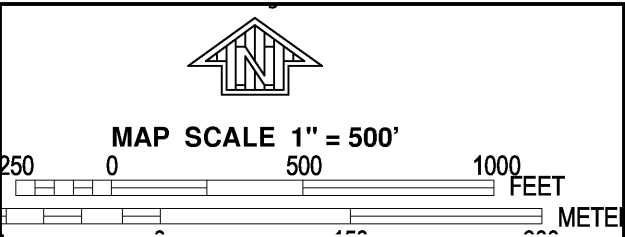
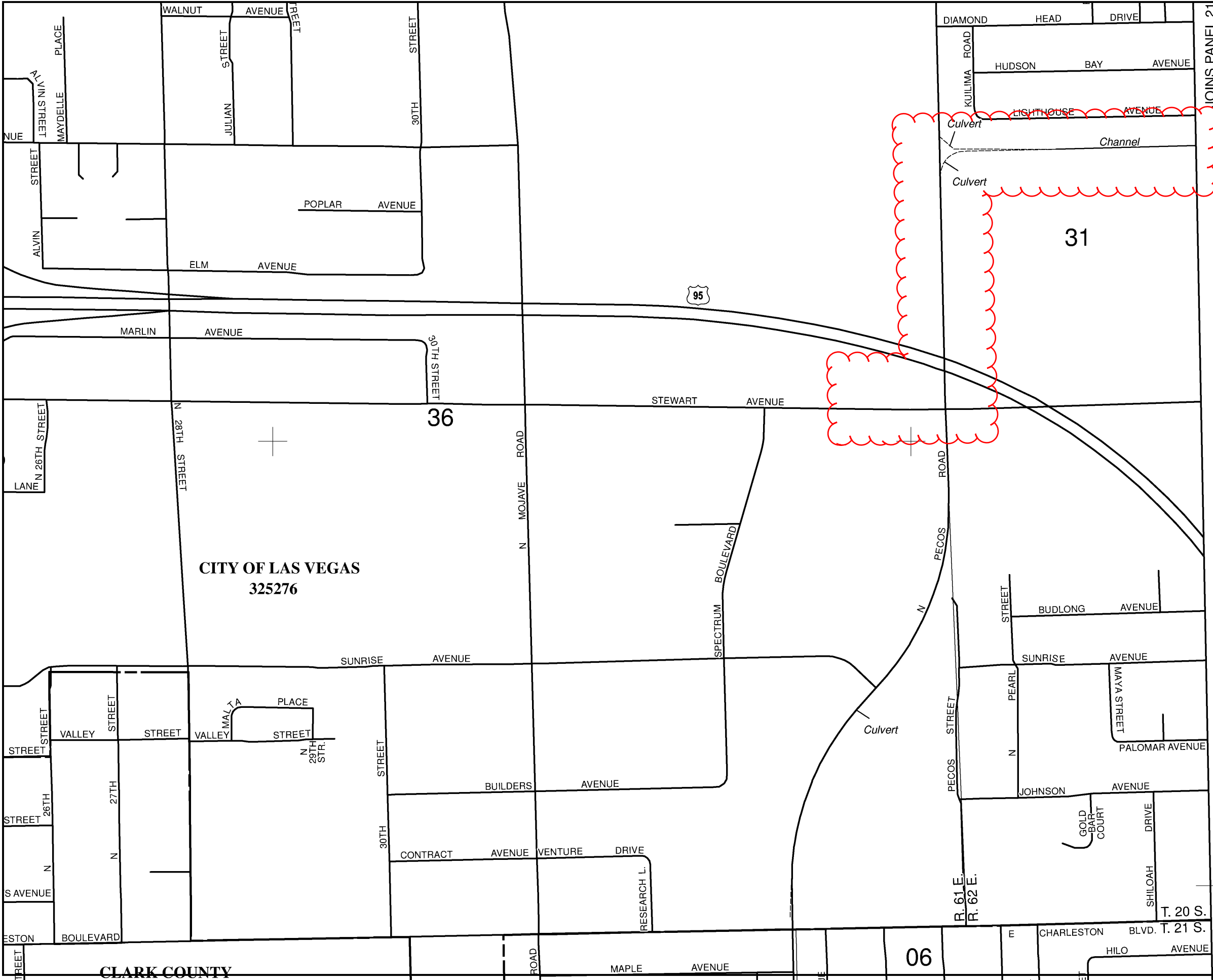
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
32003C2187F
MAP REVISED
NOVEMBER 16, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



NFIP

PANEL 2186F

FIRM
FLOOD INSURANCE RATE MAP
CLARK COUNTY,
NEVADA
AND INCORPORATED AREAS

PANEL 2186 OF 4090
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLARK COUNTY	320003	2186	F
LAS VEGAS, CITY OF	325276	2186	F
NORTH LAS VEGAS, CITY OF	320007	2186	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
32003C2186F

MAP REVISED
NOVEMBER 16, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix A-2

Existing Condition Photo Library



Photo 1: Looking at the upstream end of the channel at the two (2) 72-inch RCP's



Photo 2: Looking east at the trail along the Cedar Channel



Photo 3: Looking east at the Cedar channel upstream of Honolulu Street crossing



Photo 4: Looking east at the upstream face of Honolulu Street crossing



Photo 5: Looking west at the downstream face of Honolulu Street crossing



Photo 6: Looking east at the Cedar channel downstream of Honolulu Street crossing



Photo 7: Looking east at the Cedar channel upstream of Sandhill Road crossing



Photo 8: Looking east at the upstream face of Sandhill Road crossing



Photo 9: Looking west at the downstream face of Sandhill Road crossing



Photo 10: Looking east at the Cedar channel downstream of Sandhill Road crossing



Photo 11: Looking east at the Cedar channel upstream of Lamb Boulevard crossing



Photo 12: Looking east at the upstream face of Lamb Boulevard crossing



Photo 13: Looking west at the downstream face of Lamb Boulevard crossing



Photo 14: Looking east at the upstream face of Marion Street crossing



Photo 15: Looking west at the downstream face of Marion Street crossing



Photo 16: Looking east at the upstream face of Page Street crossing



Photo 17: Looking west at the downstream face of Page Street crossing



Photo 18: Looking north at drop inlets on Stewart Ave, west of Pecos Rd



Photo 19: Looking east at drop inlets on south side of Stewart Ave, west of Pecos Rd



Photo 20: Looking east at channel access ramp east of Honolulu St

Appendix A-3

HEC- 1 Model


```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 03JUN15 TIME 11:32:48
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

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X X XXXXXXX XXXX X
X X X X X XX
X X X X X
XXXXXXX XXXX X XXXXX X
X X X X X
X X X X X
X X XXXXXXX XXXXX XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY, DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

*DIAGRAM

*** FREE ***

```

1 ID LAS VEGAS WASH CENTRAL-CEDAR AVENUE
2 ID
3 ID INPUT FILE = CEDAR_INT.DAT
4 ID INPUT FILE DATE = APRIL 2014
5 ID DESIGN STORM = 100-YEAR 6-HR STORM AND 100-YEAR 6-HR STORM
6 ID STORM DISTRIBUTION = SDN #3
7 ID MODELED BY ATKINS (MANOGYA KHANAL)
8 ID CHECKED BY ATKINS (BRIAN ROWLEY, PE, CFM)
9 ID NO STORM CENTERING
10 ID REFERENCED HYDROLOGIC MODELS:
11 ID 2008 LAS VEGAS VALLEY FLOOD CONTROL DISTRICT
12 ID MASTER PLAN UPDATE (PBS&J, SEPTEMBER 2008)
13 ID CENTRAL NEIGHBORHOOD STUDY
14 ID
15 ID
16 ID JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:
17 ID
18 ID AREA DARF
19 ID SQ. MI.
20 ID 0-0.5 0.990
21 ID 0.5-1 0.975
22 ID 1-2 0.950
23 ID 2-3 0.925
24 ID 3-4 0.915
25 ID 4-5 0.908
26 ID 5-6 0.903
27 ID
28 IT 5 0 0 300
29 IO 5 0 0
30 IN 5 0 0
31 JR PREC 0.99 0.975 0.95 0.925 0.915 0.908 0.903 0.57
*
32 KK CA03a
33 BA 0.095
34 PB 2.77
35 PC 0.000 0.020 0.057 0.070 0.087 0.108 0.124 0.130 0.130 0.130
36 PC 0.130 0.130 0.130 0.133 0.140 0.142 0.148 0.158 0.172 0.181
37 PC 0.190 0.197 0.199 0.200 0.201 0.204 0.214 0.229 0.241 0.249
38 PC 0.251 0.256 0.270 0.278 0.281 0.283 0.295 0.322 0.352 0.409
39 PC 0.499 0.590 0.710 0.744 0.781 0.812 0.819 0.835 0.851 0.856
40 PC 0.860 0.868 0.876 0.888 0.910 0.926 0.937 0.950 0.970 0.976
41 PC 0.982 0.985 0.987 0.989 0.990 0.993 0.993 0.994 0.995 0.998
42 PC 0.998 0.999 1.000
43 LS 0 87.8
44 UD 0.234
*

```

1 HEC-1 INPUT PAGE 2

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

45 KK CA03c
46 BA 0.022
47 PB 2.77

```



```

111      HC      2
112      *
113      KK      RCA04d
114      KM      ROUTE CA04c TO CCA04d
115      KM      SUNRISE
116      RD      3050 0.01148 0.016 0 TRAP 0 50
117      *

```

1

HEC-1 INPUT

PAGE 4

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

116      KK      CA04e
117      BA      0.190
118      PB      2.77
119      LS      0 90.0
120      UD      0.349
121      *
122      KK      CCA04e
123      KM      COMBINE RCBN03 AND BN08
124      KM      SUNRISE AND MOJAVE
125      HC      2
126      *
127      KK      RCCA04e
128      KM      ROUTE CCA04e TO CCA04f
129      KM      MOJAVE
130      RD      1360 0.00368 0.016 0 TRAP 0 50
131      *

```

```

129      KK      CA04f
130      BA      0.046
131      PB      2.77
132      LS      0 91.6
133      UD      0.209
134      *

```

```

134      KK      CCA04f
135      KM      COMBINE RCCA04d AND CA04e
136      KM      MOJAVE AT STEWART
137      HC      2
138      *

```

```

138      KK      CCA04
139      KM      COMBINE CCA04 AND CCA04e
140      KM      STEWART AT MOJAVE
141      HC      2
142      *

```

```

142      KK      RCCA04
143      KM      ROUTE CCA04 TO CCA05
144      KM      STEWART
145      RD      2130 0.00892 0.016 0 TRAP 0 50
146      *

```

```

146      KK      CA05a
147      BA      0.036
148      PB      2.77
149      LS      0 91.0
150      UD      0.215
151      *

```

1

HEC-1 INPUT

PAGE 5

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

151      KK      CA05b
152      BA      0.050
153      PB      2.77
154      LS      0 91.9
155      UD      0.232
156      *

```

```

156      KK      CCA05-1
157      KM      COMBINE RCCA04, CA05a AND CA05b
158      KM      STEWART AT PECOS
159      HC      3
160      *

```

```

160      KK      DCCA05
161      KM      DIVERT BYPASS FLOW ON STEWART THAT CONTINUES EAST ON STEWART
162      KM      REMAINING FLOW IS THE FLOW COLLECTED IN INLETS
163      DT      DSTEWQ
164      DI      0 200 400 430 600 745 900
165      DQ      0 0 0 0 170 315 470
166      *

```

```

166      KK      CA05c
167      BA      0.023
168      PB      2.77
169      LS      0 91.9
170      UD      0.146
171      *

```



```

171      KK  RCA05c
172      KM  ROUTE CA05c TO CCA05e
173      KM  SUNRISE
174      RD    750 0.00933    0.016        0    TRAP        0        50
      *

175      KK  CA05d
176      BA  0.043
177      PB  2.77
178      LS    0    91.5
179      UD  0.202
      *

180      KK  CA05e
181      BA  0.003
182      PB  2.77
183      LS    0    92.0
184      UD  0.104
      *

185      KK  CCA05e
186      KM  COMBINE RCA05d AND CA05c
187      KM  SUNRISE AT PECOS
188      HC    3
      *

```

1

HEC-1 INPUT

PAGE 6

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

189      KKDTCCA05e
190      KM  DIVERT FLOW INTO THE STREET.
191      KM  REMIANING WILL FLOW INTO 29"X45" RCEP.
192      KM  AT PECOS NORTH OF SUNRISE
193      DT  DIA05e
194      DI    0    49.5    99
195      DQ    0    26.5    53
      *

```

```

196      KK  CA05f
197      BA  0.009
198      PB  2.77
199      LS    0    92.0
200      UD  0.123
      *

```

```

201      KK  DTCA05f
202      KM  DIVERT FLOW INTO THE STREET.
203      KM  REMIANING WILL FLOW INTO 29"X45" RCEP.
204      KM  AT PECOS NORTH OF SUNRISE
205      DT  DIA05f
206      DI    0    3.5    7
207      DQ    0    1.75    3.5
      *

```

```

208      KK  CCA05f
209      KM  COMBINE RCA05e AND CA05f
210      HC    2
      *

```

```

211      KK  RCCA05f
212      KM  ROUTE CCA05f TO CCA05f
213      KM  PECOS
214      RD    820 0.00732    0.013        0    CIRC        3        0
      *

```

```

215      KK  CA05h
216      BA  0.003
217      PB  2.77
218      LS    0    92.0
219      UD  0.101
      *

```

```

220      KK  CA05i
221      BA  0.004
222      PB  2.77
223      LS    0    92.0
224      UD  0.093
      *

```

1

HEC-1 INPUT

PAGE 7

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

225      KK  CA05k
226      BA  0.010
227      PB  2.77
228      LS    0    91.9
229      UD  0.105
      *

```

```

230      KK  CCA05k
231      KM  COMBINE RCCA05f, CA05h, CA05i AND CA05k
232      KM  UNDEVELOPED PARCEL AT STEWART AND PECOS

```


233 HC 4
 *
 234 KK CA05g
 235 BA 0.007
 236 PB 2.77
 237 LS 0 92.0
 238 UD 0.101
 *
 239 KK CA05j
 240 BA 0.005
 241 PB 2.77
 242 LS 0 92.0
 243 UD 0.083
 *
 244 KK CA05p
 245 BA 0.006
 246 PB 2.77
 247 LS 0 91.1
 248 UD 0.183
 *
 249 KK CCA05p
 250 KM COMBINE CA05g, CA05j AND CA05p
 251 KM ON PECOS SOUTH OF STEWART
 252 HC 3
 *
 253 KK DRA05e
 254 KM RETURN FLOW FROM DIVERTED
 255 KM FLOW ON THE STREET
 256 DR DTA05e
 *
 257 KK DRA05f
 258 KM RETURN FLOW FROM DIVERTED
 259 KM FLOW ON THE STREET
 260 DR DTA05f
 *

1

HEC-1 INPUT

PAGE 8

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

261 KK CCA05-3
 262 KM COMBINE DRA05f, DRA05e AND CCA05p
 263 KM ON PECOS SOUTH OF STEWART
 264 HC 3
 *
 265 KKDTCCA053
 266 KM DIVERT FLOW INTO THE STREET.
 267 KM REMIANING WILL FLOW INTO THE DROPINTET
 268 KM AT PECOS SOUTH OF STEWART, WEST
 269 DT DTA05-3
 270 DI 0 43.5 87
 271 DQ 0 40 80
 *
 272 KK CCA05-2
 273 KM COMBINE CCA05-1 AND CCA05p
 274 KM ON PECOS SOUTH OF STEWART
 275 HC 2
 *
 276 KKCCA05-2a
 277 KM COMBINE CCA05-2 AND CCA05-1
 278 KM ON STEWART AND PECOS
 279 HC 2
 *

280 KK CHAR
 281 BA 0.0365
 282 QI 0.0 0.0 0.0 0.0 0.0 0.3 0.8 1.3 1.8 1.5
 283 QI 1.3 0.8 0.5 0.5 0.5 0.8 1.0 1.3 2.3 2.8
 284 QI 3.1 2.8 2.6 2.1 1.8 1.8 2.3 3.6 3.9 3.6
 285 QI 3.6 3.6 3.6 3.6 3.6 4.6 11.3 18.0 27.0 36.0
 286 QI 42.2 43.0 39.4 33.7 27.3 17.8 14.2 11.3 9.3 8.2
 287 QI 8.5 9.3 9.8 10.0 9.8 9.0 7.7 6.4 4.9 3.9
 288 QI 3.1 2.3 1.8 1.3 1.3 1.0 1.0 0.8 0.5 0.5
 289 QI 0.3 0.3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 290 QI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 *

291 KK RCHAR
 292 KM ROUTE CHAR TO CH70-C
 293 KM LOCAL FACILITY PECOS ROAD STORM DRAIN
 294 RD 4600 0.0098 0.016 0 TRAP 0 50
 *

295 KK CH70-C
 296 BA 0.137
 297 PB 2.77

298 LS 0 92.7
299 UD 0.305
*

1

HEC-1 INPUT

PAGE 9

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

300 KK CCHAR
301 KM COMBINE CHAR AND CH70-C
302 HC 2
*

303 KK RCCHAR
304 KM ROUTE CCHAR TO CCA05-2
305 KM LOCAL FACILITY PECOS ROAD STORM DRAIN
306 KM LINING = RCP
307 RD 1250 0.0096 0.013 0 CIRC 5.5 0
*

308 KK CA05m
309 BA 0.005
310 PB 2.77
311 LS 0 91.5
312 UD 0.134
*

313 KK CCA05n
314 KM COMBINE CHAR AND CA05m
315 KM ON PECOS AND SUNRISE
316 HC 2
*

317 KK RCCA05m
318 KM ROUTE CCA05n TO CCA05-2
319 KM LOCAL FACILITY PECOS ROAD STORM DRAIN
320 KM LINING = RCP
321 RD 1580 0.00633 0.013 0 CIRC 5.5 0
*

322 KK CCA05-4
323 KM COMBINE CCA05n AND CA05m
324 KM ON PECOS AND SUNRISE
325 HC 2
*

326 KK CA05n
327 BA 0.004
328 PB 2.77
329 LS 0 91.4
330 UD 0.106
*

331 KK CA05q
332 BA 0.013
333 PB 2.77
334 LS 0 82.5
335 UD 0.215
*

1

HEC-1 INPUT

PAGE 10

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

336 KK CCA05q
337 KM COMBINED FLOW IN EXISTING STORM DRAIN
338 KM STEWART AND PECOS
339 HC 2
*

340 KK CCA05
341 KM TOTAL FLOW ON SURFACE AND SYSTEM
342 KM STEWART AND PECOS
343 HC 2
*

344 KK RCCA05
345 KM ROUTE CCA05 TO CCA08
346 KM PROPOSED FACILITY IN PECOS ROAD
347 KM LINING = RCB
348 RD 1310 0.005 0.013 0 TRAP 14 0
*

349 KK CA06-C
350 BA 0.407
351 PB 2.77
352 LS 0 82.5
353 UD 0.465
*

354 KK CH59-C
355 BA 0.213
356 PB 2.77
357 LS 0 94.4
358 UD 0.371

*
 359 KK DCH58-C
 360 KM FLOW SPLIT TO CH58-C
 361 KM SPLIT TO FLAMINGO WASH SYSTEM
 362 KM DEVELOPED FROM CWH MODEL
 363 KM CAPACITY = 144 CFS (100 YR STORM DRAIN CAPACITY)
 364 DT DFLAM
 365 DI 0 144 1000
 366 DQ 0 0 856
 *

367 KK RDCH58
 368 KM ROUTE DCH58-C TO CCH58-C
 369 KM LAS VEGAS BLVD STORM DRAIN
 370 RD 5900 0.01 0.013 0 CIRC 4 0
 *

1 HEC-1 INPUT PAGE 11

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

371 KK CH58-C
 372 BA 0.128
 373 PB 2.77
 374 LS 0 93.4
 375 UD 0.312
 *

376 KK CCH58-C
 377 KM COMBINE DCH58-C AND CH58-C
 378 KM US 95
 379 HC 2
 *

380 KKDDCH59-C
 381 KM FLOW SPLIT TO BN03-C
 382 KM DIVERT Q EXCEEDING LAS VEGAS BLVD DRAIN CAPACITY: 48" PIPE, 167 CFS
 383 KM DBN00 IN CWH
 384 DT DBN03
 385 DI 0 167 1000
 386 DQ 0 0 833
 *

387 KK DDCH59
 388 KM DIVERT FLOW OUT OF PECOS/BONANZA SYSTEM
 389 DT DBN03a
 390 DI 0 167 1000
 391 DQ 0 167 1000
 *

392 KK BN06-C
 393 BA 0.340
 394 PB 2.77
 395 LS 0 89.1
 396 UD 0.201
 *

397 KK BN03-C
 398 BA 0.539
 399 PB 2.77
 400 LS 0 87.3
 401 UD 0.344
 *

402 KK DBN03
 403 KM RETREIVE DBN03
 404 DR DBN03
 *

405 KK RDBN03
 406 KM ROUTE DBN03 TO CBN03
 407 KM BONANZA
 408 RD 5900 0.0264 0.016 0 TRAP 0 50
 *

1 HEC-1 INPUT PAGE 12

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

409 KK CBN03
 410 KM COMBINE BN06-C, BN03-C, AND RDBN03
 411 KM BONANZA AND EASTERN
 412 HC 3
 *

413 KK RCBN03
 414 KM ROUTE CBN03 TO CBN08
 415 KM FACILITY = LAS VEGAS WASH - BONANZA
 416 KM FACILITY # = LVBZ 0211,0224
 417 KM LINING = RCB
 418 RD 2980 0.0072 0.015 0 TRAP 8 0
 *

419 KK BN08


```

420      BA    0.210
421      PB    2.77
422      LS     0    91.8
423      UD    0.378
      *

424      KK    CBN08
425      KM    COMBINE RCBN03 AND BN08
426      KM    BONANZA AND MOJAVE
427      HC     2
      *

428      KK    RCBN08
429      KM    ROUTE CBN08 TO CBN09
430      KM    FACILITY = LAS VEGAS WASH - BONANZA
431      KM    FACILITY # = LVBZ 0167, 0188
432      KM    LINING = RCB
433      RD    2330  0.007  0.015      0    TRAP      9      0
      *

434      KK    BN09
435      BA    0.233
436      PB    2.77
437      LS     0    83.9
438      UD    0.411
      *

439      KK    CBN09
440      KM    COMBINE RCBN08 AND BN09
441      KM    BONANZA AND PECOS
442      HC     2
      *

443      KK    DBN09
444      KM    FLOW SPLIT TO PECOS
445      KM    DIVERT Q EXCEEDING 60" PIPE, 202 CFS
446      DT    DBN09a
447      DI     0      202      1000      2000
448      DQ     0      0      798      1798
      *

```

1

HEC-1 INPUT

PAGE 13

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

449      KK    CCBN09
450      KM    COMBINE DDCH59 AND DBN09
451      KM    SHOULD BE THE SAME AS CBN09
452      KM    DDCH59 HAS ZERO FLOW
453      KM    BONANZA AND PECOS
454      HC     2
      *

455      KK    CCA06-1
456      KM    BONANZA FLOW AND CA06-C
457      HC     2
      *

458      KK    CCA06
459      KM    CEDAR AND PECOS
460      HC     2
      *

461      KK    RCCA06
462      KM    ROUTE CCA05 TO CCA08
463      KM    FACILITY = CEDAR AVENUE CHANNEL
464      KM    FACILITY # = CACH 0127,0129,0146,0148
465      KM    LINING = CONCRETE
466      RD    1545  0.0026  0.015      0    TRAP      10    1.5
      *

467      KK    CA08
468      BA    0.073
469      PB    2.77
470      LS     0    85.4
471      UD    0.258
      *

472      KK    CCA08
473      KM    CEDAR AND HONOLULU
474      HC     2
      *

475      KK    RCCA08
476      KM    ROUTE CCA08 TO CCA09
477      KM    FACILITY = CEDAR AVENUE CHANNEL
478      KM    FACILITY # = CACH 0079,0081
479      KM    LINING = CONCRETE
480      RD    1050  0.0026  0.015      0    TRAP      10    1.5
      *

481      KK    CA09
482      BA    0.048
483      PB    2.77
484      LS     0    89.6

```

1 485 UD 0.225
 *
 HEC-1 INPUT PAGE 14

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

486 KK CCA09
 487 KM CEDAR AND SANDHILL
 488 HC 2
 *
 489 KK RCCA09
 490 KM ROUTE CCA09 TO CCA10
 491 KM FACILITY = CEDAR AVENUE CHANNEL
 492 KM FACILITY # = CACH 0000,0027,0029,0051,0053,0079
 493 KM LINING = CONCRETE
 494 RD 935 0.002 0.015 0 TRAP 12 1.5
 *
 495 KK CA10
 496 BA 0.032
 497 PB 2.77
 498 LS 0 93.0
 499 UD 0.221
 *
 500 KK CCA10
 501 KM CEDAR AVE CHANNEL
 502 HC 2
 *
 503 KK RCCA10
 504 KM ROUTE CCA10 TO CCA11
 505 KM FACILITY = CEDAR AVENUE CHANNEL
 506 KM FACILITY # = CACH 0000,0027,0029,0051,0053,0079
 507 KM LINING = CONCRETE
 508 RD 1730 0.002 0.015 0 TRAP 12 1.5
 *
 509 KK CA11
 510 BA 0.092
 511 PB 2.77
 512 LS 0 90.2
 513 UD 0.288
 *
 514 KK CCA11
 515 KM CEDAR AND LAMB
 516 HC 2
 *
 517 KK RCCA11
 518 KM ROUTE CCA11 TO CCA12
 519 KM FACILITY = CEDAR AVENUE CHANNEL
 520 KM FACILITY # = CACH 0000,0027,0029,0051,0053,0079
 521 KM LINING = CONCRETE
 522 RD 1340 0.0038 0.015 0 TRAP 10 1.5
 *

1 HEC-1 INPUT PAGE 15

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

523 KK CA12
 524 BA 0.062
 525 PB 2.77
 526 LS 0 94.1
 527 UD 0.245
 *
 528 KK CCA12
 529 KM CEDAR AND PAGE
 530 HC 2
 *
 531 KK RCCA12
 532 KM ROUTE CCA12 TO CCA13
 533 KM FACILITY = CEDAR AVENUE CHANNEL
 534 KM FACILITY # = CACH 0000,0027,0029,0051,0053,0079
 535 KM LINING = CONCRETE
 536 RD 1365 0.0037 0.015 0 TRAP 10 1.5
 *
 537 KK CA13a
 538 BA 0.065
 539 PB 2.77
 540 LS 0 95.9
 541 UD 0.247
 *
 542 KK CCA13a
 543 KM CEDAR AND MARION
 544 HC 2
 *

545 KK BN10-C
546 BA 0.257
547 PB 2.77
548 LS 0 88.8
549 UD 0.406
*

550 KK DBN09a
551 KM RETREIVE DBN09a
552 DR DBN09a
*

553 KK CBN10-C
554 KM COMBINE DBN09a AND BN10-C
555 KM BONANZA AND SANDHILL
556 HC 2
*

1

HEC-1 INPUT

PAGE 16

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

557 KKRCBN10-C
558 KM ROUTE CBN10-C TO CBN12-C
559 KM FACILITY = LAS VEGAS WASH - BONANZA
560 KM FACILITY # = LVBZ 0064
561 KM LINING = RCB
562 RD 2630 0.004 0.015 0 TRAP 24 0
*

563 KK BN12-C
564 BA 0.323
565 PB 2.77
566 LS 0 87.4
567 UD 0.397
*

568 KK CBN12-C
569 KM COMBINE RCBN10-C AND BN12-C
570 KM BONANZA AND LAMB
571 HC 2
*

572 KKRCBN12-C
573 KM ROUTE CBN12-C TO CBN15-C
574 KM FACILITY = LAS VEGAS WASH - BONANZA
575 KM FACILITY # = LVBZ 0000
576 KM LINING = RCB
577 RD 2740 0.004 0.015 0 TRAP 24 0
*

578 KK BN15-C
579 BA 0.283
580 PB 2.77
581 LS 0 87.0
582 UD 0.414
*

583 KK CBN15-C
584 KM COMBINE RCBN12-C AND BN15-C
585 KM LAS VEGAS WASH AND BONANZA
586 HC 2
*

587 KKRCBN15-C
588 KM ROUTE CCBN15-C TO CCA13a
589 KM TO CEDAR CHANNEL FROM MARION DRIVE
590 KM LINING = RCB
591 RD 1371 0.0073 0.015 0 TRAP 20 0
*

1

HEC-1 INPUT

PAGE 17

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

592 KK CCA13
593 KM CEDAR CHANNEL AT MARION DRIVE
594 KM COMBINES FLOWS FROM CEDAR CHANNEL AND BONANZA
595 HC 2
*

596 KK RCCA13
597 KM ROUTE CCA13 TO CCA14
598 KM FACILITY = CEDAR AVENUE CHANNEL
599 KM FACILITY # = CACH 0000,0027,0029,0051,0053,0079
600 KM LINING = CONCRETE
601 RD 1680 0.002 0.015 0 TRAP 14 1.5
*

602 KK CA14
603 BA 0.055
604 PB 2.77
605 LS 0 97.7
606 UD 0.233

```

*
607      KK   CCA14
608      KM   CEDAR CHANNEL AT WASH
609      HC     2
        *

610      KK   DRDTA05
611      KM   RETURN FLOW FROM DIVERTED
612      KM   FLOW ON THE STREET FROM PECOS
613      DR   DTA05-3
        *

614      KK   DRDSTEW
615      KM   RETURN FLOW FROM DIVERTED
616      KM   FLOW ON THE STREET FROM STEWART
617      DR   DSTEWQ
        *

618      KK   CSTEWBY
619      KM   BYPASS FLOW ON STEWART
620      HC     2
        *
621      ZZ

```

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

```

INPUT
LINE      (V) ROUTING      (--->) DIVERSION OR PUMP FLOW

NO.      (.) CONNECTOR      (<---) RETURN OF DIVERTED OR PUMPED FLOW

32      CA03a
        .
45      .      CA03c
        .
50      CCA03c.....
        .
54      .      CA03b
        .
59      CCA03.....
        V
        V
63      RCCA03
        .
67      .      CA04b
        .
72      CCA04b.....
        V
        V
76      RCCA04b
        .
80      .      CA04a
        .
85      .      .      CA04c
        .
90      CCA04-1.....
        .
94      .      CA04g
        .      V
        .      V
99      .      RCA04g
        .
103     .      .      CA04d
        .
108     .      CCA04d.....
        .      V
        .      V
112     .      RCA04d
        .
116     .      .      CA04e
        .
121     .      CCA04e.....
        .      V
        .      V
125     .      RCCA04e
        .
129     .      .      CA04f
        .
134     .      CCA04f.....

```



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      .
      .
138   CCA04.....
      V
      V
142   RCCA04
      .
146   .      CA05a
      .      .
151   .      .      CA05b
      .      .      .
156   CCA05-1.....
      .
163   .----->  DSTEWQ
160   DCCA05
      .
166   .      CA05c
      .      V
      .      V
171   .      RCA05c
      .      .
175   .      .      CA05d
      .      .      .
180   .      .      .      CA05e
      .      .      .      .
185   .      CCA05e.....
      .
193   .      .----->  DTA05e
189   .      DTCCA05e
      .
196   .      .      CA05f
      .      .      .
205   .      .      .----->  DTA05f
201   .      .      DTCA05f
      .      .      .
208   .      CCA05f.....
      .      V
      .      V
211   .      RCCA05f
      .
215   .      .      CA05h
      .      .      .
220   .      .      .      CA05i
      .      .      .      .
225   .      .      .      .      CA05k
      .      .      .      .      .
230   .      CCA05k.....
      .
234   .      .      CA05g
      .      .      .
239   .      .      .      CA05j
      .      .      .      .
244   .      .      .      .      CA05p
      .      .      .      .      .
249   .      .      CCA05p.....
      .
256   .      .      .      .----->  DTA05e
253   .      .      DRA05e
      .      .      .
260   .      .      .      .----->  DTA05f
257   .      .      .      DRA05f
      .      .      .
261   .      .      CCA05-3.....
      .
269   .      .      .----->  DTA05-3
265   .      .      DTCCA053
      .
272   .      CCA05-2.....
      .
      .

```

```

276 CCA05-2a.....
    .
280 .      CHAR
    .      V
    .      V
291 .      RCHAR
    .
295 .      .      CH70-C
    .      .
300 .      CCHAR.....
    .      V
    .      V
303 .      RCCHAR
    .
308 .      .      CA05m
    .      .
313 .      CCA05n.....
    .      V
    .      V
317 .      RCCA05m
    .
322 CCA05-4.....
    .
326 .      CA05n
    .
331 .      .      CA05q
    .
336 .      CCA05q.....
    .
340 .      CCA05.....
    .      V
    .      V
344 .      RCCA05
    .
349 .      CA06-C
    .
354 .      .      CH59-C
    .      .
364 .      .      .-----> DFLAM
359 .      .      DCH58-C
    .      .      V
    .      .      V
367 .      .      RDCH58
    .
371 .      .      .      CH58-C
    .      .
376 .      .      CCH58-C.....
    .      .
384 .      .      .-----> DBN03
380 .      .      DDCH59-C
    .
389 .      .      .-----> DBN03a
387 .      .      DDCH59
    .
392 .      .      .      BN06-C
    .      .
397 .      .      .      .      BN03-C
    .      .
404 .      .      .      .      .      .<----- DBN03
402 .      .      .      .      .      V
    .      .      .      .      .      V
405 .      .      .      .      .      RDBN03
    .      .
409 .      .      .      CBN03.....
    .      .      V
    .      .      V
413 .      .      .      RCBN03
    .
419 .      .      .      .      BN08
    .      .
424 .      .      .      CBN08.....

```



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      .      .      .      V
      .      .      .      V
428    .      .      .      RCBN08
      .      .      .      .
434    .      .      .      .      BN09
      .      .      .      .
439    .      .      .      CBN09.....
      .      .      .      .
446    .      .      .      .-----> DEN09a
443    .      .      .      DBN09
      .      .      .      .
449    .      .      CCBN09.....
      .      .      .
455    .      CCA06-1.....
      .      .      .
458    CCA06.....
      .      .      .
      .      .      .
461    RCCA06
      .      .      .
467    .      CA08
      .      .      .
472    CCA08.....
      .      .      .
      .      .      .
475    RCCA08
      .      .      .
481    .      CA09
      .      .      .
486    CCA09.....
      .      .      .
      .      .      .
489    RCCA09
      .      .      .
495    .      CA10
      .      .      .
500    CCA10.....
      .      .      .
      .      .      .
503    RCCA10
      .      .      .
509    .      CA11
      .      .      .
514    CCA11.....
      .      .      .
      .      .      .
517    RCCA11
      .      .      .
523    .      CA12
      .      .      .
528    CCA12.....
      .      .      .
      .      .      .
531    RCCA12
      .      .      .
537    .      CA13a
      .      .      .
542    CCA13a.....
      .      .      .
545    .      BN10-C
      .      .      .
552    .      .      .      <----- DEN09a
550    .      .      DBN09a
      .      .      .
553    .      CBN10-C.....
      .      .      .
      .      .      .
557    .      RCCA10-C
      .      .      .
563    .      .      BN12-C
      .      .      .
568    .      CBN12-C.....

```

```

      .      V
      .      V
572      .      RCBN12-C
      .      .
      .      .
578      .      .      BN15-C
      .      .
      .      .
583      .      CBN15-C.....
      .      V
      .      V
587      .      RCBN15-C
      .      .
      .      .
592      .      CCA13.....
      .      V
      .      V
596      .      RCCA13
      .      .
      .      .
602      .      .      CA14
      .      .
      .      .
607      .      CCA14.....
      .      .
      .      .
613      .      .      .<----- DTA05-3
610      .      .      DRDIA05
      .      .
      .      .
617      .      .      .<----- DSTEWQ
614      .      .      DRDSTEW
      .      .
      .      .
618      .      .      CSTEWB.....

```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
*      JUN 1998
*      VERSION 4.1
*
* RUN DATE 03JUN15 TIME 11:32:48
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

```

LAS VEGAS WASH CENTRAL-CEDAR AVENUE

```

INPUT FILE = CEDAR_INT.DAT
INPUT FILE DATE = APRIL 2014
DESIGN STORM = 100-YEAR 6-HR STORM AND 100-YEAR 6-HR STORM
STORM DISTRIBUTION = SDN #3
MODELED BY ATKINS (MANOGYA KHANAL)
CHECKED BY ATKINS (BRIAN ROWLEY, PE, CFM)
NO STORM CENTERING
REFERENCED HYDROLOGIC MODELS:
2008 LAS VEGAS VALLEY FLOOD CONTROL DISTRICT
MASTER PLAN UPDATE (PBS&J, SEPTEMBER 2008)
CENTRAL NEIGHBORHOOD STUDY

```

JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:

AREA	DARF
SQ. MI.	
0-0.5	0.990
0.5-1	0.975
1-2	0.950
2-3	0.925
3-4	0.915
4-5	0.908
5-6	0.903

```

29 IO      OUTPUT CONTROL VARIABLES
      IPRNT      5      PRINT CONTROL
      IPLOT      0      PLOT CONTROL
      QSCAL      0.      HYDROGRAPH PLOT SCALE

IT      HYDROGRAPH TIME DATA
      NMIN      5      MINUTES IN COMPUTATION INTERVAL
      IDATE      1      0      STARTING DATE
      ITIME      0000      STARTING TIME
      NQ      300      NUMBER OF HYDROGRAPH ORDINATES
      NDDATE      2      0      ENDING DATE
      NDTIME      0055      ENDING TIME
      ICENT      19      CENTURY MARK

      COMPUTATION INTERVAL      .08 HOURS
      TOTAL TIME BASE      24.92 HOURS

```


JR	MULTI-RATIO OPTION							
	RATIOS OF PRECIPITATION							
	.99	.98	.95	.93	.92	.91	.90	.57

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION							
					RATIO 1 .99	RATIO 2 .98	RATIO 3 .95	RATIO 4 .93	RATIO 5 .92	RATIO 6 .91	RATIO 7 .90	RATIO 8 .87
HYDROGRAPH AT +	CA03a	.09	1	FLOW TIME	107. 3.67	104. 3.67	100. 3.67	96. 3.67	95. 3.67	94. 3.67	93. 3.67	43. 3.67
HYDROGRAPH AT +	CA03c	.02	1	FLOW TIME	25. 3.67	24. 3.67	23. 3.67	22. 3.67	22. 3.67	22. 3.67	22. 3.67	10. 3.67
2 COMBINED AT +	CCA03c	.12	1	FLOW TIME	131. 3.67	128. 3.67	123. 3.67	119. 3.67	117. 3.67	115. 3.67	115. 3.67	53. 3.67
HYDROGRAPH AT +	CA03b	.08	1	FLOW TIME	86. 3.67	84. 3.67	81. 3.67	77. 3.67	76. 3.67	75. 3.67	75. 3.67	35. 3.67
2 COMBINED AT +	CCA03	.20	1	FLOW TIME	217. 3.67	212. 3.67	204. 3.67	196. 3.67	193. 3.67	191. 3.67	189. 3.67	88. 3.67
ROUTED TO +	RCCA03	.20	1	FLOW TIME	211. 3.75	205. 3.75	199. 3.75	191. 3.75	188. 3.75	185. 3.75	183. 3.75	86. 3.75
HYDROGRAPH AT +	CA04b	.06	1	FLOW TIME	71. 3.58	69. 3.58	66. 3.58	64. 3.58	63. 3.58	62. 3.58	62. 3.58	29. 3.67
2 COMBINED AT +	CCA04b	.26	1	FLOW TIME	278. 3.67	272. 3.67	262. 3.67	251. 3.67	248. 3.67	245. 3.67	242. 3.67	112. 3.75
ROUTED TO +	RCCA04b	.26	1	FLOW TIME	271. 3.75	270. 3.75	256. 3.75	248. 3.75	249. 3.75	243. 3.75	238. 3.75	113. 3.83
HYDROGRAPH AT +	CA04a	.04	1	FLOW TIME	44. 3.67	43. 3.67	41. 3.67	40. 3.67	39. 3.67	38. 3.67	38. 3.67	18. 3.67
HYDROGRAPH AT +	CA04c	.03	1	FLOW TIME	41. 3.58	40. 3.58	39. 3.58	38. 3.58	37. 3.58	37. 3.58	36. 3.58	18. 3.58
3 COMBINED AT +	CCA04-1	.33	1	FLOW TIME	345. 3.75	342. 3.75	326. 3.75	315. 3.75	315. 3.75	308. 3.75	303. 3.75	143. 3.75
HYDROGRAPH AT +	CA04g	.05	1	FLOW TIME	81. 3.58	79. 3.58	77. 3.58	74. 3.58	73. 3.58	73. 3.58	72. 3.58	39. 3.58
ROUTED TO +	RCA04g	.05	1	FLOW TIME	79. 3.75	77. 3.75	75. 3.75	71. 3.75	70. 3.75	69. 3.75	69. 3.75	38. 3.75
HYDROGRAPH AT +	CA04d	.05	1	FLOW TIME	72. 3.58	70. 3.58	68. 3.58	66. 3.58	65. 3.58	64. 3.58	64. 3.58	33. 3.58
2 COMBINED AT +	CCA04d	.10	1	FLOW TIME	140. 3.67	137. 3.67	133. 3.67	129. 3.67	127. 3.67	125. 3.67	123. 3.67	65. 3.75
ROUTED TO +	RCA04d	.10	1	FLOW TIME	142. 3.83	139. 3.83	135. 3.83	129. 3.83	128. 3.83	126. 3.83	125. 3.83	64. 3.92

HYDROGRAPH AT												
+	CA04e	.19	1	FLOW TIME	194. 3.75	190. 3.75	184. 3.75	177. 3.75	174. 3.75	172. 3.75	171. 3.75	85. 3.83
2 COMBINED AT												
+	CCA04e	.29	1	FLOW TIME	333. 3.83	326. 3.83	315. 3.83	304. 3.83	299. 3.83	296. 3.83	294. 3.83	148. 3.83
ROUTED TO												
+	RCCA04e	.29	1	FLOW TIME	321. 3.92	319. 3.83	306. 3.92	294. 3.92	293. 3.92	293. 3.92	291. 3.92	147. 3.92
HYDROGRAPH AT												
+	CA04f	.05	1	FLOW TIME	61. 3.58	60. 3.58	58. 3.58	56. 3.58	55. 3.58	55. 3.58	54. 3.58	29. 3.67
2 COMBINED AT												
+	CCA04f	.34	1	FLOW TIME	363. 3.83	360. 3.83	344. 3.83	331. 3.83	329. 3.83	330. 3.83	328. 3.83	163. 3.92
2 COMBINED AT												
+	CCA04	.67	1	FLOW TIME	683. 3.83	675. 3.83	648. 3.83	623. 3.83	620. 3.83	617. 3.83	611. 3.83	292. 3.83
ROUTED TO												
+	RCCA04	.67	1	FLOW TIME	669. 3.83	664. 3.83	637. 3.92	609. 3.83	607. 3.83	602. 3.83	601. 3.83	292. 3.92
HYDROGRAPH AT												
+	CA05a	.04	1	FLOW TIME	47. 3.67	46. 3.67	44. 3.67	43. 3.67	42. 3.67	42. 3.67	41. 3.67	21. 3.67
HYDROGRAPH AT												
+	CA05b	.05	1	FLOW TIME	66. 3.67	65. 3.67	62. 3.67	60. 3.67	60. 3.67	59. 3.67	59. 3.67	31. 3.67
3 COMBINED AT												
+	CCA05-1	.75	1	FLOW TIME	751. 3.83	745. 3.83	714. 3.83	685. 3.83	682. 3.83	676. 3.83	674. 3.83	323. 3.92
DIVERSION TO												
+	DSTEWQ	.75	1	FLOW TIME	321. 3.83	315. 3.83	284. 3.83	255. 3.83	252. 3.83	246. 3.83	244. 3.83	0. .00
HYDROGRAPH AT												
+	DCCA05	.75	1	FLOW TIME	430. 3.58	430. 3.67	430. 3.67	430. 3.67	430. 3.67	430. 3.67	430. 3.67	323. 3.92
HYDROGRAPH AT												
+	CA05c	.02	1	FLOW TIME	36. 3.58	35. 3.58	34. 3.58	33. 3.58	32. 3.58	32. 3.58	32. 3.58	17. 3.58
ROUTED TO												
+	RCA05c	.02	1	FLOW TIME	34. 3.58	33. 3.58	32. 3.58	31. 3.58	30. 3.58	30. 3.58	30. 3.58	16. 3.67
HYDROGRAPH AT												
+	CA05d	.04	1	FLOW TIME	58. 3.58	57. 3.58	55. 3.58	53. 3.58	53. 3.58	52. 3.58	52. 3.58	27. 3.67
HYDROGRAPH AT												
+	CA05e	.00	1	FLOW TIME	5. 3.50	5. 3.50	5. 3.50	5. 3.50	4. 3.50	4. 3.50	4. 3.50	2. 3.50
3 COMBINED AT												
+	CCA05e	.07	1	FLOW TIME	97. 3.58	95. 3.58	92. 3.58	89. 3.58	87. 3.58	86. 3.58	86. 3.58	44. 3.58
DIVERSION TO												
+	DTA05e	.07	1	FLOW TIME	52. 3.58	51. 3.58	49. 3.58	47. 3.58	47. 3.58	46. 3.58	46. 3.58	24. 3.58
HYDROGRAPH AT												
+	DTCCA05e	.07	1	FLOW TIME	45. 3.58	44. 3.58	43. 3.58	41. 3.58	41. 3.58	40. 3.58	40. 3.58	21. 3.58
HYDROGRAPH AT												
+	CA05f	.01	1	FLOW TIME	14. 3.58	14. 3.58	14. 3.58	13. 3.58	13. 3.58	13. 3.58	13. 3.58	7. 3.58
DIVERSION TO												
+	DTA05f	.01	1	FLOW TIME	7. 3.58	7. 3.58	7. 3.58	7. 3.58	6. 3.58	6. 3.58	6. 3.58	3. 3.58
HYDROGRAPH AT												
+	DTCA05f	.01	1	FLOW TIME	7. 3.58	7. 3.58	7. 3.58	7. 3.58	6. 3.58	6. 3.58	6. 3.58	3. 3.58
2 COMBINED AT												
+	CCA05f	.08	1	FLOW TIME	52. 3.58	51. 3.58	49. 3.58	48. 3.58	47. 3.58	47. 3.58	46. 3.58	24. 3.58
ROUTED TO												
+	RCCA05f	.08	1	FLOW TIME	50. 3.58	49. 3.58	48. 3.58	46. 3.58	45. 3.58	45. 3.58	44. 3.58	23. 3.67

HYDROGRAPH AT +	CA05h	.00	1	FLOW TIME	5. 3.50	5. 3.50	5. 3.50	5. 3.50	5. 3.50	4. 3.50	4. 3.50	2. 3.50
HYDROGRAPH AT +	CA05i	.00	1	FLOW TIME	7. 3.50	7. 3.50	7. 3.50	6. 3.50	6. 3.50	6. 3.50	6. 3.50	3. 3.50
HYDROGRAPH AT +	CA05k	.01	1	FLOW TIME	16. 3.50	16. 3.50	16. 3.50	15. 3.50	15. 3.50	15. 3.50	15. 3.50	8. 3.50
4 COMBINED AT +	CCA05k	.09	1	FLOW TIME	77. 3.58	75. 3.58	73. 3.58	70. 3.58	69. 3.58	69. 3.58	68. 3.58	36. 3.58
HYDROGRAPH AT +	CA05g	.01	1	FLOW TIME	12. 3.50	11. 3.50	11. 3.50	11. 3.50	11. 3.50	10. 3.50	10. 3.50	5. 3.50
HYDROGRAPH AT +	CA05j	.00	1	FLOW TIME	9. 3.50	9. 3.50	8. 3.50	8. 3.50	8. 3.50	8. 3.50	8. 3.50	4. 3.50
HYDROGRAPH AT +	CA05p	.01	1	FLOW TIME	8. 3.58	8. 3.58	8. 3.58	8. 3.58	8. 3.58	8. 3.58	7. 3.58	4. 3.58
3 COMBINED AT +	CCA05p	.02	1	FLOW TIME	28. 3.50	27. 3.50	26. 3.50	25. 3.50	25. 3.50	25. 3.50	25. 3.50	13. 3.50
HYDROGRAPH AT +	DRA05e	.00	1	FLOW TIME	52. 3.58	51. 3.58	49. 3.58	47. 3.58	47. 3.58	46. 3.58	46. 3.58	24. 3.58
HYDROGRAPH AT +	DRA05f	.00	1	FLOW TIME	7. 3.58	7. 3.58	7. 3.58	7. 3.58	6. 3.58	6. 3.58	6. 3.58	3. 3.58
3 COMBINED AT +	CCA05-3	.02	1	FLOW TIME	86. 3.58	84. 3.58	81. 3.58	79. 3.58	77. 3.58	77. 3.58	76. 3.58	40. 3.58
DIVERSION TO +	DTA05-3	.02	1	FLOW TIME	79. 3.58	77. 3.58	75. 3.58	72. 3.58	71. 3.58	71. 3.58	70. 3.58	37. 3.58
HYDROGRAPH AT +	DTCCA053	.02	1	FLOW TIME	7. 3.58	7. 3.58	7. 3.58	6. 3.58	6. 3.58	6. 3.58	6. 3.58	3. 3.58
2 COMBINED AT +	CCA05-2	.11	1	FLOW TIME	84. 3.58	82. 3.58	79. 3.58	77. 3.58	75. 3.58	75. 3.58	74. 3.58	39. 3.58
2 COMBINED AT +	CCA05-2a	.86	1	FLOW TIME	514. 3.58	502. 3.67	500. 3.67	498. 3.67	497. 3.67	496. 3.67	496. 3.67	340. 3.92
HYDROGRAPH AT +	CHAR	.04	1	FLOW TIME	43. 3.42	43. 3.42	43. 3.42	43. 3.42	43. 3.42	43. 3.42	43. 3.42	43. 3.42
ROUTED TO +	RCHAR	.04	1	FLOW TIME	44. 3.67	44. 3.67	44. 3.67	44. 3.67	44. 3.67	44. 3.67	44. 3.67	44. 3.67
HYDROGRAPH AT +	CH70-C	.14	1	FLOW TIME	165. 3.75	162. 3.75	156. 3.75	151. 3.75	149. 3.75	148. 3.75	147. 3.75	79. 3.75
2 COMBINED AT +	CCHAR	.17	1	FLOW TIME	206. 3.67	203. 3.67	198. 3.67	192. 3.67	190. 3.67	189. 3.67	188. 3.67	121. 3.67
ROUTED TO +	RCCHAR	.17	1	FLOW TIME	205. 3.75	202. 3.75	197. 3.75	192. 3.75	190. 3.75	188. 3.75	187. 3.75	120. 3.75
HYDROGRAPH AT +	CA05m	.00	1	FLOW TIME	8. 3.58	8. 3.58	7. 3.58	7. 3.58	7. 3.58	7. 3.58	7. 3.58	4. 3.58
2 COMBINED AT +	CCA05n	.18	1	FLOW TIME	210. 3.75	206. 3.75	201. 3.75	196. 3.75	194. 3.75	192. 3.75	191. 3.75	122. 3.75
ROUTED TO +	RCCA05m	.18	1	FLOW TIME	208. 3.75	205. 3.75	199. 3.75	194. 3.75	192. 3.75	191. 3.75	190. 3.75	121. 3.75
2 COMBINED AT +	CCA05-4	1.04	1	FLOW	699.	695.	688.	681.	678.	676.	674.	450.

				TIME	3.67	3.67	3.75	3.75	3.75	3.75	3.75	3.83
HYDROGRAPH AT												
+	CA05n	.00	1	FLOW TIME	6.3.50	6.3.50	6.3.50	6.3.50	6.3.50	6.3.50	6.3.50	3.3.50
HYDROGRAPH AT												
+	CA05q	.01	1	FLOW TIME	12.3.67	11.3.67	11.3.67	10.3.67	10.3.67	10.3.67	10.3.67	4.3.67
2 COMBINED AT												
+	CCA05q	.02	1	FLOW TIME	17.3.58	17.3.58	16.3.58	16.3.58	15.3.58	15.3.58	15.3.58	6.3.58
2 COMBINED AT												
+	CCA05	1.06	1	FLOW TIME	715.3.67	710.3.67	702.3.67	694.3.67	692.3.67	689.3.67	687.3.67	454.3.83
ROUTED TO												
+	RCCA05	1.06	1	FLOW TIME	713.3.75	708.3.75	701.3.75	693.3.75	690.3.75	688.3.75	686.3.75	449.3.92
HYDROGRAPH AT												
+	CA06-C	.41	1	FLOW TIME	255.3.92	248.3.92	237.3.92	226.3.92	222.3.92	219.3.92	217.3.92	83.4.00
HYDROGRAPH AT												
+	CH59-C	.21	1	FLOW TIME	246.3.75	242.3.75	234.3.75	227.3.75	224.3.75	222.3.75	221.3.75	124.3.83
DIVERSION TO												
+	DFLAM	.21	1	FLOW TIME	102.3.75	98.3.75	90.3.75	83.3.75	80.3.75	78.3.75	77.3.75	0.00
HYDROGRAPH AT												
+	DCH58-C	.21	1	FLOW TIME	144.3.58	144.3.58	144.3.58	144.3.58	144.3.58	144.3.58	144.3.58	124.3.83
ROUTED TO												
+	RDCH58	.21	1	FLOW TIME	149.3.67	147.3.67	147.3.75	148.3.75	148.3.75	148.3.75	148.3.75	125.3.92
HYDROGRAPH AT												
+	CH58-C	.13	1	FLOW TIME	156.3.75	153.3.75	149.3.75	144.3.75	142.3.75	141.3.75	140.3.75	77.3.75
2 COMBINED AT												
+	CCH58-C	.34	1	FLOW TIME	302.3.75	299.3.75	295.3.75	292.3.75	290.3.75	289.3.75	288.3.75	194.3.83
DIVERSION TO												
+	DBN03	.34	1	FLOW TIME	135.3.75	132.3.75	128.3.75	125.3.75	123.3.75	122.3.75	121.3.75	27.3.83
HYDROGRAPH AT												
+	DDCH59-C	.34	1	FLOW TIME	167.3.50	167.3.50	167.3.50	167.3.58	167.3.58	167.3.58	167.3.58	167.3.75
DIVERSION TO												
+	DBN03a	.34	1	FLOW TIME	167.3.50	167.3.50	167.3.50	167.3.58	167.3.58	167.3.58	167.3.58	167.3.75
HYDROGRAPH AT												
+	DDCH59	.34	1	FLOW TIME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGRAPH AT												
+	BN06-C	.34	1	FLOW TIME	420.3.58	411.3.58	396.3.58	382.3.58	376.3.58	371.3.58	368.3.58	179.3.67
HYDROGRAPH AT												
+	BN03-C	.54	1	FLOW TIME	496.3.75	485.3.75	466.3.75	448.3.75	440.3.75	435.3.75	431.3.75	197.3.83
HYDROGRAPH AT												
+	DBN03	.00	1	FLOW TIME	135.3.75	132.3.75	128.3.75	125.3.75	123.3.75	122.3.75	121.3.75	27.3.83
ROUTED TO												
+	RDBN03	.00	1	FLOW TIME	139.3.92	144.3.92	148.3.83	119.3.92	121.3.92	122.3.92	123.3.92	27.4.08
3 COMBINED AT												
+	CBN03	.88	1	FLOW TIME	868.3.67	862.3.83	873.3.83	817.3.83	807.3.83	798.3.83	790.3.83	353.3.75
ROUTED TO												
+	RCBN03	.88	1	FLOW TIME	861.3.83	853.3.83	852.3.83	803.3.83	794.3.83	783.3.83	778.3.83	353.3.75
HYDROGRAPH AT												
+	BN08	.21	1	FLOW TIME	220.3.83	216.3.83	209.3.83	202.3.83	199.3.83	197.3.83	196.3.83	103.3.83
2 COMBINED AT												

+	CBN08	1.09	1	FLOW TIME	1082. 3.83	1069. 3.83	1061. 3.83	1005. 3.83	994. 3.83	980. 3.83	974. 3.83	453. 3.75
ROUTED TO												
+	RCEB08	1.09	1	FLOW TIME	1080. 3.83	1065. 3.83	1050. 3.83	998. 3.83	987. 3.83	974. 3.83	966. 3.83	445. 3.75
HYDROGRAPH AT												
+	BN09	.23	1	FLOW TIME	167. 3.83	163. 3.83	156. 3.83	149. 3.83	146. 3.83	144. 3.83	143. 3.83	59. 3.92
2 COMBINED AT												
+	CBN09	1.32	1	FLOW TIME	1247. 3.83	1228. 3.83	1206. 3.83	1147. 3.83	1133. 3.83	1118. 3.83	1109. 3.83	499. 3.83
DIVERSION TO												
+	DBN09a	1.32	1	FLOW TIME	1045. 3.83	1026. 3.83	1004. 3.83	945. 3.83	931. 3.83	916. 3.83	907. 3.83	297. 3.83
HYDROGRAPH AT												
+	DBN09	1.32	1	FLOW TIME	202. 3.33	202. 3.33	202. 3.33	202. 3.42	202. 3.42	202. 3.42	202. 3.42	202. 3.50
2 COMBINED AT												
+	CCBN09	1.66	1	FLOW TIME	202. 3.33	202. 3.33	202. 3.33	202. 3.42	202. 3.42	202. 3.42	202. 3.42	202. 3.50
2 COMBINED AT												
+	CCA06-1	2.07	1	FLOW TIME	457. 3.92	450. 3.92	439. 3.92	428. 3.92	424. 3.92	421. 3.92	419. 3.92	285. 4.00
2 COMBINED AT												
+	CCA06	3.13	1	FLOW TIME	1138. 3.83	1128. 3.83	1110. 3.83	1092. 3.83	1085. 3.83	1080. 3.83	1077. 3.83	733. 3.92
ROUTED TO												
+	RCCA06	3.13	1	FLOW TIME	1136. 3.83	1126. 3.83	1108. 3.83	1090. 3.83	1083. 3.83	1078. 3.83	1075. 3.83	731. 3.92
HYDROGRAPH AT												
+	CA08	.07	1	FLOW TIME	71. 3.67	69. 3.67	66. 3.67	63. 3.67	62. 3.67	61. 3.67	61. 3.67	26. 3.75
2 COMBINED AT												
+	CCA08	3.20	1	FLOW TIME	1196. 3.83	1184. 3.83	1164. 3.83	1144. 3.83	1136. 3.83	1131. 3.83	1127. 3.83	750. 3.92
ROUTED TO												
+	RCCA08	3.20	1	FLOW TIME	1193. 3.83	1182. 3.83	1162. 3.83	1141. 3.83	1133. 3.83	1127. 3.83	1123. 3.83	745. 3.92
HYDROGRAPH AT												
+	CA09	.05	1	FLOW TIME	58. 3.67	57. 3.67	55. 3.67	53. 3.67	52. 3.67	52. 3.67	51. 3.67	25. 3.67
2 COMBINED AT												
+	CCA09	3.25	1	FLOW TIME	1237. 3.83	1224. 3.83	1202. 3.83	1181. 3.83	1172. 3.83	1166. 3.83	1162. 3.83	760. 3.92
ROUTED TO												
+	RCCA09	3.25	1	FLOW TIME	1234. 3.83	1221. 3.83	1199. 3.83	1177. 3.83	1167. 3.83	1161. 3.83	1157. 3.83	753. 3.92
HYDROGRAPH AT												
+	CA10	.03	1	FLOW TIME	44. 3.67	43. 3.67	42. 3.67	41. 3.67	40. 3.67	40. 3.67	39. 3.67	22. 3.67
2 COMBINED AT												
+	CCA10	3.28	1	FLOW TIME	1265. 3.83	1252. 3.83	1229. 3.83	1206. 3.83	1196. 3.83	1189. 3.83	1185. 3.83	765. 3.92
ROUTED TO												
+	RCCA10	3.28	1	FLOW TIME	1256. 3.83	1242. 3.83	1218. 3.83	1194. 3.83	1183. 3.83	1174. 3.83	1170. 3.83	760. 4.00
HYDROGRAPH AT												
+	CA11	.09	1	FLOW TIME	103. 3.75	101. 3.75	97. 3.75	94. 3.75	92. 3.75	91. 3.75	91. 3.75	46. 3.75
2 COMBINED AT												
+	CCA11	3.38	1	FLOW TIME	1349. 3.83	1333. 3.83	1306. 3.83	1279. 3.83	1266. 3.83	1257. 3.83	1253. 3.83	789. 4.00
ROUTED TO												
+	RCCA11	3.38	1	FLOW TIME	1339. 3.83	1323. 3.83	1295. 3.83	1266. 3.83	1254. 3.92	1246. 3.92	1242. 3.92	787. 4.00
HYDROGRAPH AT												
+	CA12	.06	1	FLOW TIME	86. 3.67	85. 3.67	82. 3.67	80. 3.67	79. 3.67	78. 3.67	77. 3.67	43. 3.67
2 COMBINED AT												
+	CCA12	3.44	1	FLOW TIME	1405. 3.83	1389. 3.83	1359. 3.83	1328. 3.83	1314. 3.83	1304. 3.83	1299. 3.83	809. 4.00

ROUTED TO												
+	RCCA12	3.44	1	FLOW TIME	1394. 3.83	1375. 3.83	1345. 3.83	1316. 3.92	1305. 3.92	1296. 3.92	1291. 3.92	806. 4.00
HYDROGRAPH AT												
+	CA13a	.06	1	FLOW TIME	95. 3.67	93. 3.67	91. 3.67	88. 3.67	87. 3.67	86. 3.67	86. 3.67	50. 3.67
2 COMBINED AT												
+	CCA13a	3.50	1	FLOW TIME	1467. 3.83	1447. 3.83	1415. 3.83	1381. 3.83	1364. 3.83	1354. 3.83	1350. 3.83	830. 4.00
HYDROGRAPH AT												
+	BN10-C	.26	1	FLOW TIME	232. 3.83	227. 3.83	219. 3.83	211. 3.83	208. 3.83	205. 3.83	204. 3.83	97. 3.83
HYDROGRAPH AT												
+	DBN09a	.00	1	FLOW TIME	1045. 3.83	1026. 3.83	1004. 3.83	945. 3.83	931. 3.83	916. 3.83	907. 3.83	297. 3.83
2 COMBINED AT												
+	CBN10-C	.26	1	FLOW TIME	1278. 3.83	1254. 3.83	1223. 3.83	1156. 3.83	1139. 3.83	1122. 3.83	1111. 3.83	394. 3.83
ROUTED TO												
+	RCBN10-C	.26	1	FLOW TIME	1267. 3.83	1241. 3.83	1200. 3.83	1141. 3.83	1116. 3.83	1105. 3.83	1089. 3.83	392. 3.83
HYDROGRAPH AT												
+	BN12-C	.32	1	FLOW TIME	278. 3.83	272. 3.83	262. 3.83	251. 3.83	247. 3.83	244. 3.83	242. 3.83	111. 3.83
2 COMBINED AT												
+	CBN12-C	.58	1	FLOW TIME	1545. 3.83	1513. 3.83	1462. 3.83	1392. 3.83	1363. 3.83	1349. 3.83	1331. 3.83	503. 3.83
ROUTED TO												
+	RCBN12-C	.58	1	FLOW TIME	1521. 3.92	1491. 3.92	1444. 3.92	1374. 3.92	1346. 3.92	1339. 3.92	1316. 3.92	498. 3.92
HYDROGRAPH AT												
+	BN15-C	.28	1	FLOW TIME	234. 3.83	229. 3.83	220. 3.83	211. 3.83	208. 3.83	205. 3.83	203. 3.83	92. 3.92
2 COMBINED AT												
+	CBN15-C	.86	1	FLOW TIME	1753. 3.83	1716. 3.92	1660. 3.92	1582. 3.92	1551. 3.92	1541. 3.92	1516. 3.92	589. 3.92
ROUTED TO												
+	RCBN15-C	.86	1	FLOW TIME	1750. 3.92	1715. 3.92	1658. 3.92	1580. 3.92	1549. 3.92	1538. 3.92	1513. 3.92	582. 3.92
2 COMBINED AT												
+	CCA13	4.37	1	FLOW TIME	3201. 3.83	3142. 3.83	3056. 3.92	2949. 3.92	2906. 3.92	2885. 3.92	2856. 3.92	1399. 3.92
ROUTED TO												
+	RCCA13	4.37	1	FLOW TIME	3190. 3.92	3135. 3.92	3051. 3.92	2939. 3.92	2895. 3.92	2872. 3.92	2849. 3.92	1388. 4.00
HYDROGRAPH AT												
+	CA14	.05	1	FLOW TIME	85. 3.67	83. 3.67	81. 3.67	79. 3.67	78. 3.67	77. 3.67	77. 3.67	47. 3.67
2 COMBINED AT												
+	CCA14	4.42	1	FLOW TIME	3238. 3.92	3182. 3.92	3096. 3.92	2983. 3.92	2939. 3.92	2916. 3.92	2892. 3.92	1408. 4.00
HYDROGRAPH AT												
+	DRDTA05	.00	1	FLOW TIME	79. 3.58	77. 3.58	75. 3.58	72. 3.58	71. 3.58	71. 3.58	70. 3.58	37. 3.58
HYDROGRAPH AT												
+	DRDSTEW	.00	1	FLOW TIME	321. 3.83	315. 3.83	284. 3.83	255. 3.83	252. 3.83	246. 3.83	244. 3.83	0. .00
2 COMBINED AT												
+	CSTEWBY	.00	1	FLOW TIME	364. 3.83	357. 3.83	325. 3.83	294. 3.83	290. 3.83	285. 3.83	283. 3.83	37. 3.58

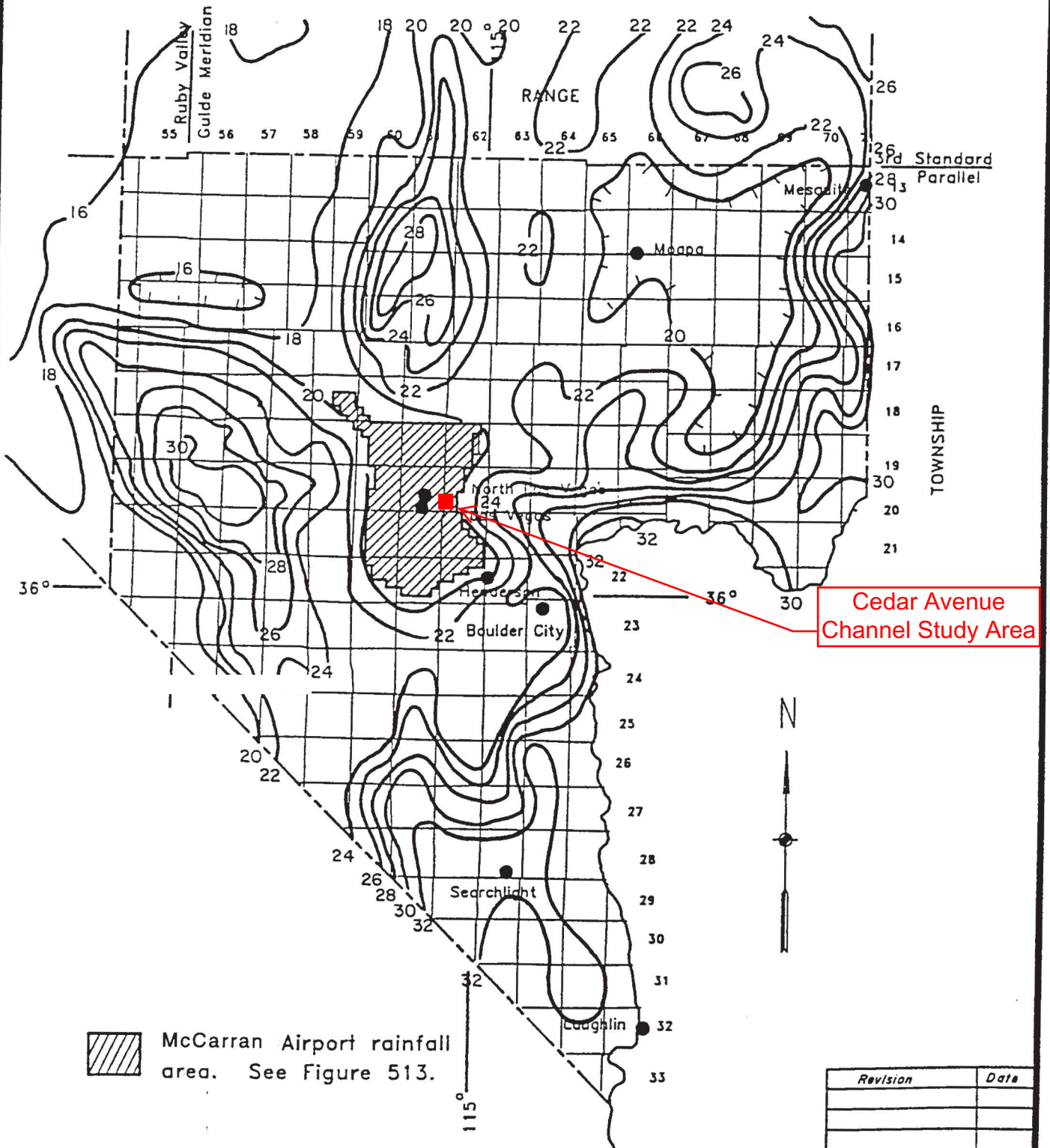
1

*** NORMAL END OF HEC-1 ***

Appendix A-4

CCRFCD Design Manual Tables

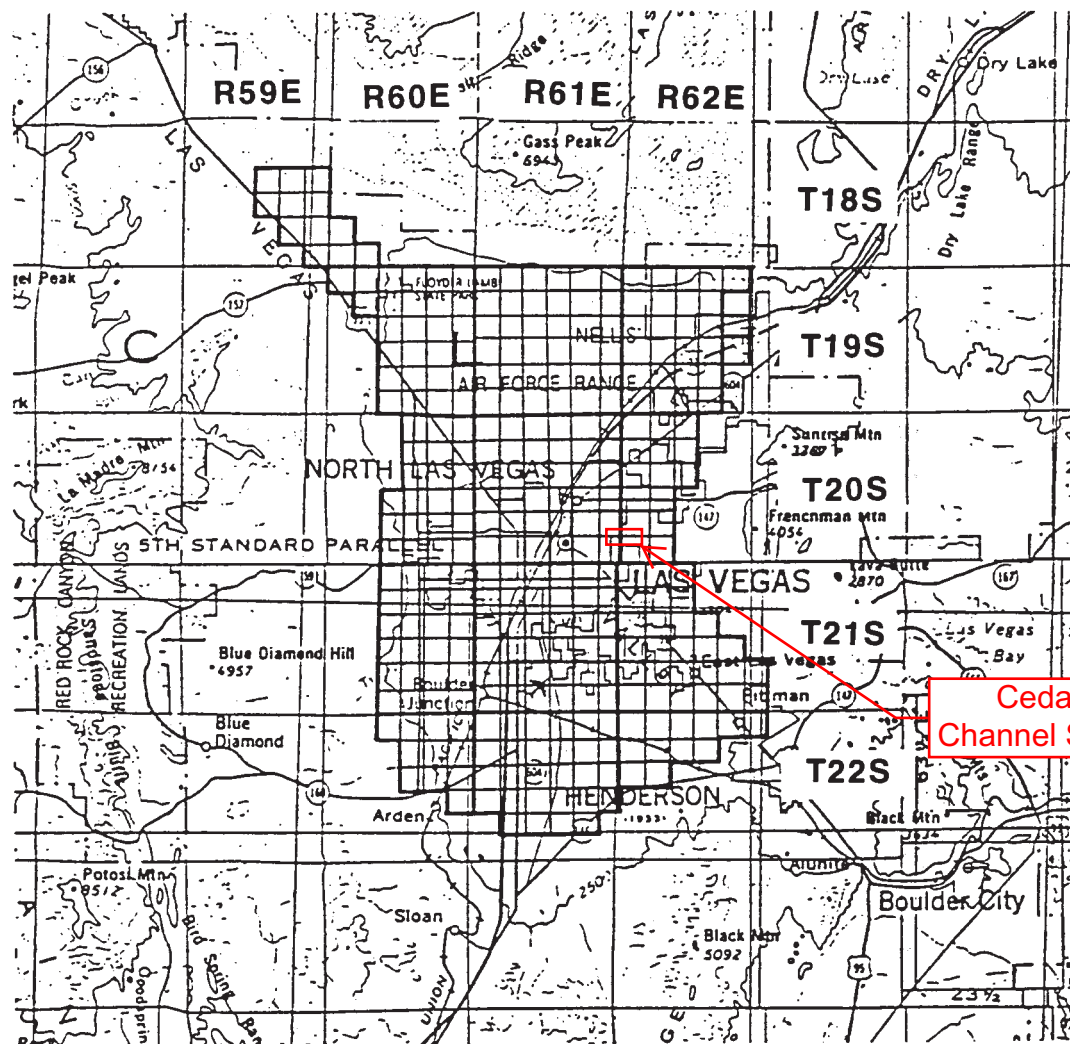
RAINFALL DEPTH-DURATION-FREQUENCY 100-YEAR, 6-HOUR (DEPTHS IN TENTHS OF INCHES)



Revision	Date

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

McCARRAN AIRPORT RAINFALL AREA



Cedar Avenue
Channel Study Area

TOWNSHIP RANGE SECTIONS

18 South	59 East	13-15, 22-26, 36
18 South	60 East	30-32
19 South	60 East	1-6, 8-16, 21-28, 33-36
19 South	61 East	ALL SECTIONS
19 South	62 East	2-11, 14-23, 27-34
20 South	60 East	1-3, 10-15, 21-28, 33-36
20 South	61 East	ALL SECTIONS

TOWNSHIP RANGE SECTIONS

20 South	62 East	4-9, 16-20, 29-32
21 South	60 East	1-4, 9-16, 21-28, 33-36
21 South	61 East	ALL SECTIONS
21 South	62 East	4-9, 15-23, 25-36
22 South	60 East	1-4, 10-15, 24
22 South	61 East	1-24, 26-29
22 South	62 East	1-10, 17-18

Notes:

1. Refer to Table 505 and Figure 516 Depth-Duration-Frequency values in the McCarran Airport Rainfall Area.
2. Refer to Table 506 and Figure 517 for Time-Intensity-Frequency values on the McCarran Airport Rainfall Area.

Revision	Date

WRC
ENGINEERING

REFERENCE:

USACE, Los Angeles District, 1988

FIGURE 513

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DEPTH-DURATION-FREQUENCY VALUES FOR McCARRAN AIRPORT RAINFALL AREA (IN INCHES)

TIME	RECURRENCE INTERVAL					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5 min.	0.15	0.27	0.35	0.46	0.54	0.63
10 min.	0.25	0.44	0.57	0.74	0.89	1.02
15 min.	0.33	0.57	0.74	0.97	1.15	1.32
30 min.	0.44	0.78	1.01	1.31	1.55	1.79
1 hour	0.52	0.89	1.15	1.50	1.78	2.06
2 hour	0.59	1.01	1.30	1.70	2.01	2.30
3 hour	0.64	1.08	1.39	1.82	2.15	2.48
6 hour	0.72	1.22	1.58	2.05	2.41	2.77
24 hour (TR-55)	1.20	1.60	1.80	2.40	2.70	2.96

- NOTE: 1. Refer to Figure 513 for a description and drawing of the area included in the McCarran Airport Rainfall Area.
2. The 24 hour values presented above are for use with TR-55 only.
3. Table 501 adjustments not required.

Revision	Date

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

SIX-HOUR STORM DISTRIBUTIONS

Percent of Total Storm Depth				Percent of Total Storm Depth			
Storm Time (In Minutes)	SDN3	SDN4	SDN5	Storm Time (In Minutes)	SDN3	SDN4	SDN5
0	0.0	0.0	0.0	185	32.2	37.6	43.0
5	2.0	2.0	2.0	190	35.2	41.5	47.7
10	5.7	5.8	5.9	195	40.9	46.2	51.4
15	7.0	7.5	8.0	200	49.9	53.0	56.1
20	8.7	9.9	11.0	205	59.0	61.0	63.0
25	10.8	12.6	14.4	210	71.0	71.0	71.0
30	12.4	13.7	15.0	215	74.4	73.2	72.0
35	13.0	14.5	16.0	220	78.1	75.6	73.1
40	13.0	14.9	16.8	225	81.2	78.2	75.2
45	13.0	15.1	17.1	230	81.9	79.9	77.9
50	13.0	15.5	18.0	235	83.5	81.3	79.0
55	13.0	15.6	18.2	240	85.1	82.3	79.5
60	13.0	15.9	18.7	245	85.6	83.0	80.4
65	13.3	16.2	19.0	250	86.0	83.5	81.0
70	14.0	16.9	19.7	255	86.8	84.4	82.0
75	14.2	17.2	20.2	260	87.6	85.1	82.6
80	14.8	17.9	21.0	265	88.8	86.4	84.0
85	15.8	18.9	22.0	270	91.0	88.5	85.9
90	17.2	20.1	23.0	275	92.6	90.8	88.9
95	18.1	21.1	24.1	280	93.7	92.4	91.0
100	19.0	22.0	25.0	285	95.0	94.4	93.8
105	19.7	22.8	25.9	290	97.0	96.8	96.6
110	19.9	23.2	26.5	295	97.6	97.3	97.0
115	20.0	24.0	28.0	300	98.2	97.8	97.4
120	20.1	24.6	29.0	305	98.5	98.2	97.9
125	20.4	25.2	30.0	310	98.7	98.4	98.1
130	21.4	26.0	30.5	315	98.9	98.6	98.3
135	22.9	26.9	30.9	320	99.0	98.8	98.5
140	24.1	27.6	31.0	325	99.3	99.1	98.9
145	24.9	28.3	31.7	330	99.3	99.2	99.0
150	25.1	28.6	32.1	335	99.4	99.3	99.2
155	25.6	29.2	32.7	340	99.5	99.4	99.3
160	27.0	30.2	33.3	345	99.8	99.7	99.6
165	27.8	31.2	34.6	350	99.8	99.8	99.7
170	28.1	32.1	36.1	355	99.9	99.9	99.9
175	28.3	33.2	38.1	360	100.0	100.0	100.0
180	29.5	35.2	40.8				

- Notes: 1. For drainage areas less than 8 square miles in size, use SDN 3.
 2. For drainage areas greater than or equal to 8 square miles and less than 12 square miles in size, use SDN 4.
 3. For drainage areas greater than or equal to 12 square miles, use SDN 5.
 4. A graphical representation of these values is presented on **Figure 515**.

Revision	Date

REFERENCE:

TABLE 503

SIX HOUR DEPTH-AREA REDUCTION FACTORS

<u>Drainage Area (Square Miles)</u>	<u>Six-Hour Depth-Area Reduction Factor</u>
0.0	1.00
0.5	0.98
1.0	0.97
2.0	0.93
4.0	0.91
6.0	0.90
8.0	0.88
10.0	0.86
20.0	0.79
30.0	0.74
50.0	0.68
100.0	0.60
150.0	0.55
200.0	0.51
300.0	0.46
400.0	0.42
500.0	0.39

NOTES: 1. A graphical representation of these factors is presented in Figure 514.

2. Consult with the local entity and/or the CCRFCD for guidance in using the Depth-Area Reduction Factors for drainage areas greater than 200 square miles.

<i>Revision</i>	<i>Date</i>

Hydrologic Parameters

Design Storm

The rainfall values used in the hydrologic model are intended to produce runoff discharges for 100-year recurrence interval events. The 100-year recurrence interval is defined as having a 1-percent chance of being equalled or exceeded in any given year. Storm duration of six hours was used in accordance with the Design Manual.

Precipitation Depths

All subbasins contributing runoff to the study area are within the McCarran Airport rainfall area as defined in the Design Manual. Therefore, the 100-year, 6-hour rainfall depth is 2.77 inches for all subbasins (see Figure 506, Figure 513, and Table 505 of the Design Manual in this Appendix).

Storm Distribution

The 100-year, 6-hour rainfall depth was distributed over the 6-hour design storm period using the SDN 3 storm distribution (see Table 503 of the Design Manual in this Appendix). According to established CCRFCD methodology, SDN 3 is used for drainage areas less than 8 square miles which is all combination points and subbasins in the Cedar Avenue Channel analysis.

Depth-Area Reduction Factors

The precipitation depths obtained for the McCarran Airport Rainfall Area from the Design Manual represent rainfall frequency at isolated points. Storms, however, cause rainfall to occur over widespread areas simultaneously, with the most intense rainfall typically occurring near the center of the storm. To account for the rainfall variation, standard precipitation analysis methods require adjusting point precipitation depths downward in order to better represent the average depth of rainfall over the entire storm area. This is done using depth-area reduction curves that relate point precipitation reduction factors to storm area and duration. The reduction factors cause the rainfall depth to decrease as the tributary area increases.

The six hour depth-area reduction factors (DARFs) from Table 502 in the Design Manual were applied to the rainfall depths in the HEC-1 models at each subbasin and concentration point based on upstream tributary area. Rather than interpolating precise reduction factors at every concentration point, an average DARF value was used for a range of tributary areas to be consistent with the 2008 MPU models and methodology. The DARF values applied to the model are shown below. The depth-area reduction factor table from the Design Manual is included in this Appendix.

Depth-Area Reduction Factors

Tributary Area (sq mi)	DARF
$0 \leq \text{Area} < 0.5$	0.99
$0.5 \leq \text{Area} < 1$	0.975
$1 \leq \text{Area} < 2$	0.95
$2 \leq \text{Area} < 3$	0.925
$3 \leq \text{Area} < 4$	0.915
$4 \leq \text{Area} < 5$	0.908

Land Use

Land use information was based on the land use data that was compiled for the 2008 MPU. The land use is based on the ultimate condition and assumes that the full “build out” condition has been reached and that available land within the watershed is fully developed. Minor updates and revisions were made to the land use data based on aerial imagery and coordination with the City to reflect changes that have occurred or to better represent actual land use conditions in the watershed.

The land use data consists of 13 categories of land use as defined in table below. Each category is defined by a specified percentage of impervious area, percentage of ground cover in good hydrologic condition, and percentage of desert shrub in poor hydrologic condition. Land use data was obtained in GIS format, with polygon areas delineated to represent specific land use categories in the study area. The land use data is shown in **Figure A-1**.

It should be noted that in the 2008 MPU, land use categories were adjusted to reflect restrictions on the amount of allowable grass landscaping per the Southern Nevada Water Authority drought ordinance. The drought ordinance requirements are only applied to certain areas as determined by CCRFCD. The Cedar Avenue Channel study area does not fall within the drought ordinance area, and therefore, the nine additional land use categories from the 2008 MPU representing the drought ordinance revision are not included in this analysis.

Land Use Categories

Land Use Index Number	Description - Typical Land Uses	Directly Connected Impervious (%)	Open Landscaped Good Condition (%)	Open Desert Shrub Poor Condition (%)
1	Undeveloped Land, Open Desert	0	0	100
2	Parks, Golf Courses	5	85	10
5	Medium Density Residential, 2-4 units per acre	29	71	0
6	High Density Residential, 4-8 units per acre	62	38	0
7	Public Facility and Residential, 8-12 units/acre	72	28	0
8	Very High Density Residential, 12 units/acre or more	85	15	0
9	Commercial, Retail, Casino, High Rise Condominiums	90	10	0
10	Light Industrial	70	15	15

Soils

Soils data for the Cedar Avenue Channel hydrologic analysis comes from the Soil Survey of the Las Vegas Valley Area by the National Conservation Resources Service (NRCS), dated July 1985. Soils data was obtained in GIS format for the study area, and the limits of each soil type are delineated in the GIS layer and assigned a soil map unit number. NRCS methodology divides soils into four hydrological groups, as defined below:

- A. High infiltration rate, low runoff potential

- B. Moderate infiltration rate, moderately low runoff potential
- C. Slow infiltration rate, moderately high runoff potential
- D. Very slow infiltration rate, high runoff potential

Each soil map unit number is made up of a certain percentage of hydrologic soil group A, B, C, and D. Curve number calculations for each of the subbasins were based on the individual breakdown of each soil type into the percentages of the minor hydrologic soil group components (A, B, C, or D). Detailed soils data and the soil boundaries are shown on **Figure A-2**.

Curve Numbers

Rainfall losses due to soil infiltration, depression storage, and other factors are computed using the NRCS curve number (CN) method described in the Design Manual. The curve number method is a function of soil type, land cover, and antecedent moisture condition. Based on the Design Manual, the average antecedent moisture condition (AMC II) is used for computing losses. Curve number information was compiled using GIS polygon processing of subbasin delineations, soil map unit delineations, and land use layers. To calculate a curve number for a given subbasin, the following procedure was used:

1. Base curve numbers are taken from the CCRFCD Design Manual for the three assumed land cover conditions (directly connected impervious area, open landscaped area in good condition, open desert shrub in poor condition) for each of the four Hydrologic Soil Groups. In addition, a curve number of 90 is assumed for rock outcrop, and directly connected impervious is assumed to have a curve number of 98 for all soil types.
2. A curve number matrix is compiled to calculate a base curve number for a given combination of soil map unit and land use type.
3. The land use, soils, and subbasin polygons were overlaid in GIS to subdivide each subbasin into polygons (subareas) of unique land use and soil type combinations.
4. The curve number matrix is then used to assign a curve number for each subarea, and an area-weighted composite curve number is calculated for the whole subbasin based on the areas of the subdivided polygons and their associated curve numbers. The curve number and total area of each subbasin is then used in the hydrologic models input files.

Supporting information for the curve number calculations (including the curve number matrix) is included in this Appendix.

Lag Time

All subbasins within the Cedar Avenue Channel watershed are less than 0.5 square miles. The time of concentration for subbasins of this size was computed with the time of concentration equation (velocity method) from the Design Manual. This method is explained below. Note that initial length (overland flow) was set to 100 feet for all subbasins to represent urbanized drainage patterns and to be consistent with the 2008 MPU.

The lag time is related to the time of concentration by the following empirical relationship:

$$T_{lag} = 0.6T_c$$

Where:

$$\begin{aligned} T_{lag} &= \text{Lag Time} \\ T_c &= \text{Time of concentration} \end{aligned}$$

The time of concentration is calculated as follows:

$$T_c = T_i + T_t$$

Where:

$$\begin{aligned} T_c &= \text{Time of concentration} \\ T_i &= \text{Initial, inlet, or overland flow time} \\ T_t &= \text{Travel time in the ditch, gutter, etc.} \end{aligned}$$

Initial flow time is calculated as follows:

$$T_i = 1.8(1.1 - K)L_o^{1/2}/S^{1/3}$$

Where:

$$\begin{aligned} T_i &= \text{Initial overland flow time (minutes)} \\ K &= 0.0132 * CN - 0.39 \\ CN &= \text{Curve number} \\ L_o &= \text{Length of overland flow (ft, maximum 500 feet)} \\ S &= \text{Average basin slope (percent)} \end{aligned}$$

Travel time is calculated as follows:

$$T_t = 500/(60 V_1) + (L_t - 500)/(60 V_2)$$

Where:

$$\begin{aligned} T_t &= \text{Travel time in the ditch, gutter, etc. (minutes)} \\ L_t &= \text{Travel length (feet)} \\ V_1 &= \text{Average velocity of flow for the first 500 feet of travel distance (feet/second)} \\ V_2 &= \text{Average velocity of flow for the remaining travel distance (feet/second)} \end{aligned}$$

V_1 and V_2 are calculated as follows:

$$\begin{aligned} V_1 &= C_1 * (S/100)^{1/2} \\ V_2 &= C_2 * (S/100)^{1/2} \end{aligned}$$

Where:

$$C_1 = 20.2 \text{ for developed areas and } 14.8 \text{ for undeveloped areas}$$

$$\begin{aligned}
 C2 &= 30.6 \text{ for developed areas and } 29.4 \text{ for undeveloped areas} \\
 S &= \text{Average slope for the flow path (percent)}
 \end{aligned}$$

In urbanized areas, the time of concentration calculated above should not exceed the time of concentration calculated by the following equation:

$$T_c = (L / 180) + 10$$

Where:

$$\begin{aligned}
 T_c &= \text{Time of concentration at the first design point in an urban watershed (minutes)} \\
 L &= \text{Watershed length (feet)}
 \end{aligned}$$

The smaller of the two calculations for time of concentration controls minimum T_c for any watershed and should not be less than 5 minutes. Standard Form 4 from the Design Manual was used to compute lag times and is included in this Appendix.

Routing

In this study all routings in the model were through streets or storm drains, and therefore, only Muskingum-Cunge method for floodwave routing was used in the HEC-1 model to be consistent with the 2008 MPU. Muskingum-Cunge routing requires the following input parameters: roughness coefficient, base width, side-slope, slope, and reach length.

LAS VEGAS WASH CENTRAL
Cedar Avenue Channel

PERVIOUS AREA CURVE NUMBERS

CONDITION 1: -----> DESERT SHRUB POOR HYDROLOGIC CONDITION

CONDITION 2: -----> LANDSCAPED, LAWNS, TREES, GOOD HYDROLOGIC CONDITION

CN VALUES

CONDITION	HYDROLOGIC SOIL GROUP				
	A	B	C	D	ROCK
1 ----->	63	77	85	88	90
2 ----->	39	61	74	80	90

						CONDITION	CONDITION
MAP	HYDROLOGIC SOIL GROUP					1	2
UNIT	%A	%B	%C	%D	%ROCK	CN	CN
200	3	88	9	0	0	77	62
270	0	100	0	0	0	77	61
282	0	10	90	0	0	84	73
325	5	90	0	5	0	77	61
326	0	100	0	0	0	77	61
341	0	0	100	0	0	85	74
615	0	0	100	0	0	85	74

LAS VEGAS WASH CENTRAL
Cedar Avenue Channel

Curve Number Matrix												
MAP #	COMPONENTS			LAND USE CLASSIFICATION INDEX NUMBER								
	OPEN	OPEN	% IMP	1	2	5	6	7	8	9	10	12
	DESERT	GOOD										
	% --->			100	10	0	0	0	0	0	15	0
		% --->		0	85	71	38	28	15	10	15	50
			% --->	0	5	29	62	72	85	90	70	50
	CN	CN	CN	SOIL TYPE COMPOSITE CN FOR LAND USE TYPE								
200	77	62	98	77.0	65.0	72.0	84.0	88.0	93.0	94.0	89.0	80.0
270	77	61	98	77.0	64.0	72.0	84.0	88.0	92.0	94.0	89.0	80.0
282	84	73	98	84.0	75.0	80.0	89.0	91.0	94.0	96.0	92.0	86.0
325	77	61	98	77.0	64.0	72.0	84.0	88.0	92.0	94.0	89.0	80.0
326	77	61	98	77.0	64.0	72.0	84.0	88.0	92.0	94.0	89.0	80.0
341	85	74	98	85.0	76.0	81.0	89.0	91.0	94.0	96.0	92.0	86.0
615	85	74	98	85.0	76.0	81.0	89.0	91.0	94.0	96.0	92.0	86.0

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL

CN Calculation Summary

LAND USE INDEX NUMBER	LAND USE DESCRIPTION	SOIL MAP UNIT #	SUBREGION CN	SUBREGION AREA (SQ FT)	SUBBASIN AREA (SQ FT)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	1401035	2651085	52.8%	52.8%	44.39	44.39	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	615	89	11703	2651085	0.4%	53.3%	0.39	44.78	
7	Public Facility and Residential, 8-12 units/acre	270	88	448715	2651085	16.9%	70.2%	14.89	59.68	
7	Public Facility and Residential, 8-12 units/acre	615	91	42035	2651085	1.6%	71.8%	1.44	61.12	
8	Very High Density Residential, 12 units/acre or more	270	92	191074	2651085	7.2%	79.0%	6.63	67.75	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	125038	2651085	4.7%	83.7%	4.43	72.19	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	431485	2651085	16.3%	100.0%	15.62	87.81	87.8
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	1026874	2206782	46.5%	46.5%	39.09	39.09	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	615	89	7656	2206782	0.3%	46.9%	0.31	39.40	
7	Public Facility and Residential, 8-12 units/acre	270	88	581794	2206782	26.4%	73.2%	23.20	62.60	
7	Public Facility and Residential, 8-12 units/acre	615	91	87076	2206782	3.9%	77.2%	3.59	66.19	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	209423	2206782	9.5%	86.7%	8.92	75.11	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	293959	2206782	13.3%	100.0%	12.79	87.90	87.9
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	359884	605203	59.5%	59.5%	49.95	49.95	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	615	89	7569	605203	1.3%	60.7%	1.11	51.06	
7	Public Facility and Residential, 8-12 units/acre	270	88	17295	605203	2.9%	63.6%	2.51	53.58	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	198962	605203	32.9%	96.4%	30.90	84.48	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	21493	605203	3.6%	100.0%	3.41	87.89	87.9
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	1098617	1266640	86.7%	86.7%	72.86	72.86	
7	Public Facility and Residential, 8-12 units/acre	270	88	11123	1266640	0.9%	87.6%	0.77	73.63	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	156900	1266640	12.4%	100.0%	11.64	85.27	85.3
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	340883	1095013	31.1%	31.1%	26.15	26.15	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	84704	1095013	7.7%	38.9%	6.88	33.03	
7	Public Facility and Residential, 8-12 units/acre	270	88	424871	1095013	38.8%	77.7%	34.14	67.18	
7	Public Facility and Residential, 8-12 units/acre	282	91	243620	1095013	22.2%	99.9%	20.25	87.42	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	934	1095013	0.1%	100.0%	0.08	87.50	87.5
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	149	1669105	0.0%	0.0%	0.01	0.01	
7	Public Facility and Residential, 8-12 units/acre	270	88	1610638	1669105	96.5%	96.5%	84.92	84.92	
7	Public Facility and Residential, 8-12 units/acre	282	91	23313	1669105	1.4%	97.9%	1.27	86.20	
8	Very High Density Residential, 12 units/acre or more	270	92	19243	1669105	1.2%	99.1%	1.06	87.26	
8	Very High Density Residential, 12 units/acre or more	282	94	15762	1669105	0.9%	100.0%	0.89	88.14	88.1
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	5801	873595	0.7%	0.7%	0.56	0.56	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	5092	873595	0.6%	1.2%	0.52	1.08	
7	Public Facility and Residential, 8-12 units/acre	270	88	93711	873595	10.7%	12.0%	9.44	10.52	
7	Public Facility and Residential, 8-12 units/acre	282	91	737858	873595	84.5%	96.4%	76.86	87.38	
8	Very High Density Residential, 12 units/acre or more	282	94	31133	873595	3.6%	100.0%	3.35	90.73	90.7
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	129415	1458124	8.9%	8.9%	7.46	7.46	
7	Public Facility and Residential, 8-12 units/acre	270	88	564058	1458124	38.7%	47.6%	34.04	41.50	
7	Public Facility and Residential, 8-12 units/acre	615	91	35216	1458124	2.4%	50.0%	2.20	43.69	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	379303	1458124	26.0%	76.0%	24.45	68.15	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	350132	1458124	24.0%	100.0%	23.05	91.20	91.2

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL

CN Calculation Summary

LAND USE INDEX NUMBER	LAND USE DESCRIPTION	SOIL MAP UNIT #	SUBREGION CN	SUBREGION AREA (SQ FT)	SUBBASIN AREA (SQ FT)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	883487	5294449	16.7%	16.7%	14.02	14.02	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	615	89	21346	5294449	0.4%	17.1%	0.36	14.38	
7	Public Facility and Residential, 8-12 units/acre	270	88	662010	5294449	12.5%	29.6%	11.00	25.38	
7	Public Facility and Residential, 8-12 units/acre	282	91	126488	5294449	2.4%	32.0%	2.17	27.55	
7	Public Facility and Residential, 8-12 units/acre	325	88	310298	5294449	5.9%	37.8%	5.16	32.71	
7	Public Facility and Residential, 8-12 units/acre	615	91	58612	5294449	1.1%	39.0%	1.01	33.72	
8	Very High Density Residential, 12 units/acre or more	270	92	844166	5294449	15.9%	54.9%	14.67	48.39	
8	Very High Density Residential, 12 units/acre or more	282	94	298373	5294449	5.6%	60.5%	5.30	53.68	
8	Very High Density Residential, 12 units/acre or more	325	92	55083	5294449	1.0%	61.6%	0.96	54.64	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	858166	5294449	16.2%	77.8%	15.24	69.88	
9	Commercial, Retail, Casino, High Rise Condominiums	325	94	75017	5294449	1.4%	79.2%	1.33	71.21	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	80339	5294449	1.5%	80.7%	1.46	72.67	
10	Light Industrial	270	89	18407	5294449	0.3%	81.1%	0.31	72.98	
10	Light Industrial	282	92	215939	5294449	4.1%	85.1%	3.75	76.73	
10	Light Industrial	325	89	786716	5294449	14.9%	100.0%	13.22	89.95	90.0
7	Public Facility and Residential, 8-12 units/acre	282	91	554550	1290284	43.0%	43.0%	39.11	39.11	
8	Very High Density Residential, 12 units/acre or more	282	94	6609	1290284	0.5%	43.5%	0.48	39.59	
10	Light Industrial	282	92	729125	1290284	56.5%	100.0%	51.99	91.58	91.6
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	228689	1452065	15.7%	15.7%	13.23	13.23	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	615	89	107532	1452065	7.4%	23.2%	6.59	19.82	
7	Public Facility and Residential, 8-12 units/acre	270	88	13797	1452065	1.0%	24.1%	0.84	20.66	
7	Public Facility and Residential, 8-12 units/acre	615	91	317347	1452065	21.9%	46.0%	19.89	40.54	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	1588	1452065	0.1%	46.1%	0.10	40.65	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	783112	1452065	53.9%	100.0%	51.77	92.42	92.4
7	Public Facility and Residential, 8-12 units/acre	282	91	995364	995364	100.0%	100.0%	91.00	91.00	91.00
7	Public Facility and Residential, 8-12 units/acre	282	91	197771	1381174	14.3%	14.3%	13.03	13.03	
10	Light Industrial	282	92	1183403	1381174	85.7%	100.0%	78.83	91.86	91.9
7	Public Facility and Residential, 8-12 units/acre	282	91	95114	642952	14.8%	14.8%	13.46	13.46	
10	Light Industrial	282	92	547786	642952	85.2%	100.0%	78.38	91.84	
10	Light Industrial	325	89	52	642952	0.0%	100.0%	0.01	91.85	91.9
7	Public Facility and Residential, 8-12 units/acre	282	91	129453	1206589	10.7%	10.7%	9.76	9.76	
7	Public Facility and Residential, 8-12 units/acre	325	88	14783	1206589	1.2%	12.0%	1.08	10.84	
10	Light Industrial	282	92	931143	1206589	77.2%	89.1%	71.00	81.84	
10	Light Industrial	325	89	131210	1206589	10.9%	100.0%	9.68	91.52	91.5
7	Public Facility and Residential, 8-12 units/acre	282	91	177	83379	0.2%	0.2%	0.19	0.19	
10	Light Industrial	282	92	83202	83379	99.8%	100.0%	91.80	92.00	92.0
7	Public Facility and Residential, 8-12 units/acre	282	91	1122	238847	0.5%	0.5%	0.43	0.43	
10	Light Industrial	282	92	237725	238847	99.5%	100.0%	91.57	92.00	92.0
7	Public Facility and Residential, 8-12 units/acre	282	91	805	199861	0.4%	0.4%	0.37	0.37	
10	Light Industrial	282	92	199056	199861	99.6%	100.0%	91.63	92.00	92.0

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL

CN Calculation Summary

LAND USE INDEX NUMBER	LAND USE DESCRIPTION	SOIL MAP UNIT #	SUBREGION CN	SUBREGION AREA (SQ FT)	SUBBASIN AREA (SQ FT)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
10	Light Industrial	282	92	83909	83909	100.0%	100.0%	92.00	92.00	92.0
7	Public Facility and Residential, 8-12 units/acre	282	91	581	98074	0.6%	0.6%	0.54	0.54	
10	Light Industrial	282	92	97493	98074	99.4%	100.0%	91.46	91.99	92.0
7	Public Facility and Residential, 8-12 units/acre	282	91	3036	131463	2.3%	2.3%	2.10	2.10	
10	Light Industrial	282	92	128427	131463	97.7%	100.0%	89.88	91.98	92.0
7	Public Facility and Residential, 8-12 units/acre	282	91	14198	278126	5.1%	5.1%	4.65	4.65	
10	Light Industrial	282	92	263927	278126	94.9%	100.0%	87.30	91.95	91.9
7	Public Facility and Residential, 8-12 units/acre	282	91	123082	147734	83.3%	83.3%	75.81	75.81	
8	Very High Density Residential, 12 units/acre or more	282	94	24637	147734	16.7%	100.0%	15.68	91.49	
10	Light Industrial	282	92	15	147734	0.0%	100.0%	0.01	91.50	91.5
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	26896	98113	27.4%	27.4%	24.40	24.40	
7	Public Facility and Residential, 8-12 units/acre	282	91	40038	98113	40.8%	68.2%	37.14	61.53	
8	Very High Density Residential, 12 units/acre or more	282	94	31179	98113	31.8%	100.0%	29.87	91.41	91.4
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	6607	165859	4.0%	4.0%	3.55	3.55	
7	Public Facility and Residential, 8-12 units/acre	282	91	148182	165859	89.3%	93.3%	81.30	84.85	
8	Very High Density Residential, 12 units/acre or more	282	94	11070	165859	6.7%	100.0%	6.27	91.12	91.1
2	Parks, Golf Courses	282	75	362597	680958	53.2%	53.2%	39.94	39.94	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	29	680958	0.0%	53.3%	0.00	39.94	
7	Public Facility and Residential, 8-12 units/acre	282	91	318331	680958	46.7%	100.0%	42.54	82.48	82.5
2	Parks, Golf Courses	282	75	3906784	11023434	35.4%	35.4%	26.58	26.58	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	270	84	268927	11023434	2.4%	37.9%	2.05	28.63	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	90200	11023434	0.8%	38.7%	0.73	29.36	
7	Public Facility and Residential, 8-12 units/acre	270	88	1621882	11023434	14.7%	53.4%	12.95	42.31	
7	Public Facility and Residential, 8-12 units/acre	282	91	1439354	11023434	13.1%	66.5%	11.88	54.19	
8	Very High Density Residential, 12 units/acre or more	270	92	1784633	11023434	16.2%	82.7%	14.89	69.08	
8	Very High Density Residential, 12 units/acre or more	282	94	990757	11023434	9.0%	91.6%	8.45	77.53	
9	Commercial, Retail, Casino, High Rise Condominiums	270	94	820957	11023434	7.4%	99.1%	7.00	84.53	
9	Commercial, Retail, Casino, High Rise Condominiums	282	96	99941	11023434	0.9%	100.0%	0.87	85.40	85.4
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	632998	2023089	31.3%	31.3%	27.85	27.85	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	341	89	243973	2023089	12.1%	43.3%	10.73	38.58	
7	Public Facility and Residential, 8-12 units/acre	282	91	265594	2023089	13.1%	56.5%	11.95	50.53	
7	Public Facility and Residential, 8-12 units/acre	341	91	494869	2023089	24.5%	80.9%	22.26	72.79	
8	Very High Density Residential, 12 units/acre or more	282	94	194379	2023089	9.6%	90.5%	9.03	81.82	
9	Commercial, Retail, Casino, High Rise Condominiums	282	96	187523	2023089	9.3%	99.8%	8.90	90.72	
12	Schools	341	86	3752	2023089	0.2%	100.0%	0.16	90.88	90.9
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	69502	1343561	5.2%	5.2%	4.60	4.60	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	341	89	284548	1343561	21.2%	26.4%	18.85	23.45	
7	Public Facility and Residential, 8-12 units/acre	282	91	140990	1343561	10.5%	36.8%	9.55	33.00	
7	Public Facility and Residential, 8-12 units/acre	341	91	88523	1343561	6.6%	43.4%	6.00	39.00	
12	Schools	282	86	455375	1343561	33.9%	77.3%	29.15	68.15	
12	Schools	341	86	304623	1343561	22.7%	100.0%	19.50	87.64	87.6

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL

CN Calculation Summary

LAND USE INDEX NUMBER	LAND USE DESCRIPTION	SOIL MAP UNIT #	SUBREGION CN	SUBREGION AREA (SQ FT)	SUBBASIN AREA (SQ FT)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	665843	901919	73.8%	73.8%	65.70	65.70	
7	Public Facility and Residential, 8-12 units/acre	282	91	235656	901919	26.1%	100.0%	23.78	89.48	
9	Commercial, Retail, Casino, High Rise Condominiums	282	96	420	901919	0.0%	100.0%	0.04	89.53	89.5
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	413258	2562276	16.1%	16.1%	14.35	14.35	
7	Public Facility and Residential, 8-12 units/acre	282	91	157109	2562276	6.1%	22.3%	5.58	19.93	
8	Very High Density Residential, 12 units/acre or more	282	94	413586	2562276	16.1%	38.4%	15.17	35.11	
9	Commercial, Retail, Casino, High Rise Condominiums	282	96	1578323	2562276	61.6%	100.0%	59.13	94.24	94.2
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	396478	1736783	22.8%	22.8%	20.32	20.32	
7	Public Facility and Residential, 8-12 units/acre	282	91	326946	1736783	18.8%	41.7%	17.13	37.45	
8	Very High Density Residential, 12 units/acre or more	282	94	536473	1736783	30.9%	72.5%	29.04	66.48	
9	Commercial, Retail, Casino, High Rise Condominiums	282	96	476886	1736783	27.5%	100.0%	26.36	92.84	92.8
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	859672	1822470	47.2%	47.2%	41.98	41.98	
7	Public Facility and Residential, 8-12 units/acre	282	91	826266	1822470	45.3%	92.5%	41.26	83.24	
9	Commercial, Retail, Casino, High Rise Condominiums	282	96	136531	1822470	7.5%	100.0%	7.19	90.43	90.4
1	Undeveloped Land, Open Desert	200	77	121689	1542930	7.9%	7.9%	6.07	6.07	
1	Undeveloped Land, Open Desert	282	84	27562	1542930	1.8%	9.7%	1.50	7.57	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	200	84	347890	1542930	22.5%	32.2%	18.94	26.51	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	700972	1542930	45.4%	77.7%	40.43	66.95	
7	Public Facility and Residential, 8-12 units/acre	200	88	110372	1542930	7.2%	84.8%	6.29	73.24	
7	Public Facility and Residential, 8-12 units/acre	282	91	234444	1542930	15.2%	100.0%	13.83	87.07	87.1
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	282	89	497604	3814154	13.0%	13.0%	11.61	11.61	
6	High Density Residential, 4-8 units/acre (uses 6 units/acre)	615	89	15002	3814154	0.4%	13.4%	0.35	11.96	
7	Public Facility and Residential, 8-12 units/acre	282	91	241707	3814154	6.3%	19.8%	5.77	17.73	
7	Public Facility and Residential, 8-12 units/acre	325	88	557610	3814154	14.6%	34.4%	12.87	30.59	
7	Public Facility and Residential, 8-12 units/acre	615	91	125282	3814154	3.3%	37.7%	2.99	33.58	
8	Very High Density Residential, 12 units/acre or more	282	94	699248	3814154	18.3%	56.0%	17.23	50.82	
9	Commercial, Retail, Casino, High Rise Condominiums	325	94	653160	3814154	17.1%	73.1%	16.10	66.91	
9	Commercial, Retail, Casino, High Rise Condominiums	615	96	1023306	3814154	26.8%	100.0%	25.76	92.67	
10	Light Industrial	282	92	1235	3814154	0.0%	100.0%	0.03	92.70	92.7

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL																			
TIME OF CONCENTRATION																			
PBS&J File: FORM4.XLS						Las Vegas Wash Central Cedar Avenue Channel						BY: BR DATE: 3/24/14				Ultimate Condition			
SUB-BASIN DATA						INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)						Tc	Tc Check	Tag	REMARKS	
DESIG: (1)	DEV./EX. (D or E)	CN	K (2)	AREA Ac (3)	AREA MI ²	INITIAL LENGTH Feet (4)	SLOPE % (5)	Ti Min (6)	TRAVEL LENGTH Feet (7)	SLOPE % (8)	V1 VELOCITY FPS (9a)	V2 VELOCITY FPS (9b)	Tt Min (10)	Min (13)	Min (14)	Tag= 0.6Tc/60 Hours	RAINFALL Q ₁₀₀ Inches		
CA03a	D	87.8	0.7691	60.86	0.095	100	1.0	6.0	5010	2.7	3.3	5.0	17.4	23.4	38.4	0.234	2.77		
CA03b	D	87.9	0.7702	50.66	0.079	100	1.0	5.9	4000	1.4	2.4	3.6	19.8	25.7	32.8	0.257	2.77		
CA03c	D	87.9	0.7702	13.89	0.022	100	1.0	5.9	5000	2.6	3.2	4.9	17.9	23.8	38.3	0.238	2.77		
CA03d	D	85.3	0.7356	29.08	0.045	100	1.0	6.6	4220	3.0	3.5	5.3	14.0	20.6	34.0	0.206	2.77		
CA04a	D	87.5	0.7651	25.14	0.039	100	1.0	6.0	2930	1.1	2.1	3.2	16.4	22.4	26.8	0.224	2.77		
CA04b	D	88.1	0.7735	38.32	0.060	100	1.0	5.9	2360	1.0	2.0	3.0	14.4	20.3	23.7	0.203	2.77		
CA04c	D	90.7	0.8076	20.06	0.031	100	1.0	5.3	2460	1.0	2.0	3.1	14.7	19.9	24.2	0.199	2.77		
CA04d	D	91.2	0.8138	33.47	0.052	100	1.0	5.2	2640	1.3	2.3	3.5	13.9	19.1	25.2	0.191	2.77		
CA04e	D	90.0	0.7974	121.54	0.190	100	1.0	5.4	5100	1.0	2.0	3.0	29.5	34.9	38.9	0.349	2.77		
CA04f	D	91.6	0.8189	29.62	0.046	100	1.0	5.1	2160	0.7	1.7	2.6	15.8	20.9	22.6	0.209	2.77		
CA04g	D	92.4	0.8300	33.34	0.052	100	1.0	4.9	3030	2.8	3.4	5.1	10.7	15.6	27.4	0.156	2.77		
CA05a	D	91.0	0.8112	22.85	0.036	100	1.0	5.2	2450	0.8	1.8	2.8	16.3	21.5	24.2	0.215	2.77		
CA05b	D	91.9	0.8225	31.71	0.050	100	1.0	5.0	2870	0.9	1.9	2.9	18.3	23.2	26.5	0.232	2.77		
CA05c	D	91.9	0.8224	14.76	0.023	100	1.0	5.0	1380	0.9	1.9	2.9	9.6	14.6	18.2	0.146	2.77		
CA05d	D	91.5	0.8180	27.70	0.043	100	1.0	5.1	2440	0.9	2.0	3.0	15.1	20.2	24.1	0.202	2.77		
CA05e	D	92.0	0.8244	1.91	0.003	100	1.0	5.0	760	1.1	2.1	3.1	5.4	10.4	14.8	0.104	2.77		
CA05f	D	92.0	0.8243	5.48	0.009	100	1.0	5.0	1130	1.1	2.1	3.2	7.3	12.3	16.8	0.123	2.77		
CA05g	D	92.0	0.8243	4.59	0.007	100	1.0	5.0	690	1.0	2.0	3.1	5.1	10.1	14.4	0.101	2.77		
CA05h	D	92.0	0.8244	1.93	0.003	100	1.0	5.0	650	0.9	1.9	2.9	5.1	10.1	14.2	0.101	2.77		
CA05i	D	92.0	0.8243	2.25	0.004	100	1.0	5.0	520	1.0	2.0	3.0	4.3	9.3	13.4	0.093	2.77		
CA05j	D	92.0	0.8241	3.02	0.005	100	1.0	5.0	540	1.7	2.6	4.0	3.4	8.3	13.6	0.083	2.77		
CA05k	D	91.9	0.8237	6.38	0.010	100	1.0	5.0	961	1.5	2.4	3.7	5.5	10.5	15.9	0.105	2.77		
CA05m	D	91.5	0.8178	3.39	0.005	100	1.0	5.1	1240	1.0	2.0	3.0	8.3	13.4	17.4	0.134	2.77		
CA05n	D	91.4	0.8165	2.25	0.004	100	1.0	5.1	690	0.9	1.9	2.9	5.5	10.6	14.4	0.106	2.77		
CA05p	D	91.1	0.8128	3.81	0.006	100	1.0	5.2	1630	0.6	1.6	2.4	13.1	18.3	19.6	0.183	2.77		
CA05q	D	82.5	0.6987	15.63	0.024	100	1.0	7.2	2380	1.0	2.0	3.1	14.3	21.5	23.8	0.215	2.77		
CA06-C	D	82.5	0.6987	253.06	0.395	100	1.0	7.2	6470	0.6	1.6	2.4	46.0	53.3	46.5	0.465	2.77		
CA08	D	85.4	0.7373	46.44	0.073	100	1.0	6.5	2750	0.6	1.5	2.3	21.5	28.0	25.8	0.258	2.77		
CA09	D	89.6	0.7923	30.84	0.048	100	1.0	5.5	2150	0.6	1.5	2.3	17.6	23.1	22.5	0.225	2.77		
CA10	D	93.0	0.8379	20.71	0.032	100	1.0	4.7	2080	0.5	1.4	2.1	18.4	23.1	22.1	0.221	2.77		
CA11	D	90.2	0.8013	58.82	0.092	100	1.0	5.4	3280	0.5	1.4	2.1	28.5	33.9	28.8	0.288	2.77		
CA12	D	94.1	0.8515	39.87	0.062	100	1.0	4.5	2510	0.4	1.3	2.0	22.8	27.2	24.5	0.245	2.77		
CA13	D	95.9	0.8753	41.84	0.065	100	1.0	4.0	2545	0.5	1.4	2.2	21.4	25.4	24.7	0.247	2.77		
CA14	D	97.7	0.8990	35.42	0.055	100	1.0	3.6	2290	0.5	1.4	2.1	20.0	23.6	23.3	0.233	2.77		
CH70-C	D	92.7	0.8336	87.56	0.137	100	1.0	4.8	4300	0.9	1.9	3.0	25.7	30.5	34.4	0.305	2.77		

$T_c = T_i + T_t$ $T_{tag} = 0.6 T_c$
 $T_i = 1.8 (1.1 - K) L^{1/2} / S^{1/3}$
 $K = 0.0132 (CN) - 0.39$
 $T_c \text{ Check} = L/180 + 10$

For the travel time (Tt) calculations,
 V1 applies to the first 500 feet of travel distance;
 V2 applies to the remaining travel distance.

Existing $V1 = 14.8 \cdot (S/100)^{1/2}$ Developed $V1 = 20.2 \cdot (S/100)^{1/2}$
 Existing $V2 = 29.4 \cdot (S/100)^{1/2}$ Developed $V2 = 30.6 \cdot (S/100)^{1/2}$

REFERENCE :	STANDARD FORM 4
-------------	-----------------

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL

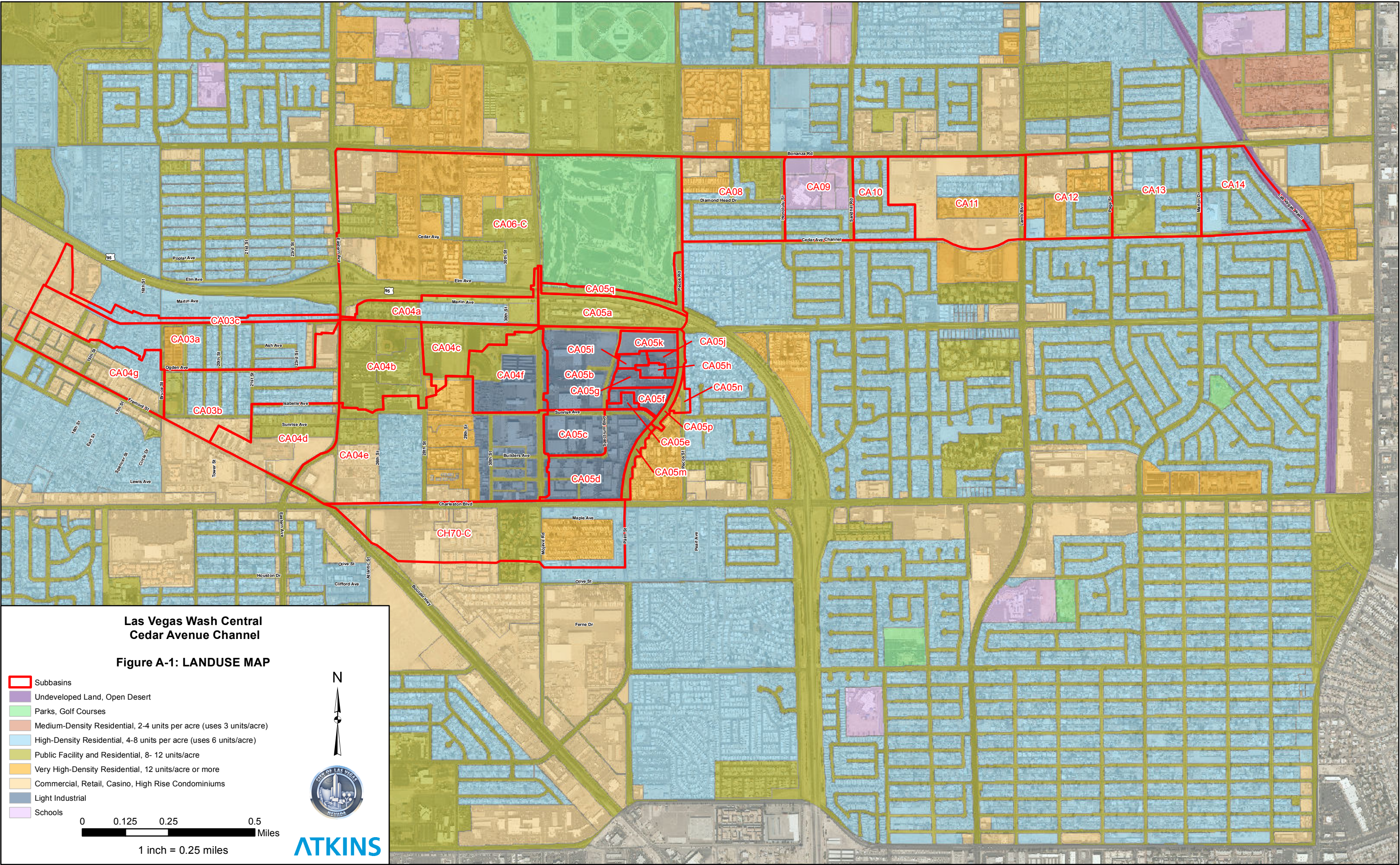
Muskingum-Cunge Routing Summary

Ultimate Model

Reach ID	Length (ft)	Slope (ft/ft)	Manning's n	Shape	Bottom Width (ft)	Side Slope (H:V, X:1)
RCCA04b	1780	0.00955	0.016	TRAP	50	0
RCA04g	3500	0.0140	0.016	TRAP	50	0
RCA04d	3050	0.01148	0.016	TRAP	50	0
RCCA04e	1360	0.00368	0.016	TRAP	50	0
RCCA04	2130	0.00892	0.016	TRAP	50	0
RCA05c	750	0.00933	0.016	TRAP	50	0
RCCA05f	820	0.00732	0.013	CIRC	3	-
RCHAR	4600	0.0098	0.016	TRAP	50	0
RCCHAR	1250	0.0096	0.013	CIRC	5.5	-
RCCA05m	1580	0.00633	0.013	CIRC	5.5	-
RCCA05	1310	0.0050	0.013	TRAP	14	-
RCCA06	1545	0.0026	0.015	TRAP	10	1.5
RCCA08	1050	0.0026	0.015	TRAP	10	1.5
RCCA09	935	0.002	0.015	TRAP	12	1.5
RCCA10	1730	0.0020	0.015	TRAP	12	1.5
RCCA11	1340	0.0038	0.015	TRAP	10	1.5
RCCA12	1365	0.0037	0.015	TRAP	10	1.5
RCCA13	1680	0.002	0.015	TRAP	14	1.5

Appendix A-6

Land Use Map and Soils Map



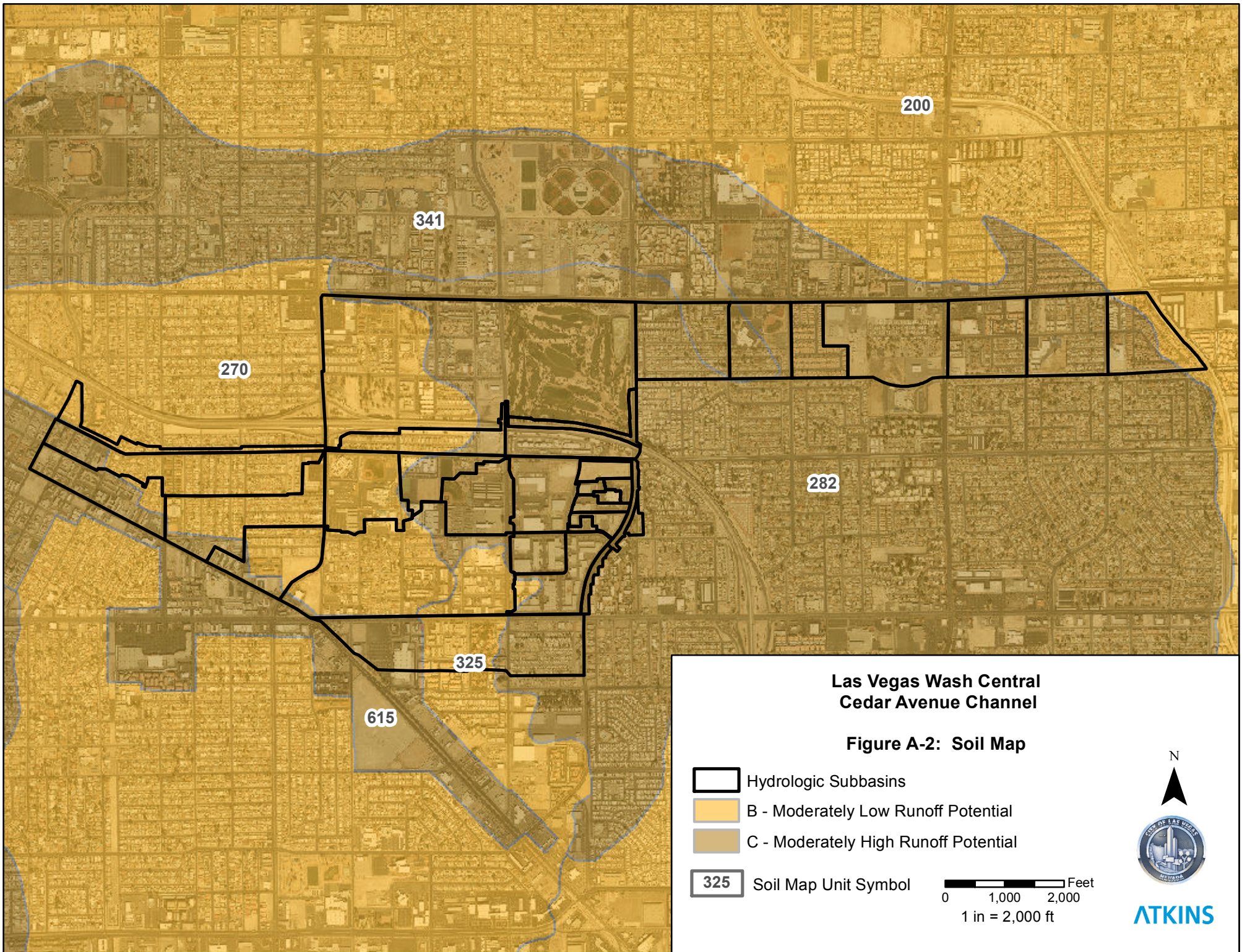
**Las Vegas Wash Central
Cedar Avenue Channel**

Figure A-1: LANDUSE MAP

- Subbasins
- Undeveloped Land, Open Desert
- Parks, Golf Courses
- Medium-Density Residential, 2-4 units per acre (uses 3 units/acre)
- High-Density Residential, 4-8 units per acre (uses 6 units/acre)
- Public Facility and Residential, 8- 12 units/acre
- Very High-Density Residential, 12 units/acre or more
- Commercial, Retail, Casino, High Rise Condominiums
- Light Industrial
- Schools

0 0.125 0.25 0.5 Miles
1 inch = 0.25 miles





Appendix B

Hydraulic Analysis

- Appendix B-1: WSPG Model
- Appendix B-2: HEC-RAS Model
- Appendix B-3: Channel Freeboard Analysis

Appendix B-1

WSPG Model

[TITLE]

[REPORT]
COMPOSITE_ONLY

[NETWORK]
**TYPE NAME
**-----
Outlet "Node13"
Reach "Link12"
Reach "Link11"
Reach "Link10"
Reach "Link14"
Transition "Link9"
Reach "Link31"
Junction "Node32"
Reach "Link8"
Join "Node8"
Reach "Link7"
Transition "Link6"
Reach "Link5"
Reach "Link4"
Transition "Link3"
Join "Node3"
Reach "Link2"
Reach "Link1"
Join "Node1"
Reach "Link15"
WallExit "Node16"
Reach "Link26"
Reach "Link18"
Junction "Node19"
Reach "Link22"
Junction "Node23"
Reach "Link24"
Headwork "Node25"

**BRANCH DEFINITIONS

"Node1_Branch1"
Join "Node1"
Reach "Link19"
Reach "Link28"
Junction "Node29"
Reach "Link27"
Headwork "Node28"

"Node3_Branch1"
Join "Node3"
Reach "Link20"
Reach "Link30"
Junction "Node31"
Reach "Link29"
Headwork "Node30"

"Node8_Branch1"
Join "Node8"
Reach "Link25"
Headwork "Node26"

[OUTLET]
**NAME STATION INVERT GROUND CHANNEL WATER SURFACE
** ELEV ELEV ID ELEV (opt.)
**-----
"Node13" -3125.16 1777.39 1787 "12X6" 1781.57

[HEADWORK]
**NAME INVERT GROUND CHANNEL FLOW WATER SURFACE
** ELEV ELEV ID ELEV (opt.)
**-----
"Node25" 1788.35 1794.5 "7X3" 100 0
"Node26" 1787.11 1792.5 "8X4" 186 0
"Node28" 1788.19 1793.7 "7X3" 82 0
"Node30" 1788.08 1793.5 "5X3" 55 0

[WALLENTANCE]
**NAME INVERT GROUND CHANNEL LOSS
** ELEV ELEV ID COEFFICIENT (opt.)
**-----

[WALLEXIT]
**NAME INVERT GROUND CHANNEL LOSS
** ELEV ELEV ID COEFFICIENT (opt.)
**-----

"Node16" 1787.78 1795 "8X4" 0

[BRIDGEENTRANCE]

**NAME INVERT GROUND CHANNEL REDUCTION
** ELEV ELEV ID FACTOR(opt.)
**-----

[BRIDGEEXIT]

**NAME INVERT GROUND CHANNEL REDUCTION
** ELEV ELEV ID FACTOR(opt.)
**-----

[JOIN]

**NAME INVERT GROUND CHANNEL LENGTH MANNINGS n NUMBER OF CONFLUENCE
** ELEV ELEV ID ID BRANCHES ANGLE
**-----

"Node1"	1787.61	1795	"18X4"	0	0	1	
"Node1_Branch1"	1787.61		"8X4"				30
"Node3"	1787.47	1795.5	"18X4"	0	0	1	
"Node3_Branch1"	1787.47		"7X3"				30
"Node8"	1786.56	1793	"18X4"	0	0	1	
"Node8_Branch1"	1786.54		"8X4"				30

[JUNCTION]

**Name INVERT GROUND CHANNEL LENGTH MANNINGS n NUMBER OF CONFLUENCE FLOW
** ELEV ELEV ID ID LATERALS ANGLE
**-----

"Node19"	1787.93	1794	"7X3"	4	0.015	1		
"Node19_Lateral1"	1787.98		"8X4"				0	100
"Node23"	1787.97	1794	"7X3"	2	0.015	1		
"Node23_Lateral1"	1788.5		"24"				90	19
"Node29"	1787.76	1793.7	"7X3"	4	0	1		
"Node29_Lateral1"	1787.76		"8X4"				0	82
"Node31"	1787.65	1793.5	"5X3"	4	0.015	1		
"Node31_Lateral1"	1787.65		"7X3"				0	64
"Node32"	1785.32	1793	"18X4"	10	0.015	1		
"Node32_Lateral1"	1785.32		"24"				90	14

[TRANSITION]

**NAME INVERT GROUND CHANNEL LENGTH MANNINGS n
** ELEV ELEV ID ID
**-----

"Link3"	1787.43	1795	"18X4"	2	0.015
"Link6"	1787.18	1793	"2:8X4"	10.69	0.015
"Link9"	1785.02	1793.5	"18X4"	30	0.015

[REACH]

**NAME INVERT GROUND CHANNEL LENGTH MANNINGS n CURVE ANGLE NUMBER
** ELEV ELEV ID ID (opt) POINT(opt) MANHOLES(opt)
**-----

"Link1"	1787.57	1795	"18X4"	8.55	0.015	0	0	0
"Link2"	1787.53	1795.5	"18X4"	21	0.015	0	0	0
"Link4"	1787.42	1795	"2:8X4"	39.55	0.015	0	0	0
"Link5"	1787.27	1793	"2:8X4"	22.17	0.015	0	0	0
"Link7"	1787.14	1793	"18X4"	11.31	0.015	0	0	0
"Link8"	1786.04	1793	"18X4"	143.99	0.015	0	0	0
"Link10"	1782.54	1790	"12X6"	623.14	0.015	0	0	0
"Link11"	1780.04	1797	"12X6"	176.4	0.015	0	0	0
"Link12"	1779.34	1794	"12X6"	487.18	0.015	0	0	0
"Link14"	1783.37	1793.5	"12X6"	208	0.015	0	0	0
"Link15"	1787.78	1795	"18X4"	50	0.015	0	0	0
"Link18"	1787.91	1794	"8X4"	12.8	0.015	0	15	0
"Link19"	1787.68	1793.7	"8X4"	12.8	0.015	0	0	0
"Link20"	1787.54	1793.5	"7X3"	16.545	0.015	0	15	0
"Link22"	1787.96	1794	"7X3"	8	0.015	0	0	0
"Link24"	1788.35	1794.5	"7X3"	75.67	0.015	0	0	0
"Link25"	1787.11	1792.5	"8X4"	66.53	0.015	0	0	0
"Link26"	1787.84	1795	"8X4"	12.8	0.015	0	15	0
"Link27"	1788.19	1793.7	"7X3"	85.65	0.015	0	0	0
"Link28"	1787.74	1793.7	"8X4"	12.8	0.015	0	15	0
"Link29"	1788.08	1793.5	"5X3"	85.67	0.015	0	0	0
"Link30"	1787.63	1793.5	"7X3"	16.545	0.015	0	15	0
"Link31"	1785.27	1793	"18X4"	50	0.015	0	0	0

[CHANNEL]

**REGULAR TYPES 1-4

**ID TYPE HEIGHT WIDTH LEFT RIGHT NUMBER AVG PIER INVERT
** SLOPE SLOPE PIERS WIDTH CROSS FALL
**-----

"12X6"	3	6	12	0	0	0	0	0
"7X3"	3	3	7	0	0	0	0	0
"8X4"	3	4	8	0	0	0	0	0

"5X3"	3	3	5	0	0	0	0	0			
"18X4"	3	4	18	0	0	0	0	0			
"24"	4	2	2								
"2:8X4"	3	4	18	0	0	1	2	0			
**IRREGULAR TYPES 5-6											
**ID	TYPE NUMBER		AVG PIER	PIER1	PIER2	PIER3	PIER4	PIER5	PIER6	PIER7	PIER8
PIER9	PIER10										
**	PIERS		WIDTH	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
ELEV	ELEV										
**-----	-----		-----	-----	-----	-----	-----	-----	-----	-----	-----
-----	-----										

[POINT]		
**ID	XCOORD	YCOORD
**-----	-----	-----

Water Surface Profile Gradient (WSPG)
XP WSPG
Engine Version 1.3 06/09/2010
XP Software www.xpsoftware.com

INPUT FILE

X:\Projects\100039014_Cedar\Drainage\H&H\Hydraulics\WSPG\PDR\StormDrain.wsx
Computed 06/15/15 10:38:06

TITLE INFORMATION

WARNING SUMMARY

WARNING 47: Junction Node19 has a different channel than its direct downstream element.
WARNING 47: Junction Node29 has a different channel than its direct downstream element.
WARNING 49: Manning's n for open flow of element Node29 not in recommended range 0.01 - 0.06.
WARNING 47: Junction Node31 has a different channel than its direct downstream element.
WARNING 49: Manning's n for open flow of element Node1 not in recommended range 0.01 - 0.06.
WARNING 49: Manning's n for open flow of element Node3 not in recommended range 0.01 - 0.06.
WARNING 45: One of the elevations of junction's Node8 laterals is less than the U/S elevation.
WARNING 49: Manning's n for open flow of element Node8 not in recommended range 0.01 - 0.06.
WARNING 25: Link type element Link1 has different invert elevation than its upstream node.
WARNING 25: Link type element Link8 has different invert elevation than its upstream node.
WARNING 25: Link type element Link18 has different invert elevation than its upstream node.
WARNING 25: Link type element Link22 has different invert elevation than its upstream node.
WARNING 25: Link type element Link28 has different invert elevation than its upstream node.
WARNING 25: Link type element Link30 has different invert elevation than its upstream node.
WARNING 25: Link type element Link31 has different invert elevation than its upstream node.
WARNING 25: Link type element Link3 has different invert elevation than its upstream node.
WARNING 36: D/S processing stopped in junction Node23 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node19 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node1 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node3 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node8 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node32 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node29 because critical momentum is greater than maximum momentum.
WARNING 36: D/S processing stopped in junction Node31 because critical momentum is greater than maximum momentum.

RESULTS

=====
Main Line
=====

Composite Profile:

ELEMENT NAME	TYPE	STATION	INVERT ELEV	GROUND ELEV	W.S. ELEV	DEPTH	Q	VELOC.	VELOC. HEAD	ENERGY GRADE LN	SUPER ELEV	CRITICAL DEPTH	FROUDE NUMBER	SLOPE	NORMAL DEPTH	CROSS SECTION
###																
"Node13"	Outlet	-3125.16	1777.39	1787.00	1782.128	4.738	702.00	12.35	2.37	1784.50	0.000	4.738	0.000	0.00000	0.000	Tr./Rect.closed
	"i.p."	-3097.69	1777.50	1787.11	1782.339	4.839	702.00	12.09	2.27	1784.61	0.000	4.738	0.968	0.00400	4.839	Tr./Rect.closed
"Link12"	Reach	-2637.98	1779.34	1794.00	1784.179	4.839	702.00	12.09	2.27	1786.45	0.000	4.738	0.968	0.00400	4.839	Tr./Rect.closed
	"i.p."	-2569.13	1779.61	1794.27	1784.468	4.854	702.00	12.05	2.26	1786.72	0.000	4.738	0.964	0.00397	4.854	Tr./Rect.closed
"Link11"	Reach	-2461.58	1780.04	1797.00	1784.894	4.854	702.00	12.05	2.26	1787.15	0.000	4.738	0.964	0.00397	4.854	Tr./Rect.closed
	"i.p."	-2409.46	1780.25	1797.21	1785.084	4.835	702.00	12.10	2.27	1787.36	0.000	4.738	0.970	0.00401	4.835	Tr./Rect.closed
"Link10"	Reach	-1838.44	1782.54	1790.00	1787.375	4.835	702.00	12.10	2.27	1789.65	0.000	4.738	0.970	0.00401	4.835	Tr./Rect.closed
	"i.p."	-1767.79	1782.82	1790.28	1787.666	4.845	702.00	12.08	2.26	1789.93	0.000	4.738	0.967	0.00399	4.845	Tr./Rect.closed
"Link14"	Reach	-1630.44	1783.37	1793.50	1788.215	4.845	702.00	12.08	2.26	1790.48	0.000	4.738	0.967	0.00399	4.845	Tr./Rect.closed
"Link9"	Transition	-1600.44	1785.02	1793.50	1789.206	4.186	702.00	9.78	1.49	1790.69	0.000	3.616	0.864	0.05500	0.000	Tr./Rect.closed
"Link31"	Reach	-1550.44	1785.27	1793.00	1789.460	4.190	702.00	9.78	1.49	1790.95	0.000	3.616	0.864	0.00500	3.160	Tr./Rect.closed
"Node32"	Junction	-1540.44	1785.32	1793.00	1789.628	4.308	688.00	9.59	1.43	1791.06	0.000	3.567	0.000	0.00500	0.000	Tr./Rect.closed

"Link8"	Reach	-1396.45	1786.04	1793.00	1790.330	4.290	688.00	9.59	1.43	1791.76	0.000	3.567	0.846	0.00500	3.117	Tr./Rect.closed
"Node8"	Join	-1396.45	1786.56	1793.00	1791.257	4.697	502.00	7.00	0.76	1792.02	0.000	2.891	0.000	0.00000	0.000	Tr./Rect.closed
"Link7"	Reach	-1385.14	1787.14	1793.00	1791.287	4.147	502.00	7.00	0.76	1792.05	0.000	2.891	0.618	0.05128	1.198	Tr./Rect.closed
"Link6"	Transition	-1374.45	1787.18	1793.00	1791.144	3.964	502.00	7.92	0.97	1792.12	0.000	3.127	0.701	0.00374	0.000	Tr./Rect.closed
"Link5"	Reach	-1352.28	1787.27	1793.00	1791.169	3.899	502.00	8.05	1.01	1792.17	0.000	3.127	0.718	0.00406	3.336	Tr./Rect.closed
"Link4"	Reach	-1312.73	1787.42	1795.00	1791.230	3.810	502.00	8.23	1.05	1792.28	0.000	3.127	0.743	0.00379	3.420	Tr./Rect.closed
"Link3"	Transition	-1310.73	1787.43	1795.00	1791.558	4.128	502.00	7.00	0.76	1792.32	0.000	2.891	0.618	0.00500	0.000	Tr./Rect.closed
"Node3"	Join	-1310.73	1787.47	1795.50	1791.937	4.467	383.00	5.34	0.44	1792.38	0.000	2.414	0.000	0.00000	0.000	Tr./Rect.closed
"Link2"	Reach	-1289.73	1787.53	1795.50	1791.969	4.439	383.00	5.34	0.44	1792.41	0.000	2.414	0.471	0.00286	2.545	Tr./Rect.closed
"Link1"	Reach	-1281.18	1787.57	1795.00	1791.982	4.412	383.00	5.34	0.44	1792.42	0.000	2.414	0.471	0.00468	2.166	Tr./Rect.closed
"Node1"	Join	-1281.18	1787.61	1795.00	1792.260	4.650	219.00	3.05	0.14	1792.40	0.000	1.663	0.000	0.00000	0.000	Tr./Rect.closed
"Link15"	Reach	-1231.18	1787.78	1795.00	1792.285	4.505	219.00	3.05	0.14	1792.43	0.000	1.663	0.269	0.00340	1.674	Tr./Rect.closed
"Node16"	WallExt	-1231.18	1787.78	1795.00	1792.285	4.505	219.00	6.90	0.74	1793.02	0.000	2.856	0.000	0.00000	0.000	Tr./Rect.closed
"Link26"	Reach	-1218.38	1787.84	1795.00	1792.364	4.524	219.00	6.90	0.74	1793.10	0.000	2.856	0.610	0.00469	2.867	Tr./Rect.closed
"Link18"	Reach	-1205.58	1787.91	1794.00	1792.443	4.533	219.00	6.90	0.74	1793.18	0.000	2.856	0.610	0.00547	2.713	Tr./Rect.closed
"Node19"	Junction	-1201.58	1787.93	1794.00	1793.063	5.133	119.00	5.73	0.51	1793.57	0.000	2.078	0.000	0.00500	0.000	Tr./Rect.closed
"Link22"	Reach	-1193.58	1787.96	1794.00	1793.089	5.129	119.00	5.73	0.51	1793.60	0.000	2.078	0.587	0.00375	2.266	Tr./Rect.closed
"Node23"	Junction	-1191.58	1787.97	1794.00	1793.395	5.425	100.00	4.82	0.36	1793.76	0.000	1.851	0.000	0.00500	0.000	Tr./Rect.closed
"Link24"	Reach	-1115.91	1788.35	1794.50	1793.565	5.215	100.00	4.82	0.36	1793.93	0.000	1.851	0.493	0.00502	1.809	Tr./Rect.closed
"Node25"	Headwrk	-1115.91	1788.35	1794.50	1793.565	5.215	100.00	4.82	0.36	1793.93	0.000	1.851	0.000	0.00000	0.000	Tr./Rect.closed

*) in the W.S.ELEV column indicates flooding, it is set whenever W.S.ELEV > GROUND ELEV
i.p. = intermediate point processing results for reaches

=====

Node1_Branch1

=====

Composite Profile:

ELEMENT NAME	TYPE	STATION	INVERT ELEV	GROUND ELEV	W.S. ELEV	DEPTH	Q	VELOC.	VELOC. HEAD	ENERGY GRADE LN	SUPER ELEV	CRITICAL DEPTH	FROUDE NUMBER	SLOPE	NORMAL DEPTH	CROSS SECTION
###																
"Outlet/N"	Outlet	-1281.18	1787.61	1795.00	1792.141	4.531	164.00	5.17	0.41	1792.56	0.000	2.355	0.000	0.00000	0.000	Tr./Rect.closed
"Link19"	Reach	-1268.38	1787.68	1793.70	1792.165	4.485	164.00	5.17	0.41	1792.58	0.000	2.355	0.457	0.00547	2.211	Tr./Rect.closed
"Link28"	Reach	-1255.58	1787.74	1793.70	1792.209	4.469	164.00	5.17	0.41	1792.62	0.000	2.355	0.457	0.00469	2.334	Tr./Rect.closed
"Node29"	Junction	-1251.58	1787.76	1793.70	1792.578	4.818	82.00	3.95	0.24	1792.82	0.000	1.621	0.000	0.00500	0.000	Tr./Rect.closed
"Link27"	Reach	-1165.93	1788.19	1793.70	1792.707	4.517	82.00	3.95	0.24	1792.95	0.000	1.621	0.404	0.00502	1.578	Tr./Rect.closed
"Node28"	Headwrk	-1165.93	1788.19	1793.70	1792.707	4.517	82.00	3.95	0.24	1792.95	0.000	1.621	0.000	0.00000	0.000	Tr./Rect.closed

*) in the W.S.ELEV column indicates flooding, it is set whenever W.S.ELEV > GROUND ELEV
i.p. = intermediate point processing results for reaches

=====

Node3_Branch1

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Composite Profile:

ELEMENT NAME	TYPE	STATION	INVERT ELEV	GROUND ELEV	W.S. ELEV	DEPTH	Q	VELOC.	VELOC. HEAD	ENERGY GRADE LN	SUPER ELEV	CRITICAL DEPTH	FROUDE NUMBER	SLOPE	NORMAL DEPTH	CROSS SECTION
###																
"Outlet/N"	Outlet	-1310.73	1787.47	1795.50	1791.767	4.297	119.00	5.73	0.51	1792.28	0.000	2.078	0.000	0.00000	0.000	Tr./Rect.closed
"Link20"	Reach	-1294.18	1787.54	1793.50	1791.846	4.306	119.00	5.73	0.51	1792.36	0.000	2.078	0.587	0.00423	2.171	Tr./Rect.closed
"Link30"	Reach	-1277.64	1787.63	1793.50	1791.924	4.294	119.00	5.73	0.51	1792.43	0.000	2.078	0.587	0.00544	1.987	Tr./Rect.closed
"Node31"	Junction	-1273.64	1787.65	1793.50	1792.423	4.773	55.00	3.73	0.22	1792.64	0.000	1.555	0.000	0.00500	0.000	Tr./Rect.closed
"Link29"	Reach	-1187.97	1788.08	1793.50	1792.558	4.478	55.00	3.73	0.22	1792.77	0.000	1.555	0.383	0.00502	1.595	Tr./Rect.closed
"Node30"	Headwrk	-1187.97	1788.08	1793.50	1792.558	4.478	55.00	3.73	0.22	1792.77	0.000	1.555	0.000	0.00000	0.000	Tr./Rect.closed

*) in the W.S.ELEV column indicates flooding, it is set whenever W.S.ELEV > GROUND ELEV
i.p. = intermediate point processing results for reaches

=====

Node8_Branch1

Composite Profile:

ELEMENT NAME	TYPE	STATION	INVERT ELEV	GROUND ELEV	W.S. ELEV	DEPTH	Q	VELOC.	VELOC. HEAD	ENERGY GRADE LN	SUPER ELEV	CRITICAL DEPTH	FROUDE NUMBER	SLOPE	NORMAL DEPTH	CROSS SECTION
###																
"Outlet/N"	Outlet	-1396.45	1786.54	1793.00	1791.054	4.514	186.00	5.86	0.53	1791.59	0.000	2.561	0.000	0.00000	0.000	Tr./Rect.closed
"Link25"	Reach	-1329.92	1787.11	1792.50	1791.214	4.104	186.00	5.86	0.53	1791.75	0.000	2.561	0.518	0.00857	2.064	Tr./Rect.closed
"Node26"	Headwrk	-1329.92	1787.11	1792.50	1791.214	4.104	186.00	5.86	0.53	1791.75	0.000	2.561	0.000	0.00000	0.000	Tr./Rect.closed

*) in the W.S.ELEV column indicates flooding, it is set whenever W.S.ELEV > GROUND ELEV
i.p. = intermediate point processing results for reaches

Appendix B-2

HEC-RAS Model

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL

Staion Conversion

HEC-RAS Station	30% Drainage Plan Station
9063.206	3125.88
8922.776	3266.88
8873.57	3316.08
8824.36	3365.28
8775.16	3414.48
8725.96	3463.68
8676.75	3512.88
8627.55	3562.08
8578.35	3611.28
8529.14	3660.48
8479.94	3709.68
8430.738	3758.89
8380.9	3808.73
8331.07	3858.57
8281.24	3908.41
8231.4	3958.25
8181.57	4008.09
8131.743	4057.93
8103.225	4086.45
8070	4086.95
8041.023	4148.45
8010.899	4178.57
7961.26	4228.22
7911.62	4277.87
7861.98	4327.52
7812.34	4377.17
7762.7	4426.82
7713.06	4476.47
7663.42	4526.12
7613.79	4575.77
7564.15	4625.42
7514.51	4675.07
7464.87	4724.72
7415.23	4774.37
7365.59	4824.02
7315.95	4873.67
7266.31	4923.32
7216.68	4972.97
7167.04	5022.62
7117.403	5072.27
7068.177	5121.5
7030	5122
6988.652	5201
6936.664	5252.99
6887.95	5301.7
6839.24	5350.41

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL

Staion Conversion

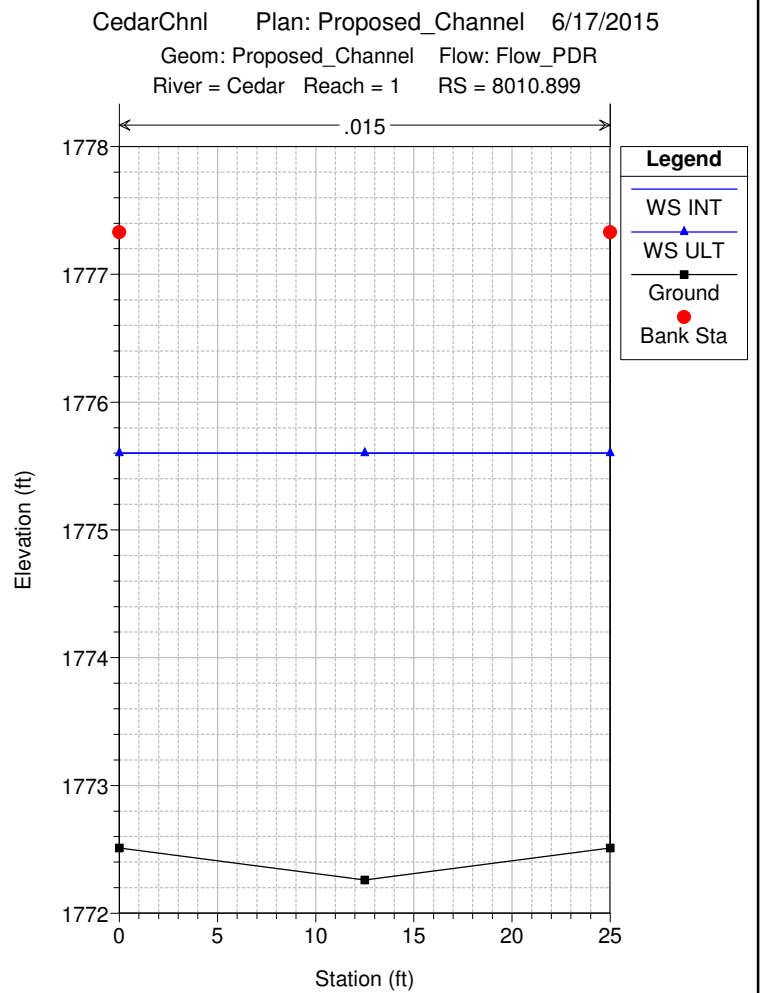
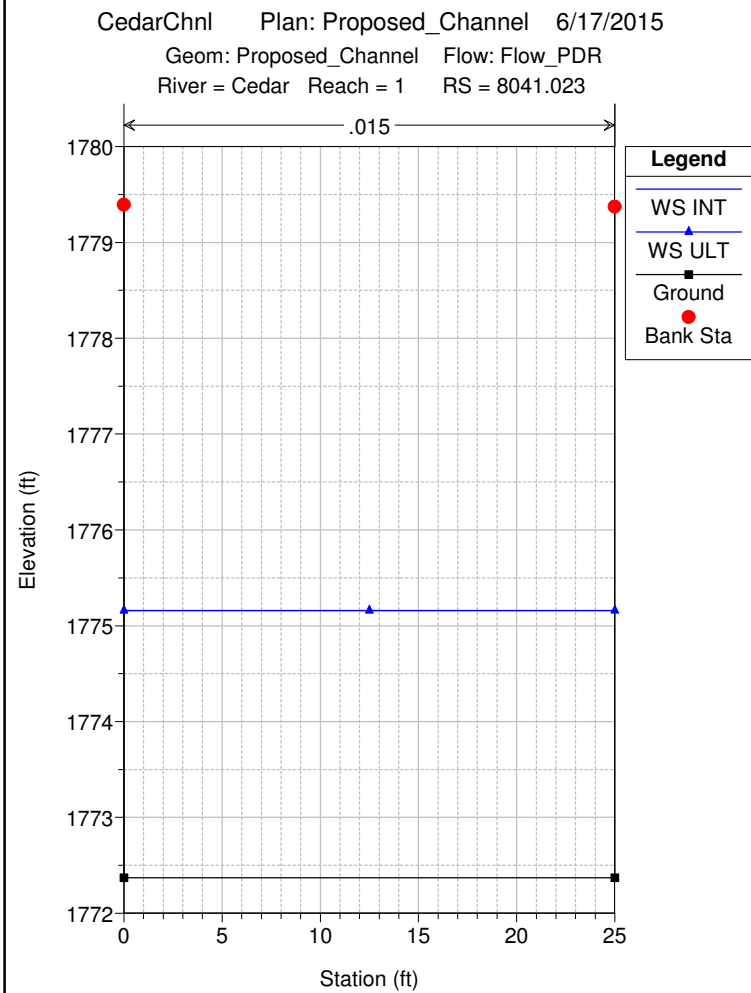
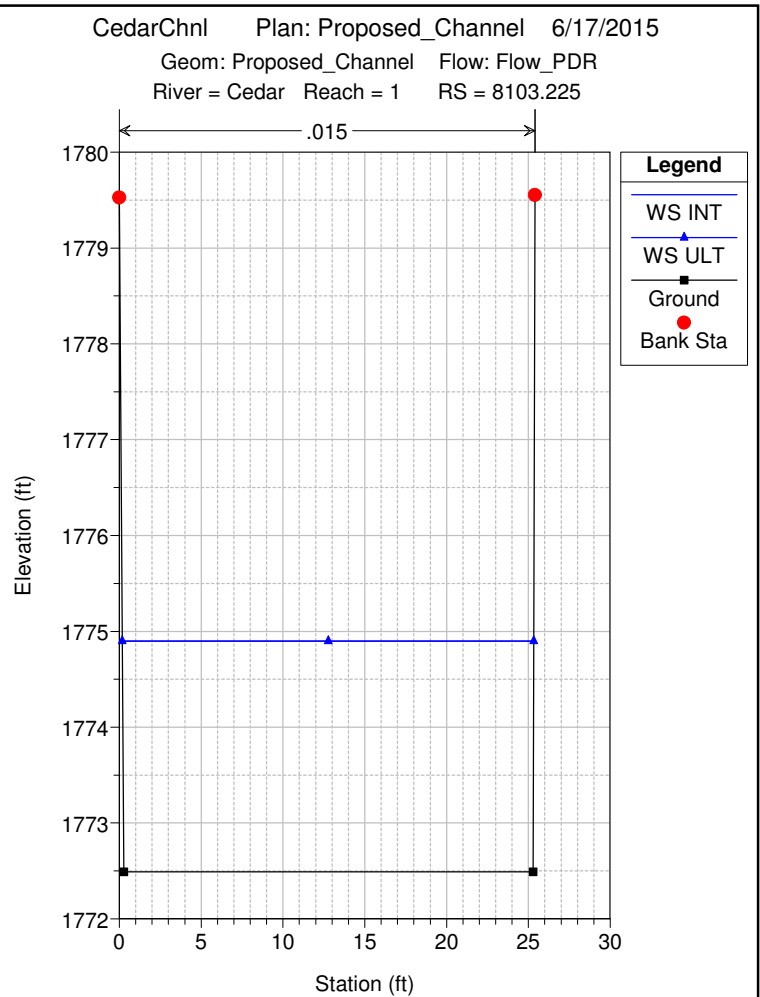
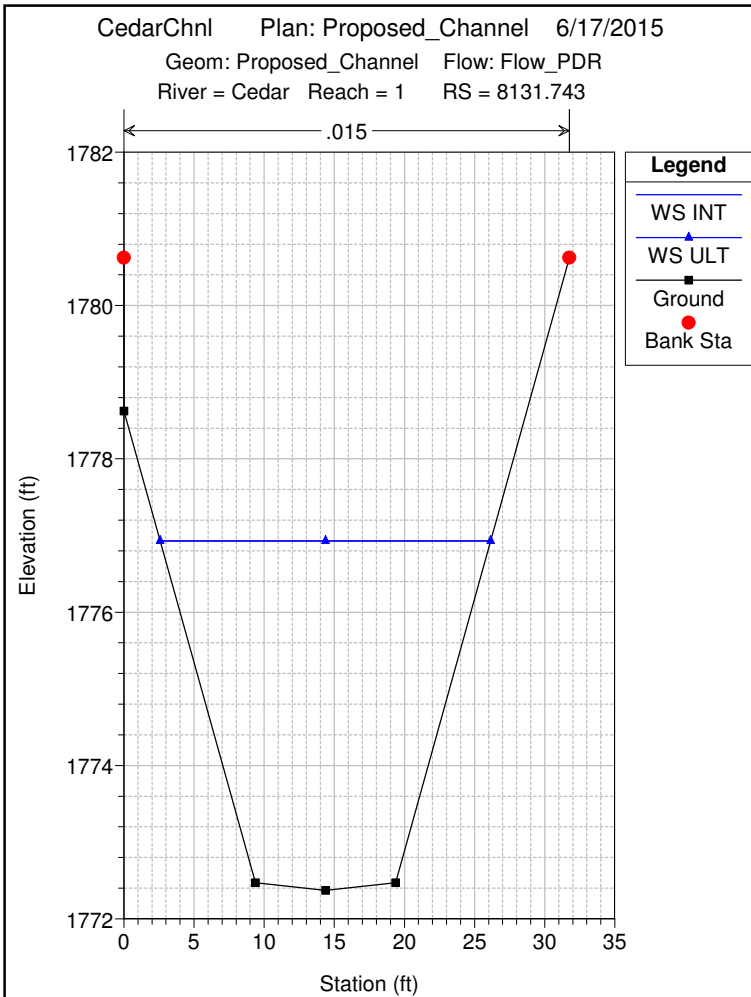
HEC-RAS Station	30% Drainage Plan Station
6790.53	5399.12
6741.82	5447.83
6693.11	5496.54
6644.4	5545.25
6595.69	5593.96
6546.98	5642.67
6498.27	5691.38
6449.56	5740.09
6400.85	5788.8
6352.14	5837.51
6303.43	5886.22
6254.72	5934.93
6206.01	5983.64
6157.3	6032.35
6108.59	6081.06
6059.88	6129.77
6010.11	6179.53
5960.34	6229.29
5910.58	6279.05
5860.81	6328.81
5811.04	6378.57
5761.28	6428.33
5711.51	6478.09
5661.75	6527.85
5611.98	6577.61
5562.21	6627.37
5512.45	6677.13
5462.68	6726.89
5412.91	6776.65
5363.15	6826.41
5313.38	6876.17
5263.62	6925.93
5213.85	6975.69
5164.08	7025.45
5114.32	7075.21
5064.55	7124.97
5014.78	7174.73
4965.02	7224.49
4915.25	7274.25
4865.49	7324.01
4815.72	7373.77
4765.95	7423.53
4716.19	7473.29
4666.42	7523.05
4616.65	7572.81
4566.89	7622.57

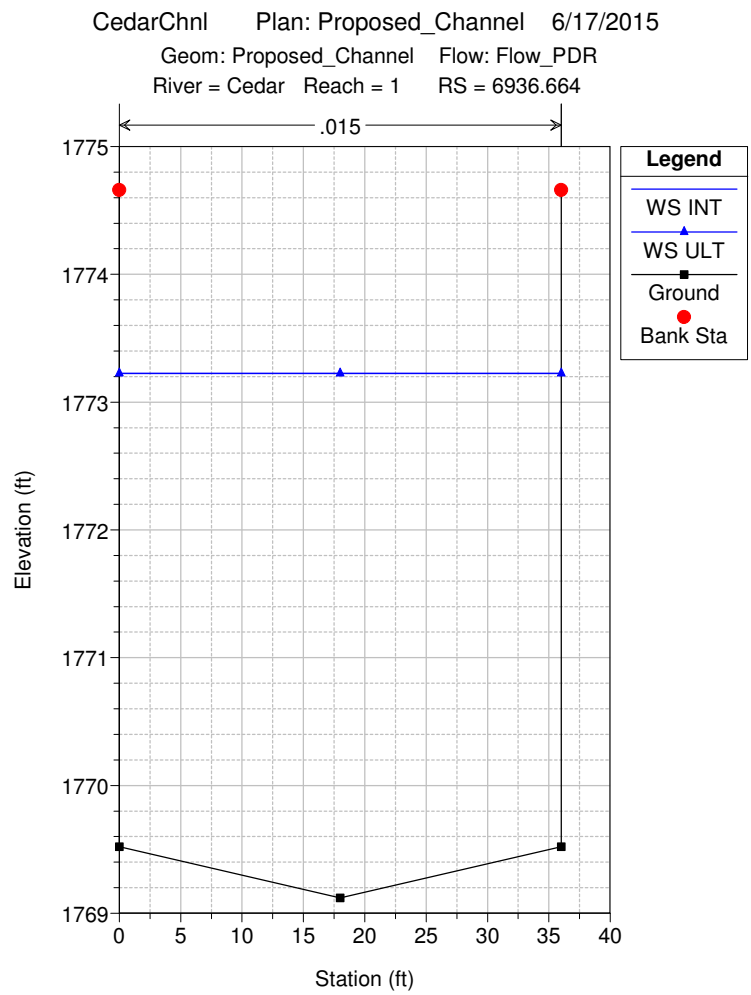
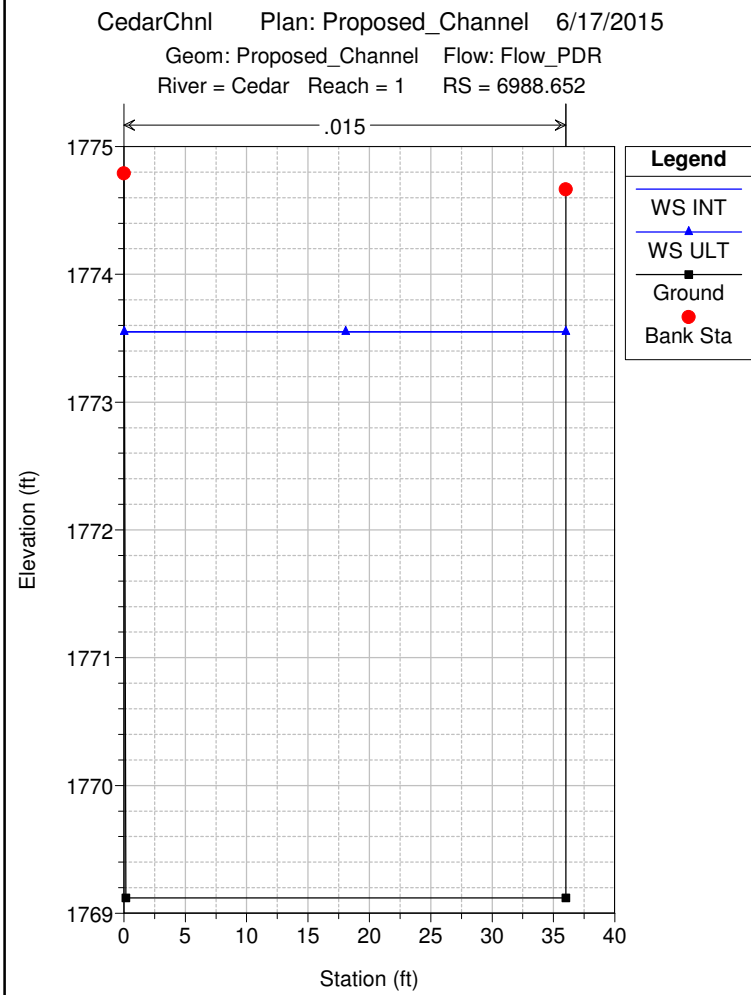
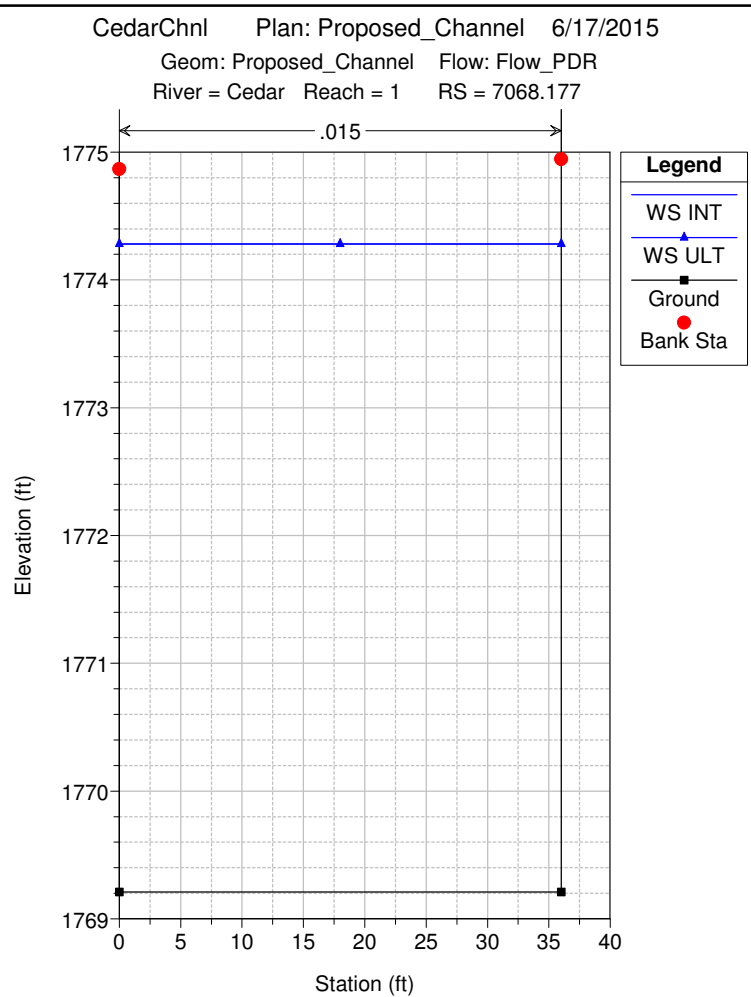
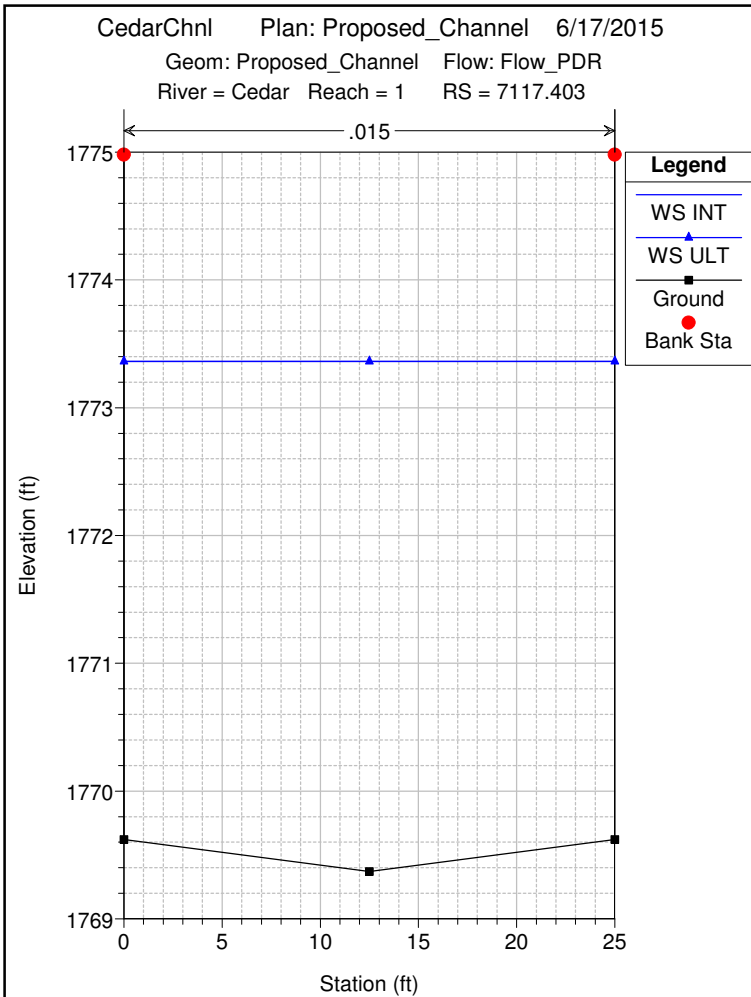
LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL**Staion Conversion**

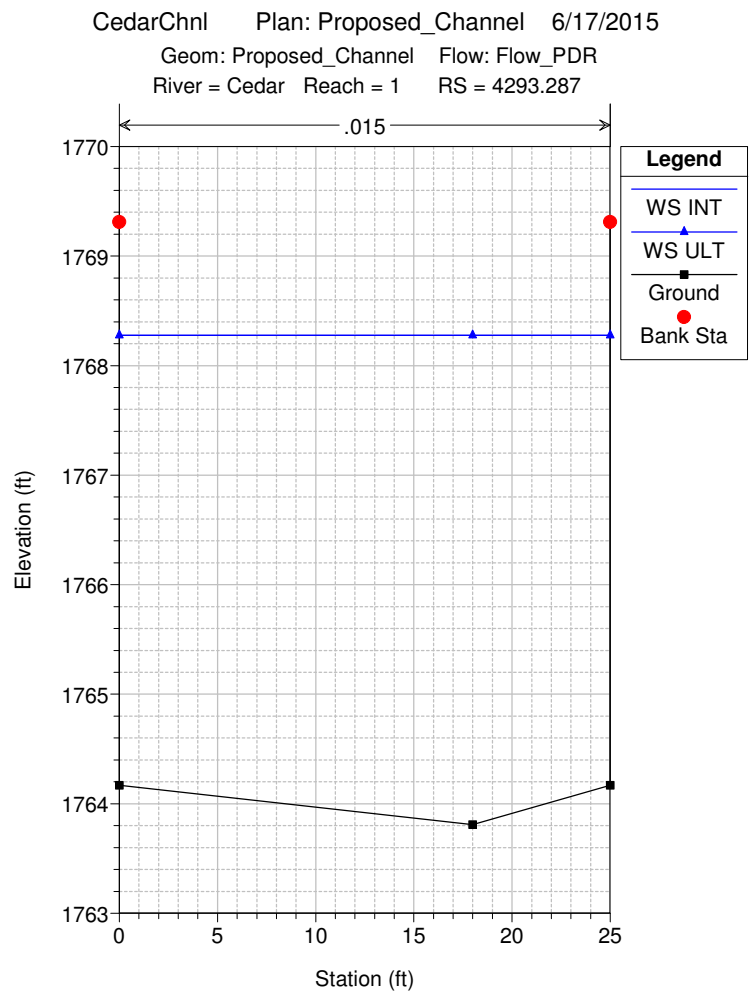
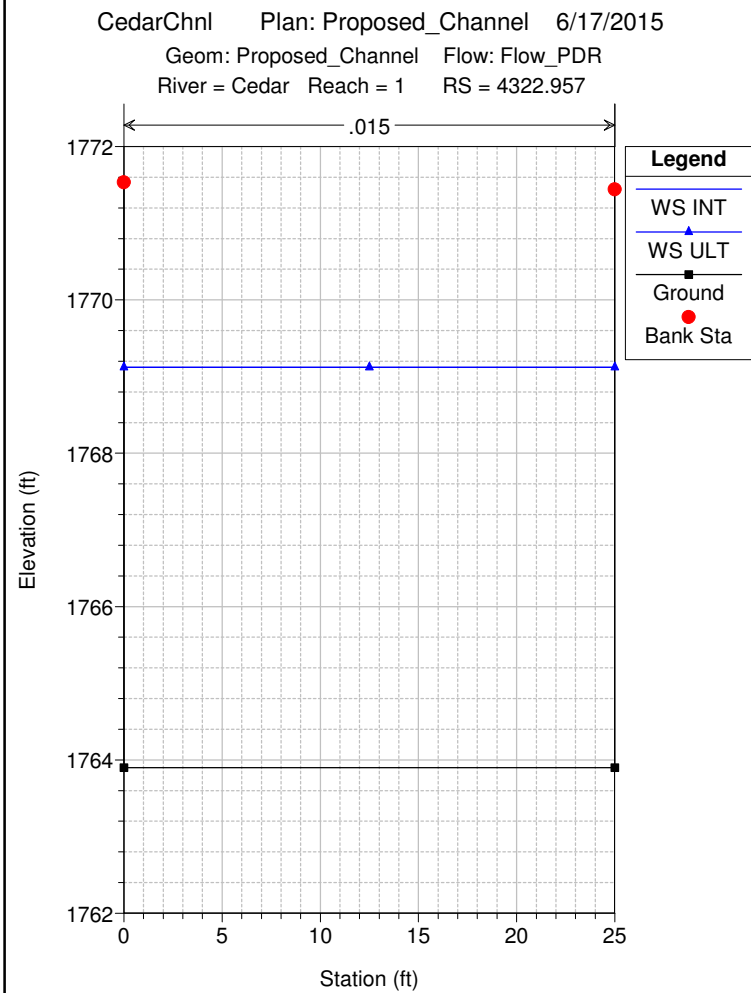
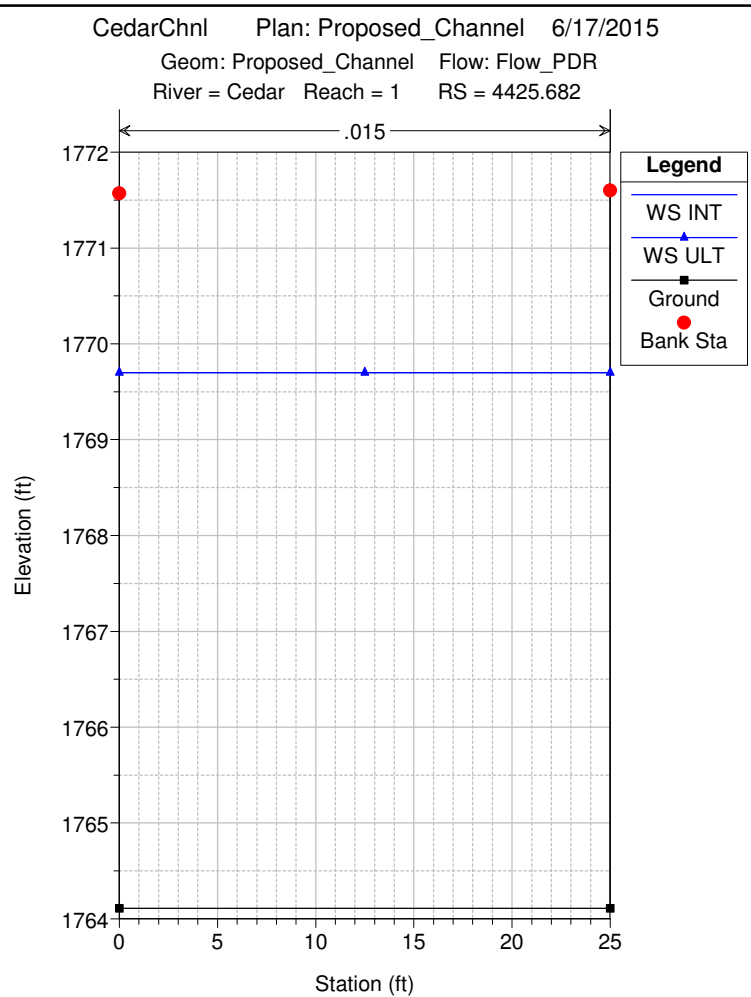
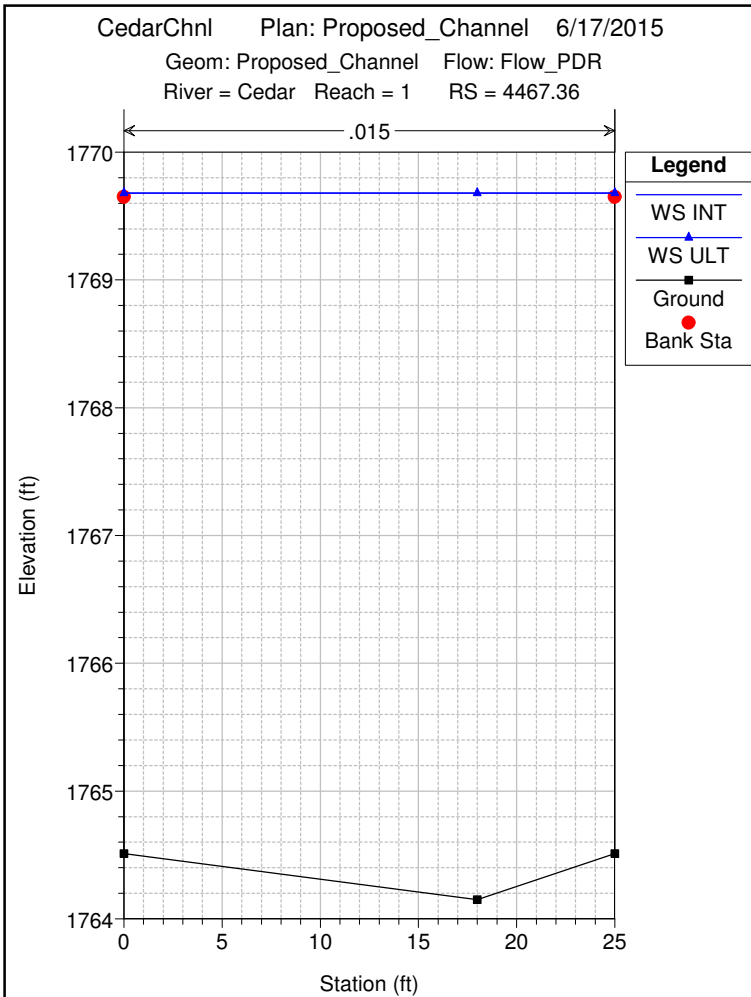
HEC-RAS Station	30% Drainage Plan Station
4517.12	7672.33
4467.36	7722.09
4425.682	7763.77
4380	7764.27
4322.957	7866.27
4293.287	7895.94
4244.75	7944.48
4196.21	7993.02
4147.67	8041.56
4099.14	8090.1
4002.07	8187.18
3953.53	8235.72
3904.99	8284.26
3856.46	8332.8
3807.92	8381.34
3759.38	8429.88
3710.85	8478.42
3662.31	8526.96
3613.78	8575.5
3565.24	8624.04
3516.7	8672.58
3468.17	8721.12
3419.63	8769.66
3371.1	8818.2
3322.56	8866.74
3274.02	8915.28
3225.49	8963.82
3176.95	9012.36
3128.41	9060.9
3079.883	9109.44
3049.332	9139.99
3020	9140.49
2985.898	9202.99
2956.266	9232.62
2907.31	9281.57
2858.36	9330.52
2809.42	9379.47
2760.47	9428.42
2711.52	9477.37
2662.57	9526.32
2613.62	9575.27
2564.67	9624.22
2515.72	9673.17
2466.78	9722.12
2417.83	9771.07
2368.88	9820.02

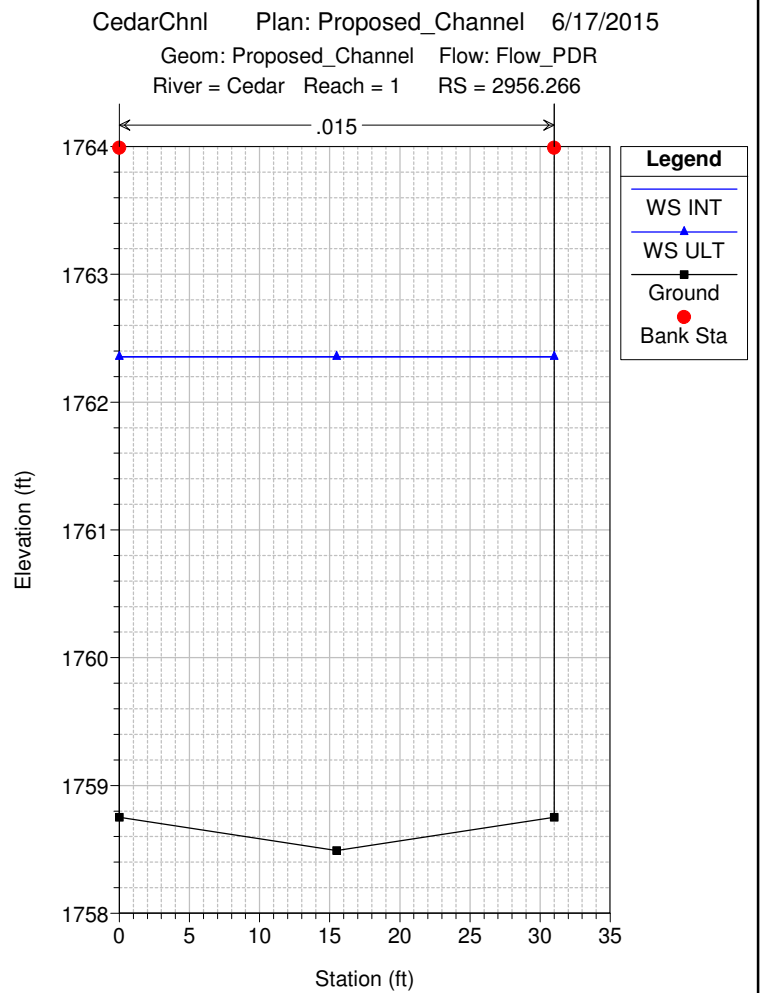
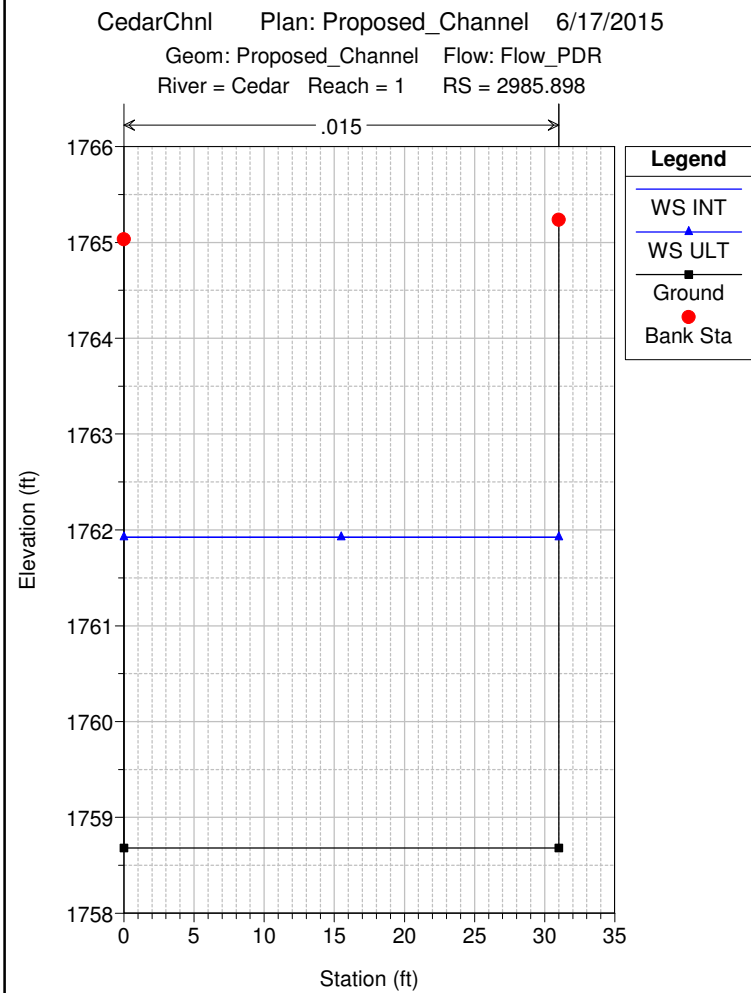
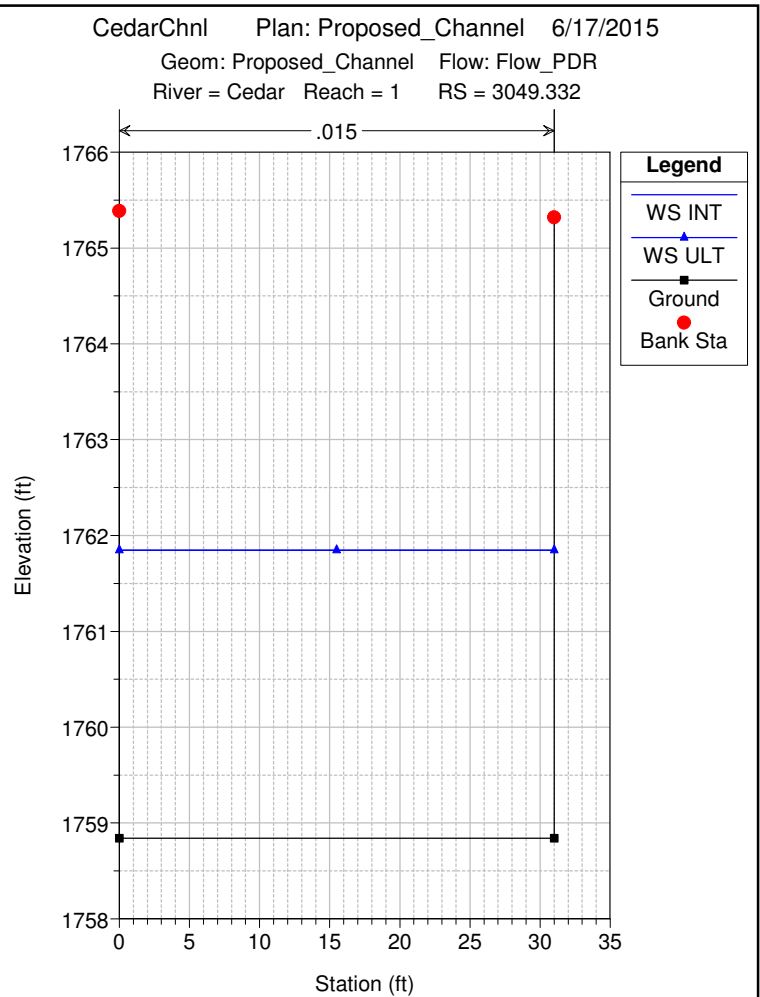
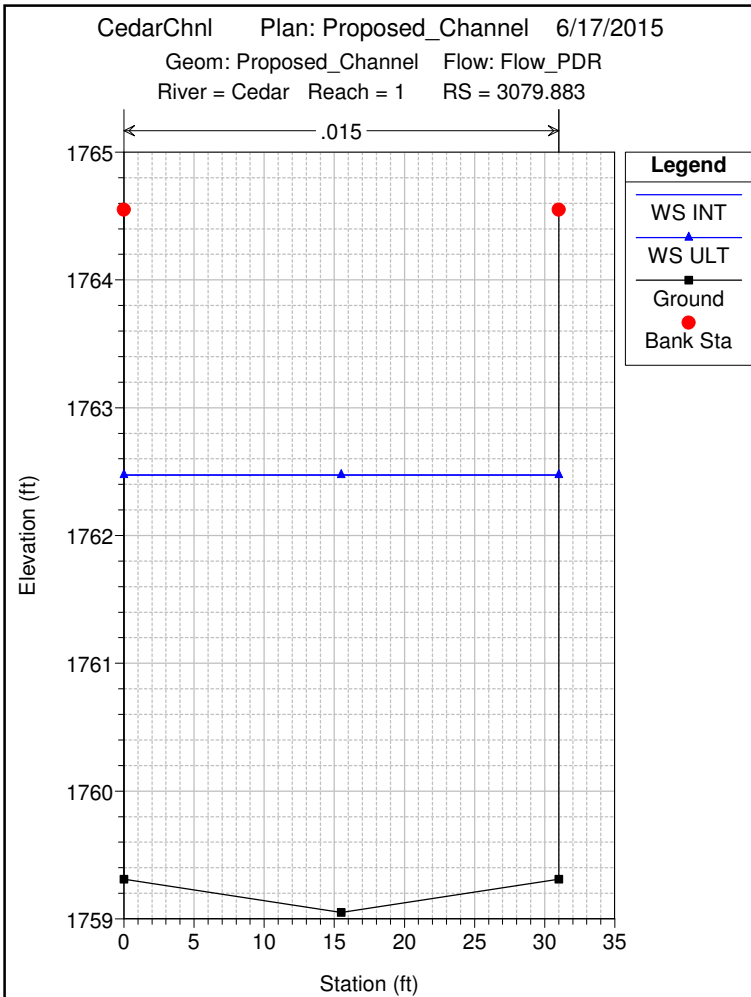
LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL**Staion Conversion**

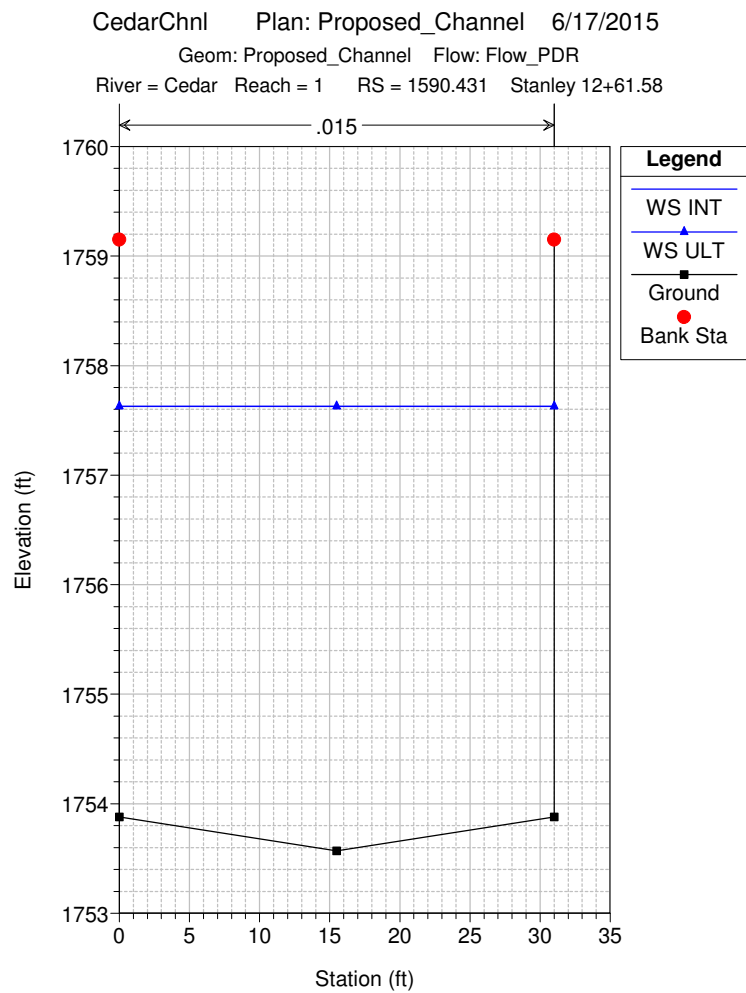
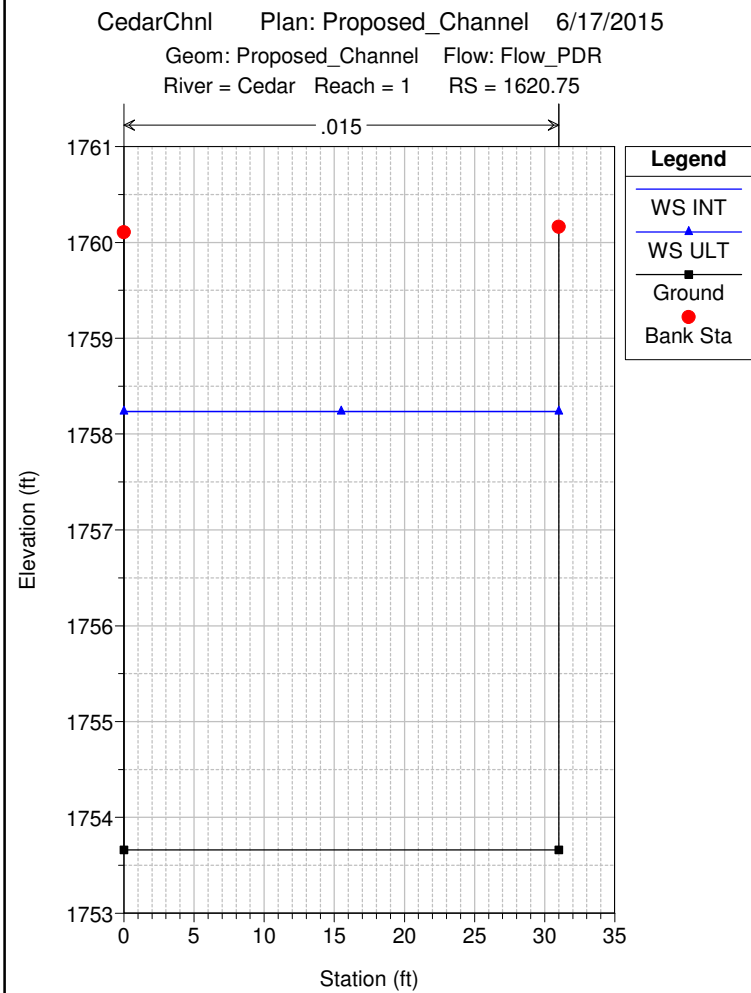
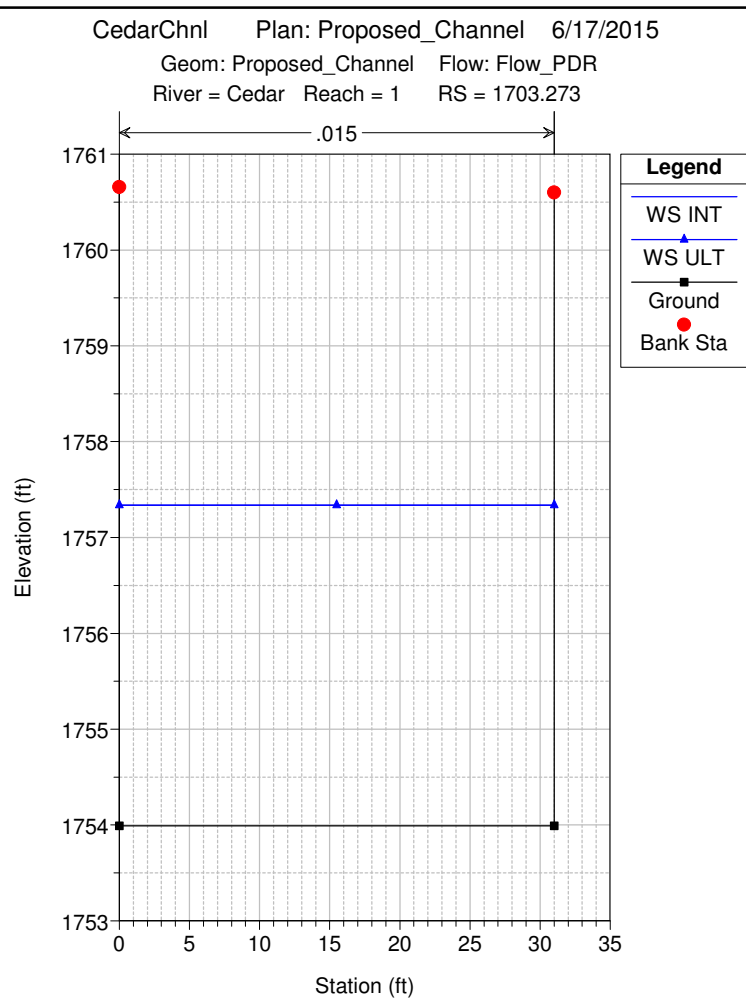
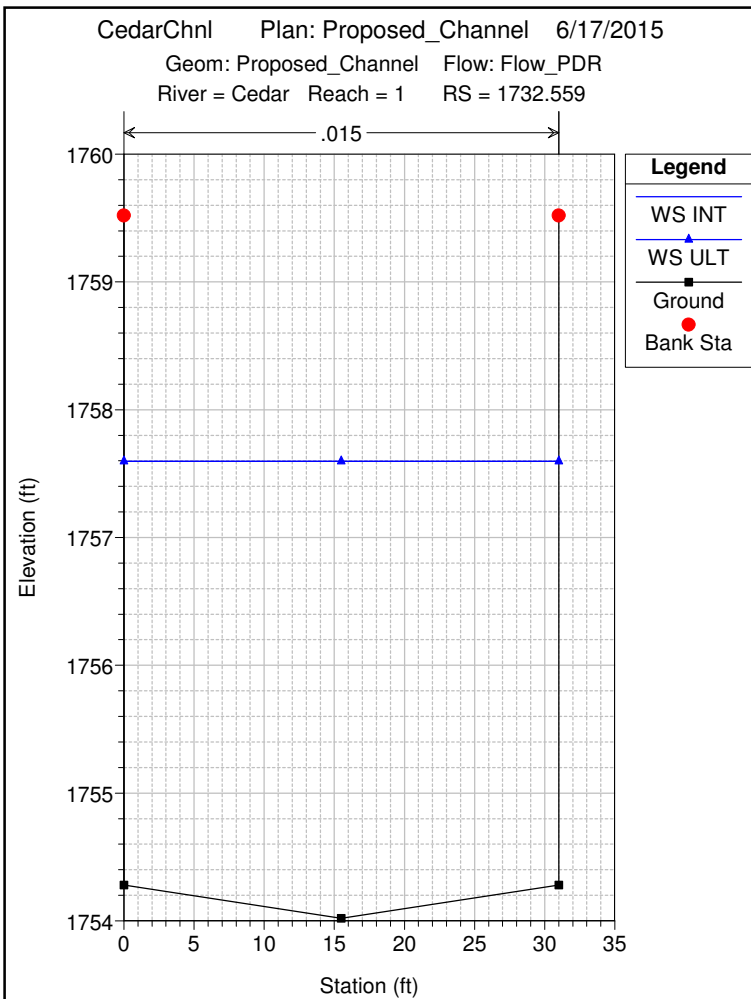
HEC-RAS Station	30% Drainage Plan Station
2319.93	9868.97
2270.98	9917.92
2222.04	9966.87
2172.99	10015.91
2123.94	10064.95
2075.01	10113.88
2026.09	10162.81
1977.17	10211.74
1928.25	10260.67
1879.32	10309.6
1830.4	10358.53
1781.48	10407.46
1732.559	10456.39
1703.273	10485.69
1660	10486.19
1620.75	10568.19
1590.431	10598.51
1532.01	10641.01
1473.59	10683.51
1415.17	10726.01
1356.76	10768.51
1151.76	10973.51
1105.9	11019.36
1060.04	11065.21
1014.18	11111.06
968.328	11156.91
922.47	11202.76
876.612	11248.61
830.754	11294.46
784.896	11340.31
739.038	11386.16
693.18	11432.01
643.624	11481.57
594.067	11531.13
544.512	11580.69
494.955	11630.25
445.399	11679.81
395.843	11729.37
346.287	11778.93
296.731	11828.49
247.175	11878.05
197.619	11927.61
148.063	11977.17
98.5078	12026.73











Appendix B-3

Channel Freeboard Analysis

Channel Freeboard Analysis

Freeboard required is calculated by the following equation for supercritical flow regime (Equation 747 in HCDDM).

$$F_b = 1.0 + 0.025 V (d)^{1/3}$$

Where F_b = Freeboard height (ft)

V = velocity (ft/s)

D = depth of flow (ft)

Freeboard required is calculated by the following equation for subcritical flow regime (Equation 741 in HCDDM).

$$F_b = 0.5 + V^2/2g$$

Where F_b = Freeboard height (ft)

V = velocity (ft/s)

g = acceleration of gravity (ft/s²)

Super-elevation is calculated by the following equation (Equation 748 in HCDDM).

$$S_e = C V^2 T_w / g r$$

Where S_e = super-elevation (ft)

$C = 1.0$ for all other Channel Section, with or without Spiral Transition Curves

V = velocity (ft/s)

T_w = Normal channel flow top width (ft)

r = channel centerline radius (ft)

g = acceleration of gravity (ft/s²)

The maximum allowable super-elevation per HCDDM is 2 feet.

Super-elevation for subcritical flow is taken as 0.5 feet.

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL																								
Freeboard Calculation																								
River Sta	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	DEPTH	Type of Flow	Calculated FB	Depth+ Calculated FB	Super Elevation		Required Freeboard	Top of Wall (ft)		Available Freeboard (ft)		Minimum Available FB	Criteria
30% Design Plans	HEC-RAS Model	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)		(ft)	(ft)	Supercritical flow(ft)	SubCritical flow (ft)	(Depth+Calc FB+super evev)	Left	Right	Left	Right	(ft)	
3125.88	9063.206	1085	1777.39	1781.81	1782.73	1784.96	0.005263	14.23	76.22	25.03	1.44	4.42	Super	1.58	6.00			1.58	1785.00	1786.90	3.19	5.09	3.19	Met
3266.88	8922.776	1085	1776.52	1781.15	1782.02	1784.23	0.004854	14.06	77.14	23.8	1.38	4.63	Super	1.59	6.22			1.59	1784.90	1785.10	3.75	3.95	3.75	Met
3316.08	8873.57	1085	1776.26	1780.87	1781.76	1783.99	0.004949	14.17	76.6	23.73	1.39	4.61	Super	1.59	6.20			1.59	1784.80	1785.00	3.93	4.13	3.93	Met
3365.28	8824.36	1085	1775.99	1780.57	1781.49	1783.75	0.005083	14.3	75.86	23.64	1.41	4.58	Super	1.59	6.17			1.59	1784.50	1785.00	3.93	4.43	3.93	Met
3414.48	8775.16	1085	1775.73	1780.3	1781.23	1783.5	0.005127	14.35	75.61	23.6	1.41	4.57	Super	1.60	6.17			1.60	1784.10	1785.80	3.80	5.50	3.80	Met
3463.68	8725.96	1085	1775.47	1780.03	1780.97	1783.25	0.005161	14.38	75.43	23.58	1.42	4.56	Super	1.60	6.16			1.60	1783.90	1785.70	3.87	5.67	3.87	Met
3512.88	8676.75	1085	1775.2	1779.75	1780.7	1782.99	0.005234	14.46	75.05	23.53	1.43	4.55	Super	1.60	6.15			1.60	1783.63	1785.43	3.88	5.68	3.88	Met
3562.08	8627.55	1085	1774.94	1779.49	1780.44	1782.73	0.005214	14.44	75.15	23.54	1.42	4.55	Super	1.60	6.15			1.60	1783.37	1785.17	3.88	5.68	3.88	Met
3611.28	8578.35	1085	1774.68	1779.23	1780.18	1782.46	0.005201	14.42	75.22	23.55	1.42	4.55	Super	1.60	6.15			1.60	1783.10	1784.90	3.87	5.67	3.87	Met
3660.48	8529.14	1085	1774.42	1778.98	1779.92	1782.2	0.005184	14.41	75.31	23.56	1.42	4.56	Super	1.60	6.16			1.60	1782.84	1784.64	3.86	5.66	3.86	Met
3709.68	8479.94	1085	1774.15	1778.69	1779.65	1781.95	0.005251	14.47	74.96	23.52	1.43	4.54	Super	1.60	6.14			1.60	1782.57	1784.37	3.88	5.68	3.88	Met
3758.89	8430.738	1085	1773.89	1778.44	1779.39	1781.68	0.005232	14.46	75.06	23.53	1.43	4.55	Super	1.60	6.15			1.60	1782.31	1784.11	3.87	5.67	3.87	Met
3808.73	8380.9	1085	1773.64	1778.2	1779.14	1781.42	0.005188	14.41	75.29	23.56	1.42	4.56	Super	1.60	6.16			1.60	1782.04	1783.84	3.84	5.64	3.84	Met
3858.57	8331.07	1085	1773.38	1777.94	1778.88	1781.16	0.005187	14.41	75.3	23.56	1.42	4.56	Super	1.60	6.16			1.60	1781.77	1783.57	3.83	5.63	3.83	Met
3908.41	8281.24	1085	1773.13	1777.69	1778.63	1780.91	0.005187	14.41	75.3	23.56	1.42	4.56	Super	1.60	6.16			1.60	1781.50	1783.30	3.81	5.61	3.81	Met
3958.25	8231.4	1085	1772.88	1777.44	1778.38	1780.66	0.005187	14.41	75.3	23.56	1.42	4.56	Super	1.60	6.16			1.60	1781.23	1783.03	3.79	5.59	3.79	Met
4008.09	8181.57	1085	1772.63	1777.19	1778.13	1780.41	0.005187	14.41	75.3	23.56	1.42	4.56	Super	1.60	6.16			1.60	1780.96	1782.76	3.77	5.57	3.77	Met
4057.93	8131.743	1085	1772.37	1776.93	1777.87	1780.15	0.005187	14.41	75.3	23.56	1.42	4.56	Super	1.60	6.16			1.60	1780.69	1782.49	3.76	5.56	3.76	Met
4086.45	8103.225	1085	1772.49	1774.9	1776.37	1779.92	0.01287	17.98	60.35	25.14	2.05	2.41	Super	1.60	4.01			1.60	1779.50	1779.50	4.60	4.60	4.60	Met
4086.95	8070		Honolulu Street Bridge																					
4148.45	8041.023	1085	1772.37	1775.16	1776.24	1778.92	0.008229	15.57	69.71	25	1.64	2.79	Super	1.55	4.34			1.55	1779.40	1779.40	4.24	4.24	4.24	Met
4178.57	8010.899	1136	1772.26	1775.6	1776.37	1778.7	0.005754	14.13	80.4	25	1.39	3.34	Super	1.53	4.87			1.53	1779.79	1779.79	4.19	4.19	4.19	Met
4228.22	7961.26	1136	1772.1	1775.58	1776.21	1778.43	0.005078	13.56	83.76	25	1.31	3.48	Super	1.51	4.99			1.51	1779.57	1779.57	3.99	3.99	3.99	Met
4277.87	7911.62	1136	1771.94	1775.55	1776.05	1778.19	0.004522	13.05	87.02	25	1.23	3.61	Super	1.50	5.11			1.50	1779.62	1779.62	4.07	4.07	4.07	Met
4327.52	7861.98	1136	1771.78	1775.51	1775.9	1777.98	0.004067	12.61	90.11	25	1.17	3.73	Super	1.49	5.22			1.49	1779.46	1779.46	3.95	3.95	3.95	Met
4377.17	7812.34	1136	1771.62	1775.46	1775.74	1777.78	0.003704	12.22	92.93	25	1.12	3.84	Super	1.48	5.32			1.48	1779.29	1779.29	3.83	3.83	3.83	Met
4426.82	7762.7	1136	1771.46	1775.36	1775.58	1777.61	0.003534	12.04	94.39	25	1.09	3.9	Super	1.47	5.37			1.47	1779.13	1779.13	3.77	3.77	3.77	Met
4476.47	7713.06	1136	1771.3	1775.23	1775.42	1777.44	0.00345	11.94	95.14	25	1.08	3.93	Super	1.47	5.40			1.47	1778.97	1778.97	3.74	3.74	3.74	Met
4526.12	7663.42	1136	1771.14	1775.16	1775.26	1777.27	0.00321	11.66	97.45	25	1.04	4.02	Super	1.46	5.48			1.46	1778.81	1778.81	3.65	3.65	3.65	Met
4575.77	7613.79	1136	1770.98	1775	1775.1	1777.11	0.00321	11.66	97.45	25	1.04	4.02	Super	1.46	5.48			1.46	1778.64	1778.64	3.64	3.64	3.64	Met
4625.42	7564.15	1136	1770.81	1774.8	1774.93	1776.95	0.003287	11.75	96.68	25	1.05	3.99	Super	1.47	5.46			1.47	1778.48	1778.48	3.68	3.68	3.68	Met
4675.07	7514.51	1136	1770.65	1774.64	1774.77	1776.79	0.003287	11.75	96.68	25	1.05	3.99	Super	1										

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL																								
Freeboard Calculation																								
River Sta	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	DEPTH	Type of Flow	Calculated FB	Depth+ Calculated FB	Super Elevation		Required Freeboard	Top of Wall (ft)		Available Freeboard (ft)		Minimum Available FB	Criteria
30% Design Plans	HEC-RAS Model	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)		(ft)	(ft)	Supercritical flow(ft)	SubCritical flow (ft)	(Depth+Calc FB+super evev)	Left	Right	Left	Right	(ft)	
5788.8	6400.85	1172	1768.06	1772.78	1771.43	1773.58	0.000928	7.16	163.59	36	0.59	4.72	Sub	1.30	6.02			1.30	1774.58	1774.77	1.80	1.99	1.80	Met
5837.51	6352.14	1172	1767.96	1772.76	1771.33	1773.53	0.000884	7.05	166.24	36	0.58	4.8	Sub	1.27	6.07			1.27	1774.48	1774.67	1.72	1.91	1.72	Met
5886.22	6303.43	1172	1767.86	1772.73	1771.23	1773.48	0.000841	6.94	168.95	36	0.56	4.87	Sub	1.25	6.12			1.25	1774.38	1774.57	1.65	1.84	1.65	Met
5934.93	6254.72	1172	1767.76	1772.71	1771.13	1773.43	0.000801	6.83	171.71	36	0.55	4.95	Sub	1.22	6.17			1.22	1774.28	1774.47	1.57	1.76	1.57	Met
5983.64	6206.01	1172	1767.66	1772.69	1771.03	1773.39	0.000762	6.72	174.52	36	0.54	5.03	Sub	1.20	6.23			1.20	1774.19	1774.38	1.50	1.69	1.50	Met
6032.35	6157.3	1172	1767.56	1772.67	1770.93	1773.35	0.000725	6.61	177.38	36	0.52	5.11	Sub	1.18	6.29			1.18	1774.20	1773.95	1.53	1.28	1.28	Met
6081.06	6108.59	1172	1767.46	1772.65	1770.84	1773.3	0.00069	6.5	180.29	36	0.51	5.19	Sub	1.16	6.35			1.16	1774.11	1773.86	1.46	1.21	1.21	Met
6129.77	6059.88	1196	1767.36	1771.88	1771.2	1773.19	0.001688	9.19	130.08	30	0.78	4.52	Sub	1.81	6.33			1.81	1774.02	1773.77	2.14	1.89	1.89	Met
6179.53	6010.11	1196	1767.26	1771.8	1771.1	1773.1	0.001659	9.14	130.83	30	0.77	4.54	Sub	1.80	6.34			1.80	1773.92	1773.67	2.12	1.87	1.87	Met
6229.29	5960.34	1196	1767.16	1771.73	1771	1773.01	0.001629	9.09	131.64	30	0.76	4.57	Sub	1.78	6.35			1.78	1774.50	1773.70	2.77	1.97	1.97	Met
6279.05	5910.58	1196	1767.06	1771.66	1770.9	1772.92	0.001597	9.03	132.51	30	0.76	4.6	Sub	1.77	6.37			1.77	1774.45	1773.65	2.79	1.99	1.99	Met
6328.81	5860.81	1196	1766.96	1771.59	1770.8	1772.84	0.001558	8.95	133.58	30	0.75	4.63	Sub	1.74	6.37			1.74	1774.30	1773.40	2.71	1.81	1.81	Met
6378.57	5811.04	1196	1766.86	1771.53	1770.7	1772.75	0.001519	8.88	134.72	30	0.74	4.67	Sub	1.72	6.39			1.72	1774.15	1773.25	2.62	1.72	1.72	>1
6428.33	5761.28	1196	1766.76	1771.47	1770.6	1772.67	0.001478	8.8	135.94	30	0.73	4.71	Sub	1.70	6.41			1.70	1774.00	1773.25	2.53	1.78	1.78	Met
6478.09	5711.51	1196	1766.66	1771.42	1770.5	1772.59	0.001436	8.71	137.24	30	0.72	4.76	Sub	1.68	6.44	0.15	0.50	2.18	1774.01	1774.01	2.59	2.59	2.59	Met
6527.85	5661.75	1196	1766.56	1771.36	1770.4	1772.52	0.001394	8.63	138.61	30	0.71	4.8	Sub	1.66	6.46	0.14	0.50	2.16	1773.91	1773.91	2.55	2.55	2.55	Met
6577.61	5611.98	1196	1766.46	1771.31	1770.3	1772.44	0.001351	8.54	140.06	30	0.7	4.85	Sub	1.63	6.48	0.14	0.50	2.13	1773.81	1773.81	2.50	2.50	2.50	Met
6627.37	5562.21	1196	1766.36	1771.26	1770.2	1772.37	0.001307	8.45	141.58	30	0.69	4.9	Sub	1.61	6.51	0.14	0.50	2.11	1773.71	1773.71	2.45	2.45	2.45	Met
6677.13	5512.45	1196	1766.26	1771.21	1770.1	1772.3	0.001264	8.35	143.18	30	0.67	4.95	Sub	1.58	6.53	0.14	0.50	2.08	1773.61	1773.61	2.40	2.40	2.40	Met
6726.89	5462.68	1196	1766.16	1771.17	1770	1772.23	0.001221	8.26	144.84	30	0.66	5.01	Sub	1.56	6.57	0.13	0.50	2.06	1773.51	1773.51	2.34	2.34	2.34	Met
6776.65	5412.91	1196	1766.06	1771.13	1769.9	1772.16	0.001178	8.16	146.57	30	0.65	5.07	Sub	1.53	6.60	0.13	0.50	2.03	1773.41	1773.41	2.28	2.28	2.28	Met
6826.41	5363.15	1196	1765.96	1771.09	1769.8	1772.1	0.001136	8.06	148.37	30	0.64	5.13	Sub	1.51	6.64	0.13	0.50	2.01	1773.31	1773.31	2.22	2.22	2.22	Met
6876.17	5313.38	1196	1765.86	1771.05	1769.7	1772.03	0.001094	7.96	150.23	30	0.63	5.19	Sub	1.48	6.67	0.12	0.50	1.98	1773.21	1773.21	2.16	2.16	2.16	Met
6925.93	5263.62	1196	1765.76	1771.01	1769.59	1771.97	0.001049	7.85	152.35	30	0.61	5.25	Sub	1.46	6.71	0.12	0.50	1.96	1773.11	1773.11	2.10	2.10	2.10	Met
6975.69	5213.85	1196	1765.65	1770.98	1769.49	1771.91	0.001005	7.74	154.53	30	0.6	5.33	Sub	1.43	6.76	0.12	0.50	1.93	1773.01	1773.01	2.03	2.03	2.03	Met
7025.45	5164.08	1196	1765.55	1770.95	1769.39	1771.86	0.000967	7.64	156.56	30	0.59	5.4	Sub	1.41	6.81	0.11	0.50	1.91	1772.92	1772.92	1.97	1.97	1.97	Met
7075.21	5114.32	1196	1765.45	1770.92	1769.28	1771.8	0.00093	7.54	158.64	30	0.58	5.47	Sub	1.38	6.85	0.11	0.50	1.88	1772.82	1772.82	1.90	1.90	1.90	Met
7124.97	5064.55	1196	1765.35	1770.89	1769.19	1771.75	0.000893	7.44	160.77	30	0.57	5.54	Sub	1.36	6.90	0.11	0.50	1.86	1772.72	1772.72	1.83	1.83	1.83	>1
7174.73	5014.78	1196	1765.25	1770.86	1769.09	1771.7	0.000858	7.34	162.94	30	0.56	5.61	Sub	1.34	6.95	0.10	0.50	1.84	1772.62	1772.62	1.76	1.76	1.76	>1
7224.49	4965.02	1196	1765.15	1770.84	1768.99	1771.65	0.000825	7.24	165.15	30	0.54	5.69	Sub	1.31	7.00	0.10	0.50	1.8>						

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL																								
Freeboard Calculation																								
River Sta	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	DEPTH	Type of Flow	Calculated FB	Depth+ Calculated FB	Super Elevation		Required Freeboard	Top of Wall (ft)		Available Freeboard (ft)		Minimum Available FB	Criteria
30% Design Plans	HEC-RAS Model	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)		(ft)	(ft)	Supercritical flow(ft)	SubCritical flow (ft)	(Depth+Calc FB+super evev)	Left	Right	Left	Right	(ft)	
8478.42	3710.85	1266	1761.52	1764.94	1765.37	1767.33	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1767.77	1768.52	2.83	3.58	2.83	Met
8526.96	3662.31	1266	1761.33	1764.75	1765.18	1767.14	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1767.57	1768.32	2.82	3.57	2.82	Met
8575.5	3613.78	1266	1761.14	1764.56	1764.99	1766.95	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1767.38	1768.13	2.82	3.57	2.82	Met
8624.04	3565.24	1266	1760.95	1764.37	1764.8	1766.76	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1767.19	1767.94	2.82	3.57	2.82	Met
8672.58	3516.7	1266	1760.76	1764.18	1764.61	1766.57	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1766.99	1767.74	2.81	3.56	2.81	Met
8721.12	3468.17	1266	1760.57	1763.99	1764.42	1766.38	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1766.80	1767.55	2.81	3.56	2.81	Met
8769.66	3419.63	1266	1760.38	1763.8	1764.23	1766.19	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1766.60	1767.35	2.80	3.55	2.80	Met
8818.2	3371.1	1266	1760.19	1763.61	1764.04	1766	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1766.41	1767.16	2.80	3.55	2.80	Met
8866.74	3322.56	1266	1760	1763.42	1763.85	1765.81	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1766.22	1766.97	2.80	3.55	2.80	Met
8915.28	3274.02	1266	1759.81	1763.23	1763.65	1765.62	0.004093	12.4	102.13	31	1.2	3.42	Super	1.47	4.89			1.47	1766.02	1766.77	2.79	3.54	2.79	Met
8963.82	3225.49	1266	1759.62	1763.04	1763.47	1765.43	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1765.83	1766.58	2.79	3.54	2.79	Met
9012.36	3176.95	1266	1759.43	1762.85	1763.27	1765.24	0.004093	12.4	102.13	31	1.2	3.42	Super	1.47	4.89			1.47	1765.63	1766.38	2.78	3.53	2.78	Met
9060.9	3128.41	1266	1759.24	1762.66	1763.09	1765.05	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1765.44	1766.19	2.78	3.53	2.78	Met
9109.44	3079.883	1266	1759.05	1762.47	1762.9	1764.86	0.004094	12.4	102.12	31	1.2	3.42	Super	1.47	4.89			1.47	1765.27	1766.09	2.80	3.62	2.80	Met
9139.99	3049.332	1266	1758.84	1761.85	1762.56	1764.71	0.005493	13.59	93.18	31	1.38	3.01	Super	1.49	4.50			1.49	1765.38	1765.38	3.53	3.53	3.53	Met
9140.49	3020	Page Street Bridge																						
9202.99	2985.898	1266	1758.68	1761.92	1762.4	1764.39	0.004332	12.59	100.57	31	1.23	3.24	Super	1.47	4.71			1.47	1765.14	1765.14	3.22	3.22	3.22	Met
9232.62	2956.266	1314	1758.49	1762.36	1762.44	1764.36	0.002993	11.35	115.8	31	1.03	3.87	Super	1.45	5.32			1.45	1765.32	1766.82	2.96	4.46	2.96	Met
9281.57	2907.31	1314	1758.31	1762.03	1762.26	1764.2	0.003395	11.82	111.15	31	1.1	3.72	Super	1.46	5.18			1.46	1765.21	1766.71	3.18	4.68	3.18	Met
9330.52	2858.36	1314	1758.13	1761.81	1762.07	1764.02	0.003488	11.93	110.17	31	1.11	3.68	Super	1.46	5.14			1.46	1765.03	1766.53	3.22	4.72	3.22	Met
9379.47	2809.42	1314	1757.95	1761.59	1761.89	1763.86	0.003636	12.09	108.7	31	1.14	3.64	Super	1.46	5.10			1.46	1764.85	1766.35	3.26	4.76	3.26	Met
9428.42	2760.47	1314	1757.78	1761.42	1761.72	1763.69	0.003636	12.09	108.7	31	1.14	3.64	Super	1.46	5.10			1.46	1764.67	1766.17	3.25	4.75	3.25	Met
9477.37	2711.52	1314	1757.6	1761.24	1761.54	1763.51	0.00363	12.08	108.76	31	1.14	3.64	Super	1.46	5.10			1.46	1764.49	1765.99	3.25	4.75	3.25	Met
9526.32	2662.57	1314	1757.43	1761.07	1761.37	1763.34	0.003629	12.08	108.76	31	1.14	3.64	Super	1.46	5.10			1.46	1764.31	1765.81	3.24	4.74	3.24	Met
9575.27	2613.62	1314	1757.26	1760.9	1761.2	1763.17	0.00363	12.08	108.76	31	1.14	3.64	Super	1.46	5.10			1.46	1764.13	1765.63	3.23	4.73	3.23	Met
9624.22	2564.67	1314	1757.08	1760.72	1761.02	1762.98	0.003622	12.07	108.84	31	1.14	3.64	Super	1.46	5.10			1.46	1764.10	1765.45	3.38	4.73	3.38	Met
9673.17	2515.72	1314	1756.91	1760.55	1760.85	1762.81	0.003622	12.07	108.84	31	1.14	3.64	Super	1.46	5.10			1.46	1764.07	1765.27	3.52	4.72	3.52	Met
9722.12	2466.78	1314	1756.74	1760.38	1760.68	1762.64	0.003622	12.07	108.84	31	1.14	3.64	Super	1.46	5.10			1.46	1764.04	1765.09	3.66	4.71	3.66	Met
9771.07	2417.83	1314	1756.57	1760.21	1760.51	1762.47	0.003622	12.07	108.84	31	1.14	3.64	Super	1.46	5.10			1.46	1764.02	1764.92	3.81	4.71	3.81	Met
9820.02	2368.88	1314	1756.4	1760.04	1760.34	1762.3	0.003622	12.07	108.84	31	1.14	3.64	Super	1.46	5.10			1.46	1763.99	1764.74	3.95	4.70	3.95	Met
9868.97	2319.93	1314	1756.22	1759.86	1760.16	1762.12	0.003613	12.06	108.92	31	1.13	3.64	Super	1.46	5.10			1.46	1763.81	1764.56	3.95	4.70	3.95	Met
9917.92	2270.98	1314	1756.05	1759.69	1759.99	1761.95	0.003613	12.06	108.92	31	1.13	3.64	Super	1.46	5.10			1.46	1763.63	1764.38	3.94	4.69		

LAS VEGAS WASH CENTRAL, CEDAR AVENUE CHANNEL																								
Freeboard Calculation																								
River Sta	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	DEPTH	Type of Flow	Calculated FB	Depth+ Calculated FB	Super Elevation		Required Freeboard	Top of Wall (ft)		Available Freeboard (ft)		Minimum Available FB	Criteria
30% Design Plans	HEC-RAS Model	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)		(ft)	(ft)	Supercritical flow(ft)	SubCritical flow (ft)	(Depth+Calc FB+super evev)	Left	Right	Left	Right	(ft)	
11111.06	1014.18	2885	1745.71	1755.72	1753.93	1758.44	0.001967	13.25	217.76	22	0.74	10.01	Sub	3.2	13.2			3.2	1762.8	1762.8	7.1	7.1	7.1	Met
11156.91	968.328	2885	1745.62	1755.63	1753.84	1758.35	0.001967	13.25	217.76	22	0.74	10.01	Sub	3.2	13.2			3.2	1762.6	1762.6	7.0	7.0	7.0	Met
11202.76	922.47	2885	1745.53	1755.54	1753.76	1758.27	0.001971	13.26	217.58	22	0.74	10.01	Sub	3.2	13.2			3.2	1762.5	1762.5	6.9	6.9	6.9	Met
11248.61	876.612	2885	1745.44	1755.44	1753.67	1758.18	0.001975	13.27	217.39	22	0.74	10	Sub	3.2	13.2			3.2	1762.3	1762.3	6.8	6.8	6.8	Met
11294.46	830.754	2885	1745.35	1755.35	1753.58	1758.09	0.001975	13.27	217.37	22	0.74	10	Sub	3.2	13.2			3.2	1762.1	1762.1	6.8	6.8	6.8	Met
11340.31	784.896	2885	1745.27	1755.25	1753.5	1758	0.001984	13.3	216.99	22	0.75	9.98	Sub	3.2	13.2			3.2	1761.9	1761.9	6.7	6.7	6.7	Met
11386.16	739.038	2885	1745.18	1755.16	1753.41	1757.91	0.001985	13.3	216.95	22	0.75	9.98	Sub	3.2	13.2			3.2	1761.7	1761.7	6.6	6.6	6.6	Met
11432.01	693.18	2885	1745.09	1755.07	1753.32	1757.82	0.00199	13.31	216.75	22	0.75	9.98	Sub	3.3	13.2			3.3	1761.6	1761.6	6.5	6.5	6.5	Met
11481.57	643.624	2885	1744.99	1755.05	1753.08	1757.69	0.001896	13.04	221.31	22	0.72	10.06	Sub	3.1	13.2			3.1	1761.4	1761.4	6.3	6.3	6.3	Met
11531.13	594.067	2916	1744.89	1754.8	1753.06	1757.58	0.002018	13.38	217.96	22	0.75	9.91	Sub	3.3	13.2			3.3	1761.2	1761.2	6.4	6.4	6.4	Met
11580.69	544.512	2916	1744.78	1754.7	1752.95	1757.47	0.002011	13.36	218.25	22	0.75	9.92	Sub	3.3	13.2			3.3	1761.0	1761.0	6.3	6.3	6.3	Met
11630.25	494.955	2916	1744.68	1754.6	1752.85	1757.37	0.002011	13.36	218.25	22	0.75	9.92	Sub	3.3	13.2			3.3	1760.9	1760.9	6.3	6.3	6.3	Met
11679.81	445.399	2916	1744.58	1754.5	1752.75	1757.27	0.002011	13.36	218.27	22	0.75	9.92	Sub	3.3	13.2			3.3	1760.8	1760.8	6.3	6.3	6.3	Met
11729.37	395.843	2916	1744.47	1754.41	1752.64	1757.17	0.002003	13.34	218.56	22	0.75	9.94	Sub	3.3	13.2			3.3	1760.7	1760.7	6.3	6.3	6.3	Met
11778.93	346.287	2916	1744.37	1754.31	1752.54	1757.07	0.002003	13.34	218.58	22	0.75	9.94	Sub	3.3	13.2			3.3	1760.6	1760.6	6.3	6.3	6.3	Met
11828.49	296.731	2916	1744.27	1754.21	1752.44	1756.97	0.002002	13.34	218.6	22	0.75	9.94	Sub	3.3	13.2			3.3	1760.5	1760.5	6.3	6.3	6.3	Met
11878.05	247.175	2916	1744.17	1754.11	1752.34	1756.87	0.002002	13.34	218.61	22	0.75	9.94	Sub	3.3	13.2			3.3	1760.4	1760.4	6.3	6.3	6.3	Met
11927.61	197.619	2916	1744.06	1754.01	1752.23	1756.77	0.001994	13.32	218.92	22	0.74	9.95	Sub	3.3	13.2			3.3	1760.3	1760.3	6.3	6.3	6.3	Met
11977.17	148.063	2916	1743.96	1753.91	1752.13	1756.67	0.001994	13.32	218.95	22	0.74	9.95	Sub	3.3	13.2			3.3	1760.2	1760.2	6.3	6.3	6.3	Met
12026.73	98.5078	2916	1743.86	1753.81	1752.03	1756.57	0.001993	13.32	218.98	22	0.74	9.95	Sub	3.3	13.2			3.3	1760.1	1760.1	6.3	6.3	6.3	Met

Appendix C

Geotechnical Investigations

- Appendix C-1: Draft Geotechnical Data Report
- Appendix C-2: Draft Geotechnical Interpretive Report
- Appendix C-3: Draft Hydrogeologic Aquifer Testing Report

Appendix C-1

Draft Geotechnical Data Report

**GEOTECHNICAL DATA REPORT
LAS VEGAS WASH CENTRAL
CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA**

PREPARED FOR:

Atkins
2270 Corporate Circle, Suite 200
Henderson, Nevada 89074

PREPARED BY:

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
6700 Paradise Road, Suite E
Las Vegas, Nevada 89119

April 10, 2015
Project No. 303710001

April 10, 2015
Project No. 303710001

Mr. Harshal Desai
Atkins
2270 Corporate Circle, Suite 200
Henderson, Nevada 89074-7755

Subject: Geotechnical Data Report
Las Vegas Wash Central Cedar Avenue Channel Facility
Las Vegas, Nevada

Dear Mr. Desai:

Transmitted herewith are the data results of Ninyo & Moore's geotechnical evaluation for the proposed Las Vegas Wash Central Cedar Avenue Channel Facility in Las Vegas, Nevada. The purposes of our geotechnical study were to evaluate the subsurface soil conditions along the subject alignment and to provide our findings. We appreciate the opportunity to be of service to you on this project.

Respectfully submitted,
NINYO & MOORE

Naik Banavathu, P.E.
Principal Engineer
NB/BLO/dh

Brad L. Olsen, PE
Principal Engineer

Distribution: (1) Addressee (via e-mail)

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1. INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical evaluation for the proposed Las Vegas Wash Central Cedar Avenue Channel Facility project in Las Vegas, Nevada. The approximate location of the alignment is indicated on Figure 1. The purposes of our geotechnical study were to evaluate the subsurface soil conditions along the subject alignment. This report presents the findings of our subsurface exploration, results of our background review and laboratory testing.

This study was performed concurrently with a hydrogeologic study, also performed by Ninyo & Moore. A report presenting the results of our hydrogeologic study will be submitted under separate cover.

Ninyo & Moore is currently performing a geotechnical evaluation for the City of Las Vegas Bonanza-Mojave Reuse Pipeline project, which includes a pipeline alignment extending from the City of Las Vegas Water Pollution Control Facility to Freedom Park in Las Vegas, Nevada. This evaluation included preparation of a geotechnical interpretive report. Data from this report, including two exploratory borings (B-108 and B-109) that were performed along Pecos Road approximately between Stewart Avenue and Bonanza Road, were used to the extent possible for this evaluation.

2. SCOPE OF SERVICES

The scope of our services included the following:

- Review of pertinent background data listed in the References section of this report. The data reviewed included drawings, in-house geotechnical and soils data, aerial photographs, and published soils and geologic maps and literature.
- Coordination and mobilization for subsurface exploration. Markout of existing utilities in areas of our exploratory borings was conducted through Underground Service Alert (USA).
- Drilling, logging, and sampling of 20 exploratory borings, which were advanced to depths ranging from approximately 10 to 25 feet. The borings were performed to evaluate subsurface conditions along the proposed alignment and to obtain soil samples for laboratory testing.

- Performance of laboratory tests on selected soil samples obtained from the exploratory borings to evaluate physical and engineering properties of the soils, including in-place moisture content and dry density, gradation, plasticity, expansivity, sodium content, sulfate content, sodium sulfate content, and solubility potential (total salts).
- Compilation and analysis of accumulated data.
- Preparation of this data report presenting results of our background review, subsurface exploration and laboratory testing.

3. PROJECT DESCRIPTION

Based on our conversations with Atkins personnel, we understand that the project will include design and construction/installation of new flood control structures, including reinforced concrete box (RCB) and a concrete lined rectangular channel. The project will include approximately 1,400 linear feet of 14-foot by 6-foot RCB extending north along Pecos Road from Stewart Avenue to a wash channel right-of-way (ROW) where it will then turn and extend east within the wash ROW another 400 feet to its confluence with the existing concrete-lined trapezoidal channel. From this point, the alignment will extend east approximately 9,000 linear feet to its terminus at Las Vegas Wash. The project will include converting the existing trapezoidal channel to a rectangular channel by removing the current side slopes. The existing trapezoidal channel is approximately 7 to 10 feet deep. The project will also include improvements under the street crossings at Lamb Boulevard and Marion Drive. It is anticipated that the RCB's in Pecos Road will have approximately 2 to 12 feet of cover and will be installed by cut-and-cover methods. It is anticipated that the invert depths of the improved channel will be similar to the current invert depths except at the downstream end of the channel (from 400 feet upstream of Marion Drive to the Las Vegas Wash).

4. GENERAL ALIGNMENT CONDITIONS

The proposed alignment will extend along portions of Pecos Road and existing Cedar Avenue Channel ROW. At the time of our geotechnical reconnaissance, Pecos Road extended in a north-to-south direction and was generally bordered by residential properties to the east and a golf course to the west. The existing concrete-lined trapezoidal channel extended in an east-to-west

direction and was generally bordered by residential properties to the north and south. An elementary school was located to the south of the channel near the Lamb Boulevard crossing and north of the channel near Page Street crossing. Chain-link fencing and concrete block screen walls were located on the north and south sides of the channel.

The existing channel was up to approximately 30 feet wide and up to approximately 10 feet deep. An asphalt-concrete paved trail, up to approximately 15 feet wide, was located to the north of the existing channel. The existing trail is at an elevation of approximately 1,792 feet above mean sea level (AMSL) near Pecos Road and at an elevation of approximately 1,760 feet AMSL near Las Vegas Wash. Water, several inches deep, was observed flowing in the channel bottom. The existing channel crosses under numerous streets, including Honolulu Street, Sandhill Road, Lamb Boulevard, Page Street, and Marion Drive. At the time of our geotechnical reconnaissance, all these streets were paved with asphalt concrete and extended in a north-south direction. All these streets in the vicinity of the project alignment were fully improved with curb, gutter, and sidewalks. Honolulu Street and Page Street included one lane each way, Marion Drive and Sandhill Road included one lane each way with a turn lane, and Lamb Boulevard included three lanes each way with a two-way left turn lane.

Indications of underground utilities observed in the vicinity of the alignment included gas, water, storm drain, and electric lines. Other underground utilities may be present in the vicinity of the project.

5. GEOLOGY

Based on our field observations, subsurface exploration, and review of referenced geologic and soils data, the project alignment is underlain primarily by relatively shallow fill, which is in turn underlain by Quaternary-age alluvium (native soil). Ninyo & Moore's findings regarding the geologic setting, potential geologic hazards and problematic soils, and ground motions are provided in the following sections.

5.1. Geologic Setting

The project alignment is located in the eastern portion of Las Vegas Valley, which lies in the southwestern portion of the Great Basin, within the Basin and Range physiographic province. Las Vegas Valley is a naturally formed structural basin as a result of block faulting, a fundamental characteristic of the Basin and Range physiographic province.

Las Vegas Valley extends in a northwest-southeast direction and drains generally toward the southeast through Las Vegas Wash into Lake Mead. Bordering the alluvium-filled valley are relatively steep mountain ranges, including the Spring Mountains to the west; the Desert, Sheep, and Las Vegas ranges to the north; the McCullough Range to the south; and Sunrise Mountain, Frenchman Mountain, and River Mountains to the east.

Las Vegas Valley is underlain at depth by Proterozoic-age igneous and metamorphic basement rock, which is overlain by thick layers of Paleozoic- and Mesozoic-age sedimentary rock, and Tertiary-age volcanic rock. The lower lying areas of Las Vegas Valley generally contain relatively fine-grained alluvial, aeolian, and playa deposits. Extending outward into the valley from the bordering mountain fronts, are sloping alluvial aprons, or fans, comprised primarily of poorly sorted gravel and sand deposits with cobbles and boulders. The soils are up to approximately 5,000 feet thick in some areas of the valley.

5.2. Potential Geologic Hazards and Problematic Soils

Ninyo & Moore's geotechnical study included an evaluation of the possible presence of geologic hazards, such as faults and ground fissures, in the project alignment area. This evaluation included visual observation of the alignment for indications of adverse geologic features and review of published geologic and soils maps and literature, and other data listed in the References section of this report. Referenced geologic data were also reviewed to evaluate seismic activity levels, and associated potential earthquake hazards, for faults in the alignment vicinity. It should be noted that the fault seismic activity levels provided in this section were obtained/interpreted primarily from United States Geological Survey (USGS, 2015b) data.

Review of referenced geologic data indicates that the nearest active fault (i.e., a fault that has experienced ground surface rupture within the past 11,000 years) to the alignment is the Black Hills fault. The Frenchman Mountain fault and the Eglington fault, which are considered potentially active (i.e., faults that have experienced ground surface rupture within the past 1.6 million years) are also located in the alignment vicinity. The distances from the alignment to these active and potentially active faults are provided in Table 1.

Review of referenced geologic data also indicates that an unnamed Las Vegas Valley fault extends through the western portion of the alignment (Figure 2). Referenced USGS data indicate that this fault is of uncertain origin and that its seismic activity level has not been established. During our geologic field reconnaissance along the project alignment, surficial indications of previous faulting were not observed. The origin of this geologic feature, and other similar features in southern Nevada, which have been previously referred to as “compaction faults.” Differing proposed origins for these faults include:

- Differential consolidation or compaction over time of the thick alluvial and lakebed sediments in valley areas.
- Tectonic factors associated with faults that may extend into the basement bedrock beneath the valley sediment.
- A combination of differential consolidation and tectonic factors.

Table 1 – Faults in Project Alignment Vicinity

Fault Name	Seismic Activity Level *	Approximate Distance From Project Alignment to Fault (miles)
Black Hills fault	Active	16
Eglington fault	Potentially Active	8
Frenchman Mountain fault	Potentially Active	3
Unnamed Las Vegas Valley fault	Not Established	Extends through alignment (see Figure 2)
*From United States Geological Survey (USGS, 2015b) data.		

Ground fissures, generally believed to be caused by erosion and differential stress resulting from regional subsidence due primarily to withdrawal of groundwater, are known to occur near faults in southern Nevada. Review of the referenced geologic data does not indicate the

presence of ground fissures along the project alignment and no ground fissures were observed during our field activities. However, it should be noted that the ground surface had been disturbed/obscured by previous development.

As part of this study, Ninyo & Moore evaluated whether the project alignment is located in a Special Geotechnical Considerations Area, as shown on the referenced Clark County Soil Guidelines Map (Clark County Building Department, 1998). This map indicates important aspects of near-surface soils and geologic features in the Las Vegas Valley. Review of the Clark County Soil Guidelines Map indicates that the portion of the project alignment between Stewart Avenue and Sandhill Road is located in a *Special Geotechnical Considerations Area - Subsidence and 2,000-Foot Compaction or Seismic Fault Buffer Zone*. This buffer zone is considered to contain 90 percent of mapped ground fissures. These potential ground fissure areas extend approximately 1,000 feet to each side of faults. The portion of the project alignment between Sandhill Road and Marion Drive is located in a *Special Geotechnical Considerations Area - Solubility, Clay Swell, Corrosion, Gypsum Salt, Expansive or Hydro-collapsible Potential*: This area is indicative of potentially moisture-sensitive and corrosive soils. The portion of the alignment located between Marion Drive and Las Vegas Wash is located in a *Special Geotechnical Considerations Area - Potential Drainage Areas or Recent Sediment Deposits, which may also have Solubility, Clay Swell, Corrosion, Gypsum Salt, Expansive or Hydro-collapsible Potential*. This area is in the vicinity of major drainages and may also contain potentially moisture-sensitive and corrosive soils.

The Clark County Expansive Soil Guidelines Map (Clark County Development Services Department, 2006) indicates general trends of near-surface soils in the Las Vegas Valley. This map shows areas of the valley where previous geotechnical studies have indicated the presence of moderately, highly, and critically expansive soils. Based on review of this map, the portion of the project alignment between Stewart Avenue and Honolulu Street is located in an area prone to moderately expansive soil and the remaining portion of the alignment is located in an area prone to highly expansive soil.

5.3. Ground Motions

Using the referenced United States Geological Survey database (USGS, 2015a), estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the project alignment, which is located at approximately 36.1699 degrees north latitude and -115.0891 degrees west longitude. Based on the referenced International Building Code (ICC, 2012) and due to a detailed seismic site class evaluation not being performed for the project, Seismic Site Class D is appropriate for the project alignment and the parameters in the following table are characteristic of the project alignment for design purposes.

Table 2 – Seismic Design Parameters

Parameters	Value		Reference (ICC, 2012)
	Short Period	Long Period	
Mapped Maximum Considered Earthquake Spectral Response Acceleration, S_S and S_1	0.495g	0.164g	Figure 1613.3.1 and referenced database (USGS, 2015a)
Site Coefficient, F_a and F_v	1.40	2.14	Table 1613.3.3
Maximum Considered Earthquake Spectral Response Acceleration Adjusted for Site Class Effects, S_{MS} and S_{M1}	0.695g	0.352g	Equations 16-37 and 16-38
Design Spectral Response Acceleration, S_{DS} and S_{D1}	0.463g	0.235g	Equations 16-39 and 16-40

6. FIELD EXPLORATION, LABORATORY TESTING, AND SUBSURFACE CONDITIONS

Ninyo & Moore's subsurface exploration along the project alignment was performed from March 5 through March 16, 2015. This exploration consisted of drilling, logging, and sampling of 20 small-diameter exploratory borings. The borings were advanced to depths ranging from approximately 10 to 25 feet with a truck-mounted Mobile B-57 and CME-75 drill rigs utilizing 8-inch diameter hollow-stem augers and a track-mounted CME-55 drill rig utilizing 8-inch diameter hollow-stem augers. The purpose of the borings was to evaluate subsurface conditions along the project alignment, as well as to collect bulk and relatively undisturbed soil samples for laboratory testing. The approximate locations of the borings along with the pertinent borings from the other study previously discussed are shown on Figure 2.

Laboratory tests were performed on representative soil samples collected from the borings to evaluate physical and engineering properties of the soils, including in-place moisture content and dry density, gradation, plasticity, expansivity, sodium content, sulfate content, sodium sulfate content, and solubility potential (total salts). The results of the in-place moisture content and dry density tests are provided on the boring logs in Appendix A. Ground surface elevations at boring locations surveyed by Atkins personnel are also provided on the boring logs. Descriptions of the laboratory testing procedures utilized and the other test results are presented in Appendix B and Appendix C.

6.1. Subsurface Soils Encountered

Generalized descriptions of the subsurface soils (fill and native soil) encountered in the exploratory borings are provided in the following sections.

6.1.1. Fill

Fill material, up to approximately 1.8 feet deep, was encountered in our exploratory borings. In addition, fill material approximately 7.0 feet deep was encountered in boring B-17. The encountered fill soils were comprised primarily of medium dense to dense, silty gravel with sand. A dense, clayey sand with gravel layer was also encountered in boring B-17. Much of the fill encountered in our borings was likely associated with channel sidewall backfill and/or roadway fill material.

Asphalt concrete pavement and underlying aggregate base material was penetrated in all of our 20 borings drilled during our subsurface evaluation for the subject project. The approximate thicknesses of asphalt concrete and underlying aggregate base material encountered in these borings are summarized in the following table.

Table 3 – Existing Asphalt Concrete Pavement and Aggregate Base Thicknesses

Boring	Approximate Thickness of Asphalt Concrete (inches)	Approximate Thickness of Aggregate Base Material (inches)
B-1	9-1/8	12 to 13
B-2	2	3-1/2
B-3	2	4-1/2
B-4	2-1/2	5-1/2
B-5	1-1/2	5-1/2
B-6	1-7/8	5
B-7	2-1/2	4
B-8	2-1/2	4
B-9	2-3/4	4
B-10	2-1/2	5-1/2
B-11	3	4
B-12	2-7/8	5-1/2
B-13	2-3/4	4-1/2
B-14	2-5/8	4-3/4
B-15	2-1/2	11
B-16	2-1/2	12 to 13
B-17	2-5/8	12 to 13
B-18	3-1/2	12 to 13
B-19	3	12 to 13
B-20	3-1/4	8-1/2
B-108*	8-3/4	5
B-109*	8-1/4	7

* Boring from previous evaluation

6.1.2. Native Soil

Native soil was encountered beneath the noted fill and extended to the total depths of our exploratory borings. The encountered native soil consisted primarily of firm to very stiff lean clay and fat clay with varying amounts of sand and gravel. An approximately 5-foot thick layer of stiff to very stiff silt with sand was encountered at a depth of approximately 12 and 15 feet in borings B-19 and B-20, respectively.

Layers of hard to very hard, strongly cemented soil (caliche) were not encountered in our exploratory borings. However, moderately hard, moderately cemented soils were encountered at the bottom of borings B-19 and B-20 at a depth of approximately 26 feet. Caliche is a naturally occurring cemented soil with rock-like characteristics. The following describes typical properties of caliche encountered in southern Nevada.

- Generally occurs in layers a few inches to several feet thick.

- Layers typically vary significantly in thickness, degree of cementation, and hardness over relatively short distances.
- Varies in composition from primarily fine-grained material to primarily coarse-grained material.
- Moderately hard, moderately cemented caliche can generally be gouged with a knife with difficulty and broken with a few hammer blows.
- Hard and very hard, strongly cemented caliche is difficult to scratch with a knife and breaks with difficulty with repeated hammer blows.
- Impedes earthwork operations, including grading and utility line trenching. Rock excavation methods are generally needed.

Laboratory tests were performed on representative samples of native soil obtained from the exploratory borings. Results of these tests are summarized in the following table.

Table 4 – Summary of Laboratory Test Results

Test Type	Test Results	Remarks
Atterberg Limits Liquid Limit Plastic Limit Plasticity Index	24 to 64 16 to 32 7 to 42	Low to high plasticity
Expansion Index	41 to 140	Low to very high
Sodium Sulfate Content	0.03 to 0.70 percent	Negligible to moderate chemical heave (salt heave) potential
Sodium Content	0.03 to 0.42 percent	--
Sulfate Content	0.02 to 0.47 percent	Negligibly to severely deleterious to concrete
Total Salts (Solubility)	0.15 to 1.86 percent	Low to high solubility potential

6.2. Selected and Granular Backfill Suitability

As a part of this study, Ninyo & Moore evaluated the suitability of encountered soils for use as trench backfill material. Clark County gradation and plasticity requirements (Clark County, 2003) for Selected and Granular Backfill (USSPWC Sections 207.02.01 and 207.02.02, respectively), along with the results of gradation and Atterberg limits tests performed by Ninyo & Moore, are presented in the following table.

Table 5 – Selected and Granular Backfill Suitability

Sieve Size	Specified Percent of Weight Passing *		Percent of Weight Passing				
	Selected Backfill	Granular Backfill	B-1 5.0-6.5	B-3 2.0-3.5	B-5 2.0-3.5	B-6 5.0-6.5	B-9 5.0-6.5
3-inch	80-100	100	100	100	100	100	100
No. 4	35-100	35-100	100	82	100	100	100
No. 16	--	25-100	100	73	100	100	100
No. 200	--	5-15	86.1	61.6	88.8	84.3	93.8
Plasticity Index	15 max	15 max.	42	34	31	23	17
Meets Selected Backfill Requirements?			No	No	No	No	No
Meets Granular Backfill Requirements?			No	No	No	No	No
* USSPWC requirements							

Table 5 (continued) – Selected and Granular Backfill Suitability

Sieve Size	Specified Percent of Weight Passing *		Percent of Weight Passing				
	Selected Backfill	Granular Backfill	B-12 5.0-6.5	B-14 5.0-6.5	B-17 5.0-6.5	B-18 10.0-11.5	B-20 15.0-16.5
3-inch	80-100	100	100	100	100	100	100
No. 4	35-100	35-100	100	100	58	99	100
No. 16	--	25-100	98	100	41	99	100
No. 200	--	5-15	95.0	96.6	19.0	82.3	81.8
Plasticity Index	15 max	15 max.	8	12	14	7	20
Meets Selected Backfill Requirements?			No	No	No	No	No
Meets Granular Backfill Requirements?			No	No	No	No	No
* USSPWC requirements							

6.3. Groundwater

Groundwater was encountered in 12 of our 20 exploratory borings. Borings B-1, B-2, B-6, and B-20 were converted to temporary monitoring wells for the hydrogeologic study. The approximate depths to groundwater levels measured in the exploratory borings are presented in the following table. Depths to groundwater are also included on the boring logs in Appendix A.

Table 6 – Measured Groundwater Levels

Boring	Approximate Boring Elevation (feet-amsl)	Approximate Time Measured After Drilling (days)	Approximate Depth to Groundwater (feet)*	Approximate Groundwater Elevation (feet-amsl)
B-1	1,795.4	3	12.2	1,783.2
B-2	1,791.6	4	12.7	1,778.9
B-3	1,783.9	1	8.2	1,775.7
B-4	1,781.9	1	8.4	1,773.5
B-5	1,779.6	4	6.9	1,772.7
B-6	1,778.2	4	8.4	1,769.8
B-10	1,772.5	4	13.6	1,758.9
B-16	1,764.1	4	13.6	1,750.5
B-17	1,761.7	4	15.4	1,746.3
B-18	1,762.3	1	18.4	1,743.9
B-19	1,761.7	3	18.7	1,743.0
B-20	1760.5	3	18.4	1,742.1
*Measured from top of ground surface (top of channel bank) adjacent to boring.				

Ninyo & Moore's groundwater measurements reflect conditions at the time of our subsurface exploration and do not preclude local and/or seasonal fluctuations in groundwater levels. These fluctuations may be due to variations in ground surface topography, subsurface geologic conditions, rainfall, and other factors. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this study.

7. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical data report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the findings presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that

our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for data purposes only. It does not provide sufficient data to prepare an accurate bid by some contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

If geotechnical conditions different from those described in this report are encountered, our office should be notified. It should be understood that the conditions along the project alignments could change with time as a result of natural processes or the activities of man along the subject alignments or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings of this report by parties other than the client is undertaken at said parties' sole risk.

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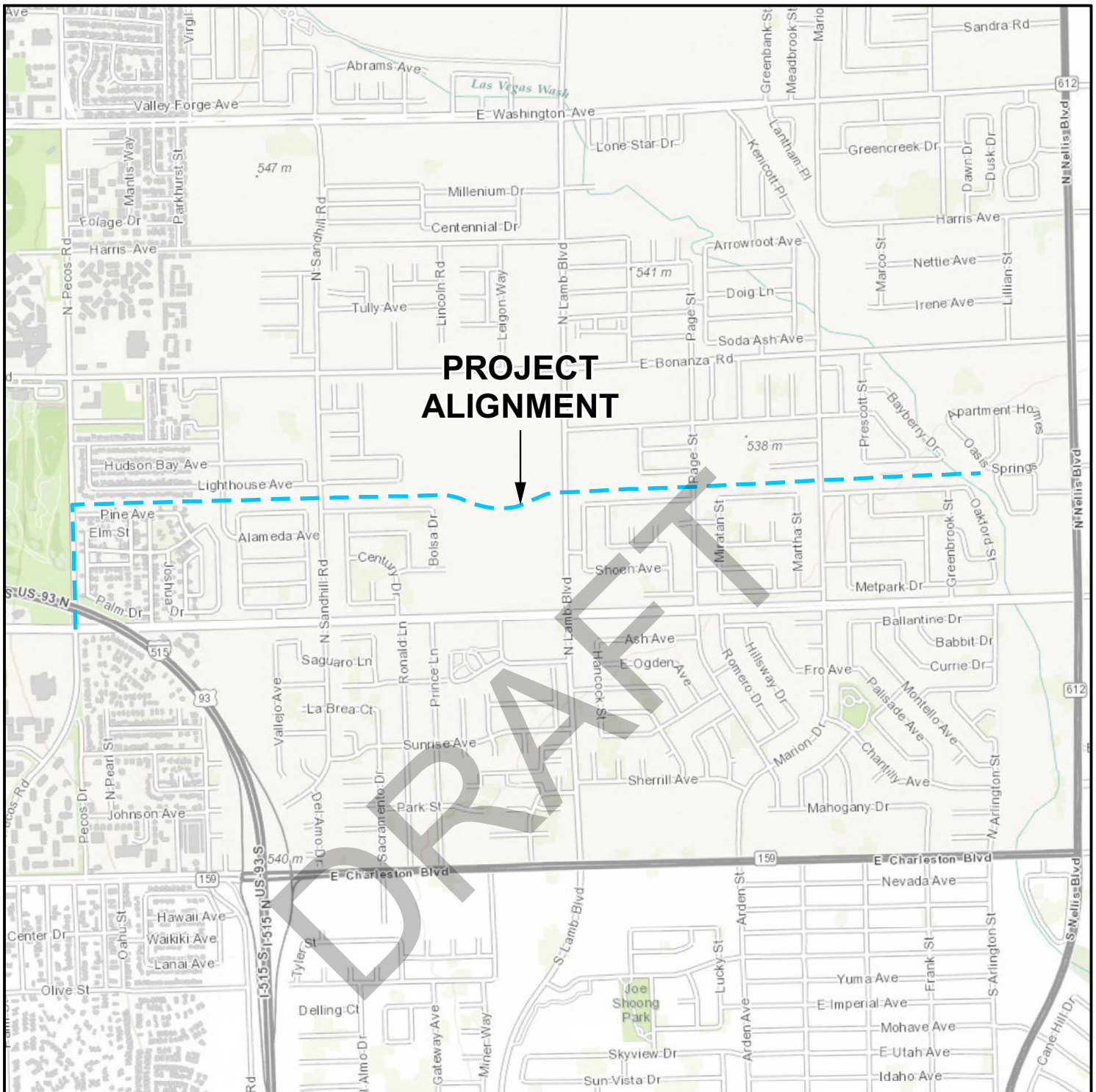
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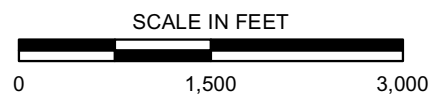
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DRAFT



SOURCES: ESRI WORLD TOPO, 2015



NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore

ALIGNMENT LOCATION

FIGURE

PROJECT NO.

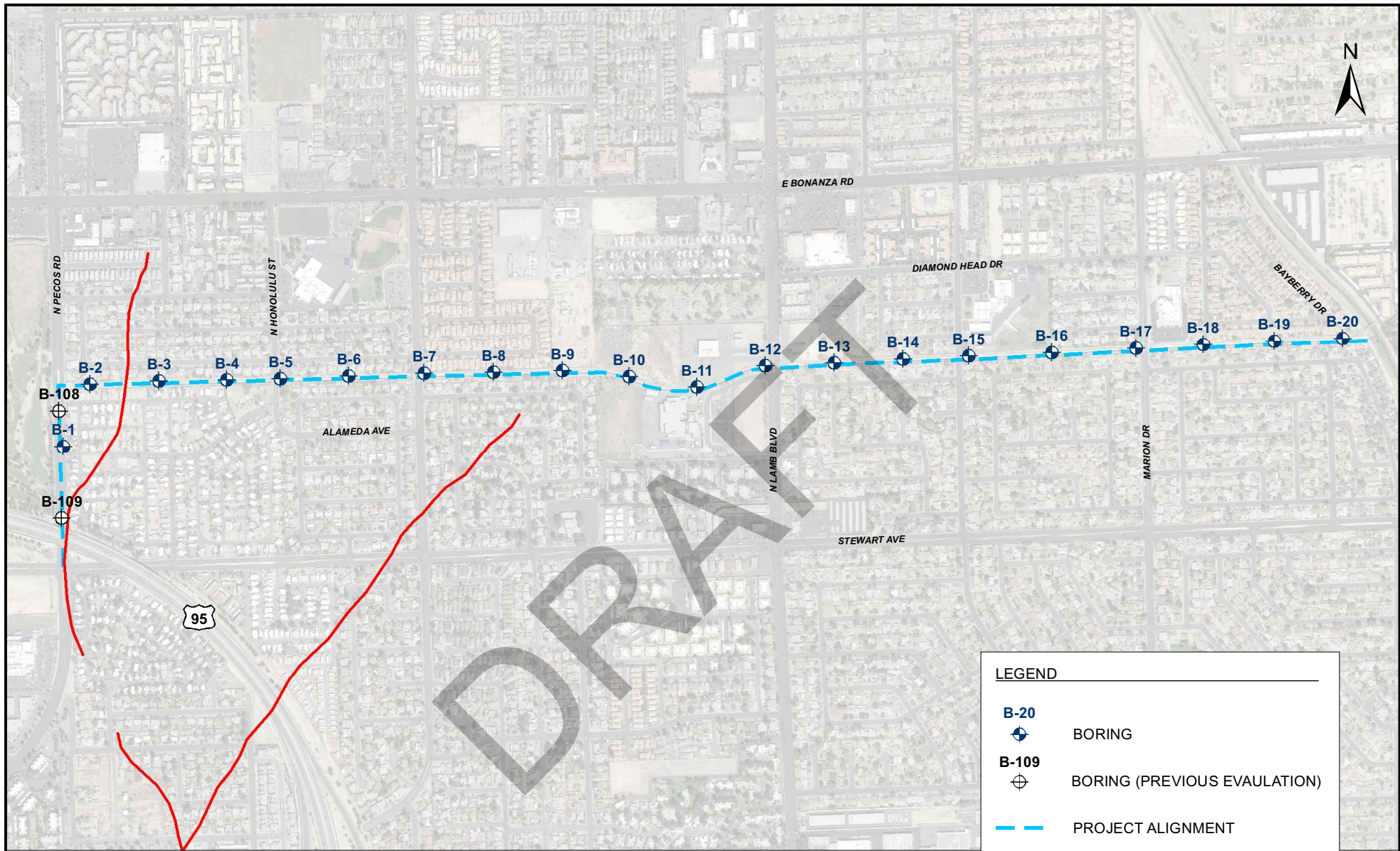
DATE

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA

303710001

4/15

1



SOURCE: DEPOLO, C.M. AND BELL, J.W., 2000, MAP OF FAULTS AND EARTH FISSURES IN THE LAS VEGAS AREA (NEVADA BUREAU OF MINES AND GEOLOGY); GOOGLE EARTH, 2015

LEGEND

B-20

BORING

B-109

BORING (PREVIOUS EVALUATION)

PROJECT ALIGNMENT

MAPPED FAULT

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

BORING LOCATIONS

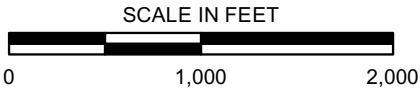
FIGURE

PROJECT NO.
303710001

DATE
4/15

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA

2



Appendix C-2

Draft Geotechnical Interpretive Report

**GEOTECHNICAL INTERPRETIVE REPORT
LAS VEGAS WASH CENTRAL
CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA**

PREPARED FOR:

Atkins
2270 Corporate Circle, Suite 200
Henderson, Nevada 89074

PREPARED BY:

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
6700 Paradise Road, Suite E
Las Vegas, Nevada 89119

April 10, 2015
Project No. 303710001

April 10, 2015
Project No. 303710001

Mr. Harshal Desai
Atkins
2270 Corporate Circle, Suite 200
Henderson, Nevada 89074-7755

Subject: Geotechnical Interpretive Report
Las Vegas Wash Central Cedar Avenue Channel Facility
Las Vegas, Nevada

Dear Mr. Desai:

Transmitted herewith is the Geotechnical Interpretive Report, which is based on the results of Ninyo & Moore's geotechnical evaluation for the proposed Las Vegas Wash Central Cedar Avenue Channel Facility in Las Vegas, Nevada. The purposes of our geotechnical study were to evaluate the subsurface soil conditions along the subject alignment and to provide design and construction recommendations regarding geotechnical aspects of the project. We appreciate the opportunity to be of service to you on this project.

Respectfully submitted,
NINYO & MOORE

Naik Banavathu, P.E.
Principal Engineer

NB/BLO/dh

Brad L. Olsen, PE
Principal Engineer

Distribution: (1) Addressee (via e-mail)

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Appendix B – Laboratory Testing
Appendix C – Chemical Test Results
Appendix D – Exploratory Boring logs From Our Previous Evaluation

1. INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical evaluation for the proposed Las Vegas Wash Central Cedar Avenue Channel Facility project in Las Vegas, Nevada. The approximate location of the alignment is indicated on Figure 1. The purposes of our geotechnical study were to evaluate the subsurface soil conditions along the subject alignment and to provide design and construction recommendations regarding geotechnical aspects of the project. This report presents the findings of our subsurface exploration, results of our laboratory testing, conclusions regarding the subsurface soil conditions along the alignment, and geotechnical recommendations for the design and construction of this project.

This study was performed concurrently with a hydrogeologic study, also performed by Ninyo & Moore. A report presenting the results of our hydrogeologic study will be submitted under separate cover.

Ninyo & Moore is currently performing a geotechnical evaluation for the City of Las Vegas Bonanza-Mojave Reuse Pipeline project, which includes a pipeline alignment extending from the City of Las Vegas Water Pollution Control Facility to Freedom Park in Las Vegas, Nevada. This evaluation included preparation of a geotechnical interpretive report. Data from this report, including two exploratory borings (B-108 and B-109) that were performed along Pecos Road approximately between Stewart Avenue and Bonanza Road, were used to the extent possible for this evaluation.

2. SCOPE OF SERVICES

The scope of our services included the following:

- Review of pertinent background data listed in the References section of this report. The data reviewed included drawings, in-house geotechnical and soils data, aerial photographs, and published soils and geologic maps and literature.
- Coordination and mobilization for subsurface exploration. Markout of existing utilities in areas of our exploratory borings was conducted through Underground Service Alert (USA).

- Drilling, logging, and sampling of 20 exploratory borings, which were advanced to depths ranging from approximately 10 to 25 feet. The borings were performed to evaluate subsurface conditions along the proposed alignment and to obtain soil samples for laboratory testing.
- Performance of laboratory tests on selected soil samples obtained from the exploratory borings to evaluate physical and engineering properties of the soils, including in-place moisture content and dry density, gradation, plasticity, expansivity, sodium content, sulfate content, sodium sulfate content, and solubility potential (total salts).
- Compilation and analysis of accumulated data.
- Preparation of this geotechnical interpretive report presenting our findings, conclusions, and recommendations regarding the subject project.

3. PROJECT DESCRIPTION

Based on our conversations with Atkins personnel, we understand that the project will include design and construction/installation of new flood control structures, including reinforced concrete box (RCB) and a concrete lined rectangular channel. The project will include approximately 1,400 linear feet of 14-foot by 6-foot RCB extending north along Pecos Road from Stewart Avenue to a wash channel right-of-way (ROW) where it will then turn and extend east within the wash ROW another 400 feet to its confluence with the existing concrete-lined trapezoidal channel. From this point, the alignment will extend east approximately 9,000 linear feet to its terminus at Las Vegas Wash. The project will include converting the existing trapezoidal channel to a rectangular channel by removing the current side slopes. The existing trapezoidal channel is approximately 7 to 10 feet deep. The project will also include improvements under the street crossings at Lamb Boulevard and Marion Drive. It is anticipated that the RCB's in Pecos Road will have approximately 2 to 12 feet of cover and will be installed by cut-and-cover methods. It is anticipated that the invert depths of the improved channel will be similar to the current invert depths except at the downstream end of the channel (from 400 feet upstream of Marion Drive to the Las Vegas Wash).

4. GENERAL ALIGNMENT CONDITIONS

The proposed alignment will extend along portions of Pecos Road and existing Cedar Avenue Channel ROW. At the time of our geotechnical reconnaissance, Pecos Road extended in a north-to-south direction and was generally bordered by residential properties to the east and a golf course to the west. The existing concrete-lined trapezoidal channel extended in an east-to-west direction and was generally bordered by residential properties to the north and south. An elementary school was located to the south of the channel near the Lamb Boulevard crossing and north of the channel near Page Street crossing. Chain-link fencing and concrete block screen walls were located on the north and south sides of the channel.

The existing channel was up to approximately 30 feet wide and up to approximately 10 feet deep. An asphalt-concrete paved trail, up to approximately 15 feet wide, was located to the north of the existing channel. The existing trail is at an elevation of approximately 1,792 feet above mean sea level (AMSL) near Pecos Road and at an elevation of approximately 1,760 feet AMSL near Las Vegas Wash. Water, several inches deep, was observed flowing in the channel bottom. The existing channel crosses under numerous streets, including Honolulu Street, Sandhill Road, Lamb Boulevard, Page Street, and Marion Drive. At the time of our geotechnical reconnaissance, all these streets were paved with asphalt concrete and extended in a north-south direction. All these streets in the vicinity of the project alignment were fully improved with curb, gutter, and sidewalks. Honolulu Street and Page Street included one lane each way, Marion Drive and Sandhill Road included one lane each way with a turn lane, and Lamb Boulevard included three lanes each way with a two-way left turn lane.

Indications of underground utilities observed in the vicinity of the alignment included gas, water, storm drain, and electric lines. Other underground utilities may be present in the vicinity of the project.

5. GEOLOGY

Based on our field observations, subsurface exploration, and review of referenced geologic and soils data, the project alignment is underlain primarily by relatively shallow fill, which is in turn

underlain by Quaternary-age alluvium (native soil). Ninyo & Moore's findings regarding the geologic setting, potential geologic hazards and problematic soils, and ground motions are provided in the following sections.

5.1. Geologic Setting

The project alignment is located in the eastern portion of Las Vegas Valley, which lies in the southwestern portion of the Great Basin, within the Basin and Range physiographic province. Las Vegas Valley is a naturally formed structural basin as a result of block faulting, a fundamental characteristic of the Basin and Range physiographic province.

Las Vegas Valley extends in a northwest-southeast direction and drains generally toward the southeast through Las Vegas Wash into Lake Mead. Bordering the alluvium-filled valley are relatively steep mountain ranges, including the Spring Mountains to the west; the Desert, Sheep, and Las Vegas ranges to the north; the McCullough Range to the south; and Sunrise Mountain, Frenchman Mountain, and River Mountains to the east.

Las Vegas Valley is underlain at depth by Proterozoic-age igneous and metamorphic basement rock, which is overlain by thick layers of Paleozoic- and Mesozoic-age sedimentary rock, and Tertiary-age volcanic rock. The lower lying areas of Las Vegas Valley generally contain relatively fine-grained alluvial, aeolian, and playa deposits. Extending outward into the valley from the bordering mountain fronts, are sloping alluvial aprons, or fans, comprised primarily of poorly sorted gravel and sand deposits with cobbles and boulders. The soils are up to approximately 5,000 feet thick in some areas of the valley.

5.2. Potential Geologic Hazards and Problematic Soils

Ninyo & Moore's geotechnical study included an evaluation of the possible presence of geologic hazards, such as faults and ground fissures, in the project alignment area. This evaluation included visual observation of the alignment for indications of adverse geologic features and review of published geologic and soils maps and literature, and other data listed in the References section of this report. Referenced geologic data were also reviewed to evaluate seismic activity levels, and

associated potential earthquake hazards, for faults in the alignment vicinity. It should be noted that the fault seismic activity levels provided in this section were obtained/interpreted primarily from United States Geological Survey (USGS, 2015b) data.

Review of referenced geologic data indicates that the nearest active fault (i.e., a fault that has experienced ground surface rupture within the past 11,000 years) to the alignment is the Black Hills fault. The Frenchman Mountain fault and the Eglington fault, which are considered potentially active (i.e., faults that have experienced ground surface rupture within the past 1.6 million years) are also located in the alignment vicinity. The distances from the alignment to these active and potentially active faults are provided in Table 1.

Review of referenced geologic data also indicates that an unnamed Las Vegas Valley fault extends through the western portion of the alignment (Figure 2). Referenced USGS data indicate that this fault is of uncertain origin and that its seismic activity level has not been established. During our geologic field reconnaissance along the project alignment, surficial indications of previous faulting were not observed. The origin of this geologic feature, and other similar features in southern Nevada, which have been previously referred to as “compaction faults.” Differing proposed origins for these faults include:

- Differential consolidation or compaction over time of the thick alluvial and lakebed sediments in valley areas.
- Tectonic factors associated with faults that may extend into the basement bedrock beneath the valley sediment.
- A combination of differential consolidation and tectonic factors.

Table 1 – Faults in Project Alignment Vicinity

Fault Name	Seismic Activity Level *	Approximate Distance From Project Alignment to Fault (miles)
Black Hills fault	Active	16
Eglington fault	Potentially Active	8
Frenchman Mountain fault	Potentially Active	3
Unnamed Las Vegas Valley fault	Not Established	Extends through alignment (see Figure 2)
*From United States Geological Survey (USGS, 2015b) data.		

Ground fissures, generally believed to be caused by erosion and differential stress resulting from regional subsidence due primarily to withdrawal of groundwater, are known to occur near faults in southern Nevada. Review of the referenced geologic data does not indicate the presence of ground fissures along the project alignment and no ground fissures were observed during our field activities. However, it should be noted that the ground surface had been disturbed/obscured by previous development.

As part of this study, Ninyo & Moore evaluated whether the project alignment is located in a Special Geotechnical Considerations Area, as shown on the referenced Clark County Soil Guidelines Map (Clark County Building Department, 1998). This map indicates important aspects of near-surface soils and geologic features in the Las Vegas Valley. Review of the Clark County Soil Guidelines Map indicates that the portion of the project alignment between Stewart Avenue and Sandhill Road is located in a *Special Geotechnical Considerations Area - Subsidence and 2,000-Foot Compaction or Seismic Fault Buffer Zone*. This buffer zone is considered to contain 90 percent of mapped ground fissures. These potential ground fissure areas extend approximately 1,000 feet to each side of faults. The portion of the project alignment between Sandhill Road and Marion Drive is located in a *Special Geotechnical Considerations Area - Solubility, Clay Swell, Corrosion, Gypsum Salt, Expansive or Hydro-collapsible Potential*: This area is indicative of potentially moisture-sensitive and corrosive soils. The portion of the alignment located between Marion Drive and Las Vegas Wash is located in a *Special Geotechnical Considerations Area - Potential Drainage Areas or Recent Sediment Deposits, which may also have Solubility, Clay Swell, Corrosion, Gypsum Salt, Expansive or Hydro-collapsible Potential*. This area is in the vicinity of major drainages and may also contain potentially moisture-sensitive and corrosive soils.

The Clark County Expansive Soil Guidelines Map (Clark County Development Services Department, 2006) indicates general trends of near-surface soils in the Las Vegas Valley. This map shows areas of the valley where previous geotechnical studies have indicated the presence of moderately, highly, and critically expansive soils. Based on review of this map, the portion of the project alignment between Stewart Avenue and Honolulu Street is located

in an area prone to moderately expansive soil and the remaining portion of the alignment is located in an area prone to highly expansive soil.

5.3. Ground Motions

Using the referenced United States Geological Survey database (USGS, 2015a), estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the project alignment, which is located at approximately 36.1699 degrees north latitude and -115.0891 degrees west longitude. Based on the referenced International Building Code (ICC, 2012) and due to a detailed seismic site class evaluation not being performed for the project, Seismic Site Class D is appropriate for the project alignment and the parameters in the following table are characteristic of the project alignment for design purposes.

Table 2 – Seismic Design Parameters

Parameters	Value		Reference (ICC, 2012)
	Short Period	Long Period	
Mapped Maximum Considered Earthquake Spectral Response Acceleration, S_s and S_1	0.495g	0.164g	Figure 1613.3.1 and referenced database (USGS, 2015a)
Site Coefficient, F_a and F_v	1.40	2.14	Table 1613.3.3
Maximum Considered Earthquake Spectral Response Acceleration Adjusted for Site Class Effects, S_{MS} and S_{M1}	0.695g	0.352g	Equations 16-37 and 16-38
Design Spectral Response Acceleration, S_{DS} and S_{D1}	0.463g	0.235g	Equations 16-39 and 16-40

6. FIELD EXPLORATION, LABORATORY TESTING, AND SUBSURFACE CONDITIONS

Ninyo & Moore's subsurface exploration along the project alignment was performed from March 5 through March 16, 2015. This exploration consisted of drilling, logging, and sampling of 20 small-diameter exploratory borings. The borings were advanced to depths ranging from approximately 10 to 25 feet with a truck-mounted Mobile B-57 and CME-75 drill rigs utilizing 8-inch diameter hollow-stem augers and a track-mounted CME-55 drill rig utilizing 8-inch diameter hollow-stem augers. The purpose of the borings was to evaluate subsurface conditions

along the project alignment, as well as to collect bulk and relatively undisturbed soil samples for laboratory testing. The approximate locations of the borings along with the pertinent borings from the other study previously discussed are shown on Figure 2.

Laboratory tests were performed on representative soil samples collected from the borings to evaluate physical and engineering properties of the soils, including in-place moisture content and dry density, gradation, plasticity, expansivity, sodium content, sulfate content, sodium sulfate content, and solubility potential (total salts). The results of the in-place moisture content and dry density tests are provided on the boring logs in Appendix A. Ground surface elevations at boring locations surveyed by Atkins personnel are also provided on the boring logs. Descriptions of the laboratory testing procedures utilized and the other test results are presented in Appendix B and Appendix C.

6.1. Subsurface Soils Encountered

Generalized descriptions of the subsurface soils (fill and native soil) encountered in the exploratory borings are provided in the following sections.

6.1.1. Fill

Fill material, up to approximately 1.8 feet deep, was encountered in our exploratory borings. In addition, fill material approximately 7.0 feet deep was encountered in boring B-17. The encountered fill soils were comprised primarily of medium dense to dense, silty gravel with sand. A dense, clayey sand with gravel layer was also encountered in boring B-17. Much of the fill encountered in our borings was likely associated with channel sidewall backfill and/or roadway fill material.

Asphalt concrete pavement and underlying aggregate base material was penetrated in all of our 20 borings drilled during our subsurface evaluation for the subject project. The approximate thicknesses of asphalt concrete and underlying aggregate base material encountered in these borings are summarized in the following table.

Table 3 – Existing Asphalt Concrete Pavement and Aggregate Base Thicknesses

Boring	Approximate Thickness of Asphalt Concrete (inches)	Approximate Thickness of Aggregate Base Material (inches)
B-1	9-1/8	12 to 13
B-2	2	3-1/2
B-3	2	4-1/2
B-4	2-1/2	5-1/2
B-5	1-1/2	5-1/2
B-6	1-7/8	5
B-7	2-1/2	4
B-8	2-1/2	4
B-9	2-3/4	4
B-10	2-1/2	5-1/2
B-11	3	4
B-12	2-7/8	5-1/2
B-13	2-3/4	4-1/2
B-14	2-5/8	4-3/4
B-15	2-1/2	11
B-16	2-1/2	12 to 13
B-17	2-5/8	12 to 13
B-18	3-1/2	12 to 13
B-19	3	12 to 13
B-20	3-1/4	8-1/2
B-108*	8-3/4	5
B-109*	8-1/4	7

* Boring from previous evaluation

6.1.2. Native Soil

Native soil was encountered beneath the noted fill and extended to the total depths of our exploratory borings. The encountered native soil consisted primarily of firm to very stiff lean clay and fat clay with varying amounts of sand and gravel. An approximately 5-foot thick layer of stiff to very stiff silt with sand was encountered at a depth of approximately 12 and 15 feet in borings B-19 and B-20, respectively.

Layers of hard to very hard, strongly cemented soil (caliche) were not encountered in our exploratory borings. However, moderately hard, moderately cemented soils were encountered at the bottom of borings B-19 and B-20 at a depth of approximately 26 feet. Caliche is a naturally occurring cemented soil with rock-like characteristics. The following describes typical properties of caliche encountered in southern Nevada.

- Generally occurs in layers a few inches to several feet thick.

- Layers typically vary significantly in thickness, degree of cementation, and hardness over relatively short distances.
- Varies in composition from primarily fine-grained material to primarily coarse-grained material.
- Moderately hard, moderately cemented caliche can generally be gouged with a knife with difficulty and broken with a few hammer blows.
- Hard and very hard, strongly cemented caliche is difficult to scratch with a knife and breaks with difficulty with repeated hammer blows.
- Impedes earthwork operations, including grading and utility line trenching. Rock excavation methods are generally needed.

Laboratory tests were performed on representative samples of native soil obtained from the exploratory borings. Results of these tests are summarized in the following table.

Table 4 – Summary of Laboratory Test Results

Test Type	Test Results	Remarks
Atterberg Limits Liquid Limit Plastic Limit Plasticity Index	24 to 64 16 to 32 7 to 42	Low to high plasticity
Expansion Index	41 to 140	Low to very high
Sodium Sulfate Content	0.03 to 0.70 percent	Negligible to moderate chemical heave (salt heave) potential
Sodium Content	0.03 to 0.42 percent	--
Sulfate Content	0.02 to 0.47 percent	Negligibly to severely deleterious to concrete
Total Salts (Solubility)	0.15 to 1.86 percent	Low to high solubility potential

6.2. Selected and Granular Backfill Suitability

As a part of this study, Ninyo & Moore evaluated the suitability of encountered soils for use as trench backfill material. Clark County gradation and plasticity requirements (Clark County, 2003) for Selected and Granular Backfill (USSPWC Sections 207.02.01 and 207.02.02, respectively), along with the results of gradation and Atterberg limits tests performed by Ninyo & Moore, are presented in the following table.

Table 5 – Selected and Granular Backfill Suitability

Sieve Size	Specified Percent of Weight Passing *		Percent of Weight Passing				
	Selected Backfill	Granular Backfill	B-1 5.0-6.5	B-3 2.0-3.5	B-5 2.0-3.5	B-6 5.0-6.5	B-9 5.0-6.5
3-inch	80-100	100	100	100	100	100	100
No. 4	35-100	35-100	100	82	100	100	100
No. 16	--	25-100	100	73	100	100	100
No. 200	--	5-15	86.1	61.6	88.8	84.3	93.8
Plasticity Index	15 max	15 max.	42	34	31	23	17
Meets Selected Backfill Requirements?			No	No	No	No	No
Meets Granular Backfill Requirements?			No	No	No	No	No
* USSPWC requirements							

Table 5 (continued) – Selected and Granular Backfill Suitability

Sieve Size	Specified Percent of Weight Passing *		Percent of Weight Passing				
	Selected Backfill	Granular Backfill	B-12 5.0-6.5	B-14 5.0-6.5	B-17 5.0-6.5	B-18 10.0-11.5	B-20 15.0-16.5
3-inch	80-100	100	100	100	100	100	100
No. 4	35-100	35-100	100	100	58	99	100
No. 16	--	25-100	98	100	41	99	100
No. 200	--	5-15	95.0	96.6	19.0	82.3	81.8
Plasticity Index	15 max	15 max.	8	12	14	7	20
Meets Selected Backfill Requirements?			No	No	No	No	No
Meets Granular Backfill Requirements?			No	No	No	No	No
* USSPWC requirements							

6.3. Groundwater

Groundwater was encountered in 12 of our 20 exploratory borings. Borings B-1, B-2, B-6, and B-20 were converted to temporary monitoring wells for the hydrogeologic study. The approximate depths to groundwater levels measured in the exploratory borings are presented in the following table. Depths to groundwater are also included on the boring logs in Appendix A.

Table 6 – Measured Groundwater Levels

Boring	Approximate Boring Elevation (feet-amsl)	Approximate Time Measured After Drilling (days)	Approximate Depth to Groundwater (feet)*	Approximate Groundwater Elevation (feet-amsl)
B-1	1,795.4	3	12.2	1,783.2
B-2	1,791.6	4	12.7	1,778.9
B-3	1,783.9	1	8.2	1,775.7
B-4	1,781.9	1	8.4	1,773.5
B-5	1,779.6	4	6.9	1,772.7
B-6	1,778.2	4	8.4	1,769.8
B-10	1,772.5	4	13.6	1,758.9
B-16	1,764.1	4	13.6	1,750.5
B-17	1,761.7	4	15.4	1,746.3
B-18	1,762.3	1	18.4	1,743.9
B-19	1,761.7	3	18.7	1,743.0
B-20	1760.5	3	18.4	1,742.1

*Measured from top of ground surface (top of channel bank) adjacent to boring.

Ninyo & Moore's groundwater measurements reflect conditions at the time of our subsurface exploration and do not preclude local and/or seasonal fluctuations in groundwater levels. These fluctuations may be due to variations in ground surface topography, subsurface geologic conditions, rainfall, and other factors. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this study.

7. FINDINGS AND CONCLUSIONS

Based on the findings of this study, there are no known geotechnical or geologic conditions that would preclude construction of the proposed project, provided the recommendations presented herein are implemented and appropriate construction practices are followed. Geotechnical design and construction considerations for the proposed project include the following:

- Based on the results of our field and laboratory evaluation, it is our opinion that proposed improvements may be founded on medium dense to very dense and/or stiff to very stiff native soils or on a zone of adequately placed and compacted structural fill (reworked native or import soils).

- Groundwater was measured at relatively shallow depths in our borings. In addition, moist subgrade conditions were also encountered in our exploratory borings at relatively shallow depths. Therefore, potentially unstable and pumping subgrade conditions should be anticipated in excavation bottoms.
- Based on the results of our subsurface evaluation, we anticipate that groundwater will be encountered at or above the invert elevation along the project alignment. Accordingly, dewatering utilizing sump pumps, well points, and/or other appropriate dewatering methods will likely be needed to facilitate construction operations. During dewatering, existing structures within the limits of the resulting drawdown may be at risk of experiencing settlement. Therefore, existing structures should be monitored for possible movement associated with the dewatering operations.
- Fill material was encountered to a depth of up to approximately 1.8 feet in the exploratory borings. In addition, approximately 7 feet of fill encountered was encountered in boring B-17. This fill material is likely associated with channel sidewall backfill material. Contractors for this project should anticipate that fill will be encountered during excavation operations. The full depth of any undocumented fill material, and any loose, disturbed, or otherwise unsuitable soil should be removed from beneath proposed improvement areas and replaced with structural fill and/or appropriate backfill.
- The findings of our study indicate that some of the native soils encountered in our exploratory borings should generally be suitable for use as structural fill and backfill material for the project. However, our laboratory test results indicated that some of the on-site soils have very high expansion potential and a high solubility potential. These soils will not be suitable for use as structural fill and backfill. Additional soil sampling and laboratory testing should be performed during earthwork operations to evaluate whether on-site soils meet recommendations provided in this report for use as structural fill/backfill.
- Chemical test results performed on selected soil samples from the exploratory borings indicate that some of the on-site soils should be considered severely deleterious to concrete.
- Review of referenced geologic data indicates that a previously mapped fault traverses the western portion of the alignment (Figure 2). Published geologic data does not provide an activity level for this fault. During our field activities, surficial indications of previous faulting were not observed. A qualified geologist/geotechnical consultant should be present during trenching and excavation operations in the area of the mapped fault to assess subsurface conditions and provide recommendations as needed.
- Water, several inches deep, was observed flowing in the channel bottom. In addition, flash flooding is known to occur in Las Vegas Valley. Accordingly, the contractor for this project should be aware of the potential for adverse affects of flash flooding on construction activities and take adequate precautions.

- Layers of hard to very hard, strongly cemented soils (caliche) were not encountered in our exploratory borings performed along the project alignment. However, moderately hard, moderately cemented soils were encountered at the bottom of borings B-19 and B-20 at a depth of approximately 26 feet. Due to its variable nature, caliche may be encountered in areas between and beyond our boring locations during earthwork operations. Grading activities and excavations may be impeded due to the presence of cemented soils. Rock excavation techniques should be anticipated during grading and excavation operations.
- As indicated in the referenced International Building Code, the seismic parameters provided in Table 2 are characteristic of the alignment and may be considered where appropriate in the design of structures.

8. RECOMMENDATIONS

We anticipate that the Clark County Regional Flood Control District, Hydrological Criteria and Drainage Design Manual (CCRFCD, 1999) will be used in design of the proposed channel improvements for this project. The following sections provide geotechnical recommendations for design and construction of proposed project improvements.

8.1. Construction Dewatering

Groundwater was encountered in 12 of our 20 exploratory borings. The depths below the existing ground surface of the measured groundwater levels are provided on Table 6. In addition, moist subgrade conditions were also encountered in our exploratory borings at relatively shallow depths. Accordingly, dewatering of excavations should be anticipated during earthwork operations. The purpose of dewatering is to improve excavation wall and bottom stability, as well as subgrade stability, and to allow installation of subsurface improvements and compaction of structural fill, trench backfill, and RCB and channel bottoms. Dewatering measures may include installation of well points, deep wells, and other devices. Disposal of groundwater should be performed in accordance with guidelines of the Nevada Division of Environmental Protection (NDEP).

Existing structures within the limits of groundwater drawdown resulting from dewatering may be at risk of experiencing settlement. The amount of settlement, if it occurs, will depend primarily on the amount and duration of the dewatering and subsurface soil conditions.

Consideration should be given to monitoring nearby structures for possible movement and associated damage during dewatering operations. If significant movement/damage occurs, dewatering operations should be temporarily suspended and the project's geotechnical consultant/owner's representative should be informed. Recommendations for mitigating settlement and associated distress should be provided by the geotechnical consultant/owner's representative.

8.2. Earthwork

Specifications for construction materials to be used and construction practices to be followed when excavating and backfilling trenches within paved and unpaved ROW are provided in the referenced USSPWC. The following subsections provide additional earthwork recommendations for the project including RCB and channel excavation, subgrade stabilization, mapped fault considerations, structural fill and backfill, import soils, and stability of temporary excavations.

8.2.1. RCB and Channel Excavation

Prior to excavation, the existing concrete for the trapezoidal channel side slopes should be removed and any ground surface along the proposed channel excavation areas should be cleared of any surface and subsurface obstructions, debris, organics (including vegetation), and other deleterious material. Materials generated from clearing operations should be removed from the project area and disposed of at a legal landfill.

Fill material, including existing channel sidewall backfill material was encountered to a depth of up to approximately 7 feet in the exploratory borings. Contractors for this project should anticipate that fill will be encountered during excavation operations, particularly below or behind existing channel side slopes. The full depth of any undocumented fill material, and any loose, disturbed, or otherwise unsuitable soil should be removed from beneath proposed improvement areas and replaced with structural fill and/or appropriate backfill.

The proposed channel and RCB excavations for the proposed project should extend to the full depth and width, as specified in the project plans, or to a greater depth or width where needed, as evaluated in the field by the project's geotechnical consultant. Excavations should be deep enough to provide an approximately 8-inch thick layer of aggregate base beneath concrete channel and RCB bottoms. Excavations should be wide enough to provide an adequate work zone and trenching for the proposed structures should provide a 12-inch or more clearance on either side of the RCB for structural fill material placement and compaction. The 12-inch side clearance should be the clear distance between the RCB and shoring system where present.

Care should be taken not to overexcavate trench/channel bottoms. In the event that overexcavation occurs, the overexcavated area should be backfilled with Type II Aggregate Base compacted to 90 percent relative compaction, as evaluated by ASTM D 1557 or Controlled Low-Strength Material (CLSM) as described in the referenced USSPWC Section 208.02.07. Excavated bottoms should be cleaned of loose material generated by the excavation process. If the exposed surficial soils at the base of the excavations are loose, soft, or disturbed by excavation operations, these soils should be scarified to a depth of approximately 6 inches, moisture-conditioned to approximately optimum moisture content, and compacted to 90 percent relative compaction, as evaluated by ASTM D 1557. When the bottom of the excavation contains rocks larger than 6 inches nominal diameter, protruding above the bottom of the excavation, these protrusions should be removed and the area leveled prior to the compaction of the subgrade and placement of structural fill materials.

Consideration should be given to existing buried pipeline utilities running parallel to the planned excavation. Trench excavations within two pipe diameters of existing pipelines and extending below the springline of, and running parallel to, existing pipeline utilities may need to be supported by properly designed trench shoring and bracing to prevent damage to existing pipeline facilities.

Layers of hard to very hard, strongly cemented soils (caliche) were not encountered in our exploratory borings. However, moderately hard, moderately cemented soils were encountered at the bottom of borings B-19 and B-20 at a depth of approximately 26 feet. Due to the highly variable nature of caliche, this rock-like cemented soil may be encountered along the project alignment in areas between and beyond our exploratory boring locations. If caliche is encountered, rock excavation techniques, such as use of heavy-duty ripping equipment, heavy-duty backhoe, headache ball, hoe-ram, rock bits, etc., should be anticipated during earthwork operations. The contractor should be aware of the potential for (and take adequate precautions to reduce the potential for) vibrational damage to adjacent or nearby structures, and take appropriate precautions, when using heavy impact equipment during removal of caliche.

Some shrinkage should be anticipated when on-site soils are excavated, processed, and compacted. For planning purposes, an estimated shrinkage factor of approximately 25 percent may be used for native soils.

8.2.2. Subgrade Stabilization

As previously indicated, groundwater was measured at relatively shallow depths in some of our exploratory borings. In addition, moist subgrade conditions were also encountered in our exploratory borings at relatively shallow depths. Accordingly, pumping subgrade should be anticipated during excavation and earthwork operations. Subgrade stabilization will be needed where pumping subgrade conditions are encountered.

Stabilization methods should be provided by the grading contractor, as needed, and may include the use of a geogrid, such as Tensar TX160, or a woven geotextile fabric, such as Mirafi 600X, placed on unstable subgrade and overlain by 12 inches of crushed rock in accordance with Section 704.03.06 of Uniform Standard Specifications for Public Works Construction (USSPWC) or Type II Aggregate Base (USSPWC 704.03.04). Pushing oversized angular rock, up to approximately 6 inches in nominal diameter, into

exposed unstable subgrade soils may also be an appropriate stabilization alternative. The volume of rock needed will vary based upon factors including the moisture content of the native soil, soil type, depth to groundwater, and total affected area. Placement of angular rock should continue until the area exhibits a relatively non-yielding behavior as observed or tested by the geotechnical consultant.

If conditions (e.g. excavations extending below groundwater) are observed that indicate additional stabilization efforts may be needed, a combination of overexcavation, rock fill, and geogrid placement should be considered. Dewatering and use of relatively light or tracked equipment may also be needed. The geotechnical consultant/engineer during construction should evaluate proposed subgrade stabilization methods prior to their implementation.

8.2.3. Mapped Fault Considerations

As previously mentioned, a mapped fault transects the western portion of the project alignment. The approximate location of this fault is shown on Figure 2. Review of referenced USGS data does not provide an activity level for this fault. Published geologic data and our professional experience in the project area indicate that previous subsurface evaluation, such as fault trenching, has not been performed to confirm the fault's location, activity level, or whether it is in the mapped location. During excavation operations for this project, indications of faulting, such as off-set or deformation of soil layers, may or may not be observed. Ninyo & Moore recommends that a qualified geologist/geotechnical consultant be present during trenching/excavation operations in the area of the mapped fault to assess subsurface conditions and provide recommendations for fault mitigation as needed.

If indications of faulting, or associated potential instability, are encountered, mitigation measures may include vertical overexcavation of the trench, placement of geofabric and gravel, or a layer of geogrid across the fault prior to placement of structural fill.

8.2.4. Structural Fill and Backfill

Structural fill soils should not contain organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 3 inches nominal diameter. These soils should have a low solubility potential of 1.0 percent or less, as evaluated by Technical Guideline TG-19-2007 (Clark County Development Services Department, 2007), and a very low to low expansion potential (EI less than 50, as evaluated by ASTM D 4829).

Soils used as structural fill or backfill should be moisture-conditioned to approximately optimum moisture content and placed and compacted in uniform horizontal lifts to a relative compaction of 90 percent, as evaluated by ASTM D 1557. The optimal lift thickness of fill will depend on the type of soil and compaction equipment used, but should generally not exceed approximately 8 inches in loose thickness. Placement and compaction of structural fill should be performed in accordance with the referenced USSPWC (Clark County, 2003).

Earthwork operations should be observed and compaction of structural fill materials should be tested by the project's geotechnical consultant. Typically, one field test should be performed per lift for each approximately 500 cubic yards of fill placement in structural areas. Additional field tests may also be performed in structural and non-structural areas at the discretion of the geotechnical consultant.

8.2.5. Import Soils

Import soil for backfill or structural fill should consist of coarse-grained material (50 percent or more retained on the No. 200 sieve), with a low solubility potential of 1.0 percent or less, as evaluated by Technical Guideline TG-19-2007 (Clark County Development Services Department, 2007), a low sulfate content (less than 0.1 percent), and a very low to low expansion potential (EI less than 50, as evaluated by ASTM D 4829). Import soil should not contain organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 3 inches nominal diameter. We further recommend that proposed import material be evaluated by the project's

geotechnical consultant at the borrow source for its suitability prior to importation to the project site. Import soil should be moisture-conditioned and placed and compacted in accordance with the recommendations set forth in the previous section.

8.2.6. Stability of Temporary Excavations

Temporary excavations should be performed in accordance with the requirements and recommendations of the referenced Occupational Safety and Health Administration's Construction Industry Regulations (OSHA, 2005). Excavations deeper than 5 feet should be appropriately shored or laid back at a slope no steeper than 1:1 (horizontal to vertical) per OSHA recommendations. On-site safety of personnel is the responsibility of the contractor. Worker protection, such as trench boxes, may be needed for protection against rolling or falling particles.

Excavations for the proposed RCB and channel are anticipated to be up to approximately 15 feet deep. Spoils from excavations, heavy construction equipment, and other surcharge loads should not be placed above the excavations within a 1:1 (horizontal to vertical) plane extending up and back from the base of the excavation. In addition, surface drainage should be channeled away from the top edge of excavations and traffic should be routed as far away from the excavation as practicable during construction.

As an alternative to laying back the sides of the excavations, temporary excavations may be rigidly braced. Temporary earth retaining systems will be subjected to lateral loads resulting from earth pressures. As a guideline, lateral earth pressures presented in this report may be used in the design of internally braced excavation shoring for temporary excavations. A structural engineer experienced in retaining systems for temporary excavations should be consulted by the contractor during the design of the shoring system. The project's geotechnical engineer should review the design plans for a temporary retaining system prior to its implementation.

8.3. Vertical Loads and RCB Foundations

For calculation of overburden loads, Type II Aggregate Base and trench backfill soils, when placed and compacted as specified, may be assumed to have a unit weight of approximately 130 pounds per cubic foot (pcf). This value is based on soils being compacted to a relative compaction of 90 percent of the maximum dry density, as evaluated by ASTM D 1557. We have assumed that CLSM used as pipe zone and trench backfill material will have a unit weight of approximately 120 pcf.

The base of RCB sections should be founded on 8 inches or more of Type II Aggregate Base overlying medium dense to very dense and/or stiff to very stiff native soils or on a zone of adequately placed and compacted structural fill (reworked native or import soils). The Type II Aggregate Base should be in conformance with referenced USSPWC Subsection 704.03.04, moisture-conditioned to approximately optimum moisture content, and compacted to 90 percent relative compaction, as evaluated by ASTM D 1557. An allowable bearing pressure of 2,000 pounds per square foot (psf) may be used for RCB/structure foundations. The allowable bearing capacity, which was developed considering a factor of safety of 2.5, may be increased by one-third for short duration loads, such as seismic.

8.4. Concrete-Lined Channel Invert Slabs and Sidewalls

We recommend that concrete channel walls, invert slabs-on-grade and access ramps be founded on 8 inches or more of Type II Aggregate Base overlying medium dense to very dense and/or stiff to very stiff native soils or on a zone of adequately placed and compacted structural fill (reworked native or import soils). The Type II Aggregate Base should be in conformance with referenced USSPWC Subsection 704.03.04, moisture-conditioned to approximately optimum moisture content, and compacted to 90 percent relative compaction, as evaluated by ASTM D 1557.

We recommend that the concrete channel lining be provided with construction joints in accordance with Section 705.7.1.3 of the Clark County Regional Flood Control District, Hydrological Criteria and Drainage Design Manual (CCRFCD, 1999). For continuously reinforced concrete channel construction, we recommend that longitudinal and transverse

cutoff walls be constructed in accordance with Section 705.7.1.12 of the CCRFCD design manual. Slab reinforcement should be in accordance with Section 705.7.1.6 of the CCRFCD design manual. Additional reinforcement and control joint recommendations may be provided by a qualified structural engineer. Recommendations regarding concrete utilized for construction of the proposed channel are provided in Section 8.7.

In order to drain accumulated water below invert slabs, we recommend that 3-inch diameter weep holes be installed in the channel bottom approximately 1 foot upstream of transverse cutoff walls and at the approximate midpoint between cutoff walls. These weep holes should be protected against clogging by installation of 1 square-foot of non-woven geotextile fabric such as Trevira 1135 (or approved equivalent) between weep holes and underlying aggregate base.

In order to reduce the potential for build-up of hydrostatic pressures and to drain possible accumulated water behind concrete channel sidewalls, 3-inch diameter weep holes should be installed in the channel sidewalls at a spacing of approximately 10 feet on-center and approximately 3 inches from the channel bottom. Drainage measures should also include the placement of free-draining granular backfill over weep hole areas encased in a non-woven filter fabric such as Trevira 1135 (or approved equivalent).

8.5. Lateral Earth Pressures

Below grade walls that are not restrained from movement at the top and having level backfill behind the wall may be designed using an “active” lateral earth pressure as indicated on Figure 3. Restrained subsurface walls having a horizontal ground surface behind the wall, may be designed using an “at-rest” lateral earth pressure as indicated on Figure 4. These lateral earth pressure values assume compaction within about 5 feet of the wall will be accomplished with relatively light compaction equipment and that very low to low expansive backfill will be placed behind the wall. These values also assume that below grade walls will have a height of approximately 15 feet or less.

We understand that dynamic lateral earth pressures induced from a seismic event may be considered in the design of subsurface structures along the alignment. Ninyo & Moore has evaluated the “active” and “at-rest” seismic earth pressure coefficient based on the Mononobe-Okabe equation for an active driving wedge. Based on our calculations, Ninyo & Moore recommends that below grade walls, which are not restrained from movement at the top, be designed using an additional inverted triangular “active” equivalent fluid unit weight as indicated on Figure 3, where appropriate. Subsurface walls, which are restrained from movement at the top, be designed using an additional inverted triangular “at-rest” equivalent fluid unit weight as indicated on Figure 4.

Below grade walls should also be designed to resist an “active” and “at-rest” surcharge pressure as shown on Figure 3 and Figure 4. The value for “q” represents the pressure induced by adjacent light loads, uniform slab, or traffic loads plus any adjacent footing loads.

Measures should be taken so that hydrostatic pressure does not build up behind retaining walls. Drainage measures, as indicated on Figure 5, should include free-draining granular backfill material and perforated drain pipes, or weepholes lined with polyvinyl chloride (PVC) pipe. Drain pipes should outlet away from structures and retaining walls should be waterproofed in accordance with the recommendations of a qualified civil engineer or architect.

For passive resistance to lateral loads, we recommend that a passive lateral earth pressure of 300 psf/ft above groundwater and 130 psf/ft below groundwater be used up to a value of 2,000 psf. This value assumes that the ground surface is horizontal for a distance of 10 feet, or three times the height generating the passive pressure, whichever is more. We recommend that the upper 12 inches of soil not protected by pavement or a concrete slab be neglected when calculating passive resistance. For frictional resistance to lateral loads, we recommend that a coefficient of friction of 0.53 be used between soil and soil contacts and/or between soil and cast-against-grade concrete contacts. A coefficient of friction of 0.35 may be used between soil and formed concrete contacts. Passive and frictional resistances may be used in combination, provided the passive resistance does not exceed one-half of the total allowable resistance.

8.6. Pavement Replacement

Pavement patching in trench areas for this project should be performed in accordance with the USSPWC (Clark County, 2003), which provides specifications for thickness of pavement and underlying aggregate base/CLSM depending on the width of the roadway ROW. The existing asphalt concrete pavement thickness measured in our exploratory borings is provided in Section 6.1.

In areas of pavement removal and patching, pavement saw-cuts should be linear and vertical. The pavement should be saw-cut a few inches beyond the soil excavation as shown on Drawing No. 503AF of the referenced Uniform Standard Drawings for Public Works Construction (Clark County, 2001). Saw-cuts should be adequately cleaned and then coated with an appropriate tack-coat prior to placement of new pavement.

8.7. Concrete and Corrosion Considerations

The corrosion potential of on-site soils to concrete was evaluated in the laboratory using representative samples obtained from the exploratory borings. Laboratory testing was performed to assess the effects of sulfate content on concrete. Results of these tests are presented in Appendix C. Recommendations regarding concrete to be utilized in construction of proposed improvements and for buried metal pipes are provided in the following sections.

8.7.1. Concrete

Chemical tests performed on selected samples of on-site soils indicated sulfate contents ranging from 0.02 to 0.47 percent by weight. Based on review of the referenced International Building Code (ICC, 2012) and American Concrete Institute manual (ACI, 2005), the tested soil is considered negligibly to severely deleterious to concrete. Accordingly, we recommend that concrete in contact with on-site soils, along with subsurface walls up to 12 inches above finished grade, contain Type V cement and have a design compressive strength of 4,500 pounds per square inch (psi). In accordance with Section 501 of the referenced USSPWC, concrete in contact with on-site soils should

have a water-cement ratio of 0.45 by weight. In addition, it is recommended that reinforcing bars in cast-against-grade concrete be covered by approximately 3 inches or more of concrete. Concrete should be placed with an approximate 4-inch slump and good densification procedures should be used during placement to reduce the potential for honeycombing. Concrete samples should be obtained, as indicated by ACI manual Section 318 (ACI, 2005), and the slump should be tested at the site by the project's geotechnical consultant. Structural concrete should be placed in accordance with American Concrete Institute (ACI, 2005) and project specifications.

8.7.2. Buried Metal Pipes

Ninyo & Moore recommends that corrosion reduction methods be implemented for this project for buried metal pipes. These corrosion reduction methods may include utilization of protective coatings, pipe sleeving, and/or appropriate cathodic protection as recommended by a qualified corrosion engineer. Where permitted by jurisdictional building codes, the use of plastic pipes for buried utilities should also be considered.

9. PLAN REVIEW

The recommendations presented in this report are based on preliminary design information for the proposed project, as provided by Atkins personnel, and on the findings of our geotechnical evaluation. When finished, project plans and specifications should be reviewed by the geotechnical consultant prior to submitting the plans and specifications for bid. Additional field exploration and laboratory testing may be needed upon review of the project design plans.

10. PRE-CONSTRUCTION MEETING

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the civil engineer, the geotechnical consultant, and the contractor should be in attendance to discuss the plans and the project.

11. OBSERVATION AND TESTING

A qualified geotechnical consultant should perform appropriate observation and testing services during earthwork and construction operations. These services should include observation of removal of soft, loose, or otherwise unsuitable soils, evaluation of subgrade conditions where soil removals are performed, and performance of observation and testing services during placement and compaction of structural fill and backfill soils. The geotechnical consultant should also perform observation and testing services during placement of concrete, mortar, grout, asphalt concrete, and steel reinforcement.

12. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent

evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

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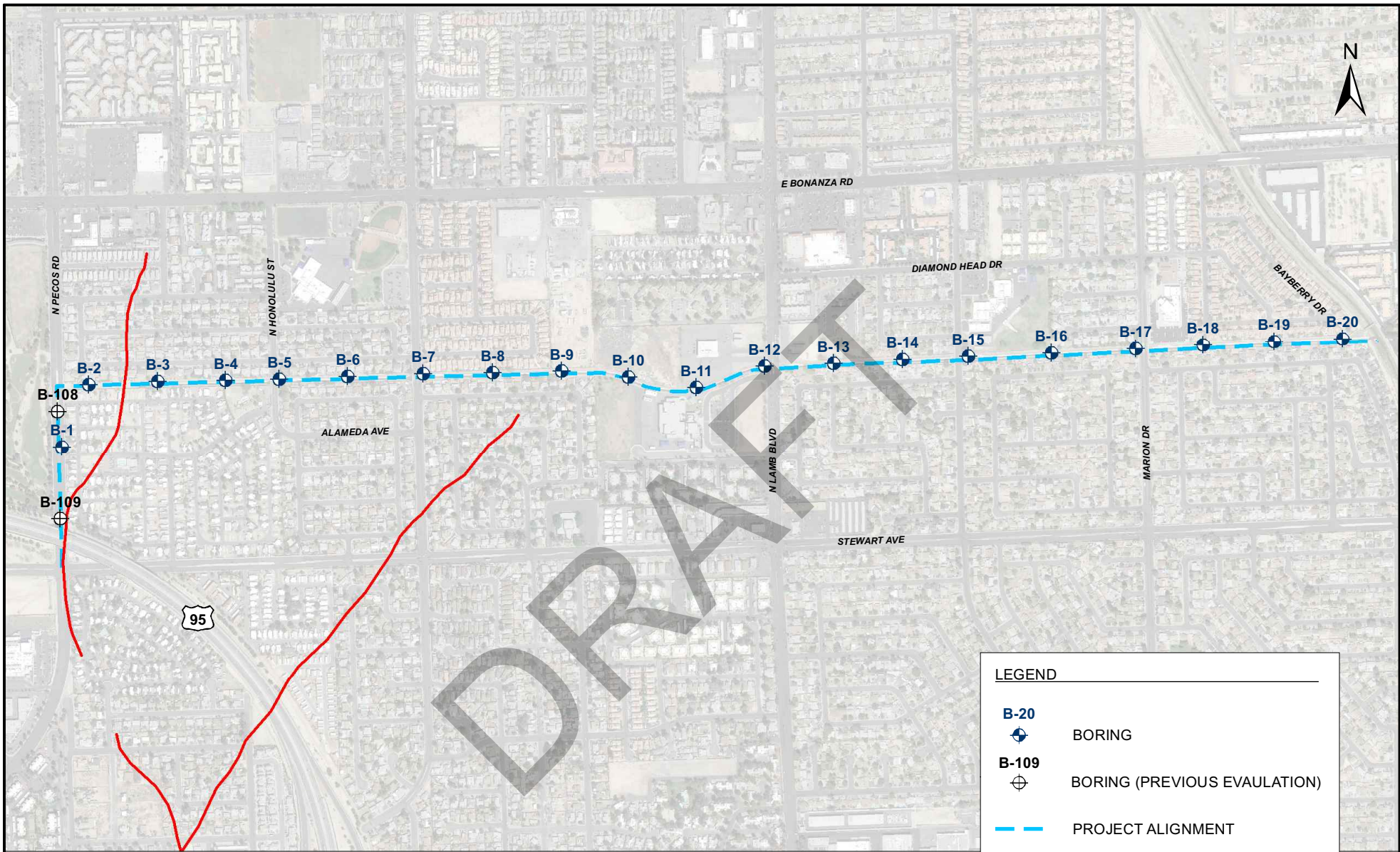
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SOURCE: DEPOLO, C.M. AND BELL, J.W., 2000, MAP OF FAULTS AND EARTH FISSURES IN THE LAS VEGAS AREA (NEVADA BUREAU OF MINES AND GEOLOGY); GOOGLE EARTH, 2015

LEGEND

B-20

BORING

B-109

BORING (PREVIOUS EVALUATION)

PROJECT ALIGNMENT

MAPPED FAULT

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

BORING LOCATIONS

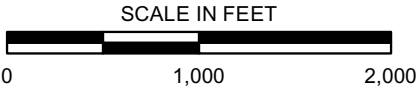
FIGURE

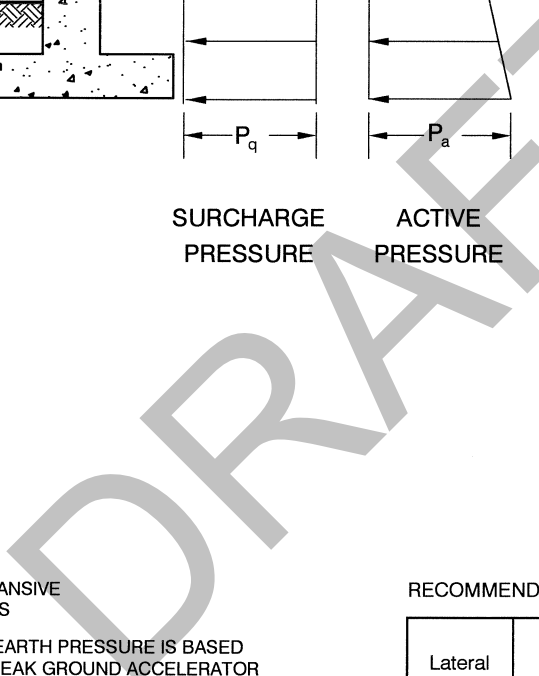
PROJECT NO.
303710001

DATE
4/15

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA

2



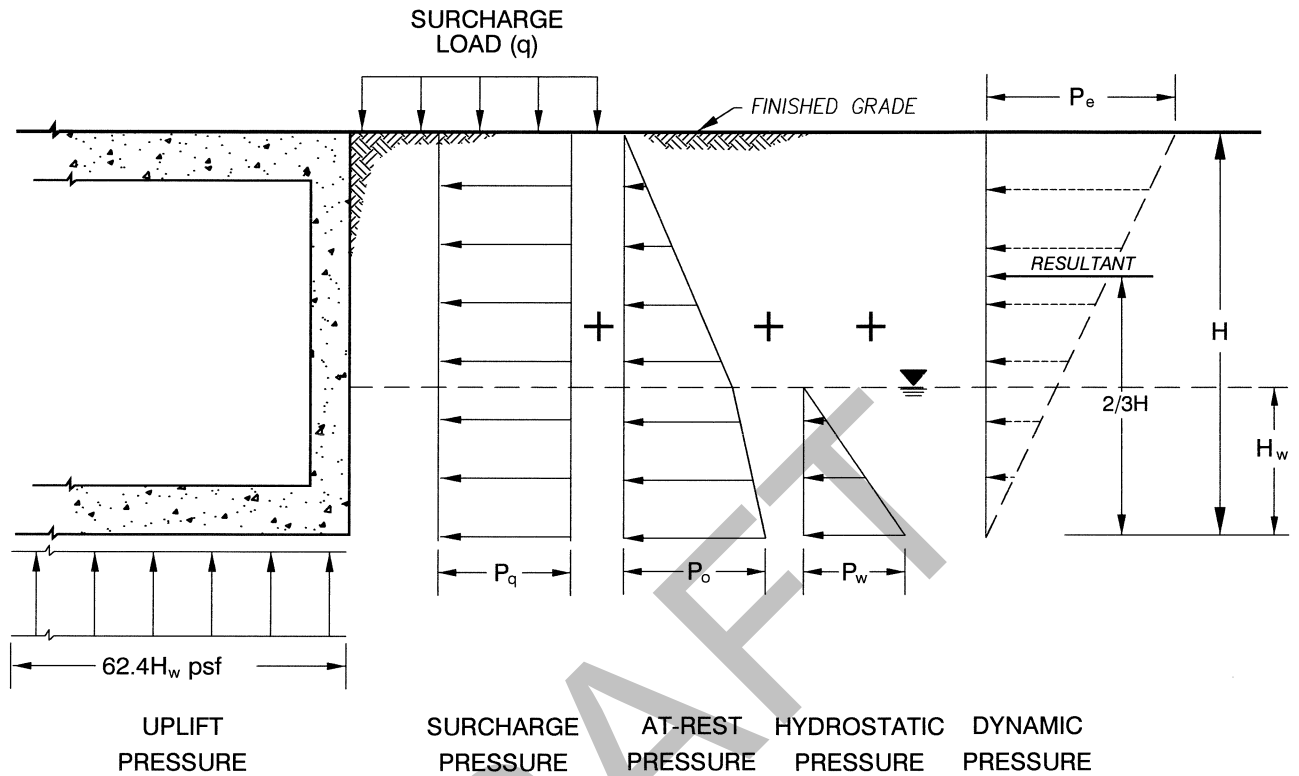


1. ASSUMES NON-EXPANSIVE BACKFILL MATERIALS
2. DYNAMIC LATERAL EARTH PRESSURE IS BASED ON AN EFFECTIVE PEAK GROUND ACCELERATOR OF 0.20g
3. H , H_w , AND D ARE IN FEET

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Lateral Earth Pressure	Equivalent Fluid Pressure (psf/ft)	
	Level Backfill with Granular Soils	Below Groundwater
P_p	300D	130D
P_q	0.36q	0.36q
P_a	43H	$43(H-H_w) + 21H_w$
P_w	--	$62.4H_w$
Resultant	Force per unit of wall	
P_e	8H	8H

NOT TO SCALE



NOTES:

1. ASSUMES NON-EXPANSIVE BACKFILL MATERIALS
2. DYNAMIC LATERAL EARTH PRESSURE IS BASED ON AN EFFECTIVE PEAK GROUND ACCELERATOR OF 0.20g
3. H , H_w , AND D ARE IN FEET

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Lateral Earth Pressure	Equivalent Fluid Pressure (psf/ft)	
	Level Backfill with Granular Soils	Below Groundwater
P_p	300D	130D
P_q	0.53q	0.53q
P_o	64H	$64(H-H_w)+31H_w$
P_w	--	$62.4H_w$
Resultant	Force per unit of wall	
P_e	18H	18H

NOT TO SCALE

Ninyo & Moore

**LATERAL EARTH PRESSURES
FOR RESTRAINED RETAINING WALLS**

FIGURE

PROJECT NO.

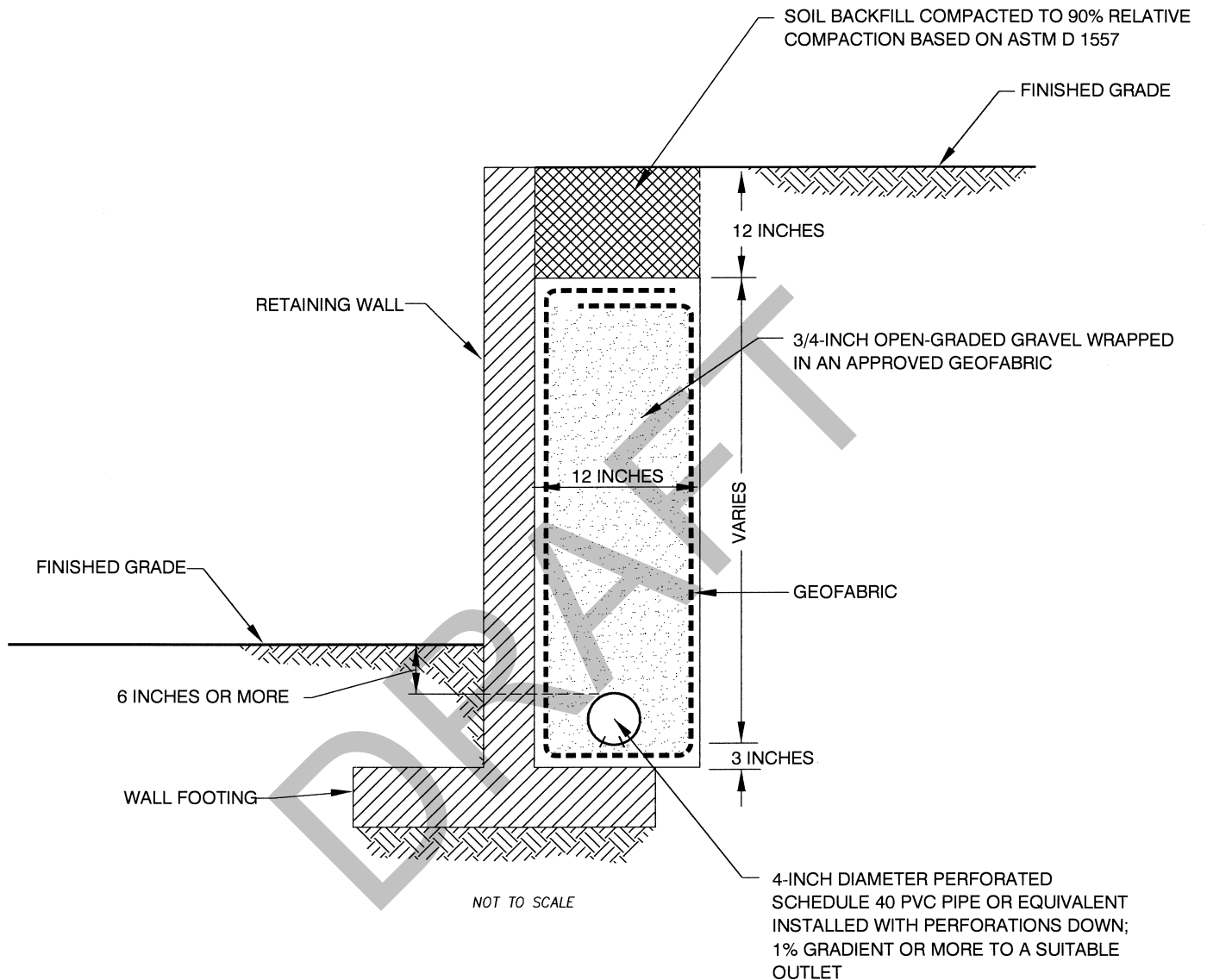
DATE

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA

303710001

4/15

4



NOTES: AS AN ALTERNATIVE, AN APPROVED GEOCOMPOSITE DRAIN SYSTEM MAY BE USED.

AS AN ALTERNATIVE TO USE OF 4" DIAMETER PVC BACKDRAINAGE PIPES, WEEP HOLES CAN BE CORED THROUGH THE WALL AND LINED WITH PVC PIPE. WEEP HOLES SHOULD BE 3" DIAMETER AND PLACED APPROXIMATELY 3" ABOVE THE LOWEST ADJACENT FINISHED GRADE AT APPROXIMATELY 10' ON-CENTER.

Ninyo & Moore

RETAINING WALL DRAINAGE DETAIL

FIGURE

PROJECT NO.

DATE

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA

5

303710001

4/15

Appendix C-3

Draft Hydrogeologic Aquifer Testing Report



**HYDROGEOLOGIC AQUIFER TESTING REPORT
LAS VEGAS WASH CENTRAL
CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA**

PREPARED FOR:

Atkins
2270 Corporate Circle, Suite 200
Henderson, Nevada 89074

PREPARED BY:

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
6700 Paradise Road, Suite E
Las Vegas, Nevada 89119

April 15, 2015
Project No. 303710002

April 15, 2015
Project No. 303710002

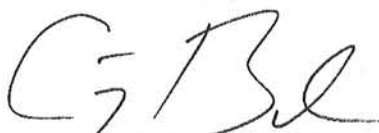
Mr. Harshal Desai
Atkins
2270 Corporate Circle, Suite 200
Henderson, Nevada 89074

Subject: Hydrogeologic Aquifer Testing Report
Las Vegas Wash Central Cedar Avenue Channel Facility
Las Vegas, Nevada

Dear Mr. Desai:

Transmitted herewith are the results of Ninyo & Moore's hydrogeologic aquifer testing for the proposed Las Vegas Wash Central Cedar Avenue Channel Facility in Las Vegas, Nevada. The purpose of this testing was to estimate the hydrogeologic conditions present along the project alignment which will be utilized in preparation of a National Pollutant Discharge Elimination System (NPDES) discharge permit application for proposed dewatering associated with the project. We appreciate the opportunity to be of service to you on this project.

Respectfully submitted,
NINYO & MOORE



Courtney J. Brooks, CEM
Senior Hydrogeologist



Robert M. Troisi, CEM
Managing Principal
Environmental Sciences Division

CB/NB/RMT/dh

Distribution: (1) Addressee (via e-mail)

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Appendix B – Laboratory Reports and Chain-of-Custody Records

Appendix C – Hydrogeologic Aquifer Test Analyses and Modeling

1. INTRODUCTION

In accordance with your request, Ninyo & Moore has performed preliminary hydrogeologic testing for the proposed Las Vegas Wash Central Cedar Avenue Channel Facility project in Las Vegas, Nevada. The approximate location of the alignment is indicated on Figure 1. The purpose of this testing was to estimate the hydrogeologic conditions present along the project alignment which will be utilized in preparation of a National Pollutant Discharge Elimination System (NPDES) discharge permit application for proposed dewatering associated with the project. This report presents the methodologies, findings, opinions, conclusions, and recommendations regarding the hydrogeologic conditions along the project alignment.

This study was performed concurrently with a geotechnical evaluation, also performed by Ninyo & Moore. A report presenting the results of the geotechnical evaluation (Ninyo & Moore, 2015) was submitted under separate cover.

2. SCOPE OF SERVICES

In accordance with our approved scope of work, Ninyo & Moore performed the following tasks.

- Coordinated the installation and development of four temporary groundwater monitoring wells collocated in geotechnical borings B-1, B-2, B-6, and B-20 advanced along the project alignment.
- Collected groundwater samples from temporary monitoring wells to measure groundwater quality. The water samples were submitted to an NDEP-certified analytical laboratory in accordance with chain-of-custody procedures.
- The groundwater samples were analyzed for the following NDEP Profile I parameters and General *DeMinimis* groundwater discharge application Category 4 parameters, as well as perchlorate and fecal coliform bacteria.
- Multiple falling head and rising head tests were performed in the temporary monitoring wells to estimate the aquifer conditions at each location. The aquifer test data was analyzed to estimate the hydraulic conductivity values in the vicinity of the proposed excavations.
- Hydrogeologic data derived from this study was utilized to create multiple finite difference groundwater models, which simulated various well configurations and pumping scenarios to estimate the expected pumping rates capable of dewatering the excavations to target levels.

- The hydrogeologic data and groundwater model output from this study may be utilized to prepare an NDEP NPDES discharge permit application for the proposed dewatering program.

3. PROJECT DESCRIPTION

Based on our conversations with Atkins personnel, we understand that the project will include design and construction/installation of new flood control structures, including reinforced concrete box (RCB) and a concrete lined rectangular channel. The project will include approximately 1,400 linear feet of 14-foot by 6-foot RCB extending north along Pecos Road from Stewart Avenue to a wash channel right-of-way (ROW) where it will then turn and extend east within the wash ROW another 400 feet to its confluence with the existing concrete-lined trapezoidal channel. From this point, the alignment will extend east approximately 9,000 linear feet to its terminus at Las Vegas Wash. The project will include converting the existing trapezoidal channel to a rectangular channel by removing the current side slopes. The existing trapezoidal channel is approximately 7 to 10 feet deep. The project will also include improvements under the street crossings at Lamb Boulevard and Marion Drive. It is anticipated that the RCB's in Pecos Road will have approximately 2 to 12 feet of cover and will be installed by cut-and-cover methods. It is anticipated that the invert depths of the improved channel will be similar to the current invert depths except at the downstream end of the channel (from 400 feet upstream of Marion Drive to the Las Vegas Wash).

4. FINDINGS

Ninyo & Moore performed hydrogeologic testing to obtain information to prepare a General *DeMinimus* groundwater discharge permit application for submittal to the NDEP. Our findings are summarized in the sections below.

4.1. Monitoring Well Installation

Beginning on March 6, 2015, Ninyo & Moore observed the installation of four temporary groundwater monitoring wells collocated in geotechnical borings B-1, B-2, B-6 and B-20. The monitoring well boring depths ranged from approximately 15 to 25 feet below existing

grade with truck-mounted Mobile B-57 and CME-75 drill rigs utilizing 8-inch diameter hollow-stem augers and a track-mounted CME-55 drill rig utilizing 8-inch diameter hollow-stem augers. The temporary groundwater monitoring wells consist of 2-inch diameter, 0.02-inch factory-machine slotted screens flush-threaded to 2-inch diameter schedule 40 polyvinyl chloride blank casing to the existing grade. Clean silica sand filter material was placed in the annulus around the perforated section of each casing. Upon completion, Ninyo & Moore staff utilized a submersible development pump with clean, dedicated tubing to remove the fine materials from the well casings and filter packs. The temporary monitoring wells were abandoned upon completion of testing. The approximate locations of the temporary monitoring wells are shown on Figure 2.

It is anticipated that the target of dewatering will be to lower the groundwater level to approximately 3 feet below the estimated maximum design depth of the planned channel excavations. Based on preliminary design specifications and our conversations with Atkins personnel, it is our understanding that the channel invert elevations along the alignment will range from approximately 1,745.5 feet above mean sea level (AMSL) near B-20 to 1,780 feet AMSL near B-1.

Subsurface geotechnical and hydrologic conditions observed as part of Ninyo & Moore's geotechnical study (Ninyo & Moore, 2015), which was submitted under separate cover, were reviewed as part of this study.

4.2. Groundwater

Groundwater was encountered in 12 of 20 exploratory borings advanced as part of Ninyo & Moore's geotechnical evaluation for the subject project. Ninyo & Moore's groundwater measurements reflect conditions at the time of our subsurface exploration and do not preclude local and/or seasonal fluctuations in groundwater levels. These fluctuations may be due to variations in ground surface topography, subsurface geologic conditions, rainfall, surface water seepage through expansion joints in the existing channel, and other factors. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this

study. Table 1 summarizes the groundwater and invert elevations observed in our borings performed as part of Ninyo & Moore's geotechnical evaluation for the subject project.

4.3. Groundwater Sampling and Analysis

Following development and purging, the temporary monitoring well was sampled utilizing clean disposable polyethylene bailers. The groundwater samples were placed in clean, laboratory-supplied containers and labeled according to the sample location, date, analysis requested, and the name of the person collecting the sample. The samples were stored in an insulated cooler, preserved on ice, and delivered under chain-of-custody protocol to an NDEP-certified laboratory for water quality analysis. The groundwater samples were analyzed for NDEP Profile I and General DeMinimis groundwater discharge Category 4 parameters, as well as for fecal coliform bacteria and perchlorate by EPA Method 331.

Tables 2 through Table 4 summarize the sample analytical results for the parameters. The analyte concentrations are printed in bold for samples that are reported above the NDEP Profile 1 and/or Category 4 recommended discharge limits. These include Sulfate and Total Dissolved Solids (TDS) in B-1, B-2, B-6 and B-20, and Chloride in B-1 and B-20. Copies of the complete laboratory report and chain-of-custody record are presented in Appendix B.

4.4. Hydrogeologic Aquifer Testing

Multiple hydraulic displacement (slug) tests were performed in the temporary monitoring well to estimate aquifer characteristics in the vicinity of the proposed excavations. The procedure involved the sudden introduction of a mechanical slug into (falling head), or the sudden removal of the mechanical slug from (rising head) the well casing. These actions caused the groundwater level to rise or fall, respectively. The water level displacement and subsequent rate of recovery was recorded and later analyzed utilizing the hydrogeologic software, Aqtesolv™, to estimate the hydraulic conditions of the aquifer in the vicinity of the monitoring well. The data analysis included the Hvorslev method (1951) and the Bouwer and Rice method (1976 and 1989), two comparable techniques for estimating the hydraulic

conductivity (K) from slug displacement test data (rising and falling head) in unconfined aquifers.

The displacement test analyses for the temporary monitoring wells, which are summarized in Appendix C, ranged from 0.8 feet per day (ft/d) to 33.2 ft/d. Data for the full hydrogeologic analysis is presented in Appendix C.

It is our understanding that the target dewatering depth for the channel excavations is approximately 3 feet below the deepest expected invert depth along the alignment.

4.4.1. Assumptions

It is assumed that no more than 500 linear feet of excavation will be open at one time during construction operations. It is expected that groundwater discharged from the dewatering systems will be pumped to one or more settling tanks, as necessary, prior to discharge to the same wash down gradient from the dewatering operations.

4.4.2. Finite Modeling

The hydraulic conductivity values were incorporated into numerical, finite difference, groundwater models to simulate the expected water level changes caused by various pumping scenarios under the modeled conditions.

The groundwater model processing platform, Groundwater Vistas, was utilized to create groundwater simulations utilizing the Modflow method (2007). Computerized finite difference groundwater models were set out on a grid with uniform 10 feet row and column spacings. The models assume that homogeneous and isotropic aquifer conditions exist horizontally across the grid similar to those ascertained from lithologic drill log and aquifer tests obtained from the temporary monitoring wells. The models' general head boundaries create a slight west to east trending water table gradient, mimicking the regional gradient across that portion of the Las Vegas Valley. The models were run until steady-state groundwater conditions were achieved. Multiple simulations

were performed with varying numbers and configurations of wells to estimate the desired water-table changes.

Groundwater was measured in our geotechnical borings at elevations ranging from approximately 1,742.1 to 1,783.2 feet AMSL, which is approximately 3.6 to 5.8 feet above the anticipated target dewatering depths in the western portion of the alignment. As the water in the lined channel could possibly be feeding the shallow alluvial aquifer due to seepage via expansion joints, depth to groundwater may decrease with closer proximity to the existing channel base, thereby increasing the potential need for additional dewatering during construction of the proposed channel improvements. However, this study cannot confirm this assumption. . In the event that groundwater is encountered during construction of the proposed channel improvements in the eastern portion of the alignment, it is not likely to require dewatering of more than 3 feet. Ninyo & Moore prepared three groundwater models to simulate the effect of 6 dewatering wells set at 100-foot intervals along a 500-foot transect near B-1, B-6, and B-20 which simulate 500-linear foot cut and fill trenches.

The simulated wells in each model were assumed to be 10 inches in diameter and screened to 10 feet below the target dewatering elevations. The wells were programmed to pump at a constant rate for the duration of each simulation until steady state conditions were achieved.

Based on the hydrogeologic conditions and assumptions described above, the model simulations were performed utilizing the highest estimated hydraulic conductivity values for each end of the proposed excavation (near Pecos Road and near Las Vegas Wash). Based on our hydrogeologic analysis, a combined flow rate ranging from approximately 6 gallons per minute (gpm) to 18 gpm could be expected to lower the water table approximately 5 to 6 feet within an adjacent 500 linear foot trench in the western portion of the alignment. In the event that groundwater is encountered during construction of the proposed channel improvements in the eastern portion of the alignment, a flow rate of approximately 120 gpm could be expected to lower the water

table approximately 3 feet within an adjacent 500 linear foot trench. These combined flow rates would be less than the 250 gpm threshold limit for a *DeMinimis* discharge permit.

Due to the very limited number of field tests relative to the length of the proposed alignment, the predicted dewatering flow rates should be treated as estimates only and not considered a dewatering design plan. Aquifer conditions may vary across the approximately 10,400 linear feet alignment where hydrogeologic testing was not performed. The hydrogeologic aquifer testing and analyses and modeling are summarized in Appendix C.

5. SUMMARY

A summary of our findings are presented as follows:

- Groundwater was measured in our geotechnical borings at elevations ranging from approximately 1,742.1 to 1,783.2 feet AMSL, which is approximately 3.6 to 5.8 feet above the anticipated target dewatering depths along the western portion of the project alignment. Ninyo & Moore recommends that the client apply for a *DeMinimis* discharge permit.
- As the water in the existing lined channel could possibly be feeding the shallow alluvial aquifer in the area, depth to groundwater may decrease with closer proximity to the channel base, thereby increasing the potential need for additional dewatering during construction of proposed channel improvements.
- Based on our hydrogeologic analysis, a combined flow rate ranging from approximately 6 gpm to 18 gpm could be expected to lower the water table approximately 5 to 6 feet within an adjacent 500 linear foot trench in the western portion of the alignment. In the event that groundwater is encountered during construction of the proposed channel improvements in the eastern portion of the alignment, a flow rate of approximately 120 gpm could be expected to lower the water table approximately 3 feet within an adjacent 500 linear foot trench. These flow rates would be less than the 250 gpm threshold limit for a *DeMinimis* discharge permit. Due to the relatively tight hydraulic conditions measured during this study, a modeled interval of 100-feet between wells was modeled instead of the typical 50-foot interval. If field conditions are found to require a more robust pumping operation, additional wells set at a shorter interval may be necessary.
- Based upon a review of the laboratory results for the groundwater samples collected from the temporary monitoring wells B-1, B-2, B-6 and B-20, the following parameters reported

concentrations above the NDEP recommended discharge limits: Sulfate and Total Dissolved Solids (TDS) in B-1, B-2, B-6 and B-20, and Chloride in B-1 and B-20. Treatment of the discharge waters would not likely be required for a *DeMinimis* permit.

6. OPERATIONAL MONITORING RESPONSIBILITIES

Ninyo & Moore recommends that the following bulleted list of issues be considered prior to commencing with the proposed dewatering operation:

- The NDEP General *DeMinimis* discharge permits, when approved, will be issued to the owner, along with a list of limitations and a compliance reporting schedule. Ninyo & Moore recommends that the owner require the dewatering contractor to fully comply with permit conditions, and be responsible for any violations and penalties incurred due to non-compliance.
- Based on the results of this study, to adequately dewater the proposed excavations as planned, the discharge rate is not likely to exceed the 250 gpm limit for a NDEP *DeMinimis* discharge permit for each outfall.
- During the planned construction, the operation of the dewatering wells should be closely monitored to ensure that all compliance monitoring and testing are performed, as will be required by the NDEP General *DeMinimis* groundwater discharge permit.
- Existing structures within the limits of groundwater drawdown resulting from dewatering may be at risk of experiencing settlement. The amount of settlement, if it occurs, would depend primarily on the depth and duration of the dewatering, as well as subsurface soil conditions. It is recommended that survey points be installed and monitored to evaluate potential settlement of nearby structures and that a photographic survey of the adjacent structures be conducted to monitor evidence of distress prior to the beginning of dewatering operations. If significant movement/damage occurs, dewatering operations should be temporarily suspended and the project's geotechnical consultant/owner's representative should be informed. Recommendations for mitigating settlement and associated distress should be provided by the geotechnical consultant/owner's representative.
- There is a potential for hydrogeologic conditions to be encountered that might require additional dewatering wells, deeper dewatering wells, and/or increased groundwater pumping and increased discharge rates to achieve the dewatering goal for the planned excavations. If an increased discharge rate is required, the NDEP might require from 6 to 9 months for issuing a new permanent NPDES permit for an increased discharge rate for this project.

7. LIMITATIONS

The dewatering discharge estimates provided in this report have been estimated from limited hydrogeologic testing performed at one location. The estimates presented in this report should be used for initial planning purposes and completion of the discharge permit only. The estimates are not presented, nor should they be construed, as a dewatering design plan.

The environmental and hydrological services described in this report have been conducted in general accordance with current regulatory guidelines and the standard of care exercised by consultants performing similar work in the project area. No other warranty, expressed or implied, is made regarding the professional opinions presented in this report. Please note that this study is based on a limited scope of work, and it did not include an extensive evaluation of geotechnical conditions or potential geologic hazards.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires any additional information or has questions regarding the content, interpretations presented, or completeness of this document.

The findings, opinions, and conclusions are based on an analysis of the observed site conditions and the referenced literature. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control. Ninyo & Moore cannot warrant or guarantee that not finding indicators of any particular hazardous material means that this particular hazardous material or any other hazardous materials do not exist in the groundwater below the site. Additional research, including additional chemical and hydrological testing, can reduce the uncertainty, but no techniques now commonly employed can eliminate the uncertainty altogether.

8. NEVADA CERTIFIED ENVIRONMENTAL MANAGER

In accordance with the Nevada Revised Statutes 459.500, Section 1, a holder of a certificate who is responsible for a service requiring certification shall ensure that each document relating to the service includes the following language:

I, Robert M. Troisi, hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state, and local statutes, regulations, and ordinances.



Robert M. Troisi, CEM
Certified Environmental Manager
No. 1247
Expires: January 15, 2017

4/15/15
Date

9. REFERENCES

- Bouwer, Herman and R.C. Rice, 1976, A Slug Test for determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, v. 12, pp 423-428.
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- Hvorselv, M.J., 1951, Time Lag and Soil Permeability in Groundwater Observations, Bull, 36, Waterways Experimental Station, U.S. Army Corps of Engineers, Vicksburg, Mississippi, pp 1-50
- Ninyo & Moore, 2015, Geotechnical Interpretive Report, Las Vegas Wash Central Cedar Avenue Channel Facility, Las Vegas, Nevada: dated April 10.
- Ninyo & Moore, proprietary in-house data.

TABLES

Table 1 –Groundwater Levels

Boring	Approximate Boring Elevation (feet-amsl)	Invert Elevation (feet-amsl)	Approximate Depth to Groundwater (feet)*	Approximate Groundwater Elevation (feet-amsl)	Dewatering Target Depth below Static Groundwater (feet)
B-1	1795.4	1,780.4	12.2	1,783.2	5.8
B-2	1791.6	1,776.6	12.7	1,778.9	5.3
B-3	1783.9	1,773.9	8.2	1,775.7	4.8
B-4	1781.9	1,771.9	8.4	1,773.5	4.6
B-5	1779.6	1,771.6	6.9	1,772.7	4.1
B-6	1778.2	1,769.2	8.4	1,769.8	3.6
B-10	1772.5	1,764.5	13.6	1,758.9	0
B-16	1764.1	1,755.1	13.6	1,750.5	0
B-17	1761.7	1,752.7	15.4	1,746.3	0
B-18	1762.3	1,748.3	18.4	1,743.9	0
B-19	1761.7	1,748.7	18.7	1,743.0	0
B-20	1760.5	1,745.5	18.4	1,742.1	0
*Measured from top of ground surface adjacent to borings.					

Table 2 - Groundwater Analytical Results - Metals							
Analyte	B-1	B-2	B-6	B-20	Reporting Limit	Groundwater Standards	
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	Federal (mg/l)	RSL (mg/l)
Aluminum	3.2	0.12	<0.25	<0.25	0.25		
Antimony	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.006	0.015
Arsenic	0.0064	0.0047	0.0058	0.0019	0.0001	0.010	0.000045
Barium	0.12	0.012	0.0057	<0.001	0.0010	2	2.6
Beryllium	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.004	0.073
Boron	2.2	0.4	0.78	1.7	0.05		7.3
Cadmium	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.005	0.018
Calcium	310	140	230	260	0.5		
Chromium	0.0047	0.0011	0.0012	<0.001	0.0010	0.1	55
Copper	<0.001	<0.001	<0.001	<0.001	0.0010	1.3	1.5
Iron	1.3	<0.5	<0.5	<0.0005	0.0005	0.30	26
Lead	<0.005	<0.001	<0.001	<0.001	0.001	0.015	
Manganese	0.039	<0.0005	<0.0005	0.0068	0.0005	0.05	0.88
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.002	0.011
Magnesium	370	200	290	410	0.1		
Molybdenum	0.005	0.012	0.0022	0.094	0.0005		0.18
Nickel	0.0019	<0.001	<0.001	<0.001	0.0010		0.73
Potassium	61	19	39	50	5		
Selenium	0.0068	0.0021	0.0075	0.024	0.001	0.05	0.18
Silver	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.1	0.18
Sodium	320	110	220	390	25		
Thallium	<0.0025	<0.0005	<0.0005	<0.0005	0.0005	0.002	0.0024
Zinc	<0.01	<0.01	<0.01	<0.01	0.010	5	11
Chloride	480	94	240	390	50	250	
Fluoride	1.3	0.96	1.4	2.4	0.5	4	2.20
Nitrogen, Nitrite (as N)	<0.5	<0.5	<0.5	<0.5	0.5	1	1
Nitrogen, Nitrate (as N)	4.5	1	4.4	6.3	0.5	10	10
Sulfate	2400	880	1400	2200	200	250	
Sulfur	820	370	630	920	50		
Hardness, Calcium (As CaCO ₃)	780	340	580	650	0.5		
Hardness, Total	2300	1200	1800	2300	1		
pH (pH units)	7.6	7.6	7.6	7.4			
Suspended Solids (Residue-Non Filterable)	260	21	15	19	10		
Total Dissolved Solids (Residue, Filterable)	4400	1700	2700	4200	33	500	
Phosphorus, Total	0.047	<0.02	<0.02	0.048	0.020		
Alkalinity, Bicarbonate (As CaCO ₃)	440	230	240	290	5		
Alkalinity, Carbonate (As CaCO ₃)	<5	<5	<5	<5	5		
Alkalinity, Hydroxide (As CaCO ₃)	<5	<5	<5	<5	5		
Alkalinity, Total (As CaCO ₃)	440	230	240	290	5		
Bio.Oxygen Demand (BOD) - field measurement	2.31	6.24	6.12	0.96			

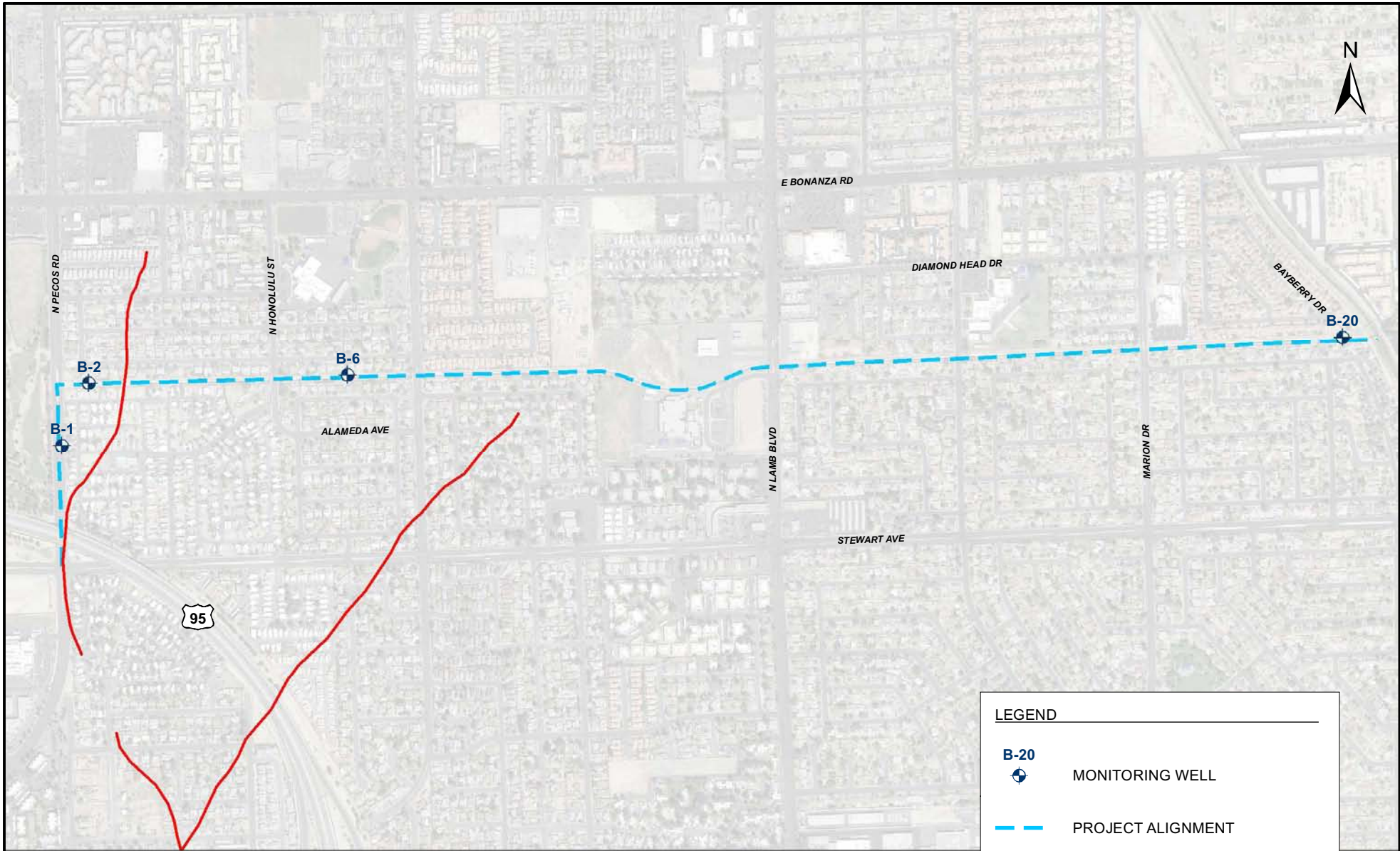
Notes:

RSL - Regional Screening Level

Table 3 - Groundwater Analytical Results - Organics and Biological							
Analyte						Groundwater Standards	
	B-1 (µg/L)	B-2 (µg/L)	B-6 (µg/L)	B-20 (µg/L)	Reporting Limit (µg/L)	Federal (µg/L)	MCL (µg/L)
Benzene	<0.50	<0.50	<0.50	<0.50	0.50	0.39	5.0
Ethylbenzene	<0.50	<0.50	<0.50	<0.50	0.50	1.3	700
m,p-Xylene	<1.0	<1.0	<1.0	<1.0	1.0	190	
Methylene chloride	<2.0	<2.0	<2.0	<2.0	2.0	9.9	5.0
MTBE	<0.50	<0.50	<0.50	<0.50	0.50	12	
o-Xylene	<0.50	<0.50	<0.50	<0.50	0.50	190	
Xylenes, Total	<1.5	<1.5	<1.5	<1.5	1.50		
Tetrachloroethene	<0.50	<0.50	<0.50	<0.50	0.50		
Toluene	<0.50	<0.50	<0.50	<0.50	0.50	860.00	1,000
Trichloroethene	<0.50	<0.50	<0.50	<0.50	0.50		

Table 4 - Organochlorine Pesticides and Herbicides							
Analyte						Groundwater Standards	
	B-1	B-2	B-6	B-20	Reporting Limit	Federal	MCL
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
4,4'-DDD ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053	0.027	
4,4'-DDE ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053	0.2	
4,4'-DDT ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053	0.2	
Aldrin ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027	0.004	
alpha-BHC ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
alpha-Chlordane ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
beta-BHC ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
Chlordane ⁽¹⁾	<0.27	<0.27	<0.27	<0.27	0.27	0.19	2.0
delta-BHD ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
Dieldrin ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053	0.0015	
Endosulfan I ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027	78	
Endosulfan II ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053		
Endosulfane sulfate ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053		
Endrin ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053	1.7	2.0
Endrin aldehyde ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053		
Endrin ketone ⁽¹⁾	<0.053	<0.053	<0.053	<0.053	0.053		
gamma-BHC ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
gamma-Chlordane ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
Heptachlor ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027	0.0018	0.4
Heptachlor epoxide ⁽¹⁾	<0.027	<0.027	<0.027	<0.027	0.027		
Methoxychlor ⁽¹⁾	<0.27	<0.27	<0.27	<0.27	0.27	27	40
Toxaphene ⁽¹⁾	<2.7	<2.7	<2.7	<2.7	2.7	0.013	3.0
Azinphos-methyl	<2.0	<2.0	<2.0	<2.0	2		
Bulstar (Sulfprofos)	<1.0	<1.0	<1.0	<1.0	1		
Chloropyrifos	<1.0	<1.0	<1.0	<1.0	1	6.200	
Coumaphos	<2.0	<2.0	<2.0	<2.0	2		
Demeton-O & S	<1.0	<1.0	<1.0	<1.0	1		
Diazinon	<1.0	<1.0	<1.0	<1.0	1	7.900	
Dichlorvos	<1.0	<1.0	<1.0	<1.0	1	0.230	
Disulfoton	<1.0	<1.0	<1.0	<1.0	1	0.380	
Ethoprop	<1.0	<1.0	<1.0	<1.0	1		
Fensulfothion	<1.0	<1.0	<1.0	<1.0	1		
Fenthion	<1.0	<1.0	<1.0	<1.0	1		
Malathion	<1.0	<1.0	<1.0	<1.0	1	300.000	
Merphos	<1.0	<1.0	<1.0	<1.0	1		
Methyl parathion	<1.0	<1.0	<1.0	<1.0	1	3.400	
Mevinphos	<2.0	<2.0	<2.0	<2.0	2		
Naled	<2.0	<2.0	<2.0	<2.0	2	31.000	
Phorate	<1.0	<1.0	<1.0	<1.0	1	2.300	
Ronnel	<1.0	<1.0	<1.0	<1.0	1	300.000	
Tetrachlorovinphos	<1.0	<1.0	<1.0	<1.0	1		
Tokuthion	<1.0	<1.0	<1.0	<1.0	1		
Trichloronate	<1.0	<1.0	<1.0	<1.0	1		
Notes:							
(1) - EPA Method 8081A							
MCL - Maximum Contaminant Level							

FIGURES



SOURCE: DEPOLO, C.M. AND BELL, J.W., 2000, MAP OF FAULTS AND EARTH FISSURES IN THE LAS VEGAS AREA (NEVADA BUREAU OF MINES AND GEOLOGY); GOOGLE EARTH, 2015

LEGEND

B-20

MONITORING WELL

PROJECT ALIGNMENT

MAPPED FAULT

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

MONITORING WELL LOCATIONS

FIGURE

PROJECT NO.
303710002

DATE
4/15

LAS VEGAS WASH CENTRAL CEDAR AVENUE CHANNEL FACILITY
LAS VEGAS, NEVADA

2

SCALE IN FEET

2_303710002_BLM.mxd 4/14/2015 JDL

Appendix D

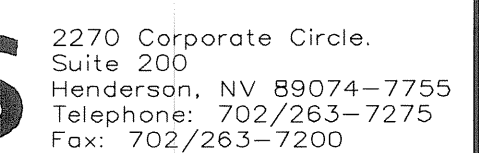
Record of Survey

LOCATED IN SECTIONS 31 AND 32, TOWNSHIP 20 SOUTH, RANGE 62 EAST, M.D.M., CITY OF LAS VEGAS, CLARK COUNTY, NEVADA.



1. THIS PLAT REPRESENTS THE RESULTS OF A SURVEY CONDUCTED UNDER MY DIRECT SUPERVISION AT THE INSTANCE OF THE CITY OF LAS VEGAS
2. THE LANDS SURVEYED LIE WITHIN SECTIONS 31 AND 32 TOWNSHIP 20 SOUTH, RANGE 62 EAST, M.D.M., CITY OF LAS VEGAS, CLARK COUNTY, NEVADA AND THE SURVEY WAS COMPLETED ON MARCH 20, 2015.
3. THIS PLAT COMPLIES WITH THE APPLICABLE STATE STATUTES AND ANY LOCAL ORDINANCES IN EFFECT ON THE DATE THAT THE GOVERNING BODY GAVE ITS FINAL APPROVAL.
4. THE MONUMENTS DEPICTED ON THE PLAT ARE OF THE CHARACTER SHOWN, OCCUPY THE POSITIONS INDICATED AND ARE OF SUFFICIENT NUMBER AND DURABILITY.

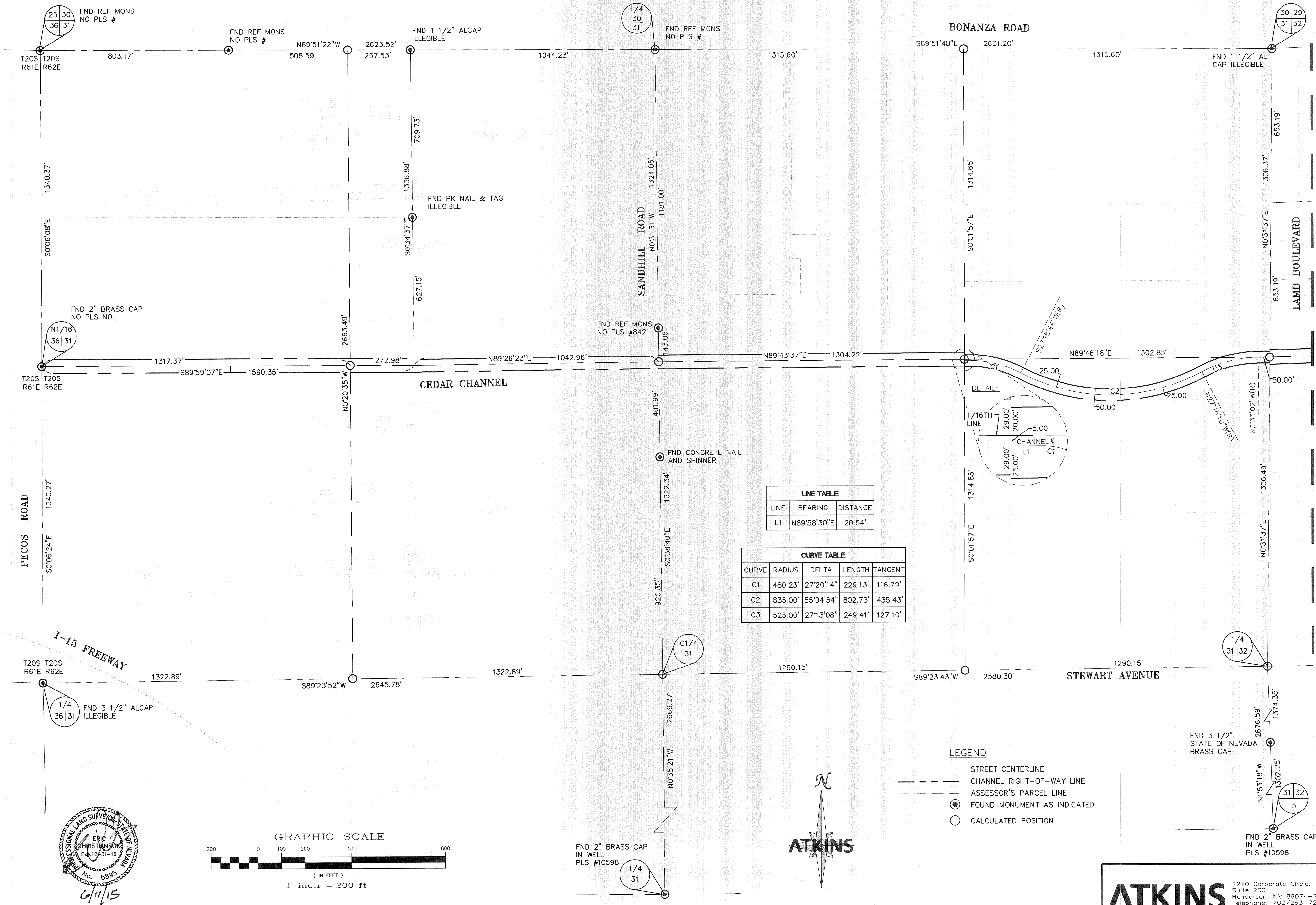
ANY SUBSEQUENT CHANGES TO THIS MAP SHOULD BE EXAMINED AND MAY BE DETERMINED
BY REFERENCE TO THE COUNTY RECORDER'S CUMULATIVE MAP INDEX NRS 278.5695



ee _____ Deputy _____

RECORD OF SURVEY FOR
**LAS VEGAS WASH CENTRAL
CEDAR AVENUE CHANNEL**

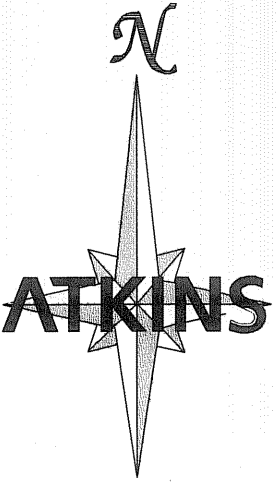
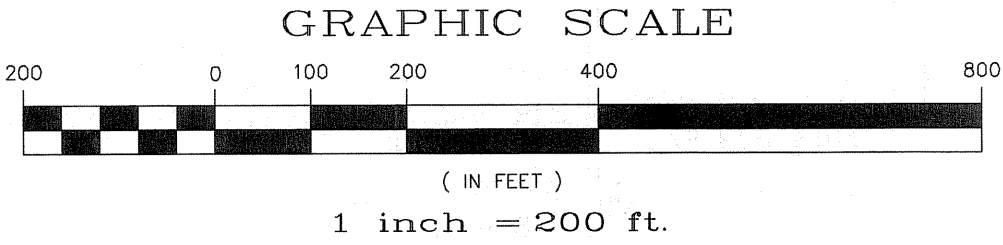
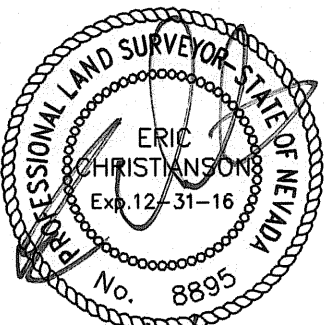
LOCATED IN SECTIONS 31 AND 32, TOWNSHIP 20 SOUTH, RANGE 62 EAST, M.D.M., CITY OF LAS VEGAS, CLARK COUNTY, NEVADA.



LINE TABLE		
LINE	BEARING	DISTANCE
L1	N89°58'30"E	20.54'

CURVE TABLE				
CURVE	RADIUS	DELTA	LENGTH	TANGENT
C1	480.23'	27°20'14"	229.13'	116.79'
C2	835.00'	55°04'54"	802.73'	435.43'
C3	525.00'	27°13'08"	249.41'	127.10'

- LEGEND
- STREET CENTERLINE
 - CHANNEL RIGHT-OF-WAY LINE
 - ASSESSOR'S PARCEL LINE
 - FOUND MONUMENT AS INDICATED
 - CALCULATED POSITION

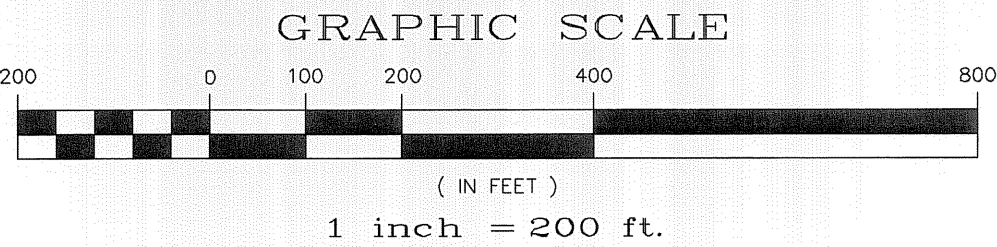
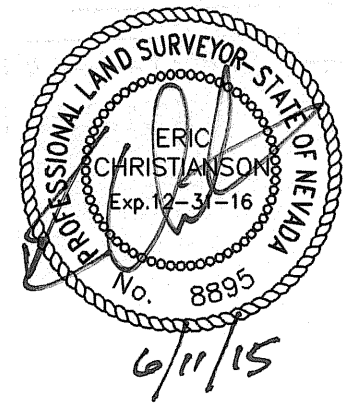
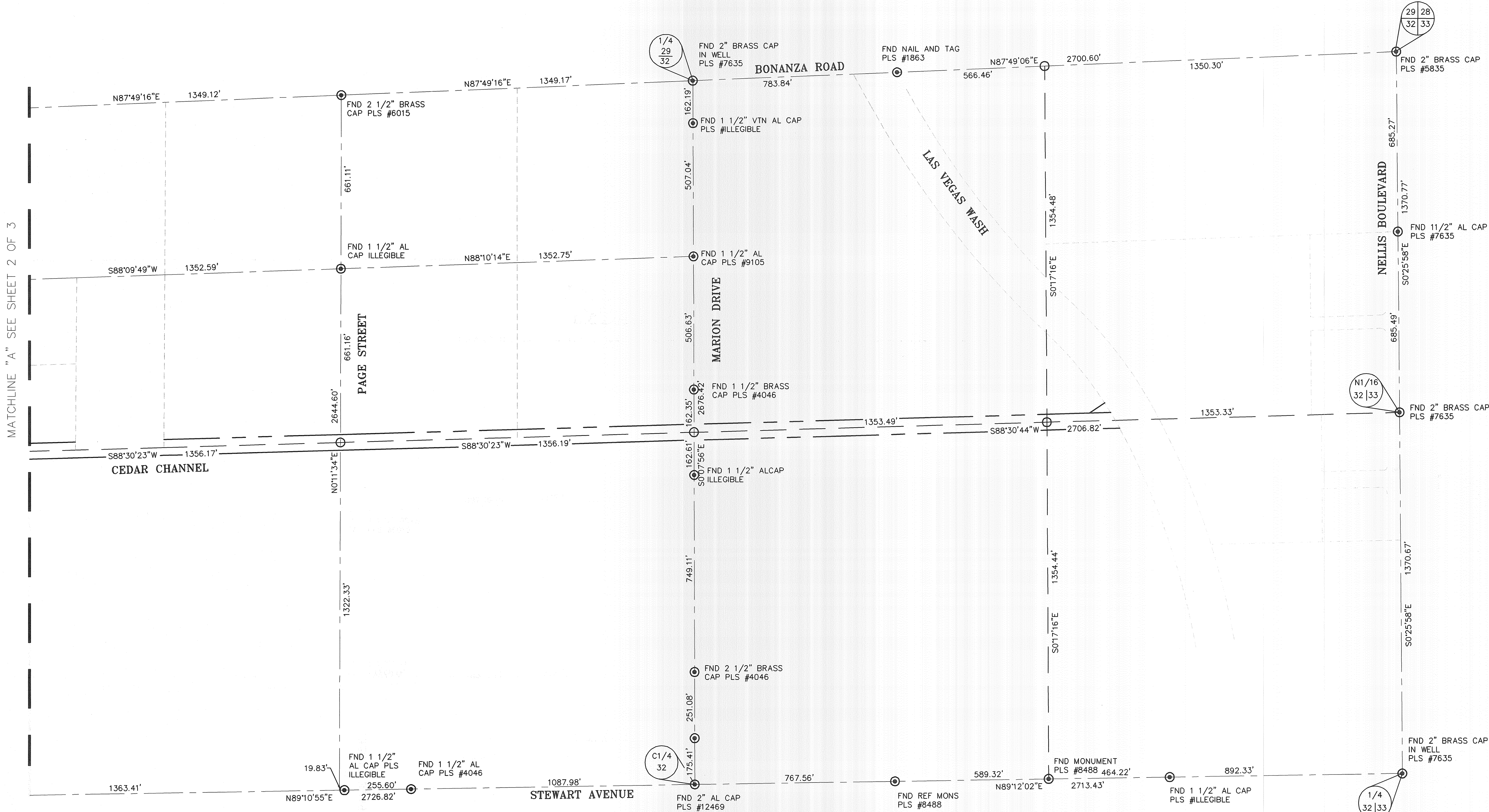


ATKINS

2270 Corporate Circle,
Suite 200
Henderson, NV 89074-7755
Telephone: 702/263-7275
Fax: 702/263-7200

RECORD OF SURVEY FOR
LAS VEGAS WASH CENTRAL
CEDAR AVENUE CHANNEL

LOCATED IN SECTIONS 31 AND 32, TOWNSHIP 20 SOUTH, RANGE 62 EAST, M.D.M., CITY OF LAS VEGAS, CLARK COUNTY, NEVADA.



- LEGEND**
- STREET CENTERLINE
 - - - CHANNEL RIGHT-OF-WAY LINE
 - - - ASSESSOR'S PARCEL LINE
 - FOUND MONUMENT AS INDICATED
 - CALCULATED POSITION

ATKINS
2270 Corporate Circle,
Suite 200
Henderson, NV 89074-7755
Telephone: 702/263-7275
Fax: 702/263-7200

Appendix E

Utility Conflict Schedule

UTILITY CONFLICT SCHEDULE - MAINLINE

PROJECT: Las Vegas Wash Central Cedar Avenue Channel

PREPARED BY: MM

DATE: 5/31/2015

PROJECT NO.: 100039014

CHECKED BY: SB

DATE: 7/17/2015

SHEET	LOCATION					UTILITY	ELEVATION		SOURCE OF INFO		IMPROVEMENT	ELEVATION		REQ. CLEARANCE		PLANS CLEARANCE		CONFLICT?	
	NO.	STA	OFFSET	TO	STA	SIZE AND TYPE	TOP	BOTTOM	POTHOLE	OTHER	SIZE AND TYPE	TOP	BOTTOM	TOP	BOTTOM	H	V	YES OR NO	RESOLUTION
	SD01	13+09.83	0'			UGP	1791.83	1791.50		TYPICAL DEPTH	2 -8'X4' RCB	1792.06	1786.73	0.5	0.5		0.00'	YES	RELOCATE
	SD01	13+19.86	0'			1-1/4" STREETLIGHT	1791.97	1791.80		TYPICAL DEPTH	2-8'X4' RCB	1792.02	1786.69	0.5	0.5		0.00'	YES	RELOCATE
	SD01	13+24.09	0'			2" ITS	1790.70	1790.53		TYPICAL DEPTH	2-8'X4' RCB	1792.00	1786.67	0.5	0.5		0.00'	YES	RELOCATE
	SD01	13+43.90	0'			10" HP STL GAS	1787.79	1786.96		BOMO TH*	2-8'X4' RCB	1791.93	1786.59	0.83	0.83		0.00'	YES	RELOCATE
	SD01	13+46.61	0'			2" ITS	1790.18	1790.02		TYPICAL DEPTH	2-8'X4' RCB	1791.91	1786.58	0.5	0.5		0.00'	YES	RELOCATE
	SD01	13+52.19	0'			2" ITS	1790.21	1790.04		TYPICAL DEPTH	2-8'X4' RCB	1791.89	1786.56	0.5	0.5		0.00'	YES	RELOCATE
	SD01	13+58.29	0'			36" RCP SS	1786.04	1782.37		MH DIPS	2-8'X4' RCB	1791.87	1786.53	0.5	0.5		0.49'	NO	PROTECT-IN-PLACE
	SD01	13+73.21		TO	14+16.42	72" RCP SD W/ CONC CAP					18'X4' RCB					0'		YES	REMOVE EX 72" RCP SD
	SD01	15+38.16	0'			24" STORM DRAIN	1789.68	1787.18		MH DIPS	18'X4' RCB	1790.41	1784.24					YES	CONNECT TO SD
	SD01	15+88.70	0'			2" ITS	1790.44	1790.27		TYPICAL DEPTH	18'X4' RCB	1790.16	1783.99	0.5	0.5		0.11'	NO	RELOCATE
	SD01	17+74.07		TO	19+00.00	72" RCP STORM DRAIN					12'X6' RCB					0'		YES	REMOVE EX 72" RCP SD
	SD01	18+49.83				UGP	1791.78	1791.45		TYPICAL DEPTH	12'X6' RCB	1789.49	1781.49	0.5	0.5		1.96'	NO	PROTECT-IN-PLACE
	SD02	19+00.00		TO	27+00.00	72" RCP STORM DRAIN					12'X6' RCB					0'		YES	REMOVE EX 72" RCP SD
	SD02	25+65.78	0'			1-1/4" STREETLIGHT	1793.92	1793.75		TYPICAL DEPTH	12'X6' RCB	1786.63	1778.63	0.5	0.5		7.12'	NO	PROTECT-IN-PLACE
	SD03	27+00.00		TO	31+25.16	72" RCP STORM DRAIN					12'X6' RCB					0'		YES	REMOVE EX 72" RCP SD
	SD04	42+05.00	33.0' LT	TO	43+16.00	33.0' LT	1-1/4" STLT				ACCESS RAMP					6.5'		NO	PROTECT-IN-PLACE
	SD05	52+59.92	33.2' LT	TO	53+56.73	32.1' LT	1-1/4" STLT				ACCESS RAMP					0.95'		NO	RELCOATE
	SD06	59+65.75	25.3' LT	TO	62+00.00	25.3' LT	4" UGP				36' CHANNEL					6.25'		NO	PROTECT-IN-PLACE
	SD07	62+00.00	19.9' LT	TO	68+00.00	19.1' LT	4" UGP				30'/36' CHANNEL					6.0'		NO	PROTECT-IN-PLACE
	SD08	68+00.00	19.1' LT	TO	75+00.00	20.5' LT	4" UGP				30' CHANNEL					6.0'		NO	PROTECT-IN-PLACE
	SD09	75+00.00	20.5' LT	TO	76+26.35	19.7' LT	4" UGP				30' CHANNEL					6.7'		NO	PROTECT-IN-PLACE
	SD09	79+53.28	26.9' LT	TO	80+50.39	27.4' LT	4" UGP				ACCESS RAMP					3.9'		NO	PROTECT-IN-PLACE
	SD11	92+58.11	33.2' LT	TO	93+60.03	29.5' LT	4" UGP				ACCESS RAMP					3.7'		NO	PROTECT-IN-PLACE
	SD14	118+77.65	0'			6" & 8" PVC SEWER					25' CHANNEL		1744.46						RELOCATE SEWER

* - USED DEPTH FROM BOMO TEST HOLES THAT WERE IN THE VICINITY OF THE PROPOSED IMPROVEMENTS.

UTILITY CONFLICT SCHEDULE - LATERALS

DATE: 5/31/2015

DATE: 6/18/2015

* - USED DEPTH FROM BOMO TEST HOLES THAT WERE IN THE VICINITY OF THE PROPOSED IMPROVEMENTS.

Appendix F

Cost Estimate

Freeway Channel
Washington, MLK to Rancho Drive
Preliminary Cost Estimate - Final Submittal

#	ITEM	DESCRIPTION	CCRFCD		UNIT	TOTAL	
			QUANTITY	COST		UNIT COST	TOTAL COST
	200.01	MOBILIZATION & DEMOBILIZATION	1	\$700,000.00	1	LS	\$700,000.00
	202.01	REMOVAL OF ASPHALT PAVEMENT	20490	\$117,817.50	20,490	SY	\$5.75
	202.02	REMOVE EXISTING SIDEWALK	1650	\$4,950.00	1,650	SF	\$3.00
	202.03	REMOVE EXISTING CURB AND GUTTER	788	\$5,516.00	788	LF	\$7.00
	202.04	REMOVE EXISTING MEDIAN ISLAND	1819	\$7,276.00	1,819	SF	\$4.00
	202.05	REMOVE EXISTING RCP STORM DRAIN	2168	\$43,360.00	2,168	LF	\$20.00
	202.06	REMOVE EXISTING MANHOLE	7	\$7,000.00	7	EA	\$1,000.00
	202.07	REMOVE EXISTING DROP INLET	4	\$6,000.00	4	EA	\$1,500.00
	202.08	REMOVE EXISTING SANITARY SEWER	271	\$2,710.00	271	LF	\$10.00
	202.09	REMOVE EXISTING CHANNEL	276256	\$1,657,536.00	276,256	SF	\$6.00
	212.01	REMOVE AND REPLACE EXISTING LANDSCAPING	1	\$75,000.00	1	LS	\$75,000.00
	270.01	DEWATERING	1	\$200,000.00	1	LS	\$200,000.00
	302.01	TYPE II AGGREGATE BASE	3660	\$91,500.00	3,660	CY	\$25.00
	402.01	2-INCH PLANTMIX BITUMINOUS SURFACE	10810	\$108,100.00	10,810	SY	\$10.00
	402.02	9-INCH PLANTMIX BITUMINOUS SURFACE	7920	\$435,600.00	7,920	SY	\$55.00
	413.01	1-INCH UTACS BONDED WITH A PMM, S3 GRADATION	7920	\$55,440.00	7,920	SY	\$7.00
	502.01	22-FOOT WIDE REINFORCED CONCRETE CHANNEL	1054	\$1,212,100.00	1,054	LF	\$1,150.00
	502.02	25-FOOT WIDE REINFORCED CONCRETE CHANNEL	1225	\$1,010,625.00	1,225	LF	\$825.00
	502.03	30-FOOT WIDE REINFORCED CONCRETE CHANNEL	1214	\$1,092,600.00	1,214	LF	\$900.00
	502.04	31-FOOT WIDE REINFORCED CONCRETE CHANNEL	2780	\$2,641,000.00	2,780	LF	\$950.00
	502.05	36-FOOT WIDE REINFORCED CONCRETE CHANNEL	1264	\$1,282,960.00	1,264	LF	\$1,015.00
	502.06	CHANNEL ACCESS RAMP	610	\$137,250.00	610	LF	\$225.00
	502.07	JUNCTION STRUCTURE	1	\$50,000.00	1	LS	\$50,000.00
	502.08	5-FT X 3-FT REINFORCED CONCRETE BOX	151	\$37,750.00	151	LF	\$250.00
	502.09	7-FT X3-FT REINFORCED CONCRETE BOX	172	\$62,780.00	172	LF	\$365.00
	502.10	8-FT X 4-FT REINFORCED CONCRETE BOX	253	\$107,525.00	253	LF	\$425.00
	502.11	12-FT X6-FT REINFORCED CONCRETE BOX	1496	\$1,458,600.00	1,496	LF	\$975.00
	502.12	18-FT X4-FT REINFORCED CONCRETE BOX	332	\$410,020.00	332	LF	\$1,235.00
	502.13	TRANSITION STRUCTURE #1	10	\$4,250.00	10	LF	\$425.00
	502.14	TRANSITION STRUCTURE #2	30	\$37,050.00	30	LF	\$1,235.00
	502.15	TEMPORARY RETAINING WALL	21470	\$644,100.00	21,470	SF	\$30.00
	603.01	18-INCH REINFORCED CONCRETE PIPE (CLASS III)	24	\$4,560.00	24	LF	\$190.00
	603.02	24-INCH REINFORCED CONCRETE PIPE (CLASS III)	11	\$2,200.00	11	LF	\$200.00
	609.01	36-INCH ACCESS MANHOLE W/ STEPS	1	\$3,000.00	1	EA	\$3,000.00
	609.02	48-INCH ACCESS MANHOLE W/ STEPS	3	\$10,500.00	3	EA	\$3,500.00
	609.03	20-FOOT TYPE "C" MODIFIED DROP INLET	5	\$100,000.00	5	EA	\$20,000.00
	609.04	CULVERT HEADWALL	1	\$4,000.00	1	EA	\$4,000.00
	613.01	L TYPE CURB AND GUTTER	312	\$7,800.00	312	LF	\$25.00
	613.02	A TYPE CURB	476	\$7,140.00	476	LF	\$15.00
	613.03	CONCRETE SIDEWALK	1650	\$8,250.00	1,650	SF	\$5.00
	613.04	TACK-ON MEDIAN	1819	\$14,552.00	1,819	SF	\$8.00
	622.01	CONSTRUCTION SURVEYING	1	\$75,000.00	1	LS	\$75,000.00
	623.01	REMOVE AND REPLACE TRAIL LIGHT	2	\$6,000.00	2	EA	\$3,000.00
	624.01	TRAFFIC CONTROL AND MAINTENANCE	1	\$150,000.00	1	LS	\$150,000.00
	629.01	REMOVE AND 18-INCH WATERLINE	1	\$80,000.00	1	LS	\$80,000.00
	630.01	8-INCH PVC SDR 35 SANITARY SEWER PIPE	370	\$64,750.00	370	LF	\$175.00
	630.02	48-INCH SANITARY SEWER MANHOLE	3	\$36,000.00	3	EA	\$12,000.00
	637.01	DUST CONTROL	1	\$150,000.00	1	LS	\$150,000.00
	637.02	NPDES DISCHARGE PERMIT	1	\$50,000.00	1	LS	\$50,000.00
		TOTAL		\$14,480,167.50			\$14,480,167.50
		Contingencies (15%)		\$2,172,025.13			\$2,172,025.13
		GRAND TOTAL		\$16,652,192.63		TOTAL PROJECT	\$16,652,192.63

Electronic Data CD

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