YREKA CREEK
HYDROLOGY / HYDRAULICS

FINAL REPORT

As required for
Department of Water Resources
State of California

August 05, 2015

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Introduction

The purpose of this study was to evaluate through hydrologic modeling the extent to which flood hazards can be reduced through non-structural floodplain restoration along portions of Yreka Creek and its tributaries Greenhorn Creek, Juniper Creek and Little Humbug Creek within and adjacent to the City of Yreka, California. Figure 1 shows the Yreka Creek watershed and vicinity.The studyalso included revision of 100-year floodplains for Yreka Creek and (Little) Humbug Creek shown in the FEMA 1978 studies. Water surface elevations and extents for 2-,10-, 25-, 50-,and 100-year storm eventswere derived for existing conditions and proposed floodplain restoration.

Floodplain restoration is an integral part of the Yreka Creek Greenway project. The purpose of the Greenway project is to provide an ecologically restored network of stream-based open space corridors within and adjacent to the City of Yreka, including trails and related recreational facilities. The Greenway is intended to yield various benefits described by the following goals:

- Reduce flood hazards throughout the City of Yreka by containing floodwaters within greenway corridors up to and including 100-year events.
- Restore and protect fish and wildlife habitat, and effectively integrate this habitat into the urban landscape.
- Provide a network of trails and related facilities for non-motorized transportation, recreation, tourism and emergency access.

The design approach for *non-structural* flood hazard reduction emphasizes restoration of floodplains by lowering the adjacent grade close to that of existing incised channels. Some improved and new road crossings (bridges) are required to convey overbank flood flows consistently downstream.

In contrast, *structural* alternatives would emphasize detention, diversions, dikes, levees, bypasses, concrete rectangular stream channels and pipe systems.

Guidelines for non-structural floodplain restoration design included:

- Lowering adjacent land to stream channels to within two feet of the existing incised streamchannel elevation (thalweg) to restore access of overbank flows in more frequent flood events.
- Widening and grading of new floodplains sufficient to allow for stable stream geomorphology (width, depth, meander, hydraulics and fish habitat) and restoration of riparian vegetation.

- Increasing cross-sectional capacity of existing bridge and culvert stream crossings and adequately sizing proposed crossing facilities to conform to the flood-flow conveyance of the widened and deepened floodplains (which serve as floodways)
- Modeling, using HEC-RAS, of the lowered/widened designed floodplains and associated crossings to show how 100-year events can be contained within the proposed floodplains.
- Determining where floodplain restoration may be limited by existing adjacent development, transportation facilities, land ownership and costs.

Executive Summary

After extensive review of the data, modeling of the existing conditions, and modeling the conditions proposed within the Yreka Creek Master Plan, 2015 Update, the improved floodplains shown in figures 23-30 satisfy the goals of this project.

Upon completion of the project, lowering the incised channel banks creates more accessible floodplains (and new riparian areas and wetlands) for higher frequency flood events, such as 2-year recurrences. The modified and lowered 100-year floodplains keep most existing stream-side development out of the 100-year floodplain.

Changes to existing development is kept to reasonable levels, limiting the number of residences and buildings that need to be removed. Spoils from floodplain excavation and grading used to raise potential building pads will elevate adjacent areas above the 100-year water surface elevations. The new floodway corridors will serve as greenways through the city and include paved multi-use trails and ecological interpretive facilities.

Figure 1. Vicinity Map

Methodology

Various hydrologic methods were compared, includingstreamflow measurements, regional peak flow equations, HEC-HMS peak flow design floods, HSPF hourly hydrographs and FEMA 1978 studies.

Streamflow Measurements

No long-termflow measurements were available for Yreka Creek or its tributaries. Yreka Creek is a tributary of the Shasta River (comprising13% of its drainage area). The current City of Yreka boundaries comprise 10% of the Yreka Creekdrainage area.

Gage No. 11517500 Shasta River near Yreka, CA recorded annual peak discharges 1934-2012 (78 years) for a drainage area of 793 square miles. See Figure 2 for locations of local stream flow gages, and Tables 1 and 2 for data from those gages.

Based on the 78 year Shasta River record the largest Yreka Creek floods were:

December 22, 1964: 100-year
January 1, 1997: 50-year
December 30, 2005: 25-year
January 16, 1974: 20-year
December 22, 1955: 10-year

Regional Hydrology Equations

The USGS analyzed annual peak flow data through water year 2006 for 771 streamflow gaging stations in California (USGS, 2012). Flood frequency estimates were computed using least squares computer fit to logarithmic Pearson Type III distributions. Regional regression analysis was used to develop a set of equations, including 50-, 10-, 4-, 2- and 1-percent annual exceedance probabilities. The final regression equations were functions of drainage area and mean annual precipitation. Selected equations for the North Coast (Klamath Mountain) region were:

2-Year: Q = 1.82 * A^0.904 * P^0.983
10-Year Q = 14.8 * A^0.880 * P^0.696
25-Year: Q = 26.0 * A^0.874 * P^0.628
50-Year: Q = 36.3 * A^0.870 * P^0.589
100-Year Q = 48.5 * A^0.866 *P^0.556

Q=peak flow in cfs

A =the drainage area at the point of interest in square miles

P=mean annual precipitation for the stream basin in inches

Subbasin annual precipitation was estimated from an annual precipitation map of California (PRISM, 2014). Mean annual precipitation in the Yreka Creek watershed ranged from 20 inches

per year in the city of Yreka to 30 inches per year on the headwater ridges. See Figure 2 for locations of local precipitation gages.

Table 1 Precipitation Records

Precipitation		Start	End	Latitude	Longitude
Fort Jones		1949	2014	41.60000	122.84778
Montague		1949	2014	41.78056	122.47167
Yreka		1949	2014	41.78139	122.46806

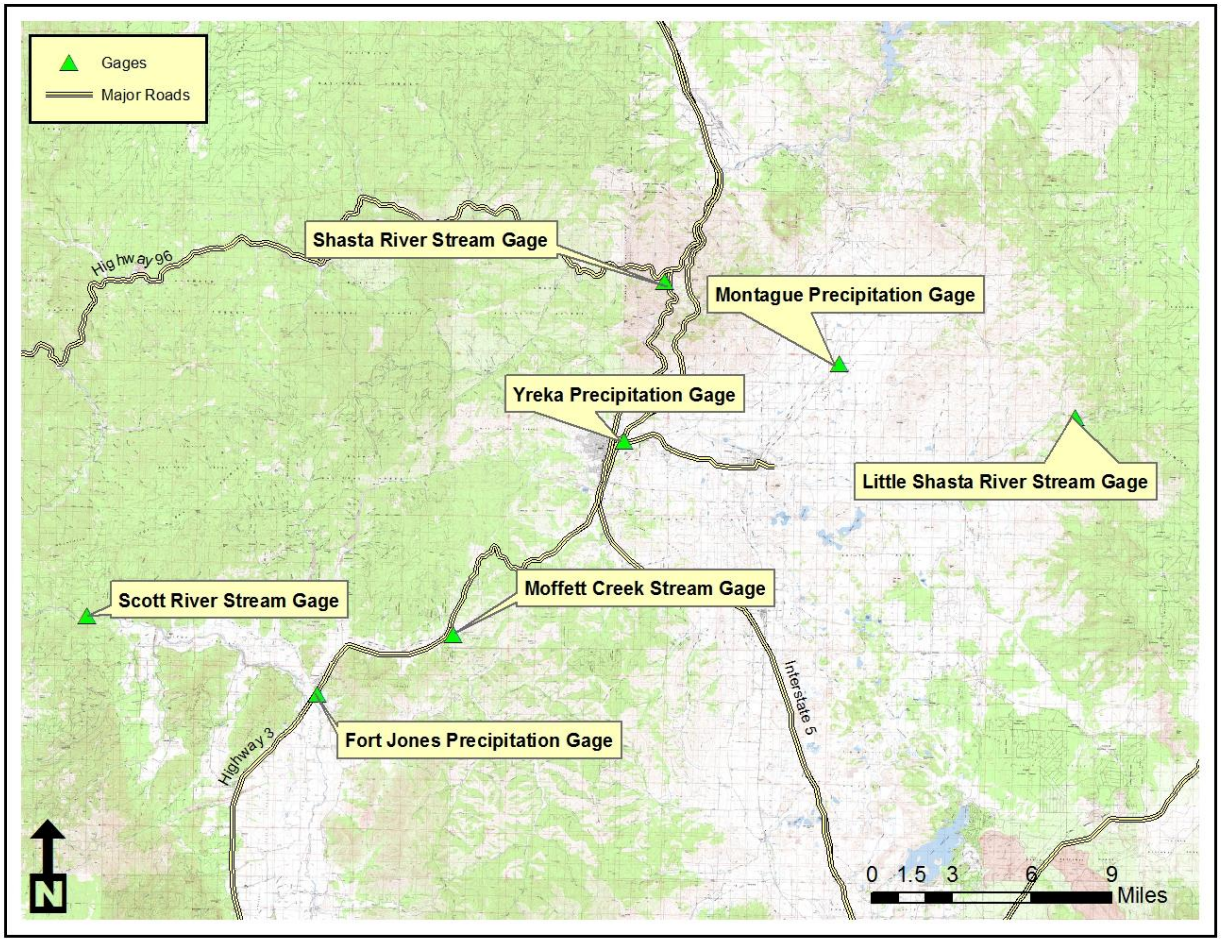
Table 2 Streamflow Records

Streamflow	USGS No.	Start	End	Latitude	Longitude
Shasta River	11517500	1934	2014	41.82306	122.59444
Little Shasta R	11516900	1958	1978	41.75306	122.29944
Scott River	11519500	1942	2014	41.64083	123.01389
Moffett Creek	11518600	1958	1967	41.63333	122.74667

Determination 85th Percentile storm

For the purposes of coordinating the proposed improvements with the City's compliance with the State's NPDES General Permits, the 85th percentile, 24-hour, storm was also examined. The Yreka data daily precipitation data shows 0.78 inches.

Figure 2 Streamflow and Precipitation Stations



HEC-1 Design Storm Model

The first published hydrology study for Yreka Creek was done by FEMA and the U.S. Army Corps of Engineers in 1976 using HEC-1. For comparison, a new study for this report was also done using HEC-HMS.

HEC-1/ HEC-HMS, developed by the Hydrologic Engineering Center in Davis, California, has long been one of the industry-standard programs for hydrologic analysis. It is a single storm event, lumped parameter model, but includes several different options for modeling rainfall, losses, unit hydrographs, and streamrouting.

The Hydrologic Modeling System (HEC-HMS) incorporated HEC-1. It was designed to simulate the complete hydrologic processes of dendritic watershed systems. The software includes many traditional hydrologic analysis procedures such as event infiltration, unit hydrographs, and hydrologic routing.

The model was designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. Each component models an aspect of the precipitation-runoff process within a portion of the basin, commonly referred to as a subbasin (see Figures 3-6). A component may represent a surface runoff entity, a stream channel, or a reservoir.

Figure 3. Yreka Creek and Tributaries Hydrologic Subbasins

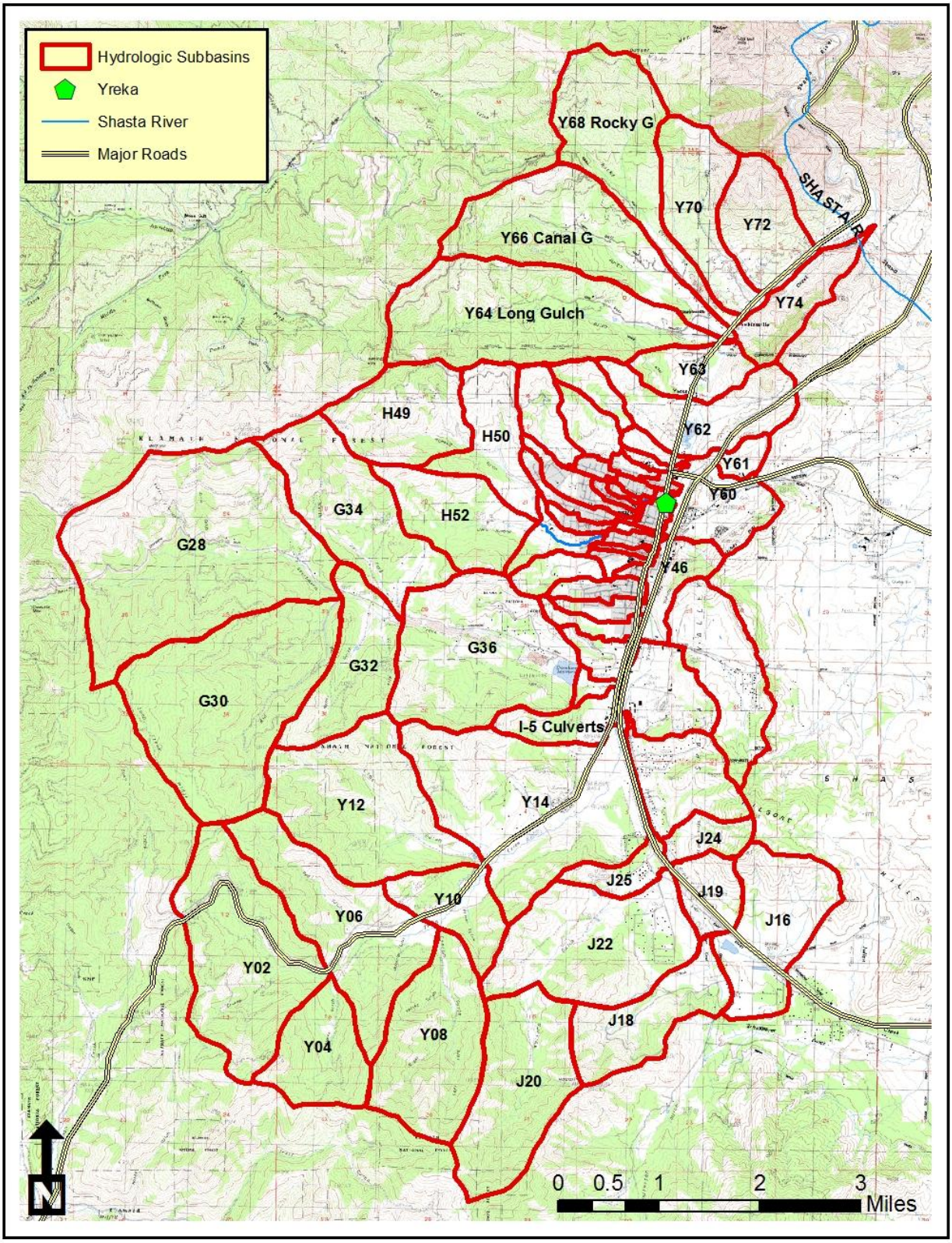


Figure 4. Yreka Creek Urban Subbasins South

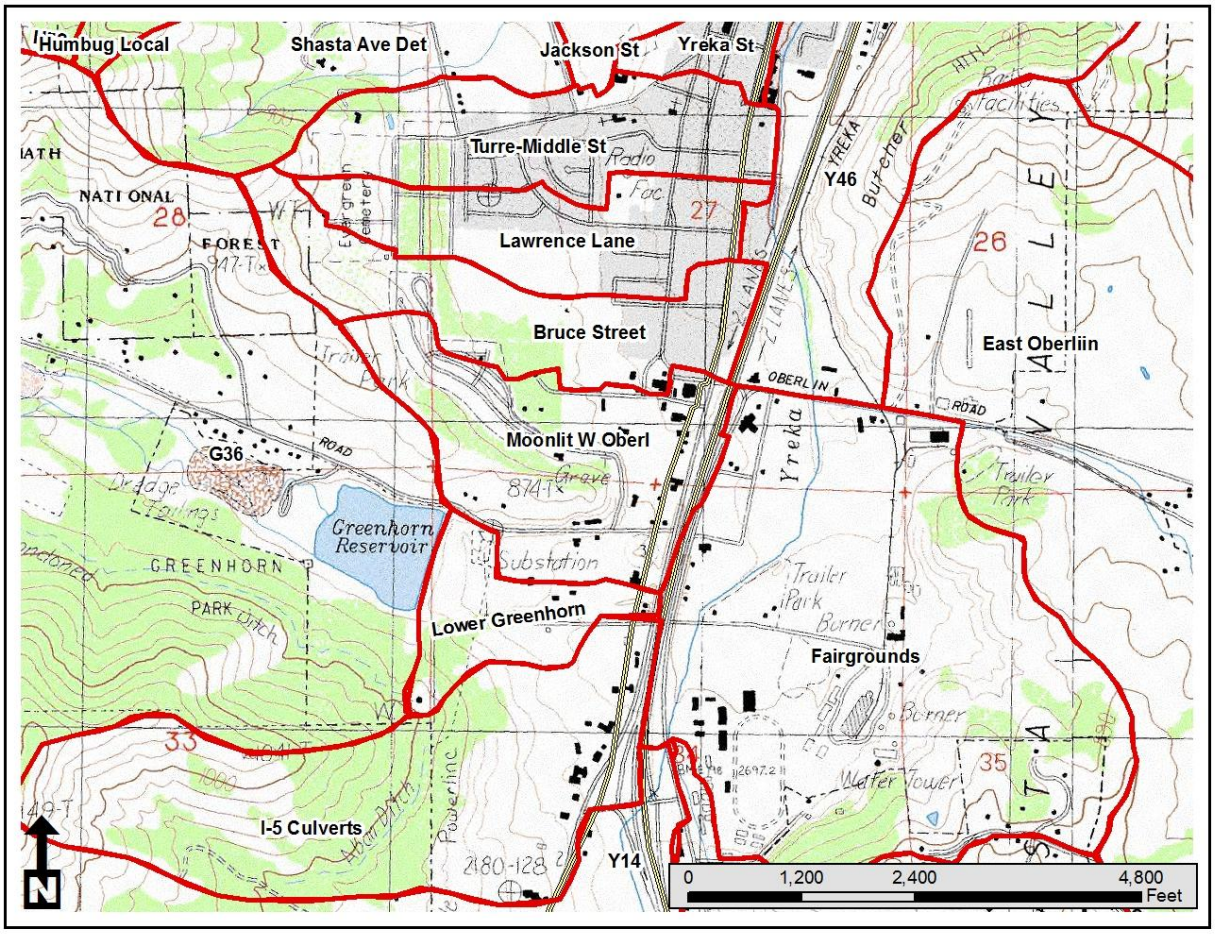


Figure 5. Yreka Creek Urban Subbasins Central

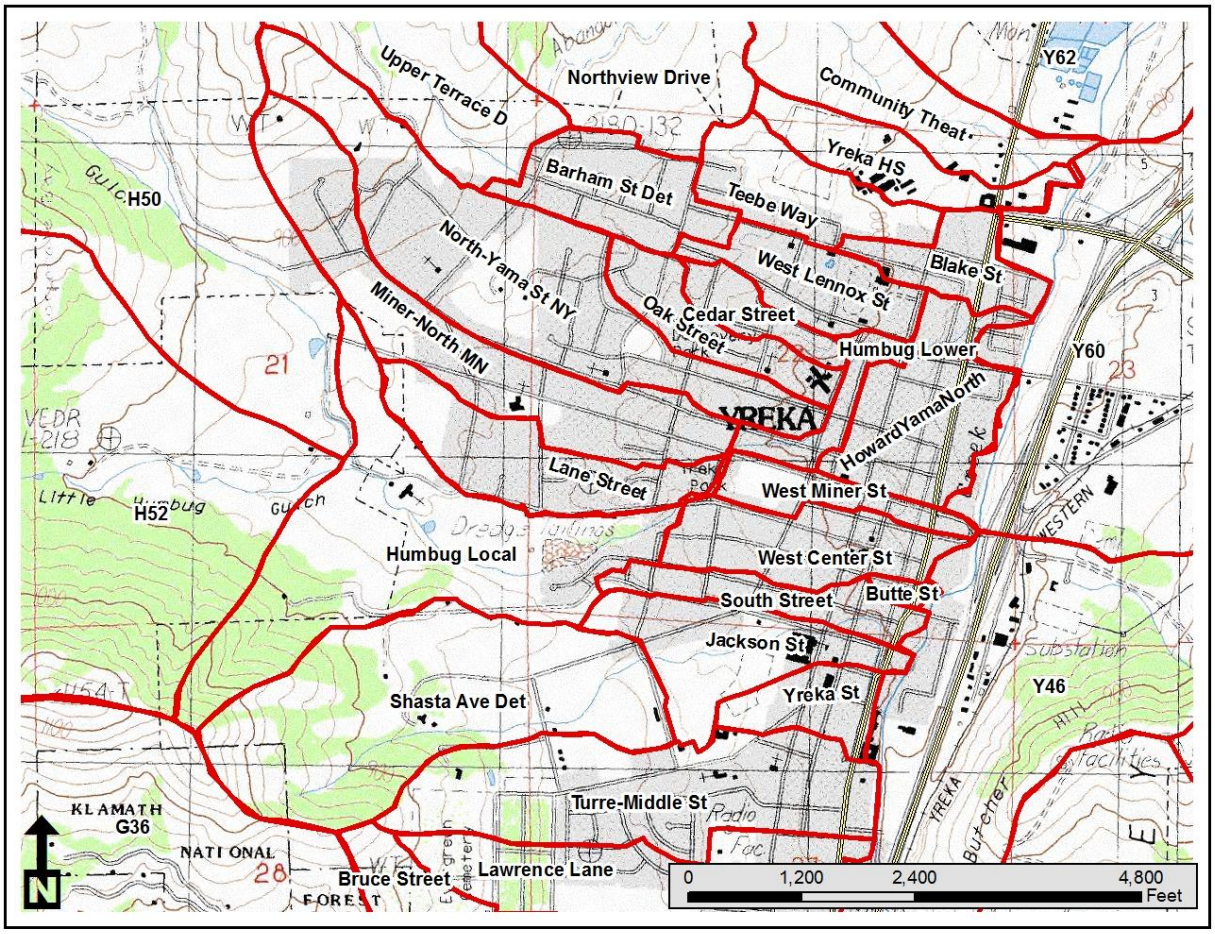
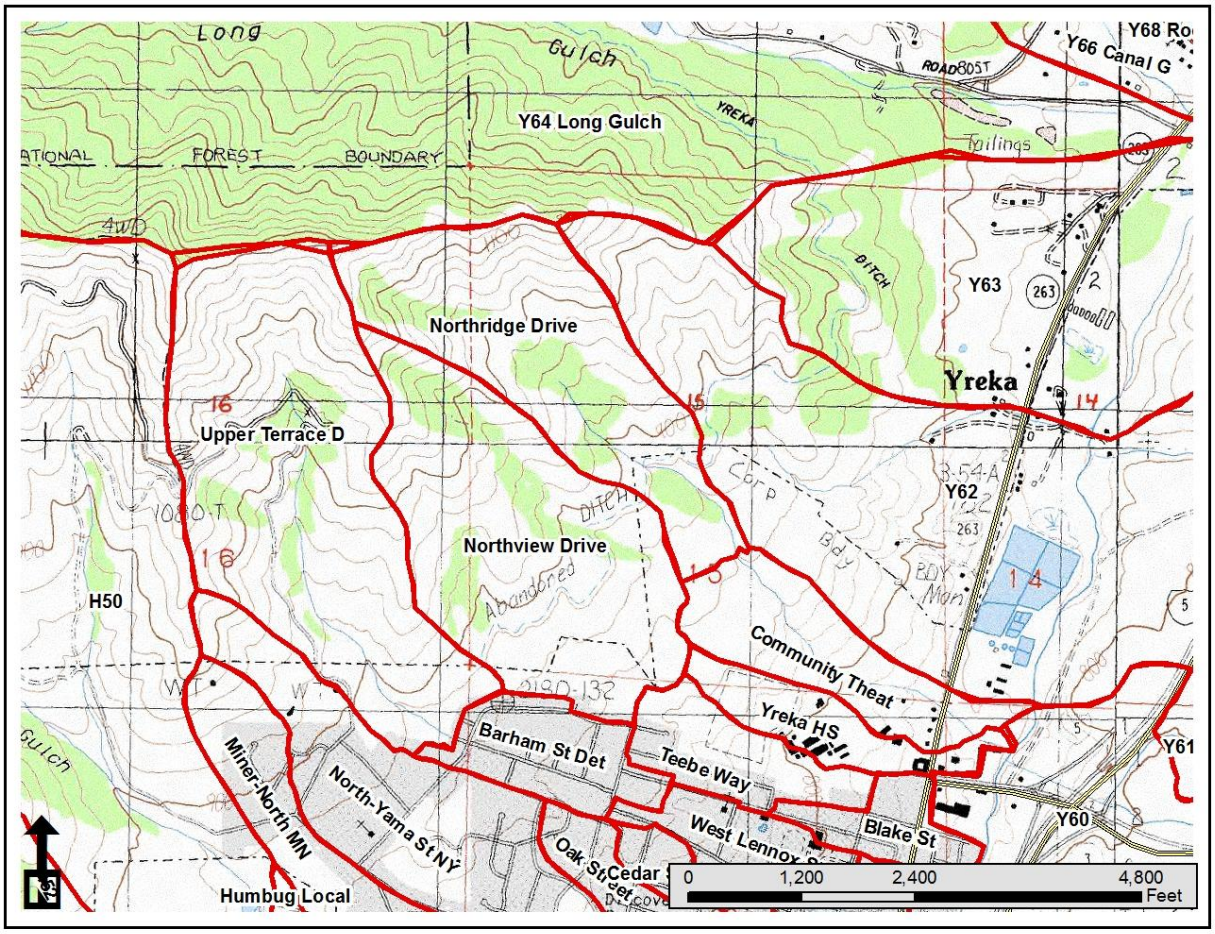


Figure 6. Yreka Creek Urban Subbasins North



This new study used the NOAA Atlas 14 precipitation depth-duration-frequency data (NOAA, 2012) and 2013 aerial photography. Flow output includedrecurrence intervals of 2, 10, 25, 50 and, 100years for floodplain analyses.

Table 3lists the HEC-HMS input parameters.

Table 3. HEC-HMS Hydrologic Parameters

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
YREKA CREEK:												
Y02	Y2	1417	3970			1			11427	689		
Y04	Y4	583	4167			1			8666	886		
C2	CY2											
R6	R6								6849		10	0.014
Y06	Y6	1184	3642			1			9969	820		
C4	CY4											
Y08	Y8	1053	3945			1			11782	976		
C6	CY6											
R10	R10											
Y10	Y10	447	3174			1			4262	303		
C8	CY8											
Y12	Y12	1359	3501			1			14076	630		
C10	CY10											
R14	R14											
Y14	Y14	1860	3150			1			6644	394		
C12	CY12											
Y15 I-	I-5 CalTrans	271	3000	0.2		0.8			8100	810		
CY14	C Y14											
JUNIPER CREEK:												
J16	J16	845	3035			1			10200	492		
J18	J18	647	3200			1			10900	820		
C16	CJ16											

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
R19	R19								4600			0.009
J19	J19	283	2950	0.1		0.9			4500	40		
CJ18	CJ18											
J20	J20	1062	4068			1			12314	984		
R22	R22								10294		10	0.012
J22	J22	1245	3117			1			9796	427		
CJ20	CJ20											
CJ19	CJ19											
R24	R24								1770		10	0.006
J24	J24	200	3091			1			4700	900		
CJ22	CJ22											
R25	R25								6500		15	
J25	J25	209		0.1	0.2	0.7			6400			
CJ24	C J24											
J L0WE	Jun Lower	541		0.1	0.1	0.8	2953	2750	4800			
CJ25	CJ25											
YREKA CREEK:												
C Y15	C I-5 Culverts											
GREENHORN CRK:												
G28	G28	2564	4208			1			18518	1173		
G30	G30	1894	3240			1			14044	681		
C28	CG28											
R32	R32								3422			0.01
G32	G32	696	3904			1			8667	869		

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
C30	CG30											
G34	G34	1022	3757			1			12275	837		
C32	CG32											
R36	R36								10016		15	0.004
G36	G36	1433	3346			1			10016	558		
C34	CG34											
S39	S39 Reservoir											
R38	R38								3205		20	0.012
L GREENHORN:	Low Green	55.6	2700	0.3		0.7	2730	2680	3000		T	
CG36	CG36											
YREKA CREEK:												
CJUNLO	C Jun Low											
R FAIR	R Fair						2676	2645	2800		25	0.01
FAIRGR	Fairgrounds	431	2795	0.4		0.6	2920	2670	5300		T	
CLGREE	C Low Green											
MOONLI	Moonlit West Oberlin]	151	2771.5	0.6	0.1	0.3	2875	2668	4300		T	
C FAIR	C Fair											
EAST O	East Oberlin	718	2975		0.2	0.8	3280	2670	12300		T	
C MOON	C Moonlit											
BRUCE	Bruce St	115	2812.5	0.2	0.7	0.1	2979	2646	5400		S	
C EAST	C East Oberlin											
LAWREN	Lawrence Lane	98.1	2719.5	0.3	0.4	0.3	2800	2639	5000		S	
CBRUCE	C Bruce											
TURRE	Turre-Middle	120	2713	0.4	0.5	0.1	2800	2626	4200		S	

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
C LAW	C Lawrence											
YrekaS	Yreka St	37.6	2643	0.9		0.1	2659	2627	1800		S	
C TURR	C Turre											
SHDD	Shasta Ave Detention	163	2853		0.1	0.9	3027	2679	4200		T	
SHASTA	Shasta Storage											
R JACK	R Jackson St						2706	2620	3000		S	
J SCHO	Jackson School JE	55.2	2651	0.3	0.3	0.4	2685	2617	3000			
CYreka	C Yreka St											
C SHAS	C Shasta Ave											
SOUTH	South St	24.8	2648.5	0.5	0.5		2685	2612	3350		S	
C J SC	C Jackson School											
BUTTE	Butte St	3.8	2615	1			2620	2610	700		S	
C SOUT	C South St											
W CENT	West Center St	48.3	2630	0.5	0.5		2664	2603	3500		S	
C BUTT	C Butte St											
W L MI	West Miner Lower	21.6	2620	0.2	0.5	0.3	2640	2602	2650		S	
C W CE	C W Center St											
RY46	RY46						2645	2595	6000		30	0.008
Y46	Y46	279	2895	0.1		0.9	2950	2600	3250		T	
C W L	C W Miners Lower											
H-Y-N	Howard-Yama-North	51.4	2620	0.5	0.5		2625	2600	2300		S	
C Y46	C Y46											
R Y60	R Y60						2595	2553	4800		30	0.008
LITTLE HUMBUG												

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
CRK:												
H49	H49	708	3850			1			8000	1400		
R50	R 50											
H50	H50	532	2950			1			6000	320		
C49	C 49											
H52	H52	639	3576			1			10068	722		
C50	C 50											
R L HU	R Humbug Local						2785	2657	4300		12	
HUM LO	Humbug Local	161	3063				3390	2736	3000			
C52	C 52											
S HUM	Hum Proposed											
LANE L	Lane St LM	55.8	2722	0.1	0.8	0.1	2787	2657	3400		S	
C HUM	C Humbug Local											
MN	Miner-North MN	102	2854	0.1	0.7	0.2	3062	2646	6100			
C LANE	C Lane											
R HUM	R Humbug Lower						2657	2570	4400			
N YUMA	North Yuma St NY	146	2783		0.9	0.1	2947	2619	5870			
C MN	C MN											
GOLD S	Oak Gold	31	2683	0.1	0.8	0.1	2750	2616	3000			
C NY	C NY											
CEDAR	Cedar St CT	17.8	2666		0.6	0.4	2718	2614	2900			
CGOLD	C Oak Gold											
U TERR	Upper Terrace	237	3273.5			1	3700	2847	5000			
R BS D	R Barnam St											

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
BS DET	Barnam St Detention	46.1	2774.5	1			2849	2700	2700			
C U TE	C Upper Terrace											
S BS D	S Barmam Detention											
RWLenn	R W Lennox						2720	2605	2700		S	
W LENN	West Lennox St (CT)	37.7	2663	0.2	0.7	0.1	2719	2607	2650			
C BS D	C B S Det											
C CEDA	C Cedar St											
L HUM	Humbug Lower	28	2605	0.1	0.9		2637	2573	3900			
C W LE	C West Lennox		Mouth									
BLAKE	Blake St	28.4	2611.5	0.1	0.8	0.1	2649	2574	2450			
C HUM	C Humbug Lower											
YREKA CREEK:												
C H-Y-	C H-Y-N											
Y 60	Y60	462	2700	0.1		0.9	2840	2553	4856	164		
CBLAKE	C Blake											
NORTHV	Northview Dr	187	3023.5		0.1	0.9	3300	2747	4200			
RTeebe	R Teebe										5	
TEEBE	Teebe Way	43.6	2664.5	0.1	0.6	0.3	2725	2604	2900			
C NV	C Northview Dr											
Y HS	Yreka HS	37.6	2640	0.6		0.4	2710	2570	3500			
C TEEB	C Teebe											
NR	Northridge Dr	150	3200			1	3610	2790	5300			
R CC	R CommTheat CC										6	
COMM T	Community Theater CC	69.5	2670.5	0.2		0.8	2780	2561	4100			

HEC	Model	Area(ac)	Elevation (ft)	C/I	Res	Nat	U Elev	L Elev	Distance	Drop	Width	Slope
C NR	C Northridge Dr											
C YHS	C Yreka HS											
Y 61	Y61	95.3	2713.5			1	2887	2540	4000			
C Y60	C Y60											
C COMM	C CommTh											
R Y62	R Y62						2553	2528	3140		30	
Y 62	Y62	649	2904			1	3280	2528	6200			
C Y61	C Y61											
R Y63	R Y63						2528	2496	3800		30	
Y 63	Y63	336	2724.5			1	2953	2496	4500			
C Y62	C Y62											
SHASTA RIVER												

HSPF Hourly Hydrologic Simulation Model

HSPF hydrologic simulations were done for the following reasons:

- Only HSPF could simulate hourly continuous flow (1949-2013) for all of the points of interest. These hourly flow records allowed realistic simulation of antecedent storage and performance of existing and proposed storage or detention reservoirs.
- HSPF had snow accumulation and snowmelt methodology which was important for simulating some of the winter flood events for Yreka.
- HSPF had continuous soil moisture accounting, which was especially important in this climatic area of winter rainfall and dry summers.

HSPF is a mathematical model developed under EPA sponsorship (EPA, Basins 4.1, 2014), for use on digital computers to simulate hydrologic and water quality processes in natural and man-made water systems. It is an analytical tool which has application in the planning, design, and operation of water resources systems. The model enables the use of probabilistic analysis in the fields of hydrology and water quality management. HSPF uses such information. such as, the time history of rainfall, temperature, evaporation, and parameters related to land use patterns and soil characteristics, to simulate the runoff processes that occur in a watershed. The initial result of an HSPF simulation is a time history of the quantity of water transported over the land surface and through various soil zones down to groundwater aquifers. The model uses runoff and stream channel information to simulate instream processes. From this HSPF produces a time history of water quantity at any point in the watershed.

The HSPF water budget simulation required long-term records of representative daily and hourly precipitation data, as listed below. Adjustments were made to these station records to account for subbasin mean elevation, PRISM annual precipitation, and daily precipitation records at Yreka. Air temperature was estimated from maximum-minimum air temperature records at Montague, adjusted for elevation.

Hourly Precipitation Records

Montague 7/1948-9/2013
Fort Jones 6 ESE 7/1946-12/1976
Fort Jones RS 11/1976-9/2013

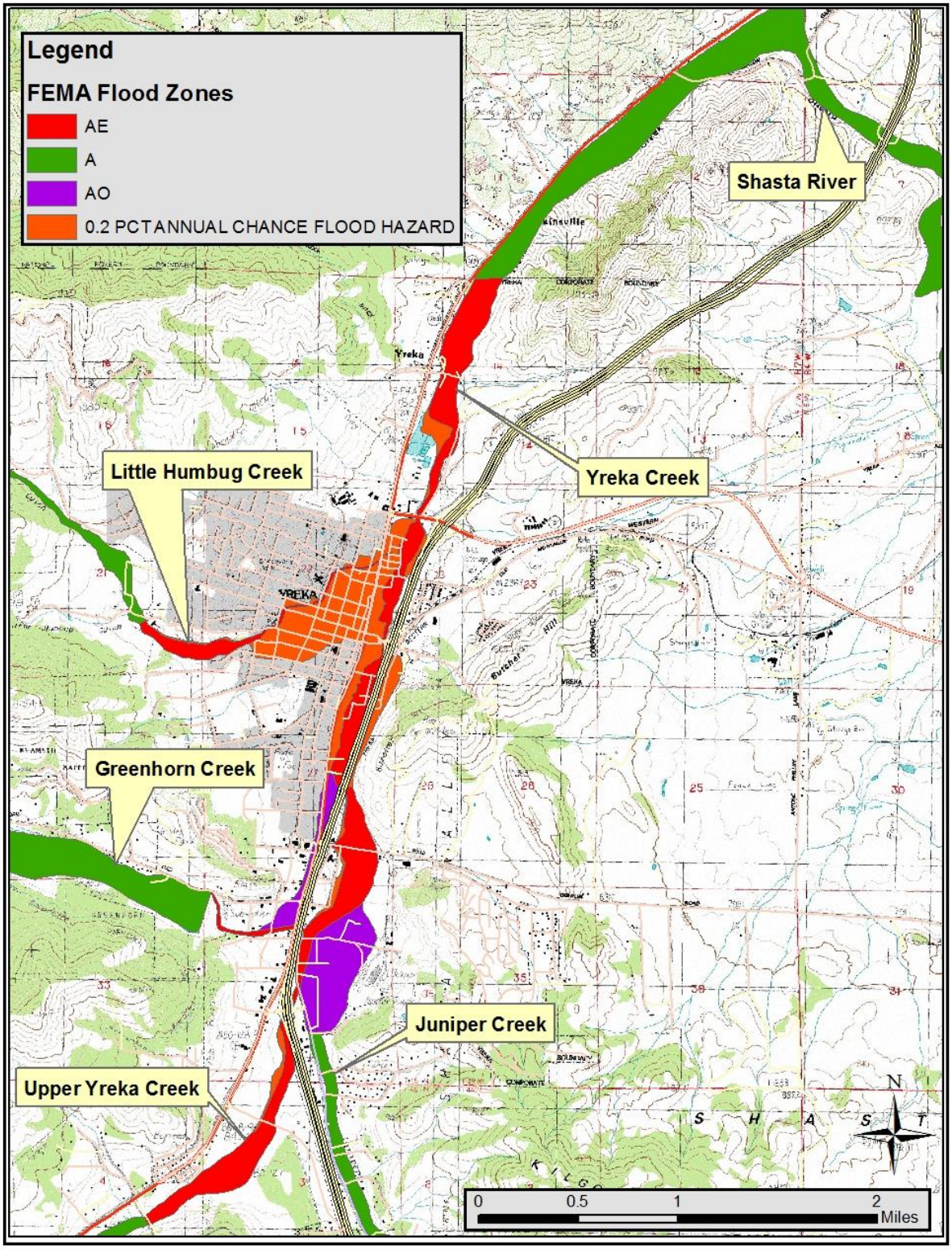
Daily Climate Records

Montague 7/1948-9/2013
Fort Jones RS 1936-2014
Yreka Klamath NF RS 1893-2014
Yreka 4.5 S 2008-2014
Yreka 0.9 WNW 2008-2014

Federal Emergency Management Agency (FEMA) Siskiyou County Flood Study

This 2011 revised study of the original 1979 report (FEMA, Siskiyou County, 2011) was based on the September 1979 USGS hydrology report and the 1976 USACE hydraulics study with no hydrology updating or revision for the 2011 re-study. The 2011 study only revised the datum to NAVD88 and provided digital flood maps. The 1978 study noted that December 22, 1964 was probably the largest flood event since 1890. The FEMA floodplain map for Yreka is shown in Figure 7, and data from the 1978 study is listed below:

Figure 7. FEMA Floodplains



Detailed studies available from FEMA:

Greenhorn Creek: Greenhorn Reservoir spillway to mouth
Humbug Creek: to 8700 ft upstream of Yreka Creek confluence
Yreka Creek: from 6675 ft downstream of Highway 3 to 29,000 ft upstream

Peak Flow Estimates by FEMA (also shown in Table 4

Yreka Creek: upstream of Juniper Cr. 12.6 sqmi 10-yr 950 cfs, 100-yr 2600 cfs
Greenhorn Creek: at Yreka Cr. 12.0 sq mi: 10-yr 900 cfs, 100-yr 2200 cfs
Yreka Creek: upstream of Greenhorn Cr 20.6 sq mi 10-yr 1650 cfs, 100-yr 4400cfs
Humbug Creek: at Yreka Cr 3.8 sq mi: 10-yr 400 cfs, 100-yr 900 cfs
Yreka Creek: upstream of Humbug Cr 36.5sq mi 10-yr 2550 cfs, 100-yr 7000 cfs
Yreka Creek: at north City Limit 42.5sq mi 10-yr 3000 cfs, 100-yr 8000 cfs

Results and Discussion

HEC-HMS design flows for various stations are shown in Table 4. The various methods showed similar results for Juniper Creek, Little Humbug Creek and Yreka Creek (Table 5). The USGS regional method did not consider storage routing in Greenhorn Reservoir and overestimated peak flows there. The regional equations also did not consider urbanization in Little Humbug Creek and underestimated peak flows there. The HSPF model was better at simulating timing of hydrograph peaks.

Where comparisons with the 1976 FEMA study were available, the 100-year peak discharges were not significantly different.

The three methods (Regional, HEC-1 and HSPF) would be acceptable at most locations, except as noted above. The HEC-HMS values (Table 4) were used for design since they could be easily assigned to specific locations. The HSPF hydrographs may be used for later storage and detention evaluation since those evaluations require runoff volumes.

Table 4 HEC-HMS Design Flows

Model	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**
Y2	104	189	266	378	474	579	837
Y4	51	93	131	185	232	283	409
CY2	151	275	386	548	689	841	1216
R6	151	274	386	547	687	839	1214
Y6	85	159	225	322	405	496	721
CY4	227	417	590	844	1064	1304	1898
Y8	78	142	200	284	357	436	630
CY6	302	556	789	1127	1421	1740	2528
R10	301	554	785	1122	1414	1732	2517
Y10	36	71	102	148	187	232	341
CY8	322	592	839	1200	1513	1853	2694
Y12	80	149	211	302	381	466	676
CY10	402	741	1050	1502	1892	2316	3363
R14	399	735	1041	1489	1877	2298	3338
Y14	214	370	505	701	869	1053	1494
CY12	518	937	1322	1887	2376	2907	4228

Model	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**
I-5 CalTrans	23	42	60	85	107	131	190
C Y14	531	960	1354	1932	2434	2979	4334
J16	42	84	122	179	229	283	418
J18	35	68	99	145	185	229	338
CJ16	77	152	221	324	414	511	754
R19	76	152	221	323	413	510	754
J19	18	35	51	74	94	116	169
CJ18	92	181	263	384	491	606	895
J20	71	133	189	271	342	419	608
R22	71	133	188	270	341	418	608
J22	65	129	188	276	352	436	643
CJ20	132	250	360	525	669	826	1217
CJ19	222	429	621	909	1159	1432	2111
R24	222	429	621	908	1158	1431	2110
J24	17	33	47	68	86	106	156
CJ22	232	446	645	943	1202	1484	2188
R25	231	445	644	941	1199	1481	2183
J25	16	30	42	61	76	94	137
C J24	241	464	670	979	1248	1541	2272
Jun Lower	42	80	114	164	207	256	374
CJ25	266	509	735	1074	1369	1690	2494
C I-5 Culverts	794	1459	2075	2989	3783	4647	6805
G28	172	307	428	602	752	913	1308
G30	105	197	282	405	511	628	912
CG28	276	501	704	1000	1254	1530	2207
R32	276	500	703	999	1253	1529	2205
G32	57	105	148	211	265	325	471

Model	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**
CG30	318	574	806	1144	1434	1750	2524
G34	70	129	182	259	326	399	578
CG32	381	690	971	1381	1734	2118	3064
R36	378	684	963	1371	1722	2104	3044
G36	135	230	313	432	535	644	910
CG34	468	840	1179	1677	2107	2574	3728
S39 Reservoir	392	719	1022	1477	1873	2301	3341
R38	392	719	1022	1477	1873	2300	3340
Low Green	6	10	14	20	25	31	44
CG36	394	722	1027	1483	1881	2309	3353
C Jun Low	1067	1981	2854	4149	5282	6510	9560
R Fair	1067	1981	2854	4148	5282	6508	9558
Fairgrounds	22	47	70	105	135	169	253
C Low Green	1081	2007	2891	4205	5354	6599	9698
Moonlit West Oberlin]	22	37	49	67	82	99	139
C Fair	1088	2019	2908	4227	5382	6633	9745
East Oberlin	32	66	99	147	189	235	352
C Moonlit	1113	2067	2980	4336	5524	6812	10023
Bruce St	42	62	78	101	121	145	200
C East Oberlin	1121	2078	2994	4354	5545	6835	10054
Lawrence Lane	39	57	72	93	112	134	186
C Bruce	1127	2087	3005	4369	5562	6855	10080
Turre-Middle	71	100	122	155	183	215	291
C Lawrence	1135	2099	3020	4387	5584	6880	10111
Yreka St	32	44	53	65	76	88	116
C Turre	1138	2103	3025	4393	5591	6887	10121
Shasta Ave Detention	12	23	34	50	64	80	118
Shasta Storage	8	16	21	27	32	36	47

Model	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**
R Jackson St	8	16	21	27	32	36	47
Jackson School JE	22	31	40	52	62	75	104
C Yreka St	22	33	44	59	73	88	123
C Shasta Ave	1148	2121	3050	4427	5631	6934	10182
South St	16	22	27	34	40	47	63
C Jackson School	1150	2123	3053	4431	5636	6939	10189
Butte St	4	5	6	7	9	10	13
C South St	1150	2124	3054	4431	5637	6940	10189
West Center St	30	42	51	64	76	89	120
C Butte St	1154	2129	3060	4439	5645	6950	10202
West Miner Lower	8	12	15	20	24	29	40
C W Center St	1155	2131	3062	4442	5649	6955	10208
RY46	1155	2130	3061	4441	5648	6953	10205
Y46	19	41	61	91	117	147	220
C W Miners Lower	1164	2145	3082	4470	5685	6998	10272
Howard-Yama-North	34	48	58	73	85	100	134
C Y46	1168	2150	3089	4478	5694	7008	10285
R Y60	1167	2150	3088	4477	5692	7006	10283
H49	18	48	80	130	174	223	349
R 50	18	48	80	130	174	223	349
H50	11	31	53	90	122	159	253
C 49	30	79	132	217	294	379	599
H52	20	48	77	123	164	209	324
C 50	49	125	207	335	450	578	908
R Humbug Local	49	125	207	335	450	578	908
Humbug Local	13	28	41	60	78	97	144
C 52	56	138	226	363	486	623	975
Hum Proposed	56	138	226	363	486		975
Lane St LM	24	35	44	57	68	81	112

Model	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**
C Humbug Local	60	146	236	375	500	640	996
Miner-North MN	37	54	69	91	109	132	184
C Lane	69	160	254	399	528	671	1036
R Humbug Lower	69	160	254	399	528	671	1036
North Yuma St NY	54	79	100	132	158	191	266
C MN	95	179	278	430	564	713	1090
Oak Gold	14	20	25	32	39	46	63
C NY	101	183	283	436	572	721	1102
Cedar St CT	4	7	9	12	15	18	26
C Oak Gold	103	185	286	439	576	726	1108
Upper Terrace	17	35	51	74	95	118	176
R Barnam St	17	35	51	74	95	118	176
Barnam St Detention	44	61	72	89	103	119	155
C Upper Terrace	46	69	86	112	133	158	214
S Barmam Detention	22	33	40	51	80	123	197
R W Lennox	22	33	40	51	80	123	197
West Lennox St (CT)	19	28	34	44	52	61	83
C B S Det	31	45	54	69	90	135	215
C Cedar St	131	223	332	497	665	851	1290
Humbug Lower	12	17	21	27	32	38	53
C West Lennox	139	227	338	503	672	860	1301
Blake St	13	19	23	30	36	42	58
C Humbug Lower	145	231	342	509	679	868	1312
C H-Y-N	1259	2321	3335	4841	6155	7578	11162
Y60	25	53	79	118	152	190	284
C Blake	1273	2347	3373	4897	6226	7668	11300
Northview Dr	14	29	42	62	79	98	145
R Teebe	14	29	42	62	79	98	145
Teebe Way	16	23	29	39	46	56	78

Model	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**
C Northview Dr	19	37	53	77	96	118	171
Yreka HS	21	30	37	47	55	66	89
C Teebe	38	59	78	104	127	153	216
Northridge Dr	11	21	31	46	58	73	108
R CommTheat CC	11	21	31	46	58	73	108
Community Theater CC	5	11	16	24	30	38	56
C Northridge Dr	15	30	44	64	83	103	153
C Yreka HS	41	76	108	154	194	238	345
Y61	6	13	20	30	38	48	72
C Y60	46	88	127	183	232	286	416
C CommTh	1295	2384	3424	4968	6315	7777	11460
R Y62	1295	2383	3423	4967	6314	7776	11459
Y62	39	81	120	179	230	287	427
C Y61	1316	2419	3475	5043	6410	7895	11641
R Y63	1315	2419	3474	5042	6410	7894	11640
Y63	23	49	73	109	141	176	263
C Y62	1325	2436	3498	5076	6452	7946	11717

Table 5. 100-Year Peak Flows

No.	Location	Area		Name	USGS	HSPF	HEC HMS	FEMA
1	Yreka Creek at South City Limit	4.97		CY04	1164	1900	1304	
2	Yreka Creek us FEMA detailed	9.44		CY10	2029		2298	
3	Yreka Creek at I-5 south	12.68		CY12	2624	2600	2907	2600
4	Juniper Creek	1.32		J16	326		356	
5	Juniper Creek ds I-5	2.77		CJ18	620		733	
6	Juniper Creek at Mouth	7.92		CJ22	1540	2100	1964	
7	Yreka Creek ds of Juniper Creek	20.59		CY14	3987		4968	4400
8	Greenhorn Creek at City Limit	6.97		CG28	1560		1530	
9	Greenhorn Cr us Greenhorn Res	11.89		CG34	2521	2500	2567	
10	Greenhorn Cr ds Greenhorn Res	11.89		SG39	2521		2301	
11	Greenhorn Cr at Mouth	12.13		CG36	2478	1500	2330	2200
12	Yreka Creek ds of Greenhorn Cr	32.72		CG38	5954	5500	6762	
13	Humbug Creek at 940 meters	1.11		CH49	318		247	
14	Humbug Creek at City Limit	1.95		CH50	518	958	469	
15	Humbug Creek at Mouth	3.85		CH52	933	958	863	900
16	Yreka Creek ds of Humbug Creek	40.33		CH54	7136	7500	7816	7000
17	Yreka Creek at north City Limit	43.93		CY60	7680	7800	8250	8000

Table 6. 50-Year Peak Flows

No.	Location	Area		Name	USGS	HSPF	HEC HMS	FEMA
1	Yreka Creek at South City t	4.97		CY04	975	1100	1062	
2	Yreka Creek us FEMA	9.44		CY10	1704		1886	
3	Yreka Creek at I-5 south	12.68		CY12	2203	1900	2369	
4	Juniper Creek	1.32		J16	270		294	
5	Juniper Creek ds I-5	2.77		CJ18	514		604	
6	Juniper Creek at Mouth	7.92		CJ22	1283	1600	1331	
7	Yreka Creek ds of Juniper	20.59		CY14	3359		3972	1900
8	Greenhorn Creek at City	6.97		CG28	1309		1250	
9	Greenhorn Cr us Res	11.89		CG34	2083		2100	
10	Greenhorn Cr ds Res	11.89		SG39	2083	1200	1868	
11	Greenhorn Cr at Mouth	12.13		CG36	2120	1500	1893	1800
12	Yreka Creek ds Greenhorn	32.72		CG38	5026	3900	5569	3300
13	Humbug Creek at 940 m	1.11		CH49	265		315	
14	Humbug Creek at City Limit	1.95		CH50	432		465	
15	Humbug Creek at Mouth	3.85		CH52	781	800	682	750
16	Yreka Creek ds of Humbug	40.33		CH54	6028	5600	6421	5150
17	Yreka Creek at north City	43.93		CY60	6494	5900	6700	6000

Table 7. 25-Year Peak Flows

No.	Location	Area		Name	USGS	HSPF	HEC HMS
1	Yreka Creek at South City L	4.97		CY04	797	900	844
2	Yreka Creek us FEMA	9.44		CY10	1396		1500
3	Yreka Creek at I-5 south	12.68		CY12	1807	1600	1887
4	Juniper Creek	1.32		J16	217		238
5	Juniper Creek ds I-5	2.77		CJ18	416		488
6	Juniper Creek at Mouth	7.92		CJ22	1041	1200	1280
7	Yreka Creek ds of Juniper Cr	20.59		CY14	2761		3168
8	Greenhorn Creek at City L	6.97		CG28	1071		1000
9	Greenhorn Cr us Res	11.89		CG34	1708		1610
10	Greenhorn Cr ds Res	11.89		SG39	1708		1200
11	Greenhorn Cr at Mouth	12.13		CG36	1738	1000	1250
12	Yreka Creek ds Greenhorn	32.72		CG38	4138	3000	4360
13	Humbug Creek at 940 m	1.11		CH49	215		134
14	Humbug Creek at City Limit	1.95		CH50	352		347
15	Humbug Creek at Mouth	3.85		CH52	638	650	523
16	Yreka Creek ds of Humbug	40.33		CH54	4968	4200	5080
17	Yreka Creek at north City L	43.93		CY60	5354	4300	5300

Table 8. 10-Year Peak Flows

No.	Location	Area		Name	USGS	HSPF	HEC HMS	FEMA
1	Yreka Creek at South City Limit	4.97		CY04	570	520	590	
2	Yreka Creek us FEMA detailed	9.44		CY10	1003		1050	
3	Yreka Creek at I-5 south	12.68		CY12	1302		1322	950
4	Juniper Creek	1.32		J16	152		172	
5	Juniper Creek ds I-5	2.77		CJ18	292		350	
6	Juniper Creek at Mouth	7.92		CJ22	859	789	907	
7	Yreka Creek ds of Juniper Creek	20.59		CY14	1992		2225	1650
8	Greenhorn Creek at City Limit	6.97		CG28	768		703	
9	Greenhorn Cr us Greenhorn Res	11.89		CG34	1229		1179	
10	Greenhorn Cr ds Greenhorn Res	11.89		SG39	1229		1022	
11	Greenhorn Cr at Mouth	12.13		CG36	1250	800	1038	900
12	Yreka Creek ds of Greenhorn Cr	32.72		CG38	2994	2000	3014	4400
13	Humbug Creek at 940 meters	1.11		CH49	152		89	
14	Humbug Creek at City Limit	1.95		CH50	250		143	
15	Humbug Creek at Mouth	3.85		CH52	455	508	340	400
16	Yreka Creek ds of Humbug Creek	40.33		CH54	3599	2750	3483	2550
17	Yreka Creek at north City Limit	43.93		CY60	3678	2810	3681	3000

Table 9. 2-Year Peak Flows

No.	Location	Area		Name	USGS	HSPF	HEC HMS
1	Yreka Creek at South City Limit	4.97		CY04	184	120	165
2	Yreka Creek us FEMA detailed	9.44		CY10	328		298
3	Yreka Creek at I-5 south	12.68		CY12	429		392
4	Juniper Creek	1.32		J16	44		73
5	Juniper Creek ds I-5	2.77		CJ18	87		148
6	Juniper Creek at Mouth	7.92		CJ22	280	240	362
7	Yreka Creek ds of Juniper Creek	20.59		CY14	663		881
8	Greenhorn Creek at City Limit	6.97		CG28	249		276
9	Greenhorn Cr us Greenhorn Res	11.89		CG34	404		468
10	Greenhorn Cr ds Greenhorn Res	11.89		SG39	404		392
11	Greenhorn Cr at Mouth	12.13		CG36	441	200	400
12	Yreka Creek ds of Greenhorn Cr	32.72		CG38	1008	700	1154
13	Humbug Creek at 940 meters	1.11		CH49	47		20
14	Humbug Creek at City Limit	1.95		CH50	79		32
15	Humbug Creek at Mouth	3.85		CH52	146	240	98
16	Yreka Creek ds of Humbug Creek	40.33		CH54	1218	920	1349
17	Yreka Creek at north City Limit	43.93		CY60	1315	950	1440

HEC-RAS Models for Existing Conditions

HEC-RAS Models were set up using the 2013 topography and stream structure surveys.

The models used the 100-year peak flows shown in Table 5.Figures 8-22 show existing 100-year floodplains for the entire study area. Note that not all of these floodplains were considered for improvement or restoration in this project. These figures also show the locations of HEC-RAS cross sections, stream crossing facilities and 100-year water surface elevations.

Figure 8. Yreka Creek 100-Year Floodplain 36332 to 32153

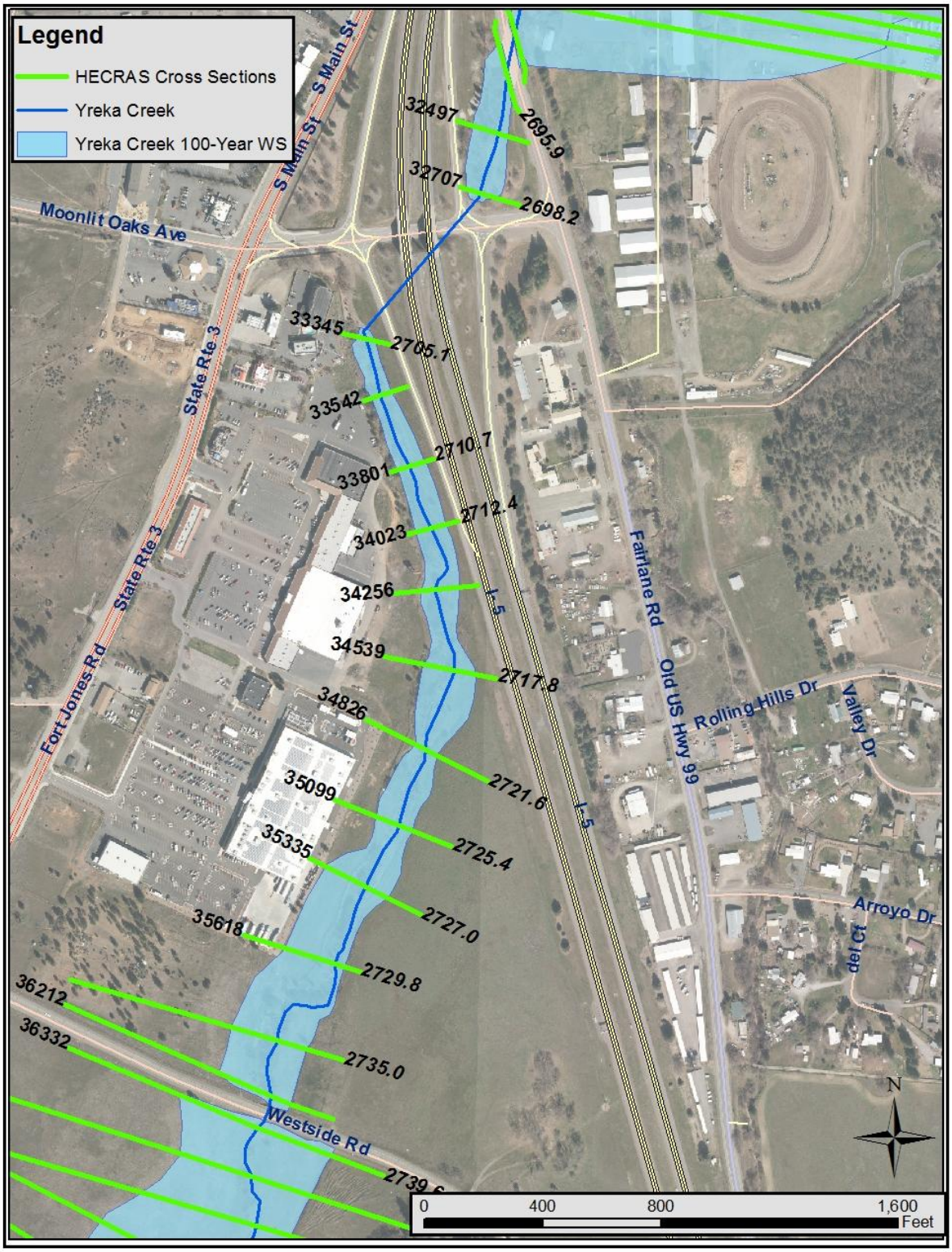


Figure 9. Yreka Creek 100-Year Floodplain 32153 to 27814

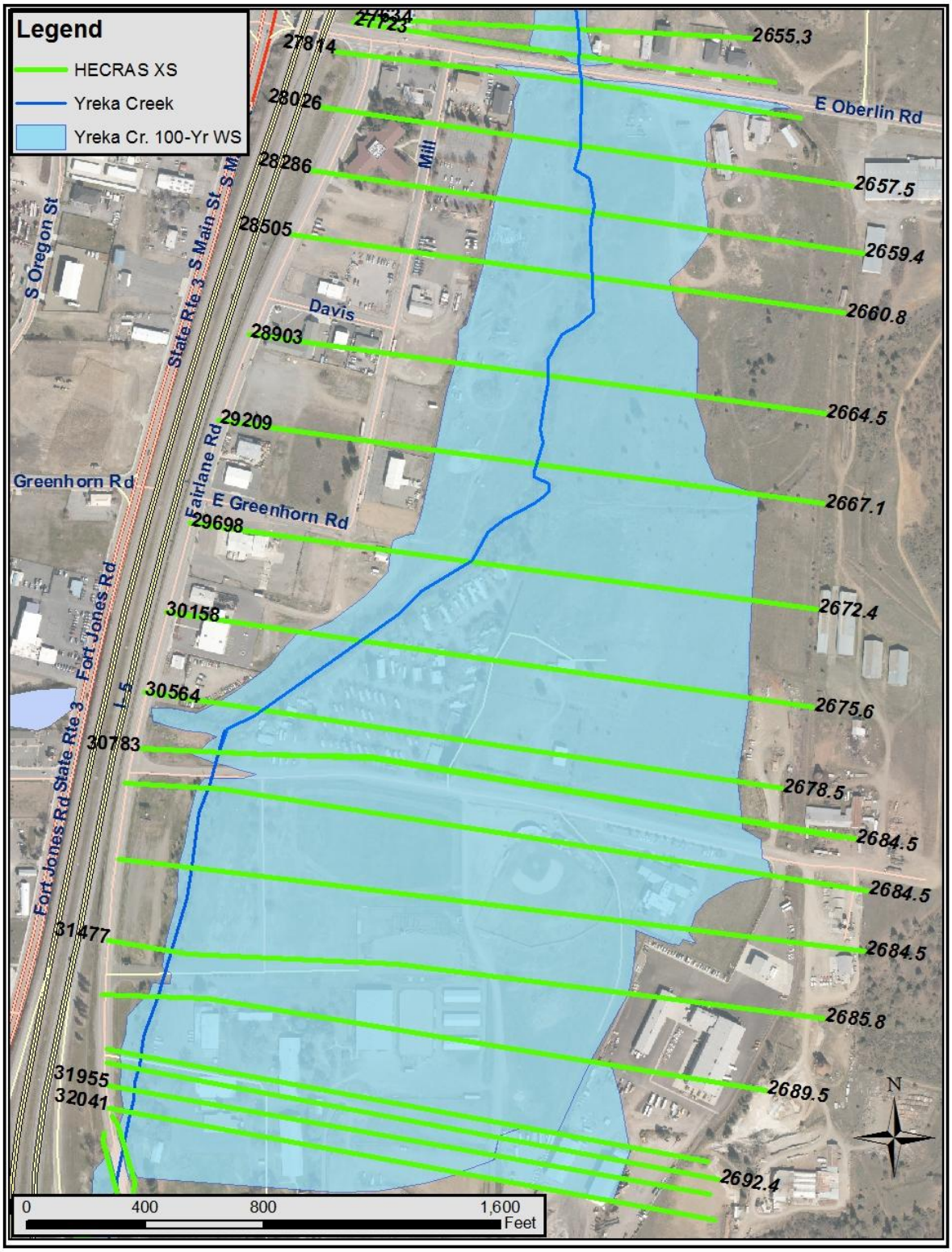


Figure 10. Yreka Creek 100-Year Floodplain 27814 to 25273

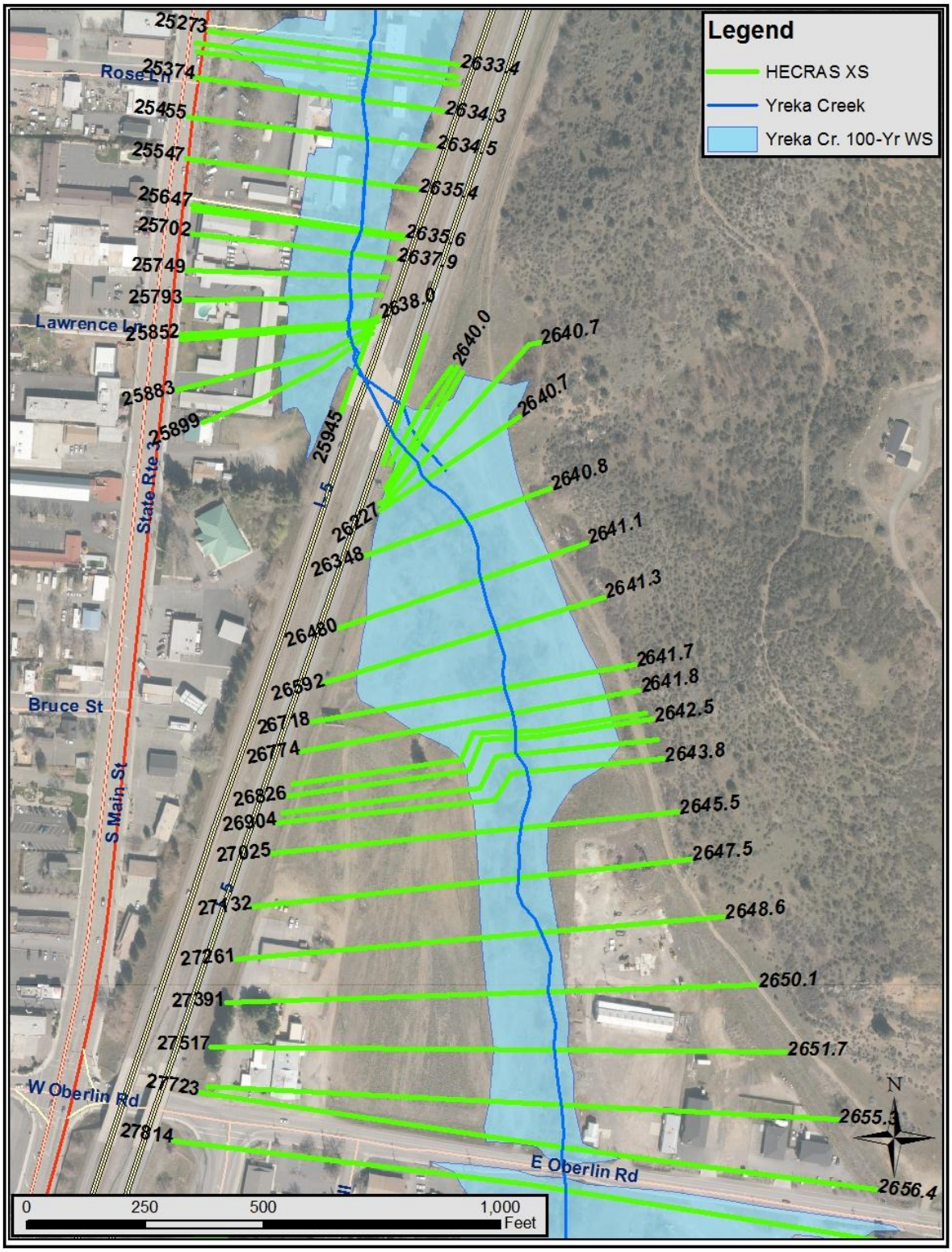


Figure 11. Yreka Creek 100-Year Floodplain 25273 to 21159

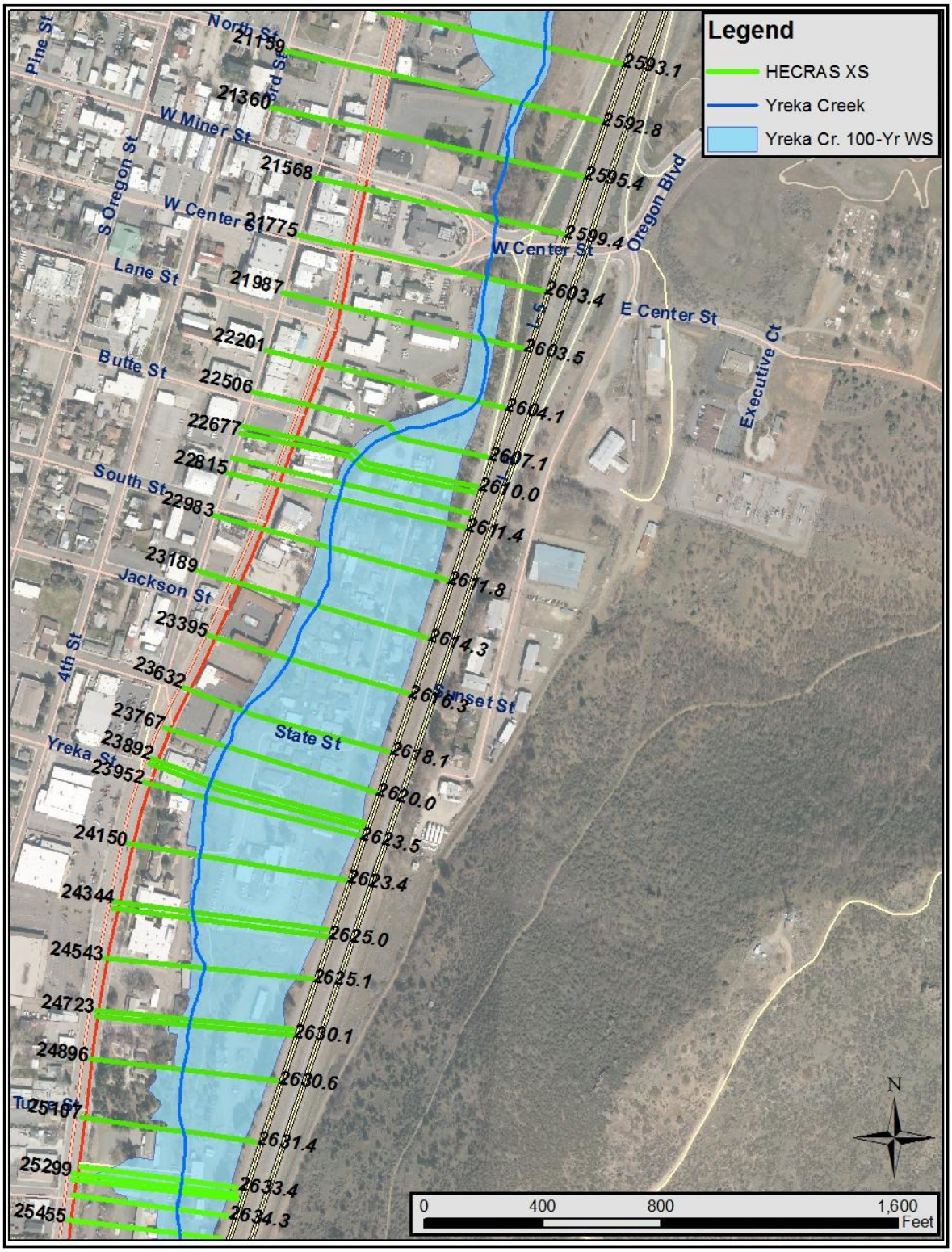


Figure 12. Yreka Creek 100-Year Floodplain 21159 to 17673

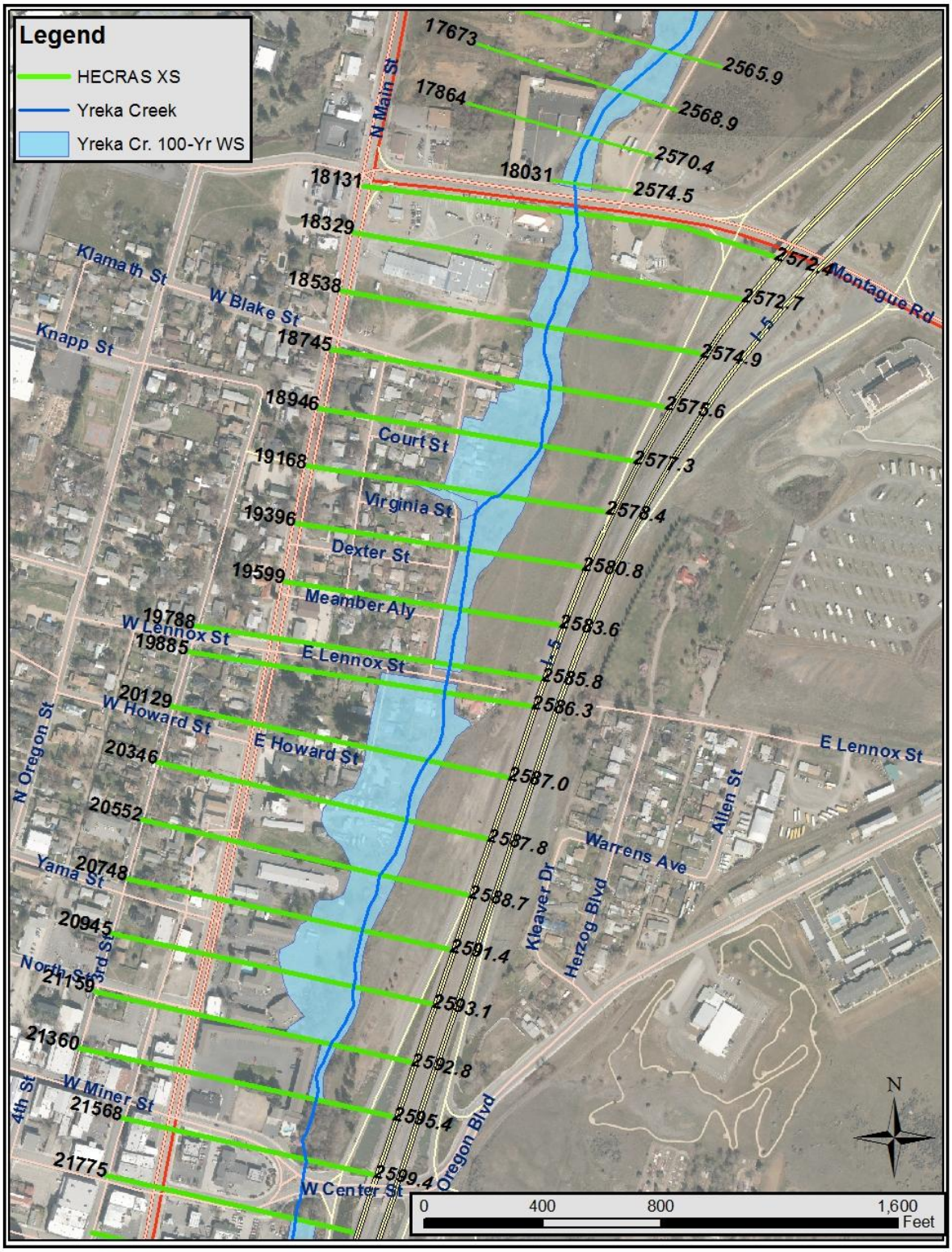


Figure 13. Yreka Creek 100-Year Floodplain 17673 to 13813

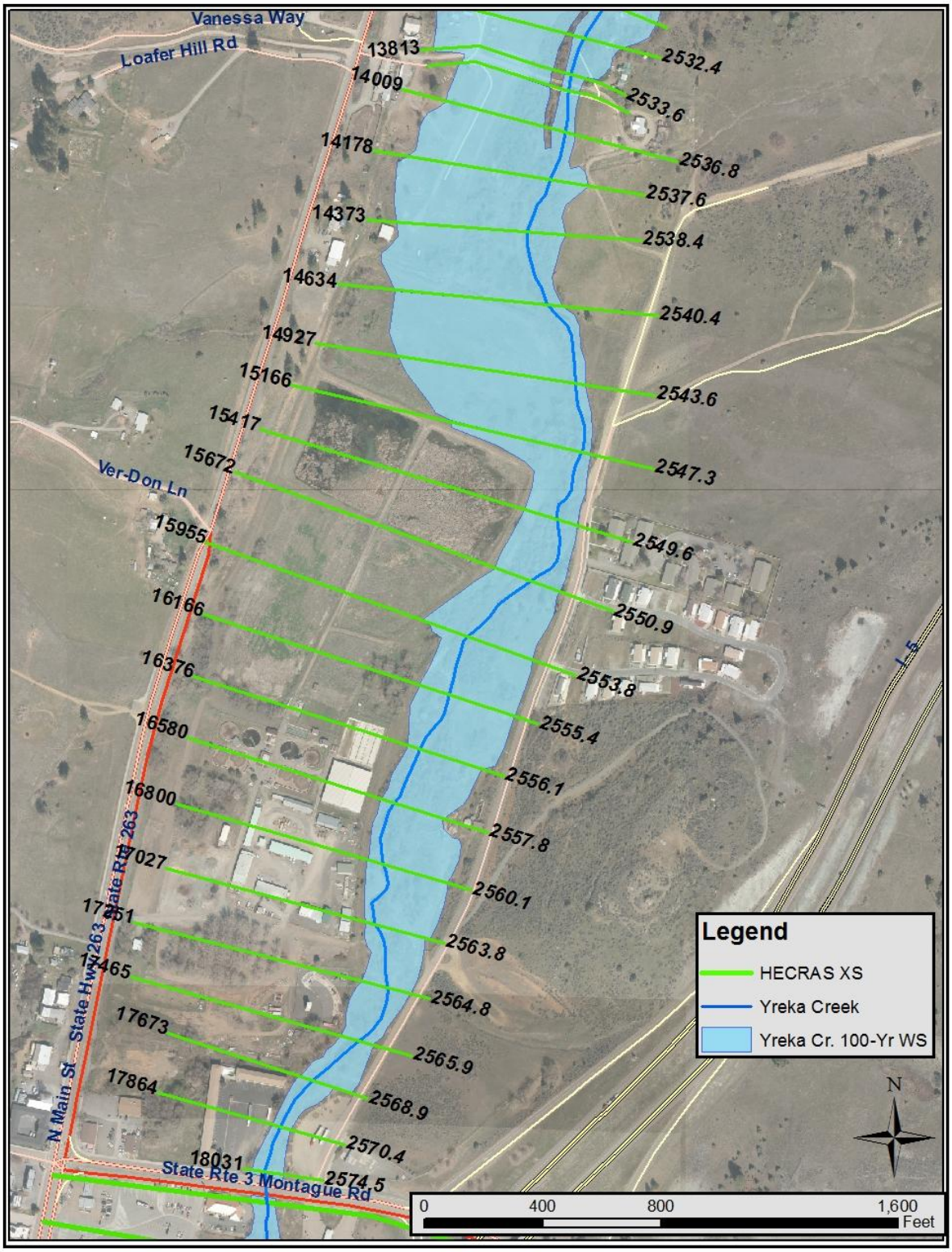


Figure 14. Yreka Creek 100-Year Floodplain 13813 to 9482

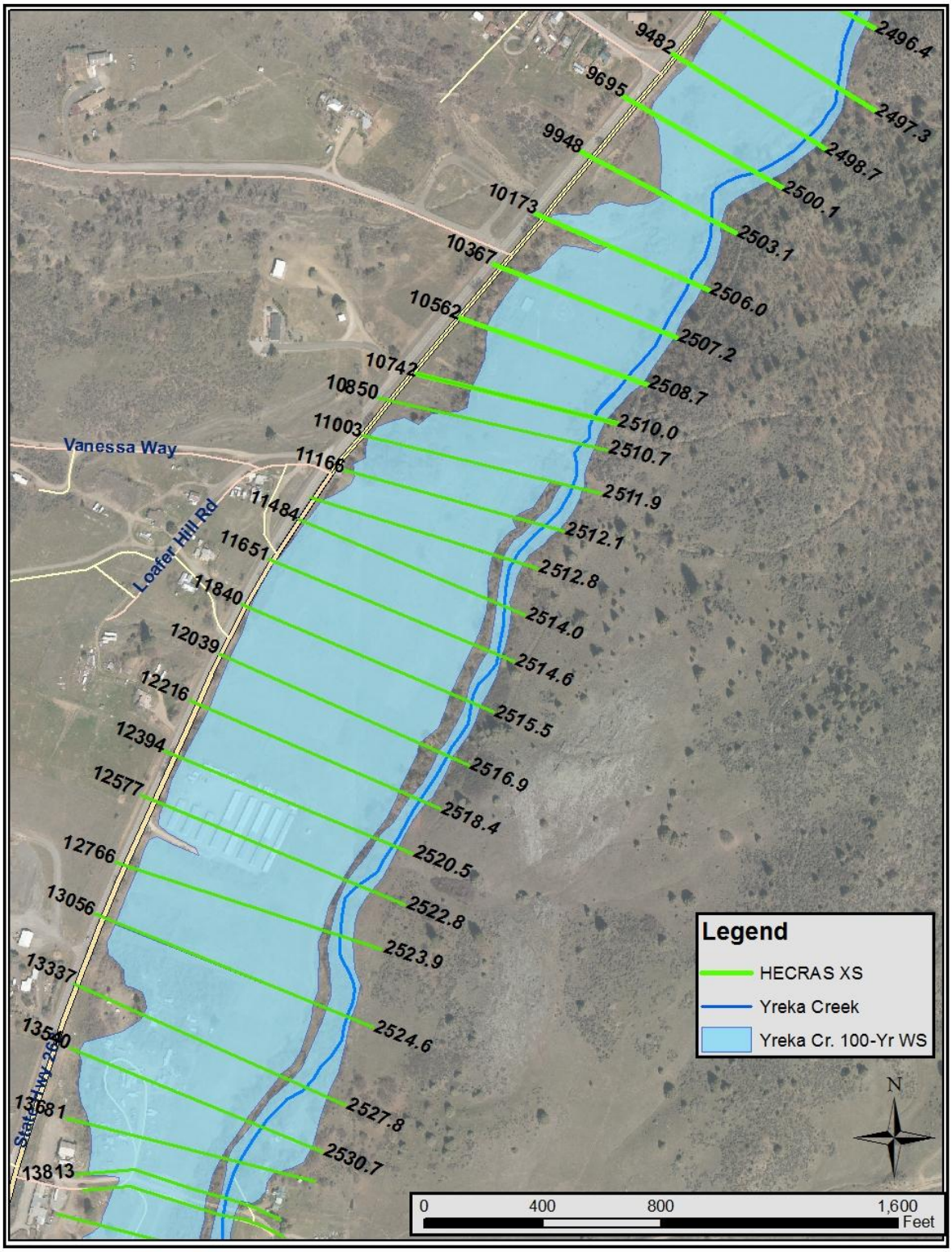


Figure 15. Yreka Creek 100-Year Floodplain 9482 to 4994

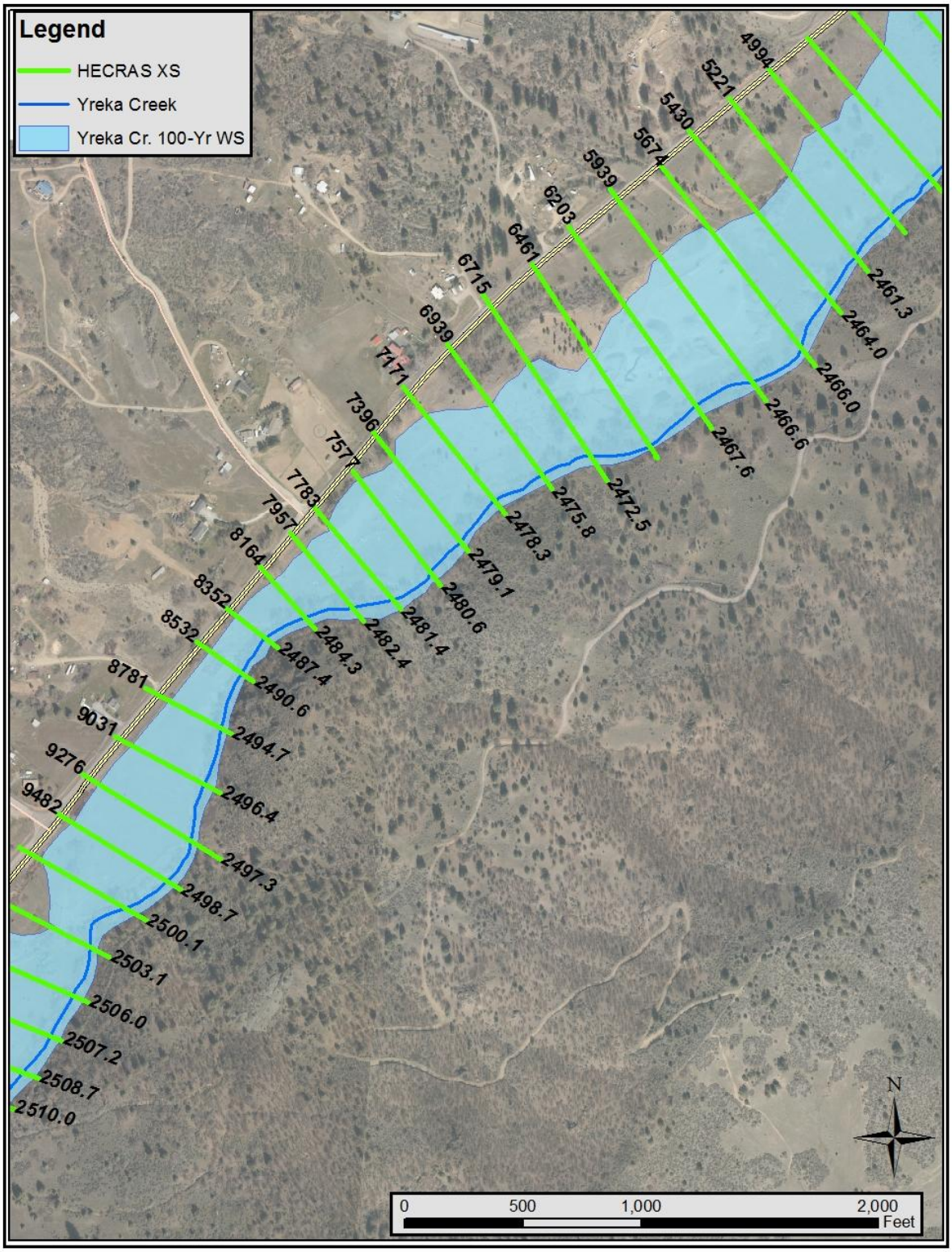


Figure 16. Yreka Creek 100-Year Floodplain 4994 to 1253

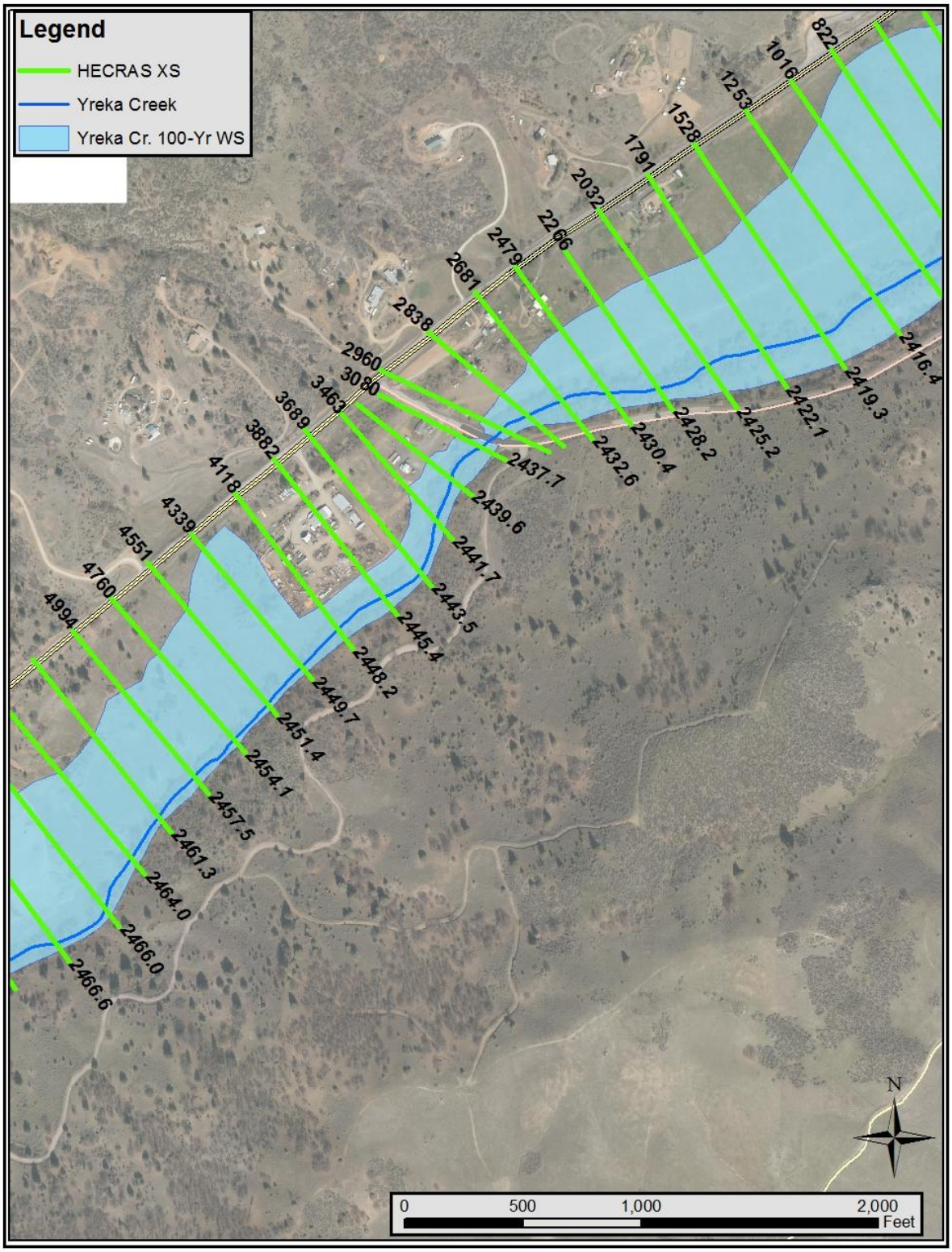


Figure 17. Yreka Creek 100-Year Floodplain 1253 to Shasta River

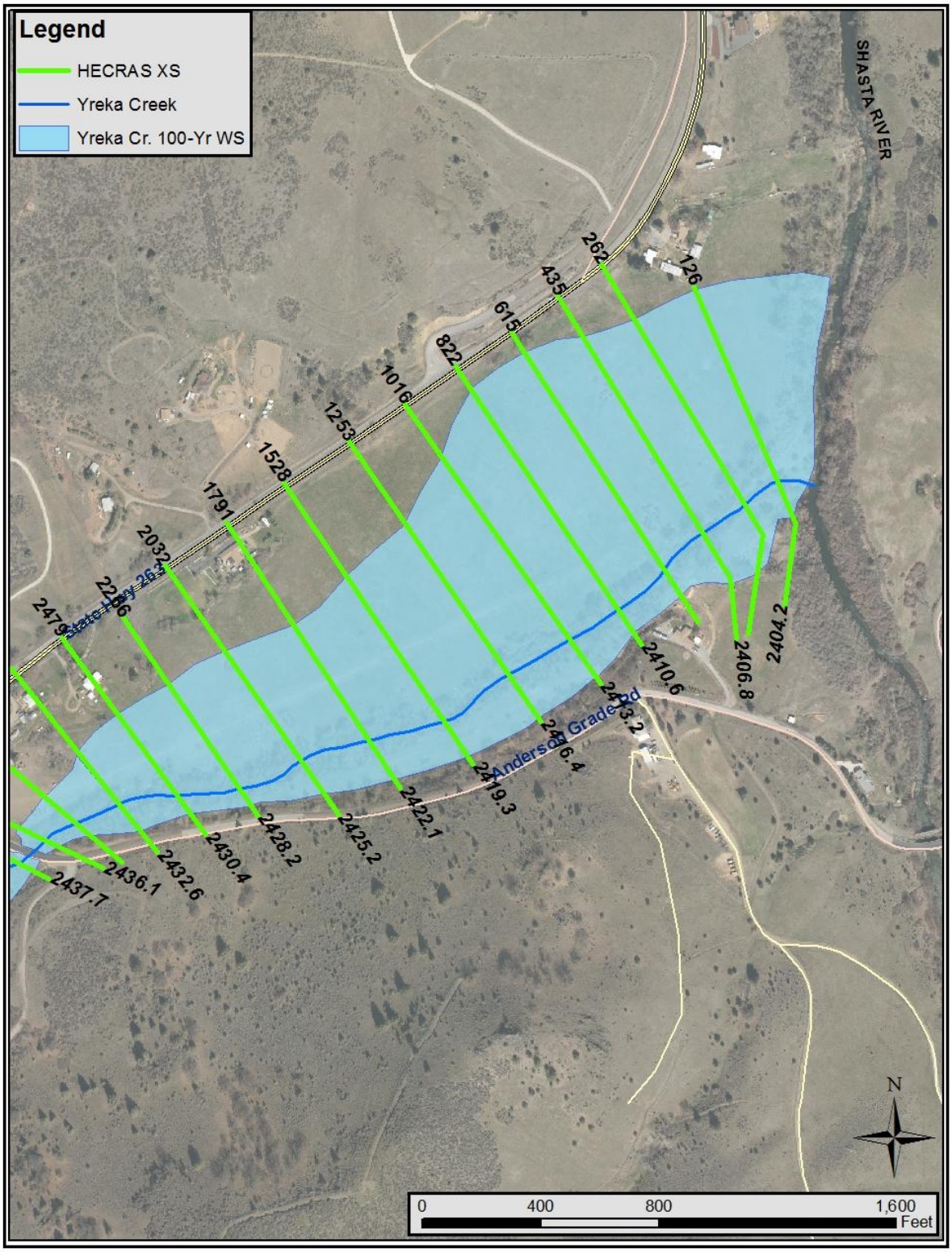


Figure 18. Juniper Creek 100-Year Floodplain

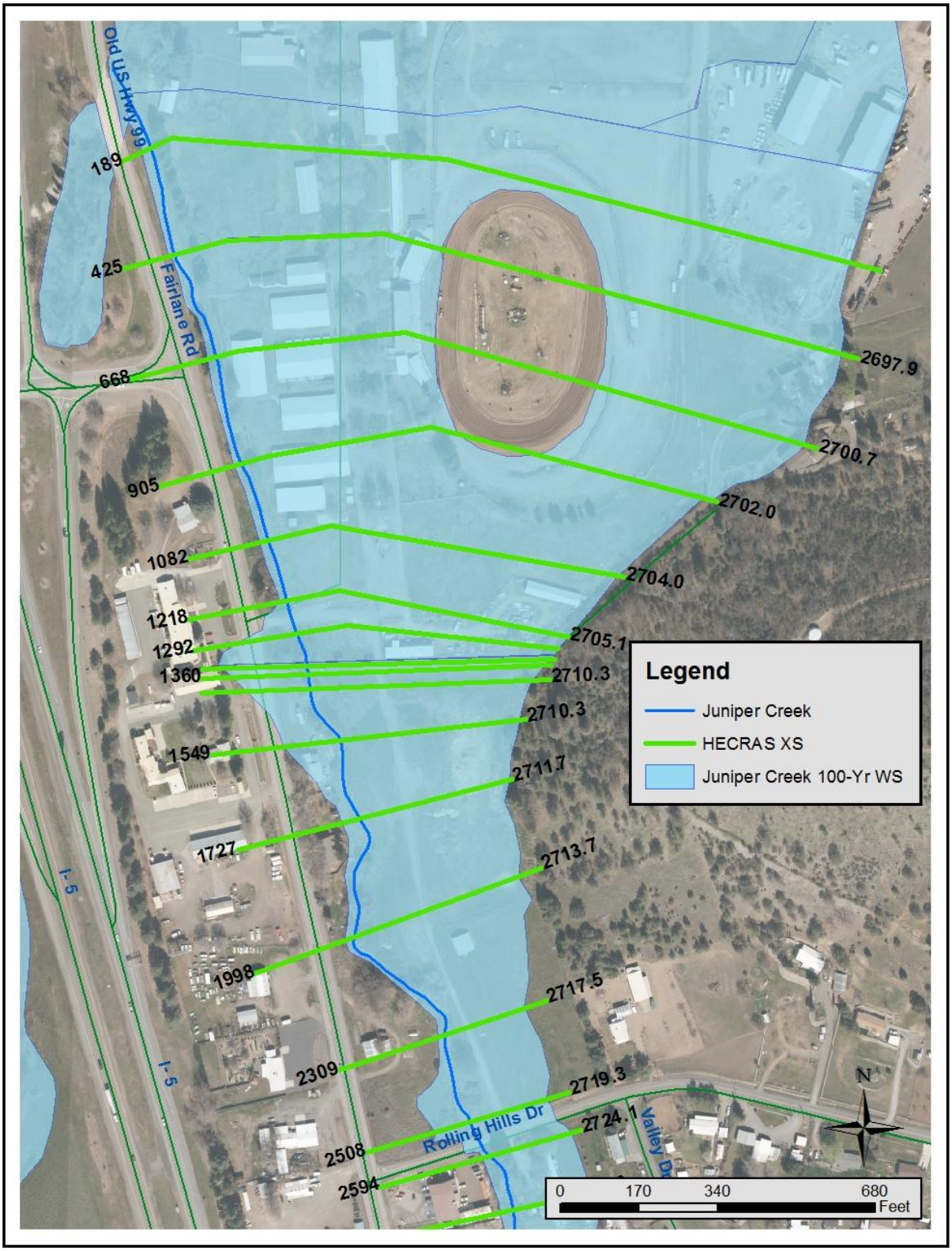


Figure 19. Lower Greenhorn Creek 100-Year Floodplain

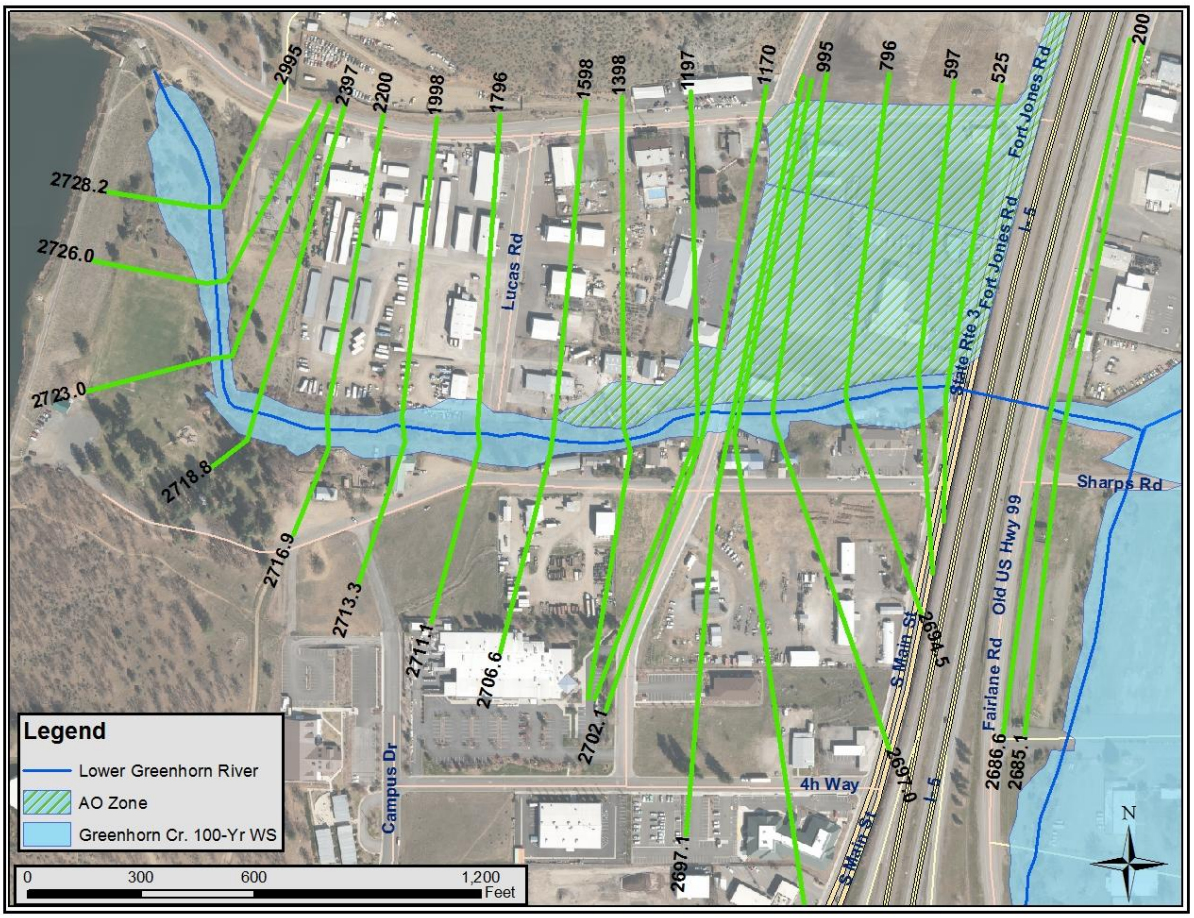


Figure 20. Humbug Creek 100-Year Floodplain 6197 to 9137

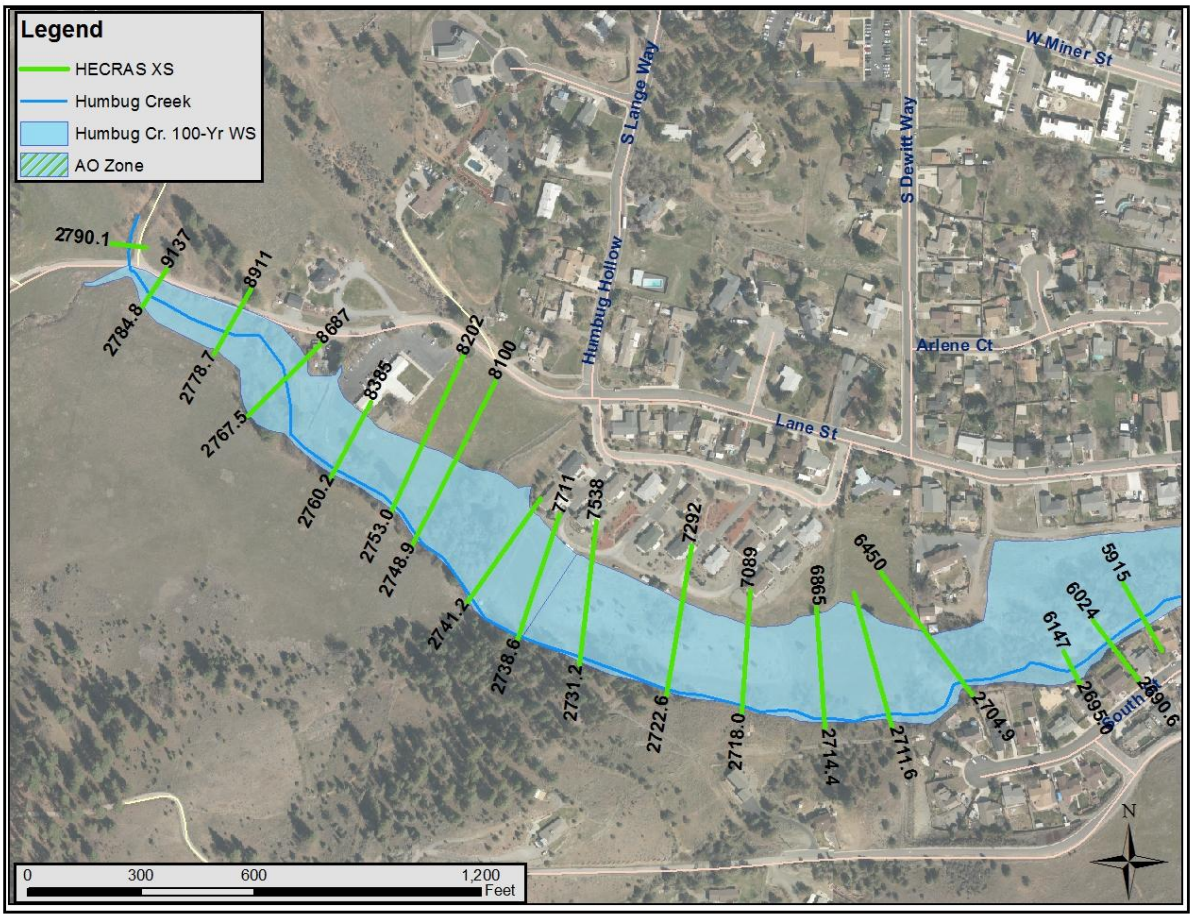


Figure 21. Humbug Creek 100-Year Floodplain North Street to 6147

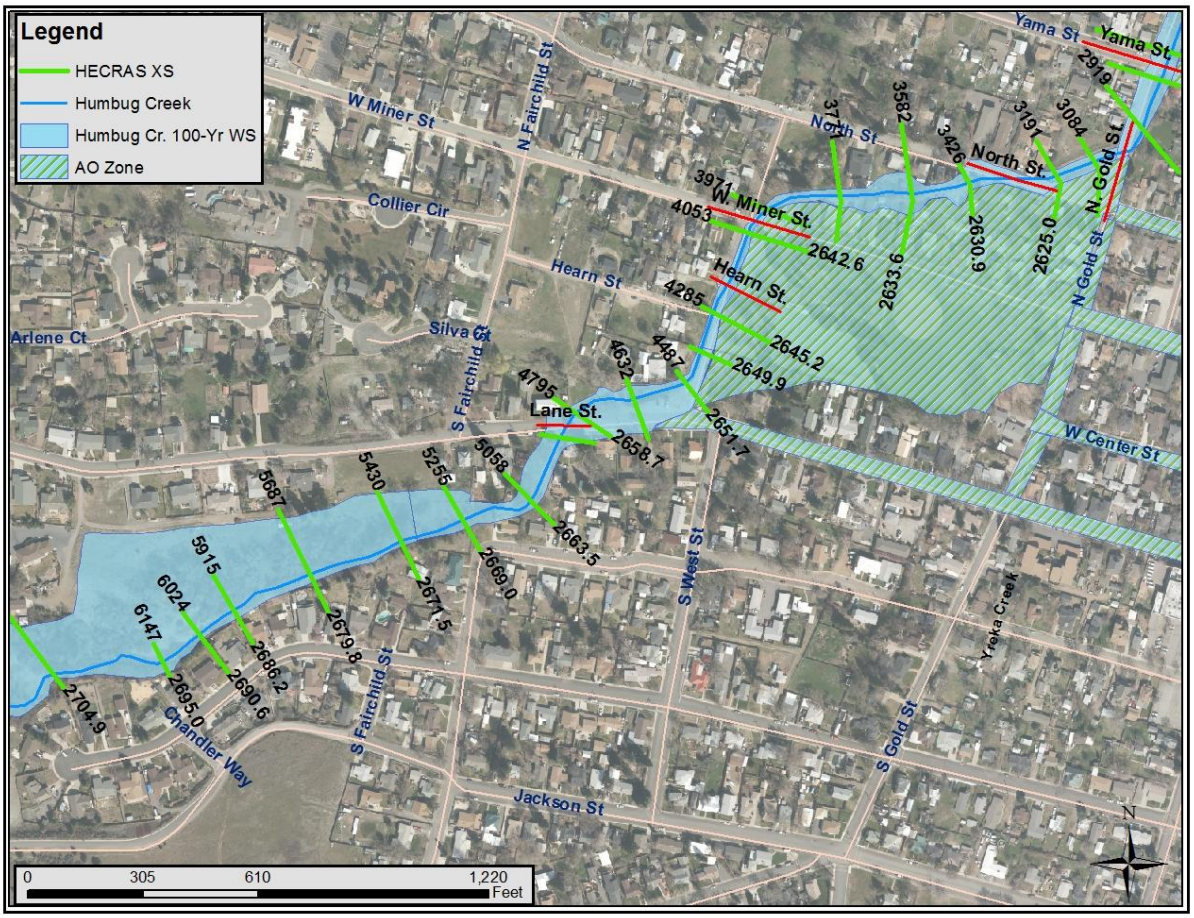
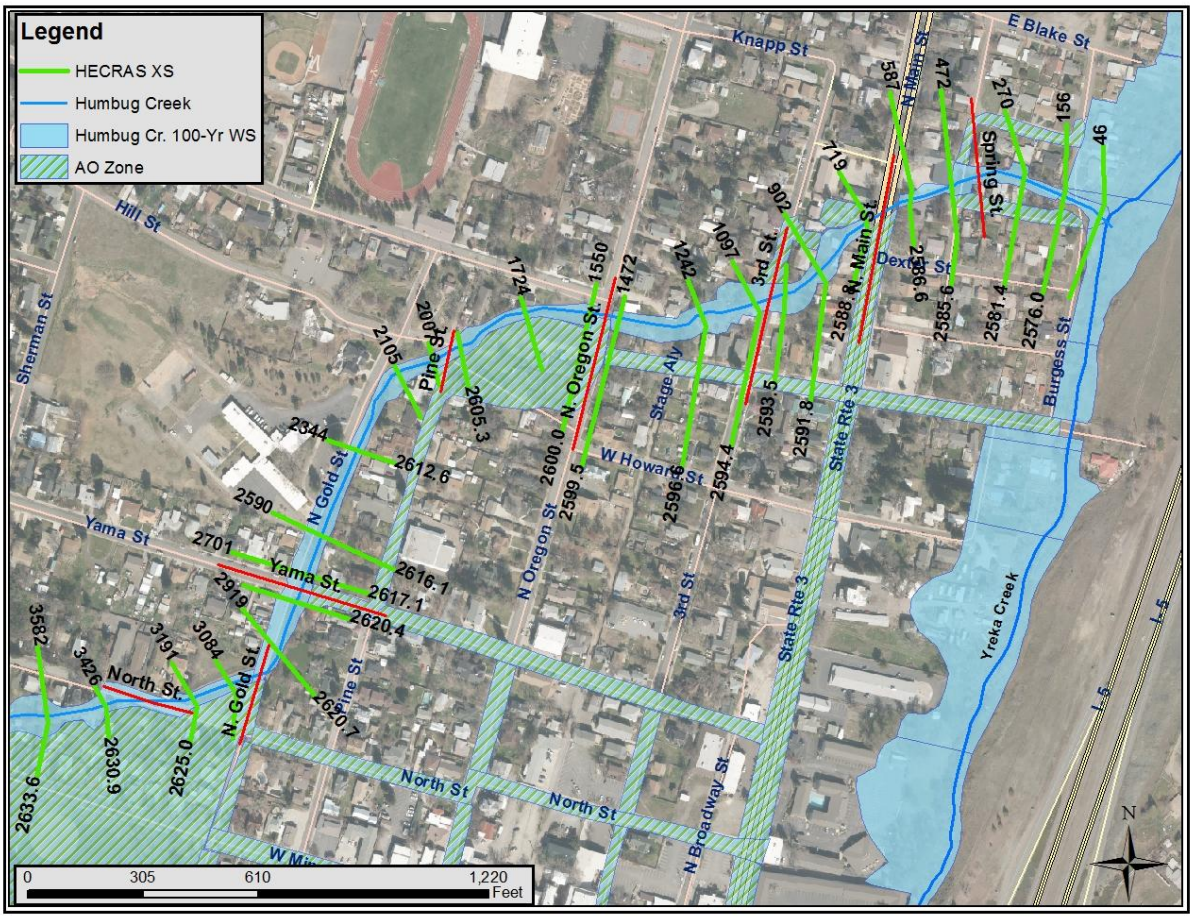


Figure 22. 100-year FloodplainYreka Creek to North Street



HEC-RAS Models of Improved Floodplains

Figures 23-30 show the 100-year floodplain for the stream reaches with improved floodplains The figures also show the associated lowering of the 100-year water surface elevations due to floodplain restoration.

Figure 23. Yreka Creek 100-Year Improved Floodplain 36332 to 32153

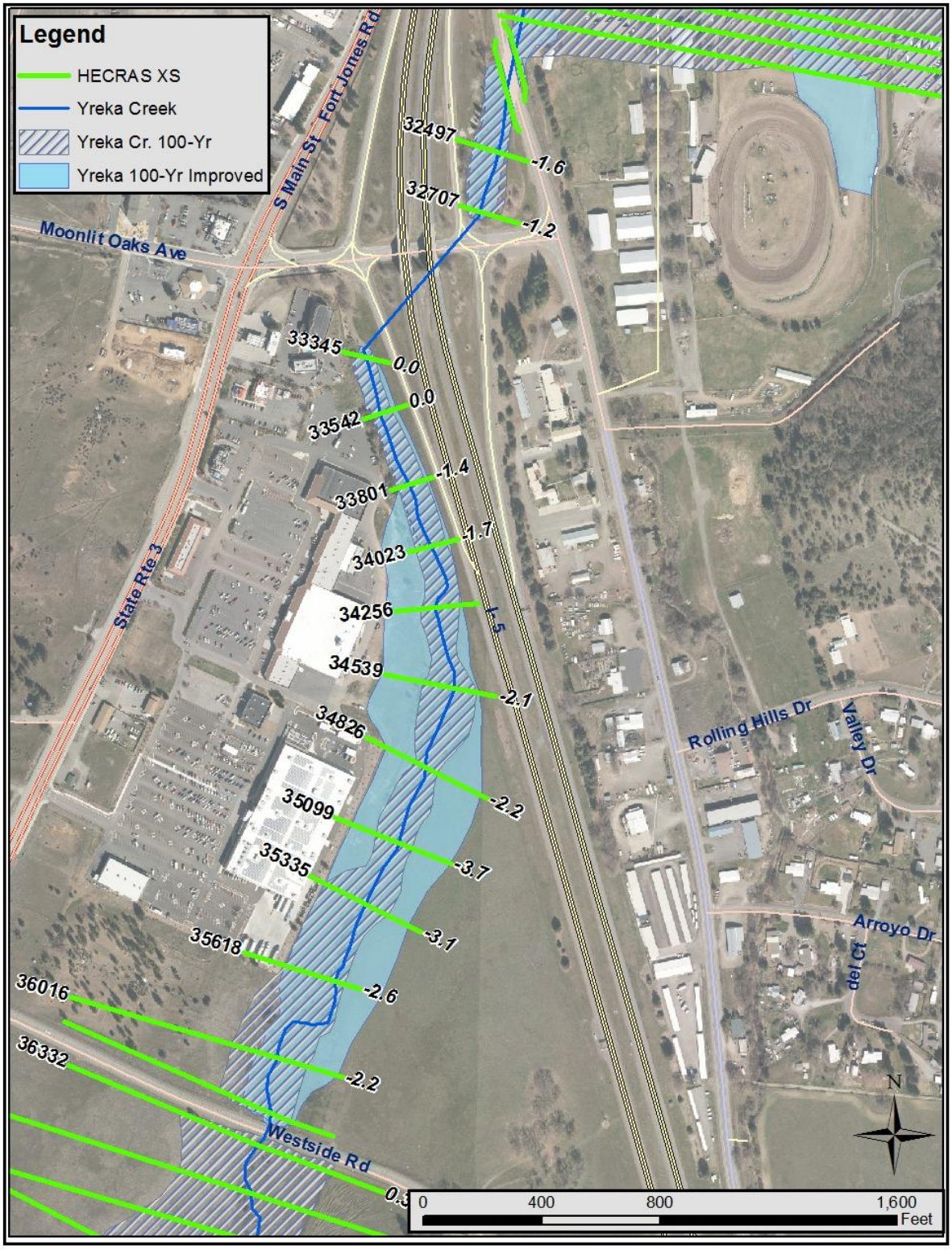


Figure 24. Yreka Creek 100-Year Improved Floodplain 32153 to 27814

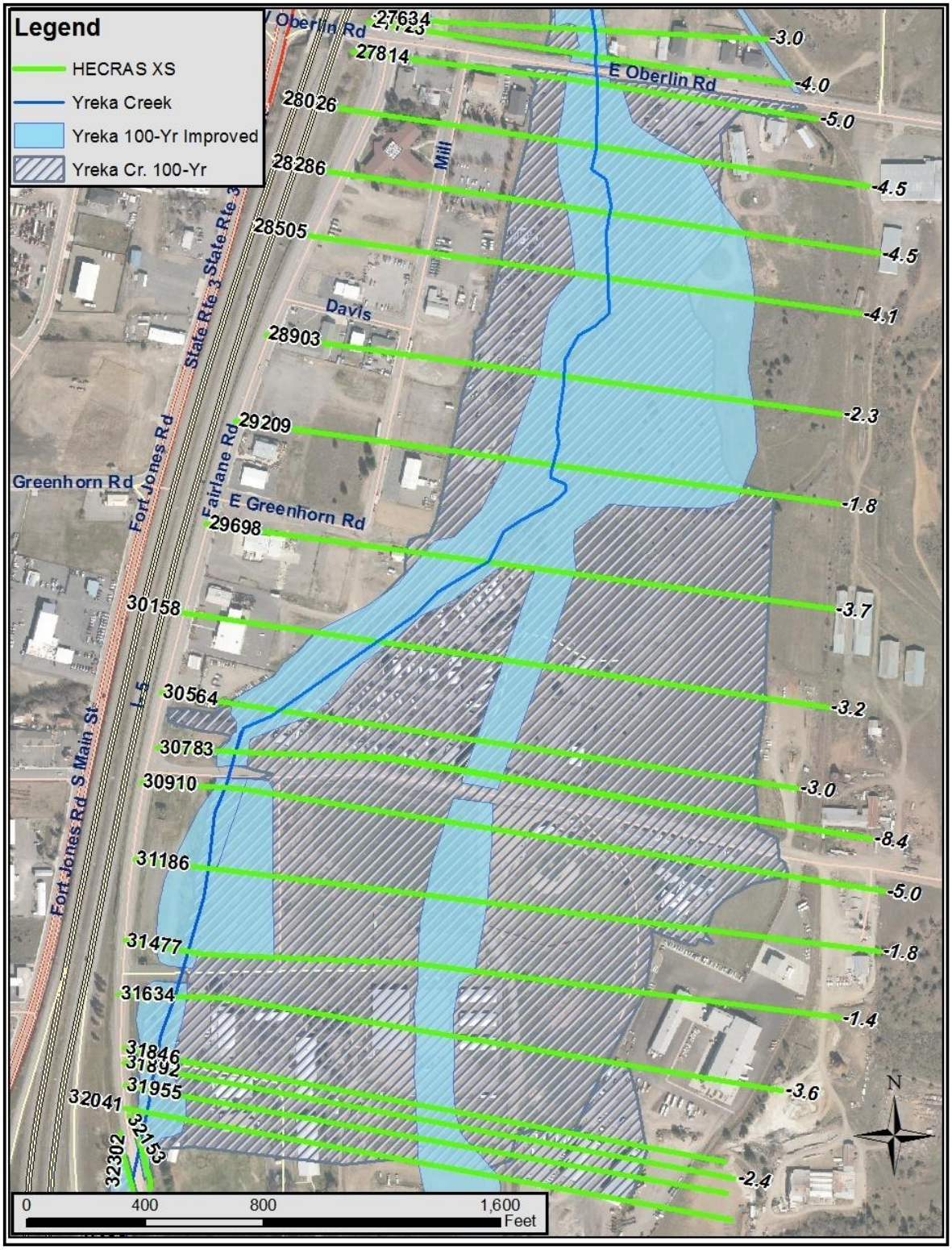


Figure 25. Yreka Creek 100-Year Improved Floodplain 27814 to 25273

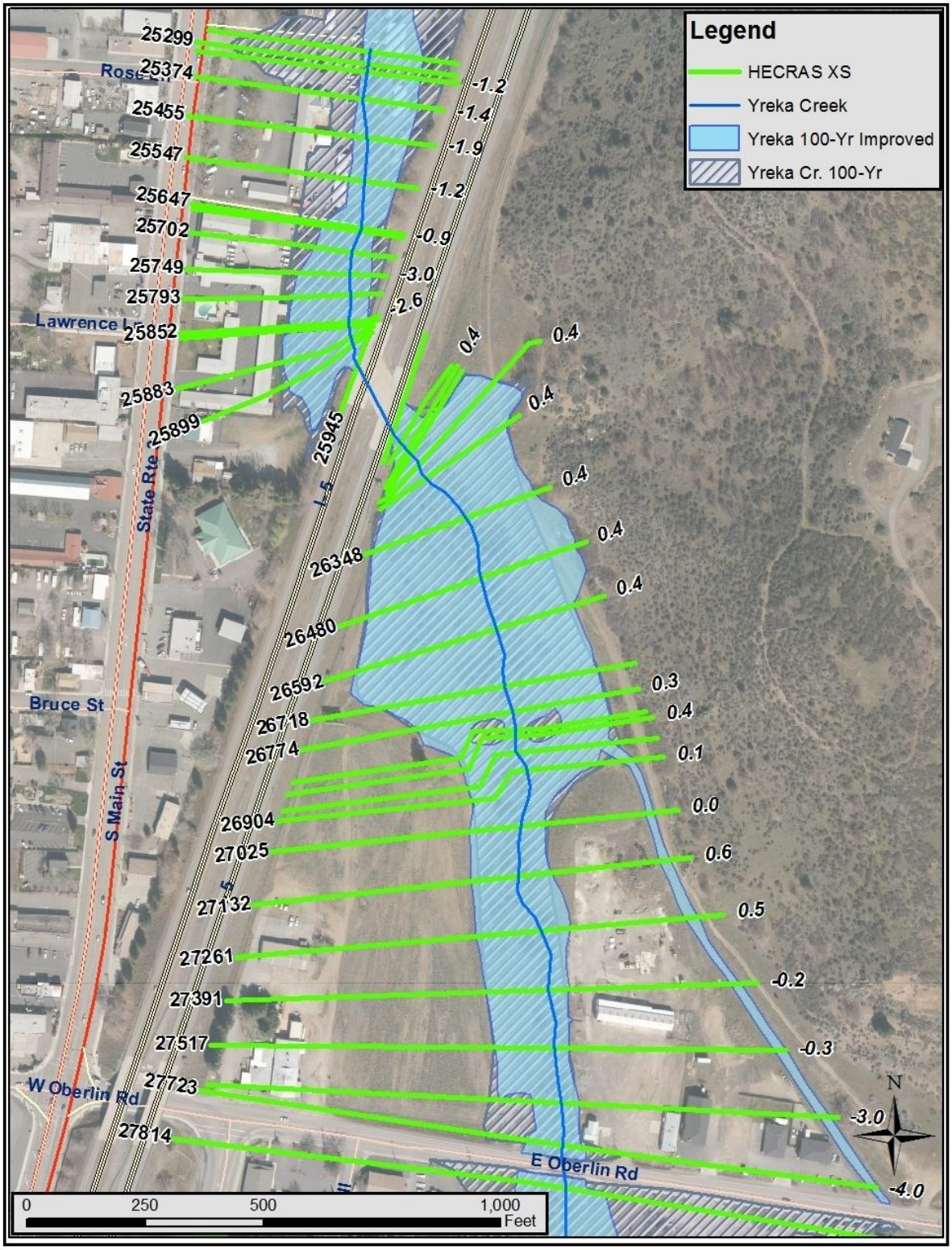


Figure 26. Yreka Creek 100-Year Improved Floodplain 25273 to 21159

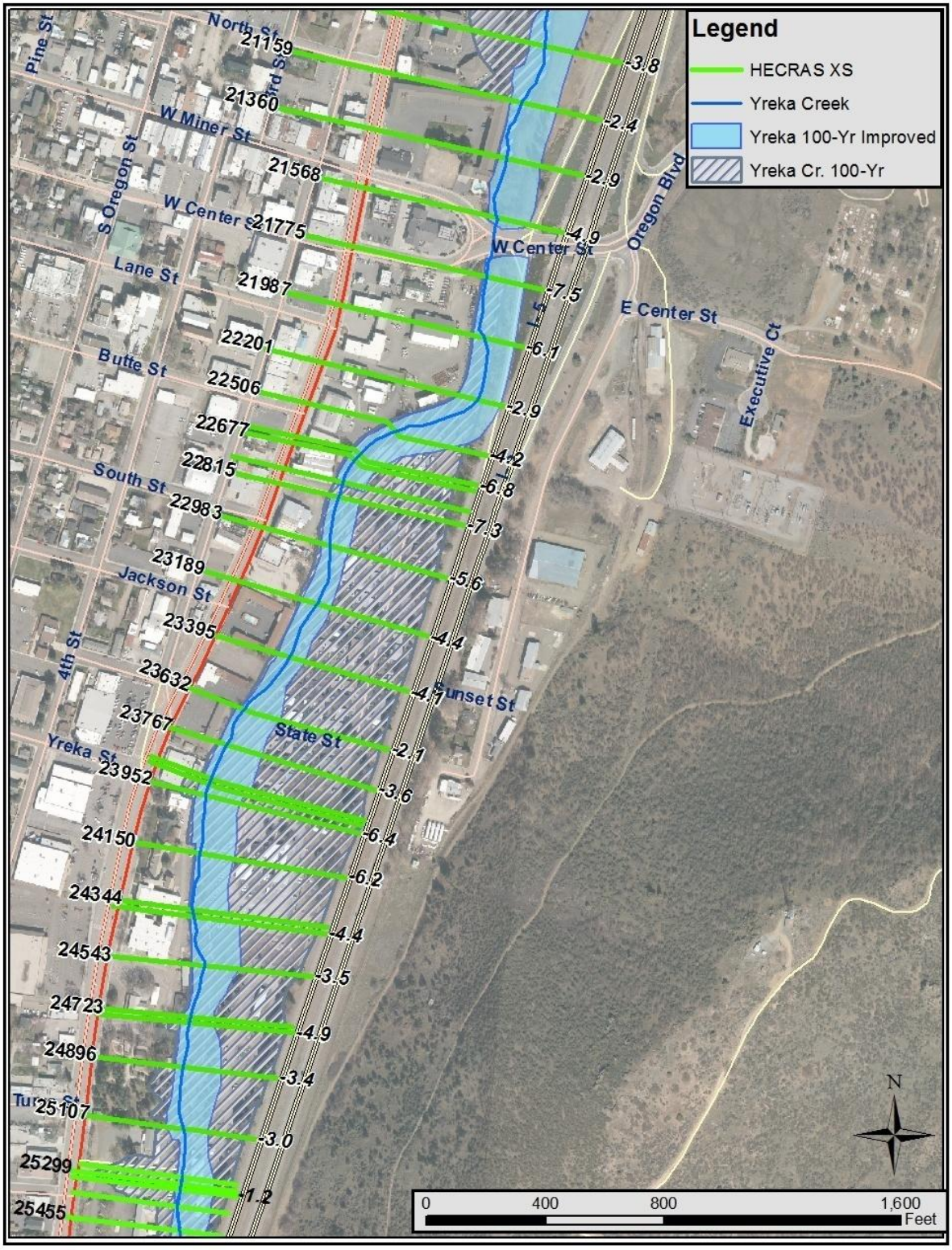


Figure 27. Yreka Creek 100-Year Improved Floodplain 21775 to 17673

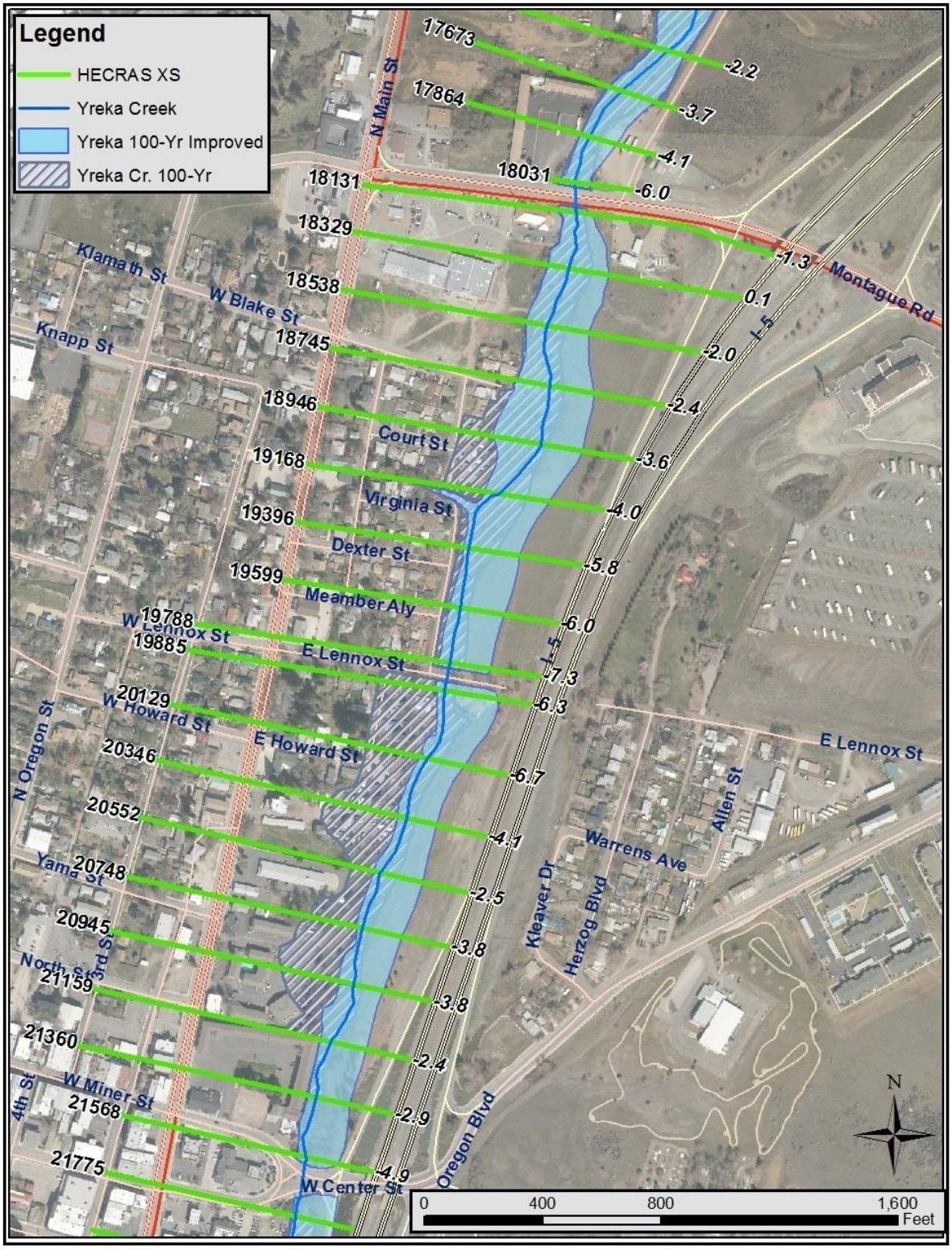


Figure 28. Yreka Creek 100-Year Improved Floodplain 17673 to 13813

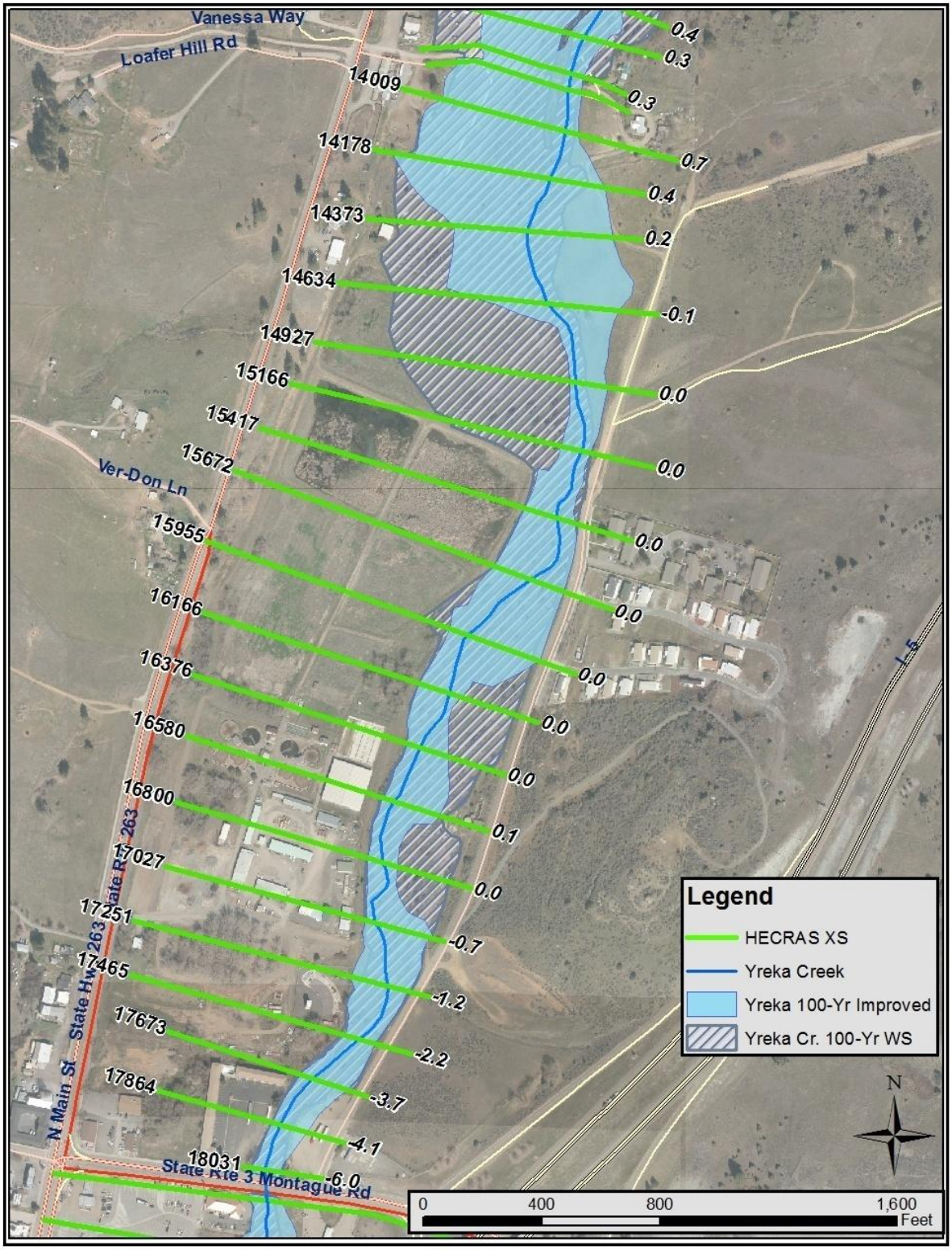


Figure 29. Juniper Creek Improved 100-Year FloodplainRolling Hills Drive to Yreka CreekConfluence

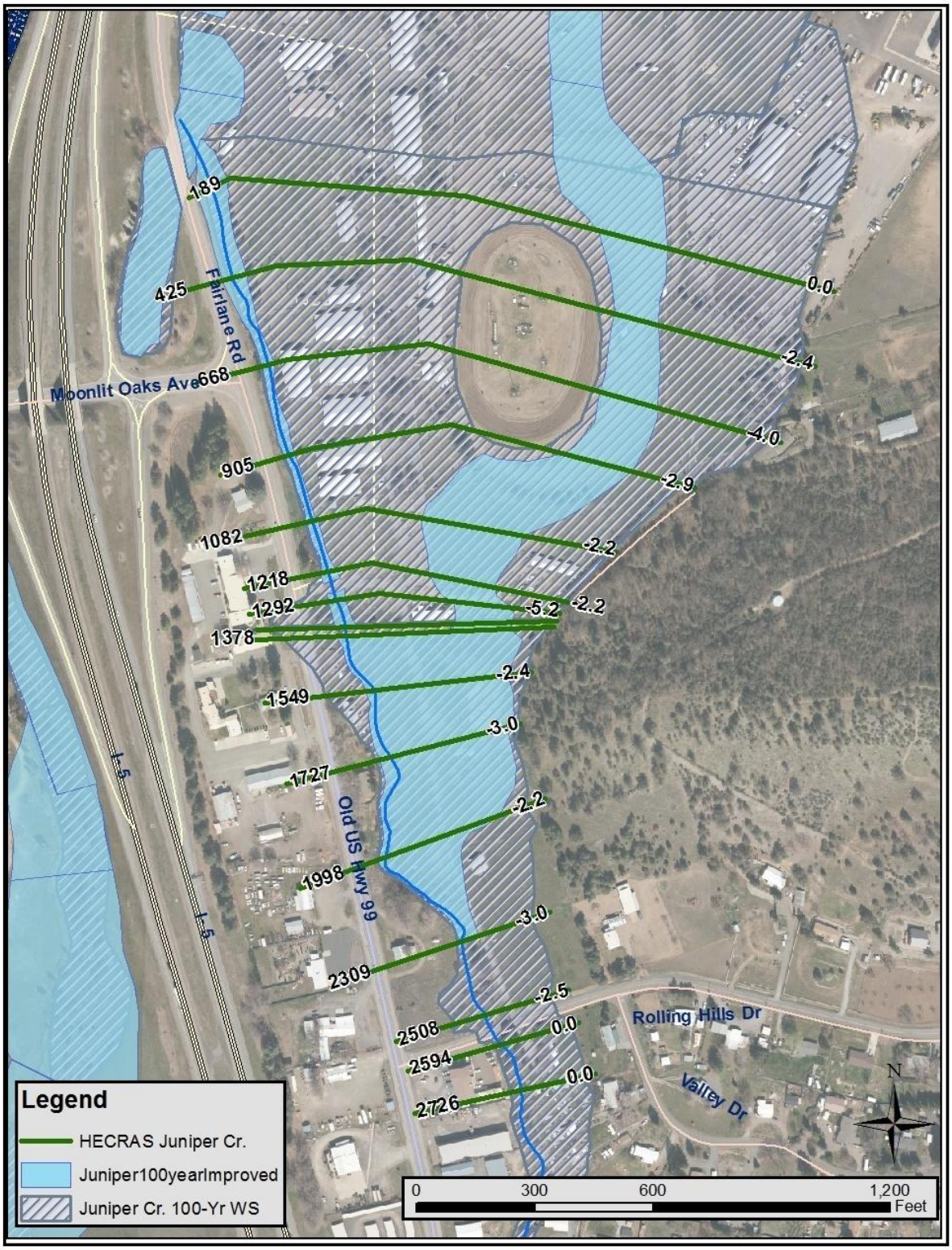
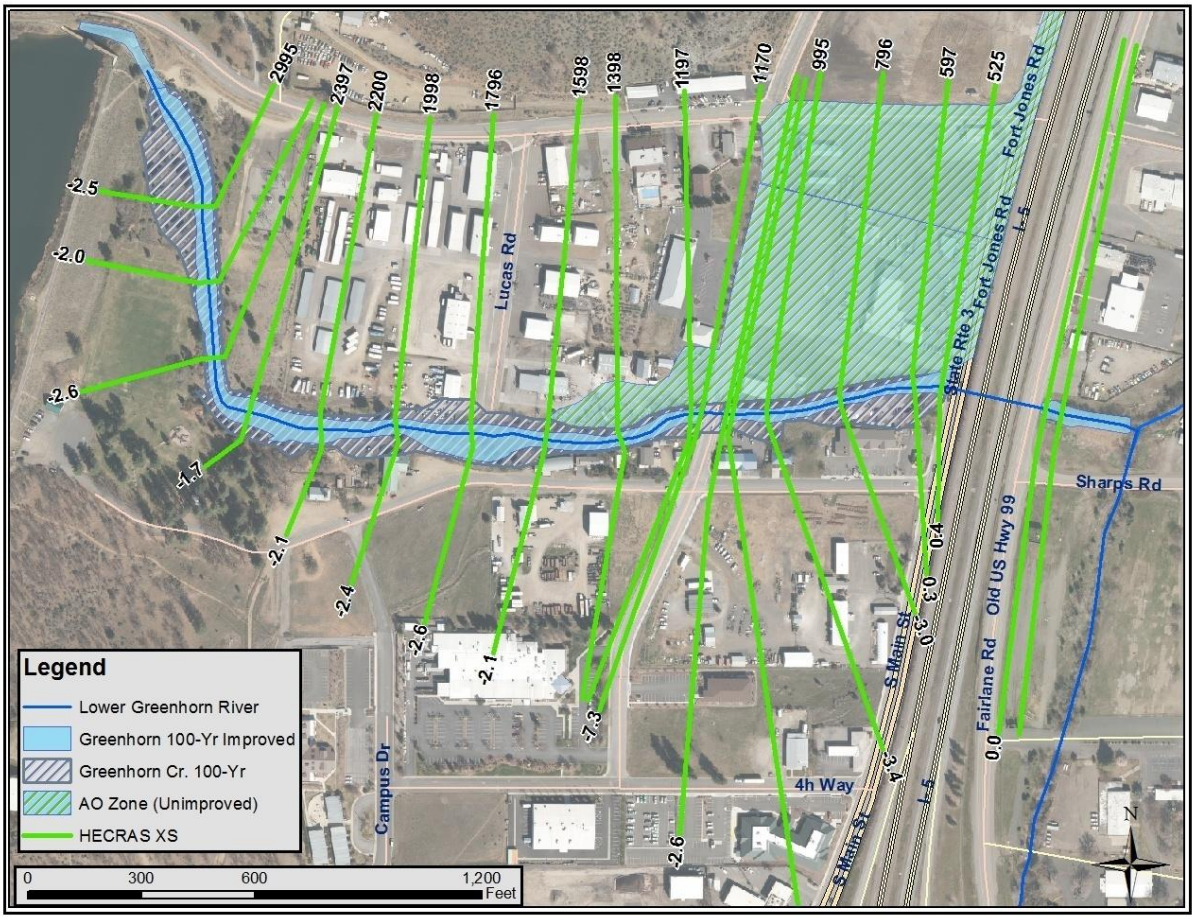


Figure 30. Lower Greenhorn Creek Improved 100-Year Floodplain Greenhorn Reservoir Spillway to Yreka Creek Confluence



Conclusion

The improved floodplains shown in figures 23-30satisfy the goals of this project, which were described in the Introduction. Lowering of the incised channel banks created accessible floodplains (and new riparian areas and wetlands) for higher frequency flood events, such as 2-year recurrences. The 100-year floodplains have been modified and lowered, keeping most existing stream-side development out of the 100-year floodplain. Changes to existing development were kept to reasonable levels,so that the number of residences and buildings requiring moving or removal were limited. Spoils from floodplain excavation and grading were used to raise potential building pads in adjacent areas above the 100-year water surface elevations. The new floodways will serve as greenways through the city and include paved multi-use trails and ecological interpretive facilities.

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