Water Resources Engineering

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Technical Memorandum

Paradise Hills Hydrology & Hydraulic Analysis – Existing Condition Assuming Post-Burn

Project No. OC10891.000

October 25, 2007

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Prepared for

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October 25, 2007

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Executive Summary

Exponent was retained by Inland Communities to analyze existing condition hydrology and hydraulics for the Paradise Hills (renamed University Hills) project in the City of San Bernardino. In particular, the analysis was to consider worst case, post-burn condition runoff and sediment yield in: 1) Badger Canyon, and 2) an unnamed, but mapped, intermediate canyon (hereinafter "FEMA" canyon or branch) tributary to Sycamore Canyon. The results were compared with the areas mapped by Federal Emergency Management Agency. The analysis will be used in conjunction with evaluation of development footprint, access, and subsequent FEMA mapping issues.

Hydrologic analysis used FEMA-1498-DR-CA[1], which was developed by FEMA and San Bernardino County for estimating post-burn floodplain hazards. Hydrologic methodology using California Regional Regression Equations[2] is consistent with FEMA's flood hazard mapping procedures[3]. Section C.1.1.3 of this document states that regional regression methodology takes precedence over rainfall-runoff relationships for estimating runoff from ungaged watersheds. Note that one percent annual chance ("100-year") peak discharges were estimated and used in floodplain hydraulic analysis for the project.

The aforementioned methodology was applied to each of the watersheds to develop tributary area vs. discharge relationships. The discharges were first adjusted upward to account for increased post-burn clear water discharges, and then adjusted upward a second time to account

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[1] "The Hydrologic and Hydraulic Methodology Used to Estimate Post-Burn Floodplain Hazards", FEMA-1498-DR-CA.

[2] U.S. Geological Survey Water-Resources Investigations Report 94-4002.

[3] "FEMA Specifications for Flood Hazard Mapping Partners", Appendix C, Guidance for Riverine Flooding Analyses and Mapping, April 2003.

for post-burn bulked discharges due to erosion. The bulking factor used in the hydrologic analysis exceeded 3, which is considered very conservative. Debris yield for a debris basin at "A" Street and Little Mountain Road was calculated using U.S. Army Corps of Engineers (CoE) Los Angeles District Debris Method[4]. The hydraulic analysis was performed using the CoE HEC-RAS computer program. The cross-sections used in the analysis were extracted from detailed topography supplied by the Inland Communities site civil engineer. Roughness coefficients were obtained from FEMA's flood insurance study[5].

FEMA had previously mapped Badger Canyon and the unnamed branch special flood hazard areas by using approximate methods with clear water flows, and designated these areas as Zone A. A request for engineering data resulted in a response from FEMA stating that their records did not have this information[6]. The results of our analysis show that floodplain widths in Badger Canyon, using detailed methods with bulked flows, were all narrower than the floodplain widths mapped by FEMA using approximate methods. Similarly, floodplain widths for the unnamed branch mapped by FEMA were also narrower than the floodplain width mapped by FEMA using approximate methods. Furthermore, the computed flow depths in upper reaches of both areas were lower than flow depths inferred from floodplain widths mapped by FEMA.

Areas within and downstream of this project will be impacted by recent FEMA action[7] regarding mapping of areas where uncertified levees are shown as providing flood protection. The revised FIRMs were released to the public on September 28, 2007. The impact of FEMA

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[4] "Debris Method, Los Angeles District Method for Prediction of Debris Yield", U.S. Army Corps of Engineers, Los Angeles District, February 1992, Updated February 2000.

[5] "Flood Insurance Study, San Bernardino County, California and Incorporated Areas", Vol. 1 of 4, Rev. January 17, 1997.

[6] Letter from FEMA Map Coordination Contractor, Re Case No. B0609007, dated 07 April 2005.

[7] "Procedure Memorandum No. 43 - Guidelines for Identifying Provisionally Accredited Levees", FEMA, September 25, 2006.

action within the project is evident in Planning Areas 9, 11, 12, 14, 15, 16, 17, and 18 which were originally outside the FIRM floodplain but now are partially or completely within Approximate Zone A floodplains. This eventuality was not included in the original modeling, so we can not provide an opinion as to whether detailed floodplain modeling would reduce or eliminate these encroachments. The impact of FEMA's revised FIRMs would be analyzed at a future date by others as a condition of development.

Proposed Project

The proposed Paradise Hills development project involves constructing infrastructure, homes, and ancillary structures adjacent to and within FEMA floodplains mapped by approximate methods. Some development activity would involve constructing access roads and utilities across FEMA mapped floodplains, and across uncertified levees previously mapped as providing flood protection. For the purposes of the present Technical Memorandum, the objective of the hydrologic and hydraulic analyses is to delineate the quantity and lateral extent of post-burn flows and debris yields so that infrastructure can be designed in accordance with San Bernardino County criteria. FEMA issues would be investigated at a future date by others as a condition of development.

FEMA Flood Insurance Study and Remapping

Even though the scope of this Technical Memorandum is focused on San Bernardino County criteria, the foundation of the hydrologic and hydraulic analyses rests on the past FEMA Flood Insurance Study (FIS) that documents potential flooding conditions in the area. FEMA studied Badger Canyon, an intermediate unnamed canyon, and Sycamore Canyon by approximate methods, assuming clear water flow in non-burn conditions. Portion of these canyons were designated Zone A by FEMA. Four Flood Insurance Rate Map panels (FIRMs) covered the area at the beginning of this project: 06071C 7930 F, 06071C 7935 F, 06071C 7940 F, and

06071C 7945 F. A FEMA External Data Request response[8] yielded no additional information beyond what was available from the FEMA map center.

On September 28, 2007, FEMA released revised FIRMs that include annotations for Provisionally Accredited Levees (PALs). The project area is now covered by seven FIRMs: 06071C 7930 G, 06071C 7933 G, 06071C 7935 G, 06071C 7940 G, 06071C 7942 G, 06071C 7944 G, and 06071C 7945 G. These FIRMs show additional areas designated Zone X that will be converted to approximate Zone A if levees are not certified by September 2009.

The FIRMs also show two Approximate Zone A areas at the project site expanded beyond the original boundaries shown in Figure 1. Figures 2 and 3 illustrate the expanded Zone A boundaries. The impact of FEMA action within the project is particularly evident in Planning Areas 16, 17, and 18 which were originally outside the FIRM floodplain but now are completely within an Approximate Zone A floodplain. There is an impact on parts of Planning Areas 9, 11, 12, 14, and 15.

Hydrologic Analysis

The aforementioned four FIRM panels were overlaid on U.S. Geological Survey San Bernardino North quadrangle to provide guidance in delineating the drainage areas used in the regression analysis. Where a mismatch existed, USGS topography was given precedence. Drainage boundaries and subarea delineations are shown in Figure 1.

California Regional Regression Equations for South Coast Rural Region 5, in U.S. Geological Survey National Flood Frequency (NFF) Program[9] were used. The variables were drainage

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[8] Letter from FEMA Map Coordination Contractor, Re Case No. B0609007, dated 07 April 2005

[9] U.S. Geological Survey National Flood Frequency (NFF) Program Version 1.1, November 21, 1994 (The documentation for this program is U.S. Geological Survey Water-Resources Investigations Report 94-4002.)

area, A (sq. mi.) and mean annual precipitation, P (in.). The mean annual precipitation, obtained from the USGS database for the site latitude and longitude, was 22.5 inches. Peak clear flow discharges at selected concentration points were calculated for 1 percent annual chance (100-year) runoff using equation:

$$Q100 = 1.95\ A^{0.83}\ P^{1.87}$$

Concentration points, tributary areas, and peak clear flow discharges are summarized in Table 2. Using FEMA post-burn procedures, the maximum clear water adjustment factor of 2.62 (high burn) was applied to each peak discharge at each concentration point. Next, the sediment-bulking factor of 40 (= 140% for Q100, area <3 sq mi) was applied to each peak discharge for each concentration point. The combined bulking factor was 3.7.

Tables 3, 4, and 5 provide calculated peak discharges for Badger Canyon, unnamed "FEMA" branch, and Sycamore Canyon, respectively, for the three watershed conditions. To model the gradual increase in flows from the upper to lower reaches of the watersheds, peak discharges for HEC-RAS cross sections at intermediate elevations were calculated by linear interpolation.

Debris Yield

If it is proposed to redirect flows from unnamed "FEMA" branch tributaries upstream of "A" Street to a debris basin at the north side of "A" Street at the intersection with Little Mountain Road. Clear flow would pass through a culvert under Little Mountain Road. CoE Debris method Equation 1 was used, to investigate two debris yield cases in accordance with San Bernardino County Flood Control District[10]: 100 year event 4 years after 100% wildfire (Fire Factor = 4.50) and 10-year event 1year after 100% wildfire (FF = 6.50). CoE Equation 1 is:

$$LOG\ Dy = 0.65(LOG\ P) + 0.62(LOG\ RR) + 0.18(LOG\ A) + 0.12(FF)$$

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[10] "Debris Flow Hazard Delineation for Areas in San Bernardino County Affected by the Hemlock Fire.", D.L. Hamilton; March 11, 1998.

This equation was solved for the two cases, for the west FEMA branch, east FEMA branch, and the total area upstream of the proposed debris basin and culvert. A summary of the spreadsheet calculations is provided in Table 6. Total debris yields for the 100-year and 10-year events are 4,693 cubic yards and 6,266 cubic yards respectively.

Proposed Project Overlay

The original Paradise Hills project footprint was subject to numerous changes over the term of this project. The final footprint has evolved as University Hills, and is illustrated in Figure 2 as an overlay on the Topographic Workmap.

There are four culvert crossing areas. The site civil engineer has provided culvert parameters for these crossings, described below.

There are encroachments into the Badger Canyon and Sycamore Canyon FEMA floodplains. Upon successful processing of a Letter of Map Revision (LOMR), it is anticipated that the Badger Canyon floodplain will be smaller, with a smaller impact to Planning Areas 9, 11, 12, 14, and 15. FEMA remapping has joined the Badger Canyon and Sycamore Canyon floodplain into a contiguous Approximate Zone A that covers Planning Areas 16, 17, and 18. The Sycamore Canyon floodplain is subject to backwater from water storage in Sycamore Canyon basin.

Culvert Discharges

Culvert design by the site civil engineer will be based on post-burn clear flow or post-burn bulked flow calculated peak discharges previously provided to the client and site civil engineer,

or discharges provided by San Bernardino County Flood Control District. The site civil engineer has developed culvert design parameters and provided them in Table 1[11].

Hydraulic Analysis

Two separate steady flow HEC-RAS hydraulic models were prepared for this project. One model covered Badger Canyon (P_HILLS_BC.*), while the second model covered the South Badger Storage Basin, Lower Sycamore Canyon, and the unnamed FEMA tributary (P_HILLS_SC.*). The HEC-RAS analyses were done with all three discharges, which are identified as PF1, PF2, and PF3, for clear flow, post-burn clear flow, and post-burn bulked flow, respectively (see Tables 3, 4, and 5).

The lower reach of Badger Canyon was designated as "Lower Badger Canyon" in the HEC-RAS model. This model also includes the two upper tributaries to "Lower Badger Canyon", which include the East Badger and West Badger Canyons. The Badger Canyon culvert location under "A" Street is downstream of Station 9+60. The results of the analysis show that the post-burn bulked flow (PF3) floodplain is narrower than, and within, the floodplain designated by FEMA using approximate methods. Figures 2 and 3 illustrate the computed floodplain for profile PF3, while Table 7 is the HEC-RAS summary printout for the Badger Canyon model. There is an encroachment into the Badger Canyon FEMA floodplain at the downstream end of the Badger Canyon Zone A floodplain. Upon successful processing of a Letter of Map Revision (LOMR), it is anticipated that the floodplain will be smaller so that there would not be an encroachment.

The second model consists of three reaches. The first downstream reach includes the South Badger Storage Basin and spillway. This reach was designated as the "South Badger Storage Basin" in HEC-RAS analysis. The culverts under Little Mountain Road convey the spillway

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[11] "2007-0926-Culvert-Parameter(1).xls", A. Fawaz, attachment to email dated Thursday, September 27, 2007 2:08 PM.

flow. The next upper reach includes the lower reach of Sycamore Canyon, which is another storage basin. Tributary to the Sycamore Canyon reach is the unnamed FEMA tributary, i.e. designated FEMA Branch. FEMA branch includes a culvert location under Little Mountain Road just upstream of the confluence with Sycamore Canyon, and a culvert location under "A" Street. A debris basin is considered upstream of these culverts.

The results of the HEC-RAS analysis show that Badger Canyon and the FEMA Branch have the capacity to convey the PF2 post-burn clear and PF3 post-burn bulked flows as appropriate.

Portions of the existing South Badger Storage Basin, Spillway Canyon, and Sycamore Canyon ranch reaches do not have sufficient conveyance for PF2 and PF3 discharges. These reaches are peripheral to the proposed project, and do not adversely impact project design. Figure 3 Topographic Workmap illustrates the computed floodplain for profile PF1 for South Badger Storage Basin, profile PF2 for Sycamore Canyon, and profile PF3 for South Badger Storage Spillway Canyon. Profile PF3 is used for unnamed West FEMA Branch, and profile PF2 is used for unnamed FEMA Branch downstream of "A" Street and the proposed debris basin. Table 8 is the HEC-RAS summary printout for the Sycamore Canyon model.

Conclusion

Hydrologic and hydraulic analyses estimated worst case, post-burn condition flow in Badger Canyon and an unnamed FEMA intermediate canyon tributary to Sycamore Canyon that had been mapped by FEMA and recently remapped using approximate methods. Floodplain widths were generally narrower than, and within, floodplains mapped or remapped by FEMA.

Floodplain widths in Badger Canyon, using detailed methods with bulked flows, were all narrower than the floodplain widths mapped or remapped by FEMA using approximate methods. Similarly, floodplain widths for the unnamed branch mapped by FEMA were also narrower than the floodplain width mapped or remapped by FEMA using approximate methods. Furthermore, the computed flow depths in upper reaches of both areas were lower than flow depths inferred from floodplain widths mapped by FEMA.

Areas within and downstream of this project will be impacted by recent FEMA action[12] regarding mapping of areas where uncertified levees are shown as providing flood protection. The revised FIRMs were released to the public on September 28, 2007. The impact of FEMA action within the project is evident in Planning Areas 9, 11, 12, 14, 15, 16, 17, and 18 which were originally outside the FIRM floodplain but now are partially or completely within Approximate Zone A floodplains. This eventuality was not included in the original modeling, so we can not provide an opinion as to whether detailed floodplain modeling would reduce or eliminate these encroachments. The impact of FEMA's revised FIRMs would be analyzed at a future date by others as a condition of development.

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[12] "Procedure Memorandum No. 43 - Guidelines for Identifying Provisionally Accredited Levees", FEMA, September 25, 2006.

Table 1. Culvert Parameters

590164-UNIVERSITY HILLS

CULVERT PARAMETERS

CULVERT NO.	Q cfs	NO. OF CULVERTS	MATERIAL	SHAPE	SPAN ft	RISE ft	ENTRANCE	LENGTH ft	Ke	U/S INV.	D/S INV.	RipRap Dimension	ROAD FS	ROAD HEIGHT ABOVE INV.(ft)
1	2000	3	RCB	BOX	9	5	90°-15°	100	0.5	1760	1752	35'x50'	1773	13
2	506	1	RCB	BOX	10	5	90°-15°	400	0.5	1620	1588	20'x30'	1630	10
3	2266	2	RCB	BOX	12	9	90°-15°	80	0.5	1541	1535	35'x50'	1556	15
4	2266	2	RCB	BOX	12	9	90°-15°	220	0.5	1478	1456	35'x50'	1504	26

NOTE: Q FOR CULVERT NO. 3&4 ARE FROM SBFCD.

Rip Rap: at the inlet and outlet of the culvert

Source: "2007-0926-Culvert-Parameter(1).xls", A. Fawaz, attachment to email dated Thursday, September 27, 2007 2:08 PM.

Table 2. Drainage Area Summary – Keyed to Figure 1

			Planimetry	Computed
Concentration Point	Note	Elevation	Acres	Sq Mi
West Badger Cyn @ N Bdy	WBC-N	2400	69.173	0.108
West Badger Cyn u/s confl	WBC-C	2020	164.095	0.256
East Badger Cyn @ N Bdy	EBC-N	2360	189.405	0.296
East Badger Cyn u/s confl	EBC-D	2020	291.065	0.455
Badger Cyn d/s confl	BC-B	2020	455.160	0.711
Badger Cyn @ Basin	BC-A	1708	524.791	0.820
Unnamed FEMA tributary "FEMA"				
FEMA West branch u/s "A" Street	F-C	1630	111.130	0.174
FEMA East branch u/s "A" Street		1620	34.880	0.055
FEMA West, East branch combined u/s "A" Street @ debris basin		1620	146.010	0.228
FEMA tributary d/s "A" Street cut off	F-B	1540	19.490	0.030
Unnamed FEMA tributary @ Sycamore Cyn	F-A	1540	165.500	0.259
Sycamore Cyn	SC-G	2800	132.831	0.208
Sycamore Cyn	SC-F	2120	318.679	0.498
Sycamore Cyn	SC-E	1840	545.293	0.852
Sycamore Cyn	SC-D	1560	656.653	1.026
Sycamore Cyn u/s confl w/FEMA	SC-C	1540	723.545	1.131
Sycamore Cyn d/s confl w/FEMA	SC-B	1540	869.049	1.358
Sycamore Cyn @ Badger Basin	SC-A		869.049	1.358

Table 3. Badger Canyon 100-year Discharges

EAST BADGER CYN AND LOWER BADGER CYN					
			Clear	Post-Burn	Post-Burn
			Flow	Clear Flow	Bulked Flow
	Elevation	Sta	cfs	cfs	cfs
Upper EBC	3700	9500	1	3	4
	3400	8800	42	110	154
	3120	8030	87	229	320
	2880	7430	123	321	449
	2680	6730	164	429	600
	2480	6030	205	537	751
EBC N Bdy	2360	5430	240	629	880
	2239	5000	259	678	948
	2200	4650	274	718	1004
	2159	4350	287	752	1052
	2120	3950	304	797	1115
	2079	3630	318	833	1166
U/S Confl	2020	3051	343	899	1258
D/S Confl	2020	3050	496	1300	1819
	1958	2600	509	1333	1865
	1917	2200	520	1362	1906
	1877	1950	527	1380	1931
	1839	1650	535	1402	1962
	1799	1300	545	1428	1998
	1760	960	554	1453	2033
	1720	837	558	1462	2045
Basin	1708	790	559	1465	2050
WEST BADGER CYN ONLY					
			Clear	Post-Burn	Post-Burn
			Flow	Clear Flow	Bulked Flow
	Elevation	Sta	cfs	cfs	cfs
Upper WBC	3830	9500	1	3	4
	3480	8500	27	70	98
	3200	8000	40	104	145
	3000	7400	55	144	202
	2800	6700	73	191	268
	2520	6000	91	238	334
WBC N Bdy	2400	5500	104	272	381
	2279	4990	127	332	464
	2240	4750	137	360	503
	2200	4500	149	389	544
	2160	4200	162	424	593
	2120	3900	175	459	642
	2080	3600	189	494	691
U/S Confl	2020	3051	213	558	781

Table 4. Unnamed "FEMA" Branch Peak 100-year Discharges

			UNNAMED FEMA BRANCH		
			Clear	Post-Burn	Post-Burn
		Area	Flow	Clear Flow	Bulked Flow
	Elv	Sq Mi	cfs	cfs	cfs
Upper FEMA					
West Branch u/s "A" St	1630	0.174	154	404	566
East Branch u/s "A" St	1620	0.054	58	153	214
Combined @ basin	1620	0.228	193	506	708
Lwr FEMA cut off	1540.5	0.031	37	97	135
Lwr FEMA @ Syc 24+00	1540.5	0.259	215	562	787

Table 5. Sycamore Canyon Peak 100-year Discharges

FLOW VS ELEVATION		SYCAMORE CYN		
		Clear	Post-Burn	Post-Burn
		Flow	Clear Flow	Bulked Flow
	Elv	cfs	cfs	cfs
Upper Sycamore	3800	1	3	4
	3760	8	21	30
	3720	15	40	56
	3680	22	59	82
	3640	29	77	108
	3600	37	96	134
	3560	44	115	160
	3520	51	133	186
	3480	58	152	213
	3440	65	171	239
	3400	72	189	265
	3360	79	208	291
	3320	86	226	317
	3280	94	245	343
	3240	101	264	369
	3200	108	282	395
	3160	115	301	422
	3120	122	320	448
	3080	129	338	474
	3040	136	357	500
	3000	143	376	526
	2960	151	394	552
	2920	158	413	578
	2880	165	432	604
	2840	172	450	630
Sycamore @ 2800'	2800	179	469	657
	2760	190	498	698
	2720	201	528	739
	2680	213	557	780
	2640	224	586	821
	2600	235	615	862
	2560	246	645	903
	2520	257	674	944
	2480	268	703	985
	2440	280	733	1026
	2400	291	762	1067
	2360	302	791	1108
	2320	313	820	1149
	2280	324	850	1190
	2240	335	879	1231

	2200	347	908	1272
	2160	358	937	1312
Sycamore @ 2120'	2120	369	967	1353
	2080	399	1045	1462
	2040	428	1122	1571
	2000	458	1200	1680
	1960	488	1278	1789
	1920	518	1356	1898
	1880	547	1434	2007
Sycamore @ 1840'	1840	577	1512	2116
	1800	591	1548	2167
	1760	604	1584	2217
	1720	618	1620	2267
	1680	632	1655	2318
	1640	646	1691	2368
	1600	659	1727	2418
Sycamore @ 1560'	1560	673	1763	2469
Sycamore d/s	1540	865	2266	3173

Table 6. Unnamed FEMA Branch Debris Yields

DEBRIS YIELD PER CoE LOS ANGELES DISTRICT				SBCFCD CRITERIA						
EQUATION 1		100-YEAR BASIS	Q100, 4 Y AFTER FIRE							
UNNAMED FEMA WATERSHED										
BRANCH	P (in)	LOG(100* P)	D ELEV (ft)	CHL LGT (mi)	RR (ft/mi)	LOG RR	AREA (ac)	LOG A	FF	LOG Dy
WEST	1.5	2.18	1220	0.82	1488	3.17	111.13	2.05	4.50	4.29
EAST	1.5	2.18	900	0.65	1385	3.14	34.88	1.54	4.50	4.18
TOTAL	1.5	2.18	1230	0.82	1500	3.18	146.01	2.16	4.50	4.31
		UNIT Dy		DEBRIS						
BRANCH	LOG Dy	(cy/sq mi)	AREA (sq mi)	YIELD (cy)						
WEST	4.29	19484	0.174	3383						
EAST	4.18	15127	0.055	824						
TOTAL	4.31	20570	0.228	4693						

EQUATION 1		10-YEAR BASIS	Q10, 1 Y AFTER FIRE							
UNNAMED FEMA WATERSHED										
BRANCH	P (in)	LOG(100* P)	D ELEV (ft)	CHL LGT (mi)	RR (ft/mi)	LOG RR	AREA (ac)	LOG A	FF	LOG Dy
WEST	1	2.00	1220	0.82	1488	3.17	111.13	2.05	6.50	4.42
EAST	1	2.00	900	0.65	1385	3.14	34.88	1.54	6.50	4.31
TOTAL	1	2.00	1230	0.82	1500	3.18	146.01	2.16	6.50	4.44
		UNIT Dy		DEBRIS						
BRANCH	LOG Dy	(cy/sq mi)	AREA (sq mi)	YIELD (cy)						
WEST	4.42	26015	0.174	4517						
EAST	4.31	20197	0.055	1101						
TOTAL	4.44	27464	0.228	6266						

Table 7. Badger Canyon HEC-RAS Model Summary Printout

HEC-RAS Plan: Plan 02												
Reach	River Sta	Profile	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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
East Badger Cyn	9500	PF 1	1	3700.00	3700.10	3700.10	3700.12	0.176790	1.28	0.78	16.15	1.02
East Badger Cyn	9500	PF 2	3	3700.00	3700.15	3700.15	3700.19	0.185519	1.71	1.75	24.17	1.12
East Badger Cyn	9500	PF 3	4	3700.00	3700.17	3700.17	3700.21	0.138437	1.65	2.43	28.44	0.99
East Badger Cyn	8800	PF 1	42	3399.50	3400.01	3400.27	3401.06	0.807732	8.24	5.10	20.05	2.88
East Badger Cyn	8800	PF 2	110	3399.50	3400.34	3400.70	3401.56	0.351476	8.86	12.42	23.42	2.14
East Badger Cyn	8800	PF 3	154	3399.50	3400.92	3400.92	3401.40	0.064694	5.58	27.62	29.19	1.01
East Badger Cyn	8030	PF 1	87	3120.00	3122.03	3122.58	3123.76	0.242971	10.54	8.26	8.13	1.84
East Badger Cyn	8030	PF 2	229	3120.00	3122.75	3123.82	3126.32	0.336644	15.16	15.10	10.99	2.28
East Badger Cyn	8030	PF 3	320	3120.00	3122.19	3124.35	3139.35	2.184176	33.24	9.63	8.78	5.59
East Badger Cyn	7430	PF 1	123	2880.00	2881.72	2882.66	2885.64	0.648002	15.89	7.74	9.02	3.02
East Badger Cyn	7430	PF 2	321	2880.00	2882.64	2883.90	2887.40	0.442833	17.51	18.33	13.87	2.68
East Badger Cyn	7430	PF 3	449	2880.00	2883.42	2884.47	2886.75	0.220199	14.65	30.64	17.94	1.98
East Badger Cyn	6730	PF 1	164	2680.00	2682.83	2683.43	2684.69	0.173324	10.95	14.98	10.60	1.62
East Badger Cyn	6730	PF 2	429	2680.00	2683.89	2685.04	2687.45	0.216424	15.14	28.34	14.58	1.91
East Badger Cyn	6730	PF 3	600	2680.00	2684.06	2685.76	2689.94	0.338396	19.46	30.83	15.21	2.41
East Badger Cyn	6030	PF 1	205	2480.00	2482.42	2483.57	2486.66	0.466177	16.53	12.40	10.27	2.65
East Badger Cyn	6030	PF 2	537	2480.00	2483.64	2485.22	2489.30	0.360416	19.10	28.12	15.46	2.50
East Badger Cyn	6030	PF 3	751	2480.00	2484.42	2486.00	2489.49	0.248051	18.05	41.60	18.80	2.14
East Badger Cyn	5430	PF 1	240	2360.00	2361.80	2362.13	2363.02	0.123244	8.88	27.02	22.66	1.43
East Badger Cyn	5430	PF 2	629	2360.00	2362.71	2363.48	2365.26	0.140238	12.83	49.04	25.70	1.64
East Badger Cyn	5430	PF 3	880	2360.00	2363.01	2364.17	2366.73	0.177507	15.48	56.85	26.69	1.87
East Badger Cyn	5000	PF 1	259	2239.00	2241.48	2243.01	2248.57	0.819639	21.36	12.12	10.20	3.45
East Badger Cyn	5000	PF 2	678	2239.00	2242.73	2245.08	2252.63	0.590346	25.25	26.86	13.33	3.13

East Badger Cyn	5000	PF 3	948	2239.00	2243.60	2245.96	2252.49	0.418244	23.93	39.62	16.52	2.72
East Badger Cyn	4650	PF 1	274	2200.00	2203.79	2203.79	2204.82	0.055806	8.14	33.64	16.36	1.00
East Badger Cyn	4650	PF 2	718	2200.00	2205.64	2205.73	2207.22	0.053485	10.11	70.99	24.18	1.04
East Badger Cyn	4650	PF 3	1004	2200.00	2206.32	2206.59	2208.32	0.058190	11.34	88.57	27.09	1.10
East Badger Cyn	4350	PF 1	287	2159.00	2161.61	2163.04	2166.86	0.454026	18.38	15.62	10.65	2.67
East Badger Cyn	4350	PF 2	752	2159.00	2162.95	2164.94	2170.58	0.438042	22.16	33.94	17.22	2.78
East Badger Cyn	4350	PF 3	1052	2159.00	2163.66	2165.76	2171.32	0.366327	22.22	47.35	21.06	2.61
East Badger Cyn	3950	PF 1	304	2120.00	2121.85	2121.85	2122.50	0.058468	6.45	47.14	37.11	1.01
East Badger Cyn	3950	PF 2	797	2120.00	2123.02	2123.04	2124.09	0.051661	8.31	95.87	46.79	1.02
East Badger Cyn	3950	PF 3	1115	2120.00	2123.49	2123.61	2124.85	0.055032	9.38	118.91	50.73	1.08
East Badger Cyn	3630	PF 1	318	2079.00	2081.42	2082.49	2084.86	0.318762	14.90	21.34	16.49	2.31
East Badger Cyn	3630	PF 2	833	2079.00	2082.52	2084.07	2088.10	0.361889	18.97	43.92	26.12	2.58
East Badger Cyn	3630	PF 3	1166	2079.00	2083.11	2084.71	2088.71	0.316354	18.99	61.41	33.11	2.46
East Badger Cyn	3051	PF 1	343	2020.00	2023.50	2022.31	2023.70	0.008446	3.59	95.56	41.97	0.42
East Badger Cyn	3051	PF 2	899	2020.00	2025.61	2023.66	2025.93	0.007392	4.55	197.67	54.65	0.42
East Badger Cyn	3051	PF 3	1258	2020.00	2026.62	2024.31	2026.99	0.007265	4.91	256.46	62.44	0.43
West Badger Cyn	9100	PF 1	1	3830.00	3830.41	3830.41	3830.52	0.121947	2.62	0.38	1.85	1.02
West Badger Cyn	9100	PF 2	3	3830.00	3830.64	3830.64	3830.80	0.103623	3.24	0.92	2.89	1.01
West Badger Cyn	9100	PF 3	4	3830.00	3830.72	3830.72	3830.90	0.099769	3.44	1.16	3.24	1.01
West Badger Cyn	8500	PF 1	27	3480.00	3481.54	3481.54	3481.94	0.078227	5.06	5.34	6.93	1.02
West Badger Cyn	8500	PF 2	70	3480.00	3481.46	3482.26	3484.74	0.692168	14.53	4.82	6.58	2.99
West Badger Cyn	8500	PF 3	98	3480.00	3481.66	3482.59	3485.54	0.692688	15.81	6.20	7.47	3.06
West Badger Cyn	8000	PF 1	40	3200.00	3201.94	3201.94	3202.44	0.076394	5.66	7.07	7.28	1.01
West Badger Cyn	8000	PF 2	104	3200.00	3201.99	3202.86	3205.02	0.448814	13.96	7.45	7.47	2.46
West Badger Cyn	8000	PF 3	145	3200.00	3202.25	3203.26	3205.87	0.456287	15.27	9.50	8.44	2.54
West Badger Cyn	7400	PF 1	55	3000.00	3001.22	3002.60	3014.90	4.544164	29.68	1.85	3.04	6.70
West Badger Cyn	7400	PF 2	144	3000.00	3002.96	3003.83	3005.65	0.273987	13.17	10.93	7.39	1.91

West Badger Cyn	7400	PF 3	202	3000.00	3003.34	3004.37	3006.60	0.281364	14.48	13.95	8.35	1.97
West Badger Cyn	6700	PF 1	73	2800.00	2802.15	2802.41	2803.12	0.125932	7.88	9.26	8.61	1.34
West Badger Cyn	6700	PF 2	191	2800.00	2802.63	2803.55	2805.59	0.295180	13.80	13.85	10.52	2.12
West Badger Cyn	6700	PF 3	268	2800.00	2803.00	2804.05	2806.45	0.289407	14.90	17.98	11.99	2.14
West Badger Cyn	6000	PF 1	91	2520.00	2521.66	2523.18	2532.60	2.411969	26.55	3.43	4.14	5.14
West Badger Cyn	6000	PF 2	238	2520.00	2523.16	2524.68	2528.82	0.527342	19.09	12.47	7.90	2.68
West Badger Cyn	6000	PF 3	334	2520.00	2523.58	2525.36	2530.35	0.534460	20.88	15.99	8.94	2.75
West Badger Cyn	5500	PF 1	104	2400.00	2402.68	2402.87	2403.65	0.096403	7.88	13.20	9.84	1.20
West Badger Cyn	5500	PF 2	272	2400.00	2403.55	2404.24	2405.70	0.149078	11.78	23.09	13.06	1.56
West Badger Cyn	5500	PF 3	381	2400.00	2404.01	2404.85	2406.59	0.151535	12.88	29.57	14.81	1.61
West Badger Cyn	4990	PF 1	127	2279.00	2280.59	2281.63	2285.42	0.794917	17.64	7.20	8.34	3.35
West Badger Cyn	4990	PF 2	332	2279.00	2281.71	2283.09	2286.60	0.368560	17.74	18.71	11.61	2.46
West Badger Cyn	4990	PF 3	464	2279.00	2282.15	2283.79	2287.96	0.357800	19.34	23.99	12.59	2.47
West Badger Cyn	4750	PF 1	137	2240.00	2241.56	2241.63	2242.18	0.078555	6.29	21.79	22.01	1.11
West Badger Cyn	4750	PF 2	360	2240.00	2242.23	2242.61	2243.68	0.105271	9.65	37.31	24.42	1.38
West Badger Cyn	4750	PF 3	503	2240.00	2242.59	2243.09	2244.42	0.108563	10.88	46.22	25.69	1.43
West Badger Cyn	4500	PF 1	149	2200.00	2201.48	2202.20	2204.00	0.370108	12.74	11.69	12.91	2.36
West Badger Cyn	4500	PF 2	389	2200.00	2202.51	2203.51	2205.70	0.226930	14.34	27.13	17.03	2.00
West Badger Cyn	4500	PF 3	544	2200.00	2202.96	2204.14	2206.67	0.214673	15.45	35.20	18.83	1.99
West Badger Cyn	4200	PF 1	162	2160.00	2161.84	2161.92	2162.56	0.073556	6.80	23.83	20.32	1.11
West Badger Cyn	4200	PF 2	424	2160.00	2162.69	2163.07	2164.17	0.094087	9.77	43.41	25.71	1.32
West Badger Cyn	4200	PF 3	593	2160.00	2163.10	2163.61	2164.94	0.097903	10.87	54.57	28.32	1.38
West Badger Cyn	3900	PF 1	175	2120.00	2120.97	2121.34	2122.15	0.296200	8.70	20.10	34.28	2.00
West Badger Cyn	3900	PF 2	459	2120.00	2121.60	2122.10	2123.12	0.208681	9.92	46.29	49.89	1.81
West Badger Cyn	3900	PF 3	642	2120.00	2121.86	2122.43	2123.63	0.200619	10.67	60.17	56.42	1.82
West Badger Cyn	3600	PF 1	189	2080.00	2081.58	2081.65	2082.20	0.077729	6.33	29.84	29.91	1.12
West Badger Cyn	3600	PF 2	494	2080.00	2082.32	2082.64	2083.60	0.092617	9.06	54.50	36.24	1.30

West Badger Cyn	3600	PF 3	691	2080.00	2082.70	2083.12	2084.27	0.094337	10.08	68.58	39.41	1.35
West Badger Cyn	3051	PF 1	213	2020.00	2023.64	2021.87	2023.71	0.002717	2.09	101.76	42.85	0.24
West Badger Cyn	3051	PF 2	558	2020.00	2025.84	2022.91	2025.95	0.002387	2.65	210.58	56.05	0.24
West Badger Cyn	3051	PF 3	781	2020.00	2026.89	2023.42	2027.02	0.002368	2.85	273.77	64.83	0.24
Lower Badger Cyn	3050	PF 1	496	2020.00	2022.75	2022.75	2023.63	0.052135	7.53	65.91	37.49	1.00
Lower Badger Cyn	3050	PF 2	1300	2020.00	2024.39	2024.39	2025.82	0.044769	9.60	135.42	47.33	1.00
Lower Badger Cyn	3050	PF 3	1819	2020.00	2025.18	2025.18	2026.86	0.042607	10.40	174.91	52.09	1.00
Lower Badger Cyn	2600	PF 1	509	1958.00	1960.49	1962.00	1966.91	0.573145	20.34	25.03	18.96	3.12
Lower Badger Cyn	2600	PF 2	1333	1958.00	1961.54	1964.32	1973.74	0.631810	28.03	47.55	23.64	3.48
Lower Badger Cyn	2600	PF 3	1865	1958.00	1962.07	1965.26	1976.76	0.616752	30.76	60.64	25.59	3.52
Lower Badger Cyn	2200	PF 1	520	1917.00	1919.99	1919.99	1920.75	0.054794	6.97	74.63	49.88	1.00
Lower Badger Cyn	2200	PF 2	1362	1917.00	1921.32	1921.36	1922.66	0.049575	9.31	146.34	58.42	1.04
Lower Badger Cyn	2200	PF 3	1906	1917.00	1921.89	1922.07	1923.61	0.051837	10.52	181.19	62.12	1.09
Lower Badger Cyn	1950	PF 1	527	1877.00	1878.64	1879.76	1884.43	0.936472	19.31	27.30	33.32	3.76
Lower Badger Cyn	1950	PF 2	1380	1877.00	1879.34	1881.14	1888.97	0.911600	24.89	55.43	45.25	3.96
Lower Badger Cyn	1950	PF 3	1931	1877.00	1879.76	1881.80	1889.99	0.752481	25.67	75.23	50.75	3.72
Lower Badger Cyn	1650	PF 1	535	1839.00	1841.23	1841.23	1841.98	0.055636	6.91	77.42	53.08	1.01
Lower Badger Cyn	1650	PF 2	1402	1839.00	1842.46	1842.61	1843.81	0.055884	9.31	150.60	66.10	1.09
Lower Badger Cyn	1650	PF 3	1962	1839.00	1843.00	1843.27	1844.70	0.058827	10.46	187.58	71.78	1.14
Lower Badger Cyn	1300	PF 1	545	1799.00	1800.08	1800.48	1801.45	0.360491	9.39	58.06	102.65	2.20
Lower Badger Cyn	1300	PF 2	1428	1799.00	1800.55	1801.29	1803.17	0.357545	13.01	109.80	118.27	2.38
Lower Badger Cyn	1300	PF 3	1998	1799.00	1800.82	1801.69	1803.86	0.321716	14.00	142.75	127.21	2.33
Lower Badger Cyn	1060	PF 1	545	1769.00	1772.59	1772.63	1773.50	0.056421	7.66	71.15	41.08	1.03
Lower Badger Cyn	1060	PF 2	1428	1769.00	1774.12	1774.27	1775.56	0.055019	9.63	148.25	59.48	1.08
Lower Badger Cyn	1060	PF 3	1998	1769.00	1774.76	1775.00	1776.50	0.056588	10.58	188.81	67.17	1.11
Lower Badger Cyn	960	PF 1	554	1760.00	1761.71	1762.34	1763.70	0.200978	11.30	49.03	42.14	1.85
Lower Badger Cyn	960	PF 2	1453	1760.00	1762.76	1763.84	1766.14	0.182930	14.77	98.38	52.56	1.90

Lower Badger Cyn	960	PF 3	2033	1760.00	1763.30	1764.56	1767.19	0.167874	15.82	128.51	58.01	1.87
"A" ST CULVERT												
Lower Badger Cyn	837	PF 1	558	1720.00	1720.70	1721.88	1735.58	5.582421	30.96	18.02	41.50	8.28
Lower Badger Cyn	837	PF 2	1462	1720.00	1721.15	1723.09	1741.18	3.874826	35.92	40.70	57.01	7.49
Lower Badger Cyn	837	PF 3	2045	1720.00	1721.36	1723.68	1744.20	3.299819	38.35	53.32	59.98	7.17
Lower Badger Cyn	790	PF 1	559	1708.00	1710.37	1710.85	1711.95	0.140426	10.07	55.49	43.23	1.57
Lower Badger Cyn	790	PF 2	1465	1708.00	1711.33	1712.37	1714.61	0.167397	14.54	100.78	51.51	1.83
Lower Badger Cyn	790	PF 3	2050	1708.00	1711.75	1713.14	1716.05	0.183977	16.64	123.22	55.16	1.96
Lower Badger Cyn	750	PF 1	559	1679.00	1680.35	1681.92	1695.37	3.043852	31.11	17.97	25.95	6.59
Lower Badger Cyn	750	PF 2	1465	1679.00	1681.17	1683.32	1697.66	1.752451	32.59	44.95	39.98	5.42
Lower Badger Cyn	750	PF 3	2050	1679.00	1681.55	1683.95	1698.71	1.466855	33.24	61.67	46.60	5.09
Lower Badger Cyn	0	PF 1	559	1640.00	1642.08	1642.08	1642.61	0.062951	5.87	95.23	91.72	1.02
Lower Badger Cyn	0	PF 2	1465	1640.00	1643.07	1643.07	1643.84	0.053803	7.04	208.06	135.57	1.00
Lower Badger Cyn	0	PF 3	2050	1640.00	1643.51	1643.51	1644.39	0.051388	7.53	272.34	155.10	1.00

Table 8. Sycamore Canyon HEC-RAS Model Summary Printout

HEC-RAS Plan: Plan 01												
Reach	River Sta	Profile	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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
FEMA Branch	3530	PF 1	215	1616.25	1617.71	1617.71	1618.12	0.056739	5.12	41.99	53.11	1.01
FEMA Branch	3530	PF 2	562	1616.25	1618.46	1618.46	1619.07	0.049228	6.29	89.31	74.50	1.01
FEMA Branch	3530	PF 3	787	1616.25	1618.80	1618.80	1619.51	0.046695	6.76	116.38	83.74	1.01
FEMA Branch	3430	PF 1	215	1601.00	1602.80	1603.67	1605.91	0.402033	14.16	15.18	15.27	2.50
FEMA Branch	3430	PF 2	562	1601.00	1603.76	1605.10	1608.45	0.327503	17.37	32.35	20.33	2.43
FEMA Branch	3430	PF 3	787	1601.00	1604.25	1605.78	1609.49	0.295531	18.37	42.83	22.82	2.36
FEMA Branch	3420	PF 1	215	1600.00	1602.40	1602.68	1603.54	0.100103	8.58	25.05	18.72	1.31
FEMA Branch	3420	PF 2	562	1600.00	1603.33	1604.08	1605.73	0.138216	12.44	45.16	24.54	1.62
FEMA Branch	3420	PF 3	787	1600.00	1603.76	1604.73	1606.79	0.149230	13.97	56.35	27.24	1.71
FEMA Branch	3370	PF 1	215	1595.00	1597.76	1597.27	1598.15	0.023540	5.06	42.49	23.45	0.66
FEMA Branch	3370	PF 2	562	1595.00	1599.29	1598.60	1600.02	0.023443	6.85	82.06	27.94	0.70
FEMA Branch	3370	PF 3	787	1595.00	1598.69	1599.26	1600.92	0.087750	12.00	65.61	26.17	1.34
FEMA Branch	3260	PF 1	215	1590.00	1593.41	1593.41	1594.26	0.057383	7.42	28.98	17.02	1.00
FEMA Branch	3260	PF 2	562	1590.00	1594.96	1594.96	1596.26	0.052506	9.12	61.60	24.82	1.02
FEMA Branch	3260	PF 3	787	1590.00	1595.97	1595.97	1597.05	0.029343	8.52	97.46	47.26	0.81
FEMA Branch	3190	PF 1	215	1584.80	1585.94	1586.32	1587.14	0.224330	8.77	24.52	33.54	1.81
FEMA Branch	3190	PF 2	562	1584.80	1586.47	1587.22	1589.01	0.285241	12.80	43.90	40.69	2.17
FEMA Branch	3190	PF 3	787	1584.80	1586.48	1587.65	1591.32	0.535000	17.65	44.59	40.92	2.98
FEMA Branch	3070	PF 1	215	1575.00	1576.81	1576.81	1577.39	0.061165	6.13	35.06	30.67	1.01
FEMA Branch	3070	PF 2	562	1575.00	1577.92	1577.92	1578.60	0.057303	6.58	85.40	64.28	1.01
FEMA Branch	3070	PF 3	787	1575.00	1578.39	1578.39	1579.05	0.039774	6.57	123.57	101.54	0.88
FEMA Branch	3010	PF 1	215	1570.00	1571.82	1571.99	1572.51	0.113456	6.65	32.31	40.03	1.31

FEMA Branch	3010	PF 2	562	1570.00	1572.48	1572.82	1573.65	0.125512	8.67	64.80	58.21	1.45
FEMA Branch	3010	PF 3	787	1570.00	1572.60	1573.26	1574.45	0.185862	10.92	72.08	61.56	1.78
CULVERT												
FEMA Branch	2730	PF 1	215	1552.00	1556.59	1553.37	1556.59	0.000167	0.56	380.73	143.52	0.06
FEMA Branch	2730	PF 2	562	1552.00	1558.74	1554.06	1558.75	0.000181	0.76	741.70	191.31	0.07
FEMA Branch	2730	PF 3	787	1552.00	1559.68	1554.38	1559.69	0.000192	0.85	929.53	211.96	0.07
FEMA Branch	2700	PF 1	215	1549.90	1556.59		1556.59	0.000037	0.32	664.82	186.04	0.03
FEMA Branch	2700	PF 2	562	1549.90	1558.74		1558.75	0.000062	0.50	1133.45	248.58	0.04
FEMA Branch	2700	PF 3	787	1549.90	1559.68		1559.68	0.000073	0.57	1377.66	275.60	0.05
FEMA Branch	2590	PF 1	215	1545.00	1556.59		1556.59	0.000002	0.15	1440.42	147.00	0.01
FEMA Branch	2590	PF 2	562	1545.00	1558.74		1558.75	0.000008	0.32	1757.34	147.00	0.02
FEMA Branch	2590	PF 3	787	1545.00	1559.68		1559.68	0.000013	0.42	1894.20	147.00	0.02
FEMA Branch	2520	PF 1	215	1543.00	1556.59		1556.59	0.000000	0.06	3368.36	345.00	0.00
FEMA Branch	2520	PF 2	562	1543.00	1558.75		1558.75	0.000001	0.14	4112.36	345.00	0.01
FEMA Branch	2520	PF 3	787	1543.00	1559.68		1559.68	0.000002	0.18	4433.73	345.00	0.01
FEMA Branch	2490	PF 1	215	1542.50	1556.59		1556.59	0.000001	0.11	1932.04	160.00	0.01
FEMA Branch	2490	PF 2	562	1542.50	1558.74		1558.75	0.000004	0.25	2276.97	160.00	0.01
FEMA Branch	2490	PF 3	787	1542.50	1559.67		1559.68	0.000006	0.32	2425.91	160.00	0.01
FEMA Branch	2400	PF 1	215	1540.50	1556.59		1556.59	0.000000	0.07	3379.87	383.00	0.00
FEMA Branch	2400	PF 2	562	1540.50	1558.74		1558.74	0.000001	0.13	4205.66	383.00	0.01
FEMA Branch	2400	PF 3	787	1540.50	1559.68		1559.68	0.000002	0.17	4562.29	383.00	0.01
Sycamore Cyn	3700	PF 1	673	1541.50	1556.66	1542.39	1556.66	0.000054	0.17	3926.59	299.95	0.01
Sycamore Cyn	3700	PF 2	1763	1541.50	1558.95	1542.97	1558.95	0.000229	0.38	4628.72	313.68	0.02
Sycamore Cyn	3700	PF 3	2469	1541.50	1559.96	1543.27	1559.97	0.000369	0.50	4950.82	319.78	0.02
Sycamore Cyn	2700	PF 1	673	1541.40	1556.60		1556.60	0.000057	0.16	2377.08	300.00	0.01
Sycamore Cyn	2700	PF 2	1763	1541.40	1558.76		1558.78	0.000128	0.27	3024.39	300.00	0.01
Sycamore Cyn	2700	PF 3	2469	1541.40	1559.68		1559.72	0.000170	0.32	3302.71	300.00	0.02
Sycamore Cyn	2400	PF 1	673	1540.50	1556.59		1556.59	0.000039	0.14	3378.74	383.00	0.01

Sycamore Cyn	2400	PF 2	1763	1540.50	1558.73		1558.74	0.000097	0.24	4199.77	383.00	0.01
Sycamore Cyn	2400	PF 3	2469	1540.50	1559.65		1559.67	0.000132	0.29	4552.20	383.00	0.01
W FEMA Branch	3720	PF 1	37	1615.00	1616.10	1616.01	1616.27	0.057650	3.34	11.08	23.22	0.85
W FEMA Branch	3720	PF 2	97	1615.00	1616.51	1616.46	1616.75	0.063015	3.89	24.91	44.39	0.92
W FEMA Branch	3720	PF 3	135	1615.00	1616.66	1616.62	1616.93	0.064027	4.18	32.26	52.26	0.94
W FEMA Branch	3645	PF 1	37	1610.00	1610.88	1610.88	1611.11	0.083412	3.81	9.70	22.02	1.01
W FEMA Branch	3645	PF 2	97	1610.00	1611.30	1611.30	1611.63	0.074044	4.63	20.97	32.49	1.01
W FEMA Branch	3645	PF 3	135	1610.00	1611.48	1611.48	1611.86	0.071322	4.95	27.28	37.10	1.02
W FEMA Branch	3575	PF 1	37	1605.00	1605.95	1605.88	1606.12	0.055496	3.27	11.30	23.77	0.84
W FEMA Branch	3575	PF 2	97	1605.00	1606.33	1606.30	1606.63	0.064232	4.39	22.12	33.38	0.95
W FEMA Branch	3575	PF 3	135	1605.00	1606.47	1606.48	1606.86	0.072368	4.98	27.13	36.99	1.02
W FEMA Branch	3500	PF 1	37	1600.00	1600.67	1600.67	1600.84	0.092434	3.33	11.11	33.33	1.02
W FEMA Branch	3500	PF 2	97	1600.00	1600.98	1600.98	1601.23	0.080656	4.03	24.08	49.07	1.01
W FEMA Branch	3500	PF 3	135	1600.00	1601.11	1601.11	1601.41	0.076743	4.41	30.62	52.47	1.02
W FEMA Branch	3430	PF 1	37	1595.00	1595.97	1595.88	1596.12	0.051048	3.17	11.66	24.15	0.80
W FEMA Branch	3430	PF 2	97	1595.00	1596.46	1596.30	1596.67	0.038402	3.67	26.46	35.60	0.75
W FEMA Branch	3430	PF 3	135	1595.00	1596.64	1596.48	1596.90	0.039922	4.05	33.35	39.80	0.78
W FEMA Branch	3330	PF 1	37	1590.00	1590.96	1590.87	1591.11	0.049261	3.10	11.94	24.91	0.79
W FEMA Branch	3330	PF 2	97	1590.00	1591.30	1591.28	1591.59	0.070177	4.37	22.19	36.07	0.98
W FEMA Branch	3330	PF 3	135	1590.00	1591.48	1591.46	1591.81	0.067030	4.62	29.20	42.16	0.98
W FEMA Branch	3250	PF 1	37	1585.00	1585.67	1585.67	1585.84	0.092082	3.33	11.11	33.33	1.02
W FEMA Branch	3250	PF 2	97	1585.00	1586.02	1585.98	1586.24	0.063389	3.71	26.12	50.34	0.91
W FEMA Branch	3250	PF 3	135	1585.00	1586.13	1586.11	1586.41	0.067545	4.27	31.65	51.96	0.96
W FEMA Branch	3070	PF 1	37	1575.00	1576.05	1575.88	1576.16	0.031084	2.68	13.81	25.36	0.64
W FEMA Branch	3070	PF 2	97	1575.00	1576.39	1576.28	1576.67	0.045071	4.24	22.86	27.75	0.82
W FEMA Branch	3070	PF 3	135	1575.00	1576.61	1576.47	1576.95	0.042109	4.64	29.09	29.28	0.82
W FEMA Branch	2970	PF 1	37	1570.00	1571.18	1571.18	1571.45	0.079026	4.20	8.80	16.47	1.01

W FEMA Branch	2970	PF 2	97	1570.00	1571.80	1571.68	1572.07	0.047110	4.14	23.43	30.48	0.83
W FEMA Branch	2970	PF 3	135	1570.00	1571.98	1571.89	1572.31	0.051501	4.62	29.22	34.49	0.88
W FEMA Branch	2870	PF 1	37	1564.80	1565.44	1565.30	1565.49	0.026964	1.74	21.21	66.88	0.55
W FEMA Branch	2870	PF 2	97	1564.80	1565.53	1565.53	1565.72	0.089239	3.53	27.45	73.66	1.02
W FEMA Branch	2870	PF 3	135	1564.80	1565.63	1565.63	1565.86	0.082424	3.89	34.68	75.79	1.01
W FEMA Branch	2700	PF 1	37	1557.00	1557.51	1557.51	1557.64	0.096342	2.86	12.92	50.42	1.00
W FEMA Branch	2700	PF 2	97	1557.00	1558.74	1557.75	1558.75	0.000979	0.65	148.81	171.08	0.12
W FEMA Branch	2700	PF 3	135	1557.00	1559.67	1557.86	1559.68	0.000192	0.38	351.54	262.94	0.06
W FEMA Branch	2400	PF 1	37	1540.50	1556.59	1541.32	1556.59	0.000000	0.01	3379.87	383.00	0.00
W FEMA Branch	2400	PF 2	97	1540.50	1558.74		1558.74	0.000000	0.02	4205.80	383.00	0.00
W FEMA Branch	2400	PF 3	135	1540.50	1559.68		1559.68	0.000000	0.03	4562.48	383.00	0.00
So Badger St Bas	2400	PF 1	865	1540.50	1556.58		1556.59	0.000065	0.18	3378.00	383.00	0.01
So Badger St Bas	2400	PF 2	2266	1540.50	1558.72		1558.74	0.000161	0.31	4195.84	383.00	0.01
So Badger St Bas	2400	PF 3	3173	1540.50	1559.63		1559.67	0.000220	0.38	4545.42	383.00	0.02
So Badger St Bas	2340	PF 1	865	1539.00	1556.58		1556.58	0.000082	0.20	2696.43	375.00	0.01
So Badger St Bas	2340	PF 2	2266	1539.00	1558.71		1558.73	0.000158	0.31	3495.32	375.00	0.01
So Badger St Bas	2340	PF 3	3173	1539.00	1559.62		1559.66	0.000201	0.36	3837.09	375.00	0.02
So Badger St Bas	2200	PF 1	865	1537.50	1556.57		1556.57	0.000047	0.18	3954.74	330.00	0.01
So Badger St Bas	2200	PF 2	2266	1537.50	1558.69		1558.71	0.000151	0.35	4655.22	330.00	0.01
So Badger St Bas	2200	PF 3	3173	1537.50	1559.60		1559.63	0.000222	0.44	4954.12	330.00	0.02
So Badger St Bas	2000	PF 1	865	1535.00	1556.56		1556.56	0.000023	0.14	5759.42	350.00	0.01
So Badger St Bas	2000	PF 2	2266	1535.00	1558.67		1558.67	0.000096	0.32	6495.52	350.00	0.01
So Badger St Bas	2000	PF 3	3173	1535.00	1559.56		1559.57	0.000154	0.41	6807.97	350.00	0.02
So Badger St Bas	1800	PF 1	865	1532.00	1556.56		1556.56	0.000011	0.11	7678.00	395.00	0.00
So Badger St Bas	1800	PF 2	2266	1532.00	1558.65		1558.65	0.000049	0.25	8503.20	395.00	0.01
So Badger St Bas	1800	PF 3	3173	1532.00	1559.53		1559.53	0.000081	0.33	8851.38	395.00	0.01
So Badger St Bas	1500	PF 1	865	1531.00	1556.56		1556.56	0.000008	0.09	9096.71	435.00	0.00

So Badger St Bas	1500	PF 2	2266	1531.00	1558.64		1558.64	0.000037	0.22	10001.39	435.00	0.01
So Badger St Bas	1500	PF 3	3173	1531.00	1559.51		1559.51	0.000063	0.29	10381.38	435.00	0.01
So Badger St Bas	1180	PF 1	865	1531.00	1556.55		1556.55	0.000108	0.30	2753.24	160.00	0.01
So Badger St Bas	1180	PF 2	2266	1531.00	1558.61		1558.63	0.000493	0.69	3082.89	160.00	0.03
So Badger St Bas	1180	PF 3	3173	1531.00	1559.47		1559.49	0.000826	0.92	3219.57	160.00	0.03
So Badger St Bas	1080	PF 1	865	1540.00	1556.51		1556.54	0.000245	0.37	1147.94	171.53	0.02
So Badger St Bas	1080	PF 2	2266	1540.00	1558.48		1558.57	0.000542	0.60	1512.41	199.53	0.03
So Badger St Bas	1080	PF 3	3173	1540.00	1559.26		1559.40	0.000729	0.72	1673.61	207.79	0.03
So Badger St Bas	1030	PF 1	865	1550.00	1554.32	1554.32	1556.30	0.016224	11.31	76.49	19.45	1.00
So Badger St Bas	1030	PF 2	2266	1550.00	1557.30	1557.30	1558.40	0.006471	10.09	317.50	123.24	0.68
So Badger St Bas	1030	PF 3	3173	1550.00	1557.86	1557.86	1559.20	0.007357	11.34	387.55	124.65	0.74
So Badger St Bas	935	PF 1	865	1533.00	1534.62	1537.31	1550.68	0.373186	32.16	26.90	17.29	4.54
So Badger St Bas	935	PF 2	2266	1533.00	1536.78	1541.28	1555.00	0.169756	34.26	66.15	19.02	3.24
So Badger St Bas	935	PF 3	3173	1533.00	1538.21	1543.03	1555.79	0.117209	33.65	94.43	21.29	2.73
So Badger St Bas	865	PF 1	865	1520.00	1522.06	1524.32	1531.73	0.170955	24.96	34.65	17.65	3.14
So Badger St Bas	865	PF 2	2266	1520.00	1523.71	1527.95	1542.68	0.180121	34.96	64.82	18.97	3.33
So Badger St Bas	865	PF 3	3173	1520.00	1524.79	1528.71	1546.00	0.156599	36.95	85.87	19.83	3.13
So Badger St Bas	790	PF 1	865	1510.00	1512.26	1514.32	1520.23	0.127226	22.65	38.18	17.81	2.73
So Badger St Bas	790	PF 2	2266	1510.00	1514.02	1517.98	1529.93	0.139334	32.01	70.79	19.22	2.94
So Badger St Bas	790	PF 3	3173	1510.00	1514.98	1518.76	1534.43	0.138429	35.39	89.66	19.99	2.94
So Badger St Bas	715	PF 1	865	1490.00	1491.75	1494.36	1505.67	0.297909	29.94	28.89	17.05	4.05
So Badger St Bas	715	PF 2	2266	1490.00	1493.49	1498.12	1516.03	0.231059	38.10	59.48	18.09	3.70
So Badger St Bas	715	PF 3	3173	1490.00	1494.43	1498.99	1520.94	0.215358	41.31	76.80	18.66	3.59
So Badger St Bas	615	PF 1	865	1479.50	1481.41	1482.67	1486.68	0.105759	20.92	52.28	46.68	2.69
So Badger St Bas	615	PF 2	2266	1479.50	1482.15	1484.30	1493.75	0.164307	32.56	92.59	62.29	3.55
So Badger St Bas	615	PF 3	3173	1479.50	1482.46	1485.10	1497.66	0.191184	37.88	113.18	68.91	3.90
So Badger St Bas	335	PF 1	865	1455.50	1457.37	1457.92	1461.00	0.077513	15.28	56.60	38.00	2.21

So Badger St Bas	335	PF 2	2266	1455.50	1457.79	1458.25	1460.68	0.077265	17.58	265.18	704.47	2.28
So Badger St Bas	335	PF 3	3173	1455.50	1457.90	1458.41	1460.70	0.080820	18.61	343.80	704.75	2.35
So Badger St Bas	260	PF 1	865	1450.00	1454.75	1455.47	1456.91	0.033239	11.94	76.18	49.95	1.48
So Badger St Bas	260	PF 2	2266	1450.00	1456.23	1456.70	1458.03	0.018932	12.38	331.72	740.00	1.21
So Badger St Bas	260	PF 3	3173	1450.00	1456.43	1456.88	1458.08	0.019229	13.00	481.40	740.00	1.24
So Badger St Bas	190	PF 1	865	1444.00	1447.38	1449.25	1454.13	0.033064	20.85	41.49	625.62	2.58
So Badger St Bas	190	PF 2	2266	1444.00	1452.23	1451.01	1452.24	0.000002	0.29	7475.23	750.00	0.02
So Badger St Bas	190	PF 3	3173	1444.00	1451.56	1451.01	1451.56	0.000006	0.41	6971.92	745.61	0.04
So Badger St Bas	20	PF 1	865	1437.80	1449.79	1441.42	1449.81	0.000026	0.98	881.86	945.52	0.06
So Badger St Bas	20	PF 2	2266	1437.80	1452.23	1442.70	1452.24	0.000001	0.20	11626.84	1050.00	0.01
So Badger St Bas	20	PF 3	3173	1437.80	1451.56	1443.37	1451.56	0.000002	0.29	10924.37	1036.87	0.02
So Badger St Bas	-170	PF 1	865	1438.00	1449.79		1449.80	0.000009	0.58	1484.17	1006.66	0.03
So Badger St Bas	-170	PF 2	2266	1438.00	1452.22		1452.23	0.000082	0.77	2960.86	1062.00	0.08
So Badger St Bas	-170	PF 3	3173	1438.00	1451.53		1451.56	0.000419	1.43	2221.69	1058.33	0.17
So Badger St Bas	-300	PF 1	865	1439.90	1449.79		1449.80	0.000020	0.77	1124.03	943.10	0.05
So Badger St Bas	-300	PF 2	2266	1439.90	1452.21		1452.22	0.000133	0.92	2502.69	1009.41	0.10
So Badger St Bas	-300	PF 3	3173	1439.90	1451.43		1451.48	0.000892	1.87	1716.75	1004.99	0.25
So Badger St Bas	-335	PF 1	865	1444.00	1449.73		1449.79	0.000339	1.95	444.65	111.65	0.17
So Badger St Bas	-335	PF 2	2266	1444.00	1452.15		1452.21	0.000242	2.23	1650.24	948.79	0.16
So Badger St Bas	-335	PF 3	3173	1444.00	1450.94		1451.40	0.001916	5.43	587.60	125.08	0.43
So Badger St Bas	-360	PF 1	865	1445.00	1448.18	1448.18	1449.63	0.014175	9.65	89.66	31.36	1.01
So Badger St Bas	-360	PF 2	2266	1445.00	1452.17		1452.19	0.000210	1.98	2070.00	943.31	0.14
So Badger St Bas	-360	PF 3	3173	1445.00	1450.88	1450.88	1451.32	0.004130	7.57	906.83	870.95	0.59
So Badger St Bas	-385	PF 1	865	1444.00	1447.69	1447.84	1449.24	0.016346	10.01	86.38	32.29	1.08
So Badger St Bas	-385	PF 2	2266	1444.00	1452.19	1450.01	1452.19	0.000001	0.14	10541.47	948.74	0.01
So Badger St Bas	-385	PF 3	3173	1444.00	1450.01	1450.01	1450.01	0.000004	0.21	8484.61	940.03	0.02
So Badger St Bas	-420	PF 1	865	1444.00	1446.72	1447.12	1448.56	0.022025	10.88	79.52	33.44	1.24

So Badger St Bas	-420	PF 2	2266	1444.00	1449.60	1449.60	1451.95	0.012167	12.31	184.10	39.20	1.00
So Badger St Bas	-420	PF 3	3173	1444.00	1450.01	1450.01	1450.01	0.000002	0.15	11667.87	1040.01	0.01

Figure 1. Hydrology Worksheet, in pocket after this page.

Figure 2. Proposed Project Overlay, in pocket after this page.

Figure 3. Topographic Workmap, in pocket after this page.